Trend Shifts in the Forward Premium and the Predictability of Excess Returns in Currency Markets*

Dooyeon Cho†
Sungkyunkwan University

Sungju Chun‡
Korea Insurance Research Institute

Abstract

This paper provides evidence that the forward premium involves structural changes in the trend function, which might affect the predictability of currency excess returns to be dependent on the choice of sample period. Accounting for the shifts in trend for the forward premium reveals that currency excess returns for the Canadian dollar, Swiss franc, euro, and pound against the U.S. dollar are significantly predictable irrespective of the sample period selected. Another advantage of detrending the forward premium is that we can obtain more consistent slope coefficient estimates in the predictive regression, which enables us to make more consistent, dependable inferences about the excess return predictability.

JEL Classification: C12; C22; F31

Keywords: Forward premium anomaly; Shifts in trend; Structural change; Predictability; Currency excess returns

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†Department of Economics, Sungkyunkwan University, Seoul 03063, Republic of Korea; Tel: +82 2 760 0148, Fax: +82 2 760 0946, E-mail: dooyeoncho@skku.edu.

‡Corresponding author. Korea Insurance Research Institute, Seoul 07328, Republic of Korea; Tel: +82 2 3775 9039, Fax: +82 2 3775 9100, E-mail: sjchun@kiri.or.kr.

1 Introduction

There is ample evidence that excess returns are time varying and predictable in currency markets. The predictability of currency excess returns implies a violation of the efficient market hypothesis. It is also associated with the apparent failure of the theory of uncovered interest rate parity (UIP), which has been a major issue in international finance. The failure of the theory of UIP is generally known as the forward premium anomaly, and the previous literature has attempted to account for it based on (i) the presence of a time-varying risk premium, (ii) irrational agents in segmented markets, (iii) peso problems, and (iv) econometric issues arising in the test of UIP. The predictability of currency excess returns and the coincident failure of the theory of UIP have been documented by Fama (1984), Bansal (1997), Backus, Foresi, and Telmer (2002), and the substantial time variation in the UIP regression has been explored by Baillie and Cho (2014) among others.[1]

One of the important econometric issues arising in the predictive regression is related to the time series properties of the forward premium. In particular, the forward premium may be non-stationary and involve structural changes in the deterministic components. Engel (1996) and Roll and Yan (2000) document that the forward premium reveals long-term fluctuations in the levels of both spot and forward exchange rates and the results of non-stationarity tests for industrialized countries' forward premia change depending on the sample period. Sakoulis et al. (2010) suggest that accounting for structural breaks in the mean of forward premium can alleviate bias in testing the forward rate unbiasedness hypothesis. It may also involve a trend term in the deterministic components, as Zhou (2002) finds that the different trend behavior between changes in spot exchange rates and the forward premium may have contributed to the forward premium anomaly.

Although currency excess returns are known to be generally predictable, we find that the predictability of currency excess returns changes with the sample period. We also assess the extent to which excess returns in currency markets are predictable if one allows for shifts in trend in the mean and slope of the forward premium series. We find that accounting for the shifts in

[1]Other studies have investigated the predictability of excess returns in financial markets. Bacchetta, Mertens, and van Wincoop (2009) show that the predictability of expectational errors tends to coincide with excess return predictability in bond, currency, and stock markets. Evans and Lewis (1993) provide evidence that there are stochastic trends in excess returns in both the bond and currency markets.

trend of the forward premium can help obtain consistent inferences regarding the predictability of currency excess returns.

We test for structural changes in the trend function of the forward premium for five major currencies using the robust test procedure recently proposed by Perron and Yabu (2009), which does not require knowledge of the degree of persistence in the noise component, and find strong evidence of trend shifts in the forward premium.[2] The Perron-Yabu test is particularly fitting for our purpose, as it is applicable without prior knowledge of whether the series is $I(0)$ or $I(1)$. We apply the estimated break date to detrend the forward premium in the full sample and compare the results of the predictive regressions using the original and detrended forward premia as we vary the sample period. We provide evidence that there exists consistent significant predictability of currency excess returns over the different sample period if one allows for shifts in trend for the forward premium series.

The remainder of the paper is organized as follows. In Section 2, we introduce the model for trend shifts and describe the estimation procedure. In Section 3, we describe the data and interpret the empirical results. In Section 4, we conclude.

2 The model

We begin by characterizing conventional predictive regressions for excess returns in currency markets. Let s_t and f_t denote the logarithms of spot and one-month forward exchange rates, respectively, which are defined as the number of units of foreign currency per U.S. dollar at time t. Then, the Fama (1984) regression employs the forward premium, $f_t - s_t$, to predict the currency excess return, er_{t+1} $(= s_{t+1} - f_t)$, at time $t+1$ as

$$er_{t+1} = \alpha + \beta (f_t - s_t) + \varepsilon_{t+1}, \tag{1}$$

where α and β are the mean and slope coefficients, respectively, and ε_{t+1} is a disturbance. The predictability of currency excess returns is implied by a non-zero β.[3]

[2] Harvey, Leybourne and Taylor (2007) proposed another trend shift test that can achieve the same goal. We choose to apply the Perron-Yabu test as it is shown to have greater power overall by Chun and Perron (2013).

[3] As noted by Fama (1984), this is equivalent to testing whether $\gamma = 1$ in the following standard forward premium regression: $\Delta s_{t+1} = \mu + \gamma (f_t - s_t) + \zeta_{t+1}$.

Following Zivot (2000) and Sakoulis et al. (2010), we can model the forward premium as a simple AR(1) model implied by a cointegrating relation between spot and forward exchange rates,

$$(f_t - s_t) = c + \delta t + \phi (f_{t-1} - s_{t-1}) + \eta_t, \tag{2}$$

where c is an intercept and δ is a slope coefficient for the time trend. Here, we include the trend term to account for the trend behavior in the forward premium implied by Zhou (2002).

We consider a model recently proposed by Perron and Yabu (2009) that allows simultaneous structural changes in both intercept and slope in equation (2). The model is given by

$$(f_t - s_t) = c_0 + \delta_0 t + c_1 1 (t > T_1) + \delta_1 1 (t > T_1) (t - T_1) + \phi (f_{t-1} - s_{t-1}) + \eta_t, \tag{3}$$

where T_1 denotes the break date and $1(\cdot)$ is the indicator function. The test performed is $H_0 : c_1 = \delta_1 = 0$ against $H_A : c_1 \neq 0$ or $\delta_1 \neq 0$.

The test procedure starts with constructing a super-efficient estimate of ϕ in equation (3) that takes either the OLS estimate obtained from an autoregression applied to detrended data or a value of 1 when the OLS estimate is very close to 1. Then, the super-efficient estimate of ϕ is used to form a feasible Generalized Least Squares regression equation for (3), and the Wald statistic is constructed to test whether the trend function involves a structural break. Since the break date is unknown, Peron and Yabu (2009) recommend to use the Exp functional of the Wald statistic, which can obtain nearly identical asymptotic critical values for both the $I(0)$ and $I(1)$ cases.[4]

3 Empirical analysis

3.1 Data

We use data for five major currencies over the last three decades: the Canadian dollar (CAD), the Swiss franc (CHF), the euro (EUR), the British pound (GBP), and the Japanese yen (JPY).[5] We collect spot and one-month forward exchange rates vis-à-vis the US dollar (USD). All the data

[4] See Perron and Yabu (2009) for further details of the test procedure.

[5] Before the introduction of the euro in January 1999, we use the Deutsche mark/U.S. dollar exchange rate adjusted by the official conversion rate between the euro and the Deutsche mark.

are monthly observations that cover the sample period from January 1985 to October 2015, and are obtained from *Datastream*. The monthly data comprise a total of 370 observations for each currency pair.

3.2 Estimation results of the model

There exists a circular testing problem between tests of unit roots and structural changes in the trend function. A reliable unit root test with good size and power requires information about the presence or absence of a structural change, while proper structural break tests usually assume priori firm knowledge whether the time series is either $I(0)$ or $I(1)$ (Kim and Perron (2009), Perron and Yabu (2009)). In order to avoid this problem, we employ a powerful testing procedure for a structural break in the mean and slope of the forward premium developed by Perron and Yabu (2009) that does not require knowledge of the degree of persistence in the time series and detrend the forward premium using the estimated break dates to prevent the predictive regression (1) from being affected by shifts in trend of the forward premium.

Table 1 presents the Perron-Yabu test results of shifts in trend and the break date estimates for the forward premia of five major currencies. We let Exp-W_{RQF} denote the Perron-Yabu Wald statistic applied to the forward premium for testing the null hypothesis of no shifts in trend against the alternative hypothesis of a possible break in either an intercept or a slope coefficient. The results indicate that we can reject the null hypothesis of no breaks in the mean and slope at the 1% statistical significance level for all five currencies. In particular, all the break dates are estimated to be between 1992 and 1994, which coincides with historical economic downturns experienced by each country. For Canada, the trend shift occurs during the severe recession associated with inflationary pressures in the early 1990s. For Switzerland, the break date corresponds to one of the recession periods that started in late 1994. For the euro area and the United Kingdom, the break dates largely correspond to the European exchange rate mechanism (ERM) crisis in 1992–93. Lastly, for Japan, the trend shift is likely to be associated with the initial burst of asset price bubbles in 1992–93 during the lost decade in the 1990s. As emphasized by Sakoulis et al. (2010), these events may have been accompanied by some types of monetary or macroeconomic shocks to cause shifting in trend for the forward premia.

Figure 1 displays the structural break and the estimated trend function for each forward premium series. In general, the forward premia show an upward trend before the structural break occurs and the pre-break slope coefficient estimates reported in Table 1 are much larger than the post-break slope coefficient estimates in absolute values, with the exception of Japan. Since covered interest parity implies $i_t^* - i_t^{US} = f_t - s_t$ where i_t^* and i_t^{US} denote the nominal interest rates in the foreign country and the United States, respectively, it represents the increasing gap between the foreign and U.S. interest rates before the break dates. Figure 2 depicts the detrended forward premium series. It clearly shows a smooth pattern with no clear trend shifts over the sample period.

We also test whether the forward premium series is $I(0)$ or $I(1)$ in our sample period. As noted by Baillie and Bollerslev (2000), it is important to test for the stationarity of the forward premium since using any non-stationary explanatory variable in the predictive regression may produce misleading results. The currency excess return (er_{t+1} $(= s_{t+1} - f_t)$) is not only $I(0)$, but also uncorrelated at higher lags. In the case where the forward premium is $I(1)$ or highly persistent, the predictive regression in equation (1) may be unbalanced because the orders of integration of the dependent and explanatory variables are not the same.[6]

As mentioned earlier, the Perron-Yabu test is appropriate in our study as it does not require prior knowledge whether the series of interest is $I(0)$ or $I(1)$. Table 2 reports the results of the augmented Dickey-Fuller (1981, ADF henceforth) unit root tests and the Phillips-Perron (1988, PP henceforth) unit root tests for both original and detrended forward premia.[7] Before detrending, the ADF tests give mixed results about the degree of persistence in the forward premium while the PP tests indicate all the series to be stationary. More specifically, the ADF tests fail to reject the null hypothesis of unit roots in four of the original forward premia, except for the CAD. After detrending, however, both the ADF and PP unit root tests indicate all of the forward premia are $I(0)$.

Table 3 presents the predictive regression results for currency excess returns employing the detrended series of forward premia with comparison to those employing the original series of

[6]As Baillie and Bollerslev (2000) explain, it also applies to the case where the forward premium is described by a fractionally integrated, or $I(d)$ process where $0 < d < 1$.

[7]For both tests, we select a lag length of $int\left[4\left(T/100\right)^{(2/9)}\right]$ as recommended by Newey and West (1994).

forward premia. Note that we use the entire sample to apply the model (3) for detrending the forward premia. For Canada, both the slope coefficient estimates, $\hat{\beta}$, of the original and detrended series are significant at the 1% level for the entire sample period. However, when we use a shorter sample period, January 1990 to October 2015, $\hat{\beta}$ is only significant at the 10% level for the original series while at the 5% level for the detrended series. Although $\hat{\beta}'$s in both cases become insignificant for the even shorter sample period of January 1995 to October 2015, it is notable that the absolute values of $\hat{\beta}$ for the detrended series are consistently greater than those for the original series, regardless of the sample period.

For the euro area, there is apparently consistent evidence that the predictability of currency excess returns is significant for the detrended forward premium. The original predictive regressions for Switzerland do not yield a significant slope coefficient estimate with the full sample but do produce a statistically significant one at the 5% level for the period from January 1990 to October 2015 or at the 1% level for the period of January 1995 to October 2015. On the contrary, the predictive regressions with the detrended forward premia yield slope coefficient estimates that are statistically significant for all the different sample periods. For the euro area, the original predictive regression results are either insignificant or significant at the 10% level, depending on the sample period. Once the detrended forward premium is employed in the predictive regressions, all the slope coefficient estimates become significant at the 5% and 10% levels. For the United Kingdom, the predictability of currency excess returns for the original forward premium also changes depending on the sample period used; the slope coefficient estimate is insignificant for the period of January 1990 to October 2015 but significant for either the entire sample period or the period of January 1995 to October 2015. Japan is the only exception in that it is far from being significant for all of the sample periods selected. Overall, when the detrended forward premium is used, there is consistent evidence that currency excess returns are predictable irrespective of the selected sample period.

It is also notable that the slope coefficient estimates for the detrended forward premia are relatively invariant to the sample period. The values of $\hat{\beta}$ are mostly between -2 and -3 for the detrended forward premium, while they are widely dispersed between 0 and -3 for the original forward premium. The more consistent estimates of the slope coefficient for the detrended forward premium also suggest that the predictability of currency excess returns may be subject to the existence of trend shifts in the forward premium, and that we can obtain more consistent, dependable inferences about the excess return predictability by accounting for the presence of structural changes in the trend function.

4 Conclusion

This paper has provided evidence that the forward premium may involve trend shifts, which might affect the predictability of currency excess returns under the impact of the selected sample period. By accounting for the shifts in trend for the forward premium, this paper finds that currency excess returns for the Canadian dollar, Swiss franc, euro, and pound against the US dollar are significantly predictable irrespective of the sample period. The break dates of the trend functions can be attributed to several historic events associated with monetary or macroeconomic shocks.

Another advantage of detrending the forward premium is that we can obtain more consistent slope coefficient estimates in the predictive regression, which enables us to make more consistent, dependable inferences about the excess return predictability.

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TABLE 1. TESTS OF TREND DEVIATIONS IN THE FORWARD PREMIUM

	CAD	CHF	EUR	GBP	JPY
	(a) Perron-Yabu (2009) test results for trend deviations				
EXP-W_{RQF}	26.991***	51.786***	21.676***	10.612***	155.342***
Break date	April 1993	October 1994	March 1994	October 1992	October 1994
	(b) Estimates of trend deviations				
Without break	–0.0005%	0.0004%	0.0003%	–0.0011%	0.0003%
Pre-break	0.0020%	0.0059%	0.0079%	0.0026%	0.0020%
Post-break	0.0001%	0.0013%	0.0005%	–0.0005%	0.0020%

Notes. The results of the Perron-Yabu (2009) test for trend deviations and estimates of trend deviations are reported. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

TABLE 2. UNIT ROOT TESTS

(1) TEST FOR THE ORIGINAL FORWARD PREMIUM

	CAD		CHF		EUR		GBP		JPY	
	(a) ADF unit root tests									
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
Test statistic	–2.902**	–3.322*	–2.423	–2.414	–1.979	–1.885	–2.039	–2.789	–2.189	–2.315
	(b) PP unit root tests									
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
Test statistic	–9.671***	–10.807***	–8.388***	–8.585***	–7.263***	–7.359***	–8.529***	–11.838***	–14.675***	–14.849***

(2) TEST FOR THE DETRENDED FORWARD PREMIUM

	CAD		CHF		EUR		GBP		JPY	
	(a) ADF unit root tests									
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
Test statistic	–4.558***	–4.550***	–3.921***	–3.918**	–3.350**	–3.348*	–3.644***	–3.646**	–3.537***	–3.535**
	(b) PP unit root tests									
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
Test statistic	–13.400***	–13.384***	–12.372***	–12.358***	–12.491***	–12.477***	–14.490***	–14.473***	–18.214***	–18.195***

Notes. The results of the augmented Dickey-Fuller (1981) unit root tests and the Phillips-Perron (1988) unit root tests are reported for (1) the original forward premium and (2) the detrended forward premium, respectively. For both tests, the lag length is selected by $int[4(T/100)^{(2/9)}]$ as in Newey and West (1994). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

TABLE 3. PREDICTIVE REGRESSIONS FOR CURRENCY EXCESS RETURNS

Original: $er_{t+1} = \alpha + \beta\,(f_t - s_t) + \varepsilon_{t+1}$,

Detrended: $er_{t+1} = \alpha + \beta\,(f_t - s_t)^{\dagger} + \varepsilon_{t+1}$ where $(f_t - s_t)^{\dagger}$ denotes the detrended forward premium.

	CAD		CHF		EUR		GBP		JPY	
	Original	Detrended	Original	Detrended	Original	Detrended	Original	Detrended	Original	Detrended
(a) January 1985 – October 2015 (Entire sample period)										
β	–1.881***	–2.402***	–1.153	–2.185*	–0.286	–1.763*	–1.751*	–2.270**	–0.945	–0.729
	(0.714)	(0.897)	(0.945)	(1.173)	(0.889)	(1.052)	(0.983)	(1.153)	(0.843)	(0.885)
R^2	0.016	0.017	0.005	0.011	0.000	0.007	0.014	0.012	0.006	0.002
T	369	369	369	369	369	369	369	369	369	369
(b) January 1990 – October 2015										
β	–1.540*	–2.268**	–1.801**	–2.069*	–1.485*	–2.202**	–1.113	–2.088*	–0.767	–0.374
	(0.786)	(1.039)	(0.911)	(1.241)	(0.861)	(1.063)	(1.121)	(1.146)	(0.820)	(0.770)
R^2	0.010	0.014	0.014	0.010	0.009	0.011	0.006	0.010	0.005	0.001
T	309	309	309	309	309	309	309	309	309	309
(c) January 1995 – October 2015										
β	–1.991	–2.084	–3.067***	–3.639***	–2.479*	–2.755**	–2.294**	–2.202*	–0.178	0.026
	(1.291)	(1.351)	(1.048)	(1.306)	(1.280)	(1.339)	(1.146)	(1.181)	(0.719)	(0.611)
R^2	0.008	0.009	0.025	0.023	0.013	0.015	0.017	0.015	0.000	0.000
T	249	249	249	249	249	249	249	249	249	249

Notes. The results of predictive regressions using both original and detrended forward premia are reported for the periods starting from January 1985, January 1990, and January 1995, respectively, and ending in October 2015. Robust Newey-West (1987) standard errors are reported in parentheses below the corresponding parameter estimates. T denotes the sample size. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

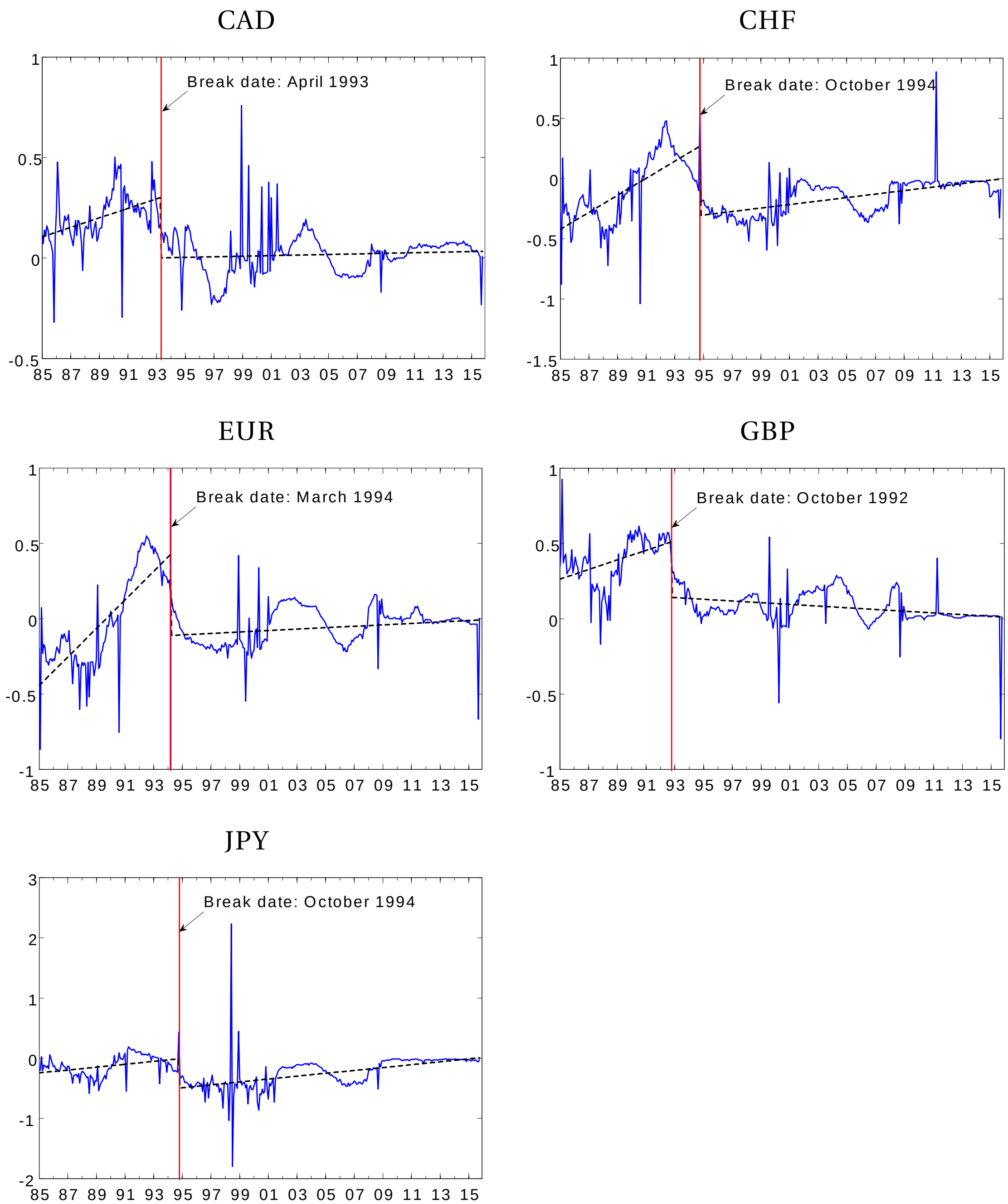

FIGURE 1. MONTHLY FORWARD PREMIUM (%) AND ESTIMATED BREAK DATE FROM THE MODEL OVER THE SAMPLE PERIOD OF JANUARY 1985 THROUGH OCTOBER 2015. THE BLACK DASHED LINE DENOTES THE ESTIMATED TREND FUNCTION.

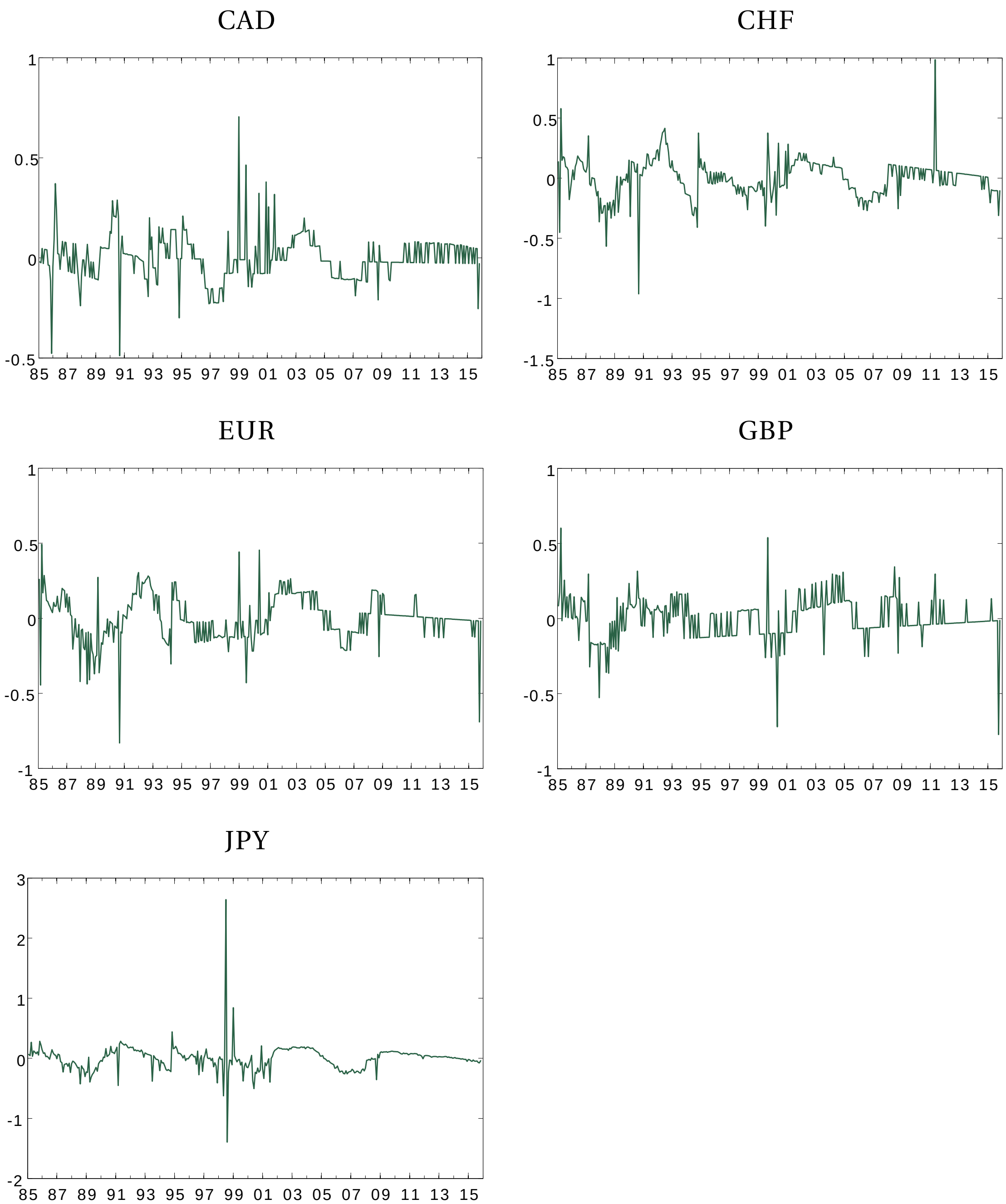

FIGURE 2. MONTHLY DETRENDED FORWARD PREMIUM (%) OVER THE SAMPLE PERIOD OF JANUARY 1985 THROUGH OCTOBER 2015.