Dissecting Exchange Rates and Fundamentals: The Role of Permanent and Transitory Shocks

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Abstract

In this paper, we apply a permanent–transitory decomposition method to analyze the link between nominal exchange rates and economic fundamentals. The results suggest that transitory shocks dominate nominal exchange rate fluctuations, while permanent shocks dominate the variations in economic fundamentals. The findings therefore suggest that the nominal exchange rate should not be approximated by a pure random walk, and this provides an alternative interpretation for the "exchange rate disconnect puzzle." Moreover, the results also suggest that comprehensive modeling of transitory components in empirical models is essential, and this helps reconcile recent empirical findings on exchange rate prediction.

Keywords: Taylor Rule Fundamentals, Exchange Rates, Permanent–Transitory Decomposition

JEL Classification: C22, F31, F47.

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1 Introduction

At least since the seminal work undertaken by Meese and Rogoff (1983), a common finding in the empirical literature is that the underlying economic fundamentals often fail to explain short-term volatility in exchange rates. In particular, it is a puzzle that economic models have difficulty outperforming a simple random-walk model in terms of out-of-sample forecasts. This apparently weak linkage between the nominal exchange rate and economic fundamentals has been subsequently explored and described, and is now well known as the "exchange rate disconnect puzzle."

Engel and West (2005) adopted a new line of attack to this puzzle, first by showing that a wide range of exchange rate models imply that the exchange rate is determined by the present discounted value of expected economic fundamentals, and then that if the fundamentals are nonstationary and the discount factor is close to one, then the models predicting the exchange rate follow an approximate random walk. As a result, Engel and West (2005) argue that judging exchange rate models based on their out-of-sample predictive power compared with a random walk is inappropriate.

By contrast, models incorporating Taylor rules have recently gained some prominence as a means of predicting the exchange rate, especially as their out-of-sample predictability significantly better than the random walk in many countries, especially at short horizons. For instance, Molodtsova and Papell (2009) provide evidence of significant short-horizon, out-of-sample predictability of exchange rates with Taylor rule fundamentals for 11 of 12 currencies vis-á-vis the US dollar during the post-Bretton Woods era. Likewise, Molodtsova et al. (2008) find evidence of out-of-sample predictability for the dollar/mark nominal exchange rate with forecasts based on Taylor rule fundamentals using a real-time dataset. Finally, Wu and Wang (2012) find that the predictability of exchange rates in the context of interval forecasting is favorable toward the Taylor rule model.

The empirical success of the Taylor rule-based model provides apparently contradictory implications for the relationship between the exchange rate and its underlying economic fundamentals, as documented by Engel and West (2005). In this paper, we attempt to reconcile these two alternative views on the exchange rate model by gauging the relative contributions of permanent and transitory shocks in both nominal exchange rates and the economic fundamentals, and point out the source of this contradiction in the present value form of the exchange rates in the Taylor rule model.

In brief, the Taylor rule model suggests that economic fundamentals determine nominal exchange rates, including price and interest rate differentials across countries and other potentially unobserved variables relating to central bank behavior. Thus, we collect quarterly data on exchange rates, price levels and interest rates from 1973Q1 to 2011Q4 for France, Germany, Italy, Japan, Switzerland, and the UK, with the US serving as the numeraire, to analyze the link between exchange rates and economic fundamentals as suggested by the Taylor rule model. We first confirm a cointegrating relationship between nominal exchange rates and economic fundamentals. This contrasts with the findings of Engel and West (2005) who found no evidence of cointegration. This then motivates us to employ vector error-correction models (VECM) to investigate the relationship between exchange rates and the economic fundamentals. We reveal the origins of these fluctuations in exchange rates and the fundamentals using the permanent–transitory decomposition method developed by Gonzalo and Ng (2001), which shows us how to empirically identify innovations as distinguished by their degree of persistence in cointegrated systems. Finally, given that the exchange rates and fundamentals are cointegrated, decomposition leads to inferences regarding the possible sources (permanent versus transitory shocks) of exchange rate and fundamental movements over time.

Our empirical findings show, at least for the countries we investigate, that transitory shocks are able to explain most exchange rate movements, while permanent shocks appear to dominate explanation of the variability in the economic fundamentals. Intuitively, this suggests that because exchange rates and economic fundamentals are cointegrated, their movements must be tied together in the very long run, and, therefore, so must any variations. However, exchange rate variation is far more volatile than economic fundamentals over short horizons. Importantly, the short- and long-run properties of these variables can only be reconciled over time if either (1) the variations in economic fundamentals increase, or (2) the variations in exchange rates decrease. The results in this paper are most consistent with the latter explanation, which suggests that the exchange rate may exhibit mean reversion, and thus adjusts over longer horizons to match the economic fundamentals.

We also show that the transitory shocks are highly persistent, and that they induce sizable movements in exchange rates. This finding yields a novel interpretation of the exchange rate disconnect puzzle. That is, it is unsurprising to obtain evidence that economic fundamentals, such as price and interest rate differentials across countries, fail to account for the large transitory impacts on exchange rates because the fluctuations in the fundamentals are primarily attributable to permanent shocks. Overall, these findings suggest that we should not approximate exchange rate behavior with a pure random-walk model, and that empirical models based solely on macroeconomic variables may fail to provide much more information beyond the permanent components in these macroeconomic variables themselves because this makes any predictability indistinguishable from a pure random walk.

In addition, our results suggest that the transitory components in the Taylor rule model, such as the policy responses of the central bank and the foreign exchange risk premium, are essential in explaining the exchange rate dynamics. Because the permanent shocks appear to dominate the variations in the economic fundamentals, the large transitory variations in exchange rates are likely to arise from these transitory components. This helps explain why the empirical evidence of models incorporating Taylor rules are mostly favorable to other models. Moreover, most of the studies in this strand of the literature do not make use of the price and interest rate differentials directly. Instead, they construct the fundamentals by estimating the expected inflation and output gap, and link them with the calibrated policy parameters of the central bank. In other words, they reveal the transitory components, or those assumed to be unobservable in Engel and West (2005). Hence, the explanatory power of the empirical exchange rate models can be improved.

The remainder of the paper is organized as follows. Section 2 presents the theoretical background for the Taylor rule model of exchange rate determination. Section 3 outlines the econometric framework. Section 4 describes the data and the preliminary test results. Section 5 provides the main empirical results. Section 6 concludes.

2 Benchmark Present Value Model of Exchange Rates

Our benchmark is the Taylor rule model derived in Engel and West (2005) and Engel et al. (2007). Assume the Taylor rule in the home country takes the form

$$i_t = \phi_\pi \pi_t^e + \phi_x x_t + \phi_s(s_t - \overline{s}_t) + \nu_t, \tag{1}$$

where i_t is the central bank's interest rate, π_t^e is expected inflation, x_t is the output gap, s_t is the log of the nominal exchange rate, and $\overline{s}_t \equiv p_t - p_t^*$ is the targeted exchange rate, which assumes that the home country targets the purchasing power parity (PPP) level of the exchange rate, defined as the differential between the price level of the home country p_t and that of the foreign country p_t^*. ϕ_π, ϕ_x and ϕ_s represent policy parameters that measure the response of the interest rate to expected inflation, the output gap, and deviation in the exchange rate, respectively. Finally, ν_t is the monetary policy shock.

Analogously, the Taylor rule of the foreign country is:

$$i_t^* = \phi_\pi \pi_t^{e*} + \phi_x x_t^* + \nu_t^*, \tag{2}$$

where i_t^* denotes the interest rate of the foreign country, π_t^{e*} and x_t^* represents the expected inflation and the output gap of the foreign country, respectively, and ν_t^* denotes the monetary policy shock of the foreign country. For simplicity, we follow Engel and West (2005) and Wu and Wang (2012) to restrict the policy response coefficients for expected inflation and output gap to be identical for the home and foreign countries.

Finally, interest parity holds:

$$E_t s_{t+1} - s_t = i_t - i_t^* + \rho_t, \tag{3}$$

where $E_t s_{t+1} - s_t$ denotes the market's expectation of a change in the exchange rate, and ρ_t represents the time-varying risk premium for home currency holdings.

Subtracting equation (2) from (1) and using interest parity (3) to substitute for $i_t - i_t^*$, we have:

$$s_t = \frac{\phi_s}{1+\phi_s}(p_t - p_t^*) - \frac{1}{1+\phi_s}[\phi_\pi(\pi_t^e - \pi_t^{e*}) + \phi_x(x_t - x_t^*) + (\nu_t - \nu_t^*) + \rho_t] + \frac{1}{1+\phi_s}E_t s_{t+1}. \tag{4}$$

Following Engel and West (2005), let the discount factor b_1 be equal to $1/(1+\phi_s)$, and $f_t = p_t - p_t^*$, $\zeta_t = -[\phi_\pi(\pi_t^e - \pi_t^{e*}) + \phi_x(x_t - x_t^*) + (\nu_t - \nu_t^*) + \rho_t]$, equation (4) can be expressed as the present value form:

$$s_t = (1 - b_1) \sum_{j=0}^{\infty} b_1^j E_t f_{t+j} + b_1 \sum_{j=0}^{\infty} b_1^j E_t \zeta_{t+j}. \tag{5}$$

We follow Engel and West (2005) and Engel et al. (2007) and consider ζ_t as unobserved variables and use $p_t - p_t^*$ as measures of the fundamentals.

By subtracting f_t from both sides of (5), we rewrite it as:

$$s_t - f_t = \sum_{j=1}^{\infty} b_1^j E_t \Delta f_{t+j} + b_1 \sum_{j=0}^{\infty} b_1^j E_t \zeta_{t+j}. \tag{6}$$

Throughout this paper, we assume that s_t and $p_t - p_t^*$ are I(1), while ζ_t is I(0). The nonstationarity of s_t and $p_t - p_t^*$ is supported by empirical evidence in the extant literature, including Engel and West (2005) and Engel et al. (2007). As ζ_t are unobserved variables, they are usually considered stationary (Engel et al., 2009). The above assumptions imply that $s_t - f_t$ are I(0); that is, the nominal exchange rate and observed fundamentals are cointegrated with the cointegration vector $[1, -1]'$ in accordance with equation (6). We thus construct a VECM based on the nominal exchange rate and the observed fundamentals, as follows:

$$\Delta Y_t = \mu + \alpha z_{t-1} + A_1 \Delta Y_{t-1} + \cdots + A_{p-1} \Delta Y_{t-p+1} + e_t, \tag{7}$$

where $Y_t \equiv [s_t, f_t]'$ and $z_t \equiv s_t - f_t$. μ is the intercept, α are coefficients reflecting the adjustment to the long-run equilibrium, and e_t represents a vector of innovations with a variance–covariance matrix $\Sigma_e \equiv E(e_t e_t')$.

Further, as pointed out by Engel and West (2005), we can re-express equation (4) as:

$$s_t = \phi_s[(p_t - p_t^*) + (i_t - i_t^*)] + \xi_t - (1 - \phi_s)\rho_t + (1 - \phi_s) E_t s_{t+1}, \tag{8}$$

where $\xi_t = -[\phi_\pi(\pi_t^e - \pi_t^{e*}) + \phi_x(x_t - x_t^*) + (\nu_t - \nu_t^*)]$. This leads to the associated present value form as follows:

$$s_t = (1 - b_2) \sum_{j=0}^{\infty} b_2^j E_t (f_{t+j} + \xi_{t+j}) + b_2 \sum_{j=0}^{\infty} b_2^j E_t \zeta_{t+j}, \tag{9}$$

where $b_2 = 1 - \phi_s$, $f_t = p_t - p_t^* + i_t - i_t^*$. In this case, the observed fundamentals are given by $f_t = p_t - p_t^* + i_t - i_t^*$. Equation (9) suggests a VECM with s_t and $p_t - p_t^* + i_t - i_t^*$ to implement the permanent–transitory decomposition. We also consider this specification later in the analysis.

3 Permanent and Transitory Decomposition

Cointegration between the exchange rates and fundamentals enables us to decompose Y_t into its permanent and transitory components. In this paper, we follow Gonzalo and Ng (2001) by identifying the permanent and transitory shocks in the VECM framework for equation (7). According to the Granger representation theorem, under the maintained hypothesis that the growth rates in Y_t are covariance stationary around some deterministic term, there exists a multivariate Wold representation of equation (7), such that:

$$\Delta Y_t = \delta + C(L)e_t, \tag{10}$$

where e_t is a 2×1 vector of innovations, $C(L)$ is a distributed lag operator, δ denotes the deterministic term. In accordance with Gonzalo and Granger (1995), we define u_t^P as a permanent shock if $\lim_{k\to\infty} \partial E_t Y_{t+k}/\partial u_t^P \neq 0$, and u_t^T as a transitory shock if $\lim_{k\to\infty} \partial E_t Y_{t+k}/\partial u_t^T = 0$.

Note that given the Granger representation theorem in Engle and Granger (1987), the parameters α and β satisfy $\beta' C(1) = 0$ and $C(1)\alpha = 0$. We let

$$G = \begin{bmatrix} \alpha'_\perp \\ \beta' \end{bmatrix}, \tag{11}$$

where $\alpha'_\perp$ is the orthogonal complementary matrix of α and $\alpha'_\perp \alpha = 0$. The permanent and transitory shocks are then given by:

$$u_t \equiv \begin{bmatrix} u_t^P \\ u_t^T \end{bmatrix} = Ge_t. \tag{12}$$

In equation (12), if there exists one cointegrating relationship, the dimension of $\alpha'_\perp$ is 1×2 and the dimension of u_t^P is 1×1. In addition, the dimension of u_t^T is also 1×1. Given the construction of the matrix G, the permanent shock is the first element of the vector u_t.

The decomposition can be intuitively understood by investigating the properties of the matrix G. Note that the matrix gives the j-th variable a large weight in the permanent innovations and a small weight in the transitory innovations when α_j is small. Thus, the element of $\alpha'_\perp$ that multiplies u_{jt} is large in absolute value, which implies that the variable participates little in the error correction required to eventually restore the variables to their common trend. Conversely, it gives the j-th variable a small weight in the permanent innovations and a large weight in the transitory innovations when α_j is large, so the element of $\alpha'_\perp$ that multiplies u_{jt} is small in absolute value, which implies that the variable plays an important role in the error correction required to restore the variables to their common trend.

Given the assumption of the nonsingularity of matrix G, we can express (10) as:

$$\begin{aligned} \Delta Y_t &= \delta + C(L)G^{-1}Ge_t \\ &= \delta + D(L)u_t. \end{aligned} \tag{13}$$

The polynomial matrix $D(L) = D_0 + D_1 L + D_2 L^2 + \cdots$ in equation (13) has the property that the last column of $D(1) = C(1)G^{-1}$ is full of zeroes because they refer to the long-run impact of the transitory shocks. However, u_t^P and u_t^T are not mutually orthogonal, and thus computing the impulse response functions and making causal statements about the nature of the permanent and transitory shocks at this stage is inappropriate. To overcome this problem, we follow Gonzalo and Ng (2001) in orthogonalizing the permanent and transitory shocks. Let $\eta_t = [\eta_t^P, \eta_t^T]'$ be the respective vectors of permanent and transitory shocks, which are mutually orthogonal to each other with a unit variance–covariance matrix. By setting $\Sigma_u \equiv E(u_t u_t')$, we obtain the following relationship between u_t and η_t:

$$u_t = H\eta_t, \tag{14}$$

$$\Sigma_u = HH', \tag{15}$$

where H is a 2×2 nonsingular matrix. Using (14) and (15), we can rewrite (13) as

$$\Delta Y_t = \delta + D(L)HH^{-1}u_t = F(L)\eta_t, \tag{16}$$

where $F(L) = F_0 + F_1 L + F_2 L^2 + \cdots$.

The relationship between Σ_e and Σ_u is as follows:

$$\Sigma_e = F_0 F_0^{'} = D_0 \Sigma_u D_0^{'}. \tag{17}$$

According to (17), Σ_e includes three unknown parameters, which is less than the number of parameters in F_0. The difference is $4 - 3 = 1$. To identify F_0, Gonzalo and Ng (2001) use the Cholesky decomposition method to decompose $\Sigma_u = G\Sigma_e G'$, where H is a lower block diagonal matrix. The orthogonalized shocks are then obtained by $\eta_t = H^{-1}Ge_t$. It is worth noting that the numbers in the last column of the matrix $F(1) = D(1)H$ are all zero, which implies no long-run impact of η_t^T on Y_t.

4 Data and Preliminary Analysis

4.1 Data

We analyze the bilateral exchange rate data for six countries, namely, France, Germany, Italy, Japan, Switzerland, and the UK. We select the US as the numeraire; i.e., the foreign country. Quarterly data, typically from 1973Q1 to 2011Q4, are obtained from the International Financial Statistics (IFS) published by the International Monetary Fund. The price level is measured by the consumer price index (CPI). [1] Following Engel and West (2005), we convert the euro (EUR) exchange rate after 1999Q1 to DEM/USD, FRF/USD and ITL/USD to obtain the Deutschemark, French franc, and Italian lira exchange rates to the US dollar (USD), respectively. [2] Finally, we measure the short-run interest rate with the money market rate (or "call money rate") for all countries (IFS line 60B). Other than interest rates, all variables are in logarithms.

4.2 Cointegration Test Results

To start with, we examine the stationarity properties of the exchange rates and the economic fundamentals series. According to the unit root test results using Elliot et al. (1996)'s Dickey–Fuller generalized least squares (DF-GLS) statistics in Table 1, the unit-root hypotheses for s_t, $p_t - p_t^*$ and $p_t - p_t^* + i_t - i_t^*$ are not rejected at the 10% level of significance, which suggests that both the exchange rates and the observed fundamentals are integrated of order one or I(1).

We then test for the presence of a cointegrating relationship between the exchange rates and the observed fundamentals. We first follow Stock and Watson (1993) and employ dynamic ordinary least squares (DOLS) to estimate the cointegration relationship as follows:

$$s_t = \gamma + \beta f_t + \sum_{j=-p}^{p} \delta_j \Delta f_{t-j} + \epsilon_t, \tag{18}$$

[1] CPI data is available from 1973Q1 to 1991Q4 for West Germany and from 1991Q1 to 2010Q4 for reunified Germany. We therefore use West German CPI data from 1973Q1 to 1991Q4 and extend it to 2011Q4 using the growth rate computed from the CPI data for reunified Germany.

[2] The conversion rates are: 1 EUR = 1.95583 DEM, 6.55957 FRF, and 1936.27 ITL. For example, the FRF/USD rate for FRF post-1999 is simply the EUR/USD exchange rate multiplied by 6.55957.

where $f_t = p_t - p_t^*$ or $f_t = p_t - p_t^* + i_t - i_t^*$, γ denotes a constant, and β represents the cointegrating coefficient.

We then estimate (18) by including the four-period lead and lag of the first differences of f_t for the independent variables, and calculate the cointegration test statistics for PO_z proposed by Phillips and Ouliaris (1990) and the test statistics for L_c proposed by Hansen (1992). We use the quadratic spectral kernel and the Andrews (1991) automatic bandwidth selector when computing the semiparametric adjustment for the PO_z statistic. The test statistics for cointegration and the cointegrating coefficient estimates are in Table 2. As shown, we reject the null hypothesis of no cointegration at the 10% significance level for all countries according to the PO_z statistics. Moreover, it is worth noting that the statistic L_c proposed by Hansen (1992) tests the null hypothesis of cointegration against the alternative of no cointegration. As argued by Rapach and Wohar (2002), if we take the Taylor rule model as the maintained hypothesis, the null of cointegration may be more appropriate than the null of no cointegration. Clearly, all the L_c statistics suggest the existence of a cointegrating relationship between exchange rates and the fundamentals.

Table 2 also reports the cointegrating coefficient estimates, together with the Wald statistics for testing $\beta = 1$.[3] We follow Rapach and Wohar (2002) and use the quadratic spectral kernel and the Andrews (1991) automatic bandwidth selector to calculate the associated p-values based on Newey–West corrected t-statistics for the DOLS estimators. For most of the sample countries, we find that the estimates of β are statistically significant and close to one, which is consistent with the cointegrating vector $[1, -1]'$ implied by the Taylor rule model. Moreover, the Wald statistics for testing the hypothesis that $\beta = 1$ suggest that the null hypothesis cannot be rejected at the 10% level for all countries.

Finally, it is worth noting that the PO_z and L_c statistics in Table 2 are obtained using an estimated cointegration relationship. We further test for cointegration by restricting the cointegrating vectors to be $[1, -1]'$ using the Johansen (1988)'s trace statistics (Trace). Table 2 shows that the Trace statistics suggest that a long-run cointegrating relationship between the exchange rates and fundamentals exists for four of the six countries, irrespective of whether we measure the fundamentals using $p_t - p_t^*$ or $p_t - p_t^* + i_t - i_t^*$. In

[3]Phillips (1994) shows that the Wald test for the restriction on cointegrating vectors is more reliable than the likelihood ratio test proposed by Johansen (1991).

sum, the cointegration tests significantly support the presence of a cointegrating relationship between exchange rates and the fundamentals for France, Germany, Italy, Japan, Switzerland, and the UK.

4.3 VECM Estimation Results

To identify the permanent and transitory components of the two-variable system including exchange rates and fundamentals, we estimate the bivariate VECM as follows:

$$\Delta s_t = \mu_1 + \alpha_1 z_{t-1} + \sum_{j=1}^{p} a_{11}^{j} \Delta s_{t-j} + \sum_{j=1}^{p} a_{12}^{j} \Delta f_{t-j} + e_{1t}, \tag{19}$$

$$\Delta f_t = \mu_2 + \alpha_2 z_{t-1} + \sum_{j=1}^{p} a_{21}^{j} \Delta s_{t-j} + \sum_{j=1}^{p} a_{22}^{j} \Delta f_{t-j} + e_{2t}, \tag{20}$$

where $f_t = p_t - p_t^*$ or $p_t - p_t^* + i_t - i_t^*$. We use the Akaike information criterion to determine the lag length. Table 3 reports the coefficient estimates from the VECM. For $f_t = p_t - p_t^*$, the estimates of α_1 in (19) for all countries are negative and statistically significant, while the estimates of α_2 in (20) are small and insignificant, which implies that the price differentials $p_t - p_t^*$ are weakly exogenous for these countries. That is, it is primarily the exchange rate that adjusts to restore the long-run equilibrium, not the price differentials. This is consistent with the findings in Cheung et al. (2004).

By contrast, the results for $f_t = p_t - p_t^* + i_t - i_t^*$ show that for France, Japan and UK, both the estimates for α_1 and α_2 are significant, so that neither the exchange rate nor the fundamentals are weakly exogenous, and both adjust to restore the long-run equilibrium, although the size of α_2 is smaller than α_1. This suggests that relative interest rate adjustments are significant in restoring the long-run equilibrium between exchange rates and fundamentals for many countries.

Overall, our VECM estimation results suggest that exchange rates are not weakly exogenous with respect to the cointegrating vector. This corroborates the arguments made by Cheung et al. (2005) that if the exchange rate is not weakly exogenous in a cointegrated system, then the exchange rate should not be characterized by a random walk. Later in the analysis, we examine further how exchange rates and the fundamentals are related to the permanent and transitory shocks.

5 Empirical Results

5.1 Orthogonalized Permanent and Transitory Shocks

We now turn to the main focus of the analysis by using the permanent–transitory decomposition discussed in Section 2 to investigate how exchange rates and fundamentals relate to the permanent and transitory shocks. The cointegration relationship between the exchange rates and fundamentals allows us to identify a permanent shock along with a transitory shock in the VECM. At first, we assume the permanent and transitory shock are mutually orthogonal, [4] and follow the suggestions of Gonzalo and Ng (2001) and restrict the values of the parameters in α to zero where they are statistically insignificant at the 10% level to obtain more reliable estimates of the permanent–transitory decomposition.

The variance decompositions in Table 4 indicate the fraction of forecast errors in Δs_t attributable to the permanent shock and the transitory shock h-step ahead when $f_t = p_t - p_t^*$, together with the 90% bootstrap confidence interval constructed using 5,000 replications. We consider $h = 1, 4, 8, 12, 16$, and 32. The results suggest that for all countries, the transitory shocks dominate in explaining the changes in the exchange rates because they account for around 90% of the variations in the exchange rates, especially at horizons between one and eight quarters. Note also that the orthogonalization of the transitory and permanent shocks above orders the transitory shock last, which gives it the smallest possible role in the transitory component in exchange rates. Despite this ordering, the transitory shocks dominate exchange rate variations for all of the countries and currencies we investigated. Conversely, the permanent shocks account for only a negligible portion of the changes in exchange rates at one to eight quarters. As for the longer horizon, we observe that the permanent shocks account for 29%, 65.8%, and 53.7% of the exchange rate variations in France, Italy, and the UK at the 32-quarter horizon, respectively. Table 5 reports the variance decomposition results for the price differentials. As shown, for all countries, over 90% of the variations in the fundamentals arise from permanent shocks, while the transitory shocks are not associated with most of the variability in the fundamentals.

[4] Note that we order the exchange rate at first to obtain the orthogonalized shocks using the Cholesky decomposition method described in Section 2. However, the results in this section are qualitatively unaffected by altering the order of the endogenous variables in the VECM.

Table 6 reports the proportion of forecast errors in the exchange rates that are attributable to the permanent and transitory shocks when $f_t = p_t - p_t^* + i_t - i_t^*$. For Germany, Italy, and Switzerland, the transitory shocks explain more than 90% of the exchange rate variations. As for France and Japan, both the permanent and transitory shocks account for the variation in exchange rates, and the transitory shocks dominate the permanent shocks. The sole exception is for the UK, whereas permanent shocks are the dominant source of variation in the exchange rate over all the horizons, the transitory shocks still explain around 30% of the exchange rate variation at horizons between one and eight quarters. Table 7 reports the variance decomposition results of the fundamentals. Clearly, the permanent shocks account for most of the variations in fundamentals in France, Germany, Italy, and Switzerland for all horizons, and its importance increases with the horizon for Japan and the UK. Overall, the empirical results based on $f_t = p_t - p_t^* + i_t - i_t^*$ are similar to the results reported in Tables 4 and 5. We thus conclude that the transitory shocks dominate permanent shocks in explaining the variations in exchange rates, especially at short horizons, while the permanent shocks provide the dominant source of variation in the fundamentals. [5]

Note that the permanent and transitory shocks that we identify correspond to a variety of structural disturbances affecting the economy. Nevertheless, as suggested by Corsetti and Konstantinou (2012), a natural interpretation of a permanent shock in our cointegrating framework is a permanent technology or total factor productivity shock. Conversely, we could interpret a transitory shock as the response of the central bank to expected inflation and the output gap, a monetary shock, the risk premium, or any arbitrary combination thereof.

Figure 1 depicts the impulse response functions of s_t, $p_t - p_t^*$ together with z_t to transitory shocks. As shown, an increase in transitory shocks leads to a persistent response in exchange rates, as well as the responses of the error-correction terms z_t on the transitory

[5] We also follow Corsetti and Konstantinou (2012) and adopt an alternative method to identify the permanent and transitory shocks. We let the permanent shock be $u_t^P = \alpha'_{\perp} e_t$ and the transitory shocks be $u_t^T = \alpha' \Sigma_e^{-1} e_t$ to transform the shocks in the VECM into orthogonal permanent and transitory shocks. The results using this alternative identification scheme are virtually identical to those reported in Tables 4 to 7 as any differences only appear beyond the third decimal point, as in Corsetti and Konstantinou (2012).

shocks. In all cases, the adjustment patterns of s_t and z_t are very much alike, which confirms our VECM estimation results that exchange rate adjustment is the primary driving force in restoring the long-run equilibrium. Moreover, the magnitudes of the responses for f_t are smaller than the responses for s_t and z_t, which indicates that the transitory shocks are a relatively unimportant source of variation in the fundamentals. It is worth noting that in this case, the existence of the cointegrating relationship between s_t and $p_t - p_t^*$ with a cointegration vector $[1, -1]'$ implies PPP holds in the long run, and that the error-correction terms equal the real exchange rates. The persistent effect of a transitory shocks on z_t is thus consistent with the PPP puzzle documented by Rogoff (1996). Furthermore, the shapes of the impulse response functions for z_t are similar to the responses for s_t, while the responses for $p_t - p_t^*$ provide a rather different picture. This suggests that PPP reversion is primarily driven by exchange rate adjustments. We can reconcile the results with those in Cheung et al. (2004) by noting that the responses in z_t are very similar to the responses in s_t with respect to the exchange rate innovations, because the exchange rates are primarily driven by transitory shocks. Figure 2 displays the impulse response functions of s_t, $p_t - p_t^* + i_t - i_t^*$ and z_t to transitory shocks; the results are quite similar to Figure 1, which again confirms that it is the transitory shocks, not the permanent shocks, that are the primary driving force in explaining the exchange rate variations. [6]

5.2 Unorthogonalized Permanent and Transitory Shocks

Up to this point, we obtain our results by assuming the transitory shock to be orthogonal to the permanent shock, which may not be warranted in the data. To address this possibility, we follow Corsetti and Konstantinou (2012) and Lettau and Ludvigson (2004) to conduct a variance–covariance decomposition analysis that does not require the shocks to be orthogonal.

Table 8 present the fraction of the h-step ahead forecast error of Δs_t and Δf_t that is attributable to the variance of the permanent and transitory shocks, and two times the

[6] The bootstrapped 90% confidence intervals for the impulse responses for s_t, f_t, and z_t to a one-standard-deviation transitory shock are presented in an not-for-publication supplementary appendix. It is worth noting that the responses of s_t and z_t are statistically significant, but not for f_t, regardless of the measurement of f_t is $p_t - p_t^*$ or $p_t - p_t^* + i_t - i_t^*$.

covariance between the permanent and transitory shocks when $f_t = p_t - p_t^*$. Compared with Table 4, the main results remain qualitatively unchanged: that is, transitory shocks continue to dominate the nominal exchange rate fluctuations, while the permanent shocks dominate the variations in the price differentials. It is also clear that the permanent components of the exchange rates and price differentials are virtually uncorrelated with the transitory component. Therefore, it is not the case that the exchange rate contains a large transitory component that is correlated with the permanent shocks, and this suggests that the transitory variation in exchange rates are likely to arise from the unobserved components ζ_t in equation (5), rather than $p_t - p_t^*$. The results from $f_t = p_t - p_t^* + i_t - i_t^*$ are reported in Table 9. We can see that the correlations between the transitory and permanent components in exchange rates are very small (less than 10%) with the exception of the UK, and that the overall results continue to indicate that the exchange rates are mostly driven by transitory shocks for most of the countries we investigate. On the other hand, the transitory component in the fundamentals is correlated with the permanent shocks in Germany, Japan, Switzerland, and the UK, but this does not alter the conclusion that the majority of variations in the fundamentals is attributable to the permanent shocks.

We obtain additional insights by checking the correlations between the exchange rates and the fundamentals with their corresponding random-walk components. We extract the random-walk components (trends, denoted by Δs_t^T) and the transitory components (cycles, denoted by Δs_t^C) using the multivariate Beveridge–Nelson decomposition. We then compute their corresponding correlations with Δs_t and Δf_t. The results in Table 10 show the correlations between the exchange rates and their random-walk components, where $Corr(\Delta s_t, \Delta s_t^T)$ lies between 0.014 to 0.232 for all countries when $f_t = p_t - p_t^*$. In contrast, the correlations between the fundamentals and their random-walk components range from 0.659 to 0.811, Clearly, the fundamentals are highly correlated with their random-walk components, while the correlations between the exchange rates and their corresponding random-walk components are considerably weaker. Conversely, the correlations between the exchange rates and their transitory components $Corr(\Delta s_t \Delta s_t^C)$ lie between 0.791 to 0.931, while the correlations between the fundamentals and their transitory components range from -0.575 to -0.161. This demonstrates that the exchange rates are highly correlated with their transitory components, while the correlations between the fundamentals and their corresponding transitory components are smaller. The case of $f_t = p_t - p_t^* + i_t - i_t^*$ delivers similar results as in $f_t = p_t - p_t^*$.

We plot the resulting random-walk components with s_t and $p_t - p_t^*$ in Figures 3 and 4, respectively. As shown, we observe essential deviations from the trends in the exchange rates. In contrast, the data series for $p_t - p_t^*$ lie close to their random-walk components for all of the countries we consider. [7]

We thus conclude that transitory shocks explain most of the variation in exchange rate movements, especially at short horizons. As the movements in the exchange rates are dominated by transitory shocks, and the economic fundamentals are dominated by permanent shocks, it follows that most of the innovations in the economic fundamentals are unrelated to exchange rates, and hence this finding explains the exchange rate disconnect puzzle. This finding also explains the existing empirical evidence that exchange rate movements are mostly forecastable by macroeconomic variables over very long horizons (Cheung et al., 2005), because according to our forecast error variance decomposition results, the permanent shocks account for the exchange rate movements only at longer horizons. Of course, this does not imply that the economic fundamentals have no effect on exchange rates, but rather that only the transitory changes in the fundamentals, which account for a small portion of the fundamental movements, are associated with the movements in exchange rates.

Furthermore, it is worth noting that in equation (5), the exchange rate is determined by the discounted sum of the observed fundamentals f_t and the discounted sum of the unobserved variables ζ_t. Engel and West (2005) show that when the discount factor b_1 is close to unity and either (1) f_t is I(1) and ζ_t is zero, or (2) ζ_t is I(1) with f_t unrestricted, the exchange rate is dominated by the permanent components in observed fundamentals, and hence follows a near-random-walk process. The value of b_1 is close to one given that intervention by central banks to target the exchange rate is not very active in practice (Engel and West, 2005) and the estimates of ϕ_s are small and close to zero (Clarida et al., 1998). However, we can rule out the possibility that ζ_t is I(1) because the cointegration test results suggest that s_t and f_t are indeed cointegrated. Hence,

[7] The result based on $f_t = p_t - p_t + i_t - i_t^*$ is very similar to Figure 3 and 4. We omit it here for brevity.

equation (5) implies that $b_1 \sum_{j=0}^{\infty} b_1^j \zeta_{t+j}$ cannot be I(1). That is, the large proportions of the transitory components in exchange rates that we observe may be attributable to the stationary terms $b_1 \sum_{j=0}^{\infty} b_1^j \zeta_{t+j}$. In other words, when potentially unobservable variables, such as ζ_t, are present in the present value model in Engel and West (2005), the importance of the transitory components in explaining the exchange rate can be restored. [8]

Our permanent–transitory decomposition results show that the transitory variations in exchange rate are unlikely to come from the observed fundamentals $p_t - p_t^*$ and $p_t - p_t^* + i_t - i_t^*$ because they are mostly driven by the permanent shocks. Conversely, the transitory variation in exchange rates is likely to come from the unobserved variables ζ_t, including the responses of a central bank to expected inflation and the output gap, monetary policy shocks, or the risk premium. This explains why recent empirical evidence is mostly favorable toward the Taylor rule model. For instance, Molodtsova et al. (2008) and Molodtsova and Papell (2009) do not forecast the exchange rates based upon the observed fundamentals like $p_t - p_t^*$ and $p_t - p_t^* + i_t - i_t^*$ as suggested by Engel and West (2005). On the other hand, they attempt to uncover $\phi_\pi(\pi_t^e - \pi_t^{*e}) + \phi_x(x_t - x_t^*)$ to predict the future exchange rate movements. By doing so, the predictability of the Taylor rule model to exchange rate movements can be enhanced because the transitory variation in exchange rates is likely to come from the unobserved variable ζ_t. [9]

5.3 Long-Horizon Regression

The permanent–transitory decomposition result implies that it is mostly transitory shocks that explain nominal exchange rate movements. Moreover, the findings based on the VECM estimates indicates that it is primarily exchange rates that adjust to restore the long-run equilibrium, which means that exchange rate is mean-reverting and that it adapts to the permanent components in the fundamentals over long horizons. That is, the error-correction terms z_t should have predictive power for exchange rates. On the other hand,

[8] These interpretations can also apply to the present value form of the exchange rate in equation (9).

[9] $\nu_t - \nu_t^*$ and ρ_t can be also essential in explaining the exchange rate. For example, Bouakez and Normandin (2010) and Bjørnland (2009) use a structural vector autoregression approach and show that monetary policy shocks can account for a nontrivial proportion of exchange rate variability. Engel et al. (2009) and Binici and Cheung (2012) find the inclusion of the foreign exchange risk premium in the Taylor rule model can substantially improve the explanatory power of the model to exchange rate movements.

Table 8 and 9 show that the permanent and transitory innovations in exchange rates and fundamentals are virtually uncorrelated, this could imply that there is no support for the conventional belief in price-stickiness in that the price differentials take many periods to converge to the long-run equilibrium. If the sluggish price differential adjustment explanation for the PPP puzzle is empirically significant, then such temporary deviations from PPP should be eliminated by a subsequent movement in the price differential because it sluggishly copes with the permanent shocks in the exchange rate. Then the error-correction terms, which measured the deviations from the long-run PPP, should predict the future changes in the price differential.

We use long-horizon regression to address the above concerns and complement the empirical investigation based upon the permanent and transitory decompositions. Table 12 displays the long-horizon predictability of the exchange rate movements by regressing $s_{t+h} - s_t$ on z_t, Δs_t, Δf_t and a constant over horizons $h = 1$, 4, 8, 12, 16, and 32 using $f_t = p_t - p_t^*$ We report the estimates of the regression Coefficients and the Newey–West corrected t-statistics in parentheses, and the adjusted R^2 in square brackets. The result shows that z_t has predictive power to all countries at any horizon, which is consistent with the finding from the VECM estimates that it is the exchange rates that adjust to restore the long-run equilibrium for these countries. It is worth noting that the $\overline{R}^2$ are increasing up to 16 quarters and then decreasing at longer horizons, which is consistent with the explanation made by Engel et al. (2007) that when the unobserved transitory components exist in the Taylor rule model, the $\overline{R}^2$ in long-horizon regressions with observed fundamentals as regressors are likely to exhibit hump-shaped patterns over horizons.[10] In addition, the $\overline{R}^2$ are unaffected by removing the Δs_t and Δf_t from the right-hand side of the predictive regression. This indicates that z_t has long-horizon predictability for exchange rates when applying conventional long-horizon regression, as found in the literature (Berkowitz and Giorgianni, 2001; Kilian, 1999; Mark, 1995; Rapach and Wohar, 2002).

Table 12 provides the results for the long-horizon predictability of the fundamentals $f_{t+h} - f_t$. The $\overline{R}^2$ peaks at four quarters then decreases for Germany, Italy, Japan, and Switzerland, which suggests that the price differentials are not very predictable at long horizons, which suggests that the random-walk component is the major source of the price

[10] For a detailed explanation, see Engel et al. (2007, p.424-425).

differential variations. Furthermore, there is little evidence that the error-correction terms predict the future fundamentals. This suggests that the error-correction terms, which capture the deviations of s_t from f_t, fail to explain future changes in price differentials because most of the fluctuations in the price differentials are attributable to the permanent shocks. Moreover, given the permanent and transitory components in the fundamentals are uncorrelated in accordance with Table 8, the error-correction terms are unlikely to predict the future price differentials in practice.

Tables 13 and 14 report the long-horizon regression results using $f_t = p_t - p_t^* + i_t - i_t^*$. The results in Table 13 are very similar to Table 12, although the $\overline{R}^2$ are a bit smaller. Conversely, Table 14 shows that there is more evidence of the predictability of z_t for the future fundamentals than Table 12, especially in Switzerland and the UK. This can be justified by looking at Table 9 that the permanent and transitory shocks are indeed correlated in these countries. Thus, when introducing interest rate differential $i_t - i_t^*$ into the fundamentals, z_t could predict the future movements in $p_t - p_t^* + i_t - i_t^*$.

In sum, the long-horizon regression results support our findings from the permanent–transitory decomposition. The statistical evidence from the long-horizon regression critically depends on whether it is the permanent or transitory shocks that dominate the movements in the exchange rates and the fundamentals. For countries with large transitory components in their exchange rates, the error-correction terms, as measured by the deviations in the exchange rates from the fundamentals, may be helpful in predicting future exchange rates. Conversely, z_t usually fails to predict the future fundamentals because the fundamentals are dominated by the permanent shocks. These results provide a fresh look at the exchange rate disconnect puzzle because the changes in the fundamentals fail to explain the changes in the exchange rates simply because the major determinants of exchange rates and the fundamentals are likely to differ. Hence, neglecting the distinction between transitory and permanent shocks may be misleading and may yield inconclusive results.

6 Conclusion

In this paper, we use the permanent–transitory decomposition method proposed by Gonzalo and Ng (2001) to investigate the role of permanent and transitory shocks in explaining exchange rates and economic fundamentals. A key finding is that the transitory variations are quantitatively large and contribute to most of the fluctuations in the exchange rates for six currencies vis-á-vis the US dollar in the post-Bretton Woods era. On the other hand, we find the variations in fundamentals based on macroeconomic variables, such as the price and interest rate differentials, appear to be dominated by permanent shocks.

Our results suggest that the nominal exchange rate should not be approximated by a pure random walk, and this provides an alternative interpretation of the "exchange rate disconnect puzzle" such that economic fundamentals fail to explain the large observed fluctuations in exchange rates. Our findings also suggest that the transitory components in the Taylor rule model, such as the policy responses to expected inflation and the output gap, monetary policy shocks or the foreign exchange risk premium, are crucial in explaining exchange rate dynamics.

The findings in this paper suggest that comprehensive modeling of the transitory components in Taylor rule models is essential. However, there are some caveats associated with the construction of these components. For instance, Rossi (2013) shows that different specifications, including the choice of the output gap measure, can substantially affect the forecasting performance of the Taylor rule model. Thus, how to correctly specify and construct the transitory components in the Taylor rule model remains an important task for future research.

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Figure 1: Impulse Response Functions of Nominal Exchange Rate (s_t), Fundamentals (f_t) and Error Correction (z_t) to a One-Standard-Deviation Transitory Shock: $f_t = p_t - p_t^*$. The solid lines, dashed lines and dotted-and-dashed lines represent the responses of s_t, f_t and z_t, respectively.

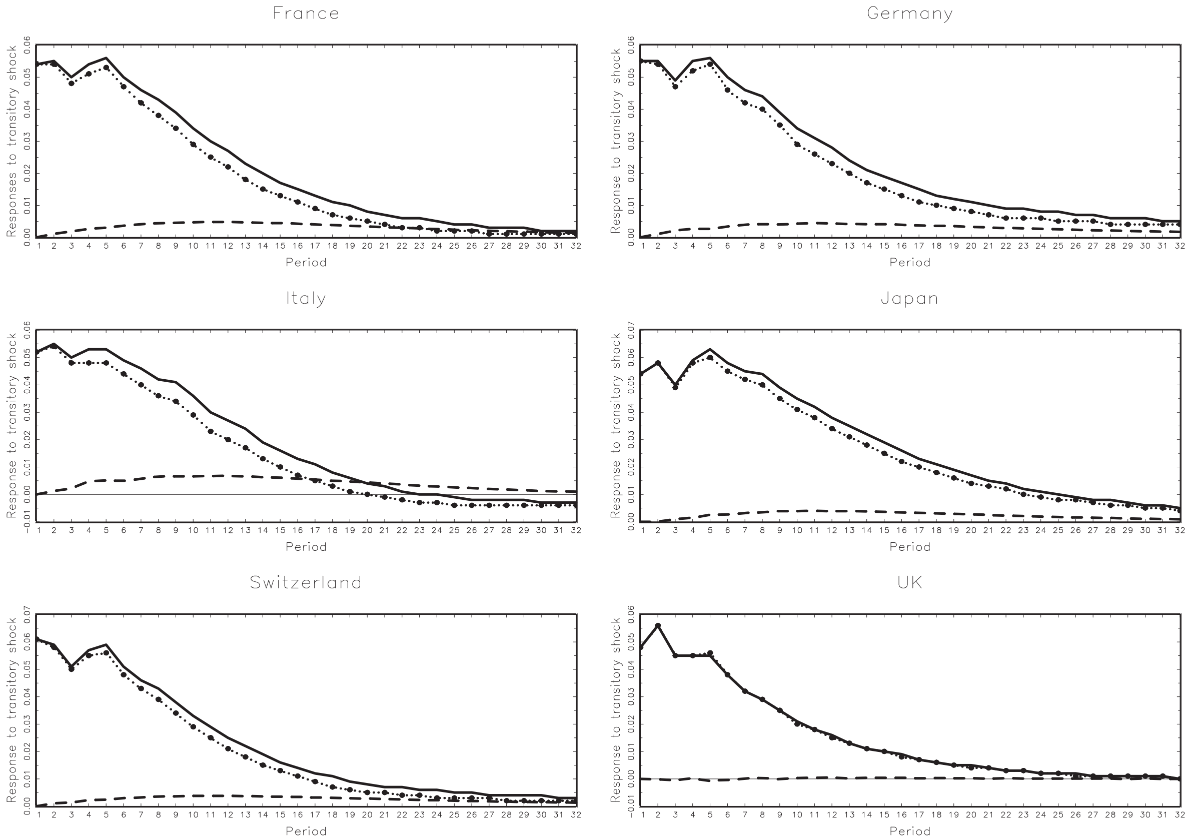


Figure 2: Impulse Response Functions of Nominal Exchange Rate (s_t), Fundamentals (f_t) and Error Correction (z_t) to a One-Standard-Deviation Transitory Shock: $f_t = p_t - p_t^* + i_t - i_t^*$. The solid lines, dashed lines and dotted-and-dashed lines represent the responses of s_t, f_t and z_t, respectively.

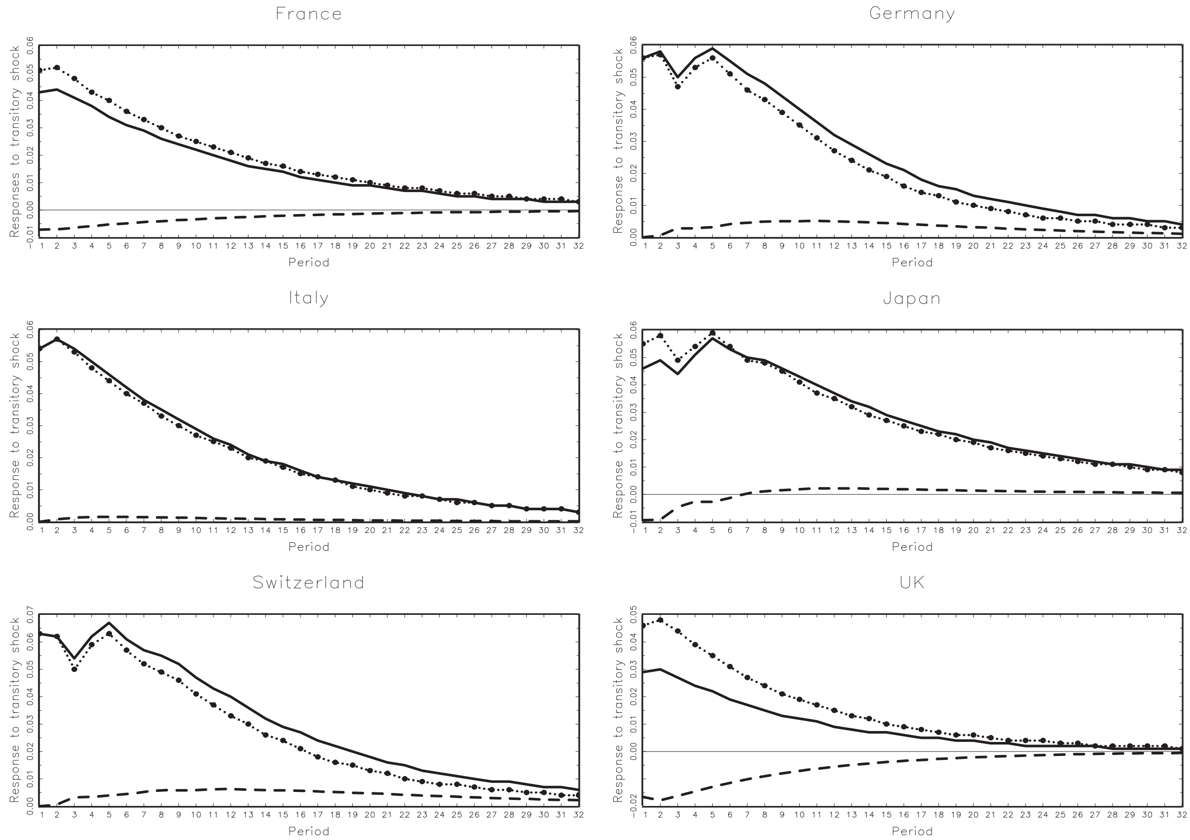
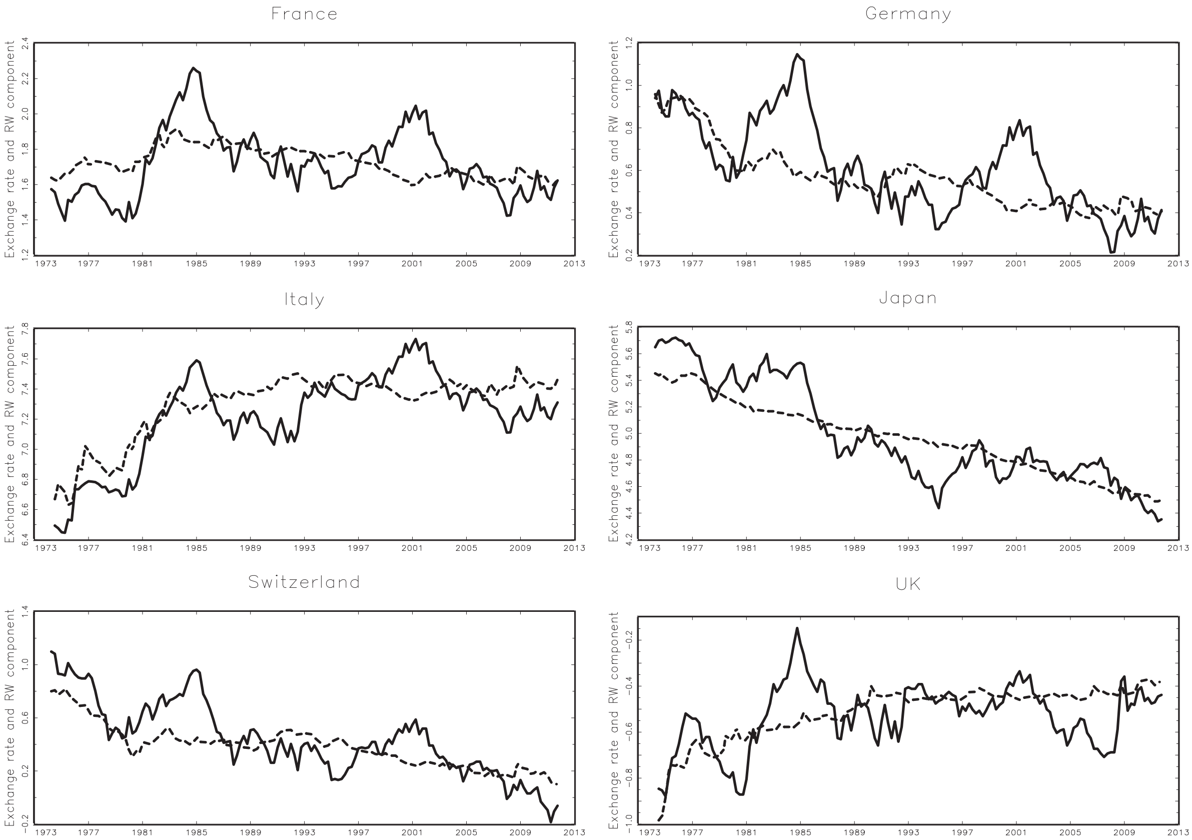
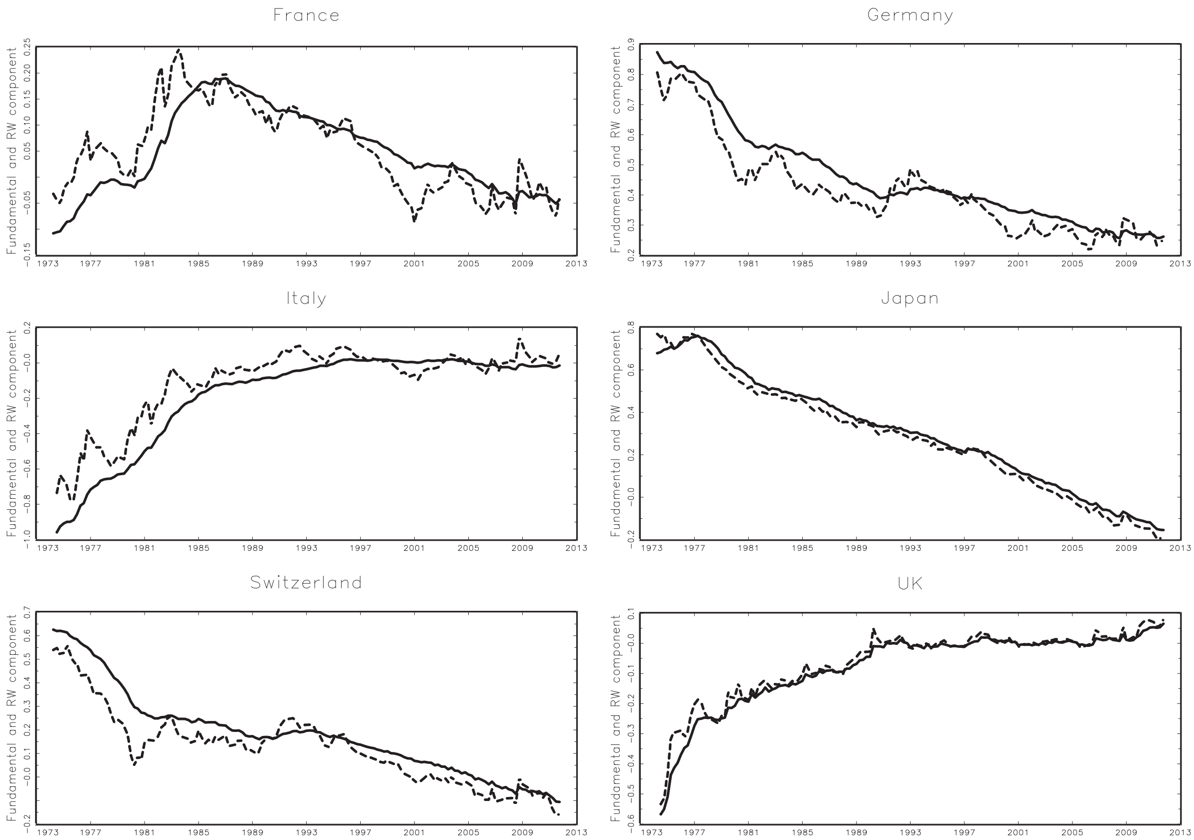


Figure 3: Random Walk Components and Nominal Exchange Rates: $f_t = p_t - p_t^*$



Note: The solid lines are s_t for each country, and the dashed lines are the random walk components defined as the multivariate Beveridge-Nelson trends.

Figure 4: Random Walk Components and Fundamentals: $f_t = p_t - p_t^*$



Note: The solid lines are f_t for each country, and the dashed lines are the random walk components defined as the multivariate Beveridge-Nelson trends.

Table 1: DF-GLS Unit Root Tests

	s_t	$p_t - p_t^*$	$p_t - p_t^* + i_t - i_t^*$	Δs_t	$\Delta(p_t - p_t^*)$	$\Delta(p_t - p_t^* + i_t - i_t^*)$
France	-1.466	-0.636	-0.849	-3.762*	-2.029*	-1.995*
Germany	-0.567	0.570	0.808	-2.732*	-2.567*	-2.724*
Italy	-0.222	-0.207	0.527	-4.663*	-4.551*	-2.685*
Japan	0.242	0.298	0.529	-4.928*	-2.978*	-3.975*
Switzerland	0.365	0.983	0.306	-5.054*	-1.970*	-5.846*
UK	-0.919	1.056	0.953	-1.958*	-2.204*	-2.403*

Note: An intercept is included in the testing equation, the lag length are chosen by modified Akaike information criterion. * indicates significance at 10% or above.

Table 2: Cointegrating Coefficient Estimates and Cointegration Tests

$f_t = p_t - p_t^*$					
	β	Wald Test	PO_z	L_c	Trace
France	1.614*	1.587	-18.157*	0.001	11.509
	(0.001)	(0.208)	(0.072)		(0.182)
Germany	1.039*	0.022	-17.607*	0.002	15.463*
	(0.000)	(0.883)	(0.081)		(0.051)
Italy	1.243*	2.082	-16.793*	0.001	27.200*
	(0.000)	(0.149)	(0.096)		(0.001)
Japan	1.263*	1.906	-18.043*	0.001	7.256
	(0.000)	(0.167)	(0.073)		(0.548)
Switzerland	1.374*	1.771	-22.399*	0.001	16.075*
	(0.000)	(0.183)	(0.028)		(0.041)
UK	0.302	0.106	-21.624*	0.003	31.598*
	(0.888)	(0.745)	(0.034)		(0.000)

$f_t = p_t - p_t^* + i_t - i_t^*$					
	β	Wald Test	PO_z	L_c	Trace
France	1.401*	0.556	-17.122*	0.001	13.884*
	(0.010)	(0.456)	(0.089)		(0.086)
Germany	1.047*	0.035	-16.930*	0.001	11.594
	(0.000)	(0.852)	(0.093)		(0.178)
Italy	1.039*	0.043	-16.705*	0.003	25.829*
	(0.000)	(0.834)	(0.097)		(0.001)
Japan	1.248*	2.607	-17.085*	0.001	5.670
	(0.000)	(0.106)	(0.090)		(0.734)
Switzerland	1.426*	0.935	-17.955*	0.001	14.006*
	(0.002)	(0.336)	(0.074)		(0.083)
UK	0.484	1.458	-22.425*	0.001	29.444*
	(0.260)	(0.227)	(0.028)		(0.000)

Note: The entries in parentheses are associated p-values. * indicates significance at 10% level or above.

Table 3: Estimates from VECMs

	$f_t = p_t - p_t^*$		$f_t = p_t - p_t^* + i_t - i_t^*$	
	α_1	α_2	α_1	α_2
France	-0.089*	0.001	-0.062*	0.014*
	(-2.549)	(0.330)	(-2.024)	(2.247)
Germany	-0.075*	0.002	-0.073*	0.007
	(-2.408)	(0.842)	(-2.332)	(1.228)
Italy	-0.108*	0.005	-0.069*	0.013
	(-3.151)	(1.172)	(-2.315)	(1.401)
Japan	-0.071*	0.004	-0.051*	0.012*
	(-2.521)	(1.356)	(-1.808)	(1.795)
Switzerland	-0.091*	0.002	-0.069*	0.009
	(-2.604)	(0.560)	(-1.982)	(1.155)
UK	-0.119*	-0.003	-0.061*	0.034*
	(-3.211)	(-0.483)	(-2.087)	(3.112)

Note: t-statistics are given in parentheses, * denotes significance at the 10% level or above.

Table 4: Forecast Error Variance Decomposition of $\Delta s_{t+h} - E_t \Delta s_{t+h}$: $f_t = p_t - p_t^*$

		$h=1$	$h=4$	$h=8$	$h=12$	$h=16$	$h=32$
France ($\alpha_2 = 0$)	P	0.034	0.076	0.099	0.127	0.158	0.290
		[0.000 , 0.074]	[0.003 , 0.168]	[0.003 , 0.246]	[0.003 , 0.327]	[0.004 , 0.394]	[0.014 , 0.543]
	T	0.966	0.924	0.901	0.873	0.842	0.710
		[0.926 , 1.000]	[0.832 , 0.997]	[0.754 , 0.997]	[0.673 , 0.997]	[0.606 , 0.996]	[0.457 , 0.986]
Germany ($\alpha_2 = 0$)	P	0.020	0.031	0.022	0.019	0.019	0.068
		[0.000 , 0.056]	[0.001 , 0.092]	[0.001 , 0.109]	[0.001 , 0.144]	[0.002 , 0.177]	[0.009 , 0.313]
	T	0.980	0.969	0.978	0.981	0.981	0.932
		[0.944 , 1.000]	[0.908 , 0.999]	[0.891 , 0.999]	[0.856 , 0.999]	[0.823 , 0.998]	[0.687 , 0.991]
Italy ($\alpha_2 = 0$)	P	0.016	0.021	0.075	0.200	0.348	0.658
		[0.000 , 0.072]	[0.000 , 0.110]	[0.005 , 0.277]	[0.015 , 0.489]	[0.056 , 0.648]	[0.280 , 0.894]
	T	0.984	0.979	0.925	0.800	0.652	0.342
		[0.928 , 1.000]	[0.890 , 1.000]	[0.723 , 0.995]	[0.511 , 0.985]	[0.352 , 0.944]	[0.106 , 0.720]
Japan ($\alpha_2 = 0$)	P	0.043	0.021	0.017	0.014	0.013	0.046
		[0.000 , 0.095]	[0.002 , 0.077]	[0.001 , 0.095]	[0.001 , 0.121]	[0.002 , 0.145]	[0.007 , 0.233]
	T	0.957	0.979	0.983	0.986	0.987	0.954
		[0.905 , 1.000]	[0.923 , 0.998]	[0.905 , 0.999]	[0.879 , 0.999]	[0.855 , 0.998]	[0.767 , 0.993]
Switzerland ($\alpha_2 = 0$)	P	0.000	0.012	0.010	0.012	0.018	0.120
		[0.000 , 0.025]	[0.000 , 0.067]	[0.000 , 0.097]	[0.001 , 0.142]	[0.002 , 0.184]	[0.015 , 0.369]
	T	1.000	0.988	0.990	0.988	0.982	0.880
		[0.975 , 1.000]	[0.933 , 1.000]	[0.903 , 1.000]	[0.858 , 0.999]	[0.816 , 0.998]	[0.631 , 0.985]
UK ($\alpha_2 = 0$)	P	0.010	0.025	0.136	0.273	0.369	0.537
		[0.000 , 0.064]	[0.000 , 0.136]	[0.005 , 0.362]	[0.022 , 0.547]	[0.078 , 0.659]	[0.221 , 0.808]
	T	0.990	0.975	0.864	0.727	0.631	0.463
		[0.936 , 1.000]	[0.864 , 1.000]	[0.638 , 0.995]	[0.453 , 0.978]	[0.341 , 0.922]	[0.192 , 0.779]

Note: The table reports the fraction of the variance in the h-step-ahead forecast error of the variable listed at the top of the table that is attributable to the permanent shock P and the transitory shock T. Values in square brackets define the 90% bootstrap confidence intervals.

Table 5: Forecast Error Variance Decomposition of $\Delta f_{t+h} - E_t \Delta f_{t+h}$: $f_t = p_t - p_t^*$

		$h=1$	$h=4$	$h=8$	$h=12$	$h=16$	$h=32$
France ($\alpha_2 = 0$)	P	1.000	0.939	0.910	0.910	0.921	0.962
		[1.000 , 1.000]	[0.881 , 1.000]	[0.831 , 0.999]	[0.832 , 1.000]	[0.853 , 1.000]	[0.924 , 1.000]
	T	0.000	0.061	0.090	0.090	0.079	0.038
		[0.000 , 0.000]	[0.000 , 0.119]	[0.001 , 0.169]	[0.000 , 0.168]	[0.000 , 0.147]	[0.000 , 0.076]
Germany ($\alpha_2 = 0$)	P	1.000	0.932	0.911	0.911	0.921	0.960
		[1.000 , 1.000]	[0.870 , 0.999]	[0.827 , 0.999]	[0.828 , 1.000]	[0.848 , 1.000]	[0.920 , 1.000]
	T	0.000	0.068	0.089	0.089	0.079	0.040
		[0.000 , 0.000]	[0.001 , 0.130]	[0.001 , 0.173]	[0.000 , 0.172]	[0.000 , 0.152]	[0.000 , 0.080]
Italy ($\alpha_2 = 0$)	P	1.000	0.942	0.923	0.930	0.944	0.980
		[1.000 , 1.000]	[0.856 , 0.997]	[0.791 , 0.999]	[0.796 , 0.999]	[0.827 , 1.000]	[0.923 , 1.000]
	T	0.000	0.058	0.077	0.070	0.056	0.020
		[0.000 , 0.000]	[0.003 , 0.144]	[0.001 , 0.209]	[0.001 , 0.204]	[0.000 , 0.173]	[0.000 , 0.077]
Japan ($\alpha_2 = 0$)	P	1.000	0.983	0.936	0.915	0.916	0.953
		[1.000 , 1.000]	[0.943 , 1.000]	[0.849 , 1.000]	[0.822 , 1.000]	[0.830 , 1.000]	[0.902 , 1.000]
	T	0.000	0.017	0.064	0.085	0.084	0.047
		[0.000 , 0.000]	[0.000 , 0.057]	[0.000 , 0.151]	[0.000 , 0.178]	[0.000 , 0.170]	[0.000 , 0.098]
Switzerland ($\alpha_2 = 0$)	P	1.000	0.963	0.945	0.945	0.952	0.978
		[1.000 , 1.000]	[0.914 , 1.000]	[0.874 , 1.000]	[0.876 , 1.000]	[0.894 , 1.000]	[0.948 , 1.000]
	T	0.000	0.037	0.055	0.055	0.048	0.022
		[0.000 , 0.000]	[0.000 , 0.086]	[0.000 , 0.126]	[0.000 , 0.124]	[0.000 , 0.106]	[0.000 , 0.052]
UK ($\alpha_2 = 0$)	P	1.000	0.999	0.999	1.000	1.000	1.000
		[1.000 , 1.000]	[0.968 , 1.000]	[0.940 , 1.000]	[0.940 , 1.000]	[0.950 , 1.000]	[0.974 , 1.000]
	T	0.000	0.001	0.001	0.000	0.000	0.000
		[0.000 , 0.000]	[0.000 , 0.032]	[0.000 , 0.060]	[0.000 , 0.060]	[0.000 , 0.050]	[0.000 , 0.026]

Note: The table reports the fraction of the variance in the h-step-ahead forecast error of the variable listed at the top of the table that is attributable to the permanent shock P and the transitory shock T. Values in square brackets define the 90% bootstrap confidence intervals.

Table 6: Forecast Error Variance Decomposition of $\Delta s_{t+h} - E_t \Delta s_{t+h}$: $f_t = p_t - p_t^* + i_t - i_t^*$

		$h = 1$	$h = 4$	$h = 8$	$h = 12$	$h = 16$	$h = 32$
France	P	0.399	0.454	0.495	0.528	0.556	0.633
		[0.000 , 0.720]	[0.000 , 0.761]	[0.003 , 0.793	[0.070 , 0.863]	[0.112 , 0.883]	[0.261 , 0.926]
	T	0.601	0.546	0.505	0.472	0.444	0.367
		[0.280 , 1.000]	[0.239 , 1.000]	[0.207 , 0.997]	[0.137 , 0.930]	[0.117 , 0.888]	[0.074 , 0.739]
Germany ($\alpha_2 = 0$)	P	0.000	0.000	0.001	0.003	0.012	0.124
		[0.000 , 0.035]	[0.000 , 0.065]	[0.000 , 0.116]	[0.001 , 0.181]	[0.001 , 0.243]	[0.010 , 0.456]
	T	1.000	1.000	0.999	0.997	0.988	0.876
		[0.965 , 1.000]	[0.935 , 1.000]	[0.884 , 1.000]	[0.819 , 0.999]	[0.757 , 0.999]	[0.544 , 0.990]
Italy ($\alpha_2 = 0$)	P	0.030	0.136	0.226	0.283	0.328	0.449
		[0.000 , 0.071]	[0.023 , 0.253]	[0.059 , 0.402]	[0.110 , 0.496]	[0.140 , 0.542]	[0.264 , 0.666]
	T	0.970	0.864	0.774	0.717	0.672	0.551
		[0.929 , 1.000]	[0.747 , 0.977]	[0.598 , 0.941]	[0.504 , 0.890]	[0.458 , 0.860]	[0.334 , 0.736]
Japan	P	0.324	0.308	0.291	0.295	0.309	0.380
		[0.000 , 0.808]	[0.000 , 0.786]	[0.001 , 0.776]	[0.001 , 0.778]	[0.002 , 0.790]	[0.032 , 0.834]
	T	0.676	0.692	0.709	0.705	0.691	0.620
		[0.192 , 1.000]	[0.214 , 1.000]	[0.224 , 0.999]	[0.222 , 0.999]	[0.210 , 0.998]	[0.166 , 0.968]
Switzerland ($\alpha_2 = 0$)	P	0.000	0.002	0.004	0.011	0.028	0.204
		[0.000 , 0.035]	[0.000 , 0.072]	[0.000 , 0.138]	[0.000 , 0.234]	[0.000 , 0.325]	[0.006 , 0.594]
	T	1.000	0.998	0.996	0.989	0.972	0.796
		[0.965 , 1.000]	[0.928 , 1.000]	[0.862 , 1.000]	[0.766 , 1.000]	[0.675 , 1.000]	[0.406 , 0.994]
UK	P	0.672	0.739	0.782	0.811	0.833	0.883
		[0.217 , 0.971]	[0.322 , 1.000]	[0.405 , 1.000]	[0.468 , 1.000]	[0.522 , 1.000]	[0.654 , 1.000]
	T	0.328	0.261	0.218	0.189	0.167	0.117
		[0.029 , 0.783]	[0.000 , 0.678]	[0.000 , 0.595]	[0.000 , 0.532]	[0.000 , 0.478]	[0.000 , 0.346]

Note: The table reports the fraction of the variance in the h-step-ahead forecast error of the variable listed at the top of the table that is attributable to the permanent shock P and the transitory shock T. Values in square brackets define the 90% bootstrap confidence intervals.

Table 7: Forecast Error Variance Decomposition of $\Delta f_{t+h} - E_t \Delta f_{t+h}$: $f_t = p_t - p_t^* + i_t - i_t^*$

		$h=1$	$h=4$	$h=8$	$h=12$	$h=16$	$h=32$
France	P	0.627	0.799	0.867	0.903	0.925	0.964
		[0.305 , 1.000]	[0.531 , 1.000]	[0.675 , 1.000]	[0.762 , 1.000]	[0.821 , 1.000]	[0.918 , 1.000]
	T	0.373	0.201	0.133	0.097	0.075	0.036
		[0.000 , 0.695]	[0.000 , 0.469]	[0.000 , 0.325]	[0.000 , 0.238]	[0.000 , 0.179]	[0.000 , 0.082]
Germany ($\alpha_2 = 0$)	P	1.000	0.971	0.945	0.938	0.942	0.970
		[1.000 , 1.000]	[0.905 , 1.000]	[0.834 , 1.000]	[0.818 , 1.000]	[0.830 , 1.000]	[0.907 , 1.000]
	T	0.000	0.029	0.055	0.062	0.058	0.030
		[0.000 , 0.000]	[0.000 , 0.095]	[0.000 , 0.166]	[0.000 , 0.182]	[0.000 , 0.170]	[0.000 , 0.093]
Italy ($\alpha_2 = 0$)	P	1.000	0.995	0.995	0.996	0.996	0.998
		[1.000 , 1.000]	[0.976 , 1.000]	[0.976 , 1.000]	[0.981 , 1.000]	[0.985 , 1.000]	[0.992 , 1.000]
	T	0.000	0.005	0.005	0.004	0.004	0.002
		[0.000 , 0.000]	[0.000 , 0.024]	[0.000 , 0.024]	[0.000 , 0.019]	[0.000 , 0.015]	[0.000 , 0.008]
Japan	P	0.492	0.762	0.906	0.941	0.955	0.977
		[0.071 , 1.000]	[0.353 , 0.982]	[0.597 , 0.970]	[0.696 , 0.979]	[0.752 , 0.984]	[0.870 , 0.993]
	T	0.508	0.238	0.094	0.059	0.045	0.023
		[0.000 , 0.929]	[0.018 , 0.647]	[0.030 , 0.403]	[0.021 , 0.304]	[0.016 , 0.248]	[0.007 , 0.130]
Switzerland ($\alpha_2 = 0$)	P	1.000	0.972	0.956	0.953	0.956	0.977
		[1.000 , 1.000]	[0.900 , 1.000]	[0.835 , 1.000]	[0.823 , 1.000]	[0.835 , 1.000]	[0.909 , 1.000]
	T	0.000	0.028	0.044	0.047	0.044	0.023
		[0.000 , 0.000]	[0.000 , 0.100]	[0.000 , 0.165]	[0.000 , 0.177]	[0.000 , 0.165]	[0.000 , 0.091]
UK	P	0.272	0.419	0.595	0.714	0.789	0.908
		[0.000 , 0.711]	[0.149 , 0.893]	[0.392 , 0.960]	[0.581 , 0.986]	[0.685 , 0.983]	[0.867 , 0.991]
	T	0.728	0.581	0.405	0.286	0.211	0.092
		[0.289 , 1.000]	[0.107 , 0.851]	[0.040 , 0.608]	[0.014 , 0.419]	[0.017 , 0.315]	[0.009 , 0.133]

Note: The table reports the fraction of the variance in the h-step-ahead forecast error of the variable listed at the top of the table that is attributable to the permanent shock P and the transitory shock T. Values in square brackets define the 90% bootstrap confidence intervals.

Table 8: Unorthogonalized Forecast Error Variance Decomposition: $f_t = p_t - p_t^*$

Forecast Error Variance Decomposition of $\Delta s_{t+h} - E_t \Delta s_{t+h}$							
		$h=1$	$h=4$	$h=8$	$h=12$	$h=16$	$h=32$
France ($\alpha_2 = 0$)	$\tilde{P}$	0.008	0.035	0.052	0.075	0.103	0.236
	$\tilde{T}$	0.975	0.932	0.909	0.881	0.849	0.717
	$\tilde{P},\tilde{T}$	0.017	0.033	0.039	0.044	0.048	0.048
Germany ($\alpha_2 = 0$)	$\tilde{P}$	0.009	0.018	0.012	0.010	0.010	0.056
	$\tilde{T}$	0.982	0.971	0.980	0.983	0.983	0.934
	$\tilde{P},\tilde{T}$	0.008	0.011	0.008	0.007	0.007	0.010
Italy ($\alpha_2 = 0$)	$\tilde{P}$	0.020	0.024	0.080	0.206	0.352	0.663
	$\tilde{T}$	0.959	0.954	0.885	0.749	0.603	0.312
	$\tilde{P},\tilde{T}$	0.021	0.022	0.034	0.045	0.045	0.025
Japan ($\alpha_2 = 0$)	$\tilde{P}$	0.012	0.034	0.040	0.047	0.057	0.108
	$\tilde{T}$	0.957	0.917	0.907	0.895	0.882	0.824
	$\tilde{P},\tilde{T}$	0.031	0.049	0.053	0.057	0.061	0.067
Switzerland ($\alpha_2 = 0$)	$\tilde{P}$	0.010	0.031	0.029	0.031	0.039	0.141
	$\tilde{T}$	0.964	0.925	0.929	0.925	0.915	0.810
	$\tilde{P},\tilde{T}$	0.026	0.044	0.042	0.044	0.047	0.049
UK ($\alpha_2 = 0$)	$\tilde{P}$	0.035	0.058	0.188	0.333	0.428	0.585
	$\tilde{T}$	0.997	0.982	0.871	0.732	0.635	0.466
	$\tilde{P},\tilde{T}$	-0.032	-0.041	-0.059	-0.065	-0.063	-0.051
Forecast Error Variance Decomposition of $\Delta f_{t+h} - E_t \Delta f_{t+h}$							
		$h=1$	$h=4$	$h=8$	$h=12$	$h=16$	$h=32$
France ($\alpha_2 = 0$)	$\tilde{P}$	1.000	0.899	0.859	0.858	0.872	0.931
	$\tilde{T}$	0.000	0.062	0.090	0.091	0.080	0.038
	$\tilde{P},\tilde{T}$	0.000	0.040	0.051	0.052	0.049	0.031
Germany ($\alpha_2 = 0$)	$\tilde{P}$	1.000	0.912	0.887	0.887	0.898	0.945
	$\tilde{T}$	0.000	0.068	0.089	0.089	0.079	0.040
	$\tilde{P},\tilde{T}$	0.000	0.020	0.024	0.025	0.024	0.016
Italy ($\alpha_2 = 0$)	$\tilde{P}$	1.006	0.945	0.919	0.920	0.931	0.970
	$\tilde{T}$	0.008	0.034	0.050	0.048	0.040	0.015
	$\tilde{P},\tilde{T}$	-0.014	0.020	0.031	0.032	0.029	0.016
Japan ($\alpha_2 = 0$)	$\tilde{P}$	0.920	0.976	0.998	0.987	0.978	0.978
	$\tilde{T}$	0.204	0.113	0.038	0.022	0.018	0.010
	$\tilde{P},\tilde{T}$	-0.124	-0.089	-0.037	-0.009	0.004	0.012
Switzerland ($\alpha_2 = 0$)	$\tilde{P}$	1.013	0.992	0.969	0.959	0.958	0.973
	$\tilde{T}$	0.045	0.012	0.012	0.014	0.014	0.007
	$\tilde{P},\tilde{T}$	-0.058	-0.004	0.020	0.027	0.028	0.020
UK ($\alpha_2 = 0$)	$\tilde{P}$	1.000	0.998	0.998	1.000	1.001	1.001
	$\tilde{T}$	0.000	0.001	0.001	0.000	0.000	0.000
	$\tilde{P},\tilde{T}$	0.000	0.002	0.002	0.000	-0.001	-0.001

Note: The table reports the fraction of the variance in the h-step-ahead forecast error of the variable listed at the top of the table that is attributable to the permanent shock $\tilde{P}$ and the transitory shock $\tilde{T}$, and two times the covariance between $\tilde{P}$ and $\tilde{T}$.

Table 9: Unorthogonalized Forecast Error Variance Decomposition: $f_t = p_t - p_t^* + i_t - i_t^*$

Forecast Error Variance Decomposition of $\Delta s_{t+h} - E_t \Delta s_{t+h}$							
		$h=1$	$h=4$	$h=8$	$h=12$	$h=16$	$h=32$
France	$\tilde{P}$	0.055	0.088	0.119	0.148	0.177	0.282
	$\tilde{T}$	0.759	0.690	0.638	0.597	0.561	0.463
	$\tilde{P}, \tilde{T}$	0.186	0.222	0.243	0.256	0.262	0.255
Germany ($\alpha_2 = 0$)	$\tilde{P}$	0.039	0.048	0.054	0.064	0.081	0.201
	$\tilde{T}$	0.857	0.840	0.828	0.810	0.785	0.667
	$\tilde{P}, \tilde{T}$	0.103	0.112	0.118	0.126	0.133	0.132
Italy ($\alpha_2 = 0$)	$\tilde{P}$	0.025	0.127	0.214	0.271	0.315	0.437
	$\tilde{T}$	0.970	0.864	0.774	0.717	0.673	0.552
	$\tilde{P}, \tilde{T}$	0.005	0.009	0.011	0.012	0.012	0.012
Japan	$\tilde{P}$	0.055	0.047	0.039	0.041	0.049	0.108
	$\tilde{T}$	0.789	0.808	0.827	0.822	0.806	0.723
	$\tilde{P}, \tilde{T}$	0.157	0.146	0.134	0.137	0.145	0.169
Switzerland ($\alpha_2 = 0$)	$\tilde{P}$	0.056	0.061	0.074	0.093	0.123	0.302
	$\tilde{T}$	0.811	0.803	0.780	0.749	0.711	0.546
	$\tilde{P}, \tilde{T}$	0.132	0.136	0.146	0.158	0.166	0.152
UK	$\tilde{P}$	0.179	0.258	0.323	0.378	0.426	0.571
	$\tilde{T}$	0.485	0.387	0.324	0.280	0.247	0.173
	$\tilde{P}, \tilde{T}$	0.336	0.355	0.354	0.343	0.327	0.257
Forecast Error Variance Decomposition of $\Delta f_{t+h} - E_t \Delta f_{t+h}$							
		$h=1$	$h=4$	$h=8$	$h=12$	$h=16$	$h=32$
France	$\tilde{P}$	1.221	1.251	1.232	1.206	1.182	1.112
	$\tilde{T}$	0.471	0.254	0.168	0.123	0.095	0.046
	$\tilde{P}, \tilde{T}$	-0.692	-0.504	-0.400	-0.329	-0.277	-0.158
Germany ($\alpha_2 = 0$)	$\tilde{P}$	1.039	1.062	1.046	1.020	1.003	0.991
	$\tilde{T}$	0.246	0.116	0.044	0.023	0.015	0.007
	$\tilde{P}, \tilde{T}$	-0.285	-0.178	-0.090	-0.043	-0.019	0.002
Italy ($\alpha_2 = 0$)	$\tilde{P}$	1.000	0.993	0.992	0.994	0.995	0.997
	$\tilde{T}$	0.000	0.005	0.005	0.004	0.004	0.002
	$\tilde{P}, \tilde{T}$	0.000	0.002	0.002	0.002	0.002	0.001
Japan	$\tilde{P}$	0.985	1.090	1.045	0.990	0.966	0.959
	$\tilde{T}$	0.593	0.277	0.110	0.069	0.053	0.027
	$\tilde{P}, \tilde{T}$	-0.578	-0.368	-0.155	-0.059	-0.019	0.014
Switzerland ($\alpha_2 = 0$)	$\tilde{P}$	1.058	1.082	1.075	1.055	1.038	1.012
	$\tilde{T}$	0.276	0.137	0.060	0.031	0.019	0.007
	$\tilde{P}, \tilde{T}$	-0.333	-0.219	-0.134	-0.086	-0.058	-0.019
UK	$\tilde{P}$	1.240	1.367	1.415	1.385	1.334	1.183
	$\tilde{T}$	1.079	0.861	0.601	0.424	0.312	0.136
	$\tilde{P}, \tilde{T}$	-1.319	-1.228	-1.015	-0.809	-0.647	-0.319

Note: The table reports the fraction of the variance in the h-step-ahead forecast error of the variable listed at the top of the table that is attributable to the permanent shock $\tilde{P}$ and the transitory shock $\tilde{T}$, and two times the covariance between $\tilde{P}$ and $\tilde{T}$.

Table 10: Correlation of Δs_t and Δf_t with Random Walk and Transitory Components

	$f_t = p_t - p_t^*$			
	Correlation with Random Walk Components		Correlation with Transitory Components	
	$Corr(\Delta s_t, \Delta s_t^T)$	$Corr(\Delta f_t, \Delta f_t^T)$	$Corr(\Delta s_t, \Delta s_t^C)$	$Corr(\Delta f_t, \Delta f_t^C)$
France ($\alpha_2 = 0$)	0.187	0.735	0.926	-0.540
Germany ($\alpha_2 = 0$)	0.123	0.760	0.929	-0.567
Italy ($\alpha_2 = 0$)	0.112	0.659	0.791	-0.458
Japan ($\alpha_2 = 0$)	0.232	0.704	0.973	-0.161
Switzerland ($\alpha_2 = 0$)	0.014	0.761	0.931	-0.575
UK ($\alpha_2 = 0$)	0.075	0.811	0.921	-0.440
	$f_t = p_t - p_t^* + i_t - i_t^*$			
	Correlation with Random Walk Components		Correlation with Transitory Components	
	$Corr(\Delta s_t, \Delta s_t^T)$	$Corr(\Delta f_t, \Delta f_t^T)$	$Corr(\Delta s_t, \Delta s_t^C)$	$Corr(\Delta f_t, \Delta f_t^C)$
France	0.618	0.742	0.953	-0.082
Germany ($\alpha_2 = 0$)	-0.032	0.894	0.927	-0.642
Italy ($\alpha_2 = 0$)	0.144	0.811	0.933	-0.421
Japan	0.540	0.611	0.949	0.219
Switzerland ($\alpha_2 = 0$)	0.002	0.900	0.858	-0.741
UK	0.804	0.502	0.874	0.244

Note: The correlations are calculated with the coefficients of adjustment speed are set to zero if they are insignificant at 10% level. Δs_t^T denotes the random walk components, and Δs_t^C denotes the transitory components based on the multivariate Beveridge–Nelson decomposition.

Table 11: Long-Horizon Regression: $f_t = p_t - p_t^*$. Dependent Variable is $s_{t+h} - s_t$

		$s_{t+h} - s_t$ regressed on					
		$h = 1$	$h = 4$	$h = 8$	$h = 12$	$h = 16$	$h = 32$
France	Δs_t	0.112	0.351*	0.637*	0.652*	0.685*	0.203
	t-ratio	(1.375)	(2.056)	(2.360)	(1.881)	(1.838)	(1.370)
	Δf_t	1.165*	2.174	5.595	5.558	5.298	15.293*
	t-ratio	(1.844)	(0.638)	(0.989)	(1.048)	(1.222)	(2.142)
	z_t	-0.081*	-0.312*	-0.709*	-1.036*	-1.320*	-1.766*
	t-ratio	(-2.387)	(-3.166)	(-6.467)	(-6.017)	(-5.394)	(-10.664)
	$\overline{R}^2$	[0.040]	[0.138]	[0.326]	[0.436]	[0.539]	[0.727]
Germany	Δs_t	0.072	0.293	0.515*	0.409*	0.518*	0.083
	t-ratio	(0.978)	(1.526)	(2.704)	(2.073)	(1.782)	(0.553)
	Δf_t	0.643	-1.090	-0.841	-1.493	-1.976	8.759*
	t-ratio	(0.912)	(-0.848)	(-0.646)	(-1.015)	(-0.534)	(2.727)
	z_t	-0.074*	-0.258*	-0.600*	-0.835*	-1.054*	-1.385*
	t-ratio	(-2.264)	(-2.323)	(-5.540)	(-8.888)	(-9.510)	(-11.730)
	$\overline{R}^2$	[0.020]	[0.116]	[0.277]	[0.385]	[0.498]	[0.782]
Italy	Δs_t	0.137*	0.382*	0.626*	0.588*	0.723*	0.447
	t-ratio	(1.661)	(1.863)	(3.096)	(2.270)	(1.854)	(1.112)
	Δf_t	0.957*	2.805*	6.614*	7.698*	9.055*	15.529*
	t-ratio	(2.649)	(1.989)	(2.428)	(2.823)	(3.500)	(2.856)
	z_t	-0.078*	-0.306*	-0.705*	-0.972*	-1.214*	-1.692*
	t-ratio	(-2.170)	(-2.748)	(-4.773)	(-6.729)	(-5.969)	(-7.709)
	$\overline{R}^2$	[0.050]	[0.140]	[0.320]	[0.351]	[0.409]	[0.504]
Japan	Δs_t	0.105	0.391*	0.240	0.235	-0.147	0.500
	t-ratio	(1.432)	(2.362)	(1.035)	(1.017)	(-1.314)	(1.633)
	Δf_t	0.615	0.741	0.107	-0.114	-0.928	8.403*
	t-ratio	(1.523)	(0.432)	(0.036)	(-0.032)	(-0.361)	(7.472)
	z_t	-0.050*	-0.197*	-0.414*	-0.629*	-0.735*	-0.938*
	t-ratio	(-1.815)	(-1.941)	(-3.479)	(-5.457)	(-6.918)	(-5.670)
	$\overline{R}^2$	[0.013]	[0.089]	[0.193]	[0.342]	[0.462]	[0.607]
Switzerland	Δs_t	0.035	0.243	0.332*	0.190	0.385*	0.039
	t-ratio	(0.478)	(1.358)	(2.307)	(1.132)	(1.816)	(0.345)
	Δf_t	0.617	-0.535	-0.197	-2.156	-4.819*	0.986
	t-ratio	(0.882)	(-0.383)	(-0.135)	(-1.620)	(-1.767)	(0.314)
	z_t	-0.075*	-0.283*	-0.625*	-0.846*	-1.058*	-1.068*
	t-ratio	(-2.197)	(-2.392)	(-5.697)	(-8.211)	(-5.842)	(-8.779)
	$\overline{R}^2$	[0.018]	[0.112]	[0.267]	[0.382]	[0.517]	[0.640]
UK	Δs_t	0.189*	0.276	0.492*	0.430	0.170	-0.288
	t-ratio	(2.200)	(1.592)	(1.787)	(1.506)	(0.578)	(-1.223)
	Δf_t	0.574	1.620	2.914*	2.897*	2.305*	6.724*
	t-ratio	(1.497)	(1.573)	(2.787)	(3.543)	(1.887)	(4.632)
	z_t	-0.081*	-0.303*	-0.599*	-0.818*	-0.986*	-0.331
	t-ratio	(-2.207)	(-3.302)	(-3.974)	(-4.018)	(-4.140)	(-0.947)
	$\overline{R}^2$	[0.054]	[0.130]	[0.249]	[0.314]	[0.396]	[0.219]

Note: The numbers in parentheses are Newey–West corrected t-statistics (using Quadratic Spectral Kernel) and the numbers in square brackets are adjusted R^2 statistics. *denote the significance at the 10% level or above.

Table 12: Long-Horizon Regression: $f_t = p_t - p_t^*$. Dependent Variable is $f_{t+h} - f_t$

		$f_{t+h} - f_t$ regressed on					
		$h = 1$	$h = 4$	$h = 8$	$h = 12$	$h = 16$	$h = 32$
France	Δs_t	0.013	0.047*	0.105*	0.172*	0.205*	0.180*
	t-ratio	(1.276)	(1.709)	(1.849)	(1.990)	(1.921)	(2.113)
	Δf_t	0.466*	1.790*	3.369*	4.348*	5.770*	9.986*
	t-ratio	(4.059)	(4.695)	(4.597)	(4.361)	(6.378)	(3.562)
	z_t	0.003	0.001	-0.023	-0.069	-0.136	-0.338*
	t-ratio	(1.284)	(0.107)	(-0.750)	(-1.264)	(-1.639)	(-2.582)
	$\overline{R}^2$	[0.258]	[0.373]	[0.365]	[0.313]	[0.337]	[0.405]
Germany	Δs_t	0.006	0.028*	0.073*	0.096*	0.095*	-0.035
	t-ratio	(0.572)	(1.710)	(2.268)	(2.590)	(2.722)	(-0.522)
	Δf_t	0.360*	1.244*	2.029*	2.263*	2.552*	3.295*
	t-ratio	(5.425)	(3.062)	(3.337)	(4.881)	(6.150)	(3.005)
	z_t	0.006*	0.018	0.022	0.017	0.015	0.085
	t-ratio	(1.748)	(0.930)	(0.506)	(0.265)	(0.193)	(0.748)
	$\overline{R}^2$	[0.159]	[0.269]	[0.216]	[0.130]	[0.090]	[0.104]
Italy	Δs_t	0.015	0.089*	0.171*	0.241*	0.287*	0.264
	t-ratio	(0.950)	(2.015)	(2.155)	(2.384)	(1.960)	(0.825)
	Δf_t	0.566*	2.000*	3.788*	5.437*	7.078*	12.221*
	t-ratio	(7.852)	(8.215)	(5.765)	(5.434)	(6.292)	(5.588)
	z_t	0.009*	0.022	0.002	-0.042	-0.111	-0.237
	t-ratio	(1.865)	(1.144)	(0.069)	(-0.765)	(-1.476)	(-1.373)
	$\overline{R}^2$	[0.396]	[0.463]	[0.442]	[0.407]	[0.399]	[0.354]
Japan	Δs_t	0.011	0.070*	0.158*	0.210*	0.223*	0.087
	t-ratio	(0.865)	(2.568)	(3.067)	(3.004)	(2.414)	(0.993)
	Δf_t	0.253*	1.310*	2.077*	2.523*	2.588*	0.984*
	t-ratio	(2.574)	(5.288)	(4.762)	(3.070)	(2.550)	(2.347)
	z_t	0.013*	0.035*	0.041	0.032	0.008	0.006
	t-ratio	(3.689)	(2.381)	(1.433)	(0.831)	(0.206)	(0.167)
	$\overline{R}^2$	[0.155]	[0.409]	[0.386]	[0.309]	[0.237]	[0.047]
Switzerland	Δs_t	0.010	0.026	0.084*	0.152*	0.194*	0.145
	t-ratio	(0.928)	(1.274)	(1.884)	(2.046)	(1.840)	(0.786)
	Δf_t	0.206*	1.224*	2.276*	2.736*	3.327*	3.091*
	t-ratio	(1.733)	(2.374)	(2.219)	(2.137)	(2.561)	(6.610)
	z_t	0.006	0.015	0.011	-0.022	-0.066	-0.060
	t-ratio	(1.496)	(0.956)	(0.402)	(-0.521)	(-1.007)	(-0.406)
	$\overline{R}^2$	[0.053]	[0.237]	[0.232]	[0.169]	[0.149]	[0.047]
UK	Δs_t	-0.009	-0.016	-0.008	-0.024	-0.041	-0.042
	t-ratio	(-0.444)	(-0.409)	(-0.159)	(-0.439)	(-0.808)	(-0.371)
	Δf_t	0.219	1.046*	1.628*	1.827*	2.022*	2.872*
	t-ratio	(1.583)	(3.662)	(3.154)	(3.649)	(4.415)	(4.606)
	z_t	0.017*	0.065*	0.123	0.160	0.209	0.351*
	t-ratio	(2.749)	(1.749)	(1.558)	(1.470)	(1.627)	(1.956)
	$\overline{R}^2$	[0.081]	[0.264]	[0.246]	[0.214]	[0.238]	[0.298]

Note: The numbers in parentheses are Newey–West corrected t-statistics (using Quadratic Spectral Kernel) and the numbers in square brackets are adjusted R^2 statistics. *denote the significance at the 10% level or above.

Table 13: Long-Horizon Regression: $f_t = p_t - p_t^* + i_t - i_t^*$. Dependent Variable is $s_{t+h} - s_t$

		$s_{t+h} - s_t$ regressed on					
		$h = 1$	$h = 4$	$h = 8$	$h = 12$	$h = 16$	$h = 32$
France	Δs_t	0.130	0.385*	0.719*	0.718	0.764*	0.590*
	t-ratio	(1.585)	(1.845)	(1.927)	(1.518)	(1.691)	(3.279)
	Δf_t	0.164	0.773	2.860	1.397	-0.075	3.079*
	t-ratio	(0.494)	(0.657)	(1.444)	(0.695)	(-0.042)	(1.918)
	z_t	-0.068*	-0.282*	-0.641*	-0.909*	-1.172*	-1.722*
	t-ratio	(-2.024)	(-2.959)	(-5.249)	(-4.540)	(-4.308)	(-7.918)
	$\overline{R}^2$	[0.021]	[0.117]	[0.289]	[0.348]	[0.448]	[0.707]
Germany	Δs_t	0.073	0.293	0.513*	0.371*	0.468	0.259*
	t-ratio	(0.978)	(1.468)	(2.230)	(1.788)	(1.613)	(2.605)
	Δf_t	-0.011	0.208	0.142	-0.811	-1.546*	1.371
	t-ratio	(-0.032)	(0.307)	(0.251)	(-1.358)	(-1.961)	(1.589)
	z_t	-0.060*	-0.238*	-0.542*	-0.744*	-0.951*	-1.336*
	t-ratio	(-1.902)	(-2.289)	(-5.736)	(-8.974)	(-9.589)	(-11.903)
	$\overline{R}^2$	[0.001]	[0.092]	[0.235]	[0.326]	[0.440]	[0.813]
Italy	Δs_t	0.152*	0.427*	0.701*	0.662*	0.851	0.784*
	t-ratio	(1.835)	(1.955)	(2.548)	(1.758)	(1.576)	(2.164)
	Δf_t	0.325	0.774	2.423*	2.224*	1.736*	3.800*
	t-ratio	(1.625)	(1.114)	(1.988)	(2.012)	(1.765)	(2.005)
	z_t	-0.066*	-0.271*	-0.597*	-0.805*	-1.022*	-1.550*
	t-ratio	(-1.850)	(-2.658)	(-4.326)	(-5.212)	(-3.898)	(-4.093)
	$\overline{R}^2$	[0.037]	[0.113]	[0.263]	[0.260]	[0.295]	[0.417]
Japan	Δs_t	0.088	0.362*	0.245	0.240	-0.158	0.513
	t-ratio	(1.162)	(2.007)	(1.183)	(1.089)	(-1.022)	(1.449)
	Δf_t	0.076	-0.145	-0.306	-0.841	-2.345*	2.359*
	t-ratio	(0.293)	(-0.179)	(-0.230)	(-0.573)	(-1.683)	(2.709)
	z_t	-0.035	-0.159	-0.377*	-0.579*	-0.681*	-0.913*
	t-ratio	(-1.300)	(-1.483)	(-3.006)	(-4.515)	(-5.010)	(-4.749)
	$\overline{R}^2$	[-0.004]	[0.062]	[0.159]	[0.299]	[0.460]	[0.558]
Switzerland	Δs_t	0.040	0.270	0.301*	0.113	0.223	0.057
	t-ratio	(0.506)	(1.318)	(1.696)	(0.725)	(1.259)	(0.501)
	Δf_t	-0.065	0.101	0.192	-1.190*	-2.922*	-0.414
	t-ratio	(-0.161)	(0.201)	(0.353)	(-2.823)	(-4.687)	(-0.813)
	z_t	-0.050	-0.194	-0.448*	-0.588*	-0.725*	-0.962*
	t-ratio	(-1.491)	(-1.482)	(-3.384)	(-5.376)	(-4.814)	(-7.577)
	$\overline{R}^2$	[-0.002]	[0.054]	[0.150]	[0.229]	[0.368]	[0.646]
UK	Δs_t	0.195*	0.299	0.533*	0.449	0.140	-0.221
	t-ratio	(2.222)	(1.531)	(1.667)	(1.285)	(0.374)	(-1.468)
	Δf_t	0.117	0.445	1.147	0.799*	0.163	1.854*
	t-ratio	(0.497)	(0.606)	(1.388)	(2.075)	(0.331)	(2.045)
	z_t	-0.061*	-0.238*	-0.461*	-0.627*	-0.769*	-0.151
	t-ratio	(-1.737)	(-2.553)	(-2.704)	(-2.555)	(-2.842)	(-0.332)
	$\overline{R}^2$	[0.032]	[0.082]	[0.166]	[0.208]	[0.280]	[0.050]

Note: The numbers in parentheses are Newey–West corrected t-statistics (using Quadratic Spectral Kernel) and the numbers in square brackets are adjusted R^2 statistics. *denote the significance at the 10% level or above.

Table 14: Long-Horizon Regression: $f_t = p_t - p_t^* + i_t - i_t^*$. Dependent Variable is $f_{t+h} - f_t$

		$f_{t+h} - f_t$ regressed on					
		$h = 1$	$h = 4$	$h = 8$	$h = 12$	$h = 16$	$h = 32$
France	Δs_t	0.033*	0.112	0.206	0.308	0.361*	0.389*
	t-ratio	(1.825)	(1.577)	(1.439)	(1.609)	(1.657)	(1.884)
	Δf_t	0.257*	0.649*	0.998*	1.059*	0.999*	1.895*
	t-ratio	(2.047)	(2.959)	(3.907)	(2.793)	(1.979)	(3.183)
	z_t	0.011	0.026	0.017	-0.022	-0.082	-0.200
	t-ratio	(1.469)	(1.537)	(0.386)	(-0.271)	(-0.618)	(-0.811)
	$\overline{R}^2$	[0.112]	[0.135]	[0.106]	[0.079]	[0.070]	[0.086]
Germany	Δs_t	0.019	0.062*	0.143*	0.180*	0.141*	-0.009
	t-ratio	(1.023)	(2.631)	(2.563)	(2.757)	(3.771)	(-0.114)
	Δf_t	0.092	0.290	0.541	0.522*	0.374*	0.410
	t-ratio	(0.914)	(0.902)	(1.564)	(2.355)	(4.035)	(1.133)
	z_t	0.016*	0.051*	0.068	0.067	0.075	0.225*
	t-ratio	(2.089)	(1.678)	(1.245)	(0.948)	(0.901)	(1.753)
	$\overline{R}^2$	[0.049]	[0.120]	[0.113]	[0.069]	[0.035]	[0.163]
Italy	Δs_t	0.031	0.163	0.286	0.404*	0.460	0.479
	t-ratio	(0.793)	(1.378)	(1.543)	(1.762)	(1.571)	(1.073)
	Δf_t	0.382*	0.752*	1.397*	1.721*	1.962*	3.531*
	t-ratio	(3.138)	(3.096)	(3.091)	(2.808)	(2.882)	(2.757)
	z_t	0.016	0.048	0.037	0.013	-0.050	-0.002
	t-ratio	(1.641)	(1.364)	(0.600)	(0.123)	(-0.308)	(-0.004)
	$\overline{R}^2$	[0.173]	[0.129]	[0.147]	[0.115]	[0.100]	[0.096]
Japan	Δs_t	0.036*	0.171*	0.227*	0.314*	0.324*	0.164
	t-ratio	(2.192)	(3.217)	(3.361)	(2.676)	(2.031)	(1.560)
	Δf_t	0.277*	0.578*	0.669	0.877*	0.509	-0.247*
	t-ratio	(2.349)	(1.927)	(1.539)	(1.852)	(0.956)	(-2.113)
	z_t	0.021*	0.063*	0.070	0.058	0.028	0.031
	t-ratio	(3.346)	(2.762)	(1.612)	(1.098)	(0.475)	(0.470)
	$\overline{R}^2$	[0.166]	[0.243]	[0.163]	[0.150]	[0.069]	[0.043]
Switzerland	Δs_t	0.007	0.060	0.129	0.213	0.222	0.046
	t-ratio	(0.310)	(1.237)	(1.132)	(1.171)	(1.016)	(0.230)
	Δf_t	0.068	0.546	1.005	1.229	1.093	0.576
	t-ratio	(0.702)	(1.414)	(1.491)	(1.593)	(1.403)	(1.103)
	z_t	0.014*	0.042*	0.072*	0.077*	0.075	0.250*
	t-ratio	(2.142)	(1.903)	(1.726)	(1.674)	(1.239)	(2.520)
	$\overline{R}^2$	[0.015]	[0.111]	[0.118]	[0.101]	[0.063]	[0.224]
UK	Δs_t	0.004	-0.013	-0.032	-0.018	-0.016	-0.024
	t-ratio	(0.117)	(-0.187)	(-0.295)	(-0.185)	(-0.104)	(-0.103)
	Δf_t	0.172	0.266	0.274	0.202	0.264	0.660
	t-ratio	(1.508)	(0.602)	(0.667)	(0.570)	(0.782)	(1.299)
	z_t	0.034*	0.141*	0.259*	0.313*	0.364*	0.567*
	t-ratio	(2.690)	(2.630)	(2.148)	(1.978)	(2.056)	(2.383)
	$\overline{R}^2$	[0.083]	[0.204]	[0.283]	[0.288]	[0.307]	[0.378]

Note: The numbers in parentheses are Newey–West corrected t-statistics (using Quadratic Spectral Kernel) and the numbers in square brackets are adjusted R^2 statistics. *denote the significance at the 10% level or above.