The Common Component in the Forward Premium: Evidence from the Asia-Pacific Region

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Abstract

This paper empirically analyzes the behavior of the forward premium. Unlike previous research, we use data from Asia-Pacific countries and adopt the panel data approach (Bai and Ng 2004) which allows us to decompose the forward premium into common and idiosyncratic (country-specific) components. Our data suggest the presence of one common factor and the stationarity of both common and idiosyncratic factors for short maturities, leading to the conclusion of a stationary forward premium. In contrast, the stationarity of the premium is less supported by the longer maturity data. Furthermore, a large portion of the premium fluctuation is shown to be due to a common factor, particularly over the short time horizon, which in turn can be explained by economic and financial developments in the US. In particular, when the US interest rate increases and the economy declines, the common factor tends to fall.

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1 Introduction

A forward market was developed after the end of the fixed exchange rate system (i.e., Bretton Woods) in 1971, following the US's suspension of convertibility from dollars to gold. Shifting to a flexible exchange rate regime forced financial investors to hedge against unknown exchange rate fluctuation. Given the significant size of the forward premium (Cheung 1993; Backus, Gregory and Telmer 1993; Bakaert 1994) today, it has become increasingly important to understand both forward and spot exchange rate behaviors.

The forward premium/discount (fp) (hereafter, the forward premium), which is our focus here, is defined as the difference between the forward and spot exchange rates in logarithmic form, i.e., $fp_t^j = f_t^j - s_t$ where s_t and f_t^j are the spot and j period forward exchange rates at time t respectively.[1] Classical studies often made the assumption that agents are risk neutral and form rational expectations (i.e., $s_{t+j} = Es_{t+j} + u_{t+j}$ where u_{t+j} is random with zero mean) and that the premium is stationary (i.e., $fp_t^j \sim I(0)$).[2]

Actually many recent studies rely on the assumption of the stationary premium. For example, one direction of recent research is based on the capital asset pricing type model. Groen and Balakrishnan (2006) and Lustig and Verdelhan (2007) extended the standard pricing model to link the stationary premium with consumption. The other investigative direction (e.g., Corte et al 2008) uses the information content of the stationary premium in order to predict the exchange rate. This is the line of research initially conducted by Fama (1984) who found a negative relationship between the exchange rate change and forward premium, known as the forward premium puzzle.[3] In addition, Burnside et al (2008) considered the information content in the stationary

[1] When the foreign (benchmark) country is the US and fp_t^j is negative, the forward dollar is said to be at a discount. In contrast, a positive fp_t^j corresponds to the forward dollar being at a premium.

[2] Analysis of the forward premium is also important because it is closely associated with the covered interest rate parity condition (CIP) which is one of the most important concepts in international finance. The stationarity of the forward premium also implies that the foreign exchange risk premium $(f_t^j - Es_{t+j})$ is stationary given $f_t^j - Es_{t+j} = (f_t^j - s_t) - (Es_{t+j} - s_t)$ and the academic consensus according to which changes in spot rates are stationary.

[3] Froot (1990) finds the average value of the parameters for the forward premium is equal to -0.88 based on his survey of 75 research papers.

premium in the trading strategy known as the "carry trade".

However, this assumption seems controversial.[4] On the one hand, there are studies supporting the stationarity of the premium. For example, Baillie and Bollerslev (1989) conducted a univariate analysis for spot and forward exchange rates for major industrial countries vis-a-vis the US dollar for 1980-1985. They first showed that both rates follow the $I(1)$ process and then are cointegrated with a cointegrating vector [1, -1]. Similarly, Hai et al (1997) carried out a cointegration test for the UK, France, and Japan from 1976 to 1992. Their analysis of bilateral rates also suggests that the spot and forward rates are cointegrated imposing a theoretical restriction on the cointegrating vector.

On the other hand, there are a number of researchers casting doubt on the stationarity of the premium. For example, Luintel and Paudyal (1988) reported a robust cointegration relationship between forward and spot exchange rates for the UK against the Canadian, French, German and Japanese currencies from 1986 to 1993, but failed to accept the unitary parameter restriction on the cointegrated equation. Similarly but using the fractionally cointegration method, Baillie and Bollerslev (1994) and Bond et al (2006) studied the forward premiums for the currencies of Canada, Germany and the UK vis-a-vis the US dollar. Baillie and Bollerslev showed that they are fractionally cointegrated with the order of integration (d) greater than (or close to) 0.5 for Canada and the UK. Since an absolute value of d greater than 0.5 indicates non-stationarity, they provide some evidence of a non-stationary premium. Furthermore, Liu and Sercu (2009) report evidence of almost non-stationary risk premiums from the data of industrial countries during the floating exchange rate regime.

Against this background, we analyze the statistical characteristics (especially the stationarity) of the forward premium in the panel data context, and attempt to investigate which economic factors explain the premium, in particular its common component, in Asia-Pacific countries. The common component may arise from economic and financial phenomena shared among these countries, while the idiosyncratic factor

[4]See Hodrick (1987) and Engel (1996) for a review of early studies.

represents country-specific behavior. The common component in this region is underscored by recent financial crises (e.g., the 1997 Asian crisis), and Bekaert et al (2005) report evidence of higher correlation in asset prices during the Asian crisis than over a tranquil period.

Thus we are making several contributions to the literature. The choice of data is one distinguishing feature of this paper. Unlike previous studies on the forward premium that focused largely on industrial countries and the short end (typically the one month maturity) of forward rates, our data set includes Asian (emerging) economies and covers a wider range of maturities. Another feature is the choice of statistical methodology: panel data analysis and decomposition of the premium which, to our knowledge, has not been attempted before. Since the stationarity of the premium is controversial, this study is expected to clarify this gray area in the academic literature.

This paper comprises 4 sections. Section 2 describes our data and conducts a preliminary investigation. Section 3, which is our main chapter, explains the statistical method used to decompose the forward premium (Bai and Ng 2004) and presents the empirical results. This section also investigates the relative importance of the common factors and whether any economic variables can explain those factors. The paper ends with Section 4 which summarizes our findings. In short, we provide evidence of stationary common and idiosyncratic factors for short maturity premiums, which lead to a stationary forward premium. We also show that the common factor can be explained by economic and financial developments in the US. Therefore, our findings confirm a close economic link between the US and Asia-Pacific countries.

2 Preliminary Studies

2.1 Data Description

Our data set comprises forward and spot exchange rates for Australia, Hong Kong (HK), India, Indonesia, Japan, New Zealand (NZ), the Philippines, Singapore, Taiwan, and Thailand.[5] Generally speaking, these countries implemented a flexible and/or managed floating exchange regime during our sample period except for HK which used a fixed rate against the US dollar since 1983 by means of the currency board systems.[6] The choice of countries was determined by the availability of the forward rate.

We use forward and spot exchange rates against the US dollar, and the forward rates have a maturity length of one, two, three, six, nine and twelve months. These exchange rates are monthly, cover the sample period from 1997:11 to 2010:02, and are downloaded from the Thomson DataStream (WM/Reuters for forward rates and National Exchange Rates for spot rates). Our sample period and type of forward rates are again determined solely by data availability in order to create a balanced data set which maximizes the total number of observations. The log spot and forward rates are shown in Figure 1. There we can observe a surge in the exchange rate in many countries in the aftermath of the Asian crisis which erupted in Thailand in July 1997 and spilled over to neighboring countries.

Table 1 summarizes the basic statistics of the forward premium for each country which is obtained as $fp_t^j = f_t^j - s_t$ where j represents the maturity length. It summarizes that the mean of the premiums is often positive (38 out of 60 cases), suggesting that in that case the forward dollar is at a premium, which implies that according to the Covered Interest Parity (CIP) condition the US interest rate should be on average lower than that of Asia-Pacific countries. Furthermore, volatility (measured by the standard deviation) is relatively high in some emerging economies, particularly Indonesia which experienced an adverse effect from the Asian crisis which created domestic disarray and forced President Suharto to end his 32 year presidency.

Table 2 displays the correlation coefficients of forward premiums between countries. Statistics equal to one indicate a perfect correlation while zero suggests no correlation between premiums. Firstly, our data often suggest a positive relationship in the for-

[5] Data on the South Korean forward rate are available from 2002 from DataStream.

[6] In May 2005, the HK Monetary Authority introduced upper and lower guaranteed limits for flucutuations in the HK dollar.

ward premiums. In 270 combinations of different countries and maturities, 91 instances exhibit a negative correlation. The number of negative correlations rise as the maturity length under consideration increases. Therefore this may suggest that common components are more significant over shorter time horizons (e.g., an one month maturity), whereas idiosyncratic components become increasingly important over longer time horizons. As regards the level of correlation, the highest positive (about 0.6 to 0.8) exists between Australia and NZ regardless of the maturity length of the forward rate. Similarly, a high premium correlation is obtained between Thailand and countries like HK, the Philippines and Singapore. Since our sample period includes the widespread economic contagion from Thailand in 1997, a high correlation could be expected to exist among countries affected by this economic and financial turmoil.[7] However, correlation between emerging markets is generally still not as high as that between Australia and NZ.

2.2 Some results

As part of our preliminary analysis, we estimate the most basic equation to analyze the forward premium puzzle, equation (1) (Fama 1984).[8] There is also a version which replaces the right hand side of the equation with the interest rate differential based on the CIP. But since previous studies (e.g., Taylor 1989) identified that the result is sensitive to the quality of interest rates, equation (1) which does not assume the CIP is chosen to study the forward premium here. Equation (1) can be derived with the assumption of investors' rational expectations and no risk premium.

To start with, under these two conditions, the relationship between the spot (S) and forward (F) rates can be expressed as:

$$S_{t+j} = F_t^j + u_{t+j}$$

where j represents the maturity length of the forward rate. Allowing parameters to

[7] Correlation between economic variables tends to increase in crisis periods (e.g., see Bekaert et al 2005).

[8] I would like to thank the referee for the suggestion to expand the research in this direction.

be estimated and assuming that the expectations error (u_{t+j}) follows the log normal distribution, the abovementioned equation can be expressed as:

$$s_{t+j} = \alpha + \beta f_t^j + e_{t+j}$$

where small scale variables are shown in log and e is the residual. Subtracting s_t from both sides under the null hypothesis of $\beta = 1$, we can obtain the Fama equation which will be analyzed.

$$\Delta s_{t+j} = \alpha + \beta \left(f_t^j - s_t \right) + e_{t+j} \tag{1}$$

where Δ is a difference operator. It is expected that the forward spread is positively associated with exchange rate changes (i.e., $\beta > 0$ in equation (1)) if not equal to unity. We estimate equation (1) by the OLS for each country and report the parameters and standard deviation obtained from the Monte Carlo simulations in Table 3. It shows quite mixed results: of the 60 cases, 29 are ones where the parameter is negative. But these results are consistent with previous studies related to the forward premium puzzle; although these negative parameters are often statistically insignificant, this indicates the presence of the forward premium puzzle in Asian countries too. However, compared with previous studies (e.g., Bansal and Dahquist 2000; Menzie 2006; Frankel and Poonawala 2010), our results show no clear differences between industrial and developing countries. Relatively higher per capita income, less inflation and inflation volatility in our emerging economies seem attributable to our outcome, following the conclusion of Bansal and Dahquist (2000).

We also test the long-run behavior of the forward premium for each country (Table 4). This is carried out by two types of unit root test (the ADF and DF-GLS). While the results are at times sensitive to test type, the null hypothesis of the unit root can be rejected by at least one of the tests, if not both, on many occasions. The finding of a stationary forward premium is consistent with some previous studies using data from industrial countries (e.g., Baillie and Bollerslev 1989; Hai et al 1997). However, the stationarity of the forward premium is not well supported by the Indian data nor by the data with a longer maturity length of the forward rate (especially, for nine and twelve months). We will come back to this issue later when analyzing them in the panel data context.

3 Common and Idiosyncratic Factors

3.1 The Statistical Method

We use the Bai-Ng method (2004) which was developed originally as a panel unit root test and which allows us to examine the stationarity of both common and idiosyncratic components in the data. The panel unit root test was developed partly due to the univariate unit root tests' lack of statistical power to distinguish hypotheses (e.g., the Dickey-Fuller test), which may arise from a finite sample bias, since researchers often have access to only limited time-series data. Therefore, the panel data test which increases the total observations by extending the number of individuals (i.e., countries) has become the popular methodology for detecting stationarity.

However, the conventional (sometimes called the first generation) panel unit root tests (e.g., Levin and Lin 1992; Levin, Lin and Chu 2002) assume cross-sectional independence (i.e., no common factors) which is unlikely to hold for actual economic and financial data. Indeed, O'Connell (1998) and Maddala and Wu (1999) show the serious deficiencies of statistics obtained from this independence assumption. Therefore, a number of tests have been proposed to overcome this (e.g., Moon and Perron 2004; Pesaran 2007). Some approaches simply assume a single common factor and remove from the original data the cross-sectional average as a proxy for the common factor prior to investigating the stationarity, while others propose estimation of the common factors.[9] Obviously, the latter is a more sensitive approach and includes the method proposed by Bai and Ng (2004) of Panel Analysis of Non-stationarity in Idiosyncratic and Common (PANIC) components. We shall use Bai-Ng estimates as a proxy for our

[9] This includes an estimation of the number of common factors in the data.

common factors.

The panel tests which do not assume cross-sectional independence are sometimes called second generation tests. The PANIC differs from other such tests (e.g., Moon and Perron 2004; Pesaran 2007) since it allows us to calculate both common and idiosyncratic factors and examine their stationarity individually. Indeed, many second generation tests are designed to test the stationarity of only the idiosyncratic component. We briefly explain below.

The PANIC with an intercept and unobservable components can be summarized as equation (2), and consists of several estimations.

$$fp_{it} = c_i + \lambda_i' F_i + e_{it} \tag{2}$$

where fp is the log forward premium, F the vector of common factors, e the vector of idiosyncratic components, and c the constant term. Subscript i ($i = 1, \ldots, N$) and t ($t = 1, \ldots, T$) denote the country and time respectively. In the PANIC we need to estimate parameters λ and c, and obtain an estimate of unobservable variables, $F(\widehat{F})$ and $e(\widehat{e})$. Given that fp and F may be nonstationary, Bai and Ng (2004) suggest differencing equation (2) to obtain unknown parameter λ_i'. Furthermore, they recommend the principal component method to calculate these unobservable components and the information criteria ($PC(k)$) to obtain an appropriate number of common factors (k).

$$PC(k) = V(k, \widehat{F}^k) + kg(N,T) \quad \text{where } V(k, \widehat{F}^k) = \min \frac{1}{NT} \sum_{i=1}^{N} \sum_{t=1}^{T} (fp_{it} - \lambda_i^{k'} \widehat{F}_t^k)^2 \tag{3}$$

Like the conventional criteria (e.g., Akaike and Schwarz information criteria), the model with the smallest $PC(k)$ can be interpreted as being statistically the most appropriate by capturing well the data generating process. According to equation (3), such a model would have an estimate of λF with the smallest possible deviation from fp while at the same time penalizing the outcome according to the dimension of the data set ($kg(N,T)$). By changing the formulation of $kg(N,T)$, Bai and Ng (2002) propose three types of information criteria, $IC1$, $IC2$ and $IC3$. However, here we use $IC3$ since all three criteria provide a consistent outcome in their experiments even in the small sample context.

$$IC3(k) = \ln V(k, \widehat{F}^k) + k \left(\frac{\ln\left(\min\left(\sqrt{N}, \sqrt{T}\right)^2\right)}{\min\left(\sqrt{N}, \sqrt{T}\right)^2} \right)$$

The common (F) and idiosyncratic (e) factors can be obtained from the first differenced equation as $e_{it} = \sum_{s=2}^{t} z_{it}$ and $F_t = \sum_{s=2}^{t} f_t$ where $z_{it} = \Delta e_t$ and $f_t = \Delta F_t$, and then their stationarity can be analyzed individually like the univariate Augmented Dickey-Fuller (ADF) test. As regards the idiosyncratic component, the null hypothesis of the unit root ($d_{i0} = 0$) can be examined using equation (4).

$$\Delta \widehat{e}_{it} = d_{i0}\widehat{e}_{it-1} + d_{i1}\widehat{e}_{it-1} + \cdots + d_{ip}\widehat{e}_{it-p} + u_{it} \tag{4}$$

The asymptotic distribution of this test is identical to the standard Dickey-Fuller (DF) test, and the critical value at the 5 percent significance level is -1.95. However, since the test is conducted with panel data, it would be useful to draw a general conclusion regarding the stationarity for a group of countries. Such a test can be carried out by pooling the results of the individual unit root tests.

$$P_e = \frac{-2\sum_{i=1}^{N} \ln p_e(i) - 2N}{\sqrt{2N}} \tag{5}$$

where $p_e(i)$ is the p-value for i country used to evaluate the null in equation (4). The pooled statistic, P_e, is shown to have the standard normal distribution. At the time of rejecting the null, $p_e(i)$ becomes a very small positive number and so $-2\sum_{i=1}^{N} \ln p_e(i)$ becomes very large. Thus, the large positive statistic (P_e) becomes evidence of rejecting the null of nonstationarity.

Similarly, Bai and Ng (2004) show that when there is a single common factor, the test to examine common factors is effectively identical to the conventional univariate

ADF test.

$$\Delta\widehat{F}_t = c + \delta_0\widehat{F}_{t-1} + \delta_1\Delta\widehat{F}_{t-1} + \cdots + \delta_p\widehat{F}_{t-p} + u_t \tag{6}$$

The null hypothesis of the unit root can be tested by $\delta_0 = 0$ in equation (5) against the alternative of $\delta_0 < 0$. The critical value for the univariate ADF test can be used for this test and is -2.86.

Thus, in short, the distinguishing feature of this method is that we can estimate the appropriate number of common factors in a panel of forward premiums, decompose them into common and idiosyncratic components, and investigate their stationarity separately. In the next section, after studying their stationarity, we shall also check the relative importance of the common and idiosyncratic components and try to infer whether the country is susceptible to economic developments in other countries.

3.2 Results

Here, we show results from decomposing the forward premium into common and idiosyncratic factors, and attempt to explain the common factor behaviors. In order to check the sensitivity of our findings to the specification, the PANIC test is conducted for a different sample period using the breakpoint of 2001:01 as will be discussed shortly as well as for a different composition of countries: all 10 countries and the nine countries, excluding HK, whose spot exchange rate was linked to the US dollar or excluding India whose forward premium appears nonstationary (Table 4). The PANIC results are shown in Table 5 and suggest that both common and idiosyncratic factors are stationary, but the stationarity of the common factors is less supported in the longer maturity analysis.

Let's look at the PANIC result in more detail. First, we examine the appropriate number of common factors (k) in our data. According to the information criterion, there is one common factor ($k = 1$) for all forward premiums, which are plotted in Figure 2. The presence of a common factor is consistent with Baillie and Bollerslev (1989) who reported that the exchange rates of industrial countries contain one unique stochastic trend (for both spot and forward rates), and this result ensures that there is a common trend in our countries and becomes evidence supportive of their close economic relationship.[10] This is an expected outcome since financial markets are highly integrated across countries due to developments in information and technology (IT).

Although the effect of structural breaks seems minimal as spot and forward rates moved together (Figure 1), there may be the possibility of breaks in our individual data given our sample period. Then, when are the structural breaks? We use the breakpoint of 2001:01 consistent with the timing of stock prices which regained the price level recorded in the pre-crisis period in most countries. This timing seems statistically appropriate given that the estimates from the recursive model stay within the 95% confidence interval in all cases (Figure 3). These estimates are obtained from a regression model where common factors are regressed against the constant, and in this regard this figure shows the stability of the mean of the common factors. Using this breakpoint, we checked if the number of common factors (k) is sensitive to the sample period, but our results from the sub-sample analysis suggest that the number of common factors remains to be one (Table 5).

Our PANIC results furthermore show that these common factors are stationary in the full sample analysis implying that a common shock is transitory (Table 5). This result from the panel study is more consistent across the maturity length than that from the univariate one (Table 4), and is attributable to the exploitation of cross-sectional information which was absent in the univariate study. But this evidence becomes weak when the analysis is based on the long maturity premiums in the sub-sample, although the findings do not seem to be seriously affected by the composition of countries. To some extent, this can also be seen in Figure 2 where we can observe that the common factors (F) of the long maturities (e.g., a twelve month forward premium (CF12)) exhibit a smooth line with less fluctuation.

[10] Evidence of a number of common factors does not always mean a closer economic relationship among countries. When their economic structure is identical, there may be only one common factor. But at least one common factor is needed in order to conclude the existence of close economic links between countries.

In contrast to the common factors, country-specific (i.e. idiosyncratic) components are generally found to be stationary regardless of the maturity length, the country composition, and the sample period: the test statistics are high enough to reject the null of the unit root (Table 5). Therefore, this table implies that the nonstationarity of the longer maturity forward premium in the sub-sample analysis is due to that of the common factors rather than idiosyncratic components.

In short, in the shorter time horizons (up to 6 month maturities), the forward premium seems to follow a stationary process. The stationarity of each component is consistent with our preliminary conclusion from the univariate unit root tests (Table 4) and the findings of some previous studies (see Section 1) that a one-to-one relationship holds between forward and spot rates in the long-run. The less supportive evidence for the long term stationary premiums in our sub-sample analysis may reflect a combination of the increased difficulty in predicting future events over a long time horizon and the absence of observations during the crisis period during which financial indicators tend to be highly correlated.

In addition, we analyze the relative importance of the common factor in terms of its variations in the premium measured by variance. These statistics reported in Tables 6a and 6b correspond to the proportion of variation in the common factor out of the total variation in the premium, and are calculated by orthogonalizing factors such that the sum of the proportion for common and idiosyncratic factors becomes one. Thus, the proportion of idiosyncratic factors, although not reported here due to space constraint, can be obtained by subtracting the ratio of common factors from unity.

These tables confirm the importance of common factors, but it is on average more pronounced for shorter maturity premiums. Indeed, around 60% of variation in the premium can be explained by common factors for a one month forward rate, but this figure declines to below 40% for a one year maturity rate (Table 6b). This is consistent with Table 2 where more correlation coefficients are negative for long maturity data. Furthermore, these tables show that the importance of common factors declines slightly during a tranquil (i.e., sub-sample) period.

Next, we investigate the economic and financial changes affecting this common component in the forward premium. While many variables can be considered, we use US interest rates (the federal funds (FFR) and three month interbank rates) and industrial production which are again obtained from DataStream. The effect of US policy and economy on other countries has been widely examined in the past by a number of researchers. Uribe and Yue (2006) for example looked at the extent to which US monetary policy affects economic activities in emerging markets. Nagayasu (2003) showed that US monetary policy is more influential over the Japanese foreign exchange rate market than Japanese monetary policy. Furthermore, because our exchange rates are denominated in US dollars, her interest rate is a reasonable candidate for explaining our common factor and is consistent with the CIP.

Tables 7a and 7b report results, and confirm that US interest rates and industrial production have useful information for explaining common factor behavior. Table 7a assumes that all common factors are stationary and thus the detrended values of the US interest rate and industrial production are used as explanatory variables. In contrast, Table 7b assumes that the common factors are nonstationary, and thus the analysis is conducted only for longer maturity factors in the sub-sample period, and explanatory variables remain in the original data without detrending.

In terms of the signs of estimates, these tables show consistent results. The US interest rate is negatively correlated with the common factor, while US industrial production is positively correlated. The former is consistent with the CIP and Uribe and Yue (2006), who found that the US interest rate can explain about 20% of economic activity in emerging markets. The signs of these variables suggest that when the US economy can be characterized as one with a positive interest rate change and negative industrial production growth, the common factor tends to decline. For the longer maturity rates (Table 7b), the multivariate cointegration (Johansen) test is also carried out and provides evidence of cointegration. Furthermore, the size and sign of parameters are confirmed in the cointegrated framework using the log-likelihood ratio test, and support our conclusion that the common factor tends to increase when the US economy is strong.

4 Conclusion

The analysis of the forward premium is important due to the increased size of the forward market worldwide and is connected with the CIP, an important economic theory in international finance. Against this, we examine the behavior of the forward premium for several countries in the Asia-Pacific region. The distinguishing feature of this study is our use of panel data of Asian countries, allowing us to decompose the premium into common and idiosyncratic components. A consideration of common factors may be pertinent to our selected countries because many of them are ASEAN members and we used bilateral exchange rates against the US dollar. Since most of the research to date is based on the premium in industrial countries and a univariate (or time-series) analysis, our approach is rather distinctive.

Using the PANIC approach originally developed as a panel unit root test, we estimate the number of common factors and conduct a decomposition of the forward premium. We find evidence of one stationary common factor as well as stationary idiosyncratic components for shorter maturities. These results lead us to the conclusion that the forward premium is stationary, and thus the forward rate does not diverge permanently from the spot rate. In contrast, our long maturity data support less their stationarity in the more recent period, and nonstationary elements are driven by the common factors. Furthermore, this study has found the importance of common factors and identified economic components influencing them. Notably, common factors are closely associated with US economic and financial developments measured by the interest rate and industrial production, and they tend to decline when the US economy has slowed down.

Finally, here we chose explanatory variables related to the US economy since it was our benchmark country, but in future studies, one could consider other variables including those from other industrial countries which may potentially dominate the common factor.

References

[1] Backus, David K., Allan W. Gregory, and Chris I. Telmer (1993), 'Accounting for forward rates in markets for foreign currency', Journal of Finance 48(5), 1887-1908.

[2] Bansal, Ravi and Magnus Dahlquist (2000) 'The forward premium puzzle: different tales from developed and developing economies' Journal of International Economics 51, 115-144.

[3] Bai, Jushan, and Serena Ng (2002), 'Determining the number of factors in approximate factor models', Econometrica 70(1), 191-221.

[4] Bai, Jushan, and Serena Ng (2004), 'A Panic attack on unit roots and cointegration', Econometrica 72(4), 1127-1177.

[5] Baillie, Richard T., and Tim Bollerslev (1989), 'Common stochastic trends in a system of exchange rates', Journal of Finance 44(1), 167-181.

[6] Bekaert, Geert, Campbell R. Harvey, and Angela Ng (2005), 'Market integration and contagion', Journal of Business 78(1), 39-70.

[7] Bond, Derek, Michael J. Harrison, Niall Hession and Edward J. O'Brien (2006), 'Some empirical observations on the forward exchange rate anomaly, Trinity Economics Papers tep2006, Trinity College Dublin, Department of Economics.

[8] Bouvatier, Vincent (2007), 'Are international interest rate differentials driven by the risk premium? The case of Asian countries', Economics Bulletin Vol. 5(6), 1-14.

[9] Burnside, Craig A., Martin S. Eichenbaum, Issac Kleshchelski, and Sergio Rebelo (2008) Do peso problems explain the returns to the carry trade? NBER Working Paper Series No. 14054.

[10] Corte, Pasquale Della, Pasquale, Lucio Sarno, and Ilias Tsiakas (2008) An economic evaluation of empirical exchange rate models, Review of Financial Studies, forthcoming.

[11] Engel, Charles, (1996), 'The forward discount anomaly and the risk premium: a survey of recent evidence', Journal of Empirical Finance 3, 123-192.

[12] Engle, Robert F., and C. W. J. Granger (1987), 'Co-integration and error correction: representation, estimation, and testing', Econometrica 55(2), 251-276.

[13] Evans, Martin D. D., and Karen K. Lewis (1992), 'Trends in expected returns in currency and bond markets', NBER Working Paper Series, Working Paper No. 4166. Cambridge: National Bureau of Economic Research.

[14] Fama, E. F. (1984), 'Forward and Spot Exchange Rates', Journal of Monetary Economics 14, 319–38.

[15] Frankel, Jeffrey and Jumana Poonawala (2010) 'The forward market in emerging currencies: less biased than in major currencies', Journal of International Money and Finance 29, 585-598.

[16] Groen, Jan J.J. and Balakrishnan, Ravi (2006) 'Asset price based estimates of sterling exchange rate risk premia', Journal of International Money and Finance 25(1), 71-92,

[17] Hallwood, C. Paul, and Ronald MacDonald (2000), International Money and Finance 3rd edition. Oxford: Blackwell.

[18] Hai, Weike, Nelson C. Mark, and Yangru Wu (1997), 'Understanding spot and forward exchange rate regressions', Journal of Applied Econometrics 12, 715-734.

[19] Hodrick, Robert J. (1987), The Empirical Evidence on the Efficiency of Forward and Futures Foreign Exchange Market. Chur: Harwood Academic Publishers.

[20] Levin, Andrew, and Chien-Fu Lin (1992), 'Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties', University of California at San Diego, Economics Working Paper Series 92-23, Department of Economics, UC San Diego.

[21] Levin, Andrew, Chien-Fu Lin, and Chia-Shang James Chu (2002), 'Unit root tests in panel data: asymptotic and finite-sample properties', Journal of Econometrics 108(1), 1-24.

[22] Liu, Fang and Piet Sercu (2009), 'The forward puzzle: the roles of exchange rate regime and base currency strength', World Economy 32(7), 1055 –1074.

[23] Luintel, K. G., and K. Paudyal (1988) 'Common stochastic trends between forward and spot exchange rates', Journal of International Money and Finance 17, 279-297.

[24] Lusting, Hanno and Adrien Verdelhan (2007) 'The cross section of foreign currency risk premia and consumption growth risk' American Economic Review 97(1), 89–117.

[25] Maddala, G.S., and Wu, S. (1999), 'A comparative study of panel data unit root tests and a new simple test', Oxford Bulletin of Economics and Statistics 61, 631-652.

[26] Chinn, Menzie D. (2006) 'The (partial) rehabilitation of interest rate parity in the floating rate era: longer horizons, alternative expectations, and emerging Markets,' Journal of International Money and Finance 26, 7-21.

[27] Moon, Hyungsik R., and Benoit Perron (2004), 'Testing for a unit root in panels with dynamic factors', Journal of Econometrics 22(1), 81-126.

[28] Nagayasu, Jun (2003), 'Asymmetric effects of monetary indicators on the Japanese yen', Japan and the World Economy 15(2), 143-159.

[29] O'Connell, P. G. J. (1998), 'The overvaluation of purchasing power parity', Journal of International Economics 44, 1-19.

[30] Pesaran, M. Hashem (2007), 'A simple panel unit root test in the presence of cross-section dependence', Journal of Applied Econometrics 22(2), 265-312.

[31] Taylor, Mark P. (1989), 'Covered interest arbitrage and market turbulence', Economic Journal 99, 376-391.

[32] Uribe, Martin, and Vivian Z Yue (2006), 'Country spreads and emerging countries: who drives whom?', Journal of International Economics 69, 6-36.

Table 1. Statistical Summary of Forward Premiums

Full sample	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
	1 month		2 months		3 months	
Australia	0.152	0.536	0.299	0.606	0.442	0.697
HK	-0.023	0.118	-0.029	0.219	-0.026	0.337
India	-0.162	0.708	0.113	0.796	0.372	0.900
Indonesia	0.893	5.695	1.569	6.041	2.312	6.613
Japan	-0.240	0.569	-0.523	0.646	-0.803	0.746
NZ	0.225	0.649	0.448	0.700	0.665	0.774
Philippines	0.466	0.686	0.882	0.850	1.297	1.089
Singapore	-0.109	0.222	-0.218	0.315	-0.327	0.416
Taiwan	-0.104	0.315	-0.193	0.497	-0.287	0.680
Thailand	0.235	0.700	0.372	0.853	0.519	1.095
	6 months		9 months		12 months	
Australia	0.874	1.042	1.306	1.421	1.727	1.796
HK	0.030	0.747	0.111	1.143	0.224	1.564
India	1.138	1.329	1.874	1.841	2.589	2.356
Indonesia	4.243	8.378	5.857	9.936	7.564	11.699
Japan	-1.653	1.119	-2.514	1.523	-3.402	1.912
NZ	1.314	1.061	1.949	1.381	2.564	1.698
Philippines	2.579	1.828	3.849	2.589	5.104	3.371
Singapore	-0.649	0.741	-0.966	1.028	-1.287	1.339
Taiwan	-0.104	0.315	-0.828	1.512	-1.085	1.951
Thailand	0.890	1.819	1.240	2.502	1.571	3.140

Note: Full sample (1997:11-2010:02).

Table 2. Correlation between Forward Premiums

	Aust	HK	Indi	Indo	Japa	NZ	Phil	Sing	Taiw	Thai
	1 \ 2 months									
Aust	1.000	-0.193	-0.060	-0.125	0.295	0.672	-0.128	0.038	-0.155	-0.015
HK	-0.071	1.000	0.215	0.593	0.061	-0.071	0.558	0.425	0.512	0.523
Indi	0.007	0.097	1.000	0.079	-0.018	0.091	0.128	-0.095	0.399	0.207
Indo	-0.092	0.428	0.023	1.000	-0.034	0.021	0.480	0.444	0.158	0.374
Japa	0.173	0.175	0.054	-0.017	1.000	0.178	-0.019	0.305	0.003	0.115
NZ	0.647	-0.057	0.127	0.013	0.110	1.000	-0.028	0.160	0.002	0.102
Phil	-0.080	0.406	0.085	0.474	-0.011	0.001	1.000	0.364	0.540	0.437
Sing	0.012	0.319	-0.015	0.345	0.215	0.097	0.282	1.000	0.103	0.427
Taiw	-0.033	0.439	0.244	0.104	0.106	0.108	0.394	0.148	1.000	0.438
Thai	0.095	0.310	0.109	0.214	0.139	0.110	0.280	0.249	0.320	1.000
	3 \ 6 months									
Aust	1.000	-0.395	-0.283	-0.267	0.638	0.766	-0.202	0.175	-0.335	-0.254
HK	-0.271	1.000	0.381	0.786	-0.171	-0.189	0.668	0.489	0.484	0.765
Indi	-0.135	0.283	1.000	0.311	-0.206	-0.197	0.263	-0.168	0.426	0.338
Indo	-0.166	0.675	0.147	1.000	-0.120	-0.079	0.534	0.486	0.354	0.695
Japa	0.415	-0.020	-0.087	-0.055	1.000	0.435	-0.067	0.449	-0.145	-0.039
NZ	0.701	-0.108	0.019	0.004	0.254	1.000	-0.085	0.339	-0.199	0.012
Phil	-0.153	0.615	0.166	0.503	-0.035	-0.048	1.000	0.433	0.496	0.603
Sing	0.093	0.451	-0.139	0.474	0.370	0.231	0.409	1.000	0.081	0.631
Taiw	-0.244	0.535	0.492	0.236	-0.073	-0.090	0.586	0.074	1.000	0.470
Thai	-0.113	0.628	0.259	0.502	0.060	0.082	0.509	0.528	0.500	1.000
	9 \12 months									
Aust	1.000	-0.472	-0.379	-0.349	0.779	0.824	-0.256	0.224	-0.452	-0.336
HK	-0.442	1.000	0.463	0.843	-0.272	-0.274	0.674	0.494	0.649	0.854
Indi	-0.344	0.435	1.000	0.446	-0.294	-0.391	0.333	-0.159	0.705	0.368
Indo	-0.326	0.828	0.408	1.000	-0.167	-0.183	0.536	0.491	0.558	0.807
Japa	0.732	-0.231	-0.258	-0.160	1.000	0.594	-0.114	0.489	-0.250	-0.105
NZ	0.801	-0.239	-0.319	-0.145	0.531	1.000	-0.126	0.389	-0.361	-0.067
Phil	-0.231	0.680	0.315	0.565	-0.089	-0.099	1.000	0.425	0.724	0.640
Sing	0.216	0.490	-0.164	0.482	0.488	0.379	0.431	1.000	0.128	0.677
Taiw	-0.433	0.626	0.675	0.518	-0.227	-0.325	0.721	0.109	1.000	0.614
Thai	-0.311	0.830	0.366	0.771	-0.081	-0.039	0.639	0.658	0.596	1.000

Note: This table displays the correlation coefficients of forward premiums. We use the following abbreviations: Australia (Aust), India (Indi), Indonesia (Indo), Japan (Japa), Philippines (Phil), Singapore (Sing), Taiwan (Taiw), and Thailand (Thai). Full sample (1997:11-2010:02).

Table 3. Fama Regression

	Coef.	SE	Coef.	SE	Coef.	SE
	1 month		2 months		3 months	
Australia	0.005	[0.007]	0.014	[0.012]	0.010	[0.014]
HK	0.004	[0.002]*	0.001	[0.001]#	0.001	[0.000]
India	-0.001	[0.002]	-0.000	[0.002]	0.000	[0.003]
Indonesia	0.003	[0.004]	0.003	[0.003]	-0.000	[0.004]
Japan	0.002	[0.005]	-0.007	[0.007]	-0.007	[0.006]
NZ	0.012	[0.005]*	0.021	[0.008]*	0.020	[0.010]#
Philippines	0.003	[0.005]	0.002	[0.007]	0.001	[0.005]
Singapore	-0.003	[0.013]	-0.011	[0.013]	-0.013	[0.010]
Taiwan	0.006	[0.005]	0.003	[0.004]	0.000	[0.004]
Thailand	0.002	[0.006]	-0.006	[0.010]	-0.012	[0.009]
	6 months		9 months		12 months	
Australia	0.004	[0.013]	-0.000	[0.011]	-0.006	[0.008]
HK	0.000	[0.000]#	0.001	[0.000]**	0.001	[0.000]**
India	-0.002	[0.002]	-0.001	[0.002]	-0.000	[0.002]
Indonesia	0.000	[0.003]	-0.005	[0.002]*	-0.005	[0.002]*
Japan	-0.013	[0.005]*	-0.015	[0.004]**	-0.015	[0.004]**
NZ	0.012	[0.012]	0.001	[0.012]	-0.008	[0.010]
Philippines	0.006	[0.003]#	0.005	[0.003]#	0.003	[0.002]
Singapore	-0.005	[0.004]	-0.003	[0.004]	-0.003	[0.003]
Taiwan	0.004	[0.011]	-0.004	[0.003]	-0.005	[0.002]*
Thailand	-0.014	[0.004]**	-0.012	[0.004]**	-0.010	[0.003]**

Note: The marks (**, *, #) indicate that statistics are significant at the one, five and ten percent level. The estimates of β in equation (1) are reported with standard errors in [ ]. Full sample (1997:11-2010:02).

Table 4. Unit Root Tests for Forward Premiums

	ADF	DF-GLS	ADF	DF-GLS	ADF	DF-GLS
	1 month		2 months		3 months	
Aust	-6.872** (1)	-4.713**	-3.905** (3)	-4.230**	-3.251* (3)	-2.356
HK	-5.695** (1)	-4.794**	-4.563** (1)	-2.688#	-2.802# (4)	-1.154
Indi	0.365 (1)	-1.081	-0.508 (1)	-1.485	-1.143 (1)	-1.802
Indo	-7.126** (1)	-5.369**	-4.220** (3)	-4.924**	-3.848** (3)	-3.007*
Japa	-6.486** (1)	-6.413**	-5.169** (1)	-5.327**	-4.212** (1)	-4.462**
NZ	-5.873** (2)	-4.481**	-6.815** (1)	-6.019**	-4.172** (2)	-3.926**
Phil	-6.468** (2)	-5.178**	-4.635** (1)	-5.461**	-4.292** (1)	-4.245**
Sing	-5.634** (2)	-6.167**	-5.043** (2)	-3.931**	-4.233** (1)	-2.853#
Taiw	-4.166** (1)	-3.712**	-3.307* (1)	-4.295**	-2.856# (1)	-4.293**
Thai	-7.914** (1)	-8.161**	-5.832** (1)	-6.148**	-4.709** (1)	-4.924**
	6 months		9 months		12 months	
Aust	-3.062* (1)	-2.906*	-2.366 (1)	-2.438	-2.002 (1)	-2.204
HK	-2.768# (4)	-0.681	-2.698# (4)	-0.613	-2.681# (4)	-1.563
Indi	-1.910 (1)	-2.215	-2.130 (1)	-2.114	-2.210 (1)	-2.100
Indo	-3.056* (3)	-2.404	-2.726# (3)	-2.232	-2.433 (4)	-2.348
Japan	-2.602# (1)	-2.854#	-1.909 (1)	-2.155	-1.544 (1)	-1.819
NZ	-2.794# (2)	-3.013*	-2.233 (2)	-2.566	-2.372 (1)	-2.769#
Phil	-3.541** (1)	-2.938#	-3.205* (1)	-2.571#	-3.366* (1)	-2.344
Sing	-3.587** (1)	-1.912	-3.099* (1)	-1.571	-3.317* (1)	-1.602
Taiw	-4.166** (1)	-3.712**	-1.868 (1)	-3.403*	-1.758 (1)	-3.130*
Thai	-3.735** (1)	-3.632**	-3.355* (1)	-3.005*	-3.172* (1)	-2.604#

Note: Full sample (1997:11-2010:02). The null hypothesis of the unit root is examined by the Augmented Dickey Fuller (ADF) and DF-GLS tests. The maximum lag order is 12. The Akaike Information Criterion (AIC) is used to determine the appropriate lag order shown in parentheses. For the ADF and DF-GLS tests, the critical value for the one, five, and ten percent significance levels is -3.42, -2.86, and -2.57 respectively. See also Table 3.

Table 5. PANIC Results

	Idio.fac P_e	Com.fac ADF	Info. $IC3$	Idio.fac P_e	Com.fac ADF	Info. $IC3$
	Full sample			Sub sample		
			N=10			
1 month	7.170**	-3.498**	1	2.590**	-4.540**	1
2 months	6.906**	-3.610**	1	1.605#	-4.171**	1
3 months	6.593**	-3.737**	1	1.389#	-3.654**	1
6 months	6.292**	-4.220**	1	1.433#	-2.696#	1
9 months	5.709**	-4.424**	1	1.332#	-2.249	1
12 months	4.850**	-4.902**	1	1.392#	-1.945	1
			N=9 Excl. HK			
1 month	6.608**	-3.498**	1	2.789**	-4.540**	1
2 months	5.655**	-3.610**	1	1.751*	-4.171**	1
3 months	4.983**	-3.736**	1	1.478#	-3.654**	1
6 months	4.730**	-4.214**	1	1.461#	-2.696#	1
9 months	3.907**	-4.413**	1	1.280	-2.248	1
12 months	3.710**	-4.885**	1	1.351#	-1.945	1
			N=9 Excl. India			
1 month	7.880**	-3.498**	1	3.002**	-4.540**	1
2 months	7.596**	-3.610**	1	1.913*	-4.171**	1
3 months	7.252**	-3.737**	1	1.669*	-3.653**	1
6 months	6.915**	-4.220**	1	1.701*	-2.694#	1
9 months	6.278**	-4.424**	1	1.570#	-2.247	1
12 months	5.352**	-4.902**	1	1.617#	-1.945	1

Note: Full-sample (1997:11-2010:02) and sub-sample (2001:01-2010:02). The 9 country analysis excludes HK or India. The PANIC method (Bai and Ng 2004) is used to estimate statistics for idiosyncratic and common factors, and the information criteria are based on Bai and Ng (2002). Statistics P_e and ADF are based on equations (5) and (6). The maximum number of common factors (k) is set as 5. See also Table 3.

Table 6a. The Importance of Common Factors in the Forward Premium (Full Sample)

	1 month	2 months	3 months	6 months	9 months	12 months
			N=10			
Australia	0.759	0.675	0.609	0.525	0.501	0.488
HK	0.586	0.725	0.790	0.868	0.889	0.892
India	0.895	0.926	0.794	0.552	0.471	0.433
Indonesia	0.759	0.795	0.741	0.648	0.638	0.624
Japan	0.724	0.550	0.436	0.305	0.262	0.235
NZ	0.747	0.615	0.515	0.371	0.321	0.296
Philippines	0.441	0.363	0.348	0.252	0.293	0.289
Singapore	0.515	0.501	0.504	0.513	0.499	0.494
Taiwan	0.675	0.757	0.758	0.794	0.708	0.702
Thailand	0.505	0.483	0.552	0.662	0.712	0.733
Average	0.661	0.639	0.605	0.549	0.529	0.519
			N=9 Excl. HK			
Australia	0.775	0.684	0.618	0.529	0.504	0.491
India	0.889	0.937	0.799	0.553	0.471	0.433
Indonesia	0.755	0.783	0.728	0.647	0.639	0.625
Japan	0.722	0.549	0.436	0.306	0.262	0.235
NZ	0.747	0.614	0.515	0.371	0.321	0.296
Philippines	0.466	0.375	0.353	0.253	0.294	0.289
Singapore	0.542	0.520	0.517	0.518	0.502	0.496
Taiwan	0.660	0.755	0.757	0.791	0.708	0.703
Thailand	0.572	0.504	0.578	0.682	0.726	0.745
Average	0.681	0.636	0.589	0.517	0.492	0.479
			N=9 Excl. India			
Australia	0.756	0.677	0.623	0.526	0.510	0.492
HK	0.638	0.725	0.784	0.862	0.891	0.892
Indonesia	0.756	0.795	0.766	0.645	0.698	0.659
Japan	0.745	0.573	0.435	0.299	0.263	0.236
NZ	0.751	0.612	0.519	0.374	0.322	0.295
Philippines	0.460	0.368	0.344	0.330	0.284	0.287
Singapore	0.541	0.519	0.509	0.494	0.515	0.506
Taiwan	0.762	0.774	0.780	0.890	0.717	0.723
Thailand	0.872	0.775	0.748	0.678	0.714	0.734
Average	0.698	0.646	0.612	0.566	0.546	0.536

Note: Full-sample (1997:11-2010:02).

Table 6b. The Importance of Common Factors in the Forward Premium (Sub-Sample)

	1 month	2 months	3 months	6 months	9 months	12 months
			N=10			
Australia	0.742	0.567	0.449	0.305	0.262	0.241
HK	0.378	0.362	0.356	0.362	0.374	0.455
India	0.776	0.795	0.733	0.480	0.417	0.374
Indonesia	0.673	0.860	0.858	0.766	0.696	0.618
Japan	0.564	0.410	0.362	0.290	0.258	0.230
NZ	0.776	0.552	0.402	0.216	0.160	0.134
Philippines	0.430	0.287	0.280	0.266	0.262	0.252
Singapore	0.437	0.312	0.303	0.291	0.279	0.273
Taiwan	0.501	0.486	0.481	0.478	0.427	0.421
Thailand	0.540	0.666	0.658	0.657	0.701	0.699
Average	0.582	0.530	0.488	0.411	0.384	0.370
			N=9 Excl. HK			
Australia	0.752	0.579	0.459	0.308	0.263	0.242
India	0.794	0.833	0.749	0.522	0.425	0.382
Indonesia	0.650	0.776	0.840	0.775	0.716	0.644
Japan	0.624	0.441	0.372	0.295	0.261	0.233
NZ	0.774	0.552	0.404	0.218	0.162	0.137
Philippines	0.430	0.274	0.291	0.276	0.270	0.268
Singapore	0.505	0.362	0.321	0.298	0.284	0.277
Taiwan	0.488	0.474	0.476	0.487	0.427	0.423
Thailand	0.623	0.862	0.773	0.652	0.704	0.715
Average	0.627	0.573	0.521	0.426	0.390	0.369
			N=9 Excl. India			
Australia	0.732	0.560	0.447	0.304	0.262	0.241
HK	0.418	0.398	0.378	0.398	0.388	0.456
Indonesia	0.902	0.875	0.865	0.783	0.713	0.633
Japan	0.513	0.459	0.404	0.308	0.271	0.238
NZ	0.778	0.552	0.401	0.217	0.161	0.135
Philippines	0.530	0.286	0.276	0.264	0.266	0.255
Singapore	0.447	0.389	0.340	0.299	0.288	0.281
Taiwan	0.493	0.466	0.466	0.523	0.421	0.417
Thailand	0.821	0.871	0.819	0.660	0.718	0.719
Average	0.626	0.540	0.488	0.417	0.388	0.375

Note: Sub-sample (2001:01-2010:02).

Table 7a. Determinants of the Common Factor of Forward premiums
(Detrended Explanatory Variables)

	1 month		2 months		3 months	
			Full sample			
FFR	-0.0349 [0.0075]	**	-0.0426 [0.0073]	**	-0.0474 [0.0069]	**
Ind. production	0.0003 [0.0000]	**	0.0003 [0.0000]	**	0.0003 [0.0000]	**
R^2	0.2167		0.3230		0.4004	
Interbank rate	-0.0393 [0.0085]	**	-0.0479 [0.0081]	**	-0.0533 [0.0078]	**
Ind. production	0.0003 [0.0001]	**	0.0004 [0.0001]	**	0.0004 [0.0001]	**
R^2	0.3230		0.4004		0.4932	
			Sub sample			
FFR	-0.0176 [0.0060]	**	-0.0232 [0.0049]	**	-0.0263 [0.0044]	**
Ind. production	0.0002 [0.0000]	**	0.0002 [0.0000]	**	0.0002 [0.0000]	**
R^2	0.2100		0.3912		0.5171	
Interbank rate	-0.0198 [0.0068]	**	-0.0261 [0.0055]	**	-0.0296 [0.0050]	**
Ind. production	0.0002 [0.0001]	**	0.0002 [0.0000]	**	0.0003 [0.0001]	**
R^2	0.2100		0.3912		0.5171	
	6 months		9 months		12 months	
			Full sample			
FFR	-0.0526 [0.0062]	**	-0.0582 [0.0053]	**	-0.0593 [0.0051]	**
Ind. production	0.0004 [0.0000]	**	0.0004 [0.0000]	**	0.0004 [0.0000]	**
R^2	0.4932		0.6029		0.6256	
Interbank rate	-0.0592 [0.0070]	**	-0.0655 [0.0061]	**	-0.0667 [0.0057]	**
Ind. production	0.0004 [0.0001]	**	-0.0667 [0.0000]	**	0.0005 [0.0000]	**
R^2	0.4932		0.6029		0.6256	
			Sub sample			
FFR	-0.0248 [0.0040]	**	-0.0317 [0.0040]	**	-0.0316 [0.0040]	**
Ind. production	0.0002 [0.0000]	**	0.0003 [0.0000]	**	0.0003 [0.0000]	**
R^2	0.6252		0.6974		0.7033	
Interbank rate	-0.0278 [0.0045]	**	-0.0356 [0.0045]	**	-0.0356 [0.0045]	**
Ind. production	0.0002 [0.0000]	**	0.0003 [0.0000]	**	0.0003 [0.0000]	**
R^2	0.6252		0.6974		0.7033	

Note: Full-sample (1997:11-2010:02) and sub-sample (2001:01-2010:02). Dependent variables are the common factors with one, two, three, six, nine and twelve month maturities. The double asterisks (**) show statistical significance at the one percent level. The common factor is regressed by the OLS on detrended values of the US interest rate (FFR) and US industrial production (Ind. Production). Figures in brackets are standard deviations obtained from the Monte Carlo simulations (10,000 replications). See also Table 3.

Table 7b. Determinants of the Common Factor of Forward premiums

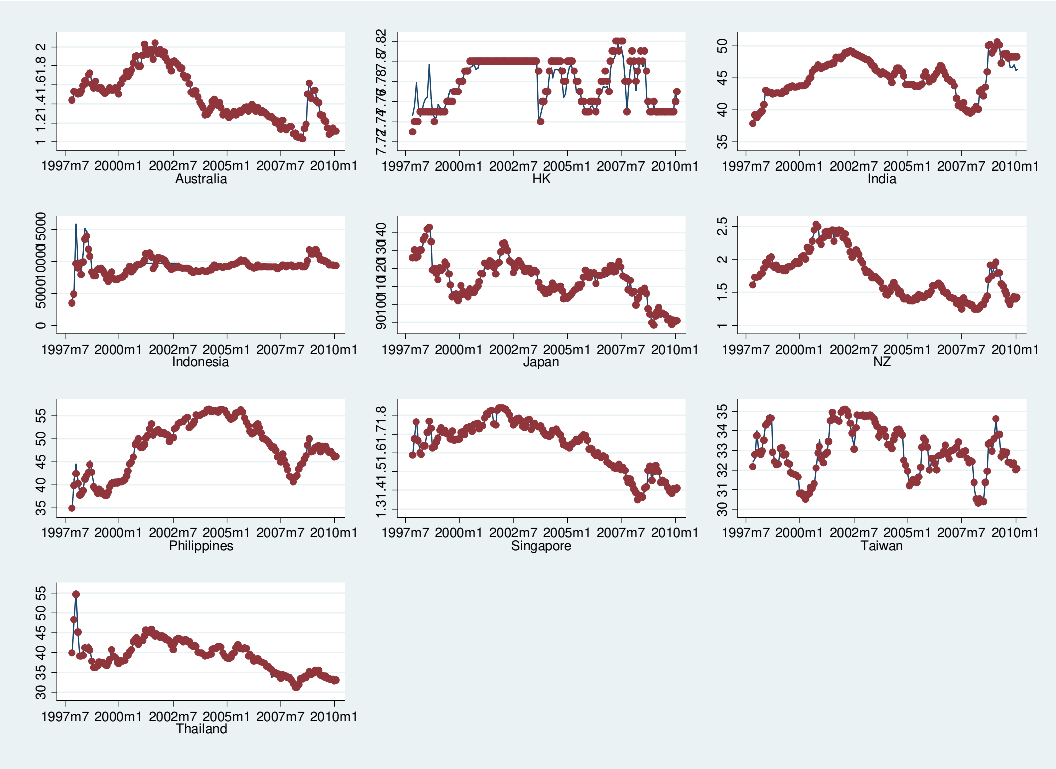
(Explanatory Variables in Level)

	9 month		12 months	
	Sub sample			
FFR	-0.0177 (0.0000)	**	-0.0186 (0.0000)	**
Ind. production	1.0027 (0.0000)	**	1.0140 (0.0000)	**
R^2	0.7757		0.7890	
Trace (r=0)	44.292	**	46.317	**
Trace (r=1)	13.108		13.437	
Trace (r=2)	3.316		3.653	
Interbank rate	-0.0210 (0.0000)	**	-0.0219 (0.0000)	**
Ind. production	1.1076 (0.0020)	**	1.1232 (0.0000)	**
R^2	0.8087		0.8240	
Trace (r=0)	35.478	**	38.337	**
Trace (r=1)	11.332		11.818	
Trace (r=2)	1.565		2.087	

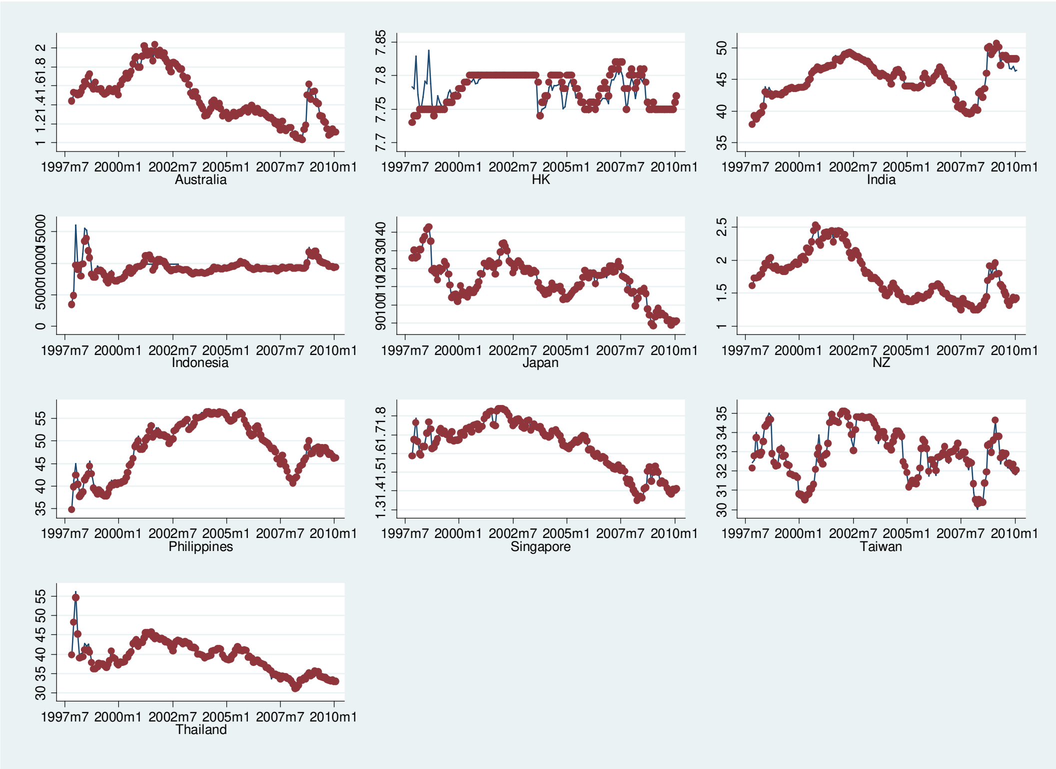
Note: Trace statistics are based on the Johansen test, where r is the number of cointegrated relationships. The figures in parentheses are p-values for the likelihood ratio. The $Chi^2(1)$ test evaluates if the parameter is equal to one. The constant is included in the specification but is not reported in the table. See also Tables 3 and 7a. Sub-sample (2001:01-2010:02).

Figure 1. The Spot and Forward Exchange Rates

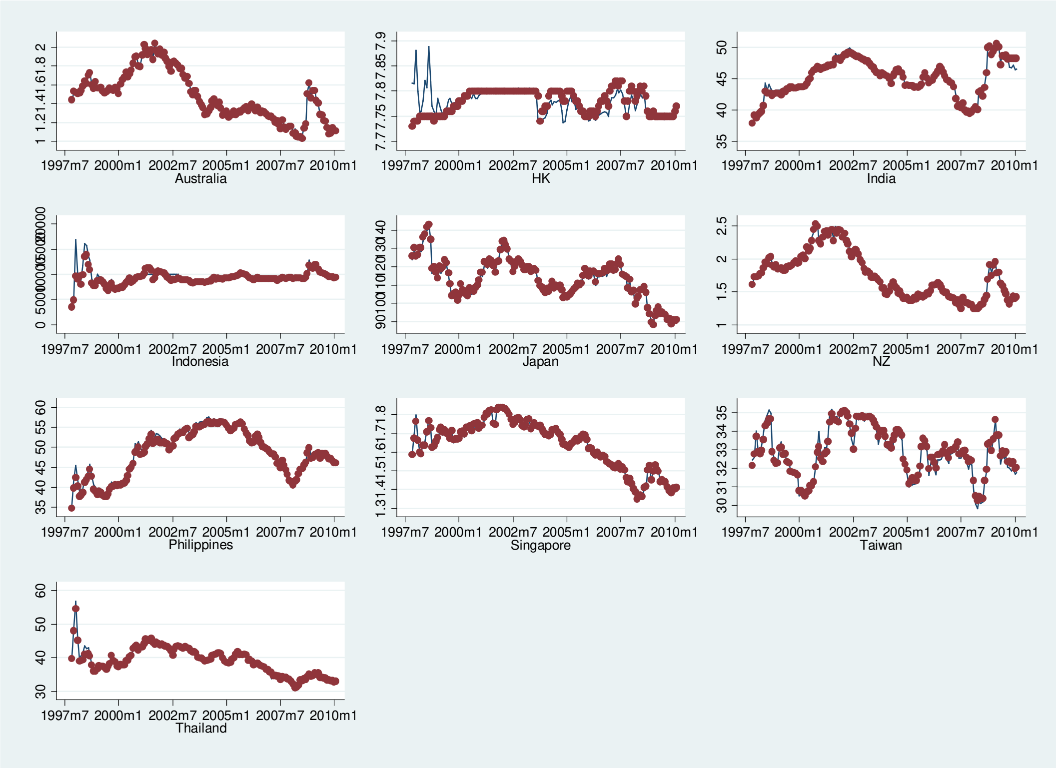
A. One Month Forward Rates



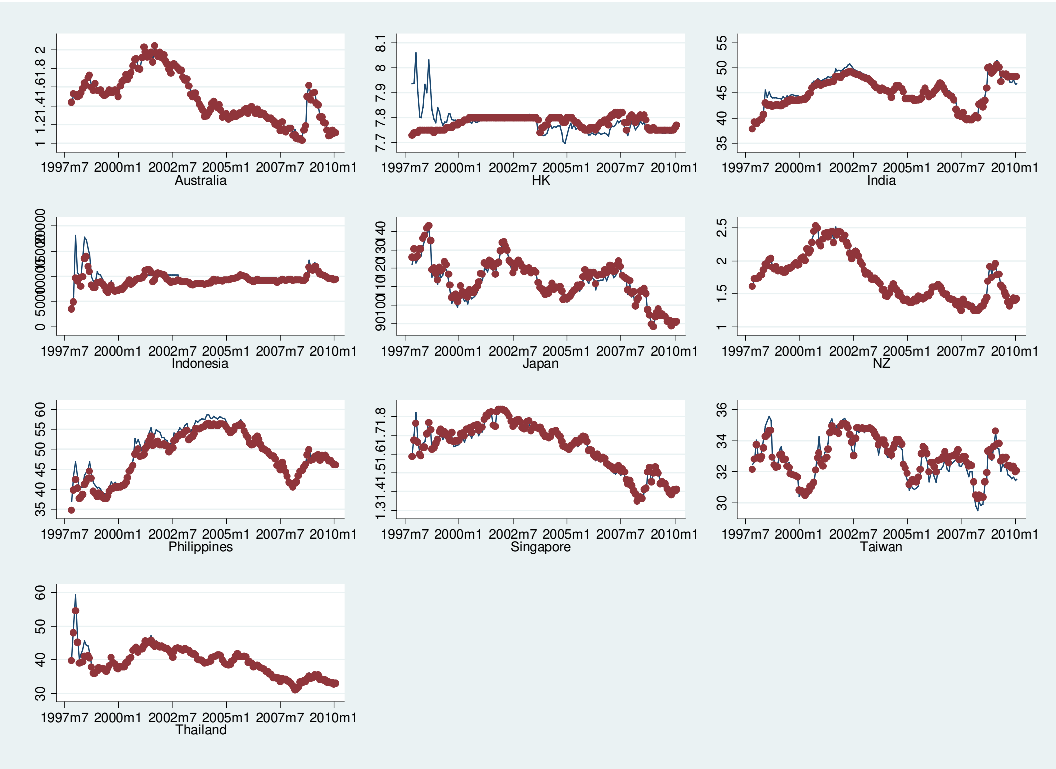
B. Two Month Forward Rates



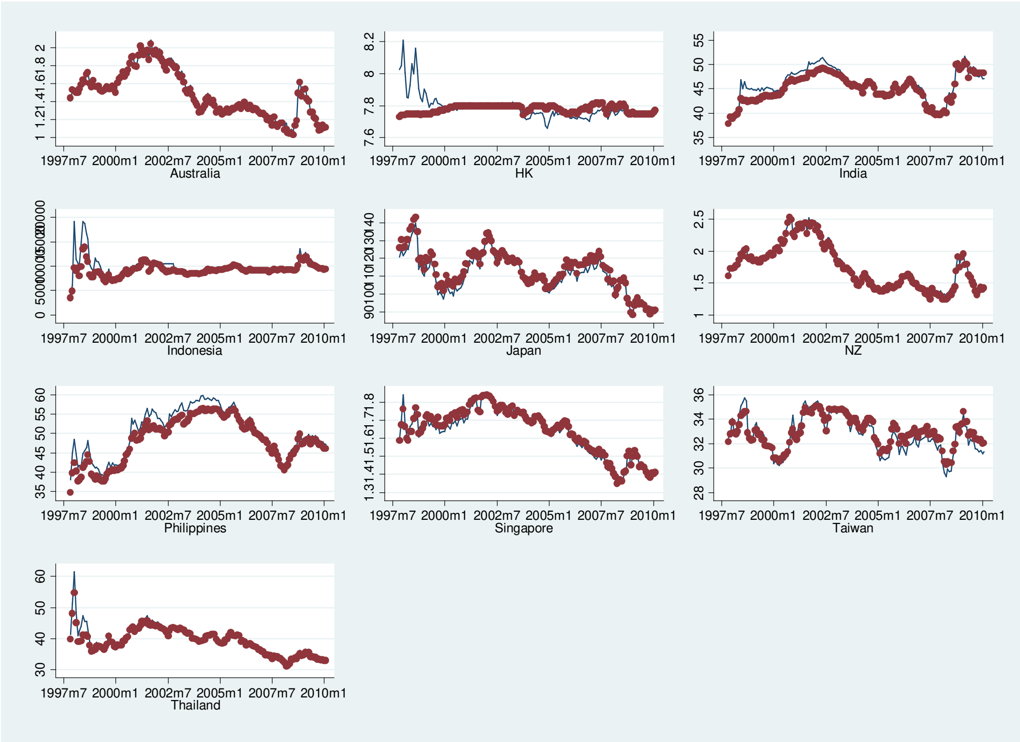
C. Three Month Forward Rates



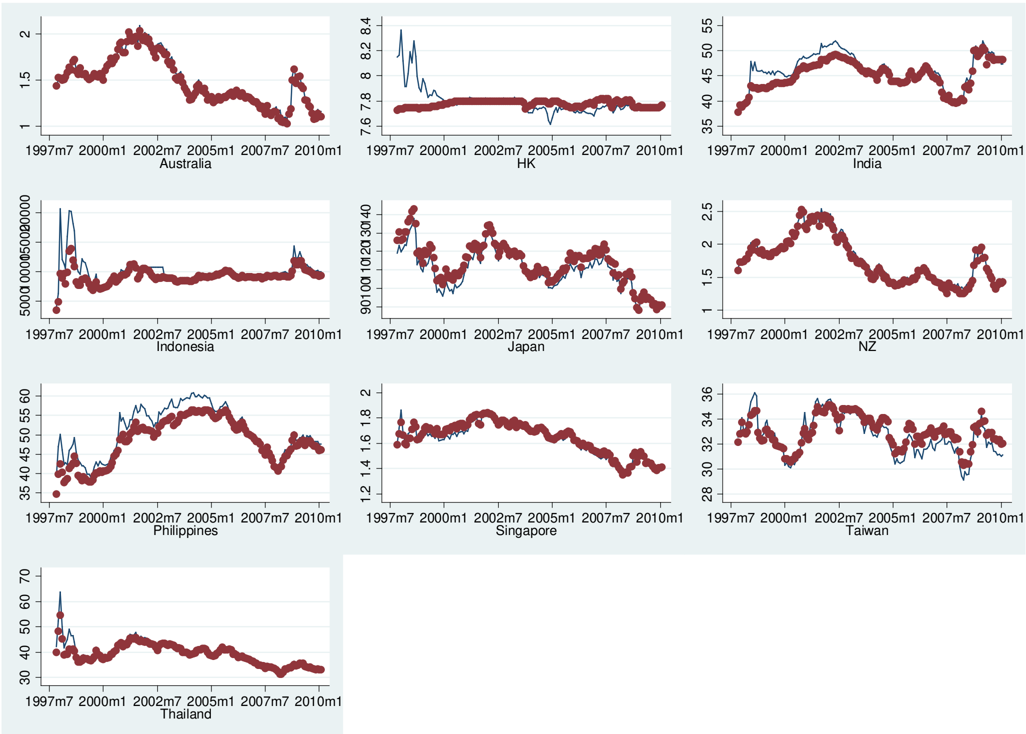
D. Six Month Forward Rates



E. Nine Month Forward Rates

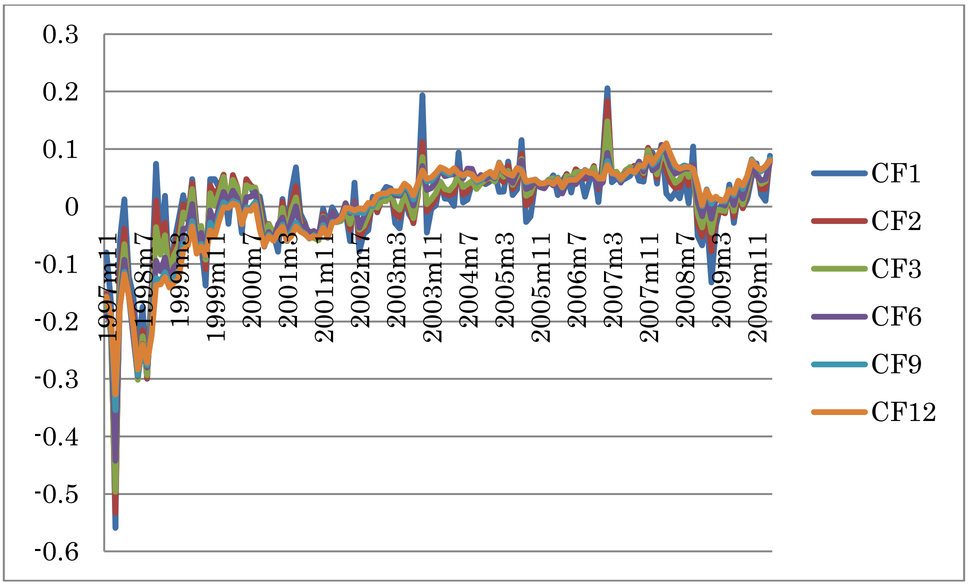


F. Twelve Month Forward Rates



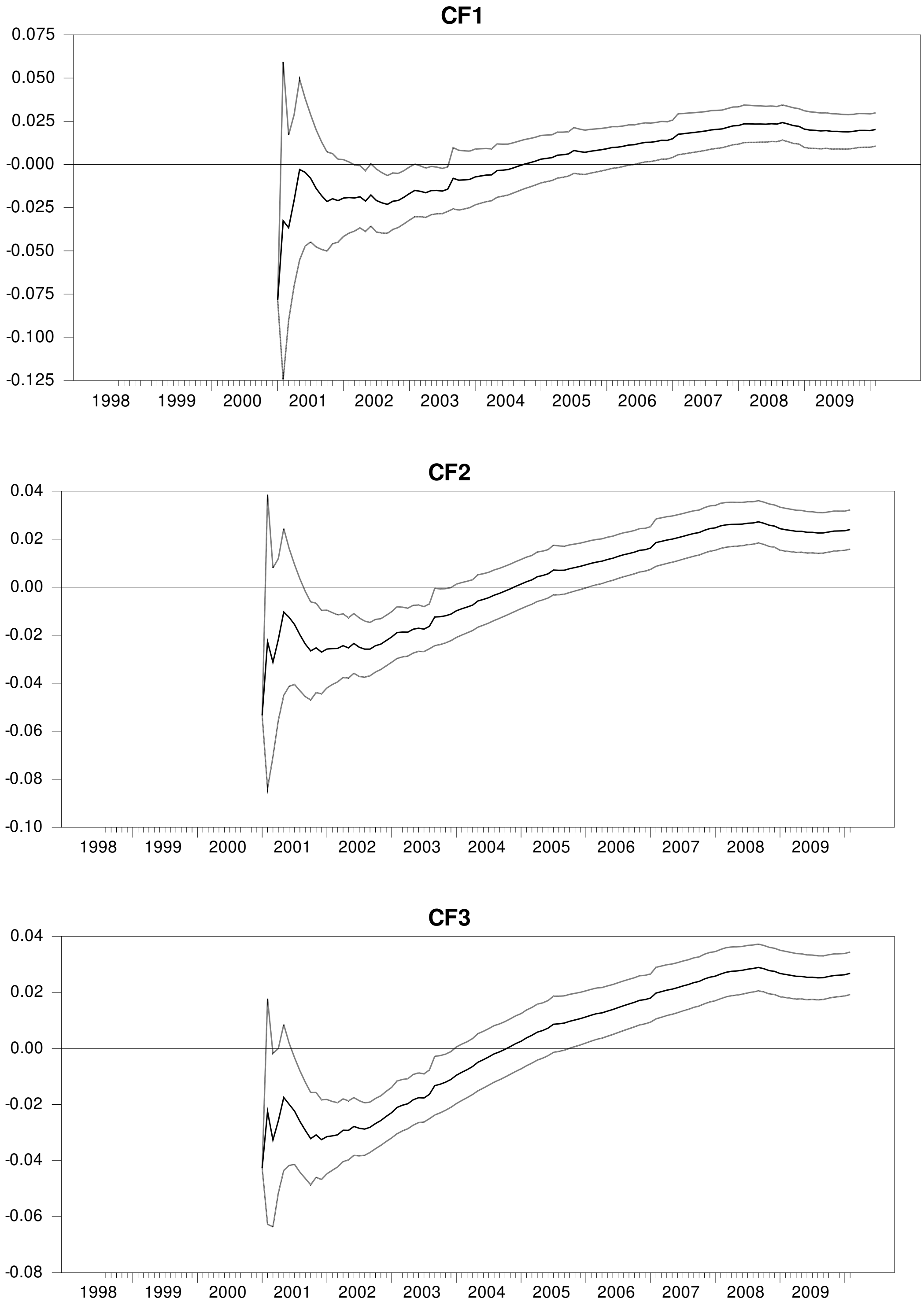
Note: Spot (dot) and forward (line) exchange rates.

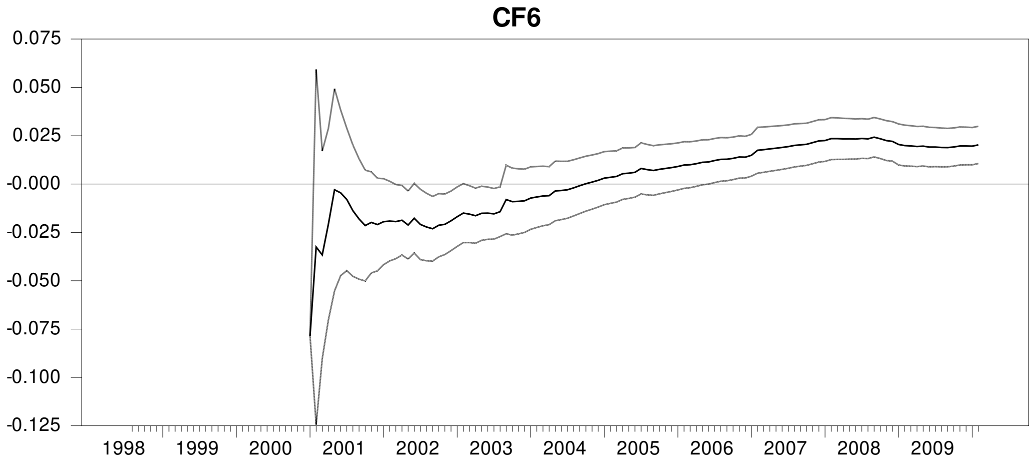
Figure 2. Common Factors

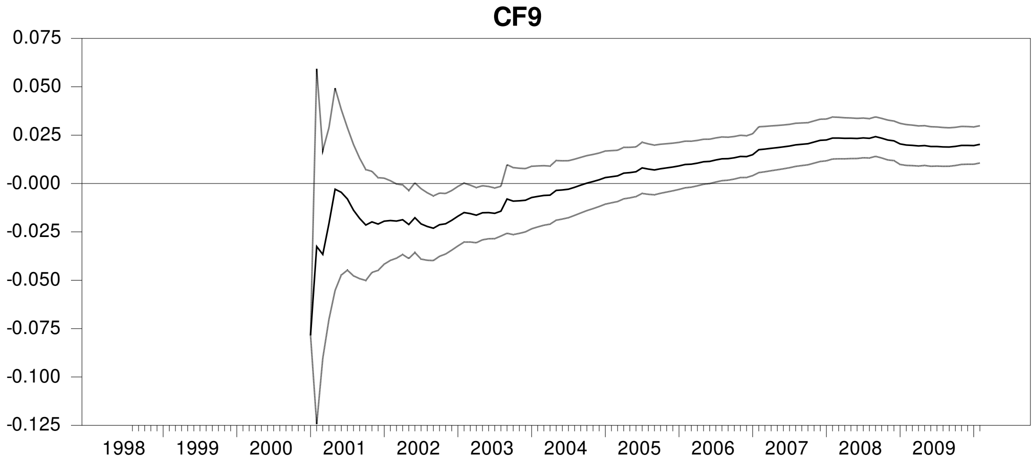


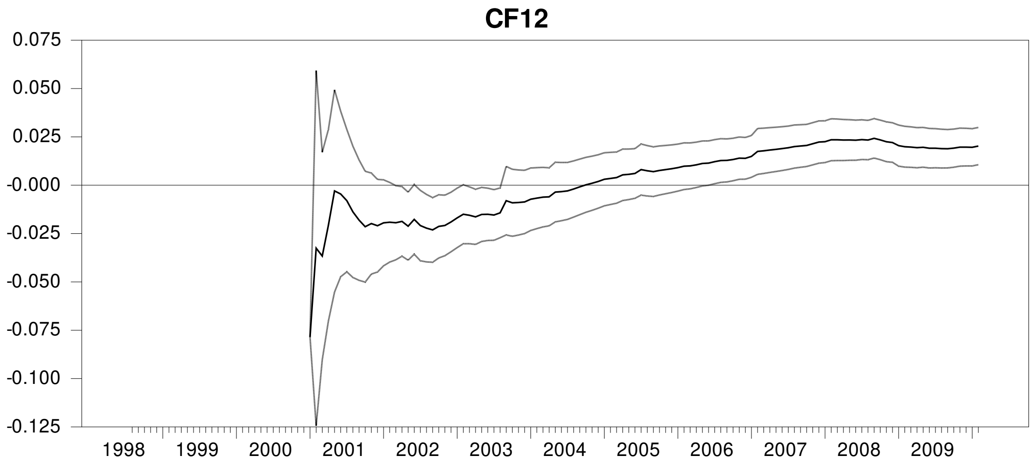
Note: The common factors using forward rates for maturities of one (CF1), two (CF2), three (CF3), six (CF6), nine (CF9) and twelve (CF12) months.

Figure 3. The Stability of Common Factors Using the Recursive Method









Note: The common factors using forward rates for maturities of one (CF1), two (CF2), three (CF3), six (CF6), nine (CF9) and twelve (CF12) months. The parameters recursively estimated from a regression between the common factors and the constant are shown above.