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A NEW TECHNIQUE FOR ESTIMATING CURRENCY PREMIUMS

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Abstract

This paper extends the model of currency premiums developed by Clarida (2012, 2013). In our extended model, a currency premium consists of two disequilibrium factors: One is the interest rate gap, i.e., the deviation of real interest rates, domestic and foreign, from their equilibrium values; the other is the exchange rate misalignment, i.e., the deviation of real exchange rates from their equilibrium values. This paper calculates these disequilibrium factors included in the dollar, euro, and yen, and shows empirically the developments of the currency premiums from the mid-2000s. The result indicates that the euro was growing to become a world currency next to the US dollar toward the late 2000s, and then the yen was preferred as a safe haven while the US and European capital markets were under stresses.

JEL classification: F31, F37

Key words: interest rate parity, purchasing power parity, currency premium, misalignment

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1. INTRODUCTION

Once a crisis occurs, whether global or local, international capital markets are dominated by trades for safe assets rather than those for high-yield assets. For instance, the *safe-haven buying of the dollar* is a typical behavior observed in such a situation. Since the end of World War II, the US dollar has been the primary currency for investors to buy in an emergency, whether political or economic. From 2007 to 2009, however, global money flowed to potential safe-haven currencies other than the US dollar. The Japanese yen and Swiss franc were currencies preferred as a safe haven in addition to the US dollar. It is argued that Japan and Switzerland suffered weak export demand due to the resulting appreciation of their currencies.

The strength of demand for a safe currency is reflected in the currency premium, i.e., the expected excess return on that currency. Below, the currency premium is called a safety premium if positive, and a risk premium if negative. The currency premium is not directly observable and must be estimated in order to be monitored. There are two strands of literature on the estimation of currency premiums. One is based on the capital asset pricing model (CAPM). A currency works as insurance if it appreciates in a global recession and depreciates in a global boom. Investors have an incentive to pay a premium for this currency; thus, the yield on this currency is discounted just by that safety premium. Based on this idea, Maggiori (2013) estimated the safety premium on the US dollar and showed that the US dollar appreciated substantially at the outbreak of the Lehman shock due to its premium.

Another strand of literature on the estimation of currency premiums was initiated by Clarida (2012, 2013). Suppose that the real yield on domestic inflation-indexed government bonds is lower than that on foreign inflation-indexed government bonds. Clarida defines the differential between the two yields as the safety premium on the domestic currency against the foreign currency. For instance, let us consider a Japanese investor who has yen funds. He can invest the funds in either Japanese inflation-indexed government bonds or US inflation-indexed government bonds and convert the earned dollars into Japanese yen. If the real yield on US bonds is higher than that on Japanese bonds, it means that a safety premium is put on the yen. This method allows us to estimate currency premiums easily for two reasons: First, we do not need to assume either complete markets or representative agents. Second, we do not need to estimate real interest rates if two countries issue inflation-indexed government bonds.

Note, however, that the Clarida model holds only in the long run. Consider an investor who has yen funds and invests them in US bonds. The real return is given by the real yield on US bonds plus the real appreciation rate of the dollar against the yen. Thus, the investor has to predict the future dollar/yen real exchange rate. Clarida exploits the purchasing power parity (PPP) for this purpose. There is a consensus among academics that the nominal exchange rate converges to the PPP rate in the long run. Put differently, if the theory holds, the real exchange rate converges to a certain constant. Furthermore, Clarida assumed that this convergence point is given by the historical average of the real exchange rate. But as reported by Rogoff (1996), it takes 3 to 5 years for the real exchange rate to return halfway to its steady state. This implies that the Clarida model is applicable only to the long-term analysis.

This paper extends the Clarida model and makes it applicable to the shorter-term analysis as well. Hara and Kamada (1999) examined a survey on investors' expectations of nominal exchange rates and pointed out the following tendency: The longer the forecast horizon is, the more regressive the expected nominal exchange rate is, that is, the more strongly it returns to its historical values. Put differently, the real exchange rate is expected to converge to an equilibrium value defined in a certain way. Following their analysis, we build up a model for investors' expectation formation process and exploit it to estimate currency premiums for various forecast horizons. The assumption of regressive expectations may not necessarily hold in all times and places. Particularly in the very short run, investors' expectations are often extrapolative or diverging further from the previous values. For instance, investors tend to expect the yen to appreciate further as it appreciates and to depreciate further as it depreciates. This paper discusses how the misspecification of expectation formation affects the measurement of currency premiums.

The remainder of this paper is organized as follows. Section 2 introduces the extended version of the Clarida model. Section 3 applies the extended model to the dollar, euro, and yen and estimates their currency premiums. Section 4 concludes.

2. THE MODEL

2.1 Clarida's definition of currency premiums

Let us consider a Japanese investor who holds yen funds. Denote the real yield per annum on the Japanese n-year inflation-indexed government bond by $r_{n,t}$. The real earnings during n years are fixed now and given by $n \cdot r_{n,t}$. Alternatively, he can invest these funds in the US n-year inflation-indexed government bond and convert the earned dollars into yen after n years. Denote Japan's price level by p_t, the US price level by p_t^*, and the nominal exchange rate of the yen against the dollar by s_t in log. Then the real exchange rate is given by $q_t \equiv p_t^* + s_t - p_t$ in log. Note that the US variables are indicated by " * " unless otherwise mentioned. Denote the n years ahead expected real exchange rate by q_{t+n}^e and the real yield per annum on the US bond by $r_{n,t}^*$. Then the expected real earnings during n years are given by $n \cdot r_{n,t}^* + q_{t+n}^e - q_t$.

If investors were risk-neutral, the two investments above would accrue the same revenues. However, since they are risk-averse in general, the revenues differ between the two depending on the relative safety of the currencies. Clarida (2012, 2013) calls this yield differential the currency premium. Let θ_t be the currency premium of the yen against the dollar. Then we have

$$\theta_t \equiv n(r_{n,t}^* - r_{n,t}) - (q_t - q_{t+n}^e) . \tag{2-1}$$

Suppose $\theta_t > 0$. The return on the Japanese bond is lower than that on the US bond. Despite this disadvantage, there are investors buying the Japanese bond. This indicates that those investors have a strong preference for the yen and thus are willing to pay a safety premium for the yen. Suppose $\theta_t < 0$. This implies that investors do not buy the Japanese bond unless its return is higher than the return on the US bond. This means that a negative safety premium or a risk premium is put on the yen.

Adjusting the observed exchange rate for the currency premium θ_t gives us the exchange rate that would be obtained if investors were risk-neutral. Clarida calls this the fair value of the currency. Denote the fair value by $\tilde{s}_t$ in log. Then we have

$$\tilde{s}_t = s_t + \theta_t \tag{2-2}$$

$$= (p_t - p_t^*) + n(r_{n,t}^* - r_{n,t}) + q_{t+n}^e . \tag{2-3}$$

We used $q_t \equiv p_t^* + s_t - p_t$ in equation (2-3). The fair value can be interpreted alternatively as the exchange rate that would be obtained if there were no risk in the investments. In this sense, the fair value can be called the risk-free exchange rate and strongly reflects economic fundamentals. For instance, the fair value of the yen decreases if the price level rises or the real interest rate declines in Japan. Furthermore, the fair value of the yen also decreases if the price level falls or the real interest rate rises in the US.

2.2 Measuring currency premiums using the purchasing power parity

The n-year ahead expected real exchange rate, q_{t+n}^e, is required to measure the currency premium and the fair value. However, this value is not observable directly in the market. Clarida (2012, 2013) utilizes the PPP for this purpose. If the PPP theory holds, q_{t+n}^e converges to a certain value. Clarida goes further to assume that this convergence point is given by the historical average of the real exchange rate, φ. That is,

$$q_{t+n}^e = \varphi . \tag{2-4}$$

Substituting this into equations (2-1) and (2-3), we have

$$\theta_t^C = n(r_{n,t}^* - r_{n,t}) - (q_t - \varphi), \qquad \text{and} \tag{2-5}$$

$$\tilde{s}_t^C = (p_t - p_t^*) + n(r_{n,t}^* - r_{n,t}) + \varphi . \tag{2-6}$$

The Clarida model is a powerful tool for exchange rate analysis: The currency premium is calculated using only directly observable variables. It is not very difficult to collect the data necessary for the calculation, such as price levels, yields on inflation-indexed government bonds, and real exchange rates. In addition, the currency premium is calculated using only elementary arithmetic; no fancy econometrics is required. Furthermore and most importantly, the Clarida model works in various situations, since it makes no special assumption except for the specification of q_{t+n}^e.

Nonetheless, there is room for improvement in the Clarida model. First, the Clarida model holds only in the long run. There is a consensus among academics that the PPP theory holds in the long run. But as pointed by Rogoff (1996), it takes 3 to 5 years for the real exchange rate to return halfway to its steady state. This implies that it will take more than 10 years for the real exchange rate to reach the steady state, and thus the Clarida model is applicable only to the long-term analysis. That is, n should be large enough.

Second, the level of currency premium depends heavily on the choice of sample period in the Clarida model. Suppose that q_t has an upward trend. In this case, as the beginning of the sample period goes back into the past, the historical average φ declines and thus the currency premium decreases throughout the sample period, as indicated by equation (2-5). This implies that the currency premium can be determined arbitrarily by the choice of sample period. This is not a serious problem if we are only interested in a change in currency premiums, but can be a critical issue when discussing the level of currency premiums.

Third, it is not necessarily clear how the Clarida model is interpreted in the equilibrium framework. In the model, the equilibrium value of the real exchange rate is given by the historical average. That is, it is assumed that the current real exchange rate is in a disequilibrium position, but will converge to its equilibrium in the future. On the other hand, no discussions are made as to whether the current real interest rates are in or out of equilibrium. Interest rate control is used as one of the basic policy measures to stabilize economic activities and price developments even in unconventional monetary policies as well as in conventional monetary policies. Therefore, the model should be designed to take into consideration that the actual real interest rate is mostly in a disequilibrium position rather than in an equilibrium position.

2.3 An extension of the Clarida model

This paper presumes that the economy is hit by various external shocks and thus is almost always out of equilibrium, but at the same time is always on the way to its equilibrium. It is also assumed that $\theta_t = 0$ holds in equilibrium. Note that equilibrium variables are indicated by " – ". Then equation (2-1) implies that in equilibrium, we have

$$\bar{q}^e_{t+n} = \bar{q}_t - n(\bar{r}^*_{n,t} - \bar{r}_{n,t}) . \qquad (2\text{-}7)$$

That is, we assume that the uncovered interest rate parity holds in real terms in equilibrium.

It is also assumed that investors expect the economy to be in equilibrium after n years. That is,

$$q^e_{t+n} = \bar{q}^e_{t+n} . \qquad (2\text{-}8)$$

Substituting equations (2-7) and (2-8) into (2-2) and (2-3), we have

$$\theta^{IKK}_t = n(\hat{r}^*_{n,t} - \hat{r}_{n,t}) - \hat{q}_t , \quad \text{and} \qquad (2\text{-}9)$$

$$\tilde{s}^{IKK}_t = (p_t - p^*_t) + n(\hat{r}^*_{n,t} - \hat{r}_{n,t}) + \bar{q}_t , \qquad (2\text{-}10)$$

where " ˆ " indicates a discrepancy between a certain variable and its equilibrium value, i.e., $\hat{x} \equiv x - \bar{x}$. Equation (2-9) says that the currency premium defined in this paper consists of two parts: the *interest rate gap*, i.e., the deviation of real interest rates, domestic and foreign, from their equilibrium values; and the *exchange rate misalignment*, i.e., the deviation of the real exchange rate from its equilibrium value.

In this paper, we discuss not only the long-run equilibrium but also the short-run equilibrium. Once hit by disturbances, the economy is thrown out of equilibrium and remains in a disequilibrium position for some time. Some of the disturbances are short-lived and their impacts disappear in a short time, but some are long-lasting and their effects remain for a long time. We assume that the short-run equilibrium is achieved when the impacts of the short-lived disturbances disappear and that the long-run equilibrium is reached after the effects of the long-lasting disturbances have gone away. Note that we do not specify what is a short-lived and a long-lasting disturbance in this paper.

We use the HP filter to determine the equilibrium values. For each n, the filter enables us to decompose a time series into two parts, a cyclical component which is extinguished in n years and a trend component which remains after n years, by choosing the smoothing parameter appropriately. We regard the disturbances and their effects as the cyclical component, and the equilibrium values (i.e., $\bar{q}_t$, $\bar{r}_{n,t}$, and $\bar{r}^*_{n,t}$) as the trend component.[1] Then, we can consider the equilibrium for various forecast horizons by changing the value of n.

Another advantage of using the HP filter is that the currency premium does not depend heavily on the choice of sample period. If the sample period is sufficiently long, a change in the beginning of the sample period does not greatly change the HP-filtered trend component, $\bar{q}_t$, particularly near the end of the sample period. In contrast, the historical average of q_t, i.e., φ, which is used as the equilibrium value in the Clarida model, strongly depends on the choice of sample period. The HP filter saves us from determining currency premiums arbitrarily.

In this paper, we take into consideration some of the so-called real-time problems when we use the HP filter to capture equilibrium values, i.e., $\bar{q}_t$, $\bar{r}_{n,t}$, and $\bar{r}^*_{n,t}$.[2] Suppose that the sample starts in period 1 and ends in period T. Consider an investor in period t ($1<t<T$). There is no doubt that this investor has the data up to period t, as in $\{x_1, x_2, \cdots, x_{t-1}, x_t\}$. One way of estimating the trend component $\bar{x}_t$ is to apply the HP filter to this data directly. However, the HP filter suffers the *end of sample problem*, which says that the beginning and the end of the trend component are strongly influenced by actual data. A variety of solutions to this problem have been proposed. Here we take a simple procedure as follows. The data is extended to both sides, as in $\{\cdots, x_2, x_1, x_1, x_2, \cdots, x_{t-1}, x_t, x_t, x_{t-1}, \cdots\}$. Then, the HP filter is applied to this extended data to obtain $\bar{x}_t$. In so doing, the weight on x_t is reduced in the estimate of $\bar{x}_t$, and thus, $\bar{x}_t$ is saved from being affected excessively by x_t. In the next period, the data extends up to $t+1$, as in $\{x_1, x_2, \cdots, x_t, x_{t+1}\}$. Again, we extend the data to both sides, as in $\{\cdots, x_2, x_1, x_1, x_2, \cdots, x_t, x_{t+1}, x_{t+1}, x_t, \cdots\}$. Then, the HP filter is applied to this new extended data to obtain $\bar{x}_{t+1}$. Repeating this procedure gives us a series of equilibrium values, i.e., $\{\bar{x}_1, \bar{x}_2, \cdots, \bar{x}_{T-1}, \bar{x}_T\}$.

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[1] Clark and MacDonald (1998) also used the cyclical component of the real exchange rate obtained by the HP filter as a proxy of the misalignment.

[2] See Orphanides and van Norden (2002) for various aspects of real-time problems.

Lastly, we mention how the Clarida model departs from our extended model from the long-run point of view. Subtracting equation (2-9) from (2-5), we have

$$\theta_t^C - \theta_t^{IKK} = n(\bar{r}_{n,t}^* - \bar{r}_{n,t}) - (\bar{q}_t - \varphi) . \quad (2\text{-}11)$$

If the real exchange rate is a stationary variable without a trend, the trend component $\bar{q}_t$ approaches the sample average φ, as n increases, due to the property of the HP filter. This means that the second term in the right-hand side of equation (2-11) converges to zero. Furthermore, if the growth rates converge to each other between the US and Japan, the real interest rates also converge to each other between the two countries, as n increases. This means that the first term in the right-hand side of equation (2-11) converges to zero. However, it is not very plausible for the growth rate convergence to occur, as indicated by the difference in realized growth rates between the US and Japan since the second half of the 1990s. The safety premium on the yen against the dollar is likely to be higher in the Clarida model than in our extended model, at least in recent years.

3. EMPIRICAL ANALYSIS

3.1 Data

In this section, we apply our extended model to the three major currencies, i.e., the dollar, euro, and yen, and examine the developments of their currency premiums from the mid-2000s. Figure 1(1) presents the time series of the dollar/yen, euro/dollar, and euro/yen real exchange rates, obtained by adjusting the spot nominal exchange rates by consumer price indices. Figure 1(2) indicates the time series of the 10-year real interest rates, obtained by adjusting nominal zero-coupon bonds by the inflation swap rates.[3,4]

[3] The data for US nominal zero-coupon rates, calculated by the method of Gürkaynak et al. (2007), are obtained on the Federal Reserve's website, www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html. The other data are provided by Bloomberg L.P. The data for Japanese nominal zero-coupon rates are calculated by the method of McCulloch (1990).

[4] Japanese inflation swap rates are adjusted for the effects of consumption taxes as follows. First, the tax-included yield curve of inflation swaps is estimated theoretically under the assumption that the hike in consumption tax rate is fully passed on to the prices of all the taxable consumption items. Next, the market-implied pass-on rate is estimated by regressing the actual yields on the theoretical yields. This allows us to estimate an

Note that the real interest rate in the euro area is represented by the German rate. The three real interest rates have followed downward trends since the Lehman shock. The US and euro-area real interest rates became negative in 2011, and so did the Japanese rate in 2013. The US rate hovered near zero percent thereafter, but the Japanese and euro-area rates have remained in negative territory.

3.2 The performance of the extended model

First, we evaluate the performance of our extended model. For this purpose, we compare it with the International Money Market (IMM) noncommercial position. We focus on the net position in particular, i.e., the long minus the short position of the IMM currency futures contracts. The IMM position is not a measure of currency safeness by itself. As we know, however, when financial risks increase in international capital markets and global money is ready to fly to the dollar as a haven, the long position of the dollar tends to increase; when the risk is gone, the short position of the dollar tends to increase. Therefore, we can see the performance of our extended model by comparing the IMM position with the currency premium calculated for the dollar. We set n=10 years here. In Figure 2(1), the IMM position is compared with the estimated currency premium of the dollar against the yen; in Figure 2(2), it is with that of the dollar against the euro. In either case, the dollar currency premium is closely correlated with the IMM position: That is, the safety premium of the dollar tends to increase as the long position of the dollar increases.

Next, we examine the difference between the Clarida model and our extended model from the empirical point of view. Again, we set n=10 years. In Figure 3, we compare the dollar currency premium in the Clarida model with that in our extended model. Figure 3(1) shows the dollar currency premium against the yen. The two estimates since 2008 coincide with each other. Figure 3(2) indicates the dollar currency premium against the euro. The two estimates since 2013 coincide with each other. However, the Clarida model is not very successful in capturing the sentiment in

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adjustment factor for consumption taxes. Note that the Japanese inflation swap market has too short a history to provide a long time series. Thus, we use the breakeven inflation rate, which is implied by inflation-indexed government bond yields, to compensate the sample.

international capital markets until then. Particularly, the Clarida model says that the risk premium was attached to the dollar rather than the euro in the global financial crisis in the period from 2008 to 2009 as well as in the subsequent period from 2010.

3.3 The dynamics and term structure of currency premiums

Figure 4 shows the effective currency premiums and fair values of the dollar, euro, and yen, with $n=10$ years. The *effective dollar fair value*, for instance, is constructed as follows. First of all, we estimate the fair values of the dollar against the yen and the euro. Next, we aggregate them with the currency weights used by the Bank for International Settlements in the calculation of effective exchange rates. This gives us the effective fair value of the dollar. The effective fair value of the euro and the yen are obtained similarly. Note that the effective exchange rates, the effective fair values, and the effective currency premiums are all defined only among the dollar, euro, and yen. In the figure, the effective fair value is drawn by a thick line and the actual effective exchange rate by a thin line. Like the effective exchange rate, the effective fair value appreciates if it goes up and depreciates otherwise. The safety premium (denoted by the blue area) is put on the currency if the actual effective exchange rate is above the effective fair value; otherwise the risk premium (denoted by the red area) is on the currency. After the end of World War II, the US dollar became the only key currency, and thus attracted the safety premium against any other currency. After the European monetary union, the euro was growing to become a world currency next to the US dollar, and thus the safety premium was put on the euro rather than the US dollar. However, once the global financial crisis occurred, the risk premium was put on the euro. Moreover, the dollar did not act sufficiently as a safe currency, since the US capital markets were also hit by the financial turmoil. Thus, the yen became a preferred safe haven in this situation. A safety premium was put on the yen in 2009, and the yen continued to be a safe haven up to 2012.

It is interesting to see how investors' attitudes toward risk evolved during the financial crisis. In Figure 5, we decompose currency premiums into short-, medium-, and long-term factors. The short-term currency premium is estimated with $n=2$ years. The medium-term premium is a 2-year-ahead 3-year premium, which is obtained by subtracting the short-term premium from the currency premium estimated with n=5 years. The long-term premium is a 5-year-ahead 5-year premium, which is obtained by subtracting the short- and medium-term premiums from the currency premium estimated with n=10 years. In early 2010, a risk premium was put on the euro instead of a safety premium. As shown in the figure, this was due to an increase in the short-term risk premium, which reflected the expectations of many investors that the market stresses would disappear shortly. Before long, however, the medium- and long-term risk premiums began to expand rapidly, reflecting investors' heightened sense of risk aversion.

3.4 Potential misspecification of expectation formation process

As clarified by the discussion in the previous section, we need to specify the expectations of the real exchange rate in order to estimate the currency premium. However, the actual process of formation of future real exchange rates can vary across investors and may depend on when and where expectations are formed. Both the Clarida model and our extended model presume a particular type of expectation formation process. A wrong specification will lead directly to a wrong estimation of currency premiums.

We consider how a misspecification of the expectation formation of the future real exchange rate affects the estimate of the currency premium. Equation (2-1) defines the currency premium and holds regardless of the expectation formation process. Adding equation (2-7), which defines the equilibrium condition in our extended model, to equation (2-1) and rearranging the result, we have

$$\theta_t^{IKK} - \theta_t = \overline{q}_{n+t}^e - q_{n+t}^e , \qquad (3\text{-}1)$$

where θ_t denotes the true currency premium. Thus, the left-hand side measures an estimation error of the currency premium. q_{n+t}^e denotes the true expectations of the future real exchange rate and $\overline{q}_{n+t}^e$ the expected real exchange rate defined in our extended model. Thus, the right-hand side indicates the misspecification of the expected real exchange rate. To sum, equation (3-1) shows that the misspecification of an expectation formation process leads to an estimation error of the currency premium.[5]

The yen carry trade, which was a popular transaction just before the global financial crisis, is an example in which a misspecification of an expectation formation process may affect the estimate of the currency premium. In this transaction, investors raise yen funds at low interest rates and invest the funds in high-yield currencies. In so doing, the investors hope for a gain both from the interest rate differential between the two currencies and from the appreciation of high-yield currencies (the depreciation of the yen). As the yen depreciated in the market, the majority of investors expected the yen to depreciate further at least in the near future, and those who expected the yen to appreciate back were a minority. Therefore, it was likely that q_{n+t}^{e} was higher than $\overline{q}_{n+t}^{e}$ and thus, from equation (3-1), θ_t^{IKK} might underestimate the true currency premium θ_t.

From the viewpoint of medium- to long-term expectations, however, a discrepancy between q_{n+t}^{e} and $\overline{q}_{n+t}^{e}$ may not matter so much. Hara and Kamada (1999) categorized investors' expectation formation processes into several types. Let us consider a case where the yen depreciates. If investors expect the yen to depreciate further, their expectations are called extrapolative. On the contrary, if they expect the yen to appreciate back, their expectations are called regressive. Hara and Kamada examined a survey on the expectations of the exchange rate of the yen against the dollar and concluded that near-future expectations are extrapolative, though becoming static recently, but that medium- to long-term expectations are regressive. Note that both the Clarida model and our extended model assume regressive expectations. That is, they consider that the exchange rate tends to converge to an equilibrium value. Therefore, the estimates of medium- to long-term currency premiums presented above are taken to be reasonable even under the situation where investors aggressively engaged in the yen carry trade.

[5] The misspecification of an expectation formation process also creates an estimation error of currency premiums in the Clarida model. That is, we have $\theta_t^{C} - \theta_t = \varphi - q_{n+t}^{e}$.

4. CONCLUSION

In this paper, we extended Clarida's (2012, 2013) model of currency premiums in the equilibrium framework. In our extended model, the currency premium consists of the two disequilibrium factors: the interest rate gap, i.e., the deviation of the real interest rates, domestic and foreign, from their equilibrium values; and the exchange rate misalignment, i.e., the deviation of the real exchange rate from its equilibrium. Thus, the currency premium is obtained by defining and estimating these two disequilibrium factors in a certain way. Our extended model inherits the conciseness and usefulness of the Clarida model and attains broader applicability. The model allows us to estimate the currency premium in the short and medium term as well as the long term.

In this paper, we examined the evolution of currency premiums of the dollar, euro, and yen empirically, focusing on the period from the mid-2000s. The analysis showed that the euro was growing to become a world currency next to the US dollar toward the late 2000s. The analysis also indicated that the yen acted as a safe haven while the US and European capital markets were in the midst of the financial turmoil. The term-structure analysis of the euro currency premium showed that the majority of investors initially expected the market stresses to disappear shortly, but before long their sense of risk aversion was heightened rapidly.

The model in this paper holds under the specific assumption regarding investors' formation of expectations. The model assumes regressive expectations in which real interest rates and real exchange rates converge to their equilibrium values. If the actual expectation formation process differs from this assumption, the currency premium includes an estimation error. For instance, the estimation error of the currency premium is enlarged if investors expect interest rates to increase further as interest rates actually increase and/or the yen to depreciate as the yen actually depreciates. Therefore, when reading the currency premium estimated in this paper, we should be careful about the plausibility of the assumptions.

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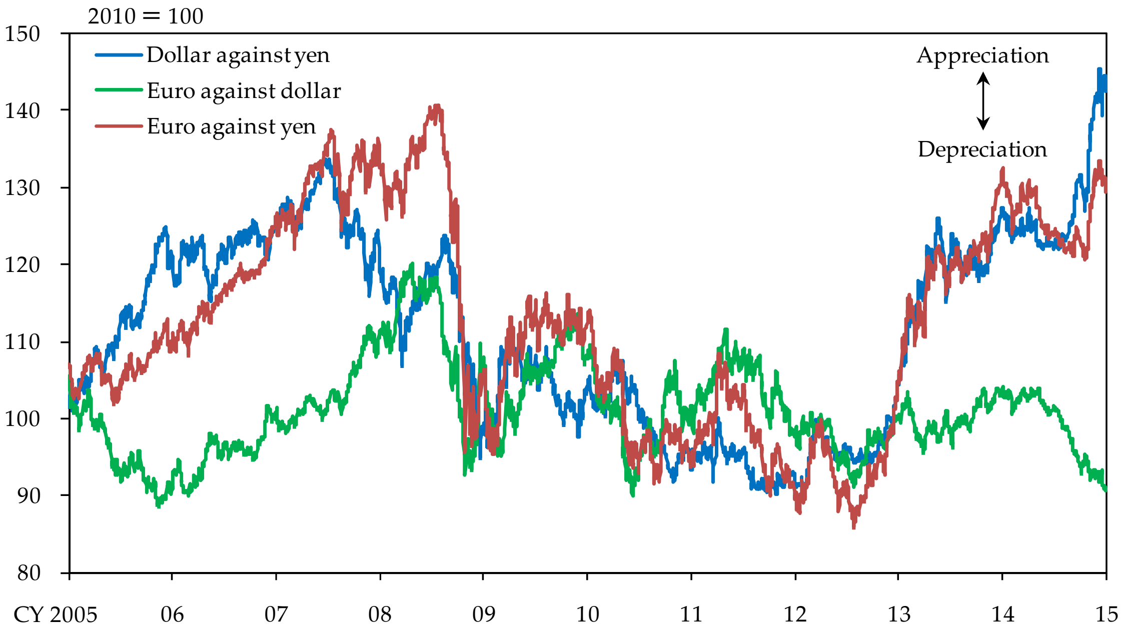
Figure 1. Data used

(1) Real exchange rates



(2) 10-year real interest rates

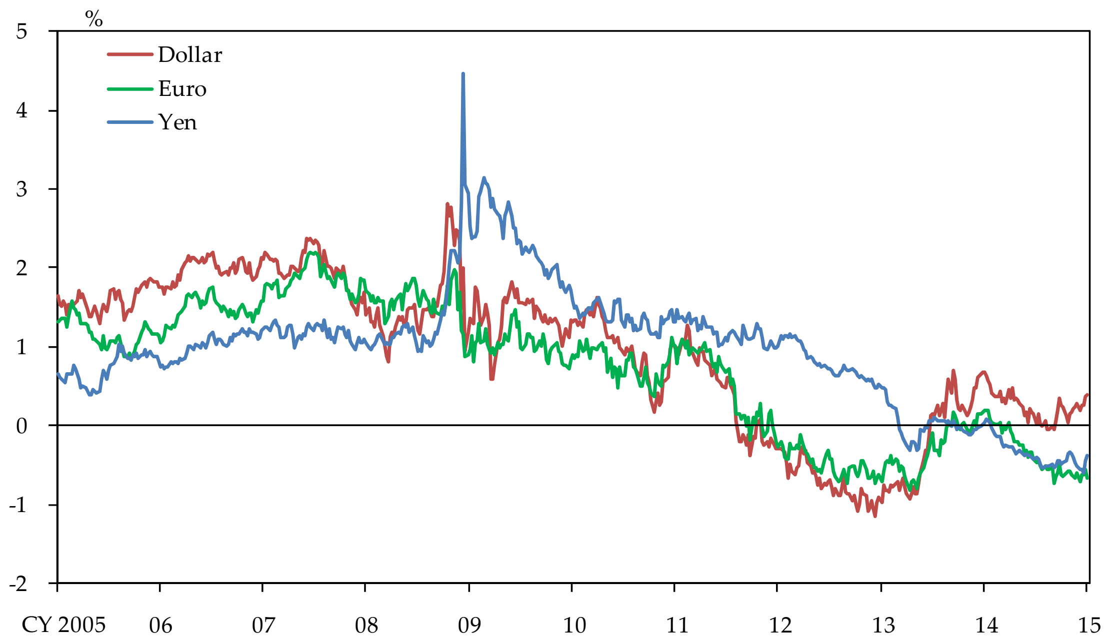
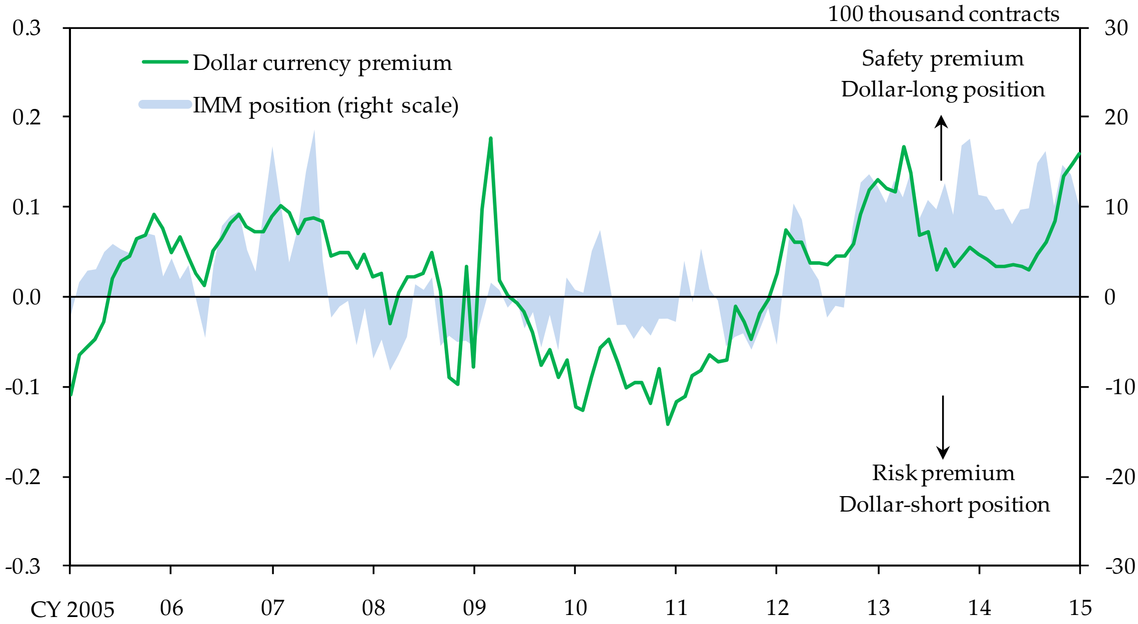
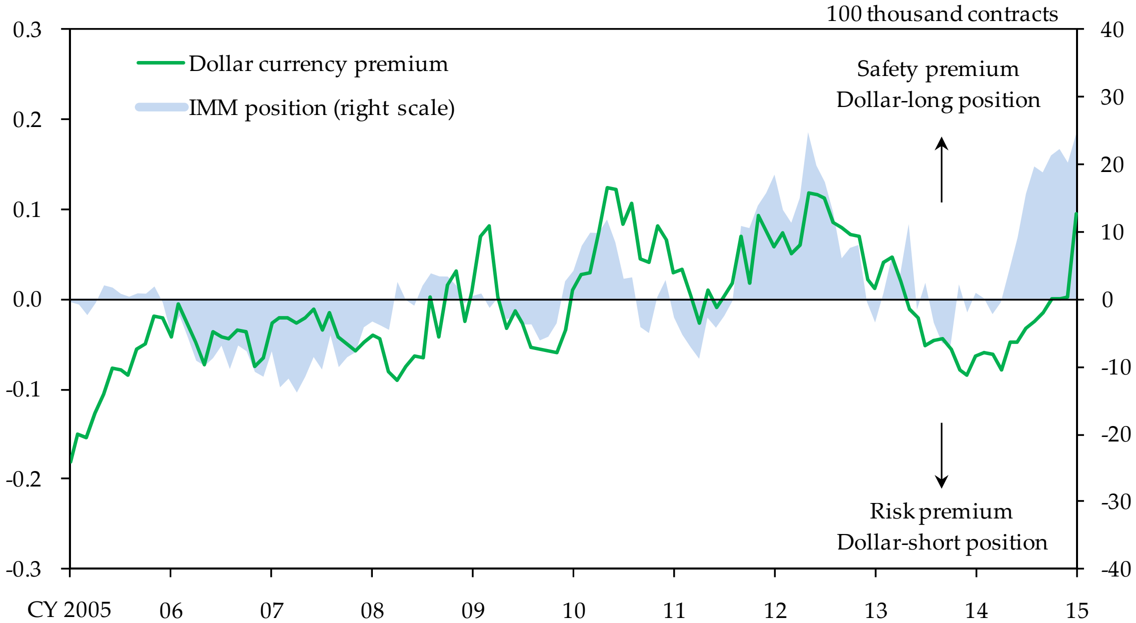


Figure 2. Dollar currency premiums and IMM positions

(1) Dollar against yen



(2) Dollar against euro

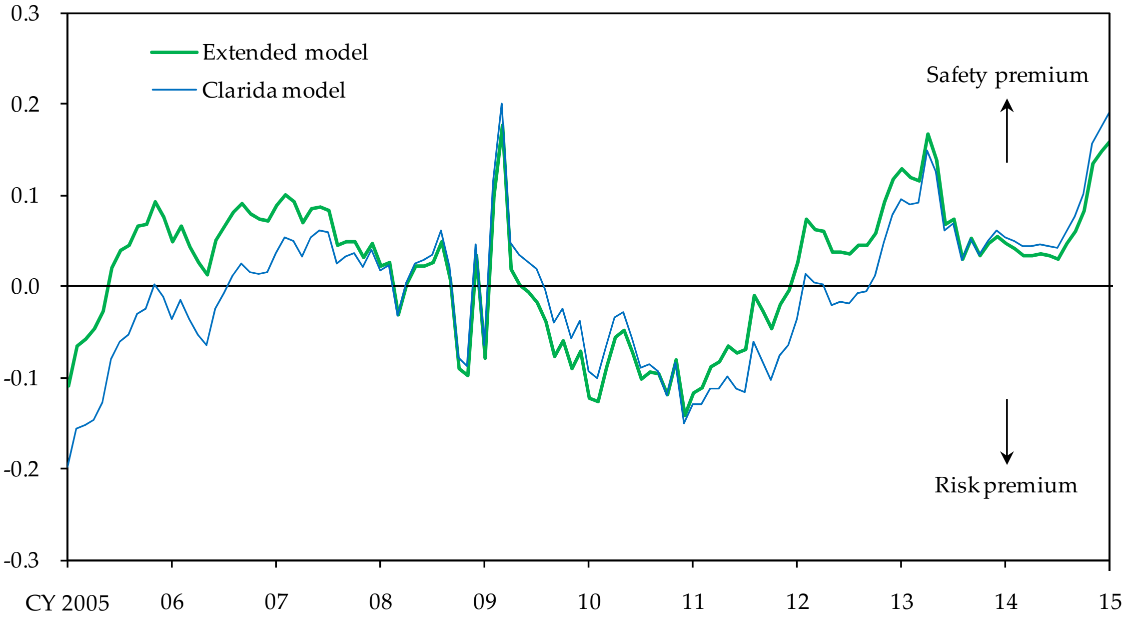


Notes: 1. The IMM position represents a net position of noncommercial contracts of the IMM currency futures.

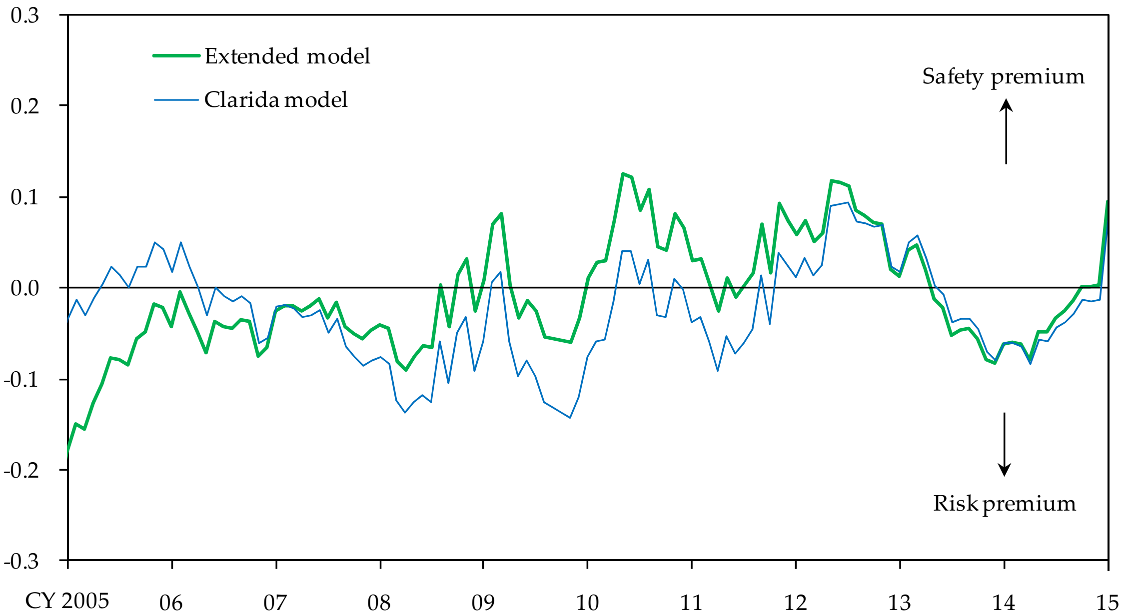
2. The left scale shows the currency premium in log.

Figure 3. Comparison of the Clarida model and the extended model

(1) Currency premiums of the dollar against the yen



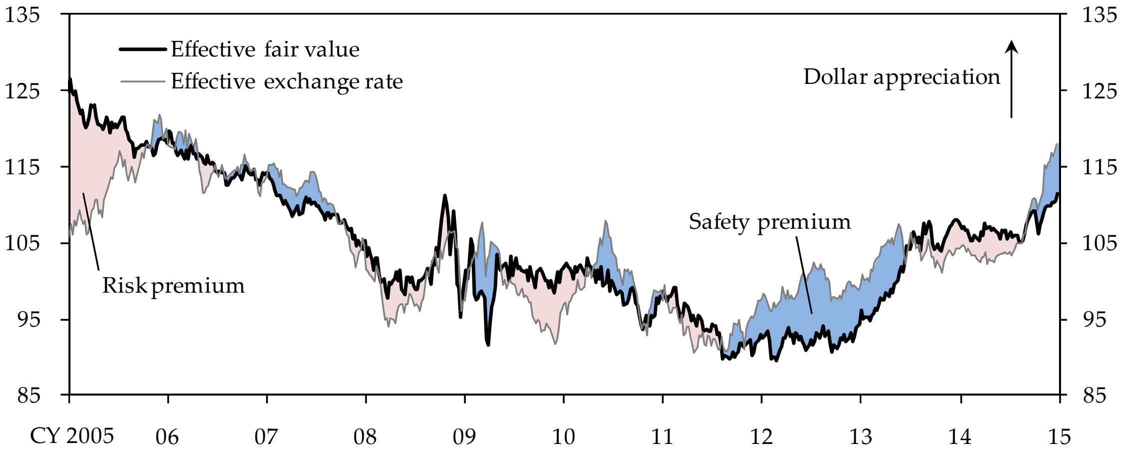
(2) Currency premiums of the dollar against the euro



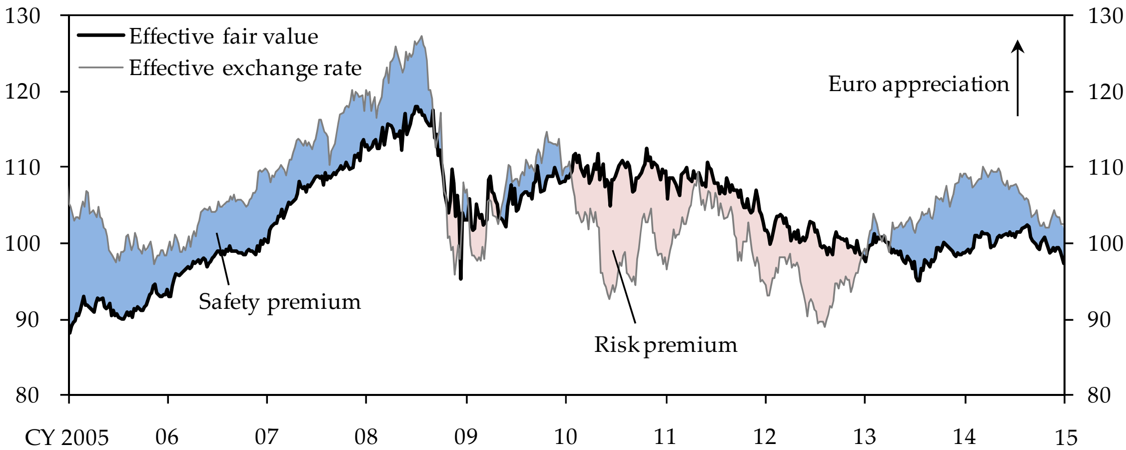
Note: The left scale shows the currency premium in log.

Figure 4. Effective fair values and effective currency premiums

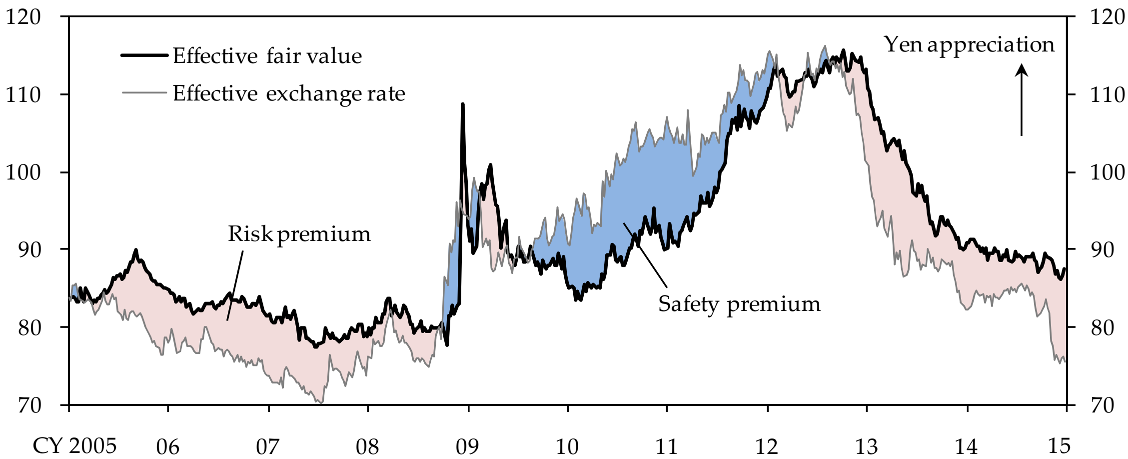
(1) Dollar



(2) Euro



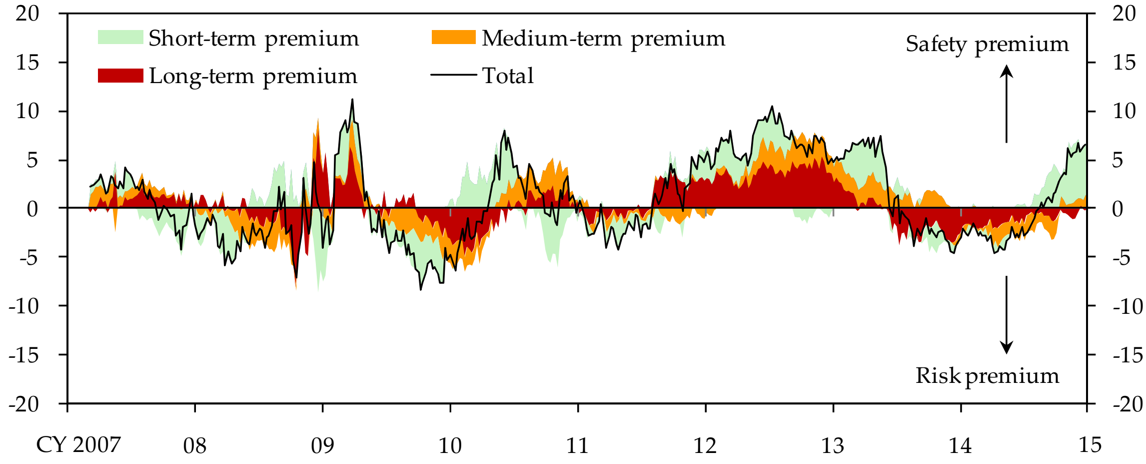
(3) Yen



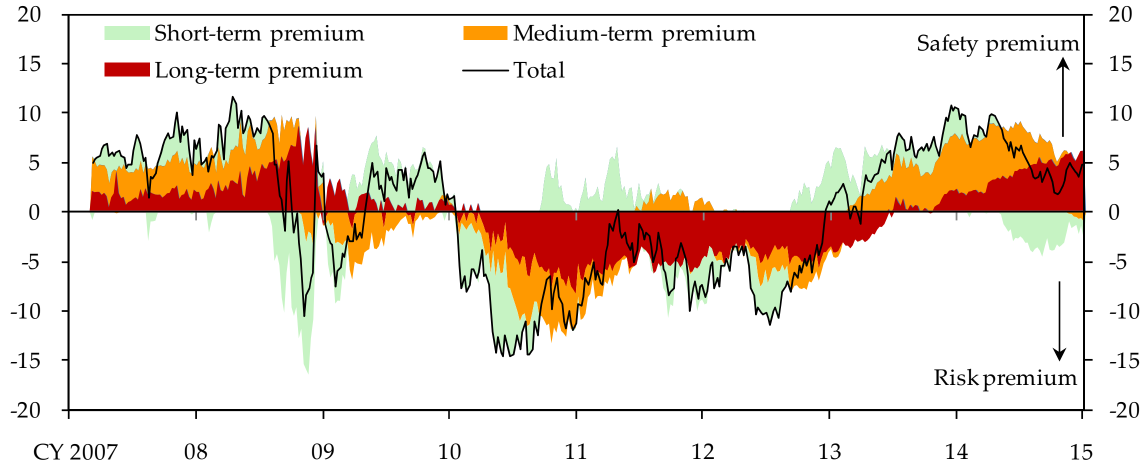
Note: The average of nominal effective exchange rates is normalized at 100 in 2010.

Figure 5. Term structure of effective currency premiums

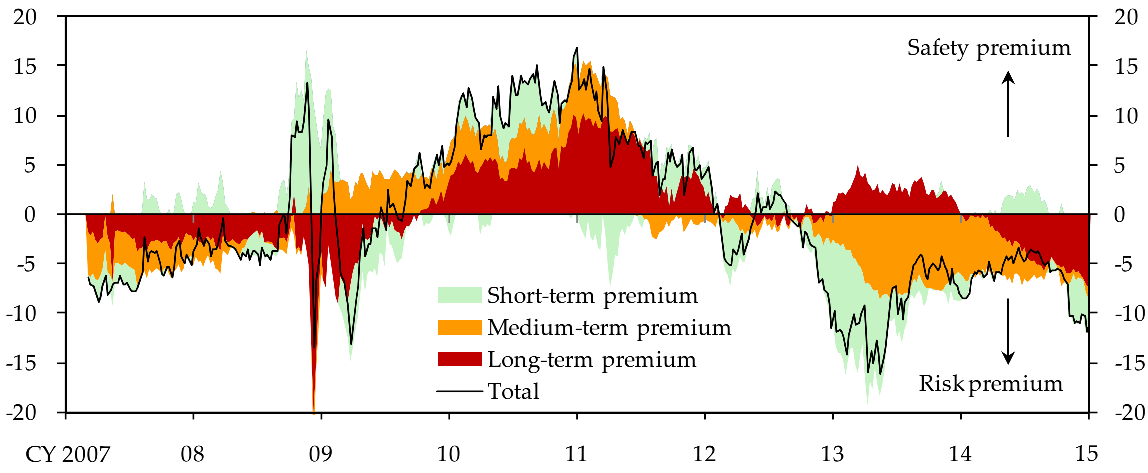
(1) Dollar



(2) Euro



(3) Yen



Note: The level of currency premiums is normalized so that the average of nominal effective exchange rates is equal to 100 in 2010.