What Factors Caused the Increasing Currency Hedging Cost?

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【Abstract】

The rise in currency hedging costs has been highlighted in recent years. Deviations from covered interest rate parity (CIP) have become evident even though there has been no symptom indicating the worsened creditworthiness of global financial institutions and the associated severe liquidity tightness since the European sovereign crisis.

This study conducts a historical decomposition analysis and panel data estimation to examine the determinants of CIP deviations. The results show that the cost of hedging exposure to foreign currencies, particularly the US dollar, can be attributed to increased outward securities investments, which were probably promoted by the different monetary policy stance across countries. The US dollar hedging costs, specifically those measured using foreign exchange swap rates with shorter term maturity, have shown a prominently increasing trend in recent years.

In addition, this study reveals that macroeconomic structural factors contribute to increasing hedging costs. The significant increase in the price of hedges for yen investors might be driven by their bias toward US dollar securities investments and their excess hedge demand for the US dollar owing to their considerable net external assets.

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1. Introduction

Japanese investors have struggled with ultra-low yields from domestic investments. Moreover, in recent years, the gap in bond yields between Japanese and US bonds, which is attributable to different monetary policy stances between the two nations, has widened and thus, promoted their investment in US dollar bonds. At the same time, however, Japanese investors are faced with the increasing cost of hedging against US dollar exposure.

Hedging costs have been growing at a faster pace than the differential between the Japanese and US money market rates, indicating the violation of covered interest rate parity (CIP). This contradicts the belief that for markets in developed countries, cross-border capital transactions are no longer restricted, an arbitrage opportunity will spontaneously disappear at all times except in a crisis period, when counterparty risks become more serious and arbitrage activities are limited owing to an acute decline in fundraising liquidity.

Since the end of the European sovereign crisis, there has been no prominent symptom suggesting the worsening creditworthiness of financial institutions in major countries. In addition, there has been no indication of fundraising liquidity tightening in international financial markets, particularly when the monetary authorities of major nations have maintained affluent liquidity provisions. The deviation from CIP, however, has become evident since 2014 and continues to grow.

For Japanese institutional investors, such as insurance companies and private pension funds, currency hedging operations account for a major part of their foreign currency exposure. According to a survey conducted by JP Morgan Chase & Co., foreign exchange hedging is performed for 90% of foreign bond portfolios in defined benefit accounts of major Japanese corporate pension funds. While this hedge rate may be reasonable considering large-scale foreign exchange (FX) standard deviation, the increasing hedging cost undermines the profitability of foreign bond investments.

This study investigates the determinants of currency hedging costs by emphasizing the effects of outward securities investments stimulated by the variation in monetary policy stance across nations and by other macroeconomic structural factors. The analysis adopts two empirical methodologies. First, a historical decomposition analysis is conducted to detect and trace the key factors contributing to the upward trend of hedging costs. Deviations from CIP measured by using the exchange rate for yen to major currencies are decomposed into several structural shocks to see what factors contributed to the increase in the hedging cost at each point of time. Second, panel data analyses are conducted to examine the relationship between CIP deviations and macroeconomic structural factors. Among investors of major nations, those in Japan have incurred the greatest increase in hedging costs for investments in US dollar-denominated assets.

Hanajiri (2000) suggests that macroeconomic structural factors possibly cause deviations from CIP; accordingly, this study explores if the prominent increase in hedging cost in terms of the yen/dollar rate is associated with Japanese bias for US dollar-denominated assets and their excess demand for the US dollar resulting from the high net external assets.

The remainder of this paper is organized as follows. Section 2 discusses the movements in hedging costs over the past decade and examines the related literature. Section 3 presents the historical decomposition results for deviations from CIP in terms of the yen to other major currencies. Section 4 reports the empirical results of the panel data analyses. Section 5 summarizes the major findings.

2. Literature survey

Hedging tools such as foreign exchange swaps and cross-currency basis swaps are often used to make investments in foreign currency-denominated securities. A yield from a hedged foreign bond between time *t* and time *t* + *k* is represented as follows:

$$R^*_{t,t+k} + fp^{t+k}_t \qquad fp^{t+k}_t = \frac{F^{t+k}_t - S_t}{S_t}, \tag{1}$$

where $R^*_{t,t+k}$ is a foreign bond yield from time *t* to time *t* + *k*. S_t and F^{t+k}_t are the spot exchange rate at time *t* and the forward exchange rate contracted at time *t* for an exchange at time *t* + *k*. *fp* is the forward premium of a foreign currency (−*fp* is a hedging cost).

Forward premium comprises the differential between the domestic and foreign interest rates and the remaining portion, also known as a basis (*Δ*).

Δ is represented as

$$\Delta = fp^{t+k}_t - \left(i^{t+k}_t - i^{*t+k}_t\right), \tag{2}$$

where i^{t+k}_t, i^{*t+k}_t are the domestic and foreign money market interest rates from time *t* to time

$t + k$. A negative Δ indicates that domestic investors are at a disadvantaged position and incur a higher hedging cost than that implied from CIP.

If the basis is zero, CIP holds as follows:

$$fp_t^{t+k} = \frac{F_t^{t+k} - S_t}{S_t} = i_t^{t+k} - i_t^{*t+k}. \quad (3)$$

CIP rests on certain assumptions. First is the free international capital movements driven by the deregulation for cross-border capital trades and the development of information technologies. CIP generally holds for financial markets in advanced economies, which no longer restrict cross-border capital transactions. The second assumption is that there is no counterparty risk in financial institutions engaging in arbitrage activities across domestic and foreign money market and FX markets. In the past financial crisis periods, financial institutions became more skeptical about counterparties' creditworthiness and withdrew from activities of market making and arbitrage, leading to the deviation from CIP. Third, transaction costs and taxes are negligible. Therefore, under calm market conditions, an implied foreign interest rate derived from the relationship with CIP slightly diverges from an actual foreign interest rate, reflecting a small amount of transaction costs and taxes.

Deviations from CIP became evident when the Japanese financial system was rendered unstable at the end of the 1990s. Hanajiri (1999) analyzes developments in the "Japan premium" during this period in three markets: the dollar currency market, the yen currency market, and the dollar/yen swap market. While the relationship "Japan premium in dollar currency market = Japan premium in yen currency market + Japan premium in dollar/yen swap market" was confirmed almost always, a divergence in the swap rate from the theoretical value was observed during the Japanese crisis period. Hanajiri presents two possible reasons for this phenomenon. First, the price of underlying assets might not fully reflect risk premiums that implicitly exist in the market. Second, the widening information gap concerning the creditworthiness of Japanese banks among market participants may have played a role. The empirical results in this study support these two possibilities.

While the Japan premium disappeared during the recovery of its financial markets, deviations from CIP re-emerged following the Paribas shock in the summer of 2007 and aggravated during the Lehman shock in the autumn of 2008. Previous studies analyzing deviations from CIP during 2007–2009 focus on the effects of not only financial institutions' creditworthiness but also

liquidity tightening intensified by mutual suspicion across financial institutions concerning their creditworthiness. For example, Coffey (2009) reveals that central bank interventions, including currency arrangements among advanced economies, helped reduce CIP deviations even though the swap lines program no longer had a significant impact on CIP deviations following the bankruptcy of the Lehman Brothers. Severo (2012) creates an indicator of systemic liquidity risk by considering the possibility that while price differentials for similar securities remain negligible under normal conditions, significant price differences emerge and persist during periods of stress. He interprets the magnitude of these differences as an indicator of investors' ability to promptly reallocate funds and earn positive excess returns while incurring small risks. Further, Severo examines the impact of liquidity risk factors on equity returns by employing the created systemic liquidity risk indicator.

CIP deviations continued to intensify even though the European sovereign crisis was almost resolved and the creditworthiness of global financial institutions significantly improved in 2014. Figure 1 presents US government bond yields, Japanese investors' hedging costs for the US dollar, and the interest rate differential between the United States and Japan. The upward trend for hedging costs became prominent in 2014 and persisted until recently. Much of the increase in hedging costs can be attributed to the increasing interest rate differential and the gap between the hedging cost and interest rate differential continues to widen. For example, in July 2016, the hedging cost measured using the one-year forward yen–dollar rate was 1.63% as a monthly average and the interest rate differential estimated by applying a one-year London inter-bank offered rate (LIBOR) for the yen and US dollar was 1.25%. Only 77% of the hedging cost is attributed to the interest rate differential, while the rest can be explained by other factors. Further, yields on hedged US government bonds at the time were less than zero (−0.13%).

Arai, Makabe, Okawara, and Nagago (2016) offer possible explanations for the divergence from CIP, including (1) increased demand for US dollars resulting from a divergence in monetary policy between the United States and other advanced countries, (2) global banks' reduced appetite for market making and arbitrage due to regulatory reforms, and (3) reduced supply of US dollars from foreign reserve managers or sovereign wealth funds against the background of declining commodity prices and emerging currency depreciations. The market liquidity of FX swap markets might reduce owing to the decrease in global banks' market-making and arbitrage activities, which were caused by newly introduced regulations such as the leverage ratio requirement and Volker rule.

Iida, Kimura, and Sudo (2016) attempt to verify factors producing CIP deviations by focusing on the differences in monetary authorities' stance among developed economies and strengthened financial regulations in recent years. They theoretically explain how monetary policy differences

and regulatory reforms are related to CIP deviations and empirically examine whether the data are in line with their theory. Their findings suggest that monetary policy was a key factor driving CIP deviations. The authors also conclude that stricter financial regulations limit non-US banks' excessive search for yield activities resulting from monetary policy divergence, which amplifies the impact of adverse shocks in the asset management sector.

Suzuki (2016) obtains empirical results suggesting that the yen/dollar swap basis following the launch of the policy package under Abenomics was affected by a significant increase in Japanese investors' outward securities investments stimulated by the divergence in monetary policies. In addition, she addresses the possibility of "regulation premium" causing CIP deviations. That is, global banks might become more unwilling to participate in FX swap trades comprising yen-denominated assets with lower sovereign credit risks because the introduced financial regulation requires them to maintain more than one buffer for an additional risk burden.

Japanese and other global investors increased investments in US dollar securities in response to the normalization of the US monetary policy. Increasing hedging costs for the US dollar have been commonly observed across major currencies, although the rise in terms of the yen/dollar rate has been the most prominent. Higher hedging costs have become a critical issue for Japanese investors, who have been struggling with ultra-low yields from domestic investment opportunities.

In fact, the increase in hedging costs for US dollar exposure has been larger for Japanese investors than for investors in countries whose policy interest rates have been lower than that by the Bank of Japan (BoJ). A possible explanation is that CIP deviations are related not to a policy interest rate differential but to a term spread differential, which is believed to reflect future monetary authorities' policy stances. Japan's term spread has remained at the lowest level since 2014. Iida et al. (2016) show that term spread differentials, calculated as the gap between a 10-year government bond yield and a 3-month overnight index swap (OIS) rate, have greater influence on the deviation movements for CIP. Another reason is macroeconomic structural factors cited in Hanajiri (2000). More specifically, Hanajiri highlights that several Japanese macroeconomic features hinder arbitrages, for example, the biased investment preference toward US dollar-denominated assets and the lacking variety of channels to raise foreign currencies. The lower amount of yen-denominated treasury bills may restrict arbitrages across the Japanese and US money markets and FX swap markets. According to Ando (2012), FX swap trades are a tool to borrow foreign currencies using raised domestic currencies as collaterals. The insufficient supply of collaterals is likely to limit arbitrages for excess returns, resulting in CIP deviations.

Given the above discussion, this study analyzes the determinants of CIP deviations by examining not only fundraising conditions and the gap in credit risk across market participants

but also the differences in monetary policy stance across developed countries and those in macroeconomic structural factors. In next section, historical decomposition analyses are conducted to investigate factors causing fluctuations in CIP deviations in terms of exchange rates of the yen to other major currencies. In section 4, panel data models are estimated to confirm if macroeconomic structural factors have rendered Japanese investors more susceptible to the increased US dollar hedging costs.

3. Historical decomposition analysis on determinants of CIP deviations

This section conducts a historical decomposition analysis to explore the determinants of deviations from CIP and detect key factors driving the upward movement in hedging costs for Japanese investors.

Iida et al. (2016) conduct a panel regression to explore the effects of three determinants on deviations from CIP: (1) term spread differential indicating the degree of monetary policy divergence between domestic and foreign countries, (2) default probability of two counterparties, and (3) market participants' liquidity needs. They use the Chicago Board Option Exchange (CBOE) volatility index as a proxy for liquidity needs owing to the precautionary demand originating from market uncertainty. Unlike Iida et al. (2016), Fukuda and Tanaka (2017) apply the spread between LIBOR and OIS rate as an indicator of currency-specific money market risks to capture financial market tightness in each currency and emphasize its effect on deviations from CIP. This study employs a vector autoregressive (VAR) model that incorporates these determinants and deviations from CIP to explore their effect on hedging costs and consider the possibility of reverse reactions such that the increased hedging costs restrain outward securities investments. The methodology of historical decomposition is employed to detect and trace a key factor contributing toward the upward trend of hedging costs.

This study adopts a recurve-type structural VAR model with four variables: funding liquidity, gap in creditworthiness between domestic and foreign banking sectors, term spread differential, and deviation from CIP. The Japanese yen is used as the benchmark currency to calculate deviations from CIP. The order in which the shocks spread is based on the assumption that the indicators of funding liquidity or creditworthiness gap are the most exogenous and CIP deviation is the least exogenous. The analysis presents the results obtained using two combinations of variables. The first combination includes the difference in credit default swap (CDS) spreads between Japanese and foreign banking sectors, gap in money market risk between the yen and a foreign currency, term spread differential, and deviation from CIP. The second combination consists of the VIX, difference in CDS spreads, amount of outward portfolio investments from Japan, and deviation from CIP. VIX and gap in money market risk are used as indicators for

fundraising liquidity and difference in CDS spreads is considered a gap in the default risk between the domestic and foreign banking sectors. Drawing on Suzuki's (2016) suggestion that the basis widens when outward portfolio investments expand, the second model incorporates the amount of outward portfolio investment instead of term spread differential. Investors searching for yields might respond to the increasing term spread differential that reflects the difference in monetary policy stance. This study uses the amount of net purchases of foreign securities divided by the volume of FX swaps traded on the Tokyo market to determine the effects of Japanese investors' investment abroad to produce excess demand for FX hedging. A lag order in the VAR model is set according to the Bayesian information criterion, Akaike information criterion, Hannan–Quinn information criterion, and General-to-Specific (GTOS) Criterion[1]. All except certain variables in this study satisfy stationarity under the augmented Dickey–Fuller (ADF) test[2].

The deviation from CIP is calculated as an annualized deviation from CIP, measured using the three-month forward premium for the yen against the US dollar, euro, pound, and Australian dollar and the three-month LIBOR for the yen and counterparty countries' currencies. A logarithmic VIX is used as one of the determinants of deviations from CIP. A difference in money market risk (money market risk for a foreign currency − money market risk for the yen) is calculated by applying a spread between the three-month LIBOR and three-month OIS rate for the two currencies. This study employed the CDS spreads available for major banks as a reference entity[3]. Further, as an indicator of default risk in a country's banking sector, this study substituted a common factor extracted using five-year CDS spreads for banks whose headquarter is located in the said country[4]. The term spread differential between a foreign and Japanese term spread is measured using the spread between the 10-year government bond yield and three-month OIS rate. Data on outward portfolio investments are downloaded from the International Transaction in Securities database, available on Japan's Ministry of Finance website, and data on FX swap volume are collected from the BoJ website. All other data are from Thomson Reuters' *Datastream*. The sample period for this study is from December 2009 to August 2018.

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[1] The lag order in this study is set on the basis of the majority rule. Estimations were conducted using an alternative lag order and produced similar results. In addition, similar results were derived using alternate combinations of variables and orderings.

[2] Although certain variables such as a difference in credit default swap (CDS) spreads between the Japanese and UK banking sectors, the gaps in the money market risks between the yen and euro and between the yen and pound, and term spread differentials between Japan and the United Kingdom and between Japan and the United States do not satisfy stationarity, this study employed these variables to conduct historical decompositions.

[3] Most of the banks are identified as global systemically important banks.

[4] This study used the first principal component derived from a principal component analysis conducted on the spreads of financial institutions' senior and subordinated CDSs located in a country as a common factor. Using a simple average of these CDS spreads marginally changes the result.

Figure 2-1 presents the historical decomposition results for the deviation from CIP derived from the model estimated using the first combination of variables. In this case, daily data are used to estimate the VAR model. The estimated contributions of each shock and the deviation from CIP are averaged for four weeks. Since 2013, the tendency of a rising basis for the four currencies has become prominent. Japanese investors' outward securities investments began expanding in the second half of 2013, when the term spread differential between Japan and the United States widened as a result of the clear difference in monetary policy stance between the two nations. Around this time, the term spread differentials between Japan and other major nations also widened. In 2016, following the termination of the zero interest-rate policy by the Federal Reserve Bank (FRB) and the implementation of the negative interest-rate policy by the BoJ, outward portfolio investments sufficiently expanded. According to the Ministry of Finance, Japan's net purchases of foreign long-term debt securities reached 13.2 trillion yen in the first half of 2016. Figure 2-1 shows that in 2014, when the term spread differential between the euro area and Japan exceeded 1%, the contribution of the term spread differential to the deviation from CIP grew, resulting in the disadvantageous increase in Japanese investors' hedging costs for the euro. From the second half of 2013 to the first half of 2014 and between the second half of 2016 and the first half of 2017, when the term spread differential between Australia and Japan sharply increased, the influence of the term spread differential became increasingly significant on the deviation from CIP in terms of the yen/Australian dollar. As for the pound, the contribution of the term spread differential became larger in the second half of 2013 and after 2016. A comparison with the three currencies reveals that the impact of the term spread differential on the US dollar basis is negligible, although a considerable portion of the investment funds is expected to have entered the US securities markets. This is partially because US bond yields were likely to decline as a result of investors' search for yield. According to the average value for four weeks, in October 2016, the basis of the US dollar reached 0.77%. The US term spread, however, showed a downward trend owing to a decline in government bond yield and a gradual increase in the short-term interest rate reflecting a tightening monetary policy[5,6].

Figure 2-2 presents the historical decomposition results for the deviations from CIP obtained using the model with the second combination of variables including the modified outward securities investments instead of the term spread differentials. Data on outward securities investment are available on a monthly basis and thus, the model is estimated using monthly data. The contribution of outward portfolio investments has increased since 2014. The feature is more

[5] Although the effect of the term spread differential slightly increases when the model is estimated for the period from January 2012 to December 2015, its contribution remains small.

[6] Similar results are observed when the gap in the money market risk is replaced with the Chicago Board Options Exchange's volatility index (VIX) and an alternative ordering of variables is selected.

clearly confirmed for the basis of the US dollar. This may be consistent with the finding in Figure 2-1 that investors searching for yield rushed into US dollar-denominated securities, thus increasing hedging costs and possibly, narrowing US term spread[7].

Figures 2-1 and 2-2 show that the increase in the cost of the euro and pound after 2014 can be attributed to the relative improvement in European banks' creditworthiness. Further, Figure 2-1 shows that the contribution of money market risk tends to increase after 2016. This tendency is commonly observed for the US dollar, euro, and Australian dollar. It is possible that the tighter liquidity condition resulting from the termination of a non-traditional monetary policy is related to the higher hedging costs, which warrant further investigation.

In 2011 and 2012, when the European sovereign crisis exacerbated, the basis for the euro largely decreased because of the tightened fundraising liquidity and the worsened creditworthiness of European financial institutions. Given the Japanese banks' superiority in default risk during the period, Japanese investors experienced advantageous conditions for investment in euro-denominated securities. Similar tendencies have been observed for the basis of the pound.

Figure 2-2 also presents the historical decomposition for deviations from CIP calculated using the one-year yen/dollar forward exchange rate. Compared with the results obtained using the three-month yen/dollar forward exchange rate, the magnitude of the deviation from CIP between 2015 and 2016 is smaller. In addition, idiosyncratic shocks, which reflect fluctuations in hedging costs caused by factors whose consideration is beyond the scope of this analysis, have a limited impact on widening the gap. Intensified regulatory reforms introduced following the global financial crisis possibly affected dollar funding liquidity. VIX and money market risk, used as fundraising liquidity indicators in this study, are unlikely to reflect changes in the availability of the US dollar as a result of global banks' reduced market-making and arbitrages activities in recent years.

Banks and institutional investors, including pension funds and life insurance companies, often use three-month FX swaps to perform rolling hedges for long-term foreign bond investments. Their preferences for short-term maturity FX swaps can be attributed to lower transaction costs resulting from the relatively affluent liquidity of markets in which many global banks participate as market makers and arbitragers. If global banks become more unwilling to burden risks because of additional restrictions, the FX swap market for shorter-term maturity could tighten. Arai et al. (2016) mention that the declining transaction volume in the FX swap markets may be related to

[7] In addition, the results confirmed that in comparison with the other currencies, the contribution of the basis for the US dollar to the term spread differential between the United States and Japan is larger in the downward trend.

global banks' reduced appetite for arbitrage trading and market-making activities, which may amplify the cross-currency basis widening. This should be rigorously examined in future analyses.

4. Impact of macroeconomic structural factors on hedging costs

In 1999, deviations from CIP were observed even though the Japanese financial crisis was almost resolved and the economic upturn became evident owing to the IT bubble. Hanajiri (2000) discusses the deviation from CIP at the end of the 1990s from the viewpoint of macroeconomic structural factors. Japan was the world's largest net external creditor and US dollar-denominated assets accounted for a considerable portion of Japan's external assets[8]. Investors in the euro area have a unified large-scale market for securities denominated in the euro and those in neighboring European countries can make investments without being subjected to large exchange risks in the euro area's markets. This is because the monetary authorities in these nations have been making efforts to stabilize their currencies against the euro. Therefore, investors can diversify their funds across markets in Europe without facing large exchange risks and markets for securities denominated in the US dollar, which report the lowest market liquidity risk. Japanese investors, on the other hand, must face exchange risks when investing in foreign currency-denominated securities and thus, are inclined toward investing in US dollar-denominated securities.

Under the above-mentioned macroeconomic conditions, Japanese investors' cost of hedging the US dollar is likely to increase by a larger extent. Figure 3 shows deviations from CIP in terms of the US dollar to other major currencies. Among them, the extent of increase in the cost of hedging the US dollar is the largest for Japanese investors. During the period of yield gap expansion, which reflected the normalization of monetary policy more quickly for FRB than any other monetary authority, global investors increased their investments in US dollar-denominated securities. For Japanese investors, the hedging cost could increase as a result of the nation's macroeconomic structural factors coupled with the widened yield gap led by the BOJ's aggressive monetary easing and the end of the FRB's quantitative easing.

This section presents the empirical results for the panel data analysis on the relationships among macroeconomic structural factors and the deviation from CIP in terms of the US dollar against the nine currencies presented in Figure 3. The regression formula is as follows:

$$DEVCIP_{i,t} = c + (b_1 + b_2 TS)USR_{i,t} + d_1 CDSBANK_{i,t} + d_2 FXVOL_{i,t} + u_{i,t} \quad (4)$$

[8] According to the International Monetary Fund's (IMF) coordinated portfolio investment survey (CPIS) estimates for 2012–2017, the average share of US dollar-denominated securities held in the euro area, Sweden, Switzerland, and Japan are 12%, 7.4%, 34%, and 46.8%, respectively.

where $DEVCIP_{i,t}$ denotes deviation from CIP (basis) for an exchange rate between the US dollar and the *i*-th country's currency at time *t*. $DEVCIP_{i,t}$ is applied with Δ in equation (2). Δ is calculated using a three-month forward rate for the US dollar against the *i*-th country's currency as well as the three-month LIBOR for the US dollar and the counterparty country's currency and is annualized. A decrease in *DEVCIP* disadvantages investors in the counterparty country as they must incur an additional increase in the cost of hedging the US dollar-denominated securities.

$TS_{i,t}$ denotes a term spread gap between the United States and the *i*-th country and a term spread is calculated using 10-year treasury bond yields and three-month OIS rates for the two countries. $USR_{i,t}$ is the ratio of the US dollar-denominated securities to the total external securities held by the *i*-th country. If the coefficients of b_1 and b_2 in equation (9) are estimated as negative, then a country with a greater *USR* is likely to incur a higher dollar hedging cost, particularly when the term spread gap widens and investments in the US dollar-denominated securities increase. Considering the limited availability of data on the ratio of US dollar securities, those for investments in the US securities markets to total external securities (*GEOUSR*) are used instead of *USR*.

$CDSBANK_{i,t}$ signifies the credit risk gap in the banking sectors between the United States and the *i*-th country. Coefficient d_1 is expected to be negative. This study employs sovereign CDS spread differentials (*CDSSOV*) considering Suzuki's (2016) suggestion that the deviation from CIP increases because global banks have become more reluctant to incur risks associated with investments in a country with a lower sovereign credit rating under the new regulation. Finally, $FXVOL_{i,t}$ is logarithmic three-month implied volatility in the exchange rate for the US dollar relative to the *i*-th country's currency. Coefficient d_2 is expected to be negative because increased volatility infers a higher risk premium. In addition, a logarithmic VIX is used as an alternative explanatory variable.

If a country holds an amount of US dollar-denominated liabilities to almost match an amount of US dollar-denominated assets, excess demand for the US dollar may decrease. However, for a country such as Japan, whose net external assets are enormous, FX hedging accompanied by investments in US dollar assets may largely exceed FX hedging derived from US dollar fundraising. Therefore, this study uses the following formula:

$$DEVCIP_{i,t} = c + (b_1 + b_2 TS)USR_{i,t} \times ALF_{i,t}$$

$$+ d_1 CDSBANK_{i,t} + d_2 FXVOL_{i,t} + u_{i,t}, \quad (5)$$

where $ALF_{i,t}$ is the *i*-th country's ratio of total external assets to total external liabilities at time *t*. By introducing *ALF*, this study examines if a country's bias toward US dollar investments and an unbalanced hedging demand structure resulting from huge net external assets are susceptible to higher hedging costs for US dollar exposure.

It is expected that investments in US bonds increase with a rise in *TS*. Next, analyses are conducted using the first-order difference between outstanding outward securities investments (*DOSI*) (or outstanding outward securities investments relative to GDP (*OSIGDP*)) instead of *TS*.

Yearly data are obtained for Japan, Switzerland, Sweden, euro area, the United Kingdom, Australia, Canada, New Zealand, and Norway. The sample period is 2009−2016. Data for exchange rates, interest rates, government bond yields, CDS spreads, FX volatilities, and VIX are downloaded from Thomson Reuters' *Datastream*. Information for securities investments is collected from International Monetary Fund's (IMF) Balance of Payments (BOP) Statistics. *USR*, *GEOUSR*, and *ALF* are calculated using data from IMF's coordinated portfolio investment survey (CPIS). This study adopts the least squares dummy variable (LSDV) method to estimate the cross-sectional, fixed-effects model. *t*-value is calculated using a covariance matrix that allows for the cross-sectional heteroscedasticity of residual terms.

Table 1 presents the estimation results. The coefficients of *USR* and *GEOUSR* are estimated to be negative, implying that investors in a country with a biased preference for US dollar-denominated assets are likely to face higher hedging costs. The coefficients for *ALF* are also negative but not statistically significant and the cross-term for *USR* and *ALF* and that for *GEOUSR* and *ALF* report a negative sign. In other words, the increase in hedging costs is intensified in a country where the demand for hedging along with outward investments exceeds that for hedging accompanied by fundraising abroad.

The cross-terms for *TS* and *USR* are not statistically significant. Table 2 presents the analyses using *DOSI* and *OSIGDP* instead of *TS*. The combination of *USR* (or *GEOUSR*) and *ALF* with *DOSI* (or *OSIGDP*) shows a negative sign. This suggests that for a country with a biased preference toward US dollar assets coupled with excess demand for hedging against foreign currency exposures as a result of considerable net external assets, hedging costs will significantly increase when outward securities investments expand.

Tables 1 and 2 report that hedging costs increase disadvantageously for financial institutions

with aggravated creditworthiness. The coefficients of *CDSSOV* are also estimated as negative, which is consistent with Suzuki's (2016) suggestion that a country with a lower credit rating is likely to make an additional risk premium payment owing to stricter financial regulations.

The coefficients of *FXVOL* and *VIX* are negative, which is consistent with our expectations. This indicates that, under stressful conditions, flight to liquidity (or flight to the US dollar) is observed and investors outside of the United States incur higher hedging costs. This tendency is confirmed for currencies of, for example, Australia, which was considered to be less severely affected by the financial crises during the analysis period.

5. Conclusions

This study reached the following salient conclusions. First, the cost of hedging major currencies, particularly the US dollar, increased because of a rise in outward securities investments, which was possibly promoted by different monetary policy stances across countries. The cost of hedging the US dollar, specifically those measured using FX swap rates with shorter-term maturity, has reported a prominently increasing trend. This phenomenon may be largely attributed to factors such as the tightened market liquidity of FX swaps caused by newly imposed financial regulations following the global financial crisis, which are beyond the scope of this study. During the European sovereign crisis, the cost of hedging the euro decreased, reflecting the worsened creditworthiness of European financial institutions.

Second, the results of the panel data analyses reveal that macroeconomic structural factors are related to an increase in hedging costs. Japanese investors tend to prefer investments in US dollar-denominated securities. Their biased preference coupled with the large amount of net external assets might produce excess demand for hedging against the US dollar. As a result of their concentrated securities investments in the United States, which has already begun reporting signs of monetary policy normalization, Japanese investors might face more expensive hedging costs. This study, however, did not reveal the effects of a term spread gap on the deviation from CIP. This is because the term spread gap shrunk in response to the concentrated investments made in US bonds by investors who searched for yield, which is left for future research.

To improve the profitability of their portfolio investments, Japanese investors may be asked to incur a higher risk burden. Alternatively, they could choose currencies other than the US dollar since the hedging cost for currencies of countries with a negative interest-rate policy are likely to be almost zero or negative. While the validity of investments in securities outside of the United States should be rigorously examined, the diversification across currencies can contribute to a decrease in dollar-hedging costs.

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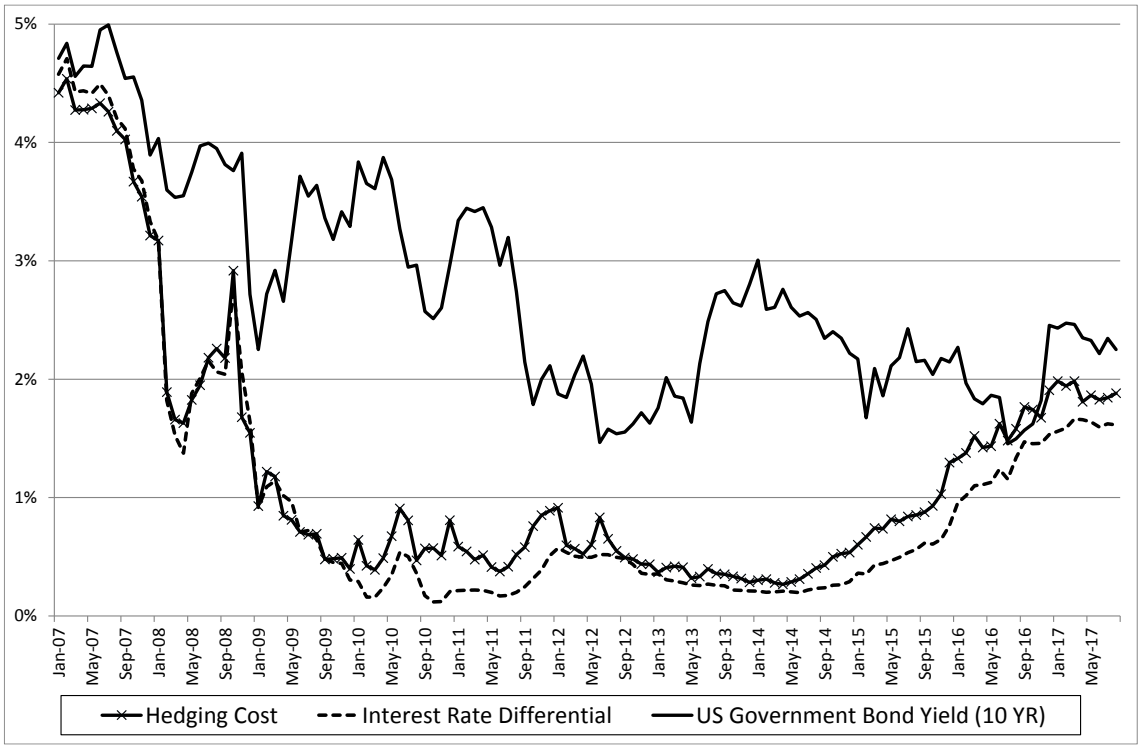
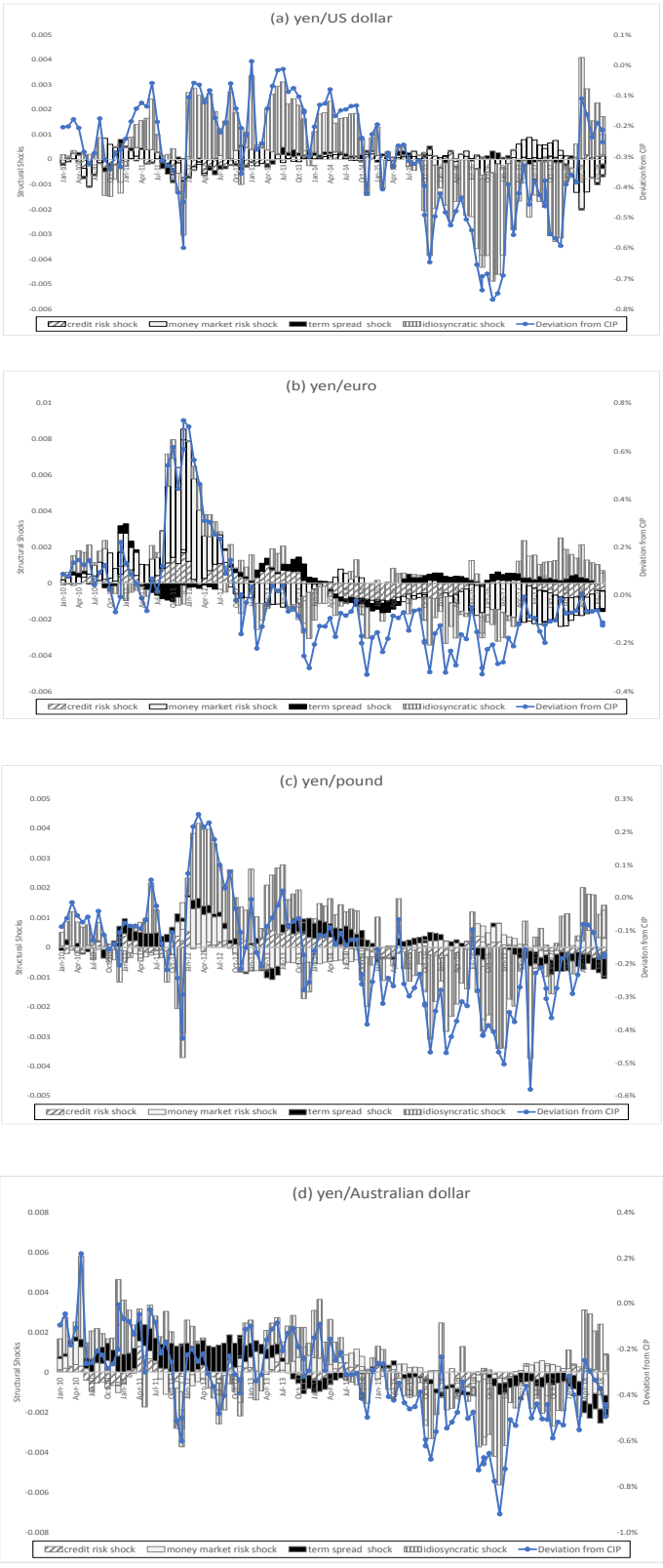
Figure 1. US Government Bond Yield and Hedging Cost



Note: The figure reflects the author's calculations using data from Thomson Reuters' *Datastream*. Hedging costs are estimated using one-year forward exchange rates for the yen/US dollar. Interest rate differentials are measured by applying one-year LIBOR for the yen and US dollar.

Figure 2-1. Historical Decomposition of CIP Deviation

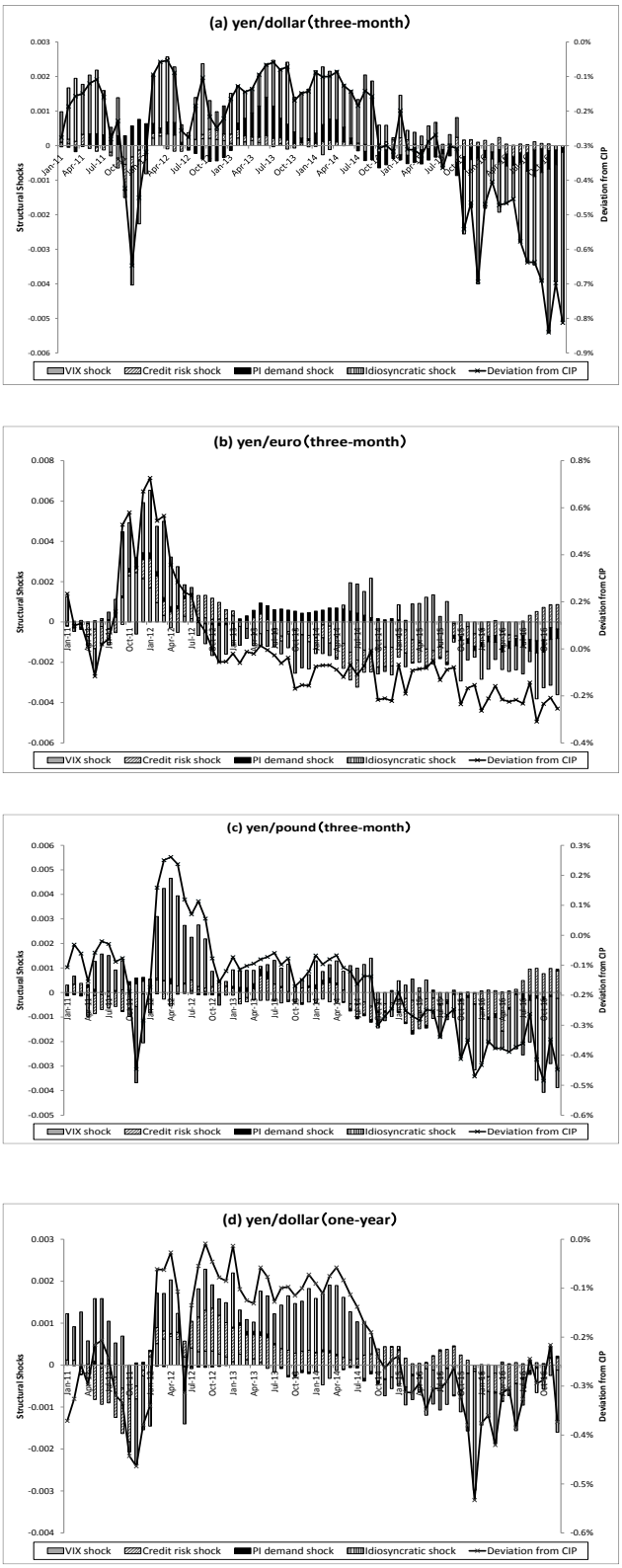
(using Money Market Risk Measure and Term Spread Differential)



Note: The barbed solid line denotes actual CIP deviation using exchange rates for yen and other major currencies and the bars represent the contributions of each shock to the deviation from CIP.

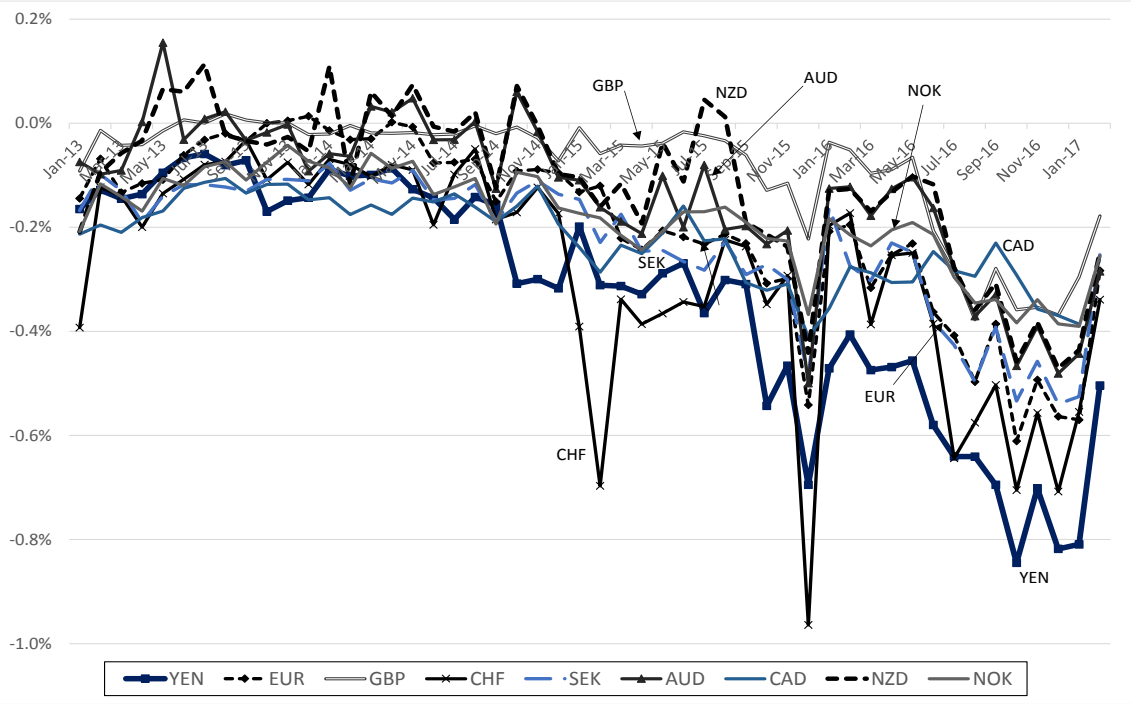
Figure 2- 2. Historical Decomposition of CIP Deviation

(using VIX and Outward Portfolio Investments)



Note: The solid barbed line represents actual CIP deviations using exchange rates for yen and other major currencies and the bars denote contributions of each shock to the deviation from CIP.

Figure 3. Deviation from CIP Calculated using Exchange Rate of the US Dollar to Other Major Currencies



Notes: The figure presents the author's calculations using data from Thomson Reuters' *Datastream*. Deviation from CIP measured using the three-month forward exchange rate for the US dollar against another major currency and the three-month money market rate for the US and a counterparty country are annualized. Negative (positive) values mean that the hedging cost for investments in the United States (a counterparty country) increases, thus exceeding the level of interest rate differential between the two nations.

Table 1. Relationship between Deviations from CIP and Macroeconomic Structural Factors

Observations	47	31	51	23	47	31	23	47	47	31	23	31
Const.	0.011 ***	0.012 ***	0.005 **	0.013 ***	0.013 **	0.015 ***	0.017 *	0.013 **	0.008 ***	0.010 ***	0.008 *	0.008 **
GEOUSR	−0.023 **		−0.004		−0.025 **			−0.026 **				
USR		−0.019 ***		−0.028 *		−0.022 ***	−0.037 *					
ALF					−0.001	−0.002	−0.002	−0.001				
GEOUSR*ALF									−0.012 **			
USR*ALF										−0.011 **	−0.009	−0.011 **
TS*GEOUSR												
TS*USR												
TS*GEOUSR*ALF												
TS*USR*ALF												
CDSBANK	−0.021	−0.067 *			−0.022	−0.070 *		−0.038	−0.054	−0.088 **		−0.094 *
CDSSOV			−0.109	−0.137			−0.148				−0.121 *	
FXVOL	−0.003 ***	−0.004 ***	−0.003 ***	−0.004 ***	−0.003 ***	−0.004 ***	−0.004 ***		−0.003 ***	−0.004 ***	−0.003 ***	
VIX								−0.003 ***				−0.002 **
adj R2	0.496	0.445	0.503	0.425	0.497	0.463	0.449	0.386	0.494	0.445	0.322	0.229

Observations	47	47	23	31	51	47	31	23	47	31
Const.	0.012 ***	0.012 ***	0.018 ***	0.013 ***	0.005 ***	0.011 ***	0.012 ***	0.013 ***	0.008 ***	0.010 ***
GEOUSR	−0.018 **	−0.016 *			−0.004	−0.023 **				
USR			−0.036 ***	−0.013 **			−0.020 ***	−0.030 *		
ALF										
GEOUSR*ALF	−0.008 *	−0.008 *							−0.012 **	
USR*ALF			−0.009 *	−0.007 *						−0.011 **
TS*GEOUSR					−0.005	0.050				
TS*USR							0.187	0.153		
TS*GEOUSR*ALF									0.047	
TS*USR*ALF										0.011
CDSBANK	−0.041	−0.024		−0.071 *		−0.020	−0.063 *		−0.054	−0.089 **
CDSSOV			−0.172		−0.110			−0.114		
FXVOL		−0.003 ***		−0.004 ***	−0.003 ***	−0.003 ***	−0.004 ***	−0.004 ***	−0.003 ***	−0.004 ***
VIX	−0.003 ***		−0.003 ***							
adj R2	0.428	0.537	0.398	0.518	0.490	0.485	0.452	0.410	0.483	0.422

***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 2. Relationship between Deviations from CIP and Macroeconomic Structural Factors.

Observations	47	51	47	31	31	31	31	31	31	47	47	47	47
Const.	0.011 ***	0.005 **	0.011 **	0.013 ***	0.012 ***	0.012 ***	0.010 ***	0.007 **	0.007 ***	0.007 ***	0.006 ***	0.008 ***	0.008 ***
GEOUSR	-0.022 ***	-0.004	-0.021 *										
USR				-0.018 ***	-0.016 **								
GEOUSR*ALF										-0.008 *	-0.008 *	-0.010 *	-0.010 **
USR*ALF						-0.012 **	-0.009 *	-0.008 *	-0.008 *				
GEOUSR*DOSI	-3.6E-09	-2.3E-09											
GEOUSR*OSIGDP			-13658.6										
USR*DOSI				-3.5E-09									
USR*OSIGDP					-24232.1								
GEOUSR*ALF*DOSI											-1.2E-08 **	-5.0E-09	
GEOUSR*ALF*OSIGDP										-63891 **			-29629 **
USR*ALF*DOSI						-4.4E-09 **			-8.6E-09 **				
USR*ALF*OSIGDP							-20441.4 *	-49294 **					
DOSI									2.27E-09 *		2.72E-09 *		
OSIGDP								20768		14018			
CDSBANK	-0.036		-0.033	-0.075 *	-0.075 **	-0.098 ***	-0.089 **	-0.033	-0.038	-0.039	-0.021	-0.074	-0.068
CDSSOV		-0.097											
FXVOL	-0.003 ***	-0.003 ***	-0.003 ***	-0.005 ***	-0.004 ***	-0.004 ***	-0.004 ***	-0.003 ***	-0.003 ***	-0.003 ***	-0.002 ***	-0.003 ***	-0.003 ***
adj R2	0.497	0.495	0.491	0.437	0.449	0.498	0.496	0.551	0.542	0.569	0.551	0.513	0.552

***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.