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MASUJIMA, Yuki
Deloitte Tohmatsu Financial Advisory LLC

SATO, Yuki
Goethe University Frankfurt

Research Institute of Economy, Trade & Industry, IAA

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Drivers of Post-Pandemic Currency Movement: Recurring impacts of sovereign risks and oil prices[1*]

Yuki MASUJIMA
Deloitte Tohmatsu Financial Advisory LLC
Yuki SATO
Goethe University Frankfurt

Abstract

This paper tries to investigate the driving factors of FX rates, focusing on the roles of sovereign credit risks and energy prices in the post-pandemic period. We find that the yen's safe-haven status has weakened, and the European currencies became more sensitive to debt risks and fragile to uncertainty. The yen's sensitivity to higher sovereign risks increased after the introduction of the yield curve control (YCC) policy implemented by the Bank of Japan (BOJ), even if its policy could have reduced the volatility of Japan's credit default swap (CDS) rates. Moreover, the type of shock (supply or demand) may change the impacts of oil prices on FX moves. Our results hint at the policy implication that the government's fiscal policy stance is important not only for sovereign risk premiums but for exchange rate movement. The BOJ's YCC could unintentionally limit some sovereign risks, but it may cause a rapid depreciation of the home currency when debt sustainability becomes more doubtful.

Keywords: Exchange Rates, CDS, Oil Prices, Post-Covid-19, Safe-haven Currency
JEL classification: E44; F31; G15

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1. Introduction

The Japanese yen and other major currencies had a historic moment in 2022. The yen hits a 32-year low against the dollar in late October 2022, driven by the wider interest rate differentials between Japan and other major advanced economies. The Bank of Japan's sticking with stimulus while the Federal Reserve and other peers withdraw theirs, which has sent the yen sliding down. The dollar/yen was traded around 115 in early 2022, rising to above 150 in late-October, and then falling to around 130 by year-end. The yen used to appreciate during the risk episode due to safe-haven demand, but the yen's safe-haven behavior wasn't clearly observed in 2022.

Besides the yield differentials among government bonds, dynamic changes in the global economic environment, such as public debt expansion, higher trade friction, and the boost in energy prices due to the COVID-19 pandemic and Putin's war, helped investors to refocus on the traditional drivers of the FX movement. This paper investigates the factors that are shaping FX rates, with a focus on the roles of sovereign credit risks and energy prices in the post-pandemic period.

At the beginning of the COVID-19 crisis, the governments of advanced economies expanded fiscal spending to support economic activity halted by the lockdown to contain the virus. It led to a sharp rise in government debt: 123% relative to GDP for advanced economies on average in 2020, compared to 104% in 2019 (International Monetary Fund 2022). The central bank's support for the economy with monetary easing kept debt sustainability. The Federal Reserve and the Bank of England cut policy rates to 0.25%, and the European Central Bank kept the negative deposit facility rate with unconventional monetary policies, such as quantitative easing and other policy instruments, to prevent risks for large government debt from materializing.

In the past, loosening fiscal discipline led to sovereign debt crises and a sell-off of currencies. However, it was different during the pandemic period. Almost all advanced countries implemented fiscal stimulus and monetary easing, even though exchange rates became more volatile as the virus infection situation changed. In the circumstances, these policy packages were unlikely to cause a particular currency to sell off.

Meanwhile, the pandemic triggered high inflation. By 2021, the lockdown had begun to raise the price of some goods due to supply chain shocks caused by factories ceasing operations and product shipment disruptions. Russia's invasion of Ukraine in February 2022 accelerated the pace of price increases in crops and energy. The crude oil Brent spot price was almost doubled to $134 per barrel on March 8, 2022, from $77 at the end of 2021 and $52 at the end of 2020. Consumer price inflation peaked at 9.1% in the U.S. in June 2022 and exceeded 10% in the euro area in October. As a result, major central banks except for the BOJ and the People's Bank of China had to tighten monetary policy to calm down inflation.

In the post-pandemic period, we witnessed two big changes: higher interest rates and rising energy prices. These changes may pose threats to fiscal and current account sustainability, especially if a country has large government debt, or a large current account deficit, or is a net energy importer. The emergence of these concerns tends to depreciate the currency of the country.

The sharp depreciation of the British pound in late September 2022 is a good and recent example of the relationship between a fiscal deficit and currency depreciation. Former U.K. Prime Minister Liz Truss' plan for growth, melding the biggest tax giveaway in half a century with Thatcherite deregulation, is a straight-up gamble with Britain's future. The market's verdict on the £220 billion policy blitz set out by Kwasi Kwarteng was swift and devastating on Sept. 24, 2022, according to Bloomberg News. The U.K. pound crashed below $1.11 for the first time since 1985, taking its slump for the year to date to 19%. Five-year gilts posted their biggest ever daily decline. As a result, the British pound also fell against the euro with wider U.K.-Germany yield spreads (Figure 1).

Britain was in a self-inflicted financial crisis, years in the making, that threatens to accelerate the economy's dive into recession, and the country's new prime minister was coming under intense pressure to blink. In the last week of September 2022, the pound has fallen to its lowest level against the dollar because the government announced the largest tax cuts since 1972 with little information on how they will be paid for, the Credit Default Swap (CDS) premium[1]—the price of insuring British government debt against default risk—has soared to the highest level since 2016 (Figure 2), and the Bank of England had been forced to intervene due to worries about the country's pension funds.

The Japanese yen's weakness in early 2022 seemed to be a typical case showing a relationship between a current account (and trade) deficit concern and currency depreciation: higher oil prices boosted Japan's imports and widened the trade deficit. Japan relies on external sources for about 90% of its total energy needs, while a weaker yen increased imports and exports (Figure 3). Not only the trade balance, but also the current account balance seasonally adjusted, became negative in October 2022. This could amplify concerns about the current account's sustainability for some investors, supporting the yen's weakness with a tailwind from the BOJ's easing stance.

In contrast, concerns for Japan's fiscal sustainability didn't seem to be directly associated with the yen's weakness, despite Japan's huge public debt—about 263% of

[1] Nominal amount outstanding of sovereign CDS was about 1.2 trillion U.S. dollar in 1H 2022, according to Bank for International Settlements. The CDS provide a measure of protection against previously agreed upon credit events in the future. So, the CDS tends to reflect a forward-looking view of investors.

GDP as of the end of 2021 (Figure 4). Prime Minister Fumio Kishida announced the large economic package in October 2022, but it led neither to a surge in Japan's CDS premium nor to the yen's further weakness immediately after his announcement. Japan's large net foreign asset holdings and high share of Japanese Government Bond (JGB) ownership by domestic investors explain some of the reasons[2]. The Japanese Ministry of Finance's exchange rate intervention also effectively capped the yen's further weakness[3]. At the same time, the BOJ's yield curve control (YCC), which was introduced in September 2016 and maintains 10-year Japanese government bond yields around 0% (Figure 5), may have limited concerns for fiscal sustainability, at least in the short term. This paper tries to check test the yen's movement after the introduction of the BOJ's YCC. For Japan-specific factors, we find the BOJ's introduction of the yield curve control increased the yen's sensitivity to sovereign risks, even if the YCC could have capped a surge in CDS premiums[4] (Figure 6). Furthermore, the effects of oil prices on FX moves appear to depend on whether it is a demand shock or not.

Against this backdrop, we extend the FX model used in Masujima (2022a) by adding sovereign credit risks (risk channel) and oil and agricultural prices (trade channel) to see changes in the FX determinants in the post-pandemic period, compared to the periods of the Global Financial Crisis and the pandemic, covering five developed economies and six emerging economies with daily samples from March 2007 until 2022.

So far, the literature on the relationship between CDS premiums, commodity

[2] Japan's CDS premiums usually reflect non-Japanese investors' view because most of transactions are traded by U.S. and European institutions. This may mean high CDS premiums doesn't necessarily trigger fire-sales of the JGBs if Japanese investors that hold the JGBs don't concern on the defaults of the JGBs.

[3] Masujima (2022b) assesses the roughly 9.2 trillion yen ($63 billion) in sales of foreign currency in September and October were surprisingly effective -- reining in the dollar by as much as 8.1 yen.

[4] Japan's CDS premiums fell to 25.2 bp (three-year average) after the announcement of the YCC, compared to 44.6 bp (three-year average) before. It's a bigger decline than Germany (14.9 vs. 24.6) and an opposite trend of United States (21.8 vs. 20.4) and United Kingdom (27.2 vs. 24.5).

prices, and FX is extremely limited, particularly for the post-COVID period. Therefore, this paper's main contributions are: (1) tracking a shift of the FX determinants during and after the COVID-19 pandemic via portfolio investment channels, compared to the Global Financial Crisis; (2) showing the significance of the risk channel for the exchange rate movements, using CDS premiums in home and overseas; (3) reconfirming the importance of the trade channel for the exchange rate movements during the COVID-crisis; and (4) proving the weakening safe-haven effects of the yen during and after the pandemic.

The policy implication from the results is that the country's fiscal discipline is important not only for sovereign risk premiums but for FX rate movement. The central bank may be able to control some of the sovereign risks in short term, but it could dampen the sovereign debt sustainability with the rapid weakness of the home currency in the long run. Moreover, removing trade restrictions could increase trade flows while possibly stabilizing the FX movement, avoiding an unexpected jump in commodity prices due to supply shocks. Therefore, promoting globalization remains a key factor for FX stability.

2. Literature Review

A limited number of papers show the relationship between the COVID-19 crisis (or the post-COVID period) and the exchange rate movement. Liao & Zhang (2020) explain the hedging channel of portfolio investments. Investors' desire to hedge exchange rate risk in their net foreign asset positions explains the movements in exchange rates and swap line usage. This hedging channel of exchange rate determination connects exchange rate behavior to countries' external imbalances through the behavior of financial intermediaries. Daehler et al. (2020) focus on the relationship between the new COVID-19 cases and CDS. COVID-19 new mortality and new mortality growth rates are positively associated with COVID-19 CDS residuals in all specifications. While the mortality and mortality growth rates together only explain a small share of the variation in residuals, adding the other COVID-related variables increases the explanatory power with the inclusion of policy responses and economic fundamentals. Following Daehler et al. (2020), Masujima (2022a) uses daily activity indices that include a mobility index and adds a policy stringency index as explanatory variables in the model.

The following sections show detailed links between the literature and this paper.

2.1. CDS-FX Relations

The relationship between exchange rates and sovereign credit risk has not been investigated yet. The inability to accurately quantify credit risk is one reason. Several empirical studies have been conducted to directly assess the impact of a default crisis on the devaluation likelihood[5]. The availability of a large dataset of sovereign credit default swaps, however, appears to be a factor in the increased focus on the correlation between default and depreciation. One of the first attempts to apply the sovereign CDS in this area was made by Carr &Wu (2007). The association between spreads on contracts and implied volatilities on various currency options from January 2002 to March 2005 was established by Carr & Wu in 2007. Pu & Zhang (2012) presented that the quanto CDS conveys information about the bilateral exchange rate dynamics through comparisons of USD and EUR-denominated sovereign CDS spreads for Eurozone countries.

Among recent empirical analyses in the literature, Hofmann et al. (2020) seem unique in that Hofmann et al. (2020) focus on the causality from exchange rate to the bond risk premium and limit the samples to emerging market economies. Augustin et al.

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[5] For instance, Reinhart 2002 and Na et al. 2018.

(2020) approach to the subject of the relation between sovereign defaults and currency depreciation from the perspective of asset pricing by using quanto spreads in the Eurozone. They confirmed the risk premium for euro depreciation surpasses the credit risk premium or the carry trade component, whereas it is less likely that default leads to currency devaluation. Probably, Corte et al. (2022) are most closely related to our work because its sample contains both developed and emerging countries against the USD and analyzes the causality from the default risk to the currency risk. Our approach differs from theirs in currency risk treatment -- directly measured by the bilateral exchange rate against the USD instead of currency excess returns. Furthermore, this paper is probably the first attempt to expand the focus beyond the Eurozone to include China, Japan, and Australia.

2.2. FX-Trade Balance Relations

As explained in a textbook of international economics such as Krugman et al. (2018), there is no doubt about the connection between the trade balance and exchange rate. The literature has been trying to shed light on the degree of elasticity; how much the exchange rate affects the trade balance[6]. The J-curve is a prominent phenomenon that claims that currency depreciation worsens the trade balance in the short run but improves it in the long run since the resulting cheaper price in a traded nation can stimulate demand there. Bahmani-Oskooee & Fariditavana (2016) conduct comprehensive empirical research on the J-curve effect, using bilateral trade balance models of the U.S. with each of its six largest trading partners over the period from 1971 to 2013. Nusair (2017) adopts the same method as in Bahmani-Oskooee & Fariditavana (2016) but for 16 European transition economies and supports the J-curve for the 12 nations.

[6] The other strand of the literature focuses on the degree of the path-through rate. See Ceglowski (2010), Shioji (2015) and Nguyen & Sato (2019) to refer to empirical studies about the Japan's path through rate.

Moreover, the inverse causality has gained traction with the higher capacity of high-frequency data. While the causality analysis above focuses on a more long-term impact using monthly or quarterly data, this relatively new relationship is a short-run phenomenon requiring at least daily frequency. Investors' attention also seems to play a key role here, so that the literature is prone to utilize unexpected macroeconomic news. Chaboud et al. (2007) adopted one-minute frequency data to track trading volume of EUR/USD and JPY/USD in the global interdealer spot market, and documented trade balance releases significantly increased trade volume. Hutchison & Sushko (2013) examined the effect of surprising macroeconomic news on the value of JPY/USD from March 2004 to December 2006 by using daily data and observed unexpected news related to the trade balance indicator significantly moving the bilateral exchange rate.

2.3. Trade Balance-FX Relations

Causality analysis from the oil price to the exchange rate demands a cautious approach as the oil price can affect other macro indicators -- endogenously related to each other as well as to the exchange rate. Amano & Norden (1998) found evidence of cointegration between the real effective exchange rate and the real oil price for Germany, Japan, and the U.S. Chen & Chen (2007) expand the sample countries to the G7 nations and the sample period to 2005 and find consistent results with Amano & Norden (1998), suggesting a cointegrating relationship between oil prices and real exchange rates. While these previous studies documented the long-term relationship, Ferraro et al. (2015) show the existence of a short-run relationship by utilizing data at a daily frequency. Moreover, the Federal Reserve Bank of San Francisco (1999) describes how trade imbalance affects exchange rates through its effect on the supply and demand for foreign exchange.

2.4. Yield Differentials, Safe-Haven Demand

Interest rates, carry trade, and the dollar are key factors that influence exchange rates, according to several literary strands. However, during the global financial crisis of 2008–2009, the movement of the exchange rate has tended to be driven by investor risk aversion, as measured by the VIX—Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index options. The Japanese yen and Swiss franc are frequently mentioned as safe-haven currencies that tend to appreciate during risk-off episodes as the uncertainty of economic policy and outlook increases, while the U.S. dollar, considered the most reliable international currency, tends to appreciate with a surge in geopolitical risks in the world.

This study tracks a change in how interest rate differentials affect the movement of the exchange rate. Investors in the United States who are risk-neutral and logical should anticipate that the foreign currency will devalue against the dollar by the difference between the two interest rates when the foreign interest rate is higher than the U.S. interest rate. Therefore, borrowing domestically and lending internationally, or vice versa, yields no return above the short-term interest rate in the United States.

Except in the case of currencies with extremely high inflation, this is known as the "uncovered interest rate parity" (UIP) condition, and it is broken in the data (Verdelhan 2018). Better international interest rates typically indicate higher excess returns for a U.S. investor in foreign currency markets, according to historical statistics. The introduction of higher-frequency trading instruments, however, might necessitate more frequent rebalancing of the currency portfolio. Therefore, a more significant determinant in determining the daily returns of exchange rates may be the daily variation in interest rate differentials across currencies rather than the magnitude of those differentials. In the same situation, a daily variation in an uncertainty gauge may be more important in influencing exchange rates than the amount of uncertainty.

The carry factor's interpretation based on risk is well recognized. The dollar factor was added to the risk-based factor model by Verdelhan (2018). Uncertainty was introduced as a new risk factor by Masujima (2019b). It's unclear what the economic causes of these global shocks and the safe-haven tendency of currencies linked to uncertainty are. Safe-haven status has historically been associated with a nation's substantial current account surplus, minimal sovereign risk, and/or high share in trade settlements. Following the 2008–2009 financial crisis, this propensity toward market-driven behavior may be changing from one based on economic fundamentals (Masujima 2019a). The interdependence of central banks throughout the world and investor risk perception may be to blame for the broad increase in cross-asset correlations during the financial crisis.

The safe-haven status could predict changes in the foreign currency market's appetite for risk (Masujima, 2019a). The VIX is frequently used as a proxy for the outlook for financial risks on a worldwide scale and as a measure of uncertainty. Numerous factors could account for the close connection between the VIX and safe-haven currency behavior, which in turn explains the sensitive behavior of emerging market currencies. Since the global financial crisis of 2008–2009, the relationship between the equity volatility index and the implied volatility of the currency has grown stronger. Higher stock market volatility may influence predictions about the future monetary policy attitudes of major central banks, which could lead to capital transfers from dollars to yen. A common response to a shift in global uncertainty is for currencies to behave in a safe-haven or susceptible manner, although this propensity doesn't always work in a pandemic situation.

Real appreciations fueled by risk-off episodes may increase the risk of deflation and put downward pressure on aggregate demand in economies with low inflation and interest rates close to zero (International Monetary Fund 2012; de Carvalho Filho 2015). When exchange rates inevitably return, a brief real appreciation may result in significant adjustment costs for the economy (Bussière, et al. 2013).

Ultimately, investors require a safe-haven to protect them from threats. Thus, it is likely that the movement of the exchange rate is driven by the safe-haven effects and the COVID-19 conditions. It may be possible to more accurately follow FX moves with time-variant betas of FX determinants captured by interaction terms with crisis dummies, by including uncertainty, trade, and virus-related data in the models. Risk factor models without a trade channel may miss a key independent factor in the pandemic crisis context.

3. Data and the Model

3.1. Data

Our data covers five developed economies and six emerging economies, with a daily sample from December 2007 until December 2022. We categorize three groups of currencies: standard hard currencies (Euro - EUR, British pound – GBP), safe-haven currencies (Japanese yen - JPY, Swiss franc - CHF), emerging-commodity currencies (Australian dollar - AUD, Brazilian real - BRL, on-shore Chinese yuan - CNY, off-shore Chinese yuan - CNH, Indonesia rupiah, IDR, South Korean won - KRW, Mexican peso - MXN, Thai baht - THB) for our empirical analyses. Standard hard currencies basically follow our assumption for government debt sustainability: higher home sovereign risks or lower U.S. sovereign risks are associated with the weakness of the home currency against the dollar; the trade channel (commodity price movement) could capture demand shocks rather than supply shocks. Safe-haven currencies are relatively insensitive to shocks in terms of their current account sustainability. Regarding emerging and commodity currencies, a higher home CDS premium tends to coincide with the weakness of home currencies while being relatively insensitive to U.S. sovereign risks. Moreover, the currencies tend to appreciate when the prices of oil and agricultural commodities rise.

The high-frequency daily data has advantages, including providing a more timely read than traditional data series. It also comes with some caveats. We can add more explanatory variables for monthly data, but it could miss investor's key responses to the changes of FX drivers, which is the focus of our paper.

3.2. The Model

The model consists of three channels of exchange rate determinants: the portfolio investment channel, the trade channel, and risk factors including safe-haven effects and the CDS. The model starts from Verdelhan (2018), which offers a simple portfolio investment model of the contemporaneous regressions of bilateral exchange rates on the interest rate differentials, carry trade, and dollar factors. Masujima (2019b) added an uncertainty measurement to the model as the new risk factor associated with the exchange rate movement. This study aims to track the exchange rate determinants amid and after the pandemic, directly expanding the model of Masujima (2022a).

Based on the background above, I start from the first empirical model that consists of three factors related to investment, risk, and trade:

$$\begin{aligned}\Delta \boldsymbol{ln}(\boldsymbol{s_t}) &= \boldsymbol{\alpha} + \boldsymbol{\beta}_s \Delta(\boldsymbol{r}_t^* - \boldsymbol{r}_t) + \boldsymbol{\beta}_l \Delta(\boldsymbol{y}_t^* - \boldsymbol{y}_t) \\ &\quad + \boldsymbol{\gamma}\Delta(\boldsymbol{VIX_t}) + \boldsymbol{\delta}\Delta(\boldsymbol{Credit\ Default\ Swap\ premium\ differentials_t}) \\ &\quad + \boldsymbol{\tau}\Delta \boldsymbol{ln}(\boldsymbol{Oil\ price_t}) + \boldsymbol{v}\Delta \boldsymbol{ln}(\boldsymbol{Agricalture\ price_t}) + \boldsymbol{\varepsilon}, \qquad -(1)\end{aligned}$$

where s_t denotes the bilateral exchange rate in home currency per U.S. dollar, $r^*_t - r_t$ is the two-year interest rate differential between the home country (r_t) and the United States (r^*_t), $y_t - y^*$ is the two-year/ten-year yield spreads between a home country (y_t) and the United States (y^*_t), and VIX_t reflects the Chicago Board Options Exchange (CBOE) volatility index of the S&P 500 index, Credit default swap differentials are estimated using swap premiums in the home country minus U.S. premiums. Oil prices and agriculture prices reflect crude oil Brent spot prices ($/barrel) and the Bloomberg Agriculture Index, which measures the daily price movements of agricultural commodities. All the data source is Bloomberg.

The VIX is a good measure of global investors' risk sentiment. Increases in the VIX are associated with higher volatility in Japanese and German stock prices, as measured by the Nikkei Volatility Index (VI) and VDAX— the volatility index of the Deutsche Börse DAX— as well as in the yen's exchange rate to the dollar. The VIX correlates to the Nikkei VI at 0.83, to the VDAX at 0.87, and to implied volatility on 1-month at-the-money yen-dollar options at 0.71. Since September 2008, the movement of equity volatility indexes has been more closely associated with the movement of exchange rate index. The sample period is from December 2007 to December 2022, which varies by currency. The *VIX* coefficient is defined as the Safe-Haven Index (*SH*), and it measures the safe-haven status as follows:

- $SH > 0$: Periodic and country-specific "safe-haven" type tendency.
- $SH < 0$: Periodic and country-specific “vulnerable currency" type tendency.
- $SH = 0$ or insignificant: exchange rate movement doesn't follow a specific tendency.

So, the expected sign of the coefficient (γ) is positive if a home currency is a safe-haven currency such as the Japanese yen and the U.S. dollar, and it's negative if a home currency is vulnerable to a common shock related to market uncertainty—typically emerging market currencies, including the Chinese renminbi.

Interest rate differentials between home and US can generate excess returns from investment in a home country borrowing the U.S. dollar. The expected sign of coefficient (β) is positive. The safe-haven status of a currency is developed under the assumption that capital flows are driven by excess returns from the currency carry trade rather than uncovered interest rate parity (UIP). This paper's view is similar to the carry trade hypothesis, in which Brunnermeier, Nagel, and Pedersen (2013) define the currency carry trade as consisting of selling low interest-rate currencies—"funding currencies"—and investing in high interest-rate currencies—"investment currencies." They discovered that carry trades losses money on average when VIX rise. While the UIP hypothesizes that the carry gains due to the interest-rate differential are offset by a commensurate depreciation of the investment currency, empirically the reverse holds. The investment currency appreciates a little on average despite having a low predictive R^2 (Fama 1984). This violation of the UIP—often referred to as the "forward premium puzzle"—is precisely what makes the carry trade profitable on average. The sample period is from March 2007 to December 2022, which varies by currency. Two-year yield differentials are common variables for both advanced and emerging nations, while two-year to ten-year yield spreads are also included for advanced economies to see the impacts of sovereign credit risks more carefully.

Higher sovereign credit risks tend to be associated with weaker currency values. We expect a positive coefficient (δ) for home CDS premiums and a negative one for U.S. premiums. In the case of the gap in the home-the U.S. CDS premiums, we expect positive coefficients.

For signs of coefficients of oil (τ) and agricultural prices (υ), we expect a positive sign for net importers of the products and a negative sign for net exporters.

To track a shift of the FX determinants, the interaction term with dummy variables for the Global Financial Crisis (from December 2007 until March 2009), the COVID-19 crisis (from February 2020 until December 2021), and the post-pandemic period (from January 2022 until December 2022) are added. It is also possible to examine the direct effects of the number of COVID-19 confirmed cases in a home country. This is the model.

$$\begin{aligned}\Delta ln(s_t) = {} & \alpha + \beta_{s1}\Delta(r_t^* - r_t) + \beta_{s2}\Delta(r_t^* - r_t)\cdot GFS\_D + \Delta\beta_{s3}\Delta(r_t^* - r_t)\cdot COVID\_D + \beta_{s4}\Delta(r_t^* - r_t)\cdot Post\ COVID\_D \\ & + \beta_{l1}\Delta(y_t - y_t^*) + \beta_{l2}\Delta(y_t - y_t^*)\cdot GFS\_D + \Delta\,\beta_{l3}\Delta(y_t - y_t^*)\cdot COVID\_D + \beta_{l4}\Delta(y_t - y_t^*)\cdot Post\ COVID\_D \\ & + \gamma_1\Delta(VIX_t) + \gamma_2\Delta(VIX_t)\cdot GFS\_D + \gamma_3\Delta(VIX_t)\cdot COVID\_D + \gamma_4\Delta(VIX_t)\cdot Post\ COVID\_D \\ & + \delta_{l1}\Delta(Home\ CDS_t) + \delta_{l2}\Delta(Home\ CDS_t)\cdot GFS_D + \delta_{l3}\Delta(Home\ CDS_t)\cdot COVID\_D + \delta_{l4}\Delta(Home\ CDS_t)\cdot Post\ COVID\_D \\ & + \delta_{d1}\Delta(US\ CDS_t) + \delta_{d2}\Delta(US\ CDS_t)\cdot GFS\_D + \delta_{d3}\Delta(US\ CDS_t)\cdot COVID\_D + \delta_{d4}\Delta(US\ CDS_t)\cdot Post\ COVID\_D \\ & + \tau_1\Delta ln(Oil_t) + \tau_2\Delta ln(Oil_t)\cdot GFS\_D + \tau_3\Delta ln(Oil_t)\cdot Covid\_D + \tau_4\Delta ln(Oil_t)\cdot Post\ COVID\_D \\ & + v_1\Delta(Agri_t) + v_2\Delta(Agri_t)\cdot GFS_D + v_3\Delta(Agri_t)\cdot Covid_D + v_4\Delta(Agri_t)\cdot Post\ Covid_D + \varepsilon, \qquad -(2)\end{aligned}$$

where the crisis dummies and the post crisis dummies are the dummy variables for a crisis and a post-crisis period, which are one during the crisis and otherwise zero.

In addition, we added the BOJ's yield curve control dummy for Japan-specific models. It is one in and after September 2016 when the BOJ introduced the YCC and otherwise zero. The sign of the coefficient of oil prices could be conditional on supply and demand balance. We also include the supply demand dummy variable. Its coefficient (τ_5) tends to be negative when the Japanese is expanding associated with higher oil prices and high level of long-term interest rates (10-year JGB yield is greater than zero), driven by exports. In this case, the current account (trade) balance tends to improve and thus the yen tends to appreciate due to the trade effects. Here is the model.

$$\begin{aligned}\Delta \ln(s_t) = {} & \alpha + \beta_{s1}\Delta(r_t^* - r_t) + \beta_{s2}\Delta(r_t^* - r_t)\cdot GFS\_D + \Delta\beta_{s3}\Delta(r_t^* - r_t)\cdot COVID\_D + \beta_{s4}\Delta(r_t^* - r_t)\cdot Post\ COVID\_D \\ & + \beta_{l1}\Delta(y_t - y_t^*) + \beta_{l2}\Delta(y_t - y_t^*)\cdot GFS\_D + \Delta\,\beta_{l3}\Delta(y_t - y_t^*)\cdot COVID\_D + \beta_{l4}\Delta(y_t - y_t^*)\cdot Post\ COVID\_D \\ & + \gamma_1\Delta(VIX_t) + \gamma_2\Delta(VIX_t)\cdot GFS\_D + \gamma_3\Delta(VIX_t)\cdot COVID\_D + \gamma_4\Delta(VIX_t)\cdot Post\ COVID\_D \\ & + \delta_{l1}\Delta(Home\ CDS_t) + \delta_{l2}\Delta(Home\ CDS_t)\cdot GFS_D + \delta_{l3}\Delta(Home\ CDS_t)\cdot COVID\_D + \delta_{l4}\Delta(Home\ CDS_t)\cdot Post\ COVID\_D \\ & + \delta_{d1}\Delta(US\ CDS_t) + \delta_{d2}\Delta(US\ CDS_t)\cdot GFS\_D + \delta_{d3}\Delta(US\ CDS_t)\cdot COVID\_D + \delta_{d4}\Delta(US\ CDS_t)\cdot Post\ COVID\_D \\ & + \tau_1\Delta ln(Oil_t) + \tau_2\Delta ln(Oil_t)\cdot GFS\_D + \tau_3\Delta ln(Oil_t)\cdot Covid\_D + \tau_4\Delta ln(Oil_t)\cdot Post\ COVID\_D + \tau_5\Delta ln(Oil_t)\cdot DS\_D \\ & + v_1\Delta(Agri_t) + v_2\Delta(Agri_t)\cdot GFS_D + v_3\Delta(Agri_t)\cdot Covid_D + v_4\Delta(Agri_t)\cdot Post\ Covid_D + \varepsilon, \qquad -(3)\end{aligned}$$

4. Results

4.1. Advanced Economies

The basic model results for eight advanced economies are shown in Table 1 and Table 2. Wider interest rate differentials (higher for home or lower for foreign) have positive impacts on a home currency, following the expectation for all the advanced economies. Its magnitude is probably linked to carry trade opportunities as well as the relationship between the U.S. and the global economy. A one percentage point increase in the differentials is associated with a 5.8% appreciation in the Japanese yen (JPY), the highest, and a 1.3% rise in Italian government bond yields (EUR), the lowest. The difference of magnitude could reflect the opportunity of carry trade. The low interest currencies such as the JPY and CHF are more sensitive to a change in yield differentials against the USD as investors tend to borrow and sell the low yield currencies to buy high yield currencies in order to receive gains from yield differentials. The UIP doesn't seem to hold in the day-to-day changes of the FX moves.

During the COVID-19 crisis, its magnitude shrank for the euro (EUR), and during the post-COVID period, the U.K. pound (GBP) and JPY showed the same direction in Table 5. These are similar results to Masujima (2017) and Masujima (2019a). This doesn't mean market participants lost focus on interest rate differentials during the Global Financial Crisis. The expansion of unconventional monetary policies in the aftermath of the financial crisis probably increased sensitivity to interest rate differentials. For example, the magnitude of the Japan-U.S. two-year yield differentials on FX moves peaked in late 2012, when the US Quantitative Easing began, and then peaked again in late 2017 after the US President Donald Trump emphasized the large fiscal stimulus. In order to capture the effects of unconventional policies that could soften risk premiums in a crisis, long-term yield spreads were added to the extended model for Japan, the U.S., and the Euro Area in the next section.

Higher market uncertainty has positive impacts on JPY. That means the yen has safe-haven status. In contrast, higher uncertainty depreciated the Australian dollar (AUD), GBP, and EUR. All the currencies move significantly with the VIX. Its negative magnitude is probably related to whether the currency is a commodity currency or not, which is highly correlated with commodity prices. A ten-point increase in the VIX is associated with a 0.5% appreciation in the JPY as the highest to a 1.6% drop in AUD.

During the COVID-19 crisis, its magnitude shrank for all the currencies but JPY. The EUR's status shifted from a fragile currency to a safe-haven currency. During the Global Financial Crisis, the magnitude of the crisis was amplified for all the countries but GBP. The difference comes from the type of crisis. The Global Financial Crisis is a financial crisis that is driven by price discrepancies in synthetic securities products. It's closely connected with the market's uncertainty. The COVID-19 crisis hit the real economy first, while the financial sector was relatively sound. On top of that, the immediate implementation of mega fiscal stimulus and additional liquidity support from the central banks significantly improved financial market sentiment. That could distort the relationship between market uncertainty and FX moves.

Safe-haven currencies such as JPY and CHF are relatively insensitive to shocks in terms of fiscal and current account sustainability. Standard currencies such as GBP and EUR basically follow our assumption for government debt sustainability: higher home sovereign risks or lower U.S. sovereign risks are associated with the weakness of the home currency against the dollar; the trade channel (commodity price movement) could capture demand shocks rather than supply shocks.

4.2. Commodity Exporters and Emerging Economies

In the cases of emerging market currencies (BRL, CNY, CNH, IDR, KRW, MXN, THB) in Table 3, Table 4, Table 6, a higher home CDS premium tends to correlate with the weakness of home currencies while being relatively insensitive to U.S. sovereign risks. Moreover, commodity currencies tend to appreciate when the prices of oil and agricultural commodities rise. Moreover, the impacts of yield differentials are negative except in China. This is because emerging economies need to follow the U.S. hikes at a faster pace to avoid a rapid depreciation of their currencies due to the hawkish Fed. However, the world's second-largest economy, China, doesn't need to follow the U.S. by implementing some control over capital flows.

4.3. Extended Model for Japan

In order to capture the effects of the yield curve control (YCC) policy that could soften sovereign risk premiums, the YCC dummies are added only for relevant variables such as long-term yield curve spread differentials and CDS premiums in the extended model for Japan (Table 7), while three crisis dummies are kept in the model. This allows the model to differentiate the YCC's impacts on the FX rate through the CDS and long-term yields from the impacts of crises[7]. Moreover, in order to check whether changes in oil prices are driven by demand shocks or supply shocks, we added the demand shock dummy for interacting terms of oil prices, which is equal to 1 when the 10-year JGB yield is above 0%; otherwise, 0.

We find the BOJ's introduction of the YCC increased the yen's sensitivity to

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[7] Most of the CDS deals were traded by non-Japanese counter parties, while the JGB holdings of foreign investors are only 14.3% as of December 2021. So, if there is a big gap in assessment of Japan's sovereign risks between domestic and overseas investors, higher CDS rates aren't necessarily associated with higher JGB yields.

sovereign risks, even if the YCC could have capped a surge in CDS premiums[8]. A one percentage point increase in long-term yield spreads increased USD/JPY by 2.1 ppt in the normal period, but the impact on the FX rate boosted 1.1 ppt more after the YCC was introduced in September (Table 7 (1)). Moreover, the impacts of oil prices on FX moves appear to depend on whether it is a demand shock or not. Japan relies on 90% of energy supply from overseas and the share of fossil fuel imports to total imports jumped after the Great East Japan Earthquake. So, ceteris paribus, higher oil prices are associated with wider trade deficits and thus the weaker yen. But if higher oil prices reflect stronger global demand, its impacts on Japan's trade balance could be different as stronger global demand tend to boost Japan's exports than imports due to higher oil prices. The sign of supply-demand dummy of oil prices follows this story.

5. Conclusion

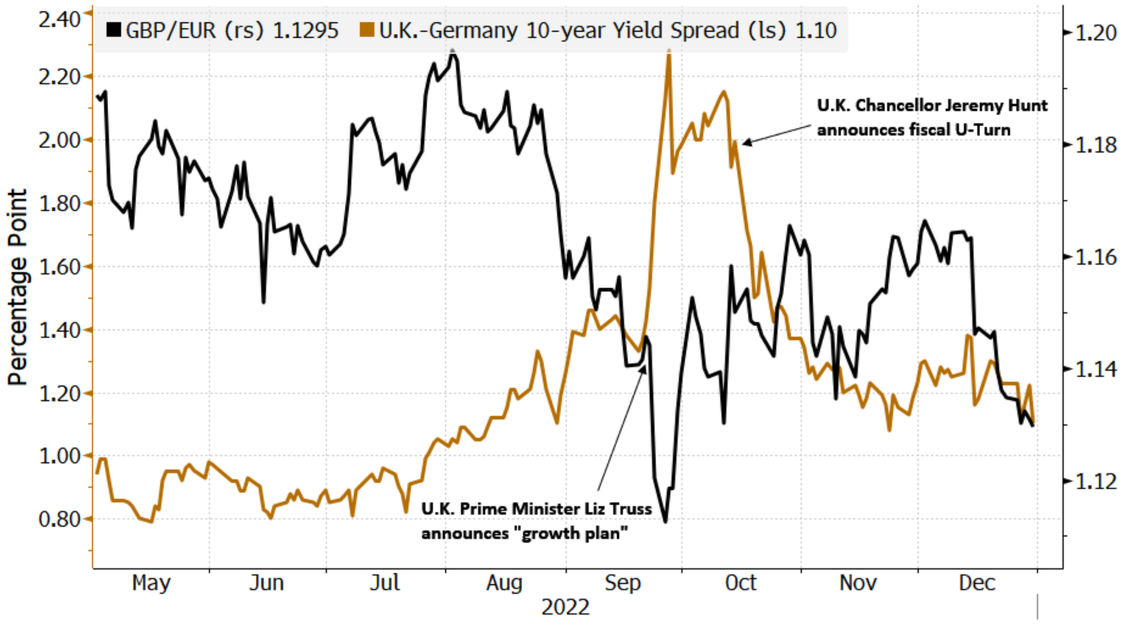
This study focuses on the roles that sovereign credit risks and energy costs play in determining what influences foreign exchange rates in the post-pandemic period. Higher interest rates and growing energy costs pose a danger to the viability of the fiscal and current account deficits, particularly if a nation has a high public debt load, a sizable current account deficit, or is a net energy importer. The country's currency tends to decline as sustainability worries about government debt and the current account deficit grow. Even though the YCC may have partially stopped a rise in CDS premiums, this research finds that the BOJ's starting YCC may have exacerbated the yen's susceptibility to sovereign risks. The impacts of oil price changes on FX moves also appear to depend on whether higher oil prices come from a demand shock or not.

[8] For a robustness check, we did rolling regressions with a 250 business day window for Japan (see Appendix I). The results basically reconfirm the main results.

Very little literature currently looks at the relationship between CDS premiums, commodity prices, and FX movements, especially when it comes to post-COVID coverage. Thus, the main contributions of this study are as follows: (1) tracking a change in the FX determinants during and after the COVID-19 pandemic via three channels, compared to the Global Financial Crisis and the normal period; (2) demonstrating the importance of the risk channel for FX movements using CDS premiums in home and U.S.; (3) reiterating the significance of the trade channel for FX movements, following the COVID-crisis period; and (4) demonstrating that the yen's safe-haven benefits weakened during and after the pandemic, while emerging markets were more susceptible to common shocks.

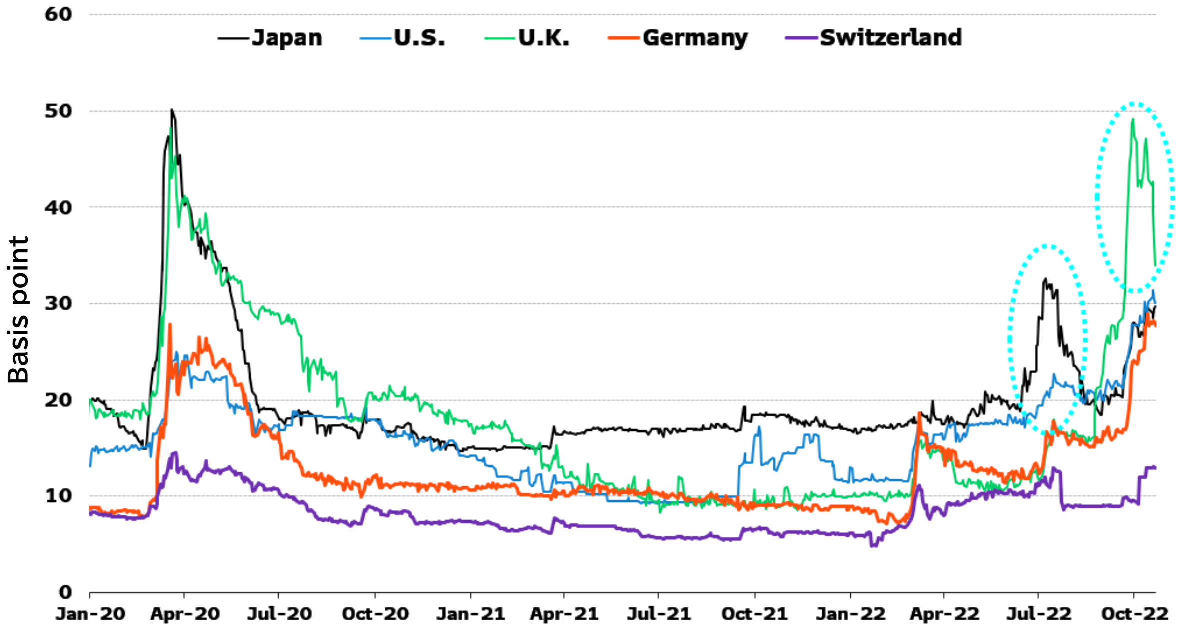
The policy implication is that fiscal restraint is crucial for both the movement of foreign exchange rates and sovereign risk premiums. The BOJ could reduce certain sovereign risks in the short term, but with the rapid depreciation of the domestic currency, it could hurt the sustainability of national debt in the long term. Additionally, eliminating trade restrictions might boost trade flows while taming FX volatility. Thus, encouraging globalization continues to be crucial for the stability of the FX market.

Figure 1. British Pound Fell with Higher Yields and Risk Premium



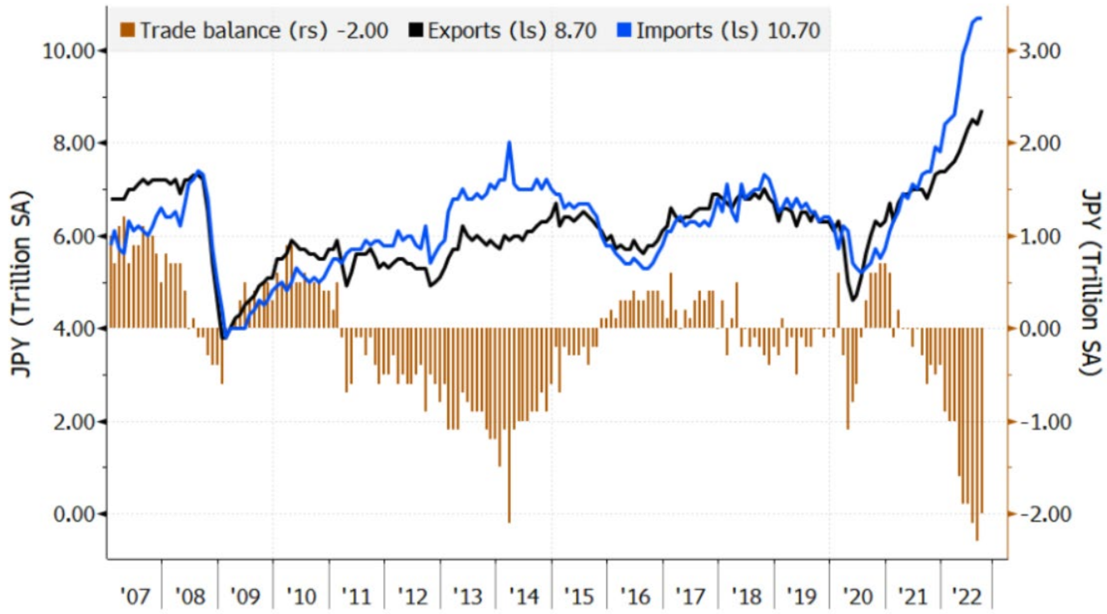
Source: Bloomberg Economics

Figure 2. U.K CDS Rate Surged after the Announcement of Growth Plan



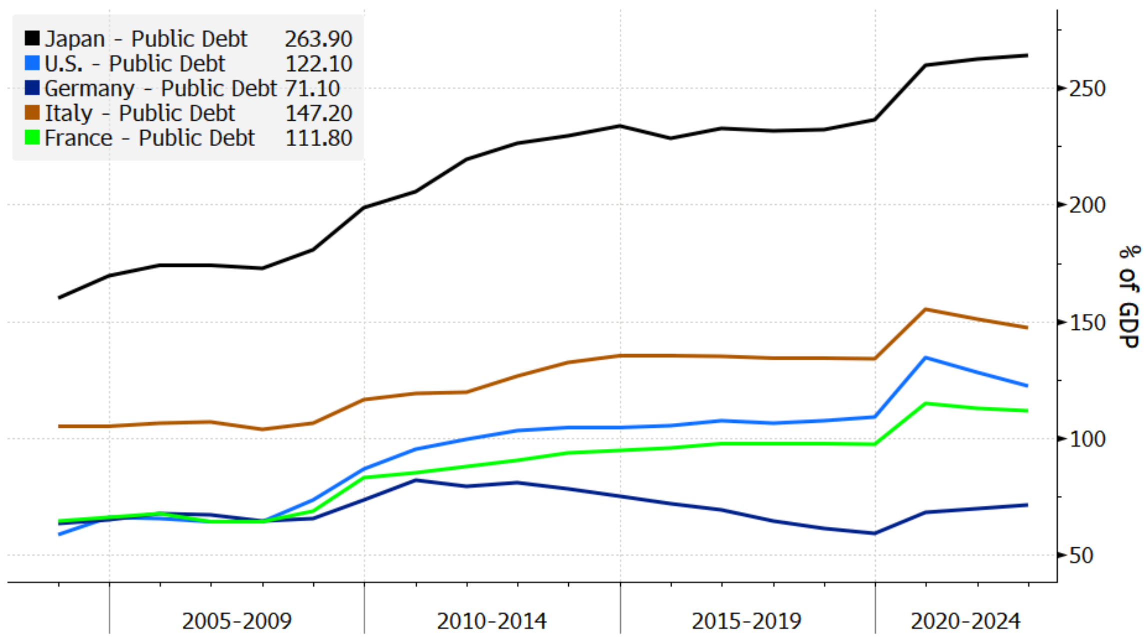
Source: Bloomberg

Figure 3. Higher Oil Prices Widened Japan's Trade Deficit



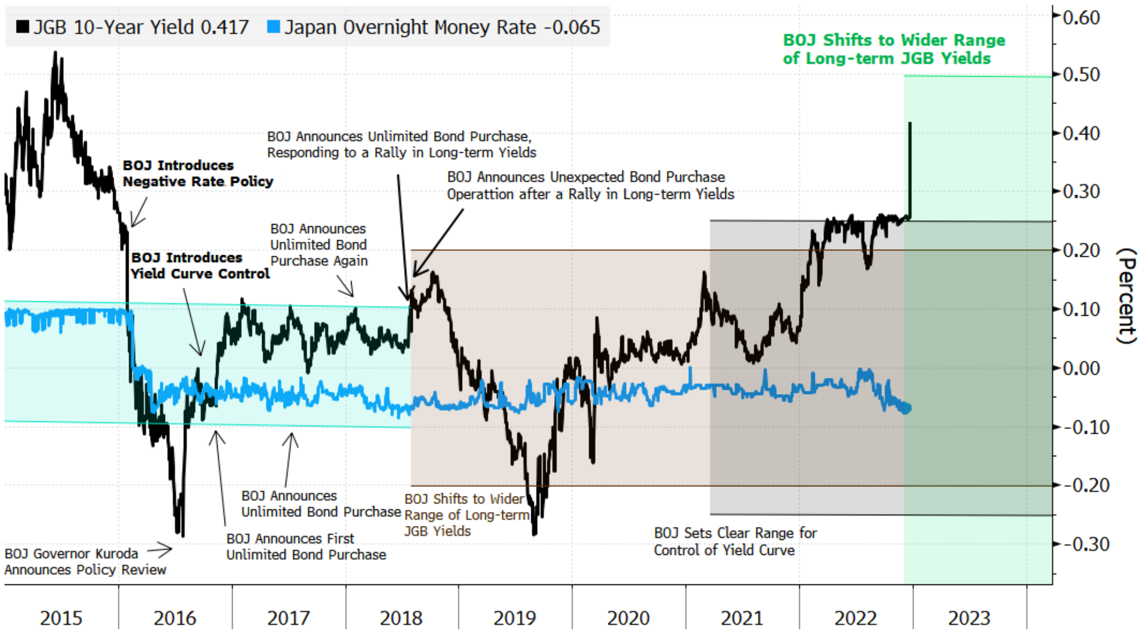
Source: Japan Ministry of Finance, Bloomberg Economics

Figure 4. Public Debt Jumped Due to COVID-19 Pandemic



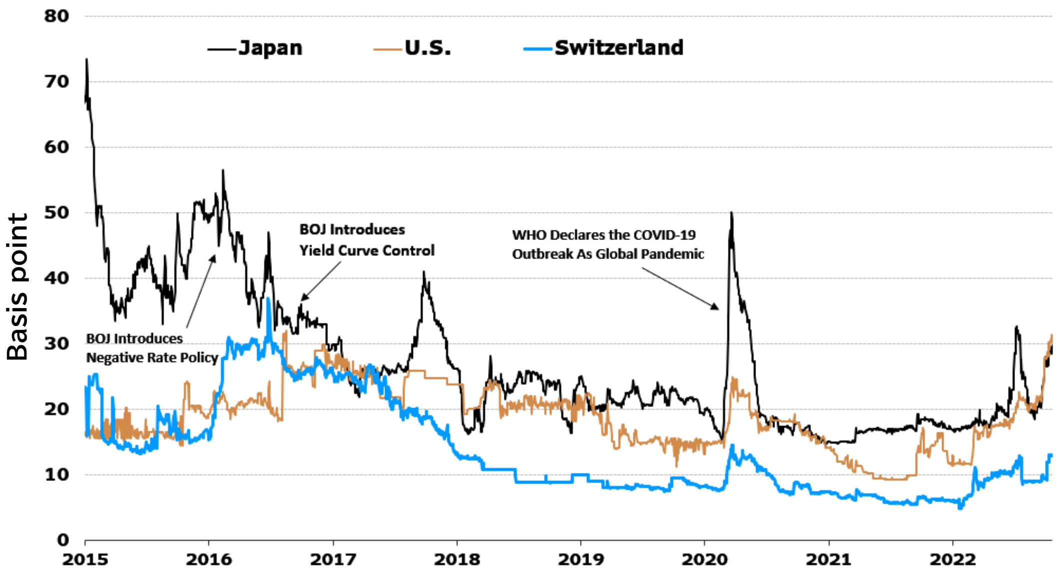
Source: IMF (2022)

Figure 5. BOJ's Yield Curve Control Changes



Source: Bank of Japan, Bloomberg Economics

Figure 6. Japan's CDS Premiums Has Been Capped after BOJ's YCC Introduction



Source: Bloomberg

Table 1. Exchange Rate Determinant Model for Advanced Economies with CDS Gaps

This table reports country-level results from the OLS regression.

$$\Delta \ln(s_t) = \alpha + \beta_s \Delta(r_t^* - r_t) + \beta_l \Delta(y_t^* - y_t)$$
$$+ \gamma\Delta(VIX_t) + \delta\Delta(Credit\ Default\ Swap\ premium\ differentials_t)$$
$$+ \tau\Delta LN(Oil\ price_t) + \nu\Delta ln(Agricalture\ price_t) \quad + \varepsilon$$

where s_t denotes the bilateral exchange rate in home currency per U.S. dollar, $r^*_t - r_t$ is the two-year interest rate differential between the home country (r_t) and the United States (r^*_t), $y_t - y^*$ is the two-year/ten-year yield spreads between a home country (y_t) and the United States (y^*_t), VIX_t reflects Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index, Credit default swap differentials are estimated by swap premiums in home country minus U.S. premiums. Oil price and agriculture prices reflect crude oil Brent spot prices ($/barrel) and Bloomberg agriculture index that measures the daily price movements of Agricultural commodities. The table reports the constant α, the slope coefficients β, γ, δ, τ, and ν, as well as the R^2 of this regression (in 0.01 percentage point). *** corresponds to a rejection of the null hypothesis at the 1% confidence level; ** and * correspond to the 5% and 10% confidence levels. Data are daily, from Bloomberg. The sample period is December of 2007 to December 2022, which varies by currency.

		(1)	(2)	(3)	(4)	(5)	(6)
Dependant Variable		*dlog(bilateral exchange rate per U.S. dollar) [t]*					
Currency		**AUD**	**CHF**	**EUR (Germany)**	**EUR (Italy)**	**GBP**	**JPY**
Starting Date		Aug. 2008	Jan. 2009	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007
End Date		Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022
Constant [t]	α	0.010	-0.013	0.006	0.008	0.010	-0.004
d(Two-year government bond yield differential[t])	β_s	2.122***	3.968***	3.753***	1.312***	2.697***	5.848***
d(Long-term yield curve spread differential[t])	β_l	-0.816***	1.961***	0.910***	0.939***	0.791***	2.552***
d(VIX[t])	γ	0.152***	0.010	0.039***	0.029***	0.051***	-0.059***
d(Credit Default Swap premium differentials[t])	δ	0.010**	0.007	0.053***	0.021***	0.039***	0.003
dlog(Oil price[t])	τ	-4.909***	-0.848	-1.256***	-1.308***	-3.310***	0.584
dlog(Agriculture spot price[t])	υ	-13.113***	-6.362***	-8.296***	-8.449***	-6.398***	-2.377***
Adj. R-squared		0.318	0.065	0.177	0.116	0.150	0.287
Durbin-Watson		2.207	2.064	2.053	2.035	1.965	2.071
Observations		3511	3317	3647	3646	3644	3633

Note: *, **, *** indicate the 10%, 5%, 1% significant level.

Table 2. Exchange Rate Determinant Model for Advanced Economies with Home CDS

This table reports country-level results from the OLS regression.

$$\Delta\ln(s_t) = \alpha + \beta_s\Delta(r_t^* - r_t) + \beta_l\Delta(y_t^* - y_t)$$
$$+ \gamma\Delta(VIX_t) + \delta_l\Delta(Home\ Credit\ Default\ Swap\ premium_t) + \delta_d\Delta(US\ Credit\ Default\ Swap\ premium_t)$$
$$+ \tau\Delta ln(Oil\ price_t) + \nu\Delta ln(Agricalture\ price_t) \quad + \varepsilon$$

where s_t denotes the bilateral exchange rate in home currency per U.S. dollar, $r^*_t - r_t$ is the two-year interest rate differential between the home country (r_t) and the United States (r^*_t), $y_t - y^*$ is the two-year/ten-year yield spreads between a home country (y_t) and the United States (y^*_t), VIX_t reflects Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index, Credit default swap premiums show swap premiums in the dollar terms in home country and U.S. premiums. Oil price and agriculture prices reflect crude oil Brent spot prices ($/barrel) and Bloomberg agriculture index that measures the daily price movements of Agricultural commodities. The table reports the constant α, the slope coefficients β, γ, δ, τ, and ν, as well as the R^2 of this regression (in 0.01 percentage point). *** corresponds to a rejection of the null hypothesis at the 1% confidence level; ** and * correspond to the 5% and 10% confidence levels. Data are daily, from Bloomberg. The sample period is December of 2007 to December 2022, which varies by currency.

		(1)	(2)	(3)	(4)	(5)	(6)
Dependant Variable		*dln(bilateral exchange rate per U.S. dollar) [t]*					
Currency		**AUD**	**CHF**	**EUR (Germany)**	**EUR (Italy)**	**GBP**	**JPY**
Starting Date		Aug. 2008	Jan. 2009	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007
End Date		Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022
Constant [t]	α	0.010	-0.014	0.006	0.006	0.010	-0.004
d(Two-year government bond yield differential[t])	β_s	2.134***	3.982***	3.694***	3.703***	2.652***	5.823***
d(Long-term yield curve spread differential[t])	β_l	-0.819***	1.944***	0.903***	0.847***	0.754***	2.490***
d(VIX[t])	γ	0.152***	0.011*	0.037***	0.036***	0.049***	-0.055***
d(Credit Default Swap premium Local Currency[t])	δ_l	0.008	-0.006	0.066***	0.009***	0.053***	-0.019***
d(Credit Default Swap premium U.S. dollar[t])	δ_d	-0.013*	-0.022***	-0.046***	-0.039***	-0.026***	-0.026***
dlog(Oil price[t])	τ	-4.934***	-0.941*	-1.173***	-1.195***	-3.165***	0.435
dlog(Agriculture spot price[t])	υ	-13.134***	-6.513***	-8.196***	-8.272***	-6.266***	-2.567***
Adj. R-squared		0.318	0.068	0.179	0.172	0.154	0.296
Durbin-Watson		2.205	2.056	2.062	2.050	1.979	2.072
Observations		3511	3317	3647	3647	3644	3633

Note: *, **, *** indicate the 10%, 5%, 1% significant level.

Table 3. Exchange Rate Determinant Model for Emerging Economies with CDS Gaps

This table reports country-level results from the OLS regression.

$$\Delta \ln(s_t) = \alpha + \beta_s \Delta(r_t^* - r_t) + \gamma \Delta(VIX_t) + \delta \Delta(Credit\ Default\ Swap\ premium\ differentials_t) + \tau \Delta ln(Oil\ price_t) + \nu \Delta ln(Agricalture\ price_t) + \varepsilon$$

where s_t denotes the bilateral exchange rate in home currency per U.S. dollar, $r^*_t - r_t$ is the two-year interest rate differential between the home country (r_t) and the United States (r^*_t), VIX_t reflects Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index, Credit default swap differentials are estimated by swap premiums in home country minus U.S. premiums. Oil price and agriculture prices reflect crude oil Brent spot prices ($/barrel) and Bloomberg agriculture index that measures the daily price movements of Agricultural commodities. The table reports the constant α, the slope coefficients β, γ, δ, τ, and ν, as well as the R^2 of this regression (in 0.01 percentage point). *** corresponds to a rejection of the null hypothesis at the 1% confidence level; ** and * correspond to the 5% and 10% confidence levels. Data are daily, from Bloomberg. The sample period is December of 2007 to December 2022, which varies by currency.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependant Variable		*dlog(local currency unit per U.S. dollar) [t]*						
Currency		**BRL**	**CNY**	**IDR**	**KRW**	**MXN**	**THB**	**CNH**
Starting Date		Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Aug. 2010
End Date		Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022
Constant [t]	α	0.031**	-0.003	0.018**	0.007	0.018	0.003	0.002
d(Two-year government bond yield differential[t])	β	-1.820***	0.179***	-0.456***	-0.704***	-0.523***	0.547***	0.542***
d(VIX[t])	γ	0.071***	0.006***	0.001	-0.005	0.121***	0.013***	0.022***
d(Credit Default Swap premium differentials[t])	δ	0.033***	0.011***	0.006***	0.054***	0.035***	0.005***	0.015***
dlog(Oil price[t])	τ	-3.157***	-0.520***	-1.572***	-1.586***	-1.226**	-0.548**	-0.576**
dlog(Agriculture spot price[t])	υ	-14.567***	-0.958***	-1.205	-1.971*	-4.754***	-2.416***	-1.726***
Adj. R-squared		0.336	0.047	0.071	0.254	0.338	0.069	0.080
Durbin-Watson		2.257	2.090	2.059	2.181	2.029	1.922	2.159
Observations		3414	2935	2889	2796	3471	2997	2369

Note: *, **, *** indicate the 10%, 5%, 1% significant level.

Table 4. Exchange Rate Determinant Model for Emerging Economies with Home CDS

This table reports country-level results from the OLS regression.

$$\Delta \ln(s_t) = \boldsymbol{\alpha} + \boldsymbol{\beta}_s \Delta(\boldsymbol{r}_t^* - \boldsymbol{r}_t) +$$
$$+ \boldsymbol{\gamma}\Delta(\boldsymbol{VIX}_t) + \boldsymbol{\delta}_l \Delta(\boldsymbol{Home\ Credit\ Default\ Swap\ premium}_t) + \boldsymbol{\delta}_d \Delta(\boldsymbol{US\ Credit\ Default\ Swap\ premium}_t)$$
$$+ \boldsymbol{\tau}\Delta ln(\boldsymbol{Oil\ price}_t) + \boldsymbol{v}\Delta \boldsymbol{ln}(\boldsymbol{Agricalture\ price}_t) \quad + \boldsymbol{\varepsilon}$$

where s_t denotes the bilateral exchange rate in home currency per U.S. dollar, $r^*_t - r_t$ is the two-year interest rate differential between the home country (r_t) and the United States (r^*_t), VIX_t reflects Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index, Credit default swap premiums show swap premiums in the dollar terms in home country and U.S. premiums. Oil price and agriculture prices reflect crude oil Brent spot prices ($/barrel) and Bloomberg agriculture index that measures the daily price movements of Agricultural commodities. The table reports the constant α, the slope coefficients β, γ, δ, τ, and ν, as well as the R^2 of this regression (in 0.01 percentage point). *** corresponds to a rejection of the null hypothesis at the 1% confidence level; ** and * correspond to the 5% and 10% confidence levels. Data are daily, from Bloomberg. The sample period is December of 2007 to December 2022, which varies by currency.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependant Variable		*dlog(bilateral exchange rate per U.S. dollar) [t]*						
Currency		**BRL**	**CNY**	**IDR**	**KRW**	**MXN**	**THB**	**CNH**
Starting Date		Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Aug. 2010
End Date		Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022
Constant [t]	α	0.031**	-0.003	0.018**	0.007	0.019	0.002	0.002
d(Two-year government bond yield differential[t])	β	-1.790***	0.175***	-0.442***	-0.732***	-0.469**	0.546***	0.539***
d(VIX[t])	γ	0.068***	0.005***	0.000	-0.008	0.119***	0.012***	0.020***
d(Credit Default Swap premium Local Currency[t])	δ_1	0.034***	0.014***	0.006***	0.056***	0.036***	0.006***	0.018***
d(Credit Default Swap premium U.S. dollar[t])	δ_2	0.000	-0.006***	0.012**	0.002	-0.008	0.003	-0.005
dlog(Oil price[t])	τ	-2.966***	-0.462***	-1.511***	-1.352**	-1.057*	-0.517**	-0.525**
dlog(Agriculture spot price[t])	υ	-14.311***	-0.927***	-1.132	-1.688	-4.596***	-2.364***	-1.666***
Adj. R-squared		0.339	0.051	0.075	0.273	0.341	0.070	0.083
Durbin-Watson		2.263	2.087	2.062	2.168	2.037	1.924	2.164
Observations		3414	2935	2889	2796	3471	2997	2369

Note: *, **, *** indicate the 10%, 5%, 1% significant level.

Table 5. Extended Exchange Rate Determinant Model for Advanced Economies

$$\Delta\ln(s_t) = \alpha + \beta_{s1}\Delta(r_t^* - r_t) + \beta_{s2}\Delta(r_t^* - r_t)\cdot GFS\_D + \Delta\beta_{s3}\Delta(r_t^* - r_t)\cdot COVID\_D + \beta_{s4}\Delta(r_t^* - r_t)\cdot Post\ COVID\_D$$

$$+ \beta_{l1}\Delta(y_t - y_t^*) + \beta_{l2}\Delta(y_t - y_t^*)\cdot GFS\_D + \Delta\,\beta_{l3}\Delta(y_t - y_t^*)\cdot COVID\_D + \beta_{l4}\Delta(y_t - y_t^*)\cdot Post\ COVID\_D$$

$$+ \gamma_1\Delta(VIX_t) + \gamma_2\Delta(VIX_t)\cdot GFS\_D + \gamma_3\Delta(VIX_t)\cdot COVID\_D + \gamma_4\Delta(VIX_t)\cdot Post\ COVID\_D$$

$$+ \delta_{l1}\Delta(Home\ CDS_t) + \delta_{l2}\Delta(Home\ CDS_t)\cdot GFS_D + \delta_{l3}\Delta(Home\ CDS_t)\cdot COVID\_D + \delta_{l4}\Delta(Home\ CDS_t)\cdot Post\ COVID\_D$$

$$+ \delta_{d1}\Delta(US\ CDS_t) + \delta_{d2}\Delta(US\ CDS_t)\cdot GFS\_D + \delta_{d3}\Delta(US\ CDS_t)\cdot COVID\_D + \delta_{d4}\Delta(US\ CDS_t)\cdot Post\ COVID\_D$$

$$+ \tau_1\Delta ln(Oil_t) + \tau_1\Delta ln(Oil_t)\cdot GFS\_D + \tau_1\Delta ln(Oil_t)\cdot Covid\_D + \tau_1\Delta ln(Oil_t)\cdot Post\ COVID\_D$$

$$+ +v_1\Delta ln(Agri_t) + v_2\Delta ln(Agri_t)\cdot GFS\_D + v_3\Delta ln(Agri_t)\cdot Covid\_D + v_4\Delta ln(Agri_t)\cdot Post\ Covid\_D + \varepsilon$$

where s_t denotes the bilateral exchange rate in home currency per U.S. dollar, $r^*_t - r_t$ is the two-year interest rate differential between the home country (r_t) and the United States (r^*_t), $y_t - y^*$ is the two-year/ten-year yield spreads between a home country (y_t) and the United States (y^*_t), VIX_t reflects Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index, CDS shows credit default swap premiums in dollar terms in home country and U.S. premiums. Oil price and agriculture prices reflect crude oil Brent spot prices ($/barrel) and Bloomberg agriculture index that measures price movements of Agricultural commodities. *GFS_D*, *COVID_D*, and *Post COVID_D* are dummy variables. The table reports the constant α, the slope coefficients β, γ, δ, τ, and ν, as well as the R^2 of this regression (in 0.01 percentage point). *** corresponds to a rejection of the null hypothesis at the 1% confidence level; ** and * correspond to the 5% and 10% confidence levels. Data are daily, from Bloomberg. The sample period is December of 2007 to December 2022, which varies by currency.

		(1)	(2)	(3)	(4)	(5)	(6)
Dependant Variable		*dlog(bilateral exchange rate per U.S. dollar) [t]*					
Currency		**AUD**	**CHF**	**EUR (Germany)**	**EUR (Italy)**	**GBP**	**JPY**
Starting Date		Aug. 2008	Jan. 2009	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007
End Date		Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022
Constant [t]	α	0.008	-0.015	0.004	0.007	0.009	-0.004
d(Two-year government bond yield differential[t])	β_{s1}	2.720***	4.049***	5.479***	0.802***	4.511***	7.105***
- Global Financial Crisis Dummy	β_{s2}	-1.741***	1.516	-3.147***	1.656***	-2.766***	-2.618***
- Covid-19 Dummy	β_{s3}	-1.133	-0.898	-3.017***	0.491	0.167	-1.140
- Post Covid Dummy	β_{s4}	-0.609	-0.246	-3.229***	0.783	-4.206***	-2.034***
d(Long-term yield curve spread differential[t])	β_{l1}	-1.245***	2.174***	0.696**	0.686***	1.084***	2.095***
- Global Financial Crisis Dummy	β_{l2}	0.486	1.815	0.562	0.400	-1.203**	0.994*
- Covid-19 Dummy	β_{l3}	0.201	-1.278	0.556	0.728	-0.633	0.359
- Post Covid Dummy	β_{l4}	1.489*		-1.145	-0.549	-1.193	0.458
d(VIX[t])	γ_1	0.157***	-1.378	0.041***	0.031***	0.062***	-0.049***
- Global Financial Crisis Dummy	γ_2	0.062***	0.010	0.003	0.010	-0.019	-0.076***
- Covid-19 Dummy	γ_3	-0.088***	0.031	-0.041***	-0.025**	-0.049***	0.020*
- Post Covid Dummy	γ_4	0.080***	-0.015	0.080***	0.087***	0.112***	0.059***
d(Credit Default Swap premium Local Currency[t])	δ_{l1}	0.002	0.072***	0.055***	0.018***	0.040***	-0.022***
- Global Financial Crisis Dummy	δ_{l2}	0.023*	-0.008	0.017	0.025***	0.013	-0.001
- Covid-19 Dummy	δ_{l3}	0.021	0.008	-0.058	-0.016**	0.073**	0.093***
- Post Covid Dummy	δ_{l4}	-0.042	-0.086	0.120**	0.032***	0.155***	0.013
d(Credit Default Swap premium U.S. dollar[t])	δ_{d1}	-0.006	0.177*	-0.036***	-0.031***	-0.016**	-0.021***
- Global Financial Crisis Dummy	δ_{d2}	-0.032**	-0.010	-0.028**	-0.035***	-0.021*	-0.015
- Covid-19 Dummy	δ_{d3}	0.008	-0.053***	-0.021	-0.009	-0.004	0.020
- Post Covid Dummy	δ_{d4}	-0.124*	-0.024	-0.186***	-0.153**	-0.106*	-0.057
dlog(Oil price[t])	τ_1	-7.293***	-0.143**	-2.950***	-2.773***	-3.944***	-0.044
- Global Financial Crisis Dummy	τ_2	4.517***	-2.618***	0.267	-0.230	-0.894	-0.255
- Covid-19 Dummy	τ_3	5.350***	-0.381	3.654***	2.893***	2.641**	2.624***
- Post Covid Dummy	τ_4	2.558	3.455***	1.972	1.879	1.865	-3.745**
dlog(Agriculture spot price[t])	υ_1	-10.434***	2.208	-7.531***	-7.716***	-4.584***	-3.801***
- Global Financial Crisis Dummy	υ_2	-15.176***	-7.124***	-5.122**	-4.589**	-5.538**	3.255
- Covid-19 Dummy	υ_3	0.718	3.853	3.015	2.995	-1.266	2.836
- Post Covid Dummy	υ_4	0.850	3.744	6.338	7.103	-1.942	4.852
Adj. R-squared		0.357	0.076	0.219	0.158	0.197	0.316
Durbin-Watson		2.162	2.057	2.054	2.035	1.997	2.067
Observations		3511	3317	3647	3647	3644	3633

Note: *, **, *** indicate the 10%, 5%, 1% significant level.

Table 6. Extended Exchange Rate Determinant Model for Emerging Economies

$$\Delta\ln(s_t) = \boldsymbol{\alpha} + \boldsymbol{\beta}_{s1}\Delta(\boldsymbol{r}_t^* - \boldsymbol{r}_t) + \boldsymbol{\beta}_{s2}\Delta(\boldsymbol{r}_t^* - \boldsymbol{r}_t)\cdot \boldsymbol{GFS_D} + \Delta\boldsymbol{\beta}_{s3}\Delta(\boldsymbol{r}_t^* - \boldsymbol{r}_t)\cdot \textit{COVID\_D} + \boldsymbol{\beta}_{s4}\Delta(\boldsymbol{r}_t^* - \boldsymbol{r}_t)\cdot \textit{Post COVID\_D}$$

$$+ \boldsymbol{\gamma}_1\Delta(\boldsymbol{VIX}_t) + \boldsymbol{\gamma}_2\Delta(\boldsymbol{VIX}_t)\cdot \boldsymbol{GFS\_D} + \boldsymbol{\gamma}_3\Delta(\boldsymbol{VIX}_t)\cdot \textit{COVID\_D} + \boldsymbol{\gamma}_4\Delta(\boldsymbol{VIX}_t)\cdot \textit{Post COVID\_D}$$

$$+ \boldsymbol{\delta}_{l1}\Delta(\boldsymbol{Home\ CDS}_t) + \boldsymbol{\delta}_{l2}\Delta(\boldsymbol{Home\ CDS}_t)\cdot \boldsymbol{GFS_D} + \boldsymbol{\delta}_{l3}\Delta(\boldsymbol{Home\ CDS}_t)\cdot \textit{COVID\_D} + \boldsymbol{\delta}_{l4}\Delta(\boldsymbol{Home\ CDS}_t)\cdot \textit{Post COVID\_D}$$

$$+ \boldsymbol{\delta}_{d1}\Delta(\boldsymbol{US\ CDS}_t) + \boldsymbol{\delta}_{d2}\Delta(\boldsymbol{US\ CDS}_t)\cdot \boldsymbol{GFS\_D} + \boldsymbol{\delta}_{d3}\Delta(\boldsymbol{US\ CDS}_t)\cdot \textit{COVID\_D} + \boldsymbol{\delta}_{d4}\Delta(\boldsymbol{US\ CDS}_t)\cdot \textit{Post COVID\_D}$$

$$+ \boldsymbol{\tau}_1\Delta\boldsymbol{ln}(\boldsymbol{Oil}_t) + \boldsymbol{\tau}_1\Delta\boldsymbol{ln}(\boldsymbol{Oil}_t)\cdot \boldsymbol{GFS\_D} + \boldsymbol{\tau}_1\Delta\boldsymbol{ln}(\boldsymbol{Oil}_t)\cdot \boldsymbol{Covid\_D} + \boldsymbol{\tau}_1\Delta\boldsymbol{ln}(\boldsymbol{Oil}_t)\cdot \textit{Post COVID\_D}$$

$$+ + \boldsymbol{v}_1\Delta\boldsymbol{ln}(\boldsymbol{Agri}_t) + \boldsymbol{v}_2\Delta\boldsymbol{ln}(\boldsymbol{Agri}_t)\cdot \boldsymbol{GFS\_D} + \boldsymbol{v}_3\Delta\boldsymbol{ln}(\boldsymbol{Agri}_t)\cdot \boldsymbol{Covid\_D} + \boldsymbol{v}_4\Delta\boldsymbol{ln}(\boldsymbol{Agri}_t)\cdot \boldsymbol{Post\ Covid\_D} + \boldsymbol{\varepsilon}$$

where s_t denotes the bilateral exchange rate in home currency per U.S. dollar, $r^*_t - r_t$ is the two-year interest rate differential between the home country (r_t), VIX_t reflects Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index, CDS shows credit default swap premiums in dollar terms in home country and U.S. premiums. Oil price and agriculture prices reflect crude oil Brent spot prices ($/barrel) and Bloomberg agriculture index that measures price movements of Agricultural commodities. *GFS_D*, *COVID_D*, and *Post COVID_D* are dummy variables. The table reports the constant α, the slope coefficients β, γ, δ, τ, and ν, as well as the R^2 of this regression (in 0.01 percentage point). *** corresponds to a rejection of the null hypothesis at the 1% confidence level; ** and * correspond to the 5% and 10% confidence levels. Data are daily, from Bloomberg. The sample period is December of 2007 to December 2022, which varies by currency.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependant Variable		*dlog(bilateral exchange rate per U.S. dollar) [t]*						
Currency		**BRL**	**CNY**	**IDR**	**KRW**	**MXN**	**THB**	**CNH**
Starting Date		Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007	Aug. 2010
End Date		Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022
Constant [t]	α	0.033**	-0.003	0.019**	0.007	0.021**	0.004	0.002
d(Two-year government bond yield differential[t])	β_1	-1.714***	0.085	-0.620***	0.232	-0.845***	0.591***	0.240*
- Global Financial Crisis Dummy	β_2	-0.030	-0.047	0.298**	-1.533***	0.962**	-0.776***	
- Covid-19 Dummy	β_3	0.378	0.308	-2.483***	-1.285	0.372	0.187	0.790**
- Post Covid Dummy	β_4	-0.291	0.253	0.320	-1.417**	0.995	0.032	0.739***
d(VIX[t])	γ_1	0.078***	0.002	0.012*	0.005	0.109***	0.014***	0.018***
- Global Financial Crisis Dummy	γ_2	0.015	0.004	-0.029***	-0.044***	0.045**	-0.020**	
- Covid-19 Dummy	γ_3	-0.056***	0.008*	-0.068***	-0.021	-0.045***	-0.005	0.007
- Post Covid Dummy	γ_4	0.063		-0.008	-0.002	0.028	0.037**	0.037***
d(Credit Default Swap premium Local Currency[t])	δ_{l1}	0.068***	0.012	0.016***	0.074***	0.076***	0.010***	0.015***
- Global Financial Crisis Dummy	δ_{l2}	-0.052***	0.011***	-0.014***	-0.023***	-0.062***	-0.008***	
- Covid-19 Dummy	δ_{l3}	-0.042***	-0.008*	0.014***	0.050**	-0.019***	-0.004**	-0.016**
- Post Covid Dummy	δ_{l4}	-0.026**	-0.005	-0.001	0.057**	-0.035***	0.014***	0.020***
d(Credit Default Swap premium U.S. dollar[t])	δ_{d1}	-0.010	0.024***	0.010*	0.009	-0.020***	0.001	-0.003
- Global Financial Crisis Dummy	δ_{d2}	0.000	-0.004	-0.013	-0.028**	0.002	0.004	
- Covid-19 Dummy	δ_{d3}	0.119*	0.002	-0.095**	-0.076	0.170***	0.021	-0.002
- Post Covid Dummy	δ_{d4}	-0.042	-0.006	0.057	-0.008	-0.032	-0.082**	-0.033
dlog(Oil price[t])	τ_1	-2.361**	0.014	-0.958*	-0.327	-1.788**	-0.835**	-0.908**
- Global Financial Crisis Dummy	τ_2	-2.906	-0.623**	-2.566**	-3.421**	2.334	1.587**	
- Covid-19 Dummy	τ_3	1.780	0.524	-0.280	0.337	4.038***	0.324	0.850
- Post Covid Dummy	τ_4	0.993	0.453	-0.008	-2.945	4.229**	-0.168	-0.551
dlog(Agriculture spot price[t])	υ_1	-9.662***	-0.916	-0.841	-0.011	-4.122***	-2.921***	-1.218**
- Global Financial Crisis Dummy	υ_2	-7.853**	-0.561	0.664	-2.683	-3.140	0.648	
- Covid-19 Dummy	υ_3	-1.453	0.296	-0.451	-3.423	4.728	-0.377	-2.252*
- Post Covid Dummy	υ_4	-24.510***	-3.360***	0.724	1.579	-4.841	2.593	0.544
Adj. R-squared		0.379	0.074	0.149	0.291	0.405	0.106	0.107
Durbin-Watson		2.267	2.087	2.126	2.183	2.104	1.932	2.157
Observations		3414	2935	2889	2796	3471	2997	2369

Note: *, **, *** indicate the 10%, 5%, 1% significant level.

Table 7. Extended Exchange Rate Determinant Model for Japan

$$\Delta\ln(s_t) = \alpha + \beta_{s1}\Delta(r_t^* - r_t) + \beta_{s2}\Delta(r_t^* - r_t)\cdot GFS\_D + \Delta\beta_{s3}\Delta(r_t^* - r_t)\cdot COVID\_D + \beta_{s4}\Delta(r_t^* - r_t)\cdot Post\ COVID\_D$$

$$+\beta_{l1}\Delta(y_t - y_t^*) + \beta_{l2}\Delta(y_t - y_t^*)\cdot GFS\_D + \Delta\beta_{l3}\Delta(y_t - y_t^*)\cdot COVID\_D + \beta_{l4}\Delta(y_t - y_t^*)\cdot Post\ COVID\_D + \beta_{l5}\Delta(y_t - y_t^*)\cdot YCC\_D$$

$$+\gamma_1\Delta(VIX_t) + \gamma_2\Delta(VIX_t)\cdot GFS\_D + \gamma_3\Delta(VIX_t)\cdot COVID\_D + \gamma_4\Delta(VIX_t)\cdot Post\ COVID\_D$$

$$+\delta_{l1}\Delta(JP\ CDS_t) + \delta_{l2}\Delta(JP\ CDS_t)\cdot GFS_D + \delta_{l3}\Delta(JP\ CDS_t)\cdot COVID\_D + \delta_{l4}\Delta(JP\ CDS_t)\cdot Post\ COVID\_D + \delta_{l5}\Delta(JP\ CDS_t)\cdot YCC\_D$$

$$+\delta_{d1}\Delta(US\ CDS_t) + \delta_{d2}\Delta(US\ CDS_t)\cdot GFS\_D + \delta_{d3}\Delta(US\ CDS_t)\cdot COVID\_D + \delta_{d4}\Delta(US\ CDS_t)\cdot Post\ COVID\_D + \delta_{d5}\Delta(US\ CDS_t)\cdot YCC\_D$$

$$+\tau_1\Delta ln(Oil_t) + \tau_1\Delta ln(Oil_t)\cdot GFS\_D + \tau_1\Delta ln(Oil_t)\cdot Covid\_D + \tau_1\Delta ln(Oil_t)\cdot Post\ COVID\_D$$

$$+ + v_1\Delta ln(Agri_t) + v_2\Delta ln(Agri_t)\cdot GFS\_D + v_3\Delta ln(Agri_t)\cdot Covid\_D + v_4\Delta ln(Agri_t)\cdot Post\ Covid\_D + \varepsilon$$

where s_t denotes the bilateral exchange rate in Japanese yen per U.S. dollar, $r_t - r^*$ is the two-year interest rate differential between the home country and the United States, $y_t - y^*$ is the two-year/ten-year yield spreads between Japan and the United States, VIX_t reflects Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index, CDS shows credit default swap premiums in dollar terms in Japan and U.S. Oil price and agriculture prices reflect crude oil Brent spot prices ($/barrel) and Bloomberg agriculture index that measures price movements of Agricultural commodities. *GFS_D*, *COVID_D*, *Post COVID_D* and *YCC_D* are dummy variables. The table reports the constant α, the slope coefficients β, γ, δ, τ, and ν, as well as the R^2 of this regression (in 0.01 percentage point). *** corresponds to a rejection of the null hypothesis at the 1% confidence level; ** and * correspond to the 5% and 10% confidence levels. Data are daily, from Bloomberg. The sample period is December of 2007 to December 2022.

		Table 2 - (6)	Table 5 - (6)	(1)	(2)
Dependant Variable		***dln(bilateral exchange rate per U.S. dollar) [t]***			
Country		Japan			
Starting Date		Dec. 2007	Dec. 2007	Dec. 2007	Dec. 2007
End Date		Dec. 2022	Dec. 2022	Dec. 2022	Dec. 2022
Constant[t]	α	-0.004	-0.004	-0.004	-0.004
d(Two-year government bond yield differential[t])	β_{s1}	5.823***	7.105***	7.137***	7.105***
- Global Financial Crisis Dummy	β_{s2}		-2.618***	-2.961***	-2.923***
- Covid-19 Dummy	β_{s3}		-1.140	-1.547	-1.693*
- Post Covid Dummy	β_{s4}		-2.034***	-1.924***	-1.881***
d(Long-term yield curve spread differential[t])	β_{l1}	2.490***	2.095***	2.053***	2.073***
- Global Financial Crisis Dummy	β_{l2}		0.994*		
- Covid-19 Dummy	β_{l3}		0.359		
- Post Covid Dummy	β_{l4}		0.458		
- Yield Curve Control Dummy	β_{l5}			1.078**	1.102**
d(VIX[t])	γ_1	-0.055***	-0.049***	-0.048***	-0.049***
- Global Financial Crisis Dummy	γ_2		-0.076***	-0.077***	-0.076***
- Covid-19 Dummy	γ_3		0.020*	0.023**	0.024**
- Post Covid Dummy	γ_4		0.059***	0.059***	0.059***
d(Credit Default Swap premium Local Currency[t])	δ_{l1}	-0.019**	-0.022***	-0.023***	-0.023***
- Global Financial Crisis Dummy	δ_{l2}		-0.001		
- Covid-19 Dummy	δ_{l3}		0.093***		
- Post Covid Dummy	δ_{l4}		0.013		
- Yield Curve Control Dummy	δ_{l5}			0.045**	0.050***
d(Credit Default Swap premium U.S. dollar[t])	δ_{d1}	-0.026**	-0.021***	-0.025***	-0.025***
- Global Financial Crisis Dummy	δ_{d2}		-0.015		
- Covid-19 Dummy	δ_{d3}		0.020		
- Post Covid Dummy	δ_{d4}		-0.057		
- Yield Curve Control Dummy	δ_{l5}			-0.012	-0.013
dlog(Oil price[t])	τ_1		-0.044	-0.024	1.817*
- Global Financial Crisis Dummy	τ_2		2.624***	0.186	0.685
- Covid-19 Dummy	τ_3		-3.745**	2.405**	2.037**
- Post Covid Dummy	τ_4			-3.809**	-3.295**
- Demand Shock Dummy (10-year JGB yield>0)	τ_5				-2.348**
dlog(Agriculture spot price[t])	υ_1		-3.801***	-3.835***	-3.753***
- Global Financial Crisis Dummy	υ_2		3.255	3.206	3.128
- Covid-19 Dummy	υ_3		2.836	2.591	2.741
- Post Covid Dummy	υ_4		4.852	4.558	4.446
		OLS	OLS	OLS	OLS
Adj. R-squared		0.298	0.322	0.321	0.322
Durbin-Watson		2.083	2.067	2.069	2.067
Observations		3633	3633	3633	3633

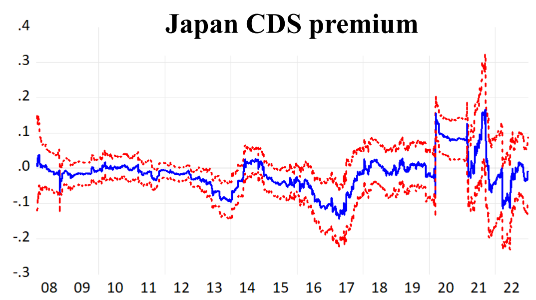
Note: *, **, *** indicate the 10%, 5%, 1% significant level.

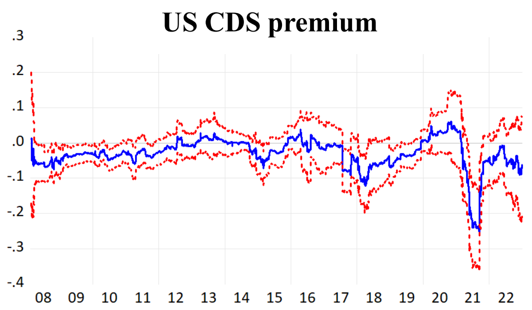
Appendix I: Japan's Confidence Interval for FX Determinant Coefficients

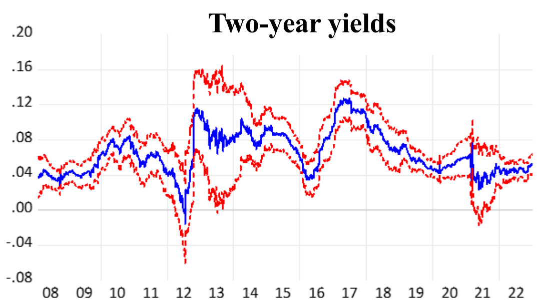
The following five charts show the coefficients and confidence intervals of the rolling regressions for the Japanese yen's basic model with a 250 business-day window, for the robustness tests. The results are consistent with the results of the Japan extended model in Table 7, overall.

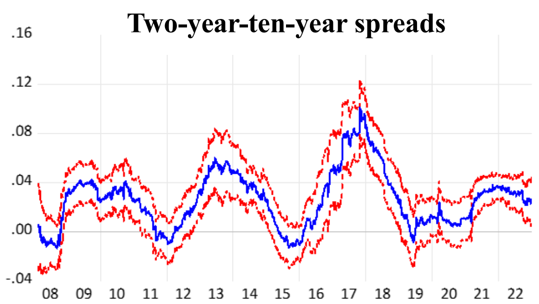
$$\Delta\ln(s_t) = \alpha + \beta_s\Delta(r_t^* - r_t) + \beta_l\Delta(y_t^* - y_t)$$
$$+ \gamma\Delta(VIX_t) + \delta_l\Delta(Home\ Credit\ Default\ Swap\ premium_t) + \delta_d\Delta(US\ Credit\ Default\ Swap\ premium_t)$$
$$+ \tau\Delta ln(Oil\ price_t) + v\Delta ln(Agricalture\ price_t) \quad + \varepsilon$$

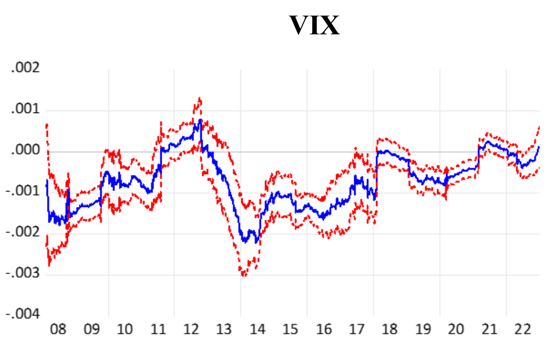
where s_t denotes the bilateral exchange rate in Japanese yen per U.S. dollar, $r^*_t - r_t$ is the two-year interest rate differential between the home country (r_t) and the United States (r^*_t), $y_t - y^*$ is the two-year/ten-year yield spreads between a home country (y_t) and the United States (y^*_t), VIX_t reflects Chicago Board Options Exchange (CBOE) volatility index of S&P 500 index, Credit default swap premiums show swap premiums in the dollar terms in home country and U.S. premiums. Oil price and agriculture prices reflect crude oil Brent spot prices ($/barrel) and Bloomberg agriculture index that measures the daily price movements of Agricultural commodities. The table reports the constant α, the slope coefficients β, γ, δ, τ, and ν, as well as the R^2 of this regression (in 0.01 percentage point). *** corresponds to a rejection of the null hypothesis at the 1% confidence level; ** and * correspond to the 5% and 10% confidence levels. Estimated Data are daily, from Bloomberg. The sample period is December of 2007 to December 2022.

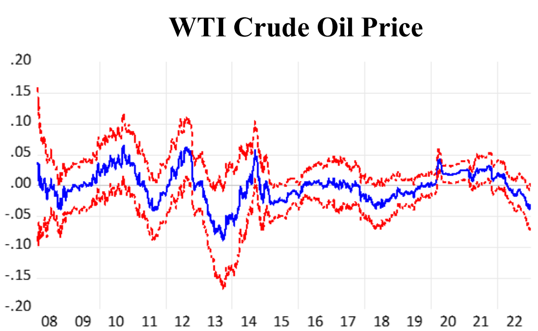












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