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Yuzo Honda † Hitoshi Inoue ‡

Abstract

We empirically investigate the dynamic nature of three alternative hypotheses on the foreign exchange rate between the Japanese yen and US dollar in a multivariate context, using data from April 1985 to October 2014. The three hypotheses are the uncovered interest rate parity hypothesis, the current account hypothesis, and the quasi purchasing power parity hypothesis. Each hypothesis has significant influence on the yen–dollar exchange rate. Furthermore, it takes two to three years for the yield spread between the yen and dollar to have its largest impact on the exchange rate. In addition, the effects of unexpected shocks to the exchange rate on the export price ratio and current account are long lasting.

Keywords: Quasi Purchasing Power Parity, Uncovered Interest Rate Parity, Soros Chart, Monetary Policy, Vector Autoregression

JEL Classification Numbers: E52, F31

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1 INTRODUCTION

The Japanese economy has been disrupted frequently, and sometimes damaged severely, by fluctuations in foreign exchange rates, following adoption of a floating exchange rate system in 1971. It is important, therefore, to understand the properties of foreign exchange rates and make use of this knowledge in policy making. In this paper, we examine the dynamic nature of the yen–dollar exchange rate over the last 30 years. In particular, we address a simple question. What determines the nominal yen–dollar exchange?

There are three prominent alternative hypotheses on exchange rate determination: (1) the uncovered interest rate parity hypothesis (UIP), (2) the current account hypothesis (CA), and (3) the purchasing power parity hypothesis (PPP). Although there is extensive literature on these hypotheses, most studies examined the validity of each hypothesis, ignoring the other competing hypotheses. Omitting other relevant variables introduces bias in estimation, and leads to inconsistent estimates. The present paper incorporates all three hypotheses into our model simultaneously, and therefore avoids this type of criticism.

The reason all relevant variables should be incorporated into a model when making policy decisions is illustrated by the following example. On December 14, 2010, *Nihon Keizai Shinbun* featured an article by one of the present authors, arguing that bold expansionary monetary policy by the US Federal Reserve was the cause of the rapid and extreme appreciation of the Japanese yen relative to the US dollar.[1] He also suggested that the Bank of Japan (BOJ) should conduct bold expansionary monetary policy to soften the impact of financial shocks by the Federal Reserve on Japan's real economy. Figure 1 was used as evidence, where the data point in the middle of the figure is for October 2008, the data points to

[1]Hamada *et al*. (2010, pp. 34–38) report that it was the late Mr. Okada Yasushi at the Cabinet Office at that time who first produced the three comparative charts on the size of central banks' balance sheets, real effective exchange rates, and industrial production for Japan, the US, the euro area, and the UK.

the northeast are prior to October 2008, and those to the southwest are posterior to October 2008.[2] Figure 1 shows a clear positive correlation between the base money ratio and the exchange rate. The correlation between the base money ratio and the foreign exchange rate is commonly known among investors as the "Soros Chart (SC)."

The day after the publication of this article, the author received an email from a BOJ economist, including five other charts using different sample periods, along with Figure 1, to show that there was little correlation between the yen–dollar exchange rate and the base money ratio.

In general, Figure 1 is not sufficient to prove a causal relationship from the base money ratio to the exchange rate; first, because it only shows a correlation, and second, because other relevant variables exist that may affect both the base money ratio and the exchange rate. Despite this counterargument, we still argue that the sharp appreciation of the Japanese yen in Figure 1 is the result of bold expansionary monetary policy by the US Federal Reserve. The action undertaken by the Federal Reserve at that time was so extreme in magnitude that it dominated all other relevant variables. In other time periods, other variables have affected the exchange rate, which is the reason we do not observe the correlation in the other five charts. The bold action by the Federal Reserve after the bankruptcy of Lehman Brothers was a kind of "natural experiment." To substantiate our arguments above, we employ a vector autoregression (VAR) to control for other relevant variables in the determination of the yen–dollar exchange rate.

[Figure 1 around here]

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[2] Recall that Lehman Brothers went bankrupt in September 2008.

Furthermore, we empirically demonstrate that it takes two to three years for monetary policy shocks to have their largest impact on the yen–dollar exchange rate. At first, this result is surprising because there is an arbitrage relationship between the exchange rate and interest rate differential between yen and dollars. We might expect that the exchange rate would respond most significantly immediately after a monetary policy shock. However, this is not the case. We will explain why in Section 6.

The outline of this paper is as follows. In Section 2, we explain the three alternative hypotheses of exchange rate determination. In Section 3, we present our baseline monthly model. To complement our baseline model, Section 4 estimates the corresponding quarterly model with a lag length of one year to examine the effects of longer lags on the exchange rate. In Section 5, we check the stability of the parameters of our models. Section 6 discusses some policy implications of our estimates. Section 7 summarizes our findings and the limitations of our study.

2 THREE ALTERNATIVE HYPOTHESES

In this section, we discuss the three alternative hypotheses of exchange rate determination, namely, UIP, CA, and PPP. We also explain SC, a variant of UIP.

2.1 Uncovered Interest Rate Parity Hypothesis

There are two distinct kinds of behavior related to UIP, the behavior of market investors and that of central banks.

2.1.1 Behavior of Market Investors

In the short run, arbitrage operates between Japanese and US government bonds. Investors in bond markets seek profits by changing portfolio allocation, and in equilibrium, the following arbitrage relationship should hold:

$$r^* - r \approx 1 - \left(\frac{e^*}{e}\right), \tag{1}$$

where r, r^*, e, and e^* denote returns from Japanese government bonds, returns from US government bonds, the foreign exchange rate, and the expected foreign exchange rate at the end of the period, respectively. This hypothesis is known as UIP. The symbol ≈ indicates "nearly equal." Arbitrage is the main force affecting the exchange rate. Many studies have tested whether UIP holds (see, for example, Ito (2005)). As this is an arbitrage relationship, causality operates both ways between the exchange rate e, the expected exchange rate e^*, and the yield spread between US and Japanese government bonds, $r^* - r$.

2.1.2 Behavior of Central Banks

The injection of base money lowers the interest rate in the two-asset model, as in the textbook IS–LM model. In slightly more complicated models with more than two assets, it is easy to show that the injection of base money lowers the value of the domestic currency. The economic reason for this conclusion is that the domestic currency and a foreign currency are imperfect substitutes in the portfolio choices of capital investors, and the additional supply of the domestic currency lowers its value relative to a foreign currency.

In normal economic conditions with positive short-term interest rates, central banks control the short-term interest rate. Lowering (raising) the short-term interest rate is equivalent to an injection (retraction) of base money to financial markets by the central bank. Hence, the Federal Reserve and BOJ have the power to influence the return on US and Japanese government bonds, r^* and r. When the Japanese and US monetary authorities affect $r^* - r$ on the left-hand side of equation (1), this should also affect the current exchange rate e on the right-hand side.[3]

As for monetary policy effects, causality only operates in one direction. Changes in monetary policy in the US or Japan affect the foreign exchange rate, but not vice versa. However, if the monetary authorities should react to changes in the foreign exchange rate, causality in the opposite direction may occur.

2.2 Current Account Hypothesis

Trade imbalances were one of the central economic issues between Japan and US in the 1980s. The resulting huge surpluses in Japan's current account increased the supply of US dollars in the foreign exchange market, and lowered the value of the US dollar relative to the Japanese yen. This is known as the CA hypothesis.

Honda(p.6, 1995) plots the yen-dollar exchange rate on the vertical axis against the Japanese current account (measured in dollars) on the horizontal axis to find both a trend (toward an appreciation of the yen) and cycles around the trend at least up until early 1990s. In terms of the cycles, increases in Japan's current account surplus appear to lead to appreciations of the yen relative to dollars.

2.3 Purchasing Power Parity Hypothesis

PPP argues that arbitrage occurs with the prices of goods and services, and that purchasing power across currencies should be the same. In symbols,

$$P = P^{*}e, \tag{2}$$

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[3] Changes in r^{*}-r on the left-hand side of equation (1) might also affect the expected exchange rate e^{*}on the right-hand side. However, reliable data on e* is not available in reality, and we did not include a proxy for e^{*}in our empirical models. Should there be reliable data for e^{*} available, its inclusion into our models would certainly be desirable.

where P and P^* denote the Japanese and US general price levels, respectively.

UIP results from arbitrage behavior among portfolio investors in bond and capital markets. PPP, on the other hand, results from arbitrage purchasing behavior by people in terms of tradable goods and service. People purchase goods and services in the country where these goods and services are cheaper. In equilibrium, the prices of these tradable goods and services should be the same across the two countries under certain conditions. The effects of arbitrage behavior on tradable goods and services will be transmitted eventually to the prices of nontradable goods and services as well, and thus equation (2) should hold in the long run. Again, many papers examine this hypothesis (see, for example, Royal Swedish Academy of Sciences (2003), and Hayashi (2000)).

In this paper, we are interested mainly in the behavior of the yen–dollar exchange rate. That is, we are interested in which factors affect the foreign exchange rate most. We expect that arbitrage is stronger for export prices than for general prices in equation (2). Hence, we use export price indexes for P and P^* instead of general price indexes. This is why we refer to the hypothesis here as the quasi purchasing power parity (quasi PPP) hypothesis instead of PPP.

2.4 The Soros Chart

The well-known investor, George Soros, is said to have taken advantage of the correlation between base money ratios and exchange rates in his portfolio decisions; the chart showing this correlation is now known among investors as the “Soros Chart.”

SC can be considered a variant of UIP. Under normal economic conditions with positive short-term interest rates, changes in base money can be considered equivalent to changes in short-term interest rates. This equivalence, however, does not hold with zero short-term interest rates. Yet even under the condition of zero short-term interest rates, investors still have a choice between intermediate- and long-term Japanese bonds and the US counterpart. Then, in equilibrium, arbitrage might still operate in the intermediate- to long-term bond markets. This is one possible explanation of SC.

An alternative possible explanation for SC is that the quantity of base money represents the monetary policy stance of central banks. In this interpretation, the base money ratio indicates the respective monetary policy stances of the Federal Reserve and/or the BOJ. An increase in base money by the Federal Reserve (or the BOJ), for example, leads to an increase in money stock in the US (or Japan) through money creation process, as time goes by, which in turn decreases the value of US dollars (or Japanese yen) in the future. This line of expectations should change the current exchange rate now toward the depreciation of the US dollar (or Japanese yen). Note that causality operates in one direction under this interpretation from the base money ratio to the exchange rate.

3 SIX-VARIABLE MODELS IN THE SHORT RUN

In this section, we use structural vector autoregressions (VAR) as our short-run baseline monthly model. The model consists of six variables:

$$Y' = (\mathrm{cpi}, \mathrm{iip}, \mathrm{epr}, \mathrm{ca}, \mathrm{spread}, \mathrm{e}), \tag{3}$$

where cpi, iip, epr, ca, spread, and e denote respectively: consumer price index; index of industrial production; export price ratio, or the ratio of the Japanese export price index to that of the US; Japanese current account measured in Japanese yen; yield spread between US and Japanese 2-year government bonds; and the yen–dollar exchange rate (measured as yen per dollar). All variables are in levels.[4] We include variables cpi and iip in our baseline model to control for the effects of the macroeconomy. Our sample covers the period from April 1985 to

[4] Regarding using variables in levels, Hamilton (1994, p. 652) notes: "(1) The parameters that describe the system's dynamics are estimated consistently. (2) Even if the true model is a VAR in differences, certain functions of the parameters and hypothesis tests based on a VAR in levels have the same asymptotic distribution as would estimates based on differenced data. (3) A Bayesian motivation can be given for the usual t or F distributions for test statistics even when the classical asymptotic theory for these statistics is nonstandard."

October 2014, and the number of observations is 355. We use Schwarz's Bayesian Information Criterion (SBIC) to choose a lag length of three months in the VAR. To identify the structural parameters, we employ a recursive structural model with a Cholesky decomposition. We order those variables with stronger exogeneity first, following the suggestion of Sims(1980), as can be seen in equation (3). We use a one standard deviation shock of each variable in the impulse response analysis.

Considering SC as a variant of UIP, we replace the yield spread variable with the base money ratio (bmr hereafter; the ratio of Japanese base money to US base money) in equation (3) when we examine the validity of SC. Next, we report the estimated results for the baseline monthly model, and the case of SC.

3.1 Responses of the Yen–Dollar Exchange Rate

Figure 2 shows the impulse response estimates of the yen–dollar exchange rate to various shocks. The solid lines indicate the point estimates, and the bands are the 95% confidence intervals, which are calculated using a bootstrap simulation with 400 repetitions. The horizontal axis measures months after a given shock.

Panel (1,3) in Figure 2 suggests that a positive shock to Japanese export prices, given US export prices, reduces the supply of US dollars in the foreign exchange market. This in turn increases the value of the US dollars, and the yen depreciates. Panel (2,1) in Figure 2 shows that a positive shock to the current account appreciates the yen relative to the dollar significantly. Panel (2,2) in Figure 2 shows that a positive shock to the yield spread, $r^{*} - r$, (for example, a more expansionary monetary policy by the Federal Reserve, relative to that by the BOJ), appreciates the yen relative to the dollar at the 5% significance level. The peak of the impact turns out to occur 20 months after the initial shock. We discuss this point in Section 6 in more detail.

[Figure 2 around here]

Table 1 shows the corresponding results of Granger causality tests on the yen–dollar exchange rate. The export price ratio (epr), current account (ca), and yield spread (spread) are all found to Granger-cause the yen–dollar exchange rate at the 1% level.

[Table 1 around here]

We also examine the variance decompositions of the effects of the abovementioned three variables on the yen–dollar exchange rate and find similar results. Therefore, the impulse response functions, variance decompositions, and Granger causality tests all indicate that the export price ratio, current account, and yield spread all have significant impacts on the yen–dollar exchange rate.

3.2 Impacts of the Yen–Dollar Exchange Rate

We examine the effects in the opposite direction, and report the possible impacts of changes in the yen–dollar exchange rate on export price ratio, current account, and yield spread.

Figure 3 reports the responses of the above three variables to a positive shock (or depreciation) in the yen–dollar exchange rate. Figure 3(1) indicates that a positive shock in the yen relative to the dollar leads to a reduction in Japanese export prices relative to US export prices. As shown, the impacts are significant but with long time lags. This dynamic effect from a yen depreciation to a reduction in export prices, and thus to increases in exports with some time delay, is known as the “J curve” effect.

Figure 3(2) shows that a positive shock in the yen relative to the dollar has little effect on the current account. However, the lag length of our baseline monthly model is only three months. We suspect that a three-month lag length might be too short to capture the full impact of a change in the exchange rate on the current account. In Section 4, we report different results from a modified model with longer lag lengths.

Figure 3(3) indicates a yen depreciation (appreciation) shock leads to a decrease (an increase) in the yield spread. This dynamic pattern might reflect Japanese government intervention in the foreign exchange market in the past to curb the sharp appreciation of the yen relative to the dollar (see, for example, Takagi (2015)).

[Figure 3 around here]

Granger causality tests of the relationships in Figure 3 are reported in Table 2. These results support the impulse response analysis in Figure 3, and confirm the validity of the above interpretation.

[Table 2 around here]

In summary, the exchange rate has significant impacts on the export price ratio and yield spread, but not on the current account in our baseline monthly model. However, the finding for the current account may be due to misspecification of the lag length; we examine this possibility in Section 4.

3.3 The Soros Chart

Figure 4(1) shows that a positive shock to Japanese base money relative to US base money leads to a depreciation of the yen at the 5% significance level. Figure 4(2) shows the impulse response estimates for the base money ratio to a positive shock in the yen–dollar exchange rate. One possible reason for the result in Figure 4(2) is that the Japanese government has intervened in the foreign exchange market in the past, and purchased US dollars to curb the sharp appreciation of yen. However, the significance of these effects can be questioned because the confidence bands cover the entire horizontal axis.

[Figure 4 around here]

Table 3 shows the results of Granger causality tests corresponding to Figure 4. Taken together, Table 3 and Figure 4 suggest that the base money ratio affects the yen–dollar exchange rate, but not vice versa.

[Table 3 around here]

Furthermore, comparing the effects of the yield spread on the exchange rate in panel (2,2) of Figure 2 and the counterpart for the base money ratio in Figure 4(1), we find that the former is clearly significant at the 5% level, while the latter is only marginally significant. This might suggest that the arbitrage relationship between the exchange rate and yield spread is stronger than that between the exchange rate and base money ratio.

3.4 Robustness

Our results in the above are robust to changes in the order of variables. We tried more than ten cases of different order of variables to find little change in our impulse response estimates.

4 QUARTERLY MODELS WITH ONE-YEAR LAGS

As with the J curve effect, it might take a long time for some shocks to have their full impact. To deal with this issue, we report the estimated results of another model with longer lag lengths. More specifically, we consider quarterly models, using the same sample period. In this case, the SBIC suggests using three lags. However, the estimates from models with three lags are very similar to those from models with four lags covering 12 months. If we put one-year lagged variables on the right-hand side, we expect these lagged variables to control any seasonality effects. Consequently, we report here the estimation results from a model with lags covering 12 months. As for the control variables, we replace cpi and iip in the monthly models with GDP deflator (def) and real GDP (rgdp) in the quarterly models, respectively.

4.1 The Quarterly Model Corresponding to the Baseline Monthly Model

Figure 5 shows the impulse response estimates of the yen–dollar exchange rate to various shocks. Figure 6 depicts the impulse responses of the export price ratio, current account, and yield spread to a depreciation shock in the yen–dollar exchange rate. The measure on the horizontal axis in Figures 5, 6, and 7 is quarters after a given shock. Tables 4 and 5 report the results of the Granger causality tests, corresponding to Figures 5 and 6.

[Figures 5 and 6 around here]

[Tables 4 and 5 around here]

Comparing these with the corresponding results from the baseline monthly model, we observe the following three points. First, overall, the results in the quarterly model are very similar to those in the baseline monthly model. Second, although we find that the yen–dollar exchange rate does not Granger-cause the current account in our baseline monthly model in

Table 2 (p-value of variable ca is 0.542), the yen–dollar exchange rate does Granger-cause the current account at the 10% significance level in our quarterly model in Table 5 (p-value of variable ca is 0.088). We also observe similar results from the impulse response analyses. That is, the time periods in which the confidence bands do not contain the horizontal line in our quarterly model in panel (2,1) of Figure 5 are much longer than the counterparts in our baseline monthly model in panel (2,1) of Figure 2. The main difference between the baseline monthly model and the quarterly model is that the former has a three-month lag length, while the latter has a 12-month lag length. These findings suggest that changes in the exchange rate affect the current account, but with a longer lag. Third, it takes as long as almost three years for the yield spread to have its largest impact on the yen–dollar exchange rate in our quarterly model in panel (2,2) of Figure 5. The corresponding time period in our baseline monthly model in panel (2,2) of Figure 2 is almost two years. Thus, we conclude that it takes two to three years for the yield spread to have its largest impact on the exchange rate.

4.2 The Soros Chart in the Quarterly Model

Figure 7(1) reports the impulse responses of the yen–dollar exchange rate to a positive shock in the base money ratio in the quarterly model. Figure 7(1) indicates that an increase in the Japanese base money relative to the US leads to a depreciation of the yen at the 5% significance level. The peak of the impact is about two years after the shock. Although the estimates of the impact are only marginally significant in the baseline monthly model in Figure 4(1), they are clearly significant at the 5% level in the quarterly model with longer time lags in Figure 7(1).

[Figure 7 around here]

Figure 7(2) shows the impulse responses of the base money ratio to a depreciation shock in the exchange rate in the quarterly model. The estimates are not significant at the 5% level. Table 6 shows the results of the Granger causality tests corresponding to Figure 7. These results together with Figure 7 suggest that the base money ratio affects the yen–dollar exchange rate, but not vice versa.

[Table 6 around here]

5 POSSIBLE STRUCTURAL CHANGES IN PARAMETERS

We now examine the possibility that the parameters in our VAR might have changed over the sample period. To check this possibility, we add another variable to each one, including the intercepts, in the right-hand side of our VAR system. The added variable is the original one multiplied by a dummy variable, which has a value of zero before a possible structural change period and one after that. Under the null hypothesis of no structural change in parameters, the coefficients of all added variables are zero. Under the alternative hypothesis, at least one of the coefficients are nonzero. We calculate the likelihood ratio test statistics, and repeat the same procedure at different points in time. The results are presented in Figure 8, where time is measured on the horizontal axis and the values of the test statistics are given on the vertical axis. Figure 8 indicates that the parameters are most likely to have changed just after March 1989. Hence, we reconducted the above analysis for our baseline monthly model using data only for the period from April 1989 onward. However, there was little difference in our estimates from the baseline monthly model with 355 observations and the model with the smaller sample of 307 observations.

[Figure 8 around here]

If we confine ourselves to the more recent years in Figure 8, we find that the test statistic is highest just after January 2006. Again, we reconducted the above analysis using our baseline monthly model, using data only from February 2006 onward. We found that the point estimates from the smaller sample had the same qualitative properties as those from our baseline monthly model, but that the confidence bands were much wider using the smaller samples. Therefore, we found less statistical significance for all variables, including the export price ratio, current account, and yield spread with the smaller samples of 105 observations.

6 SOME POLICY IMPLICATIONS

Next, we discuss our empirical results from the viewpoint of monetary policy.

6.1 UIP and Monetary Policy

It is important to distinguish between two kinds of effects when short-term interest rates (or base money ratio in the case of SC) change. One is the effects of portfolio behavior by market investors in financial markets. These effects are immediate, as arbitrage occurs immediately. Here, we call these "portfolio effects."

The second type of effects is caused by the interaction between financial variables and macroeconomic variables. We call these interactive effects of monetary policy "macroeconomic effects." It usually takes a few years for monetary policy shocks to be transmitted to the real sector and to have their full impact on the macroeconomy.

When the monetary authorities change their short-term interest rate (or the quantity of base money in the case of SC), the exchange rate reacts to this shock immediately (the first type of effects). However, the impulse response results in Figures 2, 5, and 7 suggest that the effects on the exchange rate are long lasting, and that it takes two to three years for the effects of the impact to reach their peak.[5] Why does it take so long?

Our interpretation is as follows. When a new monetary policy shock occurs, it usually takes a few years for the shock to have its full impact on the money supply through money creation process. The money supply balances of yen relative to dollars are in turn the dominant determinants of the yen–dollar exchange rate. Therefore, it takes two to three years for a new policy shock to have its full impact on the exchange rate.

6.2 Effects of an Exogenous Yen–Dollar Exchange Rate Shock

An exogenous unexpected shock to the foreign exchange rate (for example, an exogenous change in the US money supply) has long-lasting effects on the export price ratio, current account, and yield spread, as indicated by the impulse response results in Figures 3 and 6. In particular, the impact of a shock to the yen–dollar exchange rate on the export price ratio lasts more than five years, and on the current account almost permanently, as shown in Figure 6.

7 CONCLUDING REMARKS

We summarize our findings and discuss the limitations of the present paper. There are four main points. First, our empirical analyses support each of the three alternative hypotheses, UIP, CA, and quasi PPP. Second, changes in the yen–dollar exchange rate have long-lasting impacts on export prices and the current account, lasting more than five years. Third, monetary policy has its largest impact on the exchange rate with a lag of two to three years. As for the Soros Chart, we observe causality from the base money ratio to the yen–dollar exchange rate, but not vice versa.

In this paper, we concentrated our analysis on the main determinants of the yen–dollar

[5] This empirical result is robust to changes in the maturities of bonds. We tried bonds with maturities of two, three, and five years and found virtually the same results.

exchange rate and on the impacts of changes in the exchange rate. To control for the effects to and from the real sector, we incorporated cpi and iip in our baseline monthly model, and GDP deflator and real GDP in our quarterly model, respectively, for the sake of simplicity. However, to analyze fully the interaction between the exchange rate and the real sector, we need a more elaborate specification for the real sector. This is beyond the scope of the current paper, and remains for future research.

DATA APPENDIX

Variable	Description	Source
cpi	Consumer price index (all items) 2010 average = 100	Statistics Japan
iip	Index of industrial production (original index) 2010 average = 100	Ministry of Economy, Trade and Industry
epr	Ratio of Japanese export price index (yen basis, all commodities) to that of the US (all commodities), both standardized at 1990	Bank of Japan U.S. Department of Labor
ca	Current account (net balance)	Ministry of Finance Japan
spread	Yield spread between US Treasury securities and Japanese government bonds (monthly average)	Ministry of Finance Japan Board of Governors of the Federal Reserve System
e	US dollar/yen spot rate at 17:00 in JST (average in the month, Tokyo market)	Bank of Japan
bmr	Ratio of Japanese base money (average amounts outstanding) to US base money (total)	Bank of Japan Board of Governors of the Federal Reserve System
def	GDP deflator (original series, 2005 = 100)	Cabinet Office
rgdp	Real GDP (original series, 2005 = 100)	Cabinet Office

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TABLES

TABLE 1

GRANGER CAUSALITY TESTS ON THE YEN–DOLLAR EXCHANGE RATE

Causing Variables	Chi-Square Statistics	Degrees of Freedom	P-Values
cpi	12.18	3	0.007
iip	9.77	3	0.021
epr	12.94	3	0.005
ca	14.59	3	0.002
spread	16.33	3	0.001
all	49.69	15	0.000

TABLE 2

GRANGER CAUSALITY TESTS ON EXPORT PRICE RATIO, CURRENT ACCOUNT, AND YIELD SPREAD TO A POSITIVE SHOCK IN THE YEN–DOLLAR EXCHANGE RATE

Caused Variables	Chi-Square Statistics	Degrees of Freedom	P-Values
epr	15.78	3	0.001
ca	2.15	3	0.542
spread	22.58	3	0.000

TABLE 3

GRANGER CAUSALITY TESTS ON THE SOROS CHART IN THE BASELINE MONTHLY MODEL

a. Effects of Base Money Ratio on the Yen-Dollar Exchange Rate			
Causing Variables	Chi-Square Statistics	Degrees of Freedom	P-Values
bmr	8.83	3	0.032

b. Effects of Yen-Dollar Exchange Rate on Base Money Ratio			
Causing Variables	Chi-Square Statistics	Degrees of Freedom	P-Values
e	2.50	3	0.475

TABLE 4

GRANGER CAUSALITY TESTS ON THE YEN–DOLLAR EXCHANGE RATE IN THE QUARTERLY MODEL

Causing Variables	Chi-Square Statistics	Degrees of Freedom	P-Values
def	11.79	4	0.019
rgdp	4.84	4	0.304
epr	10.37	4	0.035
ca	9.17	4	0.057
spread	28.53	4	0.000
all	54.52	20	0.000

TABLE 5

GRANGER CAUSALITY TESTS ON EXPORT PRICE RATIO, CURRENT ACCOUNT, AND YIELD SPREAD TO A POSITIVE SHOCK IN THE YEN–DOLLAR EXCHANGE RATE IN THE QUARTERLY MODEL

Caused Variables	Chi-Square Statistics	Degrees of Freedom	P-Values
epr	8.24	4	0.083
ca	8.11	4	0.088
spread	6.56	4	0.161

TABLE 6

GRANGER CAUSALITY TESTS ON THE SOROS CHART IN THE QUARTERLY MODEL

a. Effects of Base Money Ratio on the Yen-Dollar Exchange Rate			
Causing Variables	Chi-Square Statistics	Degrees of Freedom	P-Values
bmr	11.19	4	0.025

b. Effects of Yen-Dollar Exchange Rate on Base Money Ratio			
Causing Variables	Chi-Square Statistics	Degrees of Freedom	P-Values
e	3.24	4	0.519

FIGURES

FIG. 1. Base Money Ratio and Exchange Rate

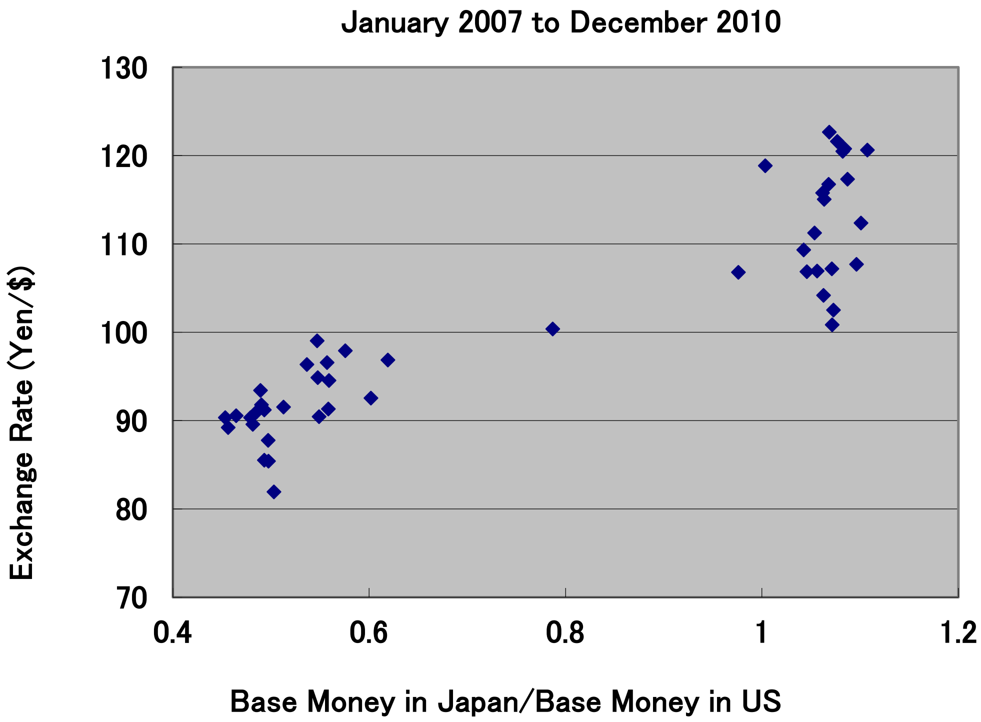

FIG. 2. Impulse Responses for the Yen–Dollar Exchange Rate in the Baseline Monthly Model

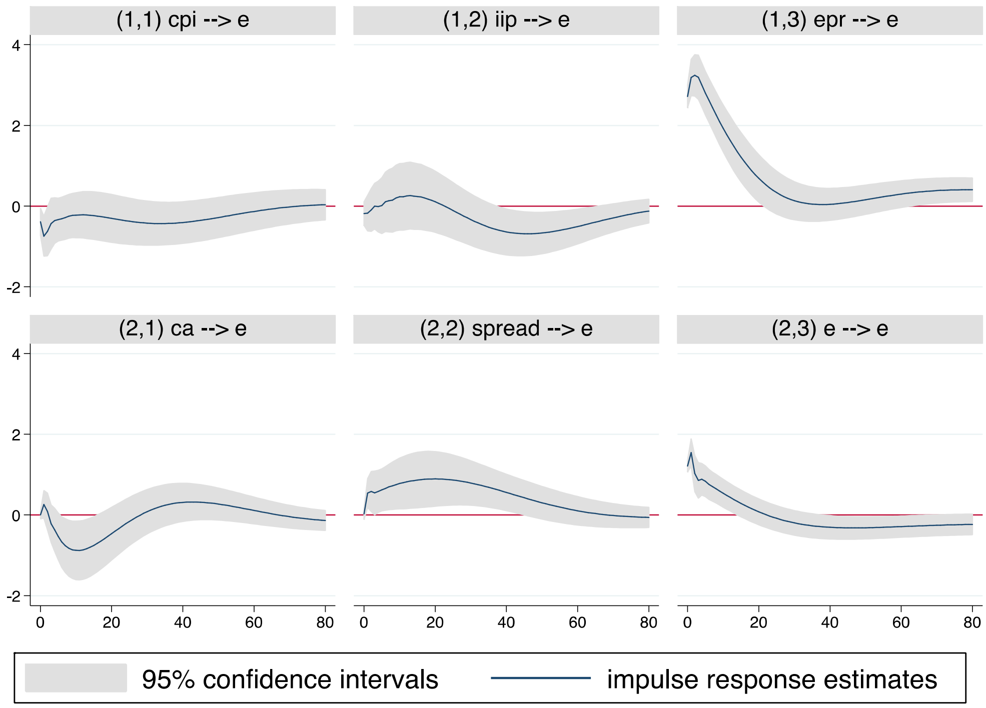

FIG. 3. Impulse Responses for Yield Spread, Current Account, and Export Price Ratio to a Positive Shock (Depreciation) in the Yen–Dollar Exchange Rate in the Baseline Monthly Model

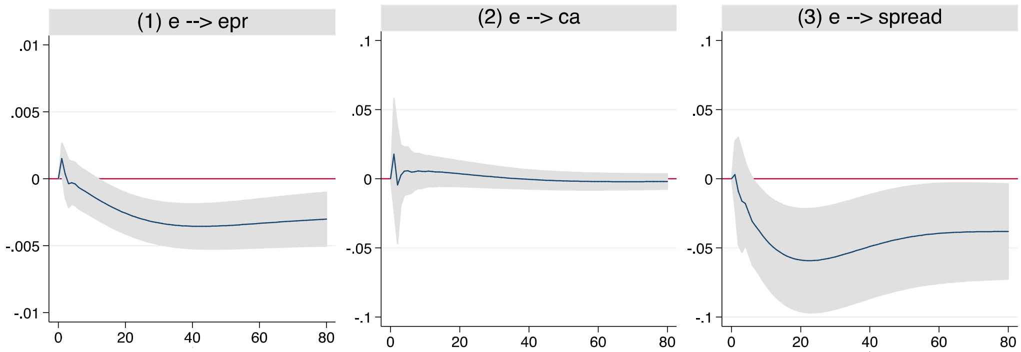

FIG. 4. Impulse Response Estimates for the Soros Chart in the Baseline Monthly Model

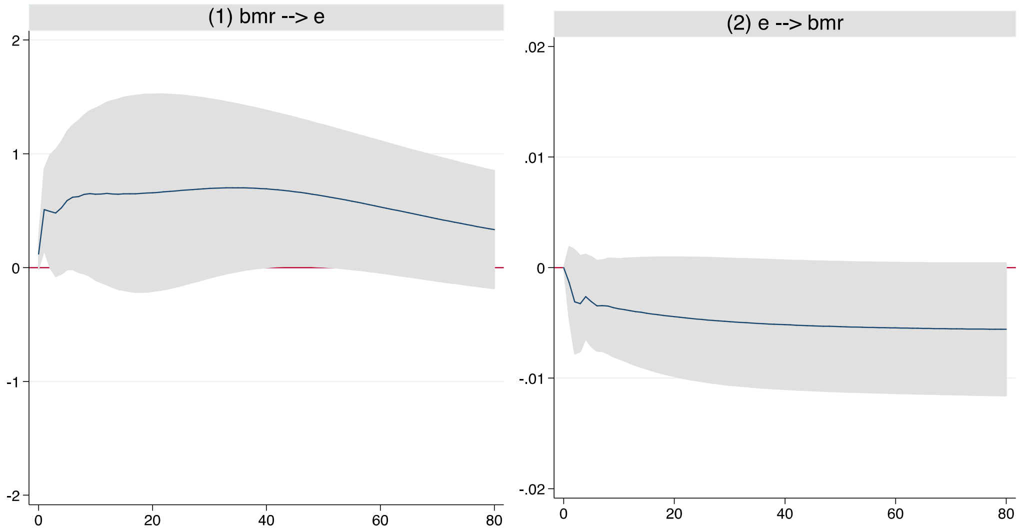

FIG. 5. Impulse Response Estimates for the Yen–Dollar Exchange Rate to Shocks in Export Price Ratio, Current Account, and Yield Spread in the Quarterly Model

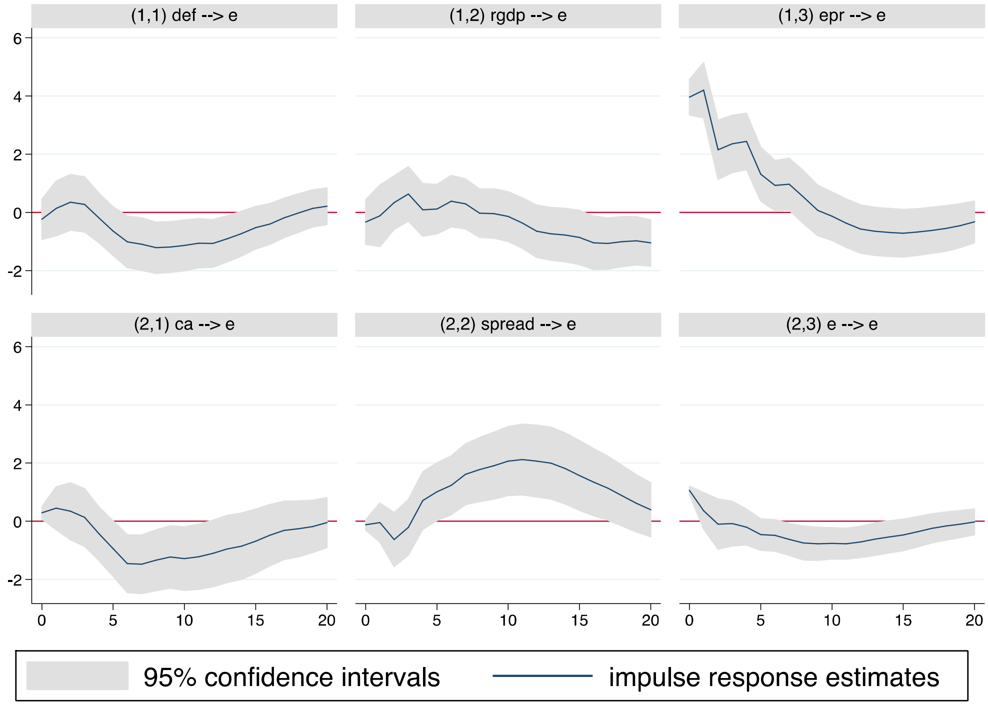

FIG. 6. Impulse Response Estimates for Export Price Ratio, Current Account, and Yield Spread to a Depreciation Shock in the Yen–Dollar Exchange Rate in the Quarterly Model

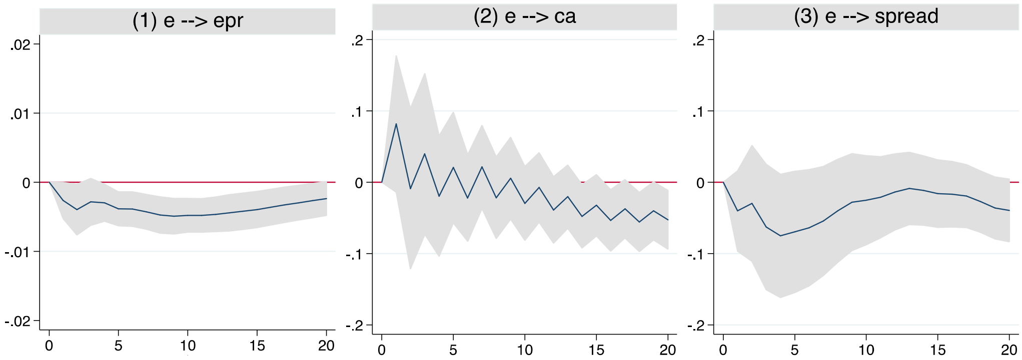

FIG. 7. Impulse Response Estimates for the Soros Chart in the Quarterly Model

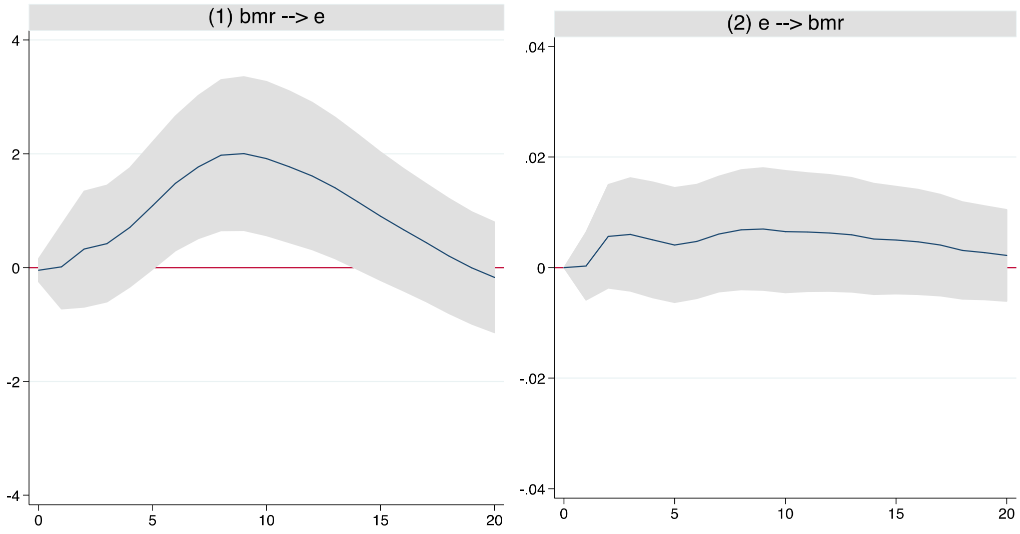

FIG. 8. Likelihood Ratio Test Statistics for Possible Structural Breaks