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Understanding How Exchange Rates are Perceived and How That Perception Affects Exchange Rate Forecasts

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Understanding How Exchange Rates Are Perceived and How That Perception Affects Exchange Rate Forecasts*

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Abstract

People perceive the same level of nominal exchange rate as overvalued at one point in time and undervalued at a different point in time. To capture the perception of the exchange rate at specific times, we suggest constructing the perceived exchange rate by counting the newspaper articles with phrases 'appreciated currency' or 'depreciated currency.' A shift in the perceived exchange rate (PER) index alters the dynamic response of exchange rates in time series. The PER index is a valid threshold variable in forecasting future exchange rates. The forecast model with the PER index as a threshold variable (PER TAR) outperforms models utilizing the lagged exchange rates as a threshold variable. We also show that the forecast precision of the PER TAR model is as good as the survey forecasts by market participants.

Keywords: Dynamic Forecasting, Exchange Rate Expectations, Perceived Exchange Rates (PER) Index, Survey Forecasts, Threshold Autoregression.
JEL Classification codes: F31(Foreign Exchange), F37(International Finance Forecasting and Simulation: Models and Applications)

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1 Introduction

Exchange rates fluctuate in a short period and experience large swings in the medium- and long-term. After an extended period, such as a decade or two, the exchange rate sometimes returns to the same previous level. For example, the monthly average of the Japanese yen per US dollar (JPY/USD) was 153.48 in February 1987. Thirty-seven years later, the monthly average of JPY/USD in April 2024 was 153.43. However, people perceive the same level of nominal exchange rate as overvalued at one point in time and undervalued at a different point in time. In 1987, the JPY/USD reached that level from 236.95 in September 1985 after France, West Germany, Japan, the UK, and the US agreed in the Plaza Hotel to jointly intervene in the foreign exchange markets to lower the value of the US dollar. In contrast, in 2024, the Japanese yen depreciated sharply in a short period to reach the same level when rising inflation in Japan had become an important policy issue after a long period of well below the inflation targeting level of two percent annually. People perceived the same level of exchange rate as appreciation (overvalued) in 1987 and as depreciation (undervalued)in 2024.

The above example is a clear-cut case; however, how can we measure the people's perception of the exchange rate for each point in time, say annually, quarterly, or monthly? The perception is subjective, but measurement of this subjectivity should be based on an objective methodology. Considering the two episodes in 1987 and 2024, utilizing the changes in the exchange rate may be a good idea to distinguish between appreciation and depreciation perceptions. However, it is not that simple. For the perception of exchange rate in the specific quarter, should we look at the past quarterly change in the exchange rate, a half-year change, or a one-year change? Is it sufficient to look at only the history of the exchange rate series, or expand the information set to include other macroeconomic variables as well as all other sources publicly available?

To address the issue of how we should measure the general perception of the exchange rates, we suggest resorting to the opinions expressed in the newspaper. The attention to the movements of the exchange rate in the media is always substantial in Japan, where international trade occupies a large share of the national income. The business leaders, market participants, and academics as well as newspaper journalists contribute to the columns and articles in the newspaper. They express their subjective view on the exchange rates in the newspaper articles. The phrases 'yendaka', yen appreciation, or 'yenyasu', yen depreciation, are often used in the newspaper articles. For example, the monthly counts of newspaper articles containing the phrase 'yen appreciation' were over one thousand in consecutive three months from March 1995 to May 1995 when the Japanese yen hit the post-war historical highest value against the US dollar. In contrast, the monthly average newspaper count of 'yen appreciation' was only 186.2 in 1998.

The use of texts in the newspaper and official documents has become popular in economics literature. Baker et al. (2016) constructed the Economic Policy Uncertainty (EPU) Index, primarily based on counting the number of relevant keywords, such as 'uncertainty', in the local newspapers. The team of these authors continued to construct the relevant macroeconomic indices after introducing the EPU index. In the literature of identifying a monetary policy shock, Hansen et al. (2018) and Shapiro and Wilson (2022) use the transcripts, minutes, and speeches of the FOMC. In the same vein, we construct the perceived exchange rate index by searching and counting for the relevant words in texts from the newspaper articles.

In this paper, we construct the perceived exchange rate (PER) index from January 1985 to March 2025.[1] The PER is based on the monthly counts of newspaper articles containing the phrase 'yen appreciation' or 'yen depreciation'. With a simple formula, we construct the PER index ranging from negative 100 to positive 100, as explained in detail in the next section. We found that the PER index is useful in the following sense. First, the division of appreciation and depreciation periods by the PER index looks consistent with the general public's impression of JPY/USD movements. Second, the PER successfully captures the long-lasting period of depreciation (or appreciation) as well as the short- to medium-term depreciation (or appreciation), including depreciation (or appreciation)in isolated months.

To examine the usefulness of the PER index, so constructed in this paper, we apply it to the exchange rate forecast model. We start with a simple autoregressive model, AR(12), and show that it has a poor performance in dynamic forecasting, starting in January 2018 until March 2025, sequentially using the forecasted values to make a further forecast. We then extend it to a nonlinear threshold autoregressive model. The threshold regression model uses a threshold variable as an indicator variable to capture a shift between regimes, where each regime has heterogeneous parameters. We showed that a threshold autoregressive model with a lagged exchange rate as a threshold variable substantially improves the forecast precision over the simple AR model. Finally, we introduced the PER index as a threshold variable to capture the shift in the autoregressive process of the JPY/USD exchange rate time series. In a three-regime TAR model with the PER index as a threshold variable, forecast precision is improved through dynamic forecasting, in which the forecasted value is used as an input to further forecasts. Furthermore, we make the PER TAR model to race against the survey forecasts of market participants and show that the forecast error of the PER TAR model is as precise as the professional forecasts.

The rest of the paper is constructed as follows. The next section describes how we constructed the perceived exchange rate index. Section 3 investigates how the perceived exchange rate index helps to improve the precision of JPY/USD exchange rate forecasts. We compare the JPY/USD forecasts incorporating the information of PER index with alternative models and the survey forecasts of market participants. The last section concludes.

[1]We intend to make the data series public and update it continuously once this study is published.

2 The construction of perceived exchange rate (PER) index

Nikkei Inc., the publisher of The Nikkei newspaper, offers a search engine platform called the Nikkei Telecon, which allows users to find newspaper articles containing keywords typed in. By restricting the sample period to an entire month, e.g., January 1, 1985 through January 31, 1985, we counted the number of articles containing the Japanese word "yen-daka (yen appreciation)" within a month. Similarly, we counted the number of articles containing the word "yen-yasu (yen appreciation)."[2] We constructed two series from January 1985 to March 2025. Figure 1 shows the number of newspaper articles that contain 'yen appreciation' in red solid line and that contain 'yen depreciation' in blue dashed line. These two lines frequently cross each other, showing that the two series alternately exceed the other in different periods. Two phenomenal episodes can be seen from the figure: the 1985 Plaza Accord and the historical high of the Japanese yen in 1995. The red solid line exceeds the blue dashed line by a substantial amount.

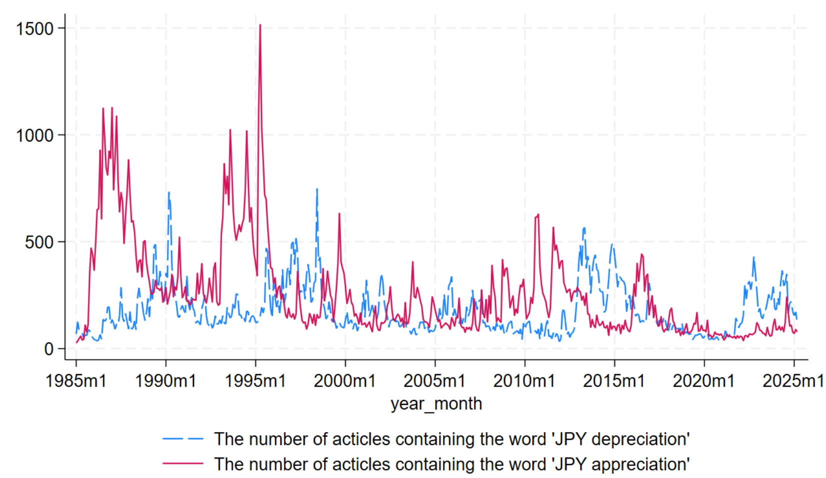

Figure 1: The number of newspaper articles containing the word appreciation versus depreciation, January 1985 - March 2025

Note: The perceived exchange rates of the Japanese yen and the JPY/USD exchange rates are plotted together.

The perceived exchange rate (PER) index is constructed as follows: The number of articles containing the word 'JPY depreciation' minus the number of articles containing 'JPY appreciation', standardized by dividing it by the sum of the two series and multiplying by 100. The PER index takes the value between -100 and +100, and an increase

[2] The Nikkei Telecom allows search in eight different newspapers, three news bulletins, and press releases by firms. For this study, we selected The Nikkei newspaper's morning and evening issues because we can trace back to the articles from 1985.

in the index indicates depreciation of the Japanese yen. By subtracting, the possibility of the simultaneous appearance of both 'yen appreciation' and 'yen depreciation', which may cause a biased impression when looking at each series individually, can be removed.

$$PER = \frac{No.dep - No.app}{No.dep + No.app} \times 100 \quad (1)$$

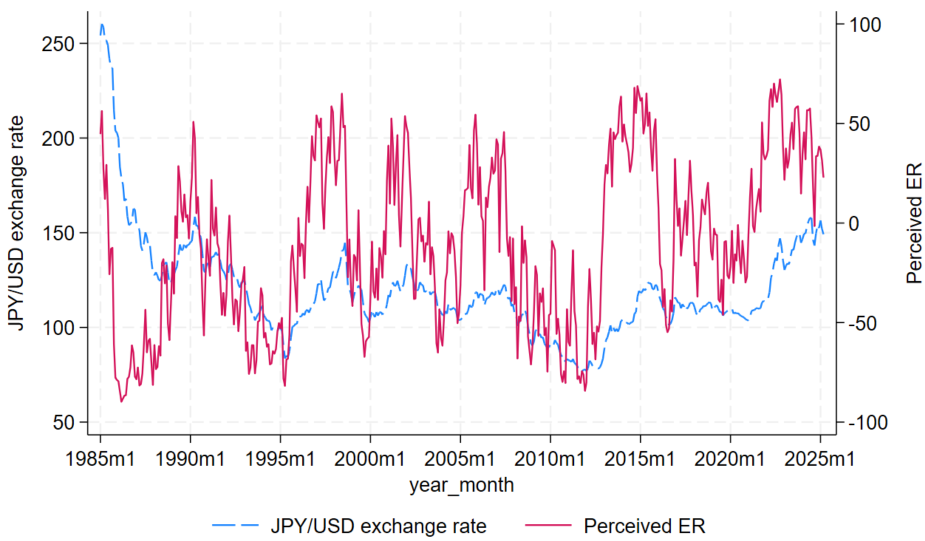

Figure 2: The perceived exchange rates versus the JPY/USD exchange rates

Note: The perceived exchange rates of the Japanese yen and the JPY/USD exchange rates are plotted together.

Among possible exchange rates for this study, We choose nominal JPY/USD exchange rates because the US dollar is the dominant currency, and the JPY/USD is the exchange rate in the mind of people when the value of the Japanese yen is discussed in the media. The exchange rate series is taken from International Financial Statistics, IMF: Exchange Rates, National Currency Per U.S. Dollar, Period Average. Figure 2 shows both the JPY/USD exchange rates and the PER index. Two series are plotted on different scales, the JPY/USD rate on the left vertical and the PER index on the right vertical. As we expected a priori, these two series do not exactly represent the same movements: They tend to move weakly together, with the concurrent correlation being 0.2034.

In Figure 3 we shaded those periods with gray by defining the depreciation period as the PER index being positive,i.e., the 'yen depreciation' articles are more than the 'yen appreciation' articles. From this figure, the PER index responds more to the depreciation/appreciation trend than to the absolute level of the JPY/USD exchange rates. The unshaded periods, therefore, represent appreciation periods. Instead, we can consider three regimes: appreciation, depreciation, and a neutral regime, which includes periods with the values of the PER index within a certain range. In Figure A.1, the depreciation periods are defined as when the PER index is equal to or less than negative 40, and are shaded with a gray color. Similarly, the appreciation periods are defined as when the PER index is equal to or greater than 40, and are shaded with light blue. In this figure, the white area represents the neutral regime in which people do not consider the current exchange rate appreciated or depreciated.

The advantages of using the PER index are highlighted below. First, it correctly captures the upward trend, i.e., continuous depreciation in consecutive months. Second, it sometimes picks up an isolated month or a two-month depreciation period with no shades in the periods before and after. Importantly, there are many short depreciation periods that the PER index does not indicate as 'perceived depreciation'. Third, the same level of JPY/USD can be classified as 'depreciation' or 'appreciation', conditional on unobserved economic situations and backgrounds.

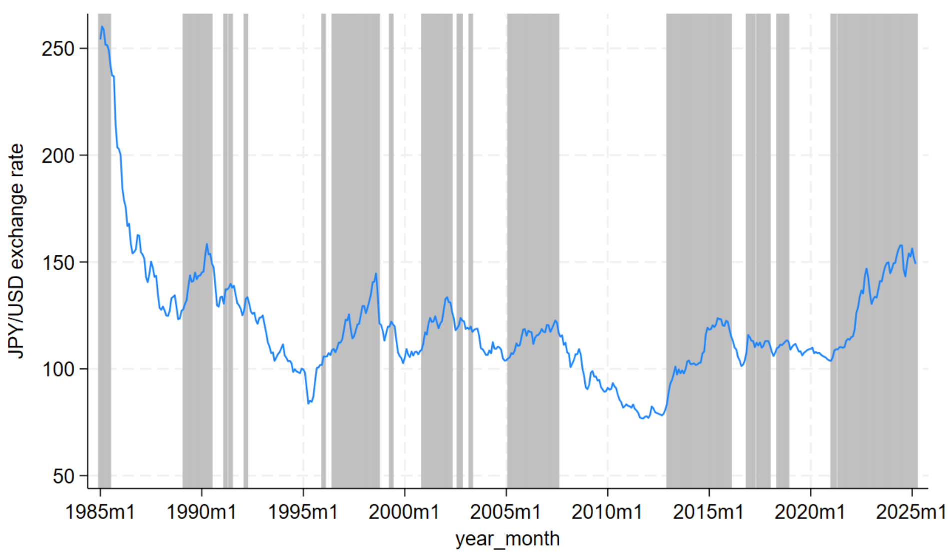

Figure 3: The depreciation period by perceived exchange rates

Note: A month is defined as the depreciation period if the perceived exchange rate index takes a positive value.

3 Forecasting JPY/USD exchange rates with the perceived exchange rates

In this section, we investigate how the PER index can help contribute to modelling exchange rate time series. Here, we apply a nonlinear AR model, a threshold autoregressive (TAR) model with the PER index as the threshold variable. We start with a simple AR model and extend it to a non-linear model with heterogeneous parameters across regimes. Then, we incorporate the PER index to indicate switches across the regimes.

A linear AR model

We start with a linear AR(K) model for the JPY/USD exchange rate, e_t, as the base model in equation (2).

$$e_t = \alpha + \sum_{k=1}^{K} \beta^k e_{t-k} + \epsilon_t \tag{2}$$

After estimating parameters,$(\tilde{\alpha}, \tilde{\beta}^k)$, we define the dynamic forecasts,$\tilde{e}$, in equation (3).

$$\tilde{e}_{t*+h} = \hat{\alpha} + \sum_{k=1}^{K} \hat{\beta}^k e_{(t*+h)-k} \tag{3}$$

where $h = 1, 2, ...$ and $e_{(t*+h)-k} = \tilde{e}_{(t*+h)-k}$ if $k \leq h$. $t*$ is the initial date from which the dynamic forecast starts. When h=0, it is equivalent to a one-period ahead forecast with only the past realized values as explanatory variables. To show more explicitly for a few horizons,

$$\text{For } h = 0,\ \tilde{e}_{t*} = \hat{\alpha} + \hat{\beta}^1 e_{t*-1} + ...$$
$$\text{For } h = 1,\ \tilde{e}_{t*+1} = \hat{\alpha} + \hat{\beta}^1 \tilde{e}_{t*} + \hat{\beta}^2 e_{t*-1} + ...$$
$$\text{For } h = 2,\ \tilde{e}_{t*+2} = \hat{\alpha} + \hat{\beta}^1 \tilde{e}_{t*+1} + \hat{\beta}^2 \tilde{e}_{t*} + \hat{\beta}^3 e_{t*-1} + ...$$

It is worth noting that forecasted exchange rates are used in subsequent forecasts, which can lead to potentially larger forecast errors.

The left panel of Figure 4 represents the dynamic forecasts of a simple AR(12) model. After January 2018,i.e., $t*$=January 2018, the dynamic forecasts are sequentially estimated as in equation (3). As seen clearly from the figure, a simple AR model with constant parameters is not capable of forecasting that aligns with the fluctuations of the market rates. This failure of forecasts of a constant parameter model leads us to non-linear models.

A nonlinear threshold AR model

To capture possible nonlinearities in the dynamics of exchange rate time series, we introduce a threshold autoregressive model (TAR), which allows heterogeneous model parameters with a threshold variable, TV, which acts as an indicator of regimes. A nonlinear TAR(K) model with two regimes is defined as follows.

$$\begin{aligned} e_t &= \alpha_1 + \sum_{k=1}^{K} \beta_1^k e_{t-k} + \epsilon_t \;\; if \;\; TV_t \leqq \lambda \\ e_t &= \alpha_2 + \sum_{k=1}^{K} \beta_2^k e_{t-k} + \epsilon_t \;\; if \; \lambda < TV_t \end{aligned} \tag{4}$$

where λ, the threshold value, is determined endogenously by minimizing the sum of squares with alternate values of λ. Analogously, a TAR(K) with multiple thresholds can be defined as in equation (5), and the Bayesian information criterion can determine the number of thresholds.

$$e_t = \alpha_n + \sum_{k=1}^{K} \beta_n^k e_{t-k} + \epsilon_t \;\; if \; \lambda_{n-1} < TV_t \leqq \lambda_n, \;\; for \, n \in (1, ..., N+1) \tag{5}$$

where the number of thresholds is N, and λ_0 is equal to the lowest value of TV and λ_{N+1} is equal to the greatest value of TV.

The dynamic forecasts of two-threshold (three-regime) TAR models can be defined as follows.

$$\tilde{e}_{t*+h} = \hat{\alpha}_n + \sum_{k=1}^{K} \hat{\beta}_n^k e_{(t*+h)-k} \;\; if \; \hat{\lambda}_{n-1} < TV_{t*+h} \leqq \hat{\lambda}_n, \;\; for \, n \in (1, 2, 3) \tag{6}$$

$$\text{where } \; e_{(t*+h)-k} = \tilde{e}_{(t*+h)-k} \text{ if } k \leq h$$

3.1 lagged ER TAR model

For a threshold variable, we simply choose the first lag of the exchange rate, i.e., $TV_t = e_{t-1}$. This model is assumed to capture the shifts in parameters at different levels of the most recent exchange rates. Therefore, we estimate a TAR model with its own lagged variable as a threshold variable. The number of threshold values, N, is chosen to be two, to be comparable with an alternative model that will be introduced shortly. The first threshold is 108.92, and the second threshold is 125.51. For the appreciation periods, from the perspective of the Japanese yen, the lagged exchange rate takes the value less than 108.92. For the neutral period, the lagged exchange rate ranges between 108.92

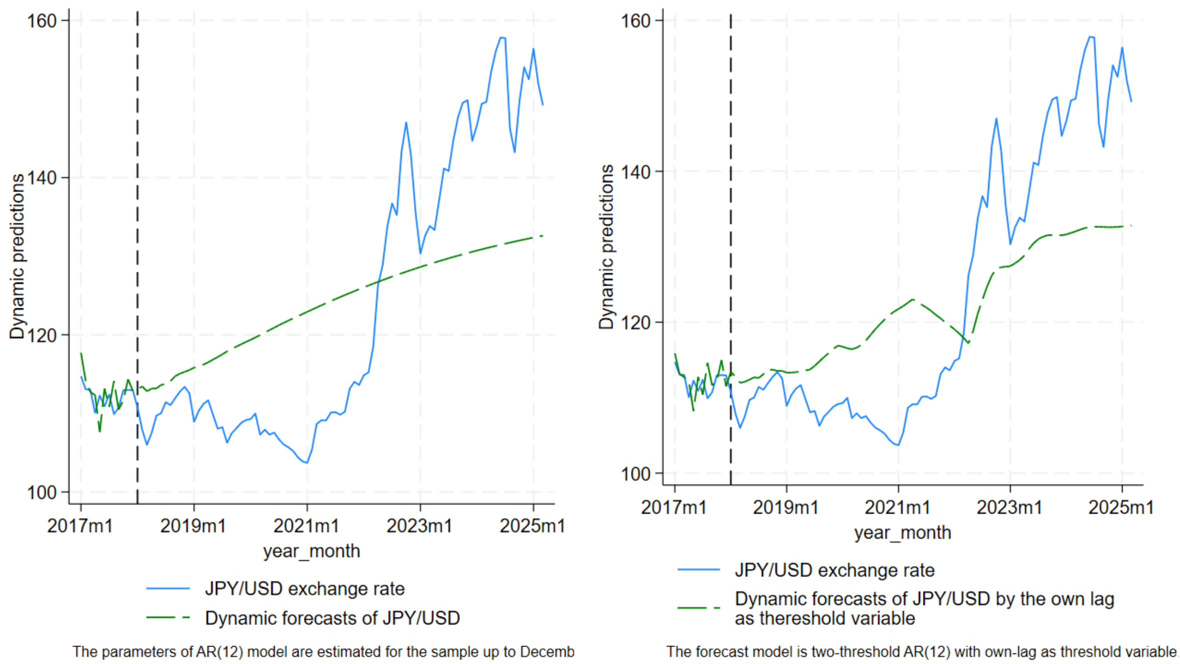

Figure 4: The JPY/USD exchange rates dynamic forecasts

Note: The forecast begins in January 2018. On the left panel, the dynamic predicted values are forecasted by the autoregressive model with 12 lags. On the right panel, the dynamic predicted values are forecasted by the two-threshold lagged-ER TAR with 12 lags.

and 125.51. The depreciation regime consists of exchange rates greater than 125.51. The dynamic predictions of the TAR model are shown in the right panel of Figure 4.

The improvement in exchange rate forecasts is expected, naturally due to the expansion of the number of parameters to triple. However, the improvement is neither clear nor substantial. The RMSE of the TAR(12) is 12.32, whereas the RMSE of the AR(12) is 13.41. The heterogeneity in parameters among regions in the lagged exchange rate variables is relatively modest. However, the constant term, α_n, differs widely between regimes: 0.50 in regime 1, 9.22 in regime 2, and 14.79 in regime 3. A shift in regimes, which occurs when the lagged exchange rate crosses the threshold values of 108.92 and 125.51, moves the exchange rate forecast by 9 to 15 yen per US dollar.

3.2 PER TAR model

Now, we will investigate whether the information on the perception of the exchange rates helps improve the accuracy of forecasts. We use the PER index as a threshold variable. By the Bayesian information criterion, the number of thresholds is chosen to be two. Table

1 shows the estimated results for the two-threshold TAR(12) model. The first threshold is -23.26, and the second threshold is 19.01. For the appreciation periods, PER index taking the value less than -23.26, the estimated coefficients are shown in the first column under Regime 1. For the neutral period, PER index being between -23.26 and 19.01, the coefficients of the lagged exchange rates are shown in the middle column under Regime 2. The autoregressive coefficients for the depreciation period are shown in the right column under Regime 3.

Table 1: Estimation results of two-threshold PER TAR model for JPY/USD exchange rates

	Regime 1	Regime 2	Regime 3
λ	<-23.26		19.01<
e_{t-1}	1.117 (0.065)	0.808 (0.085)	1.089 (0.111)
e_{t-2}	-0.334 (0.098)	0.020 (0.120)	-0.091 (0.172)
e_{t-3}	0.167 (0.099)	-0.060 (0.111)	-0.029 (0.186)
e_{t-4}	-0.080 (0.091)	0.013 (0.118)	-0.002 (0.168)
e_{t-5}	-0.026 (0.090)	-0.057 (0.129)	-0.135 (0.155)
e_{t-6}	-0.088 (0.091)	0.207 (0.128)	0.050 (0.158)
e_{t-7}	0.179 (0.091)	-0.081 (0.123)	0.112 (0.160)
e_{t-8}	-0.014 (0.091)	0.087 (0.126)	-0.144 (0.162)
e_{t-9}	0.008 (0.093)	0.057 (0.126)	0.077 (0.162)
e_{t-10}	-0.020 (0.088)	-0.187 (0.133)	0.040 (0.158)
e_{t-11}	0.062 (0.086)	0.002 (0.129)	0.020 (0.154)
e_{t-12}	-0.033 (0.054)	0.156 (0.080)	0.032 (0.107)
constant	4.867 (1.012)	4.519 (1.818)	0.489 (2.465)

Note: Standard errors in parentheses. The estimates in column Regime 1 are shown for PER below -23.26. The Reigme 2 column shows estimates when PER is between -23.26 and 19.01. The last column shows estimates for PER being greater than 19.01.

To visualize how much this extra information contributed to a JPY/USD exchange rate autoregressive model, we show the dynamic predictions after January 2018 for a two-threshold TAR(12) model with PER as a threshold variable. To be clearer about dynamic predictions, the forecasts of JPY/USD exchange rates use as inputs the realized values until December 2017 and forecasted values after January 2018, see equation (7). Therefore, forecast errors tend to grow as the forecasted period moves away from January 2018.

$$\tilde{e}_{t*+h} = \hat{\alpha}_n + \sum_{k=1}^{K} \hat{\beta}_n^k e_{(t*+h)-k} \; if \; \hat{\lambda}_{n-1} < PER_{t*+h} \leqq \hat{\lambda}_n, \; for \; n \in (1, 2, 3) \tag{7}$$

$$\text{where } e_{(t*+h)-k} = \tilde{e}_{(t*+h)-k} \text{ if } k \leq h$$

Figure 5 shows the dynamic prediction values of the TAR model with the PER index along with the realized values of the JPY/USD exchange rates and the dynamic forecasts by the lagged-ER TAR model. The improvements in the dynamic predictions by the TAR model, incorporating the PER index, are clear. To compare the forecast precision numerically, we can calculate the root mean squared error (RMSE).

$$RMSE = \sqrt{\frac{\sum_{h=0}^{H-1} (\tilde{e}_{t*+h} - e_{t*+h})^2}{H}}$$

At the five-year forecast horizon in December 2022, the RMSE of PER TAR(12) is 3.98, whereas the RMSE of lagged-ER TAR(12) is 9.85. The information of PER reduced RMSE by more than half. The precision of both models significantly reduces as the forecast horizon extends further.[3]

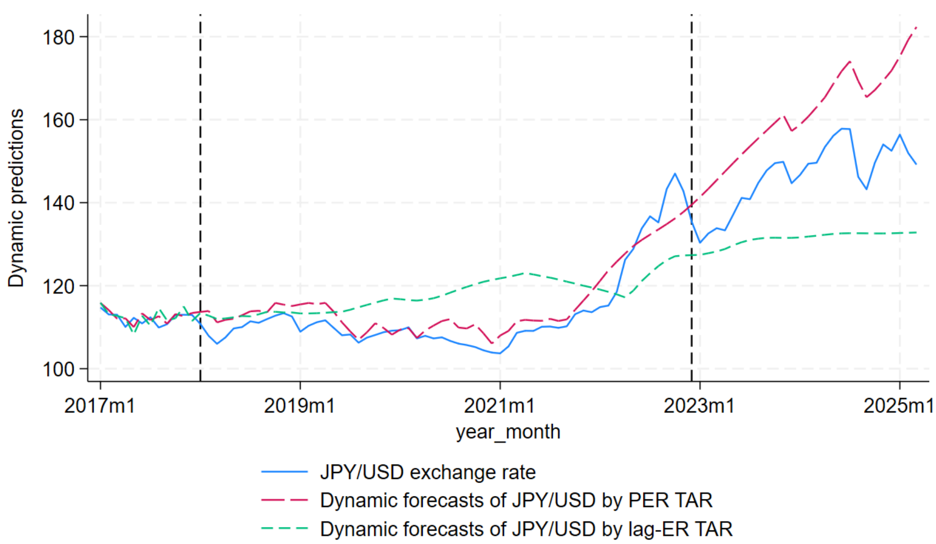

Figure 5: The JPY/USD exchange rates dynamic forecasts by two-threshold TAR(12)

Note: The forecast begins in January 2018. The dynamic predicted values are forecasted by the two-threshold 12-lag autoregressive model with the PER index or the lagged exchange rate as a threshold variable.

[3]The RMSE of the lagged ER TAR(12) model from January 2018 to March 2025 is 12.32, whereas the RMSE of PER TAR(12) is 9.52. Still, the information of PER reduced RMSE by 23 percent.

3.3 dynamic forecasts versus the survey forecasts

In the preceding subsection, we presented the evidence that the information on the frequency of keywords appearing in the newspaper articles helps improve the accuracy of exchange rate forecasts. The improvement was shown by comparing our model with an alternative threshold model using the past exchange rate information. To put this PER threshold model to further testing, it is in the interest of academicians and policy makers, as well as business practitioners, to compare the accuracy of the PER threshold AR model with the survey forecasts of market participants.

The Japan Center for International Finance (JCIF) collects forecasts from market participants for one, three, and six months ahead for exchange rates. The survey started in May 1985 with 44 respondents, including banks, short-term money market intermediaries, securities companies, Shosha (trading companies), exporting companies, insurance companies, and importing companies. The survey is conducted twice a month; except in August and December, only one survey.

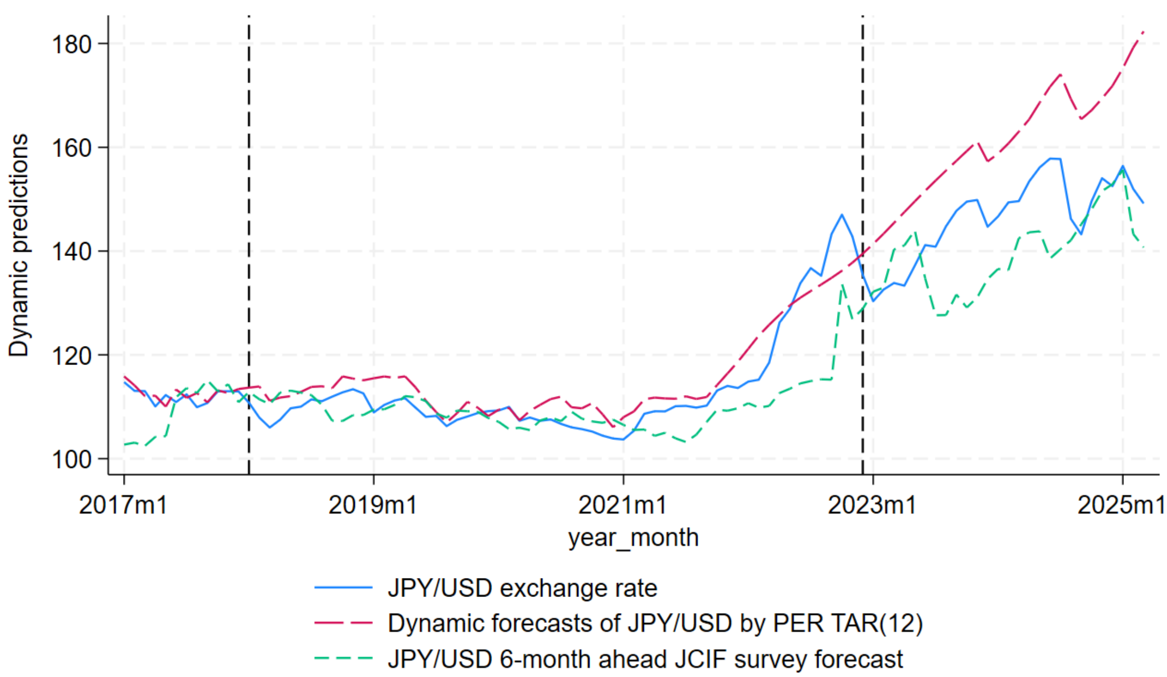

Figure 6: The dynamic forecast by the PER index versus the JCIF six-month ahead survey forecasts

Note: The forecast begins in January 2018. The dynamic predicted values are forecasted by the two-threshold 12-lag autoregressive model with the PER index as a threshold variable. The 6-month ahead JCIF survey forecast is the mean of survey correspondents' responses taken six months earlier.

Investigating the JCIF data for two years, Ito (1990) found out the tendency of wishful expectations, i.e., a favorable outcome for the forecasters. For example, exporting companies tend to have a depreciation bias for future JPY/USD exchange rates, whereas importing companies tend to have overvalued forecasts. Takagi (1991) also used the JCIF survey data in his literature review on the empirical works using five sets of survey forecasts of exchange rates. More recently, Asako et al. (2007) investigated the statistical properties of the JCIF survey dataset for the period between June 1985 and February 2004. In the following analysis, we use the mean of all survey participants, with the premise that this will smooth out their heterogeneous forecasts across groups, for the period between January 1985 and March 2025.

In Figure 6, the dynamic forecasts of the PER threshold AR model and the mean six-month JCIF forecasts are plotted along the JPY/USD exchange rates. The dynamic forecasts of the PER TAR model, represented by long-dashed line in red, are the same as in Figure 5.

The short-dashed line in green represents the six-month JCIF survey forecast. The six-month JCIF forecast in t-period is the mean of surveys taken in t-6-period. The forecast aligns closely with the market rate, denoted as the solid blue line, between 2018 and 2020; However, it overvalues the Japanese yen and undervalues the US dollar, especially after 2021.[4] With a visual inspection, it is clear that the PER TAR forecasts outperform those of the JCIF survey forecasts up to the five-year horizon, namely from July 2018 and June 2023.

The RMSE of the JCIF 6-month ahead survey forecasts between July 2018 and June 2023 is 7.80. The RMSE of the three-region PER TAR(12) for the same period is 5.29. To bear in mind that this is not fair competition between the PER TAR(12) model and the JCIF forecasts. On one hand, the forecasts of PER TAR(12) are greater than a 6-month horizon, except at the first forecast, and the forecasts beyond 12 months ahead will be estimated with the forecasted exchange rates. On the other hand, the PER TAR(12) utilizes the concurrent PER for forecast horizons.

A fair competition of forecasts among alternative models requires all models to have the same length of forecast horizon, forecasted at the same date. Therefore, the six-month ahead forecasts by the PER TAR model are estimated by sequentially adjusting t* in equation (8).

$$\tilde{e}_{t*+6} = \hat{\alpha}_n + \sum_{k=1}^{5} \hat{\beta}_n^k \tilde{e}_{(t*+6)-k} + \sum_{k=6}^{12} \hat{\beta}_n^k e_{(t*+6)-k} \ if \ \hat{\lambda}_{n-1} \leqq \widetilde{PER}_{t*+h} \leqq \hat{\lambda}_n, \tag{8}$$

for $n \in (1, 2, 3)$ and $t* \in (January\ 2018, April\ 2024)$. $\widetilde{PER}$ represents the forecasted PER. For these forecasts, we applied a simple AR(12) model to PER. The corresponding

[4] This coincides with the number of survey participants of exporting companies decreasing in this period. This is consistent with the finding of Ito (1990) that exporters tend to undervalue the Japanese yen.

root mean square error is calculated as follows.

$$RMSE = \sqrt{\frac{\sum_{t*=2018JAN}^{2018Jan+H-1} (\tilde{e}_{t*+6} - e_{t*+6})^2}{H}}$$

In Figure 7, both six-month ahead JCIF survey forecasts and six-month ahead dynamic forecasts by PER TAR(12) are plotted along with the market JPY/USD exchange rates from 2018 July to 2024 October, amounting to 76 months of observations. The RMSE of the JCIF survey forecasts in this period is 9.26, whereas the RMSE of six-month ahead dynamic forecasts by PER TAR is 9.29. Their precision is almost equal.

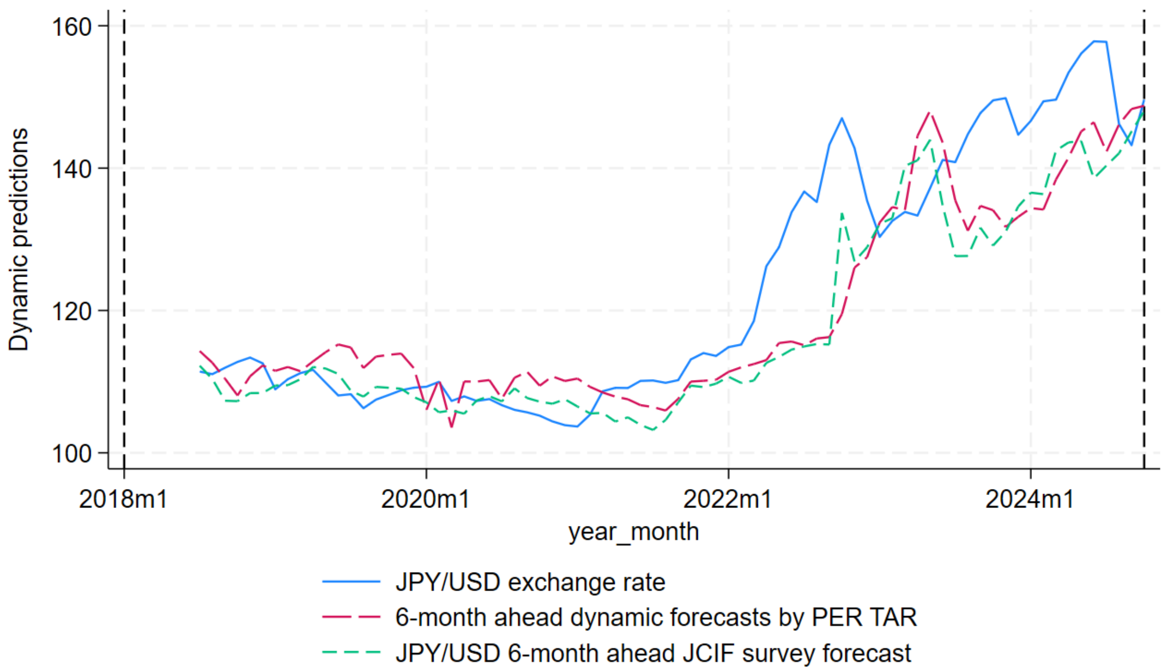

Figure 7: The direct comparison of six-month ahead forecasts: dynamic forecast by the PER index versus the JCIF survey forecasts

Note: The six-month ahead JPY/USD is forecasted at every month since January 2018. The dynamic predicted values are forecasted by the two-threshold 12-lag autoregressive model with the PER index as a threshold variable.

4 Discussion

Given the same level of exchange rate, how does the different perception, i.e., subjective interpretation of what has been observed, affect how firms and consumers form forecasts of future exchange rates? In making a forecast, one first needs to observe the relevant markets and economic indicators, process and digest pieces of information, and then form an expectation. These steps consist of observations, perceptions, and the formation of expectations. To learn how market participants have formed expectations, we can resort to the survey forecasts. However, these forecasts are the outcome of how market participants see the current level of the exchange rate and perceive it in the current economic conditions.

Can we learn how they perceive the current exchange rates?[5] In addition to making professional forecasts, market participants in a much broader sense are often asked in interviews by the media, including newspapers. If we successfully extract their opinions from the newspaper articles, we can construct an index indicating the perception of the current exchange rates. This is exactly what we did in this study.

How may this perception of exchange rates matter for the economy? A change in the perception of the current exchange rate may affect the optimal behavior of firms and consumers. One example is the responses of prices to exchange rates. The effects of a change in exchange rate on prices are thought to be different when it is appreciating or depreciating, and whether the swing is large or small. The exchange rate changes may induce the nonlinear pricing behavior of exporters and importers. Baldwin and Lyons (1994) showed in their theoretical model that a large misalignment of the exchange rate induces a hysteresis change in market structure that alters the relationship between the exchange rate and trade balance. Alternatively, the same magnitude of a change in exchange rate affects exporters and importers differently, whether the direction of exchange rate change is appreciation or depreciation, Knetter (1994). Nguyen and Sato (2019) apply the nonlinear autoregressive distributed lag model to the exchange rate pass-through of Japanese exports, using firms' exchange rate forecasts surveyed by the Bank of Japan as a threshold variable. They showed that the exchange rate pass-through differs between appreciation and depreciation periods.This is one of many applied topics where we can introduce the PER index.

So far, we interpreted the PER index as the collective and subjective opinions of market participants, and more broadly, it reflects the perception of the general public. Their professional opinions in the newspaper articles may have a ripple effect on a much wider range of market participants, government officials, and consumers in general. Social learning is the updating of beliefs based on observations of the actions of others, Bikhchandani et al. (2024). The PER may cause an information cascade to the general public. Those influenced by the trend of the newspaper articles stop processing their own private information.

[5]In different contexts, Kuziemko et al. (2015) conducted randomized online survey experiments to learn the respondents' perception of inequality, and Binetti et al. (2024) investigates the perception of inflation causes, consequences, and trade-offs.

5 Conclusion

In this paper, we constructed the perceived exchange rate (PER) index based on the frequencies of relevant keywords appearing in the newspaper articles. By augmenting a simple time-series model of exchange rate with the PER index as a threshold variable in a TAR model, we showed that the dynamic forecasts significantly improved.

We conclude this paper by listing a few future agendas for the PER index. First, the PER index may be modified by combining more relevant phrases/words in addition to the phrases/words used in this study. The candidate phrases possibly interesting include 'unexpectedly' and 'suddenly', among others. Second, we may refine the index by a higher frequency, such as weekly. In this case, manually collecting the counts of words via the Nikkei Inc. platform is too labor-intensive. We need to resort to applying the large language model directly to the original database. Third, if the PER index is proved to be a critical indicator, researchers in other countries can construct the PER index for their countries. Eventually, we can access all kinds of EPR indices with international cooperation.[6] Finally and most importantly, the PER index can be used as a threshold variable in the regression models that include an exchange rate as a dependent variable or one of the explanatory variables. For example, in an exchange rate pass-through analysis, we can analyse the nonlinear pricing behavior of exporters and importers with respect to exchange rate changes, see for example Nguyen and Sato (2019) for a study using a survey forecast as a threshold variable.

[6]For the country with the dominant currency, such as the US or the Euro area, the appropriate exchange rate is likely to be the nominal effective exchange rate.

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A Appendix:

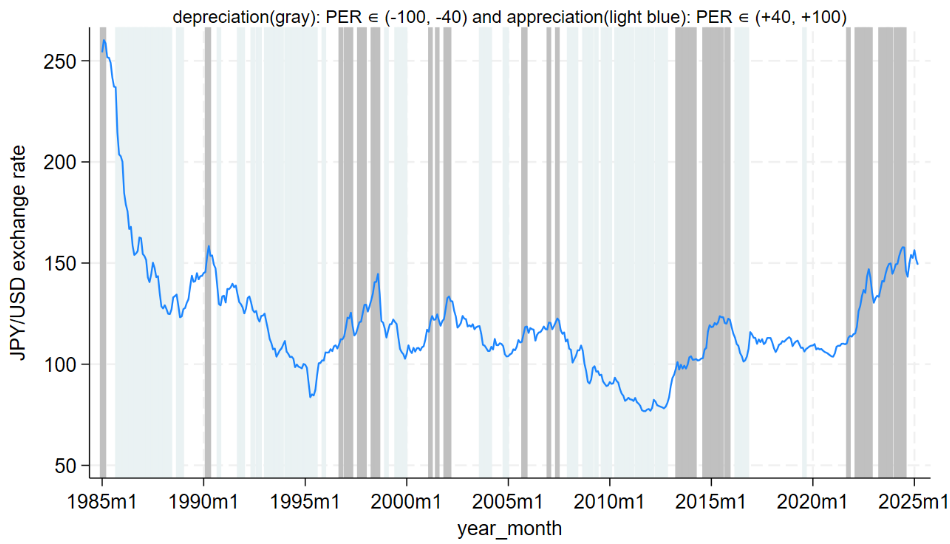

Figure A.1: The depreciation and appreciation regimes by perceived exchange rates

Note: The depreciation regime is defined as PER $\geqq$ +40 and shaded with gray color. The appreciation regime is defined as PER $\leqq$ -40 and shaded with light blue.