

# The Changing Role of the Yen/Dollar Exchange Rate for Japanese Monetary Policy<sup>1</sup>

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## Abstract

This paper studies the role of the yen/dollar exchange rate in the Bank of Japan's monetary policy reaction function. In contrast to prior estimations of reaction functions based on the Taylor-rule, we allow for regime shifts by estimating rolling coefficients from January 1974 to March 1999. The results show a temporary impact of the exchange rate on monetary policy around 1978/79 and a persistently increasing impact of the yen/dollar exchange rate after 1986. The rising importance of the yen/dollar exchange rate for Japanese monetary policy is in line with increasing efforts to stabilize the yen/dollar exchange rate by foreign exchange intervention after March 1999, when the nominal interest rate reached the zero boundary.

**Keywords:** Japan, Monetary Policy Reaction Function, Bank of Japan, Interest Rate Rules, Exchange Rates, Taylor Rule, GMM.

**JEL Classifications:** E43, E52, E58, F41

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<sup>1</sup> We thank Michael Flad for useful comments.

## I. INTRODUCTION

A number of studies have estimated the impact of the exchange rate on Japanese monetary policy, and have produced heterogeneous results. Clarida, Gali and Gertler (1998) argued, based on their GMM estimations for the period from 1979 up to 1994, that the Bank of Japan (BOJ) did not react strongly to exchange rate shocks. Similarly, Chinn and Dooley (1998) found that the exchange rate did not enter the BOJ monetary policy reaction function in either economic or statistical terms in the period from 1974 to 1994.

A second line of research has established the notion that the exchange rate did in fact have a significant impact on Japanese monetary policy. According to Hutchison (1988) the BOJ's objective to maintain short-term money control was often dominated by an attempt to moderate the yen/dollar exchange rate fluctuations between 1973 and 1986. Ueda's (1997) monetary policy reaction function found the exchange rate term to be significant for the period from 1979 up to 1995.

The two different views on the role of the exchange rate on Japanese monetary policy may be reconciled by a more dynamic approach. While most previous studies have estimated global means for the whole observation period, the impact may change over time. The Bank of Japan may follow a standard Taylor rule with inflation and output as target values, but in some periods the exchange rate may enter the set of monetary policy objectives.

Henning (1994), Funabashi (1988), McKinnon and Ohno (1997) and Esaka (2000) have provided (anecdotal) evidence that the exchange rate has played an important role for the BOJ's interest rates decisions in the years 1978/79, 1987/88 (Louvre Accord), and 1995. We try to trace the changing impact of the yen/dollar exchange rate on Japanese monetary policy based on a rolling Taylor type monetary policy reaction function with an exchange rate term. This allows us to provide the first dynamic picture of the changing role of the exchange rate for Japanese monetary policy.

## II. MODEL SPECIFICATIONS

To investigate the impact of the exchange rate on Japanese monetary policy we use the Taylor rule type, forward-looking baseline specification by Clarida, Gali and Gertler (1998) and add an exchange rate term:

$$i_t^* = \bar{i} + \beta(E[\pi_{t+12}|\Omega_t] - \pi^*) + \gamma(E[y_t|\Omega_t] - y_t^*) + \delta(e_t - e_t^*) \quad (1)$$

In equation (1)  $i_t^*$  is the central bank's target nominal interest rate at the time  $t$ , which is assumed to depend on the long-term equilibrium interest rate  $\bar{i}$ , expected inflation  $\pi$ , expected current output  $y$  and (possibly) the current exchange rate  $e$ . Equation (1) underlies the assumption that the current output is not known at the time of the interest decision, but the exchange rate  $e_t$  is known with a minimum of information costs. We define the central bank targets other than the interest rate in gaps, i.e., as expected deviations from the (desired) bliss points for inflation ( $\pi_t^*$ ), output ( $y_t^*$ ), and the exchange rate ( $e_t^*$ ).  $E$  is the expectation operator and  $\Omega_t$  is the central bank's information set at the time  $t$ .

If, for instance, within a one year time horizon expected inflation ( $E[\pi_{t+12}|\Omega_t]$ ) is rising above (falling under) the target level  $\pi^*$ , the central bank will raise (cut) the interest rate  $i_t^*$ . Similarly, the interest rate will be reduced (increased), if current output is under (above) the desired level  $y_t^*$ .

The exchange rate may influence interest rate decisions for several reasons. Exchange rate changes affect inflation expectations and output, as well as decision making in international policy coordination (as outlined by Funabashi 1988). If the exchange is appreciating below (depreciating above) the level  $e_t^*$  (in price notation), which is regarded as appropriate by the monetary authorities, interest rates will be reduced (increased).

Following Clarida, Gali and Gertler (1998), we assume interest rate smoothing as it is practised by the large (independently floating) economies (US, Euro Area, Japan before March 1999) to smooth out shocks in the money market:

$$i_t = (1 - \rho)i_t^* + \rho i_{t-1} + v_t \quad (2)$$

In equation (2)  $i_t$  is the short-term nominal interest rate set by the central bank at the time  $t$  which depends on the target interest rate  $i_t^*$  and the interest rate of the previous period. The coefficient  $\rho$  captures the degree of interest smoothing. The error term  $v_t$  is assumed to be normally distributed. Substituting equation (1) into (2), defining a constant  $\alpha \equiv \bar{i} - \beta\pi^*$ , and eliminating the unobserved forecast variables yields the final specification for the estimation given by

$$i_t = (1 - \rho)\alpha + (1 - \rho)\beta\pi_{t+12} + (1 - \rho)\gamma(y_t - y_t^*) + (1 - \rho)\delta(e_t - e_t^*) + \rho i_{t-1} + \varepsilon_t \quad (3)$$

with

$$\varepsilon_t = -(1 - \rho)(\beta(\pi_{t+12} - E[\pi_{t+12}|\Omega_t]) + \gamma(y_t - y_t^* - E[y_t - y_t^*|\Omega_t])) + v_t$$

as a linear combination of the unobserved forecast variables and the error term  $v_t$ .

### III. ESTIMATIONS

We estimate equation (3) based on a GMM framework.

#### *Data and Observation Period*

We use monthly data from the IMF International Financial Statistics. Japanese short-term interest rates are the uncollateralized money market call rates (*mutanpô kôru rêto*). Since monthly data are not available for the real GDP, we use logged changes of seasonally adjusted industrial production as a proxy. The Hodrick-Prescott filter is used to calculate the output gap. Inflation is measured as log differences of consumer price indices versus the previous years' month.

The yen/dollar gap is the deviation of the nominal yen/dollar exchange rate from a five-year (60 months) average moving backwards. We justify the moving average as a reference value for calculation of the exchange rate gap – rather than an arithmetic average – by the fact that since the early 1970s the yen appreciated considerably against the dollar. Therefore the notion by which an exchange rate was considered “high” changed over time.

The Augmented Dickey-Fuller test rejects the null hypothesis for the output gap, the exchange rate gap at the 1%-level, and for inflation at the 10%-level. But for the short-term interest rate the null cannot be rejected at the 10%-level. Following Clarida, Gali and Gertler (1998) and Jinushi, Kuroki and Miyao (2000) we interpret this low acceptance as a result of the low power of the test.

The observation period is from 1974:01, when the Japanese yen can be assumed to have become fully flexible up to 1999:03 when the Japanese short-term interest rate reached the zero bound and could therefore no longer be used as an instrument for monetary policy making.<sup>2</sup>

#### *Estimation Framework*

The Generalized Method of Moments (GMM) provides an adequate framework to cope with possible endogeneity bias between the interest rate and exogenous variables (inflation, output and exchange rate). It has satisfying asymptotic properties in large samples, but the performance declines in smaller finite samples.

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<sup>2</sup> We discuss the impact of the exchange rate on monetary policy decision making after March 1999 in section V.

We use a “two-step” GMM as suggested by Florens, Jondeau and Bihan (2001). The lags of the regressors up to twelve previous periods and a constant are used as instruments.<sup>3</sup> The variance is an estimated Newey-West covariance estimator (HAC) to control for heteroskedasticity and autocorrelation of unknown form.

The estimation proceeds in three steps. First, we estimate global coefficients for the entire observation period from 1974:01 to 1999:03 as well as for the sample from 1979:04 to 1994:12 by Clarida, Gali and Gertler (1998) (as a robustness check). Then, as suggested by Jinushi, Kuroki and Miyao (2000), we split the sample into two parts from 1974:01 to 1985:12, and from 1986:01 to 1999:03 to capture possible regime shifts. Finally, we estimate ten-year rolling windows starting in 1974:01 and iterating forward month by month until 1999:03 in order to create a continuous picture on the role of the exchange rate for Japanese monetary policy.

### *Results*

The results of the first two steps are reported in Table 1. The coefficient  $\delta$  identifies the impact of the exchange rate on Japanese monetary policy. Based on former studies such as those of McKinnon and Ohno (1997) and Schnabl and Baur (2002), we would expect mostly positive  $\delta$  coefficients: As appreciations affect output negatively, the Bank of Japan tends to lower interest rates to prevent the yen from appreciating and thereby to sustain growth. As interest rates may decline when the yen appreciates (falling exchange rate in price notation) the expected sign of the  $\delta$  coefficient is positive. In times of yen depreciation the Bank of Japan is more likely to show “benign neglect”.

In Table 1 the coefficient  $\delta$  has the expected sign and is highly significant, thereby providing evidence for a strong impact of the exchange rate on Japanese monetary policy for the whole observation period from 1974:01 up to 1999:03. This result is similar for the observation period of Clarida, Gali and Gertler (1998) from the 1979:04 to 1994:12.

For the sub-samples from 1974:01 to 1985:12, and from 1986:01 to 1999:03 there is no econometric evidence that the yen/dollar exchange rate had a significant impact on the BOJ’s interest rate decisions.<sup>4</sup> The  $\delta$  coefficients are insignificant at the common levels, which contradicts the results for the whole sample period.

[Table 1 about here]

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<sup>3</sup> We tested different sets of instruments by excluding/adding lags of the explanatory variables. The results remain widely unchanged.

<sup>4</sup> The negative value for  $\alpha$  in the second sub-sample may be due to the long-run equilibrium interest rate  $\bar{i}$  which is zero during the 90’s as argued by Ito and Mishkin (2004).

As shown by Hillebrand and Schnabl (2003) for the effects of Japanese foreign exchange intervention, distortions may be caused by arbitrary segmentation of the sample in the face of structural breaks. We therefore pursue a more continuous approach by estimating rolling  $\delta$  coefficients starting in 1974:01. If the BOJ had operated under the same (stable) regime throughout all observation periods, we would expect similar coefficients and standard errors. Otherwise, the overlapping estimated sub-samples should reveal regime shifts.

We estimate rolling  $\delta$  coefficients for equation (3) starting in 1974:01. We face a trade off with respect to the window size. The robustness of the results is increasing with the sample size due to the limited finite sample properties of the GMM. To detect potential changes in monetary policy regime we prefer small sample sizes that can be assumed to be more sensible to possible regime shifts. Based on various tests we see a window size of 120 observations (10 years) as an adequate compromise.

The respective first sub-sample which is from 1964:01 up to 1974:01 extends to the Bretton Woods system. We are aware of the fact that during the first few years of our rolling estimations Japanese monetary policy decision making is not adequately specified, as a fixed exchange rate regime constitutes a different monetary framework than modelled in equation (3). This bias declines as the window is shifted recursively.

Figure 1 shows the results. The horizontal dotted and bold lines indicate the significance levels at 5% and 1% respectively. In Figure 1 the  $\delta$  coefficients are mostly positive, as expected. The impact of the yen/dollar exchange rate on Japanese monetary policy seems to have changed over time. Up to the late 1970s the significance level is low. In the years 1978/79 there is a sharp increase in the significance level, which is in line with international policy coordination attempts to stop dollar depreciation (Henning 1994).

[Figure 1 about here]

From the early 1980s up to early 1986, the yen remained weak against the dollar and Japanese monetary policy decisions do not seem to have been significantly affected by exchange rate changes. The September 1985 Plaza agreement intended to appreciate the yen against the dollar by joint international (sterilized) foreign exchange intervention. For this time period, there is only weak evidence for an impact of the exchange rate on Japan's monetary policy.

With the February 1986 Louvre Agreement, monetary policy action was taken to prevent the yen from appreciating further (Funabashi 1988, Esaka 2000). Japanese interest rate cuts were reflected in an increasing significance of the  $\delta$ -coefficients. The strong impact of the exchange rate

on Japanese monetary policy continued throughout the second half of the 1980s and only declined after the burst of the bubble economy in late 1989.

A declining level of significance during the early 1990s indicates that the Bank of Japan gave less weight to the exchange rate. A new spike in the significance level of the  $\delta$ -coefficients is observed only in 1995, when the Bank of Japan lowered interest rates to stop the rise of the yen up to its record high of less than 80 yen per dollar (McKinnon and Ohno 1997). While the level of significance for the  $\delta$ -coefficient declined in the post 1995 yen depreciation period, a new spike was observed in 1998.

All in all, the rolling t-statistics show a dynamic picture of the role the yen/dollar exchange rate has played in Japanese monetary policy. They clearly reflect yen/dollar exchange rate movements, as is shown in Figure 2. While the role of exchange rate changes for Japanese monetary policy decisions seems rather low up to 1985, there is increasing importance placed on the exchange rate for Japanese monetary policy, as argued by Okabe (1992) and Jinushi, Kuroki and Miyao (2000).

[Figure 2 about here]

#### **IV. ROBUSTNESS TESTS**

To confirm the robustness of our results we performed several tests. Orphanides (2001) shows that different methods to calculate the output gap lead to differing results for the monetary policy reaction function of the Federal Reserve. We re-estimate equation (3) with different output gaps. Alternatively to the first specification, the output gap is calculated as a five year moving average and as a deviation from a quadratic trend, just as Clarida, Gali and Gertler (1998) did as well. The resulting t-statistics are reported in Figure 3.

[Figure 3 about here]

If the output gap is calculated based on five-year moving averages, the results obtained in section III are largely confirmed. The t-statistics of the exchange rate gap, estimated with the output gap calculated as a deviation from a quadratic trend, show a statistical significance of the exchange rate gap for around 1982/83 and from 1986 to 1995. While the role of the exchange rate for monetary policy is widely confirmed for the period from 1986 to 1999, it differs significantly for the period up to 1986.

Finally, equation (3) is re-estimated for the US Fed, which is widely accepted to show a benign neglect towards the exchange rate. If our estimation approach is robust, the t-ratios for  $\delta$ -coefficients of the Fed monetary policy reaction function should be significantly smaller than for the Bank of Japan and should remain within the 1% and 5% significance levels.

Both are true. As shown in Figure 5, the t-ratios for the impact of the yen/dollar exchange rate on US monetary policy are significantly smaller than for the Bank of Japan. Furthermore, there is less variation over time and the  $\delta$  coefficients are seldom significant. We regard this result as strong support of our conclusion that the exchange rate had an increasing impact on the monetary policy of the Japanese central bank.

[Figure 4 about here]

## V. CONCLUSION AND OUTLOOK

We studied the dynamic information content of Taylor-type monetary policy reaction functions with respect to the exchange rate. For this purpose the Bank of Japan provided a suitable case study, as it is often argued to have incorporated the exchange rate into monetary policy decision-making—at least temporarily.

The static estimations of the Taylor-rule with an exchange rate term lead to mixed results. Rolling GMM estimations provided evidence that the role of the exchange rate for the Bank of Japan's interest rate decisions has increased during certain time periods. This is in line with narrative and (static) empirical evidence on international policy coordination and (thereby) BOJ monetary policy-making as provided by Funabashi (1988), Henning (1994), McKinnon and Ohno (1997) and Esaka (2000).

Up to 1985, there is little evidence that the exchange rate had any impact on Japan's monetary policy making, except for the year 1978/79. After 1986 the role of the exchange rate seems to have increased over time—specifically in times of appreciation—until recursive interest rate cuts, which were intended to prevent the yen's appreciation, brought Japanese short-term interest rates to zero in March 1999.

Japanese monetary policy, after the advent of the “liquidity trap,” corresponds to this finding, as the ceiling of the Bank of Japan current accounts has been steadily adjusted to the scope of Japanese foreign exchange intervention (Hillebrand and Schnabl 2004). Thus, even after the advent of the liquidity trap, the yen/dollar exchange rate has remained an important determinant of Japanese monetary policy decision making.

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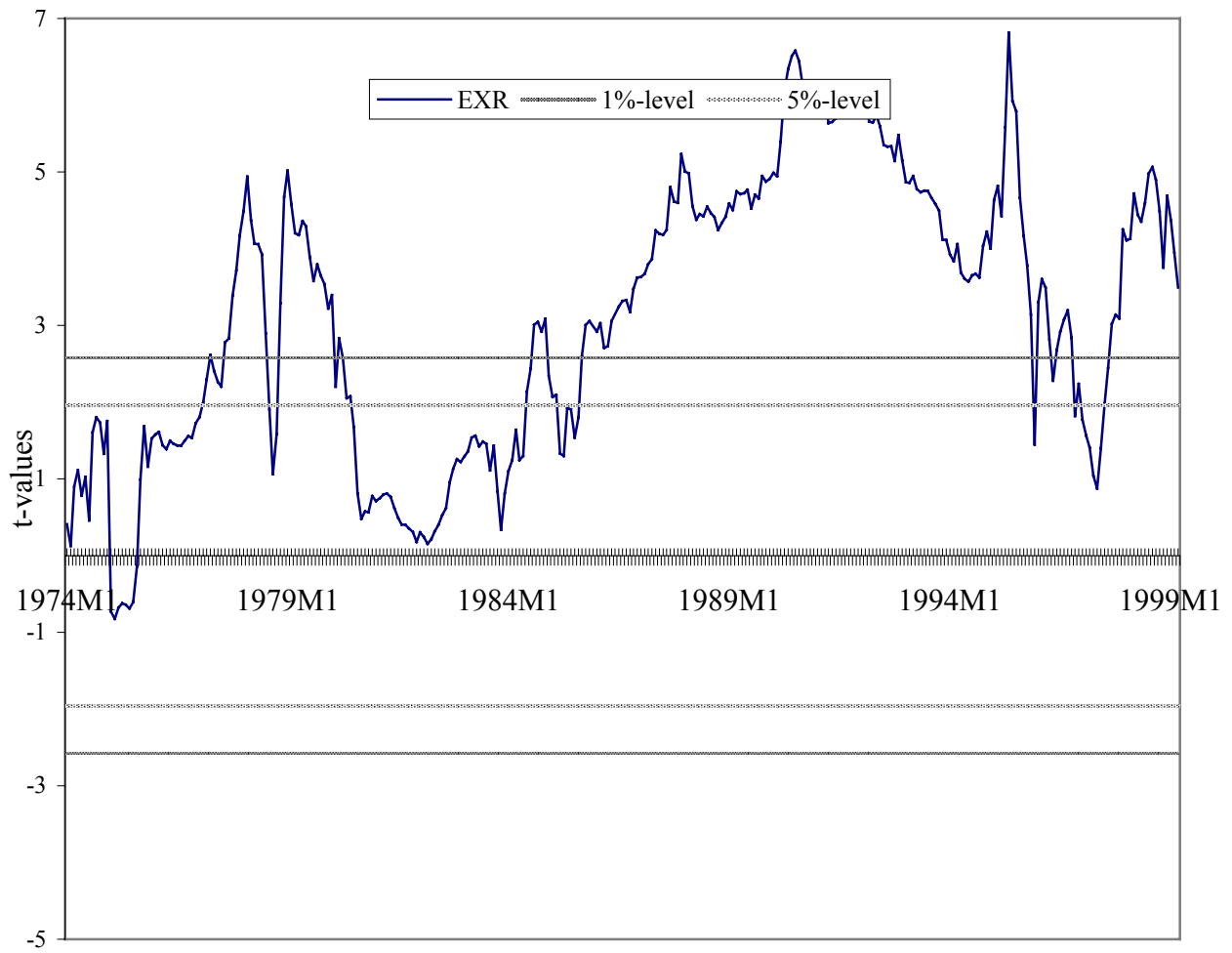
## APPENDIX

**Table 1: GMM Estimations of Equation 1 for Different Sample Periods**

Sample	Coefficients					R <sup>2</sup> adj.
	$\alpha$	$\beta$	$\gamma$	$\delta$	$\rho$	
1974:01-1999:03	0.003806 (0.009382)	1.308869*** (0.245105)	0.758157*** (0.275618)	0.000832** (0.000345)	0.976032*** (0.007416)	0.987827
1979:04-1994:12	0.022443*** (0.004503)	1.547003*** (0.185898)	0.634762*** (0.165097)	0.001226*** (0.000243)	0.943432*** (0.008015)	0.978679
1974:01-1985:12	0.010126 (0.022982)	1.199043*** (0.468009)	0.856629 (0.600476)	0.000733 (0.000389)	0.977550*** (0.013989)	0.967158
1986:01-1999:03	-0.007174 (0.007642)	2.757096*** (0.368743)	0.192144 (0.130420)	0.000291 (0.000246)	0.956234*** (0.007726)	0.991293

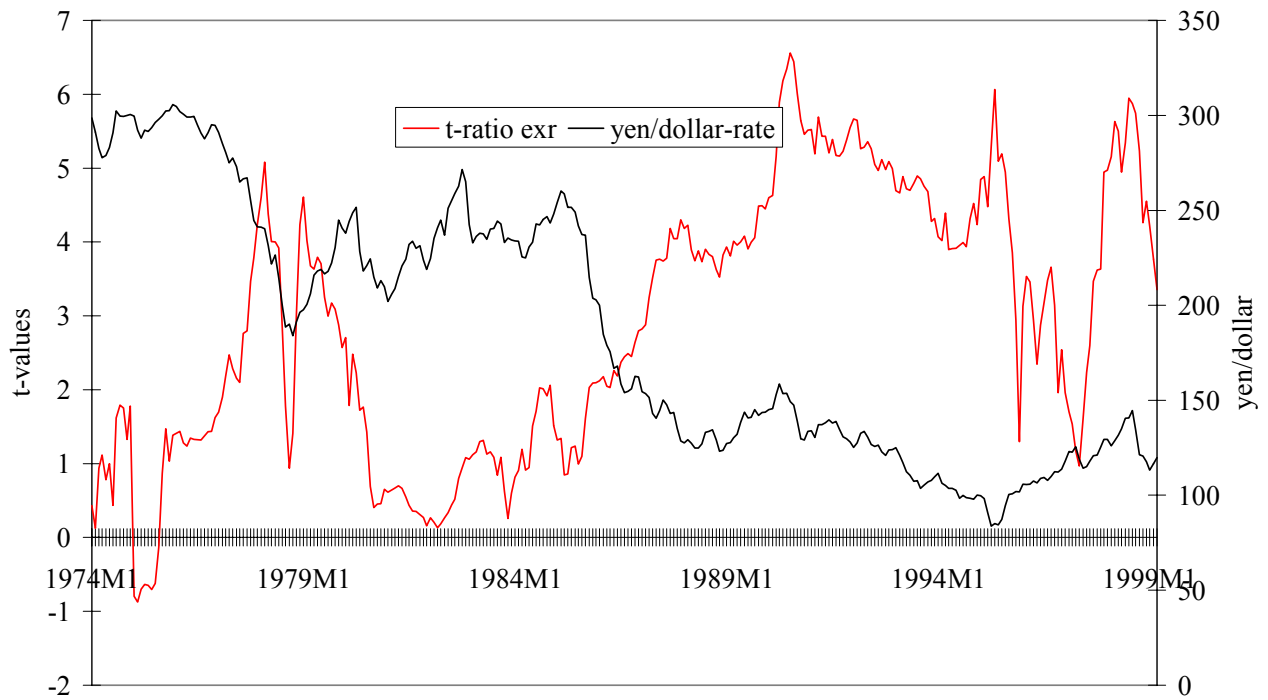
Standard errors in parentheses. \*\*\*(\*\*) denotes significance at 1% (5%)-level, test for over-identifying restrictions:  $J$ -Statistic for global estimates from 1974:01 to 1999:03.  $J = 0.067728$ ,  $\chi^2(28)$ ,  $p$ -value = 0.84.

**Figure 1: Rolling GMM T-Statistics for Japanese Exchange Rate Gap ( $\delta$  Coefficient)**



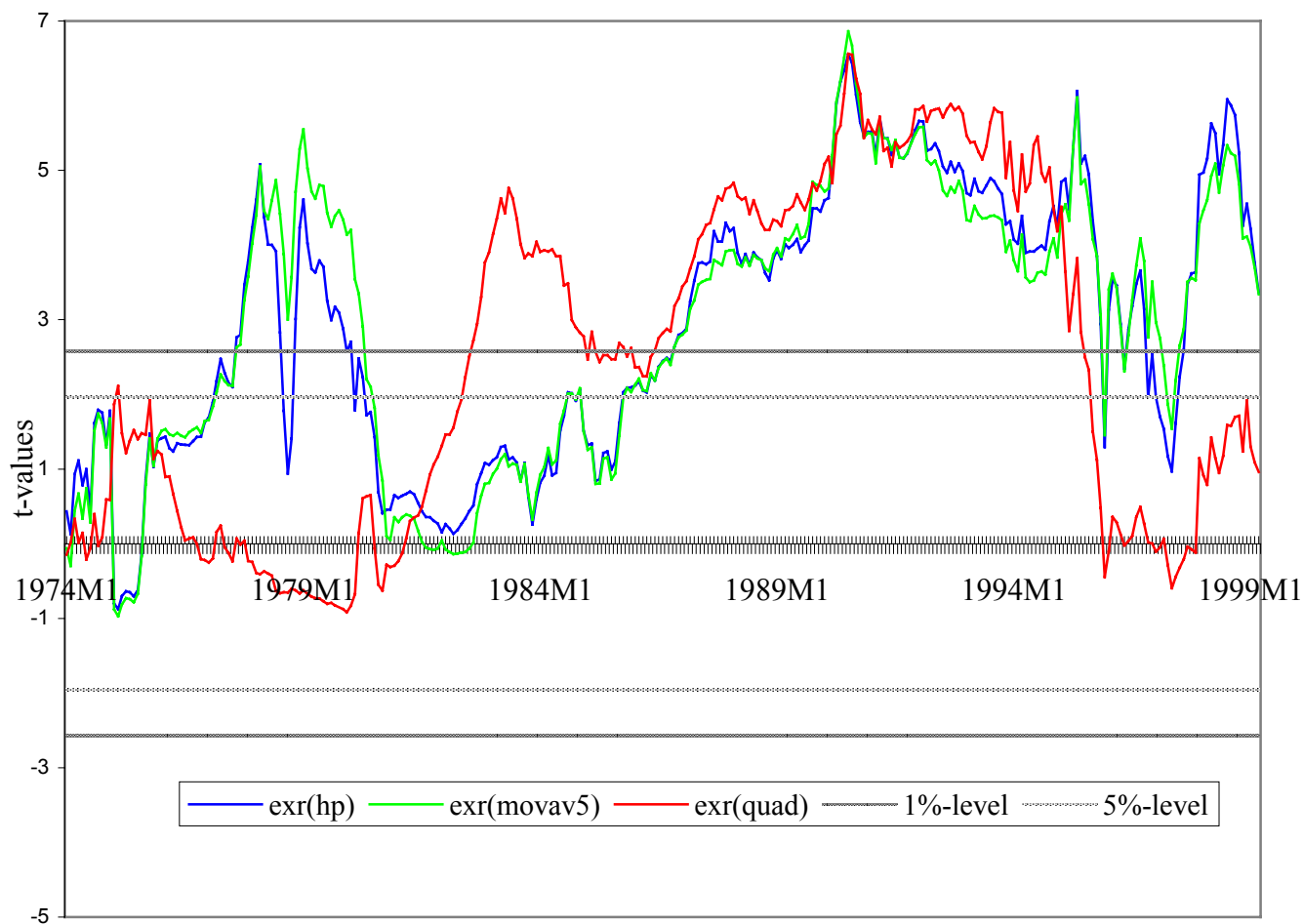
Window size corresponds to 10 years starting in 1964:01. The respective t-statistics are plotted for the last observation of the estimated sub-sample.

**Figure 2: Rolling T-statistics for GMM Estimations and Yen/Dollar Exchange Rate**



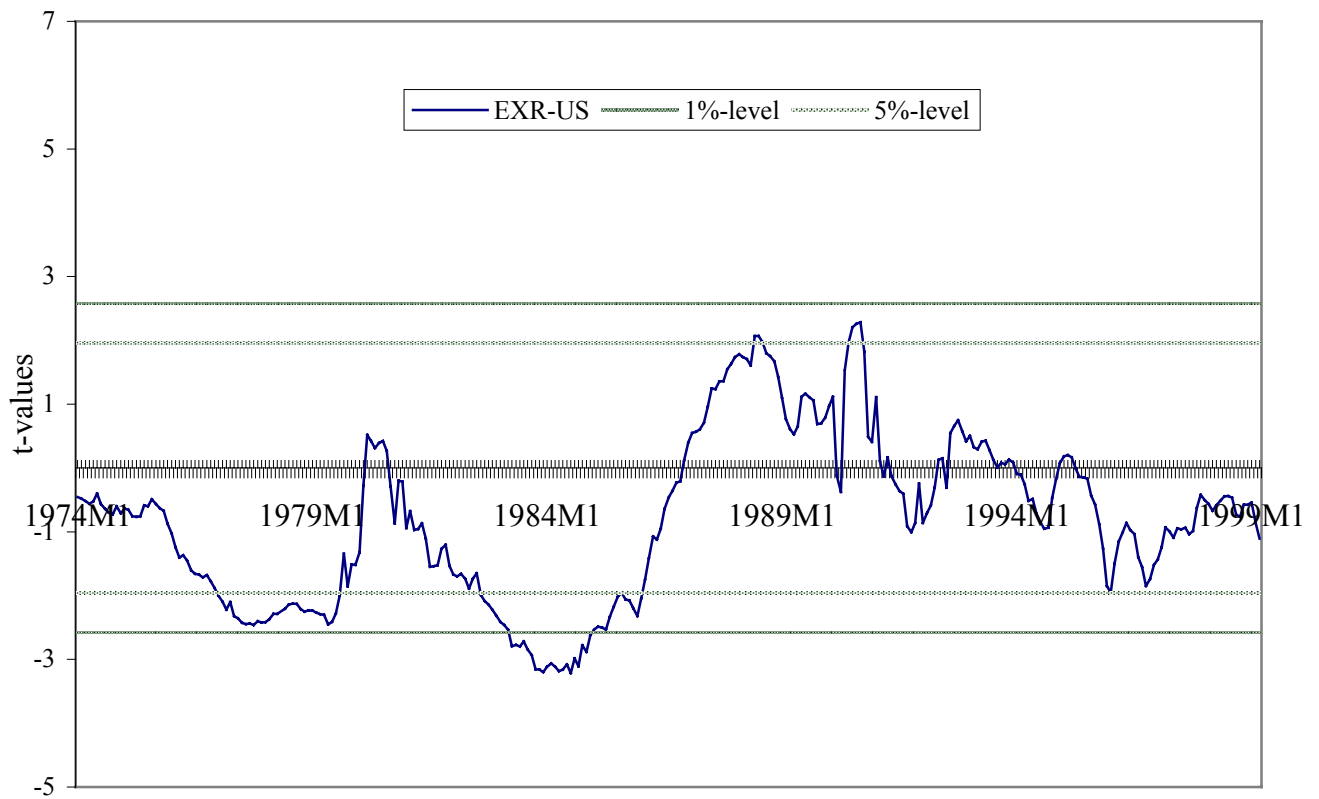
Window size corresponds to 10 years starting in 1964:01. The respective t-statistics are plotted for the last observation of the estimated sub-sample.

**Figure 3: Rolling t-statistics of the Exchange Rate Gap for Different Output Gap Measures**



Window size corresponds to 10 years starting in 1964:01. The respective t-statistics are plotted for the last observation of the estimated sub-sample.

**Figure 4: Rolling t-statistics for GMM Estimates of Exchange Rate Gap for the US Fed**



Window size corresponds to 10 years starting in 1964:01. The respective t-statistics are plotted for the last observation of the estimated sub-sample.