Monetary Approach for Determining Exchange Rates and Recent Monetary Policy of Japan

Yutaka Kurihara¹, Akio Fukushima²

Abstract
This article examines whether or not the monetary approach, or one of the main exchange rate determination theory models that consider economic fundamentals is suitable for determination of exchange rates for the Japanese yen against the US dollar. This monetary approach to exchange rate determination finds the point at which the available amount of money supply is equal to the demand to hold the money in the long run. This method has been used in the past. The monetary approach model for determination of exchange rates is appropriate for the case between Japan and the United States. However, when monetary base is used for estimation considering Japan’s recent monetary policy, this variable is not significant. Instead, other variables, namely, real incomes and prices for both countries impact the exchange rate. Also, the unconventional Japanese quantitative monetary policy is examined empirically and was found to affect the exchange rate for more than one year.

Keywords: monetary approach, monetary policy, quantitative easing, unconventional policy,
JEL code: E52, E58, F31

1. Introduction

Theory that backs the determination of exchange rates has changed and improved greatly. Now there are several major theories by which to determine exchange rates. Purchasing power parity (PPP) is the oldest and is based on the so-called law of one price. PPP holds the law of one price in the long run such that exchange rates adjust to equalize the purchasing power of currencies. Since the 1970s, exchange rates have started to move with asset prices instead of goods and service prices. Large capital flows over GDP began to occur all over the world and exchange rates began to fluctuate greatly. Before that time, exchange rates had tended to move with international trade, but the situation has changed greatly. Some famous papers, for example, Dornbusch (1976), Frenkel (1976) and Kouri (1976), have considered this issue and provided a new model. The monetary approach to determining the exchange rate finds the point at which the available money supply is equal to the demand to hold the money, also in the long run. The last approach, the portfolio-balance approach, determines the exchange rate as with asset prices of, for example, stocks, bonds, and other money market instruments. It has been said that the approach holds in the short run and is the most suitable theory for exchange rate determination in the short run.

In the field of economics, exchange rates are still one of the most controversial topics both theoretically and empirically in international finance. However, recent empirical models have mostly neglected the potential existence of a long-run relationship between exchange rates and economic fundamentals. Structural models have been used in the study of exchange rates. It is interesting to note that little attention has been paid to analysis of the relationship between exchange rates and economic fundamentals (Beckmann et al., 2011). The monetary approach focuses on this issue. However, the empirical outcomes remain mixed. Although Fry (1991) found strong support for the monetary approach,
Lyons (1992) did not. It is sometimes important to focus on exchange rates themselves to analyze them adequately. The chartist model, which is used not only in academic fields but also in business fields, is valid for analysis of exchange rate determination. Also, behavior economics begins to provide exchange rate theory (Kurihara, 2007). However, the monetary approach, which considers economic fundamental variables, is important especially when examining exchange rates for the long run.

MacDonald and Taylor (1993) demonstrated that the monetary approach model obtains exchange rate forecasts that are superior to those generated by a random walk forecasting model. Gehrig and Menkhoff (2006) suggested that various fundamentals are important for exchange rate determination at different times. Kurihara (2007, 2011), which were based on the behavioral financial economics model, showed that economic agents rely on a fundamental approach when stock prices differ from the simulations; on the other hand, market participants employ a chartist approach when the departure is small. Bacchetta and van Wincoop (2009) showed that market participants emphasize some economic fundamentals when structural parameters in the economy are unknown and subject to change. Similarly, Goldberg and Frydman (1996, 2007) showed that economic fundamentals in foreign exchange markets matter in a way that is not entirely consistent with the monetary approach model during some periods of floating. Azar (2013) suggested that fluctuations in foreign exchange rates are determined by economic fundamental elements. Hakkido and Rush (1991) showed the null of hypothesis of no cointegration between exchange rates and economic fundamentals is difficult to reject in empirical analyses because the available data are too short to analyze.

On the other hand, Cheung and Chinn (2005) showed that appropriateness of the monetary approach depends on time periods. Mansoorian (2014) showed that if the model has two goods that require different degrees of cash, the factor intensities of the goods also have a crucial impact in determination of the response of savings. In these cases, the validity of the monetary approach may be overturned.

Diamandis et al. (1998) rejected the forward-looking version of the monetary approach model but found that the unrestricted monetary approach model is an adequate framework for explaining the long-run movements of these exchange rates. Giannellis and Koukouritakis (2011) applied unit root tests and system cointegration techniques in the presence of structural changes and showed the existence of an equilibrium relationship between exchange rates and the economic fundamentals in the monetary approach model. Hanabusa (2012) indicated that the exchange rate in Japan did not reflect certain information about future economic performance from 2001 to 2006 (i.e., during the quantitative easing policy, or unconventional monetary policy period). Hoshikawa (2012) demonstrated cointegration with break to show that exchange rate and Japanese international reserves had a long-run relationship. These results vary depending on the hypotheses and aims and are inconclusive. The relationship between exchange rates and macroeconomic fundamentals remains an important area to study and should be analyzed more.

Japan introduced its unconventional monetary policy in 2001. The Bank of Japan introduced monetary policy (i.e., quantitative easing) to combat deflation. This quantitative easing policy also was later introduced in the United States and Euro area.

This paper examines whether exchange rate is related to macroeconomic fundamentals when using monetary approach to determine exchange rates and analyzes the recent monetary policy in Japan. Few studies have focused on recent Japanese cases of quantitative easing policy employing this monetary approach. Also, among fundamental variables, it is difficult to analyze exchange rates by considering fundamental variables at the same time. Above all, interest rate, change in the short run, however, other variables (e.g., money supply) changes in the long run. Also, Bank of Japan, the Japanese central bank, employs the monetary base instead of money supply for the target of monetary policy. This paper takes these issues into account.

This paper is structured as follows. Section 2 provides theoretical views for the empirical analyses. Section 3 performs the empirical analyses based on the previous section. Section 4 analyzes the results and conducts one additional empirical analysis. Finally, a brief summary is presented.
2. Theoretical Analysis

A model of exchange rates: Monetary approach model

This model relies on a stable money demand function in the following form:

\[ M/P = L(Y, i) \]  (1)

where M usually denotes the money supply, P the price level, L the money demand, Y real income, and i interest rate. A basic assumption of this monetary approach model is that the purchasing power parity (PPP) holds:

\[ S = P/P^* \]  (2)

where S means nominal exchange rate, P means domestic price, and P* means foreign price.

In the log linearized form, the exchange rate can be expressed as the difference between domestic and foreign money supply, real incomes, and interest rates. If the money supply and income elasticities are equal in each currency market, exchange rates are determined as follows:

\[ s = \alpha + \beta(m - m^*) - \gamma(y - y^*) + \eta(i - i^*) \]  (3)

\( \alpha \) is a constant term. \( \beta \), and \( \gamma \), and \( \eta \) are (semi-) elasticities. The interest rates are expressed by as percentages. So, exchange rates are explained as follows, with * meaning a foreign country:

Some other strict assumptions underpin this model: (a) real income and money market rate are at equilibrium, (b) domestic and foreign goods are perfect substitutes, (c) uncovered interest rate parity holds, and so on. (\( p - p^* \)) instead of (\( i - i^* \)) is used as one explanatory variable. The reason for the last issue is that interest rates in general fluctuate soon along with the change of economic circumstances. Therefore equation (4) is used as follows:

\[ s = s(m - m^*, y - y^*, p - p^*) \]  (4)

Unit Root Tests

It is necessary to check unit root tests for before conducting empirical estimations. This paper uses two methods: augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.

ADF is mostly used in empirical estimation to check unit root; however, if the series is correlated at higher order lags, the assumption of white noise disturbances is violated. The PP test proposes a method by which to control for higher order serial correlation in a series than is accepted in the equation. This test makes a nonparametric correction to the t-test statistic. The test is robust with respect to unspecified autocorrelation and heteroscedasticity in the disturbance process of the test equation.

VAR Analysis

This paper examines the validity of the monetary approach, considers economic fundamentals for exchange rate determination, and analyzes the effect of Japanese quantitative easing on exchange rates. The method employed is VAR (vector autoregression), which is commonly used to forecast systems of interrelated time series and to analyze the dynamic impact of random disturbances on the employed variables. Empirical estimation and interface are complicated by the fact that endogenous variables may appear on both the left and right sides of equations. The simultaneous use of VAR means can avoid this issue.

The variables employed are exchange rate, monetary base, real income, and price. For the United States, the sample period is too short for adoption of a quantitative easing policy, which is the new monetary policy instrument. For this issue, the Euro area has a similar situation. For this reason, only the Japanese case is examined. Also, impulse responses are examined to trace the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables.

Variation Period

Finally, this paper examines how long the variation from monetary approach model continues. Variation from the real data \( vt \) is calculated.
Next, variation is regressed as follows:

\[ vt = a + \beta v_{t-1} + \epsilon_t \]  

The duration period that sets the variation becomes half from the starting point. The log \(0.5/\log\beta\) is calculated.

### 3. Empirical Analyses

#### Data

The sample is quarterly from 2002:Q1 to 2014:Q1 for the case of Japan. On March 9, 2001, unconventional monetary policy, namely, quantitative easing policy started.

Monetary base is used instead of money supply as it is the target of monetary policy. Also, the monetary base is used in the case of the VAR model to analyze the effect of the Japanese quantitative easing policy. Real income is proxied by the real production index. For prices, consumer prices (index) are used. All series are seasonally adjusted and are from International Financial Statistics of the International Monetary Fund.

#### Unit Root Tests

The first step tests stationarity in levels and differences are taken and tested. The results of two methods explained in the previous section are shown in Table 1.

In a few cases, the results are mixed and are not perfectly conclusive. However, the use of first differences should be introduced for empirical estimations. Most of the results can be considered as integrated at order one.

<table>
<thead>
<tr>
<th>Table 1 Unit Root Tests</th>
<th>ADF</th>
<th>PP</th>
</tr>
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<tbody>
<tr>
<td>S</td>
<td>-3.571**</td>
<td>-2.922*</td>
</tr>
<tr>
<td>(m - m^*)</td>
<td>0.534</td>
<td>-0.539</td>
</tr>
<tr>
<td>(y - y^*)</td>
<td>-1.798</td>
<td>-1.463</td>
</tr>
<tr>
<td>(p - p^*)</td>
<td>-1.750</td>
<td>-4.530***</td>
</tr>
</tbody>
</table>

#### Empirical Results of the Model’s Regressions

The regression method is ordinary least squares (OLS) in this analysis. The checking points are whether exchange rates can be explained by macroeconomic variables, or in (4). The results are shown in the equation (6).

\[ \log s = 1.514*** + 0.008 \log (m - m^*) - 0.982*** \log (p - p^*) + 0.321*** \log (y - y^*) \]  

adj.R2: 0.995  F-statistic: 3070.897  Prob (F-statistic): 0.000  D.W.: 0.908

*** denotes significant at 1% level.

The results are pretty good except for the case of the monetary base. Exchange rates can be explained by other macroeconomic fundamental variables. Kurihara (2013) showed that money supply (M2) significantly affects exchange rates for the case of Euro area, Japan, and the United States. The use of the monetary base instead of money supply is not significant; however, the coefficient is positive as expected.

It is not adequate simply to judge that monetary policy in Japan has been effective or not. In reality, the yen depreciated strongly from 2013, which is the recent case. The movement of the exchange rates is shown in Figure 1. The left vertical axis is yen/US dollar and the right one is the Euro/US dollar.
Moreover, the Bank of Japan has not attempted to depreciate or control the yen. The Bank of Japan Act says that “The purpose of the bank of Japan, or the central bank of Japan, is to issue banknotes and to carry out currency and monetary control (Article 1)” and “currency and monetary control by the Bank of Japan shall be aimed at achieving price stability thereby contributing to the sound development of the national economy (Article 2).” There is no description applicable to exchange rates.

**VAR Results**

Table 2 shows the result of the VAR for Japan instead of the OLS[equation (6)]. One problem is that the unit root tests are mixed. The time lag is one and two. Time lag was selected by AIC (Akaike info criterion).

<table>
<thead>
<tr>
<th>Table 2 VAR Estimation of Monetary Base, Interest Rate, and Exchange Rate</th>
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<tbody>
<tr>
<td><strong>Explanation Variable</strong></td>
</tr>
<tr>
<td>Constant</td>
</tr>
<tr>
<td>Monetary base (-1)</td>
</tr>
<tr>
<td>Monetary base (-2)</td>
</tr>
<tr>
<td>price (-1)</td>
</tr>
<tr>
<td>price (-2)</td>
</tr>
<tr>
<td>Exchange rate (-1)</td>
</tr>
<tr>
<td>Exchange rate (-2)</td>
</tr>
<tr>
<td>Adj.R2</td>
</tr>
<tr>
<td>F-value</td>
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</tbody>
</table>

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

Finally, the results of impulse responses are shown in Figure 2.
The results are clear. The response of the monetary base to the exchange rate and the response of price and real income to the exchange rate continue for some time.

The variation, $v_t$, from the monetary model is calculated as follows (7). The empirical method is OLS.

$$\log v_t = \log v_{t-1} + \varepsilon_t$$  \hspace{1cm} (7)

The results are as follows (8).

$$\log v_t = -0.001 + 0.573*** \log v_{t-1}$$  \hspace{1cm} (8)

adj.R2: 0.312 F-statistic: 22.385 Prob (F-statistic): 0.000 D.W.: 1.779

*** denotes significant at 1% level.

This paper calculates the time span when the time span becomes half as follows: $\log 0.5/\log 0.573 = 3.734$ quarters.
4. Interpretation of Empirical Analyses and Further Analysis

Again, macroeconomic fundamental variables have significantly affected exchange rates, which cannot be neglected in determining exchange rates. The monetary base is positive as expected; however, it is not significant. There is a small possibility that monetary policies affect the exchange rates in the medium- or long-run. On the other hand, prices and real incomes impact exchange rates.

The literature has produced some similar results. Miyao (2000) used the VAR model and detected a persistent effect of monetary policy on real output that disappeared with the subsample of the 1990s in Japan. Gertler and Karadi (2011) showed that a quantitative monetary policy in Japan may be substantial during a crisis if the relative efficiency costs of central bank intermediation are within the reason.

Japan started an unprecedented quantitative easing policy in 2001 and a zero interest rate policy in 1999. The quantitative easing policy continued until 2006. At first, the market’s consciousness about exchange rates was not so high, but this effect may have increased greatly around 2003. At that time, the Japanese economy was hit by the 2001 terrorism and huge bad loans by banks. The Bank of Japan has taken various and drastic measures to boost the economy. The policies seem to have changed the movement of exchange rates as shown in Figure 1.

The quantitative easing policy in Japan later had a beneficial influence on exchange rates. The BOJ introduced further unconventional monetary policy in April 2013 that doubled the monetary base to promote economic growth; this effect should be analyzed much more. For example, it is difficult to judge whether the yen’s depreciation has conferred an increase in exports and boosted GDP.

Finally, the Granger causality test is conducted. The results are shown in Table 3. The null hypothesis that exchange rate fails to Granger-cause fundamentals in the middle and long run is rejected. However, only the case of price has caused exchange rate movements, indicating that the effects of price on exchange rate are important at least for a period of one year or so.

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-Statistic</th>
<th>Probability</th>
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<tbody>
<tr>
<td>EXC does not Granger Cause MB</td>
<td>0.027</td>
<td>0.959</td>
</tr>
<tr>
<td>RGDP does not Granger Cause MB</td>
<td>0.065</td>
<td>0.800</td>
</tr>
<tr>
<td>PRICE does not Granger Cause MB</td>
<td>4.203</td>
<td>0.046</td>
</tr>
</tbody>
</table>

Finally, the Chow breakpoint test is conducted. The time period, whether or not breaking time exists, is 2013Q1, which coincides with implementation of the more aggressive monetary policy called Abenomics. The result is difficult to judge (F-statistic: 1.643805; prob.: 0.1812).

5. Conclusion

This paper’s results are clear and highlight important suggestions. It examined whether or not exchange rates can be empirically explained by macroeconomic variables, whether or not monetary policy to boost the economy relates to exchange rate movements, and whether or not structural breaks exist.

Exchange rates are affected by some macroeconomic fundamental variables (i.e., real incomes and prices). Also, there is no clear evidence that expansion of the monetary base is related to exchange rate movement (depreciation of domestic currency). Moreover, whether one breakpoint was found in 2013 at the onset of the more aggressive quantitative easing policy was not clear.

However, there are some problems with this study. First, the sample period is inevitably too short, which makes it difficult to draw conclusions or make judgments. It is necessary to wait until more data have accumulated. On the other hand, division into short subperiods would be necessary. Second, there are other methods by which to calculate estimations. For example, to model exchange rates in a linear fashion would be problematic. We leave the interesting task of corroborating the results to further research.
References


