Can Depreciation of the Currency Cause Rise in Domestic Prices? Recent Japanese Case

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Abstract

In 2022, domestic prices have been rising rapidly all over the world including Japan. It is thought that the rise in domestic prices was triggered by oil prices rising, but there is also a view that the depreciation of its own currency brought by the rise in U.S. interest rates is the cause of the rise in prices. Exchange rates are usually determined by many factors, at times changes in exchange rates influence prices. Moreover, short-term factors and long-term factors have impacts on exchange rates respectively. This study employs two typical theories for exchange rate determination, namely, purchasing power parity (PPP) and monetary approach, and examines whether these theories are suitable for the determinations of exchange rates of the Japanese yen against the US dollar. The results show that it is unlikely that domestic prices in Japan will rise significantly due to the depreciation of the yen unless crude oil and resource energy prices rise abnormally.

Keywords: exchange rate, monetary policy, price, yen

1. Introduction

From the end of February 2021, domestic prices have been rising rapidly all over the world including Japan. Many people think that the rise in domestic prices was triggered by Russia's invasion of Ukraine which caused a rise in domestic prices through oil price rising, but others think that the depreciation of its own currency caused by the rises in U.S. interest rates is the main reason of the rises in domestic prices. Exchange rates are usually determined by many factors, at times changes in exchange rates influence prices. Moreover, short-term factors and long-term factors have impacts on exchange rates respectively.

There is no established theory as to how the exchange rate is determined. From the 1980s, a lot of research has been performed theoretically and empirically, however, there is no consensus. It is still one of the hot issues in the field of economics. However, recent empirical models seem to have neglected the long-term relationship between exchange rates and economic fundamentals. It should be noted that much attention has not been paid to research of the relationship between exchange rates and economic fundamentals (Beckmann et al., 2011). It is undeniable that there is a reality that it is not possible to analyze recent events due to a lack of data, however, focusing on long-term exchange rate determination for analyzing recent exchange rate fluctuations would be necessary and important. The Purchasing Power Parity Theorem (PPP) and monetary approach focuses on this issue.

It is important to consider middle- or long-term relationships rather than short-term, between import prices and exchange rate, however, such has been overlooked (Antonia, 2021).

To examine the recent Japanese economy, at least economic conditions from the 2000s and its unprecedented monetary policy should be taken into account. Japan has been under deflation ever since the so-called bubble economy burst at the beginning of the 1990s. From the middle of the 1980s, Japan enjoyed the bubble economy when stock and land prices rose greatly. However, it collapsed at the beginning of the 1990s. Since then, Japan has been under pressure of deflation. Some people say that it is the lost 30 years.

In 2001, the Bank of Japan (BOJ), Japanese central bank, increased the outstanding balance of the current account at the BOJ to solve the deflation and to boost the economy. In general, central banks in the world make short-term interest rate inductions as typical monetary policy; however, interest rates in Japan were already too low, almost zero. By the quantitative easing policy, the BOJ purchased large amounts of Japanese government bonds to reach its target level of current account balances held by banks in Japan. Under this circumstance, interest rates already at the lower end of zero, the BOJ decided to show anew goal to purchase government bonds from banks and to increase the level of cash reserves held by banks. This was thought to be unconventional and unprecedented. As a side effect, there has been some fear since then that Japanese government bond prices became unstable, however, as very few Japanese government bonds are bought by foreign investors, Japanese government bond prices has been stable and low interest rates situations have held. This quantitative easing was ended in 2006 and again the BOJ conducted a monetary policy with the uncollateralized overnight call rate as the operating target. The target was altered from volume to interest rate.
In 2010, a comprehensive monetary easing policy was introduced. The BOJ modified the target for the uncollateralized overnight call rate from around 0.1 percent to around 0 to 0.1 percent. While this policy was conducted, the account balances at the BOJ followed an uptrend.

However, the Japanese economy had not yet recovered. In 2013, the policy board of the BOJ decided to implement quantitative and qualitative monetary easing policy which was far more aggressive. The BOJ decided to set the consumer price index (CPI) target of 2% for the year-on-year rate of change in consumer prices. Deflation had been considered of as seriously damaging the Japanese economy. It was thought that the BOJ set a new stage of monetary easing both in terms of quantity and quality. The BOJ doubled the monetary base and the amounts outstanding of Japanese government bonds as well as exchange-traded funds (ETFs) in two years and more than doubled the maturity of Japanese government bond purchases (quality). These policies are called Abenomics. Abe was the prime minister's name at that time.

Many developed countries have conducted monetary easing to boost the economy. Almost all developed economies including the U.S. exited from such policies and started to raise interest rates from 2022. Japan has kept zero interest rates and continued monetary expansion until the present. Such circumstances should be considered when analyzing Japanese domestic prices and exchange rates.

This study examines the relationship between depreciation of the currency and domestic price rising. Recent trends especially occurred from spring in 2022, namely, exchange rates depreciation and rising prices seem to be regarded as tied, however, there appear to be other factors in determinations of domestic prices and exchange rates. This study is structured as follows. Section 2 reviews existing studies which focus on the relationship between exchange rates and domestic prices. In section 3, theoretical aspects are provided to analyze this issue. Following section 3, empirical analyses are performed in section 4. Finally, a brief summary is provided.

2. Existing studies

The relationship between exchange rates and prices is given much attention presently, however, it has been discussed in the past. Akbas (2020) found that an exchange rate and interest rate pass-through exists in the case of fragile countries. Beatrice et al. (2021) indicated that manufacturing and construction firms are among the sectors that are related with exchange rate movements. Phuc and Duc (2021) indicated that there exists a pass-through to import prices, producer prices, and consumer prices. Yan et al. (2021) showed that credible monetary policy with anchored inflation expectation is linked with exchange rate pass-through to consumer prices. Gritli (2021) found that exchange rate pass-through to import prices in Tunisia is large both in the short- and long-term. Risti (2021) revealed that export prices decrease by 1.7% when Australian the dollar depreciates by 10%. Tidiane and Hamidou (2021) showed that an exchange rate appreciation of 1% causes a decrease of import price by 0.25%. Sasaki et al. (2022) found that there exists a weak relationship between import prices and producer prices.

On the other hand, Anh (2021) revealed that an exchange rate pass-through to domestic price is incomplete. Danilo et al. (2022) found that shocks on exchange rates do not have an influence on the core inflation.

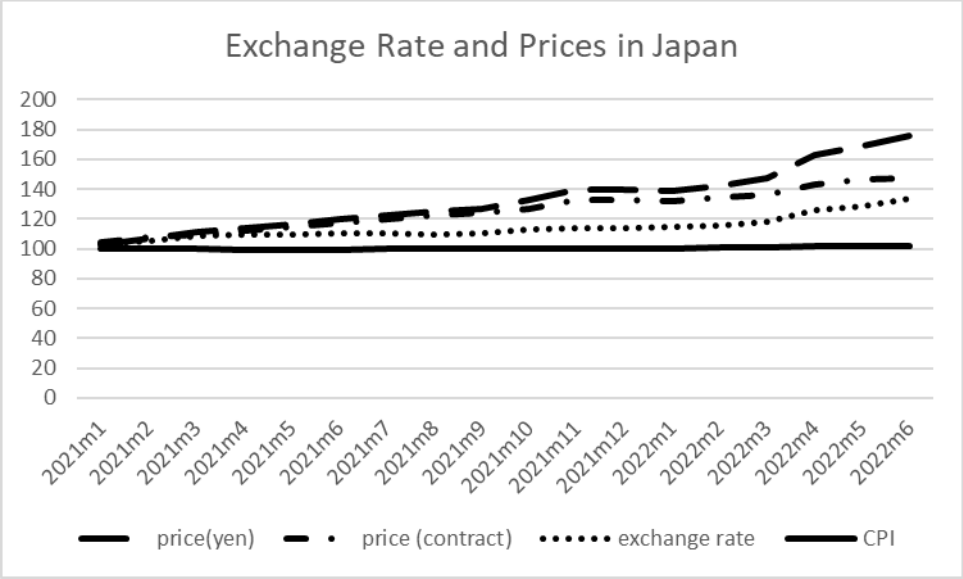
Perekunah (2022) showed that prices respond to depreciation and appreciation of the official exchange rate in Nigeria. Yepez and Dzikpe (2022) indicated that world commodity prices constitute about 30% of real exchange rate movements.

Agyabeng (2022) found that the relationship between bidirectional and unidirectional oil price and volatility, and exchange rate volatility became more prevalent recently.
Despite these many studies attempting to tackle this issue, there is no consensus on the issue.

3. Theoretical Analysis

Figure 1 is the recent movements of yen-U.S. dollar exchange rate and three domestic prices, namely, domestic price dominated in yen, domestic price dominated in contract currency, and consumer price index (CPI). The data is from 2021 to the latest June 2022. All of the prices are index and the data of 2020 is 100. The data is monthly and taken from the BOJ.

Figure 1. Yen-U.S. dollar exchange rate and Japanese domestic prices.



There seems to be a relationship between the exchange rate and two domestic prices among three. However, the relationship between the exchange rate and CPI cannot be found. At least perfect pass-through, which is thought to increase at the same rate, is not realized. As explained in section 1, it would be dangerous to judge that the relationship exists despite the fact that the relationship appears to be there.

In February 2022, Japanese domestic prices have started to rise suddenly and dramatically. Such phenomenon occurred all over the world. Russia's invasion of Ukraine surely affected rises in domestic prices, however, the relationship between the exchange rate and domestic prices seems not to be confirmative. Exchange rates are determined by many factors, at times changes in exchange rates have impacts on prices. Moreover, short-term factors and long-term factors have impacts on exchange rates.

This study at first examines how to determine exchange rates. For the middle- or long-term exchange rate determination theory, monetary approach and PPP theorem have been acknowledged and employed. Among them, PPP has a long history and has been used and discussed not only in the field of academia but also in the field of business. Big Mac index using this theorem is very famous. The PPP is acknowledged for exchange rate determination theory (for example, Aixala, et al., 2020), however, there are studies that the theory does not hold (Zenon, 2021).
Monetary policy focuses on money demand and supply in financial markets. This model is due to a stable money demand function in the following form:

$$M/P = L(Y, i) \quad (1)$$

where M usually means the money stock, P the price level, L the money demand, Y real income, and i interest rate. This model's hypothesis is based on an assumption of this monetary approach model, which is that the PPP holds:

$$s = p/p^* \quad (2)$$

where s denotes nominal exchange rate, p means domestic price, and p* means foreign price.

In this case, $L = (Y,i) = Y^{\Phi} e^{-\lambda i}$. Φ is and λ are (semi-) elasticity. In the log linearized form, the exchange rate can be expressed as the difference between domestic and foreign money stock, real incomes, and interest rates. If the money stock and income elasticities are equal in each money market, exchange rates are determined in the following form:

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

α is a constant term. β, and γ, and η are (semi-) elasticities. The interest rates are expressed as percentages. So, exchange rates are explained as follows, with * denoting a foreign country:

$$s = (m - m^*, y - y^*, i - i^*) \quad (4)$$

From the equation (2), exchange rate can be explained as the equation (5).

$$s = p - p^* \quad (5)$$

This study focuses on these theories because middle- or long-term effects of exchange rate fluctuations on domestic prices. As prices in general unlike stock prices do not change in short-terms such as in seconds. There are some exceptions such as the oil price market, however, most prices do not change as such. From these typical theories, exchange rates that can be obtained and these data calculated from these two theories are employed to examine the effects on domestic prices.

Moreover, this study considers exchange rate adjustments to the exchange rates that should be. While prices change to the prices that should be, exchange rates also move and adjust to the desired level that should be. The duration of the variation from monetary approach model and PPP continue is checked. More concretely, variation from real data Xt is calculated. The next, variation is regressed as follows in equation (6):

$$Xt = \alpha Xt\text{-}1 + \varepsilon t \quad (6)$$

The duration period that decides the variation becomes half from the starting point, example. In this case, the log 0.5/logα is calculated.

4. Empirical Analyses

As preliminary analyses, correlation coefficients among variables in recent periods are calculated. The data are monthly and the sample period is from the beginning of 2021 to the latest June 2022. From the spring 2020, exchange rates depreciate and domestic prices rise greatly. As the exchange rate, yen-U.S. exchange rate is used. Three kinds of domestic prices are used. They are import price dominated in yen, import price dominated in contract currency, and CPI. All of the data are monthly. They are from the BOJ and seasonally adjusted. Table 1 shows the results.

Table 1. Correlation coefficients among variables

	Import price dominated in yen	Import price dominated in contract currency	Exchange rate	CPI
Import price dominated in yen	1	0.985	0.973	0.909
Import price dominated in contract currency	0.985	1	0.919	0.866
Exchange rate	0.973	0.919	1	0.914
CPI	0.909	0.866	0.914	1

All of the correlations are high as expected. Prices of natural resources including oil price have soared tremendously and exchange rates depreciated greatly in many countries except for the U.S. However, high coefficients may be due to specific events or merely cosmetics. Moreover, it can be seen that domestic companies cannot pass on rises in raw material costs including oil prices to consumers. Such situations have been criticized in many ways as such companies should raise wages,

To examine this, prices are directly regressed by the exchange rate at the first step as the equation (7).

$$p = \alpha + \beta s + \varepsilon \quad (7)$$

The results of equation (7) are in Table 2.

Table 2. The relationship between exchange rate and prices (monthly)

	CPI		Import price dominated in yen		Import price dominated in contract currency	
C	89.694*** (76.271)	81.426 (31.137)	-186.051*** (-9.017)	-238.688*** (-6.558)	-46.001** (-2.489)	-129.601*** (-3.409)
Lag 0	0.092*** (8.987)	0.062 (1.853)	2.532*** (16.742)	1.414*** (3.308)	1.504*** (9.313)	0. 358 (0.735)
Lag 1		0.020 (0.371)		0.629 (0.847)		0.589 (0.760)
Lag 2		-0.042 (-0.728)		-0.356 (-0.449)		-0.384 (-0.463)
Lag 3		0.049 (0.621)		0.006 (0.006)		0.060 (0.052)
Lag 4		0.079 (1.482)		1.643* (2.215)		1.700* (2.195)
Adj.R2	0.824	0.944	0.943	0.978	0.835	0.923
F-statistic (prob.)	80.778 (0.000)	44.986 (0.000)	280.314 (0.000)	114.343 (0.000)	86.732 (0.000)	32.866 (0.000)
D.W.	0.935	1.823	0.371		0.315	0.973

Notes) Parentheses are t-value. ***, **, * are significant at 1. 5, and 10% level respectively.

The results seem quite good because the equations fit well. However, it takes time for exchange rates and prices to adjust to the ones that are expected. In international transactions, forward contracts to reduce fluctuations of exchange rates and prices are sometimes used. Therefore, time lags are born. In the theory of international account determination, it is known as the J-Curve effect. This study examines the recent relationship between the exchange rate and domestic prices, such time lags should be taken into account.

Instead of recent monthly data, quarterly data are used for estimations. The sample period is from 2002 to 2019. In 2001, a drastic change of monetary policy was decided to be conducted as explained in section 2. On the other hand, from the year of 2020, COVID-19 prevailed and international trade had been interrupted, for example, because of the damage of the supply chain.

The estimated equation is the same with (7) and independent and dependent variables are also the same, however, sample data (quarterly instead of monthly) and sample period are different. The regression results are in Table 3.

Table 3. The relationship between exchange rate and prices (quarterly)

	CPI		Import price dominated in yen		Import price dominated in contract currency	
C	1.868*** (66.430)	1.853*** (57.556)	2.546*** (9.895)	2.705*** (10.896)	4.045*** (15.535)	4.199*** (16.802)
Lag 0	0.057*** (4.139)	0.048 (0.814)	-0.257** (-2.021)	0.520 (1.154)	-0.989*** (-7.728)	-0.197 (-0.434)
Lag 1		-0.019 (-0.201)		0.150 (0.203)		0.151 (0.204)
Lag 2		0.040 (0.410)		-0.557 (-0.747)		-0.563 (-0.750)
Lag 3		-0.028 (-0.289)		0.255 (0.346)		0.256 (0.345)
Lag 4		0.025 (0.430)		-0.701 (-1.578)		-0.719 (-1.610)
Adj.R2	0.177	0.147	0.040	-1.578	0.439	0.517
F-statistic (prob.)	17.135 (0.000)	3.447 (0.008)	4.086 (0.047)	4.408 (0.000)	59.717 (0.000)	16.207 (0.000)
D.W.	0.105	0.090	0.184	0.189	0.179	0.183

Notes) Parentheses are t-value. ***, **, * are significant at 1. 5, and 10% level respectively.

The results are difficult to analyze. Not only the time lag but also the relationship between exchange rate and prices are not deterministic. Except in the case of CPI, import prices rose (declined) due to the appreciation (depreciation) of the yen. The relationship that depreciation causes rising in import prices cannot be found definitely. There may be possibilities time lags for exchange rate and price formation which should not be ignored.

Via the above analyses, it became clear that time lags for exchange rate and price determinations exist. Then, how long does it take to for exchange rates and prices that should be? Using the equations of (3) and (5), regressions are performed. The data are from International Financial Statistics (IFS; IMF). Instead of money stock, monetary base is used for estimation because it has been employed as the target of monetary policy. Interest rates are 3-month interbank market ones. The sample period is from 2002 to 2019. The results are in Table 4.

Table 4. Exchange rate determinations

	Monetary approach (3)	PPP (5)
C	1.670*** (140.807)	2.031*** (322.103)
y – y*	-1.092*** (-39.678)	
i – i*	-0.0004 (-0.411)	
m – m*	-1.98E-10*** (-17.677)	
p – p*		0.548*** (4.054)
Adj.R2	0.969	0.171
F-statistic (prob.)	795.060 (0.000)	16.438 (0.000)
D.W.	0.264	0.110

Notes) Parentheses are t-value. ***, **, * are significant at 1. 5, and 10% level respectively.

Almost all the results are confirmative. The U.S.-yen exchange rate can be explained from reality, albeit not completely. Using these results, the exchange rates that should be can be obtained. According to the estimated results in Table 4, exchange rate and prices that should be are calculated for each period and the difference between the real ones of exchange rate and estimated price are obtained. These are X in the equation (6). Then, X is regressed by the one-time lag. The results are in Table 5.

Table 5. Difference between real and ones that should be

	Monetary approach	PPP
Difference	0.875943*** (17.316)	0.949114*** (24.797)
Adj.R2	0.729	0.893
Akaike info criteria	-7.767	-5.253
D.W.	2.212	1.450

Notes) Parentheses are t-value. ***, **, * are significant at 1. 5, and 10% level respectively.

The log of 0.875943 and 0.949114 are 5.23 and 13.27. For example, about 15 months are necessary for the exchange rate to adjust for the case of monetary approach. Adding to these time lags, prices themselves need time to adjust. In reality, prices cannot adjust due to economic conditions.

The recent relationship between yen's depreciation and import prices can be found, however, there may be a specific case. Trade restrictions, limitation and so on may have had impacts on the phenomena. Only paying attention to the relationship between exchange rate and domestic prices, there is some possibility that misses the important things.

5. Conclusion

Japanese domestic prices have been rising. It is reasonable to think that the rise in domestic prices triggered by Russia's invasion of Ukraine caused a rise in domestic prices through the rising of oil price, but there is also a view that the depreciation of the yen caused by the rise in U.S. interest rates by the FRB's increase of policy interest rate. However, exchange rates are determined by many factors. Sometimes political issues affect the exchange rates. Also, there changes in exchange rates and prices to the desired ones can take time, and short-term factors and long-term factors have impacts on exchange rates.

This study empirically investigated the relationship between the exchange rate and domestic prices and found that a confirmative relationship cannot be found. Moreover, this study employs two typical theories for exchange rate determination, namely, PPP and monetary approach, and examining whether they are appropriate for the determination of exchange rates for the Japanese yen against the US dollar. Also it found that it takes time to move from the actual exchange rates to the exchange rates that are expected. All of the results showed that it is unlikely that prices will rise significantly due to the depreciation of the yen unless crude oil and resource energy prices rise abnormally. So, the view that exchange rate depreciation inevitably causes domestic price rising is sometimes dangerous.

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