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Effectiveness of the Easing of Monetary Policy in the Japanese Economy, Incorporating Energy Prices

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Abstract

Japan has reached the limits of conventional macroeconomic policy. In order to overcome deflation and achieve sustainable economic growth, the Bank of Japan (BOJ) recently set an inflation target of 2% and implemented an aggressive monetary policy so this target could be achieved as soon as possible. Although prices started to rise after the BOJ implemented monetary easing, this may have been for other reasons, such as higher oil prices. Oil became expensive as a result of the depreciated Japanese yen and this was one of the main causes of the rise in inflation. This paper shows that quantitative easing may not have stimulated the Japanese economy either. Aggregate demand, which includes private investment, did not increase significantly in Japan with lower interest rates. Private investment displays this unconventional behavior because of uncertainty about the future and because Japan's population is aging. We believe that the remedy for Japan's economic policy is not to be found in monetary policy. The government needs to implement serious structural changes and growth strategies.

JEL Classification: E47, E52, Q41, Q43

Contents

1. INTRODUCTION

In the early 1990s, Japan's real estate and stock market bubble burst and the economy went into a tailspin. Since then, Japan has suffered from sluggish economic growth. Almost 2 decades later, the collapse of Lehman Brothers in September 2008 sparked a global financial crisis that threatened the entire world economy. This was followed by a catastrophic earthquake and tsunami that struck northeastern Japan in March 2011. Japan's government budget deficit-to-gross domestic product (GDP) ratio breached 200% in 2010, mainly because of the high share of pension fund payments in government spending, and the efficiency and effectiveness of public investment was called into question. The Japanese economy required a stimulus to escape from this pattern of long-term sluggish growth. In December 2012, the Liberal Democratic Party won a general election, making Shinzo Abe the prime minister of Japan, a post that he had previously held in 2007. "Abenomics" refers to the economic policies advocated by the prime minister after the election, which were designed to revive the sluggish economy with "three arrows": (i) fiscal consolidation, (ii) more aggressive monetary easing by the Bank of Japan, and (iii) structural reforms to boost Japan's competitiveness and economic growth (Yoshino and Taghizadeh 2014a). The Bank of Japan settled on an inflation target of 2% and implemented a monetary easing policy.

In this paper we focus on the government's aggressive policy of monetary easing and pose two questions. First, does Japanese aggregate demand, which includes private investment, increase significantly when the interest rate drops following an easing of monetary policy? Second, has the inflation rate in Japan been affected by the aggressive monetary easing policy pursued by the Bank of Japan, or are there other reasons for the increase in the inflation rate, such as higher oil prices? In order to answer these questions, in the first section of the paper we explain the reasons for Japan's stagnant economy. We then attempt to shed some light on the BOJ's recent monetary policy and to explain how higher energy prices increased inflation in Japan. In the second section, we develop our model. In the third section we conduct the empirical analysis and in the fourth we present the paper's concluding remarks.

1.1 Japan's Stagnant Economy after the Bubble Bursts

The sudden imposition of tight monetary policy in 1990 pushed land and stock prices down about one-third from their peak level. The annual real growth rate of the economy was below 2% for most of the 1990s and the unemployment rate rose to almost 5% in 2002 and 2003. Paul Krugman has argued that Japan is currently in a liquidity trap;[1] a situation in which monetary policy is ineffective in lowering interest rates. However, our empirical analysis indicates that the problems of the Japanese economy stem from other sources.

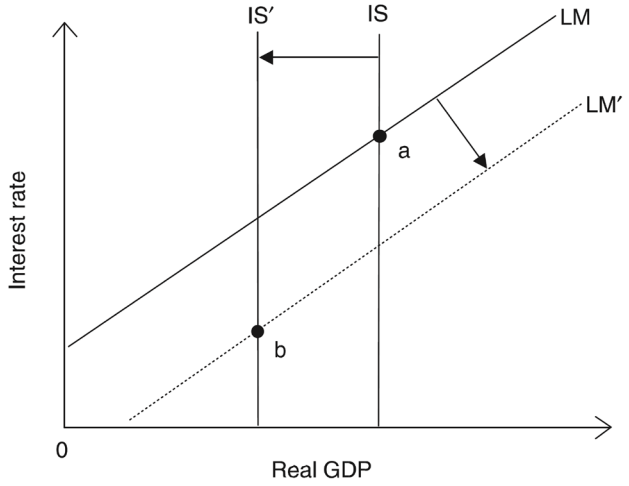
Aggregate demand, which includes private investment, has not increased significantly in Japan with lower interest rates. Private investment displays this unconventional behavior because of uncertainty about the future and because Japan's population is aging. In other words, the current monetary policy has not been effective.

The large foreign direct investment (FDI) of Japan to other Asian countries has shifted the investment–saving (IS) curve to the left, as shown in Figure 1. In such circumstances, because monetary policy is ineffective, fiscal policy needs to be used to shift the IS curve back to the right so that the economy can recover. However, the dilemma in Japan is that, despite the huge increase in government investment, the IS curve has not shifted enough to the right. This is

[1] http://www.brookings.edu/~/media/projects/bpea/1998%202/1998b_bpea_krugman_dominquez_rogoff.pdf

because the effectiveness of public works has drastically diminished, compared with that undertaken during the period of high growth (Yoshino and Nakahigashi 2000).

Figure 1: The Ineffectiveness of Monetary Policy in Japan



GDP = gross domestic product.

Source: Yoshino and Sakakibara (2002).

Public investment has not had a sufficient impact on Japan's gross national product (GNP) because it has been distributed ineffectively. The bulk of the increase in public investment has been concentrated in the countryside, where it has had a much smaller impact than it would have had in urban areas. Public investment in the agricultural sector has also been much less effective than in the industrial and service sectors. The result of this increasing rural and agricultural bias in the allocation of public investment is that the multiplier of public investment has declined sharply (Yoshino, Kaji, and Kameda 1998). This means that public investment has only increased budget deficits; it has been unable to bring about the recovery of the Japanese economy.

Several other factors have contributed to the stagnant economy in the last 2 decades:

(i) The bursting of the bubble was followed by a credit crunch because banks were less willing to make investment loans. Falling land prices made them reluctant to make loans because of the anticipated fall in the value of collateral. Prudential measures introduced in 1998, as well as higher capital requirements, forced banks to reduce the number of loans they made by even further. The growing proportion of nonperforming loans in the banks' loan portfolios meant that they reduced their lending in order to build up their loss provisions. The failures of several large financial institutions also reduced the availability of loans.

(ii) Capital flows became more sensitive to interest rates. Lower interest rates in Japan encouraged an outflow of investment to the United States (US) and other countries (Yoshino and Sakakibara 2002).

(iii) The level of consumption has decreased. The fall in the propensity to consume has been mainly a result of workers' concerns about possible layoffs. In addition, the fall in asset prices has lowered consumption, including that of the

corporate sector, because Japanese companies and individuals are no longer as wealthy as they were. Another reason for the decrease in the level of consumption is the demographic change. Japan's biggest problem is its aging population. The number of elderly and retired people is rising while the younger generation is shrinking, and usually elderly people consume less than younger generations.

1.2 Recent Monetary Policy of the Bank of Japan

The Government of Japan and the BOJ delivered a joint statement on overcoming deflation and achieving sustainable economic growth on 22 January 2013. The BOJ set a price stability target of 2% (year-on-year rate of change in the consumer price index). On 4 April 2013, the BOJ announced that, based on a decision by its Monetary Policy Meeting, it would purchase Japanese government bonds, effective 5 April 2013. This decision was taken at the first Monetary Policy Meeting after Haruhiko Kuroda had taken up his post as the new governor of the BOJ. Approximately ¥7.5 trillion per month of Japanese government bonds (2-year bonds, 5-year bonds, 10-year bonds, 20-year bonds, 30-year bonds, 40-year bonds, floating-rate bonds, and inflation-indexed bonds) would be purchased, thus increasing the monetary base, in contrast to previous attempts at an expansionary monetary policy which mainly focused on buying short-term government bonds (Yoshino and Taghizadeh 2014a). Although prices started to rise after the BOJ implemented monetary easing, it was unable to raise levels of investment and aggregate demand.[2] Japan's recent inflation has mainly stemmed from other sources such as higher energy prices as a result of the depreciation of the Japanese yen after the easing of monetary policy.[3]

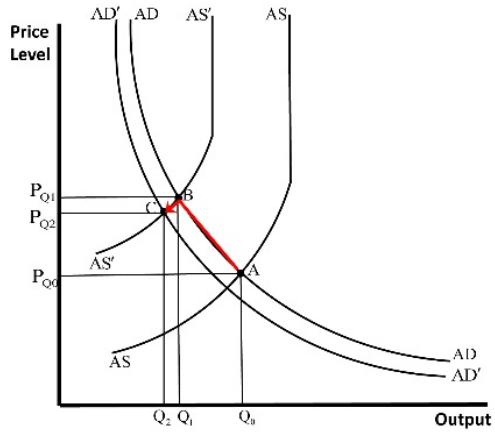
1.3 How Higher Energy Prices Can Create Inflation

A simple aggregate supply and demand model will demonstrate how higher energy prices resulting from the depreciation of the yen can create inflation in Japan.

[2] For more information on the impact of monetary policy on global oil prices see, inter alia, Taghizadeh and Yoshino (2013a; 2014); Yoshino and Taghizadeh (forthcoming).

[3] In March 2011, a 9.0 magnitude earthquake struck off the coast of Sendai, Japan, triggering a large tsunami. The damage to Japan resulted in an immediate shutdown of about 10 gigawatts (GW) of nuclear electric generating capacity. Between the 2011 Fukushima disaster and May 2012, Japan lost all of its nuclear capacity as a result of scheduled maintenance and lack of government approvals to return to operation. Japan replaced this significant loss of nuclear power with generation from imported natural gas, low-sulfur crude oil, fuel oil, and coal. This caused the price of electricity to rise for the government, utilities, and consumers, and led to inflation. Increases to the cost of fuel imports have resulted in Japan's top 10 utilities losing over $30 billion in the past 2 years. Japan spent $250 billion on total fuel imports in 2012, a third of the country's total import value. Japan consumed over 4.7 million barrels per day (bbl/d) of oil in 2012. The increased cost of imported energy had a significant negative impact on the Japanese economy. For more information on the impact of higher energy prices on the economy see, inter alia, Taghizadeh and Yoshino (2013b); Taghizadeh et al. (2013).

Figure 2: How Higher Energy Prices Can Create Inflation



Note: We assume that there is technological progress, which is why the output level in full employment also increases.

Source: Yoshino and Taghizadeh (2014b).

In Figure 2, the economy is initially in equilibrium with a price level PQ0 and a real output level Q0 at point A. AD is the aggregate demand curve and AS is the aggregate supply curve. The aggregate supply curve has an increasing slope to show that, at some real output level, it becomes difficult to increase real output despite increases in the general level of prices. At this output level, the economy achieves full employment. Let us suppose that the initial equilibrium, point A, is below the full employment level.

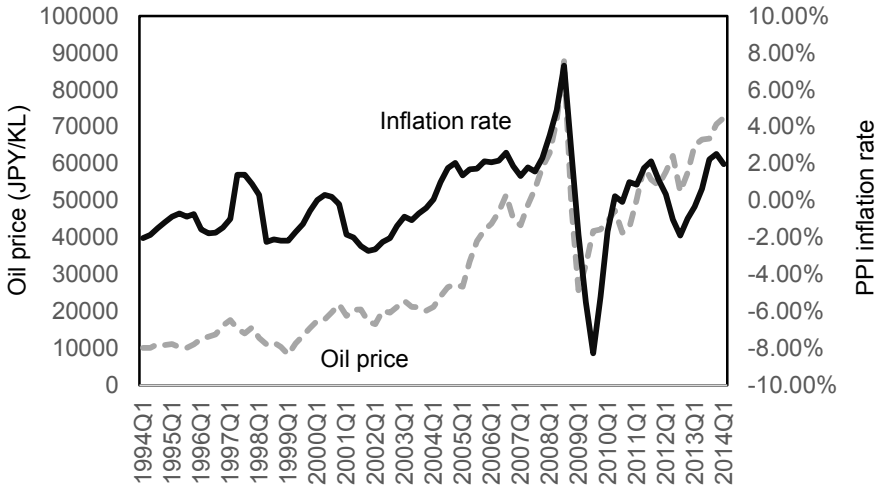
When the relative price of energy resources (e.g., crude oil, natural gas, coal) increases, the aggregate supply curve shifts to AS'. The employment of existing labor and capital with a given nominal wage rate requires a higher general price for output, if sufficient amounts of the higher-cost energy resources are to be used.

The *productivity* of existing capital and labor resources is reduced so that potential real output declines to Q1. In addition, the same rate of labor employment occurs only if real wages decline sufficiently to match the decline in productivity. This, in turn, happens only if the general level of prices rises sufficiently (PQ1), given the nominal wage rate. This moves the economy to the level of output (Q1) and price level (PQ1). This point is indicated in Figure 2 at point B, which is a disequilibrium point. Given the same supply of labor services and existing plant and equipment, the output associated with full employment declines as producers reduce their use of more expensive energy resources and as plant and equipment become economically obsolete.

On the other hand, on the demand side of the economy, when the price of energy resources rises, consumption of them declines. Because of this drop in consumption, the aggregate demand curve shifts to AD', which in turn reduces the prices from the previous disequilibrium level at PQ1 and sets them to PQ2 as the final equilibrium price. This lowers output levels because of the reduction in consumption in the economy, from the previous point of Q1 to Q2. This point is indicated in Figure 2 at point C, which is the final equilibrium point.

The economy may not adjust instantaneously to point C, even if this is the new equilibrium. For example, price rigidities due to slow-moving information or other transaction costs can keep nominal prices from adjusting quickly. Consequently, output and prices move along an adjustment path such as that indicated by the arrow in Figure 2. Figure 3 shows how this has played out in the Japanese economy.

Figure 3: Oil Price and Inflation Rate in Japan



KL = kiloliter.

Note: The inflation rate is the producer price index (PPI) growth rate for all commodities based on the year-on-year change. The oil price is the average cost, insurance and freight (CIF) imported crude oil price in Japan, in Japanese yen per kiloliter.

Source: Bank of Japan database and the Energy Data and Modelling Center (EDMC) database of the Institute of Energy Economics, Japan (IEEJ).

Figure 3 shows the movements of the inflation rate in Japan and the import price of crude oil in yen. It is clear that in most cases they followed same path and Figure 3 clearly shows the significant association between these two variables. Rising oil prices during Q1 1994 to Q1 2014 had various causes. In the first part of the period it resulted from higher crude oil demand, especially from emerging economies such as the People's Republic of China, India, Brazil, and the Middle East, which steadily led to higher global oil prices. More recently, especially since the BOJ implemented an easing of monetary policy, import prices have risen in yen terms because of the depreciation of the currency, leading to inflation.

2. MODEL

The New Keynesian approach to monetary policy analysis has emerged in recent years as one of the most influential and prolific areas of research in macroeconomics.[4] It has provided us with a framework that combines the theoretical rigor of real business cycle theory with Keynesian ingredients such as monopolistic competition and nominal rigidities. The framework has also become the basis for the new generation of models being developed at central banks, and increasingly used for simulation and forecasting purposes (see Gali, Smets, and Wouters [2012]).

In this section, we will try to develop a model with a New Keynesian approach that includes aggregate supply (Phillips Curve), aggregate demand side, and monetary policy blocks, in order to capture the impact of monetary policy and oil price shocks on the economy. We aim to answer these questions (i) can monetary easing stimulate GDP in Japan, and (ii) has the aggressive monetary policy of the BOJ raised aggregate demand and caused inflation, or has

[4] See Gali and Gertler (2007) for a quick introduction to the New Keynesian framework. The textbooks by Woodford (2003) and Gali (2008) provide a more comprehensive treatment and analysis of the New Keynesian model.

inflation in Japan stemmed from other sources, such as higher oil prices, which have shifted the aggregate supply to the left leading to inflation?

Below are three equations that constitute the simplest possible version of our New Keynesian model, and in the subsequent section we use these equations simultaneously in order to run our empirical analysis. The first equation in our simultaneous equation model (SEM), the New Keynesian Phillips Curve (NKPC), can be derived from aggregating the price-setting decisions by firms, combined with an equation describing the relationship between marginal cost and the level of activity. It takes the form in equation (1).

$$\pi_t = \alpha_\pi E_t\{\pi_{t+1}\} + \alpha_y\left(y_t - \bar{y}_t\right) + \alpha_{oil} p_t^{oil} + \alpha_{gas} p_t^{gas} + u_t \quad (1)$$

where π_t is the inflation rate, $E_t\{\pi_{t+1}\}$ is the expected inflation rate, $\left(y_t - \bar{y}_t\right)$ represents deviations of (log) output from (log) steady state (or trend level), p_t^{oil} and p_t^{gas} are crude oil and natural gas prices respectively, which are two main energy carriers and two production inputs, and changes in their prices could affect the general level of prices, and u_t is a cost-push shock.

The second key block of the model relates the output gap positively to its expected one-period-ahead value, negatively to the real interest rate, and positively to the exchange rate (e_t). When the domestic currency depreciates, this will tend to increase exports and decrease imports, which will allow output to increase, which can be seen in the left-hand side of equation (2). The real interest rate is defined as the difference between the long-term nominal interest rate (i_t^{LN}) and the expected inflation rate ($E_t\{\pi_{t+1}\}$). The resulting equation is given by:

$$\left(y_t - \bar{y}_t\right) = -\frac{1}{\beta_i}\left(i_t^{LN} - E_t\{\pi_{t+1}\}\right) + \beta_y E_t\left\{\left(y_{t+1} - \bar{y}_{t+1}\right)\right\} + \beta_e e_t \quad (2)$$

The third equation in the model is describing how monetary policy is conducted. The simplest possible such description is given by a version of the so-called “Taylor rule,” which takes the form:

$$i_t^{SN} = \gamma_0 + \gamma_\pi \pi_t + \gamma_y\left(y_t - \bar{y}_t\right) + v_t \quad (3)$$

where i_t^{SN} is the short-term nominal interest rate and v_t is the monetary shock.

Since the interest rate in equation 2 is the long-term interest rate and the interest rate in equation 3 is the short-term interest rate, in order to be able to run the SEM, we need to add one more block, which is called a “bridge equation”. This takes the form below:

$$i_t^{LN} = \lambda_0 + \lambda_i i_t^{SN} \quad (4)$$

Considering the above, the resulting SEM is given by:

$$\begin{pmatrix} \pi_t = \alpha_\pi E_t\{\pi_{t+1}\} + \alpha_y\left(y_t - \bar{y}_t\right) + \alpha_{oil} p_t^{oil} + \alpha_{gas} p_t^{gas} + u_t \\ \left(y_t - \bar{y}_t\right) = -\frac{1}{\beta_i}\left(i_t^{LN} - E_t\{\pi_{t+1}\}\right) + \beta_y E_t\left\{\left(y_{t+1} - \bar{y}_{t+1}\right)\right\} + \beta_e e_t \\ i_t^{SN} = \gamma_0 + \gamma_\pi \pi_t + \gamma_y\left(y_t - \bar{y}_t\right) + v_t \\ i_t^{LN} = \lambda_0 + \lambda_i i_t^{SN} \end{pmatrix} \quad (5)$$

Equation 5 enables us to capture impact of higher energy prices (oil and gas) and the output gap on the inflation rates. Moreover at the same time it allows us to see the impact of monetary policy on the output gap. This means that by carrying out the empirical analysis in Section 3 of this paper using the model, we should be able to answer to the two questions posed above: (i) can monetary easing stimulate GDP in Japan, and (ii) has the aggressive monetary policy of the BOJ raised aggregate demand and caused inflation, or has inflation in Japan stemmed from other sources, such as higher oil prices, which shift the aggregate supply to the left leading to inflation?

3. EMPIRICAL ANALYSIS[5]

3.1 Data Analysis

We used quarterly data from Q2 1994 to Q2 2014, a period that includes the era during which the BOJ adopted a zero interest rate policy. In Q1 2002 the short-term interest rate (the monetary policy interest rate of the BOJ) was almost zero. This forced us to separate the period of our analysis into two subperiods. The first, from Q2 1994 to Q4 2001, showed that the value of the short-term interest rate was significant and more than zero, and the second, from Q1 2002 to Q2 2014, showed that the BOJ had adopted a zero interest rate monetary policy. For most of this subperiod the short-term interest rate was almost zero.

The inflation rate that we used in our survey was the growth rate of the producer price index of Japan for all commodities based on year-on-year change. The output gap was the variation in the real GDP of Japan from GDP in a situation of full employment for the country. In order to estimate the GDP in a situation of full employment, we carried out the Hodrick Prescott filter on the real GDP. The price of oil is the average CIF imported crude oil price in Japan, in Japanese yen per kilo liter. The price of gas is the average CIF imported liquefied natural gas (LNG) price in Japan in yen per ton. As for the short-term interest rate, call rates (the average of the uncollateralized overnight rate) in Japan were used. For the long-term interest rate we used the Japanese government bond interest rate. And finally for the exchange rate we used the US dollar–Japanese yen spot rate average for the quarter, in the Tokyo market. The sources of data were the Trade Statistics of Japan, the Bank of Japan database, and the Energy Data and Modelling Center database of the Institute of Energy Economics, Japan (IEEJ).

To evaluate the stationarity of the series, we used an augmented Dickey–Fuller test. The results suggest that, with the exception of the short-term interest rate, the inflation rate, and the GDP gap, which were all stationary, all other variables are non-stationary. These variables include crude oil price, gas price, long-term interest rate, and the exchange rate. However, when we applied the unit root test to the first difference of the variables, we were able to reject the null

[5] Identification of SEM: One significant issue in simultaneous equations is identification, meaning that we must first determine whether the equation is identified or not. If the equation is not identified, then estimating its parameters is meaningless. This is because the estimates obtained cannot be interpreted, and therefore will not provide any useful information. Two popular ways for checking whether equations are identified or not are (i) the rank condition and (ii) the order condition. The order condition is a necessary but not sufficient condition for identification. The rank condition is both a necessary and sufficient condition for identification. The results of the order condition show that simultaneous equations are identified. However, as mentioned earlier, the order condition is a necessary but not sufficient condition for identification and there is one more step to go, which is the rank condition. The rank condition tells us whether the structural equations we are checking for identification can be distinguished from a linear combination of all structural equations in the simultaneous equation system. Results of the rank condition show that our simultaneous equations are identified, hence we can start the empirical analysis.

hypothesis of unit roots for each of the variables. These results suggest that the crude oil price, gas price, long-term interest rate, and exchange rate variables each contain a unit root. Once the unit root test was performed and it was discovered that the variables are non-stationary in level and stationary in the first differences level, they were integrated of order 1. Hence, variables will appear in our SEM in first differences form.

In the next step, in order to identify the cointegrating vectors among the variables, we conduct a cointegration analysis using Johansen's technique by assuming a linear deterministic trend for two cases, with intercept and with intercept and trend. The results suggested we should accept the null hypothesis of non-cointegrating variables, which means there are no cointegrating vectors among the variables.

3.2 Empirical Results

A regression would need to be run in order to assess the impact of the BOJ's easy monetary policy and higher energy prices on the Japanese economy. We ran the regression for our SEM using the weighted two-stage least squares (W2SLS) method. The results are summarized in Table 1. W2SLS is an instrumental-variable estimation methodology, for instruments we used lagged values of the two exogenous variables we have in this survey: oil price and gas price. We used the Akaike Information Criterion to select the lag orders in which the maximum lag is set to three lags of each variable.

Table 1: Empirical Results

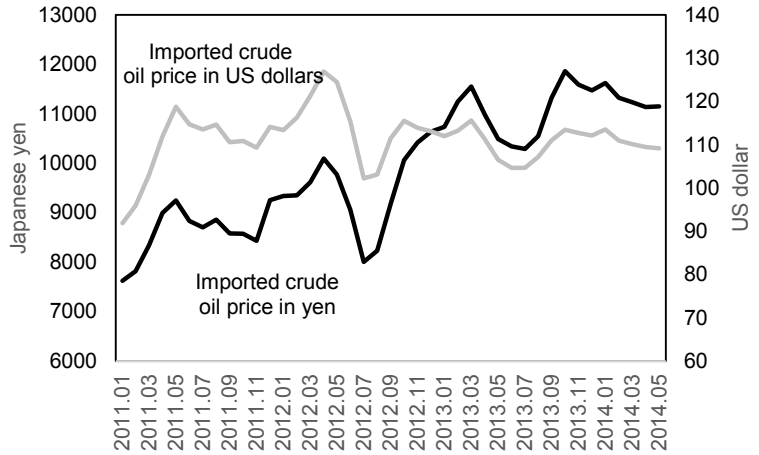
	Notation	Q2 1994–Q4 2001	Q1 2002–Q2 2014
Phillips curve			
Inflation rate π			
Lagged inflation rate	$\pi_{(-1)}$	0.89 (4.08)**	-0.36 (-1.12)
GDP gap	$(y-\bar{y})$	0.69 (2.18)*	-0.24 (-0.45)
Crude oil price	p^{oil}	0.06 (3.27)**	0.07 (2.59)**
Gas price	p^{gas}	0.03 (0.45)	0.05 (1.17)
Aggregate Demand			
GDP gap $(y-\bar{y})$			
Long-term real interest rate	$(i^{LN}-\pi)$	-0.02 (-4.71)**	-0.02 (-1.09)
Lagged GDP gap	$(y_{(-1)}-\bar{y}_{(-1)})$	-0.33 (-1.66)	0.42 (1.52)
Exchange rate	e	0.09 (2.18)*	0.07 (1.17)
Taylor Rule			
Short-term interest rate i^{SN}			
Inflation rate	π	1.21 (0.67)	1.94 (2.16)*
GDP gap	$(y-\bar{y})$	4.76 (2.72)**	3.89 (3.01)**
Bridge equation			
Long-term real interest rate i^{LN}			
Short-term interest rate	i^{SN}	3.50 (3.16)**	4.44 (2.67)*

Note: T-statistics are in parentheses; * indicates significance at 5%; ** indicates significance at 1%.

Source: Authors' calculations.

The first part of the empirical results is for the Phillips curve, which is the aggregate supply function. The y-axis of the Phillips curve is the inflation rate and the x-axis is $(y-\bar{y})$, which is the GDP gap. Usually the aggregate supply curve is upward slopping, which means the GDP gap and the rate of inflation should be positively related. Our results for Q2 1994–Q4 2001 are in accordance with an upward sloping aggregate supply, which means a larger GDP gap tended to lead to a higher inflation rate in the first period. When the economy is in an inflationary environment, that will accelerate current inflation even more, so in this situation lagged inflation should have a positive impact on the current inflation rate, which is what happened in the first period of our analysis. However after 2002, Japan was faced with deflation and a decreasing GDP gap, so the results show that the lagged inflation rate and the GDP gap in the Phillips curve are not significant in the second period of our analysis, which is valid. This means (i) the current year's inflation was not affected by lagged inflation rates, and (ii) because the economy was in recession, the GDP gap was negative and had no impact on the inflation rate. However, the increasing crude oil price shifted up the aggregate supply curve because imports of oil created inflationary pressure. Therefore the positive sign of the crude oil price in both periods is correct. This finding is in accordance with what is happening now in the Japanese economy. As mentioned earlier, the second arrow of Abenomics is an aggressive easing of monetary policy. Although inflation was created after the launch of this policy, we believe this stemmed mainly from other sources, especially from higher oil prices. Following the easy monetary policy of the BOJ, the yen started to depreciate heavily, which raised prices of crude oil and other energy imports, pushing up production costs, and creating inflation. Our empirical analysis supports this assertion. In the second period, the sign of the output gap in the Phillips curve equation was not significant, which means that the economy was in recession and aggregate demand did not raise enough to have an impact on price levels. However, the higher oil prices in yen, which were mainly a result of easy monetary policy, had significant impact on the general price levels and have been a negative development for Japanese manufacturers.

Figure 4: Crude Oil Import Price of Japan



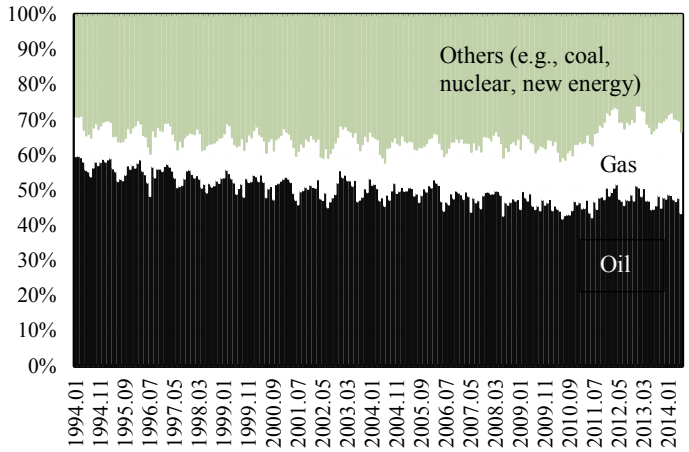
Note: Import prices are the CIF prices in Japan. The CIF price in Japan is converted into US dollars by the monthly average of the exchange.

Source: Japan Exports and Imports (Ministry of Finance).

Figure 4 compares the trend in the CIF Japan price of oil in US dollars and in yen. Because of the depreciated yen, which resulted from easy monetary policy, the black line (imported crude oil prices in Japanese yen), which was below the gray line, (imported crude oil price in US dollars) crossed it and moved upward.

As for the impact of the gas price on the inflation rate, this was not significant in either period. Oil is the main source of energy in the energy basket of Japan, which is why it was more significant in both periods. Figure 5 shows the shares of oil, gas, and other energy sources in the energy basket of Japan from January 1994 to June 2014.

Figure 5: Share of Different Energy Sources in the Japanese Energy Basket, January 1994–June 2014



Note: Shares are calculated by the calorific value of the energy sources. Oil is imported crude oil + imported petroleum products. Gas is imported LNG. Other energy sources include coal, nuclear power, hydropower, and new energy.

Source: General Energy Statistics, Agency of Resources and Energy, Ministry of Trade, Economy and Industry of Japan, METI.

It is clear the main energy source for Japan is oil and petroleum products. In the first period of our analysis (Q2 1994–Q4 2001) the average share of oil and petroleum products in the primary energy demand of Japan was almost 54%, although in the second period (Q1 2002–Q2 2014) this share diminished to about 48%. That is why oil price fluctuations had such an impact on Japan's macroeconomic variables, including the inflation rate in both periods. Gas represents a much smaller share of Japan's energy supply, 11% in the first period and 17% in the second. Following the March 2011 earthquake and catastrophic tsunami in Japan that shut down all nuclear power plants in the country, LNG imports increased dramatically and they are still growing. In future, if Japan continues to keep its nuclear power plants closed, we can expect LNG prices to exert a significant influence on the macroeconomic variables of the country.

The next part of Table 1 shows the results for the aggregate demand. When the real interest rate goes down, investment should go up, so the sign of the interest rate in the empirical findings should be negative. In both periods it is negative, although after 2002, because of the long-term recession, even when the interest rate was lower, investment did not accelerate, which is evidence for the vertical IS curve that can be seen in Figure 1. The lagged GDP gap in both periods did not have a significant impact on the current value of GDP. Exchange rates affect both exports and imports. If the value of the domestic currency appreciates, this should reduce exports and raise imports, meaning aggregate demand should go down. So the sign of the exchange rate in this equation should be positive. In this example both periods show positive signs for the exchange rate, although only in the first period it has a significant value.

The third part of the empirical results is the Taylor rule, which depends on inflation and the GDP gap. If the inflation rate keeps on going up, the central bank will tighten monetary policy, so the inflation rate should have a positive sign (Yoshino et al. 2014). In both periods it is positive, but only in the second period is it significant. With regard to the GDP gap, from Q2 1994–Q4 2001 this gap was widening. When the current GDP is higher than the full employment GDP, this

means the economy is accelerating. At this point, the central bank usually tries to tighten the money market, so the GDP gap in the Taylor rule should have a positive sign. After 2002, Japan was faced with recession, so $y - \bar{y}$ became negative. The central bank then lowered the short-term interest rate, and again the GDP gap in Taylor rule should have a positive sign.

The last part of Table 1 is for the bridge equation, which shows positive and significant association between the short-term and the long-term nominal interest rates.

4. CONCLUDING REMARKS

Currently the Bank of Japan is trying to achieve an inflation target of 2% by quantitative easing in order to overcome deflation and achieve sustainable economic growth. However, the present inflation rate may be the result of several factors, in particular the increase in the price of oil in yen terms. Based on our empirical results, after Q1 2002, the inflation rate was not affected by the GDP gap but by the higher oil prices as a result of the depreciated Japanese yen. This means that inflation in Japan may be caused less by a recovery in the Japanese economy than by an increase in the oil price, which implies Japan is experiencing stagflation.[6] In order to avoid this, Japan needs growth strategies and changes for the economy, which is dominated by an aging population. Monetary policy has not had a strong impact on this movement because from Q1 2002–Q2 2014, the long-term real interest rate has not had a significant impact on aggregate demand. The Government of Japan needs to focus on structural change and growth strategy rather than on monetary policy.

[6] This finding is in accordance with that of Taghizadeh and Yoshino (2014b). They found that higher oil prices create more inflation in advanced economies (US and Japan in their survey) than in emerging economies (the PRC in their survey). The reason is that in emerging economies aggregate supply is shifting to forward because of higher growth in outputs, so they can avoid high inflation during oil shocks.

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