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Policy Effects since the Introduction of Quantitative and Qualitative Monetary Easing (QQE)

-- Assessment Based on the Bank of Japan's Large-scale Macroeconomic Model (Q-JEM) --

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Abstract

Three and a half years or so have passed since the Bank of Japan introduced Quantitative and Qualitative Monetary Easing (QQE) in April 2013. This paper presents a simulation exercise based on the Bank of Japan's large-scale macroeconomic model (Q-JEM) to assess the impact of policies since the introduction of QQE on Japan's economic activity and prices.

In this exercise, we consider hypothetical scenarios assuming that QQE and subsequent easing measures had not been introduced, and conduct counterfactual simulations to examine how the Japanese economy and prices would have evolved under these scenarios. In this setting, we estimate the policy effects as the difference between the actual data and the counterfactual paths. We use two different starting points for the simulation: the introduction of QQE in Q2 2013, and the quarter before the introduction of QQE, when the Bank introduced its inflation target and markets may have anticipated a major policy change. Moreover, for each of the two different starting points, we consider two different cases in terms of what is regarded as part of the monetary policy shock brought about by QQE and subsequent policy measure. Specifically, in the first case, the monetary policy shock includes only the decline in real interest rates, and changes in exchange rates and stock prices are regarded as consequences of the policy shock only to the extent that they are explained within the model. In the second case, it includes *all* the changes in exchange rates and stock prices (beyond those predicted by the model).

The simulation results indicate that in three out of the four scenarios, the year-on-year rate of change in the CPI (all items less fresh food and energy) would have stayed negative or close to zero percent without the introduction of QQE and subsequent policy measures.

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1. Introduction

Quantitative and Qualitative Monetary Easing (QQE), introduced by the Bank of Japan in April 2013, has lowered nominal interest rates across the entire yield curve, including long-term interest rates, and has led to a reduction in firms' and households' borrowing costs as well as changes in asset prices. In conjunction with the commitment to the price stability target of 2 percent and asset purchases, it brought about a regime shift, affecting peoples' inflation perceptions, which, in turn, led to a rise in inflation expectations. Looking at Japan's economic activity and prices since the adoption of the policy, amid historically high levels of corporate profits and steady improvements in employment and income conditions, the Japanese economy is no longer in deflation, which is generally defined as a sustained decline in prices. However, during this period, external shocks such as the decline in crude oil prices, the weakness in demand following the consumption tax hike in April 2014, and the slowdown in emerging economies and volatile global financial markets have put downward pressure on Japan's economic activity and prices. Against this background, the price stability target of 2 percent has not been achieved.

This paper presents a quantitative analysis to gauge the policy impact of QQE and subsequent easing measures on Japan's economic activity and prices using the Bank's Quarterly Japanese Economic Model (Q-JEM).[1,2] Q-JEM is a large-scale macroeconomic model of Japan's economy consisting of more than two hundred equations, which is estimated to fit historical data to capture key characteristics of the Japanese economy. This means that Q-JEM provides an appropriate tool to conduct quantitative analyses on how changes in various economic variables -- such as real interest rates -- brought about by changes in monetary policy affect the economy and prices.[3,4]

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[1] The analyses presented in this paper were conducted as part of the Bank's comprehensive assessment of economic and price developments and the policy effects of QQE and "QQE with a Negative Interest Rate." For further details on the assessment see, Bank of Japan (2016).

[2] Other examples of policy analyses using large-scale macro models include Engen et al. (2015) on the effects of unconventional monetary policies.

[3] For more details on Q-JEM, see Fukunaga et al. (2011) and Ichiue et al. (2009).

[4] In Bank of Japan Monetary Affairs Department (2015), the policy effects over the two years after the introduction of QQE were estimated ("Assessment after Two Years" hereafter). In the "Assessment after Two Years," the change in real interest rates was calculated, and this was multiplied by the interest-rate multipliers in Q-JEM. While conceptually the approach employed in this paper is similar to the one used in the "Assessment after Two Years," the simulations here are conducted from the opposite perspective. The "Assessment after Two Years" estimated the impact of the decline in real interest rates on economic activity and prices. In contrast, the analysis in this paper estimates how the economy and prices would have evolved if real interest rates had not declined. The reason why the latter approach is used is that it can better estimate the policy effects, since developments in inflation expectations have been more complex than those observed at the time of the "Assessment after Two Years." In the "Assessment after Two Years," it was assumed that the impact of the decline in real interest rates was instantaneous with the introduction of QQE. On the other hand, in the analysis here, the impact of changes in real interest rates is assumed to affect the

Specifically, we conduct counterfactual simulations based on hypothetical scenarios assuming that QQE and associated policy measures were not introduced and examine how the economy and prices would have evolved under these circumstances. It is likely that without QQE, developments in Japan's economy and prices would have been weaker than was actually the case. Therefore, the difference between actually observed data and the corresponding counterfactual simulation results can be regarded as the effects of monetary policy. In this context, it is worth highlighting that in the three and a half years or so since the introduction of QQE in April 2013, the economy has been hit by a range of external shocks other than monetary policy shocks, including the decline in crude oil prices, the weakness in demand following the consumption tax hike in April 2014, and the slowdown in emerging economies and volatile global financial markets. The following counterfactual simulations take these shocks as given, enabling us to gauge and assess the "pure" policy effects on economic activity and prices since the introduction of QQE.

1.1 Transmission Mechanism of QQE

Before considering the assumptions for the simulations, we summarize the Bank's monetary easing measures since Q1 2013 as well as their transmission mechanism.

The Bank of Japan introduced the price stability target of 2 percent in terms of the year-on-year rate of change in the consumer price index (CPI) at the monetary policy meeting held in January 2013. In the April meeting of the same year, the Bank introduced QQE, which includes large-scale asset purchases, consisting mainly of purchases of Japanese government bonds (JGBs). After that, in October 2014, the Bank took additional measures to increase the amount of asset purchases, and in January 2016, the Bank decided to introduce a negative interest rate policy ("QQE with a Negative Interest Rate").

The main transmission channel of QQE envisaged by the Bank when it introduced the policy was the reduction in real interest rates.[5] Specifically, (1) people's deflationary mindset would be dispelled and inflation expectations would be raised through the Bank's large-scale monetary easing under its strong and clear commitment to achieving the price stability target of 2 percent. At the same time, (2) downward pressure would be put on nominal interest rates across the entire yield curve through the Bank's purchases of JGBs. (3) Together, these developments would reduce real interest rates. (4) The decline in real interest rates would lead to an improvement in the output gap. (5) The improvement in the output gap, together with rising inflation expectations, would push up the observed inflation rate. (6) Once people experienced an actual rise in the inflation rate, they would adapt their inflation expectations, resulting in

economy gradually. For this reason, the policy effects estimated here tend to be smaller than those based on the approach in the "Assessment after Two Years," even when the same period is examined.

[5] The description of the transmission mechanism of QQE is based on the "Assessment after Two Years."

higher inflation expectations and further reinforcing this process (Chart 1).

In addition, it was envisaged that as a result of the Bank's monetary easing, (7) asset prices such as stock prices as well as the exchange rate of the yen would reflect actual or anticipated improvements in economic activity and prices, thereby improving financial conditions and having a positive impact on economic activity and prices. Finally, it was envisaged that (8) it would work through the portfolio rebalancing effect by increasing investors' appetite for risky assets, thereby exerting a positive effect on prices of risky assets and leading to an increase in lending.

In the following sections, we examine how the introduction of QQE lifted inflation through the above transmission channels.

1.2 Financial and Economic Developments before and after the Monetary Policy Change

We now review developments in financial and economic conditions before and after the introduction of QQE. Chart 2 shows developments in long-term nominal interest rates, inflation expectations, the yen/U.S. dollar exchange rate, stock prices, overseas economic growth, and crude oil prices (Dubai oil) before and after the introduction of QQE in April 2013.[6]

In January 2013, the Bank introduced the 2 percent price stability target, followed, in April 2013, by the introduction of QQE -- the policy regime to achieve the target -- consisting of large-scale purchases of assets, primarily JGBs. More or less during the same period, from late 2012 to mid-2013, a sharp rise in inflation expectations, a decline in long-term nominal interest rates, a substantial depreciation of the yen, and a surge in stock prices can be observed.

From the second half of 2014, inflation expectations stopped increasing, reflecting the substantial fall in crude oil prices and weak demand following the consumption tax hike in April 2014. In response, the Bank decided to expand QQE in October of that year, and soon after this decision, another substantial depreciation of the yen and surge in stock prices can be observed.

However, since early 2016, the economic slowdown in emerging economies, especially in China, and the further decline in crude oil prices have led to an appreciation of the yen and fall in stock prices. Against this background, the Bank decided to introduce "QQE with a Negative Interest Rate." However, although long-term nominal interest rates declined sharply following the decision, it is difficult to identify any policy shock in other variables such as the exchange

[6] In this paper, we employed the 6 to 10 years ahead forecasts of year-on-year CPI inflation in the Consensus Forecasts. Since only semi-annual data are available before April 2014, we obtained quarterly data through interpolation using Kalman filtering techniques. In the estimation, we considered an AR(1) process for the state equation and used data from January 1990 to April 2016.

rate and stock prices due to the increased volatility in financial markets brought by external factors such as the economic slowdown in emerging economies.

2. Design of Simulation Using Q-JEM

In this section, we first review the transmission mechanism of QQE and the quantitative impact of the decline in real interest rates on the output gap and the consumer price index (CPI, all items less fresh food and energy) in Q-JEM.

We then present our hypothetical scenarios assuming that QQE and subsequent easing measures had not been introduced and conduct counterfactual simulations to examine how the output gap and CPI inflation (all items less fresh food and energy) would have evolved under these scenarios. Finally, we explain our approach to gauging the policy effects of QQE.

2.1 Effects and Transmission Channels of Real Interest Rate Cuts in Q-JEM

Using Q-JEM, we start by examining the transmission channels through which a cut in real interest rates stimulates economic activity and prices.[7] To this end, we look at the multipliers in Q-JEM in the case of a 1 percentage point reduction in real interest rates, which we assume consists of a 0.5 percentage point increase in inflation expectations and a 0.5 percent percentage point reduction in long-term nominal interest rates (Chart 3),[8] as well as the transmission channel in Q-JEM in the case of a cut in real interest rates (Chart 4).

The model implies that a decline in real interest rates boosts business investment and exports. Specifically, business investment in Q-JEM is linked to the shadow price of firms' capital stock (that is, Tobin's Q). A reduction in real interest rates raises the present discounted value of firms' future cash flows, which, in turn, will raise their share price and increase the shadow price of their capital stock, leading to an increase in capital investment. Similarly, as will be discussed in a later section, an increase in exports also affects firms' output and profits, leading to higher capital investment. Exports are mainly determined by growth in overseas economies and the exchange rate. In Q-JEM, based on interest rate parity, it is assumed that the yen/U.S. dollar exchange rate is driven by the difference in real interest rates between Japan and the United States. This means that a decline in real interest rates in Japan leads to a depreciation of the yen, which ultimately leads to an increase in exports.[9]

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[7] Interest rates are characterized by a term structure, with interest rate levels, their determinants, and their impact on the real economy varying depending on the maturity of the underlying financial contracts. Q-JEM generally assumes that the impact of interest rates on the real economy works through long-term interest rates and our analysis consequently focuses on long-term interest rates. For more details on the term structure of real interest rates, see Imakubo, Kojima, and Nakajima (2015).

[8] The multipliers represent the simulation results in Q-JEM of how each variable responds to a 1 percentage point reduction in real interest rates in levels.

[9] More specifically, the nominal exchange rate is determined by the real exchange rate, which is explained

Further, a decline in real interest rates will boost private consumption by households. In Q-JEM, private consumption is mainly linked to labor income, other sources of income, and wealth effects driven by changes in the value of financial assets. A decline in real interest rates increases firms' production, which has a positive impact on labor income as well as positive wealth effects due to higher stock prices.[10,11]

Therefore, the output gap, which represents the overall balance of demand and supply in the economy, improves. In the case considered here, the response of the output gap to a 1 percentage point reduction in real interest rates is about +1.2 percentage points in the second year after the real interest rate reduction and +1.1 percentage points in the third year.

Consumer prices in Q-JEM are affected by three factors: (i) changes in the output gap, (ii) changes in inflation expectations, and (iii) changes in exchange rates. The transmission channel via the output gap was already mentioned in the previous section. With regard to inflation expectations, Q-JEM assumes that expectations formation consists of two elements. The first is a forward-looking element; that is, it is assumed that private agents believe in the Bank's price stability target and expect CPI inflation to approach 2 percent. The second is a backward-looking element, which assumes that private agents gradually update their expectations based on past developments in underlying CPI inflation.[12] The aim of QQE, in conjunction with the price stability target introduced in Q1 2013, was to raise inflation expectations through this forward-looking component. Meanwhile, backward-looking inflation expectations would be pushed up by the increase in actual inflation as a result of the improvement in the output gap mentioned above and the rise in forward-looking expectations. Finally, as for the transmission through exchange rate changes, the depreciation of the yen as a result of a decline in real interest rates will boost import prices, which will then feed through to consumer prices. The overall effect of a 1 percentage point decline in real interest rates through these three mechanisms on the year-on-year rate of change in CPI (all items less fresh food and energy) is +0.5 percentage points in the second year after the real interest rate decline and +0.7 percentage points in the third year.[13]

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by differences in real interest rates in Japan and the United States as well as differences in the price level.

[10] The model also takes the positive effects of lower real interest rates on residential investment into account.

[11] In Q-JEM, a decline in nominal interest rates reduces interest income and a rise in inflation expectations reduces real income. As a result, a cut in real interest rates also has some negative effects, although these are outweighed by the positive effects.

[12] For further details on the role of expectations formation in Q-JEM, refer to the forthcoming BOJ Working Paper on the issue scheduled to be published shortly.

[13] For our example in this section, we assumed that real interest rates decline by 1 percentage point, consisting of an increase in inflation expectations by 0.5 percentage points and a decline in nominal long-term interest rates by 0.5 percentage points. However, this does not mean that a 1 percentage point decline in real interest rates has the same impact on the economy and prices regardless of how it is made up in terms of the contribution of changes in inflation expectations and nominal long-term nominal interest rates. The reason is that changes in inflation expectations feed into CPI inflation not only through the real interest rate channel but also via the Phillips curve.

The above estimates represent the impact of a 1 percentage point decline in real interest rates on the output gap and CPI inflation (all items less fresh food and energy) estimated using Q-JEM. In practice, however, real interest rates and their components -- inflation expectations and long-term nominal interest rates -- vary over time. Therefore, in the following section, we conduct simulations based on actual developments in the data.

2.2 Simulation Scenarios

We consider various hypothetical scenarios that assume that QQE and subsequent easing measures had not been introduced, and conduct counterfactual simulation to examine how the Japanese economy and prices would have evolved under these scenarios. With the policy effects mentioned in the previous section in mind, it is likely that without such monetary easing, the economy and prices would have fallen below actual observations. Therefore, the deviation between the counterfactual simulations and actual observations can be interpreted as the effects of monetary easing on growth and inflation. Chart 5 provides a schematic representation of our counterfactual simulation approach.

Starting Period of the Simulation

We use two different starting periods for the simulation, reflecting different assumptions as to when the policy effects of QQE started to materialize. As mentioned in Section 1, there were substantial changes in financial conditions such as inflation expectations, exchange rates, and stock prices, from late 2012 to the first half of 2013, so that the simulation results potentially differ substantially depending on the starting period of the simulation.

The Bank announced the 2 percent "price stability target" in January 2013, while QQE, the policy regime to achieve this target, was introduced in April 2013. Therefore, if we look at when asset purchases to achieve the target began, the starting period of the simulations should be Q2 2013 ("Simulation A" hereafter).

On the other hand, it is highly likely that policy effects with respect to inflation expectations, exchange rates, and stock prices materialized in a forward looking manner from Q1 2013, when the Bank announced the price stability target of 2 percent. This means we should also consider simulations starting from Q1 2013 ("Simulation B" hereafter).

These considerations suggest that it is rather difficult to specify the exact timing of when the policy effects of QQE actually started to materialize, so that the simulation results should be viewed with some latitude. In order to avoid arbitrarily selecting one of the two scenarios, we conduct simulations for both.

Identification of Monetary Policy Shocks

As mentioned, the aim of QQE and subsequent easing measures is to raise inflation mainly by

reducing real interest rates by lowering long-term nominal interest rates and raising inflation expectations. Therefore, for our simulations, we regard changes in long-term nominal interest rates and inflation expectations in response to the introduction of QQE as the monetary policy shock brought about by the introduction of QQE. Specifically, we consider the change in nominal interest rates and inflation expectations from one period prior to the introduction of QQE. This means that in the case of Simulation A, the shock is identified as the change after Q1 2013, while in the case of Simulation B, it is identified as the change after Q4 2012. Moreover, with regard to Simulation A and Simulation B, we consider two different counterfactual scenarios. The first is that the shock to nominal interest rates and inflation expectations did not occur (referred to as "Case 1" hereafter).[14]

From a theoretical perspective, the depreciation of the yen and increase in stock prices described in Section 2.1 can be regarded as the consequence of the shock to nominal interest rates and inflation expectations. Case 1 therefore assumes that the changes in exchange rates and prices predicted by the model (but only to the extent predicted by the model) are consequences of the monetary policy shock. However, the actual depreciation and increase in stock prices were far greater than implied by the model. One interpretation is to regard this discrepancy as reflecting shocks other than monetary policy shocks, but an alternative interpretation is to regard it as the effects of the regime shift in monetary policy. This regime shift includes policy measures such as the introduction of the 2 percent price stability target and the introduction of QQE, which may have affected not only nominal interest rates and inflation expectations but also exchange rates and stock prices in a discontinuous manner. Such shocks cannot be accurately identified using macroeconomic models estimated from long-term historical data. Given these considerations, the second case we examine, i.e., Case 2, assumes that *all* of the change in exchange rates and stock prices in this period are part of the monetary policy shock. Therefore, in addition to the assumptions in Case 1, Case 2 assumes that changes in exchange rates and stock prices did not occur. Conducting this kind of simulation allows us to some extent to overcome the limitation of macroeconomic models.[15]

Simulation results based on Case 2 should be viewed with some latitude, since a variety of shocks other than monetary policy shocks could affect exchange rates or stock prices, and the estimated policy effects could be over- or underestimated depending on the period considered.[16]

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[14] If nominal long-term interest rates and inflation expectations had remained unchanged during the simulation period, real interest rates -- which are the difference between the two -- would have remained unchanged as well.

[15] Q-JEM does not explicitly incorporate the portfolio rebalancing channel of quantitative easing. However, by conducting simulations such as Case 2, we can to some extent gauge the effects reflected in, say, actual stock prices. For further details on the portfolio rebalancing channel, see M. Saito and Y. Hogen (2014).

[16] For example, the appreciation of the yen and the fall in stock prices during the second half of FY2015 could have been due to the increase in volatility in global financial markets during this period. The

3. Simulation Results

This section presents our simulation results.

3.1 Simulation A

We start by explaining the results for Simulation A, where we assume that the policy effects began to materialize in Q2 2013 (Chart 6). As discussed in Section 2, we consider two cases. Case 1 regards only the effects of the decline in real interest rates and the endogenous change in exchange rates and stock prices as the impact of the introduction of QQE. On the other hand, Case 2 regards changes in real interest rates and *all* of the change in exchange rates and stock prices (and not just the part implied by Q-JEM) as the impact of monetary policy. In other words, we regard all of the observed depreciation of the yen, which went beyond that suggested by interest rate parity, and all of the observed increase in stock prices, which went beyond that suggested by the increase in the present discounted value of firms' cash flow due to the decline in real interest rates, as the monetary policy shock.

Case 1

Case 1 consists of the hypothetical scenario that inflation expectations and long-term nominal interest rates remained unchanged from Q1 2013 onward. Given that real interest rates are the difference between the two, real interest rates also remain unchanged.

The simulation indicates that long-term nominal interest rates would have been higher than actually was the case. Based on interest rate parity, this would have led to an appreciation of the yen, while stock prices would have decreased to some extent as a result of the decline in the present value of firms' cash flows. Since inflation expectations would have been lower, real interest rates would have been higher. Higher real interest rates, a stronger yen, and lower stock prices would have had a negative impact on business investment, private consumption, and exports, and hence would have negatively affected the output gap. In addition to the weaker developments in the output gap, the lower inflation expectations would have exerted downward pressure on consumer prices, so that the year-on-year rate of change in the CPI (all items less fresh food and energy) would have been somewhat lower than was actually the case.

These considerations imply that the gap between actual developments and the simulation results can be regarded as the policy effect of QQE. Therefore, we define the estimated policy

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estimated policy effects would be underestimated when we include these developments as policy shocks.

effect as the difference between the simulation results and actual developments. In terms of the output gap, the policy impact is estimated to be about +0.4 percentage points for FY2014 and about +0.6 percentage points for FY2015. And on the basis of this impact on the output gap, the policy effect on the year-on-year rate of change in the CPI (all items less fresh food and energy) is estimated to be about +0.2 percentage points for FY2014 and about +0.3 percentage points for FY2015.

Case 2

Case 1 considered the counterfactual scenario that inflation expectations and long-term nominal interest rates remained unchanged and that there was some appreciation of the yen and decline in stock prices. However, as mentioned, the actual depreciation of the yen and increase in stock prices during the simulation period far exceeded the changes predicted by the model. Case 2 therefore assumes that not only inflation expectations and long-term nominal interest rates, but also exchange rates and stock prices had remained unchanged since Q1 2013. As in Case 1, real interest rates remain unchanged over the simulation horizon.

Comparing the simulation in this scenario with actual developments and the results from Case 1, the yen would have been much stronger and stock prices much weaker. As a result, exports and business investment would have been much weaker and the output gap considerably worse. The large negative output gap along with the lower inflation expectations would have resulted in a lower year-on-year rate of change in the CPI (all items less fresh food and energy).

Looking at the policy effects in terms of the output gap, the simulation results suggest that without QQE the negative output gap would have been 1.6 percentage points larger in FY2014 and 2.6 percentage points larger in FY2015 than was actually the case -- results that are larger than those in Case 1. As a result, the effects on the year-on-year rate of change in the CPI (all items less fresh food and energy) are also larger than in Case 1, reaching about +0.4 percentage points in FY2014 and about +0.8 percentage points in FY2015.

3.2 Simulation B

As mentioned in Section 2, inflation expectations, exchange rates, and stock prices all showed substantial movement between Q4 2012 and Q1 2013, that is, before the Bank started its large-scale asset purchases in April 2013. In Simulation B, these changes are regarded as forming part of the policy shock. We therefore expect the estimated policy effects (Chart 7) to be larger than those based on Simulation A.

Case 1

As in Simulation A above, Case 1 assumes that long-term nominal interest rates remained

unchanged from Q1 2013 onward. However, inflation expectations are assumed to remain unchanged from Q4 2012, i.e., a quarter earlier than in Simulation A. In other words, the substantial increase in inflation expectations between Q4 2012 and Q1 2013 is regarded as forming part of the policy shock. Consequently, it is assumed that real interest rates remain unchanged from Q4 2012 onward. Since in this case the real interest rate level used for the counterfactual is much higher than in Simulation A, the impact of QQE on consumer prices through an improvement in the output gap is also larger.

The simulation results suggest that in the absence of QQE the negative output gap would have been much larger, reflecting the lower business investment and private consumption as a result of higher real interest rates. Moreover, since inflation expectations would have been much lower than actually was the case, the year-on-year rate of change in the CPI (all items less fresh food and energy) would have also have been much lower.

Looking at the policy effects, QQE reduced the negative output gap by 0.9 percentage points in FY2014 and 1.1 percentage points in FY2015, providing a clear illustration of the impact of lower real interest rates. As for the effects on the year-on-year rate of change in the CPI (all items less fresh food and energy), the higher inflation expectations, together with the contribution of the smaller negative output gap, pushed up the year-on-year rate of change, so that CPI inflation in FY2014 was 0.5 percentage points higher and that in FY2015 0.8 percentage points higher than would otherwise have been the case. These estimates are similar to those obtained in Case 2 of Simulation A.

Case 2

Case 2, in addition to the assumptions made in Case 1, further assumes that exchange rates and stock prices remained unchanged from Q4 2012 onward. Compared with Case 2 in Simulation A, this means that real interest rates would have remained at a much higher level and that the impact of the substantial depreciation of the yen and increase in stock prices between Q4 2012 and Q1 2013 is included in the policy effects, so that the policy effect on consumer prices through the impact on the output gap and the direct impact via import prices due to the yen depreciation would be even greater than in Case 1.

Looking at the simulation results, we find that the negative output gap would have been much larger than was actually the case, mainly due to lower exports and business investment. Since inflation expectations would have been much lower, the year-on-year rate of change in consumer prices would also have been much lower, so that the year-on-year rate of change in the CPI (all items less fresh food and energy) would have fallen into negative territory.

The estimated policy effect in this case is a reduction in the negative output gap of 3.2 percentage points in FY2014 and of 4.2 percentage points in FY2015, suggesting that in

addition to the decrease in real interest rates the substantial depreciation of the yen and rise in stock prices in late 2012 and early 2013 also made a large contribution to improving the output gap. The effects on the year-on-year rate of change in the CPI (all items less fresh food and energy) are much larger than in Case 1 or in Case 2 in Simulation A, reaching +0.9 percentage points in FY2014 and +1.5 percentage points in FY2015.

3.3 Summary of Simulation Results

The above results are summarized in Chart 8. The estimated policy effects on the output gap range from +0.4 to +3.2 percentage points for FY2014 and from +0.6 to +4.2 percentage points for FY2015, indicating that the range of the estimates is quite wide. Similarly, the estimated impact on the year-on-year rate of change in the CPI (all items less fresh food and energy) also shows some dispersion, ranging from +0.2 to +0.9 percentage points for FY2014 and from +0.3 to +1.5 percentage points for FY2015. This dispersion in the estimates reflects the fact that QQE was such an unprecedentedly large-scale monetary easing policy that substantial changes in inflation expectations, exchange rates, and stock prices were observed before and after its introduction. Against this background, the simulation results should be viewed with some latitude.

However, with the exception of Case 1 in Simulation A, the simulation results all show that the year-on-year rate of change in the CPI (all items less fresh food and energy) would have been negative or close to zero percent, meaning that without the introduction of QQE Japan's economy would still be experiencing deflation in the sense of a sustained decline in prices.

Of course, it needs to be kept in mind that the simulation results depend on the various assumptions made, the data used, and the nature of the macroeconomic model employed in the analysis. In particular, the scenarios used for the counterfactual simulations assume that the changes in inflation expectations, long-term nominal interest rates, exchange rates, and stock prices can be regarded as monetary policy shocks. In practice, however, other external shocks may have contributed to developments in these variables since the introduction of QQE.[17] Hence, the results presented here may over- or underestimate the policy effects to some extent. Moreover, it seems that the observation error for inflation expectations is larger than that for other economic variables. Further, Q-JEM, the macroeconomic model used for the analysis, may not adequately capture the latest structural changes in the economy, since it is estimated to fit past historical data, and, given the linear nature of the model, may not sufficiently capture possible non-linear relationships among economic variables.

[17] Specific examples of such external shocks include government spending such as the large-scale public investment conducted during this period, the consumption tax rate hike in 2014, developments in overseas economies and crude oil prices, and other factors specific to financial markets.

4. Conclusion

In this paper, in order to assess the policy effects of the introduction of QQE in April 2013 and subsequent policy measures, we conducted counterfactual simulations using a macroeconomic model to simulate how the economy and prices would have evolved in the absence of these policy measures.

The simulation results differ considerably depending on the underlying assumption. Specifically, we made different assumptions regarding the timing at which the policy effects started to materialize (i.e., from Q1 2013 or from Q2 2013) and regarding what developments to consider as part of the policy shock directly brought about by those monetary easing measures; that is, whether it includes only the decline in real interest rates and associated changes in exchange rates and stock prices predicted by the model, or whether it includes all the changes in exchange rates and stock prices, which were greater than the changes implied by the model. Given these different assumptions, the results must be viewed with some latitude. However, in most of the scenarios, the year-on-year rate of change in the CPI (all items less fresh food and energy) would have been negative or close to zero percent, meaning that Japan's economy would have still been in deflation without QQE. In other words, QQE has made a substantial contribution in helping Japan's economy to escape from persistent deflation.

References

Bank of Japan (2016), "Comprehensive Assessment: Developments in Economic Activity and Prices as well as Policy Effects since the Introduction of Quantitative and Qualitative Monetary Easing (QQE)."

Engen, E., T. Laubach, and D. Reifschneider (2015), "The Macroeconomic Effects of the Federal Reserve's Unconventional Monetary Policies," 16th Jacques Polak Annual Research Conference, November 5-6, 2015.

Fukunaga, I., N. Hara, S. Kojima, Y. Ueno, and S. Yoneyama (2011), "The Quarterly Japanese Economic Model (Q-JEM): 2011 Version," Bank of Japan Working Paper Series, No. 11-E-11.

Ichiue, H., T. Kitamura, S. Kojima, T. Shirota, K. Nakamura, and N. Hara (2009), "Hybrid-type Quarterly-Japanese Economic Model (Q-JEM)," Bank of Japan Working Paper Series, No. 09-J-6 (in Japanese).

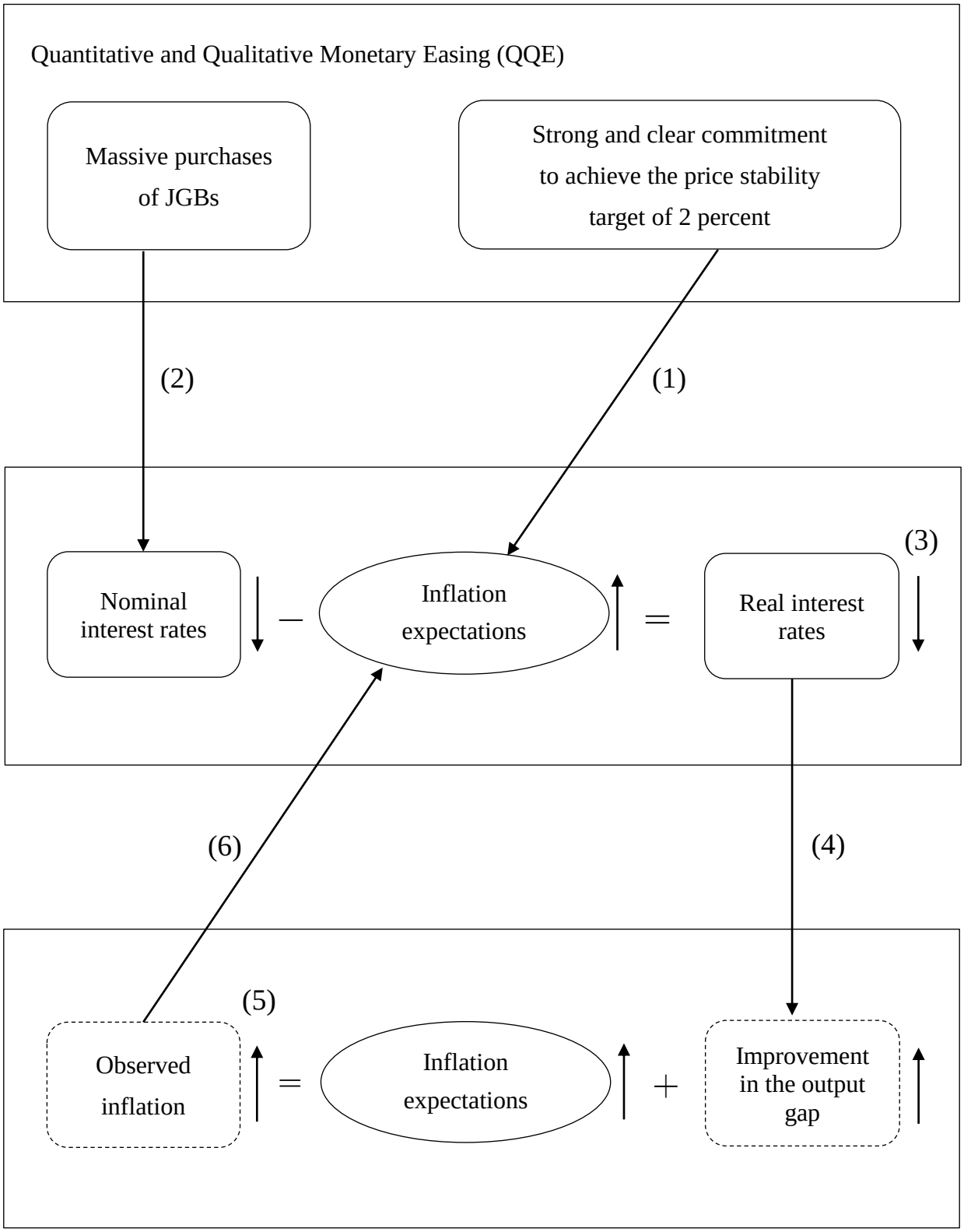
Imakubo, K., H. Kojima, and J. Nakajima (2015), "The Natural Yield Curve: Its Concept and Measurement," Bank of Japan Working Paper Series, No.15-E-5.

Monetary Affairs Department of Bank of Japan (2015), "Quantitative and Qualitative Monetary Easing: Assessment of Its Effects in the Two Years since Its Introduction," Bank of Japan Review Series, No. 2015-E-3.

Saito, M., and Y. Hogen (2014), "Portfolio Rebalancing Following the Bank of Japan's Government Bond Purchases: Empirical Analysis Using Data on Bank Loans and Investment Flows," Bank of Japan Research Papers.

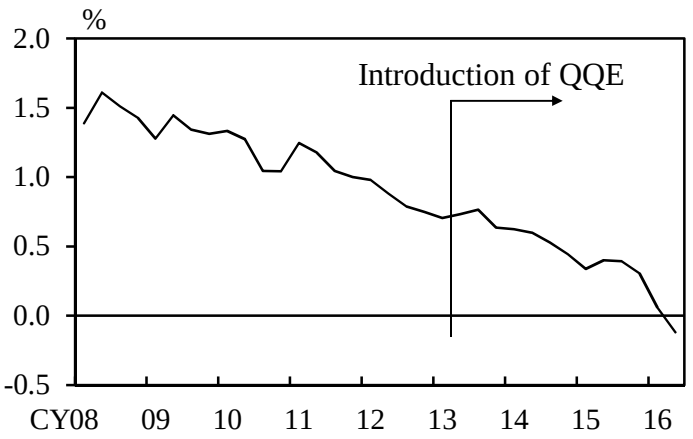
Chart 1

Transmission Mechanism of QQE Envisioned When It Was Introduced



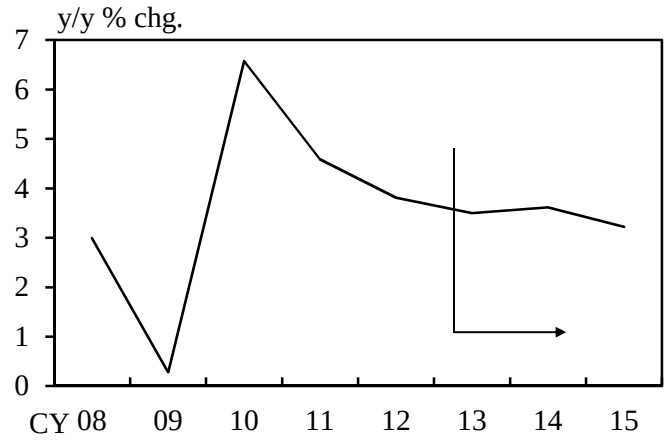
Financial and Economic Developments Before and After the Introduction of QQE

(1) Nominal Long-Term Interest Rates (10 year JGBs)

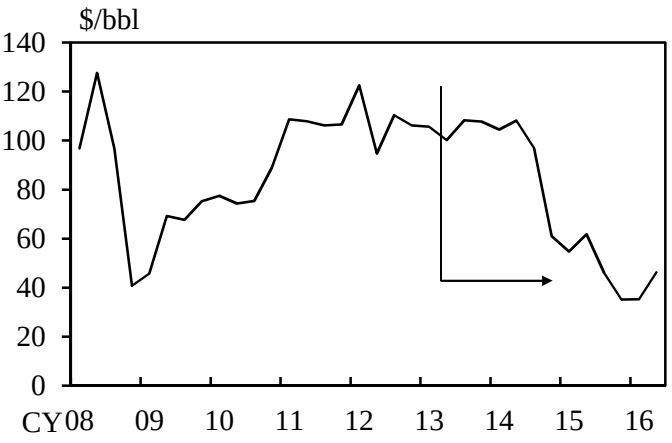


(2) Medium- to Long-Term Inflation Expectations

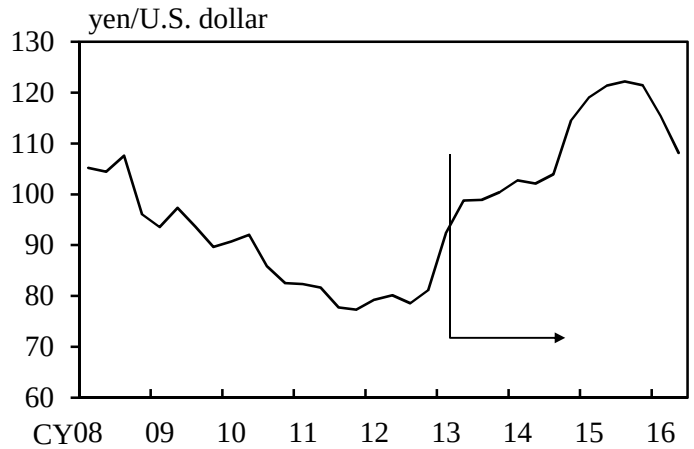
(3) Real GDP Growth Rate of Overseas Economies



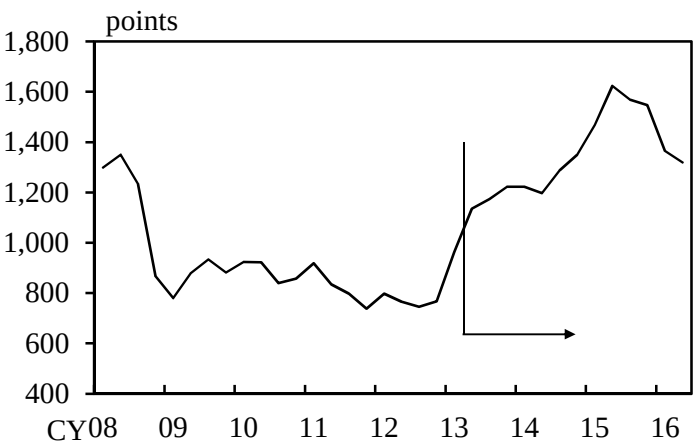
(4) Crude Oil Prices (Dubai Oil)



(5) Exchange Rate



(6) Stock Prices (TOPIX)



Notes: 1. Figures for medium- to long-term inflation expectations are the expectations for the CPI 6 to 10 years ahead and are based on the "Consensus Forecasts." Semiannual data during the period before CY2014 are interpolated using Kalman filter techniques and converted into quarterly data.

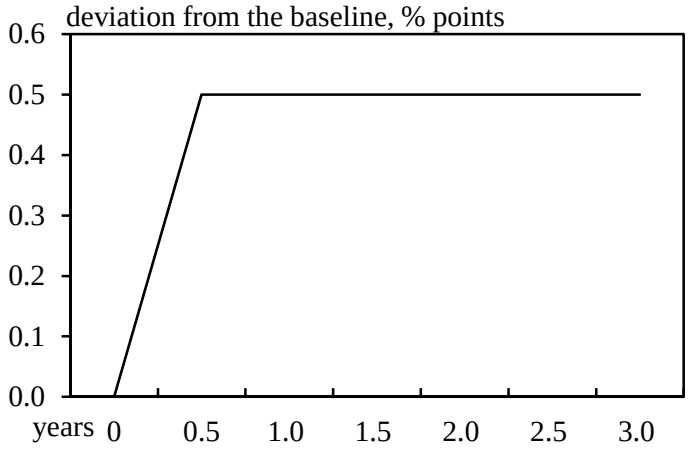
2. Real GDP growth rate of overseas economies is the weighted average of real GDP growth rates using countries' share in Japan's exports as weights. IMF's calculation of growth rates are used for calculation.

Sources: Consensus Economics Inc., "Consensus Forecasts"; Nikkei Financial Quest; Bank of Japan; Nikkei Inc.; IMF; Ministry of Finance.

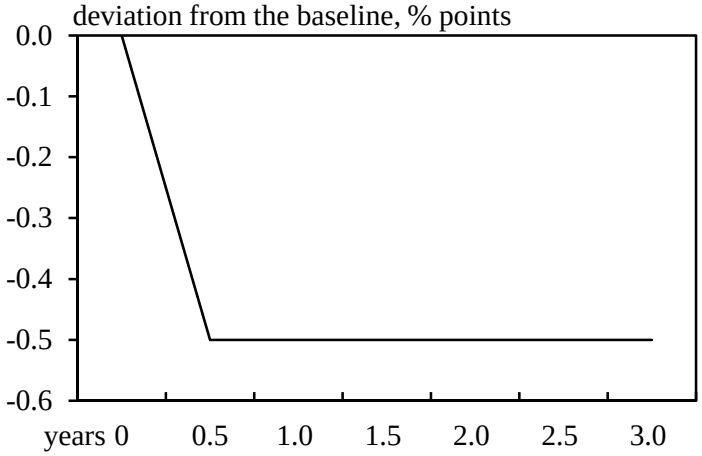
Response to a Negative Shock to Real Interest Rates in Q-JEM

Initial shock: Real interest rates drop by 1 percentage point
(i.e. Medium- to long-term inflation expectations rise by +0.5 percentage points, nominal interest rates drop by 0.5 percentage points)

(1) Medium- to Long-Term Inflation Expectations

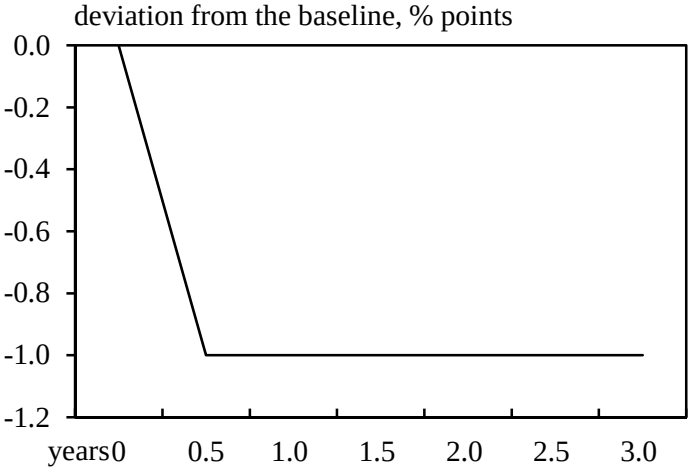


(2) Nominal Long-Term Interest Rates (10 year JGBs)

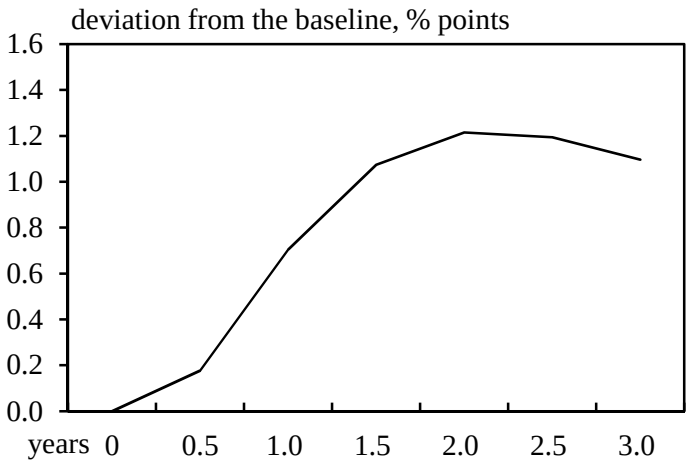


Simulation Results

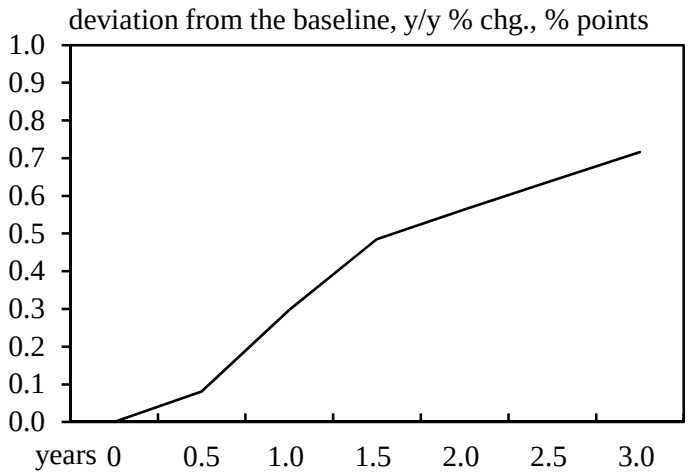
(3) Real Interest Rates



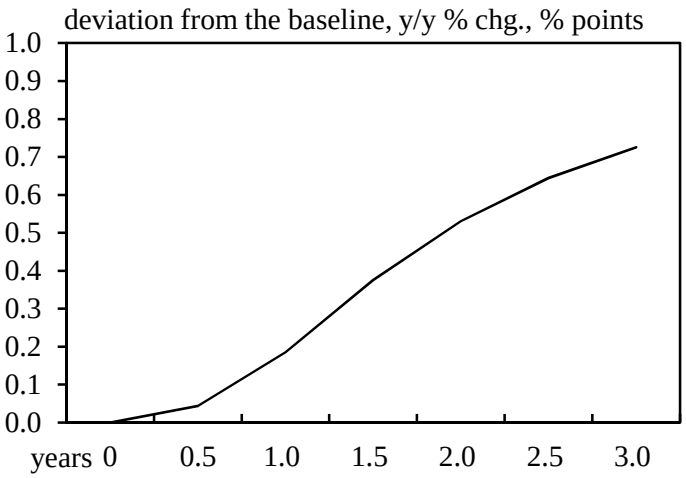
(4) Output Gap



(5) CPI (all items less fresh food)



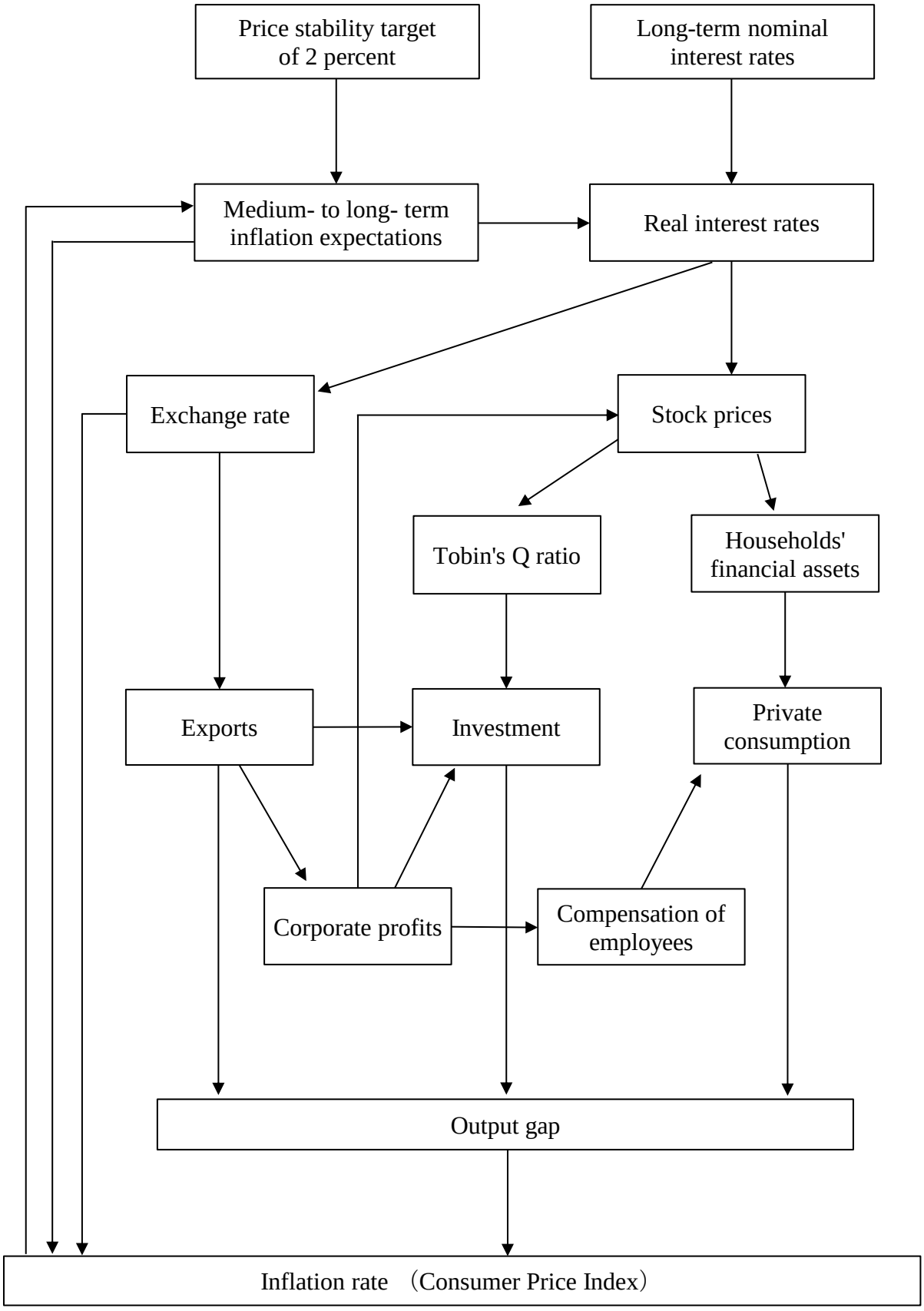
(6) CPI (all items less fresh food and energy)



Note: Real interest rates are defined as the difference between nominal long-term interest rates and medium- to long-term inflation expectations.

Chart 4

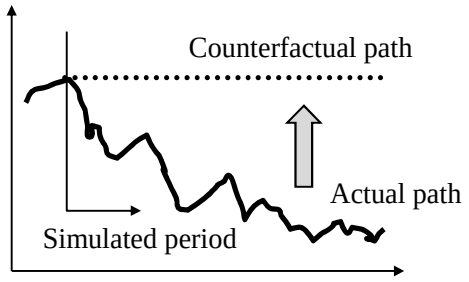
Transmission Channels of Monetary Policy in Q-JEM



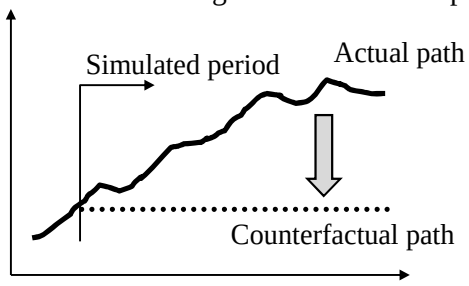
Simulation Scenarios

It is assumed that policy measures since the introduction of QQE caused declines in nominal long-term interest rates and rises in medium- to long-term inflation expectations.

Nominal Long-Term Interest Rates



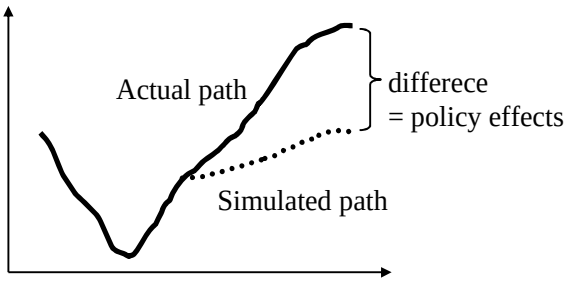
Medium- to Long-Term Inflation Expectations



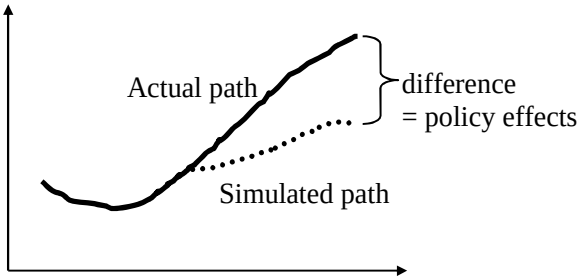
Counterfactual paths of the output gap and CPI inflation are calculated assuming that the "policy shocks (i.e. declines in the nominal long-term interest rate and rise in the medium- to long-term inflation expectations)" were absent during this past three years or so.

Simulated output gap and inflation rate are lower than actual data.
⇒ Difference = Policy effects from monetary easing

Output Gap



Inflation Rate (CPI)



Definitions of "Policy Shocks" for Each Simulation

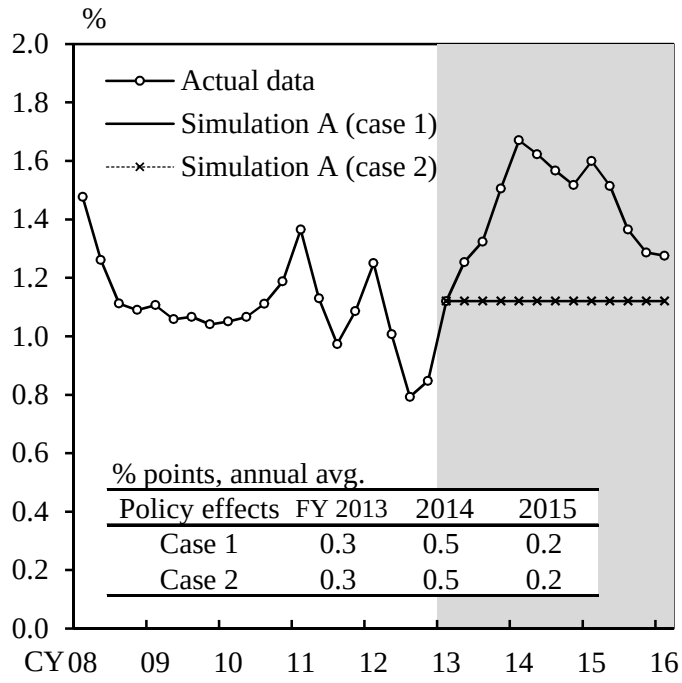
	Simulation A	Simulation B
Case 1	"Policy shocks" are defined as the declines in nominal long-term interest rate and the rise in medium- to long-term inflation expectations since one quarter prior to the introduction of QQE in April 2013.	"Policy shocks" are defined as the declines in nominal long-term interest rates and rises in medium- to long-term inflation expectation since one quarter prior to the introduction of "the price stability target" of 2 percent in January 2013.
Case 2	"Policy shocks" are defined as the declines in nominal long-term interest rates, rises in medium-to long-term inflation expectations, depreciaton of the yen, and surges in stock prices since one quarter prior to the introduction of QQE in April 2013.	"Policy effects" are defined as the declines in nominal long-term interest rates, rises in medium-to long-term inflation expectations, depreciation of the yen, and surges in stock prices since one quarter prior to the introduction of "the price stability target" of 2 percent in January 2013.

Assessment of the Policy Effects Based on Simulation A

(Changes after CY 2013 are considered as policy shocks.)

Case 1: Inflation expectations and nominal interest rates are fixed after Q1 2013.
Case 2: In addition to case 1, exchange rate and stock prices are also fixed after Q1 2013.

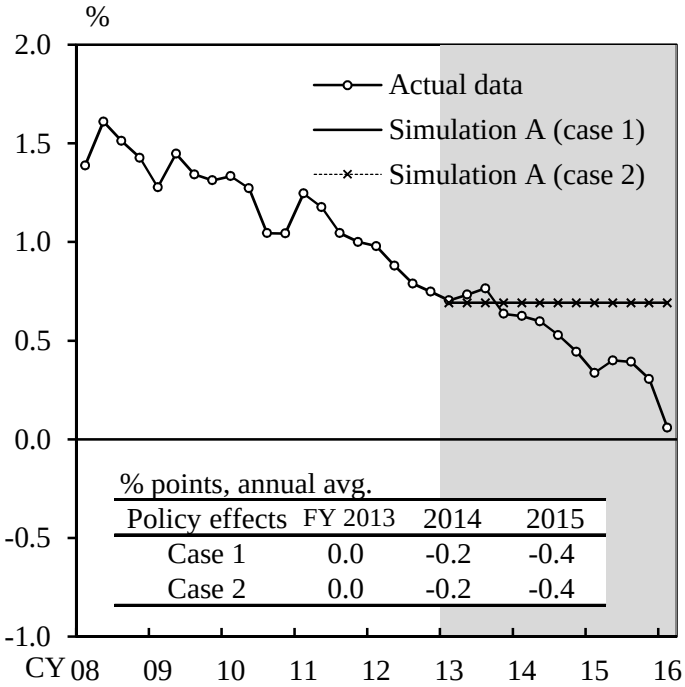
(1) Medium- to Long-Term Inflation Expectations



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.3	0.5	0.2
Case 2	0.3	0.5	0.2

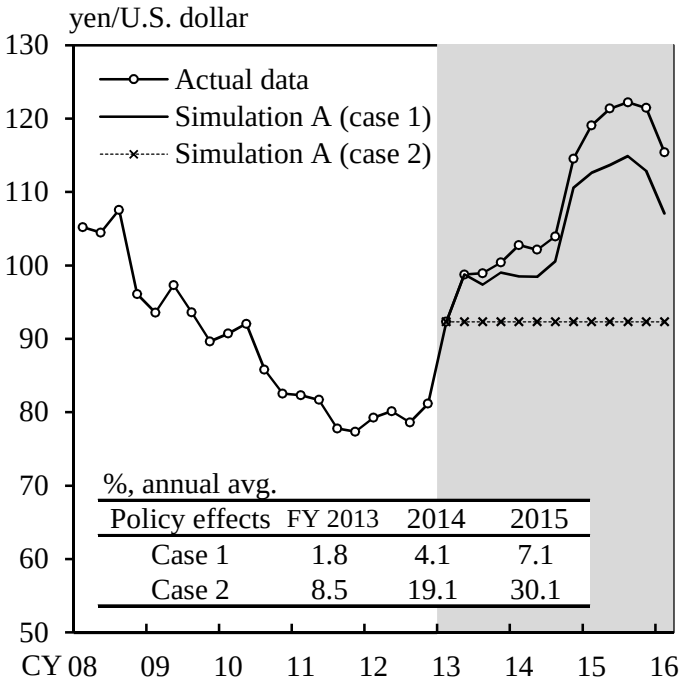
(2) Nominal Long-Term Interest Rates (10 year JGBs)



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.0	-0.2	-0.4
Case 2	0.0	-0.2	-0.4

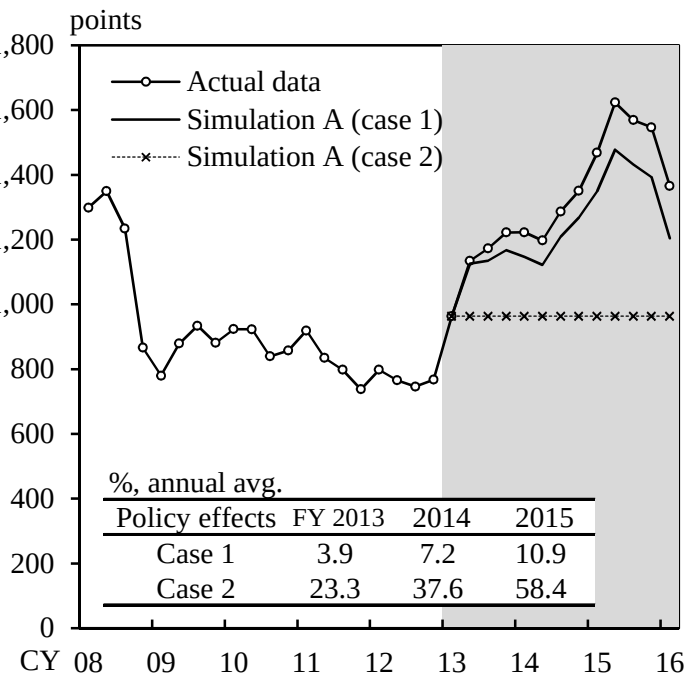
(3) Exchange Rate



%, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	1.8	4.1	7.1
Case 2	8.5	19.1	30.1

(4) Stock Prices (TOPIX)



%, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	3.9	7.2	10.9
Case 2	23.3	37.6	58.4

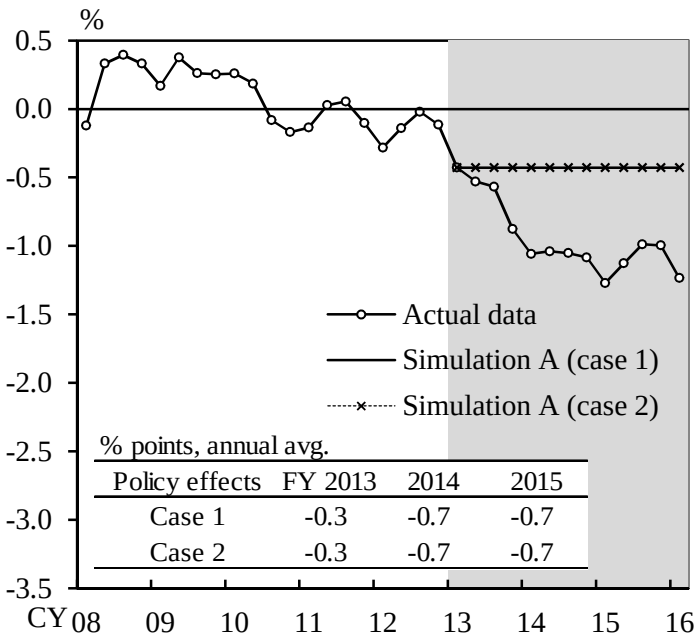
Notes: 1. The policy effects are calculated as the difference between actual values and the simulation results.
2. Shaded areas indicate the simulation period.

Sources: Consensus Economics Inc., "Consensus Forecast"; Nikkei Financial Quest; Bank of Japan.

Assessment of the Policy Effects Based on Simulation A

(Changes after CY 2013 are considered as policy shocks.)

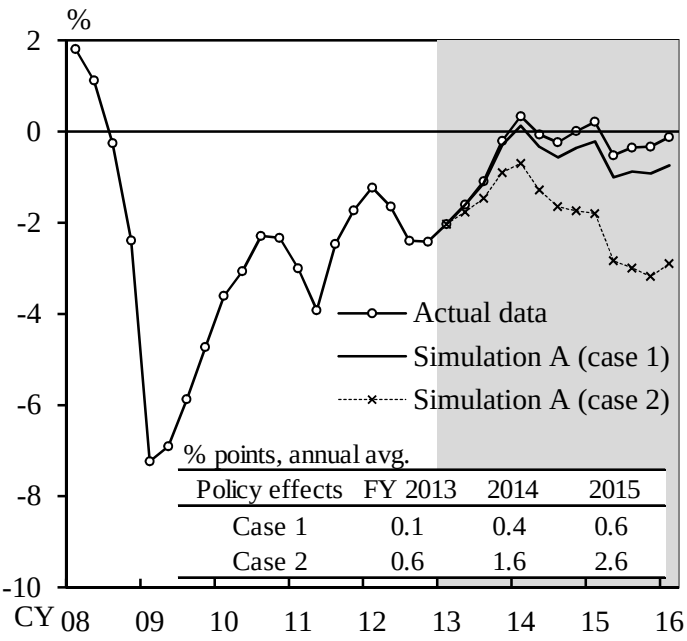
(5) Real Interest Rates



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	-0.3	-0.7	-0.7
Case 2	-0.3	-0.7	-0.7

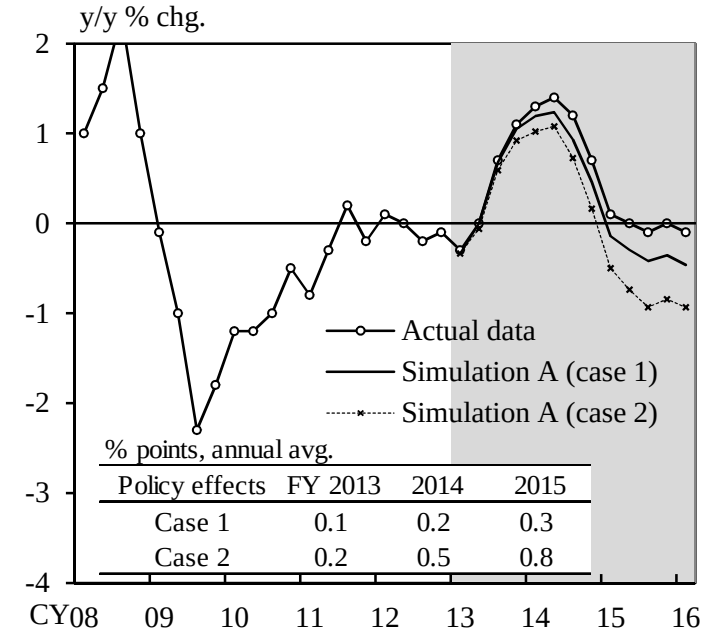
(6) Output Gap



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.1	0.4	0.6
Case 2	0.6	1.6	2.6

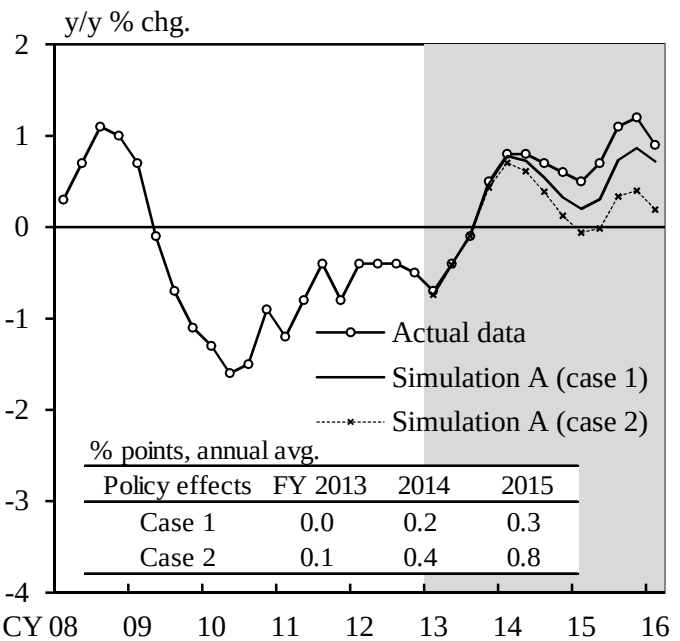
(7) CPI (all items less fresh food)



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.1	0.2	0.3
Case 2	0.2	0.5	0.8

(8) CPI (all items less fresh food and energy)



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.0	0.2	0.3
Case 2	0.1	0.4	0.8

Notes: 1. The policy effects are defined as the difference between actual values and the simulation results.
2. Shaded areas indicate the simulation period.
3. Real interest rates are defined as the difference between nominal long-term interest rates and medium- to long-term inflation expectations.
4. The output gap is estimated by the Research and Statistics Department, Bank of Japan.
5. Figures for the CPI (all items less fresh food and energy) are calculated by the Research and Statistics Department, Bank of Japan.
6. Figures for CPI are adjusted to exclude the estimated effects of changes in the consumption tax rate.

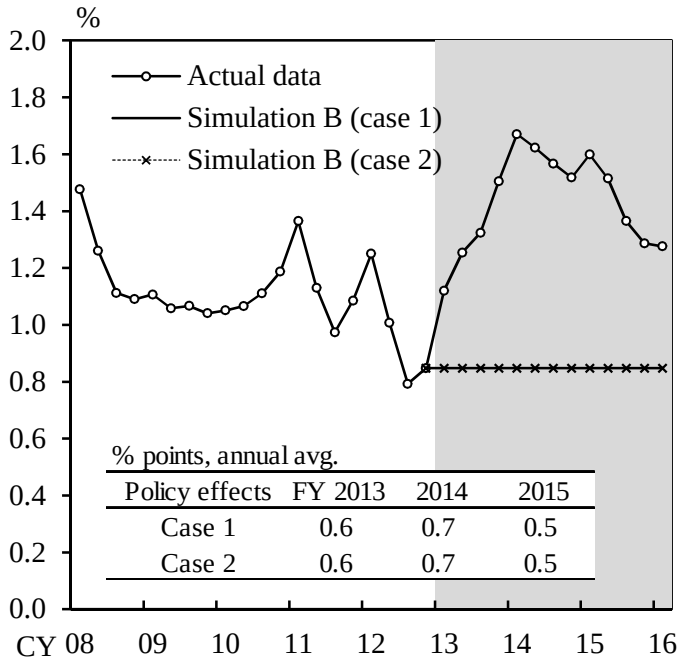
Sources: Consensus Economics Inc., "Consensus Forecast"; Nikkei Financial Quest; Bank of Japan; Cabinet Office; Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry; Research Institute of Economy, Trade and Industry; Ministry of Internal Affairs and Communications.

Assessment of the Policy Effects Based on Simulation B

(In addition to the scenarios in simulation A, changes during the period from Q4 2012 to Q1 2013 in the medium- to long-term inflation expectations, exchange rate and stock prices are assumed to be "monetary policy shocks.")

Case 1: Inflation expectations are fixed after Q4 2012. Nominal interest rates are also fixed after Q1 2013.
Case 2: In addition to case 1, exchange rate and stock prices are also fixed after Q4 2012.

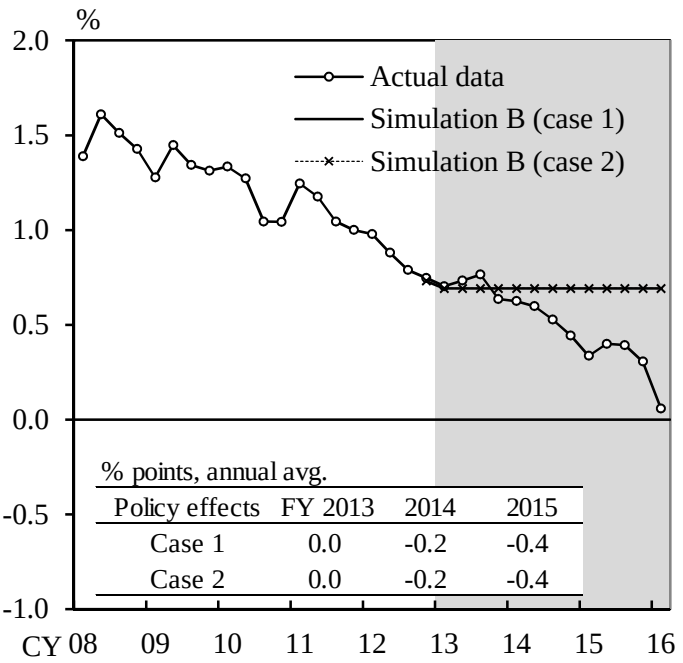
(1) Medium- to Long-Term Inflation Expectations



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.6	0.7	0.5
Case 2	0.6	0.7	0.5

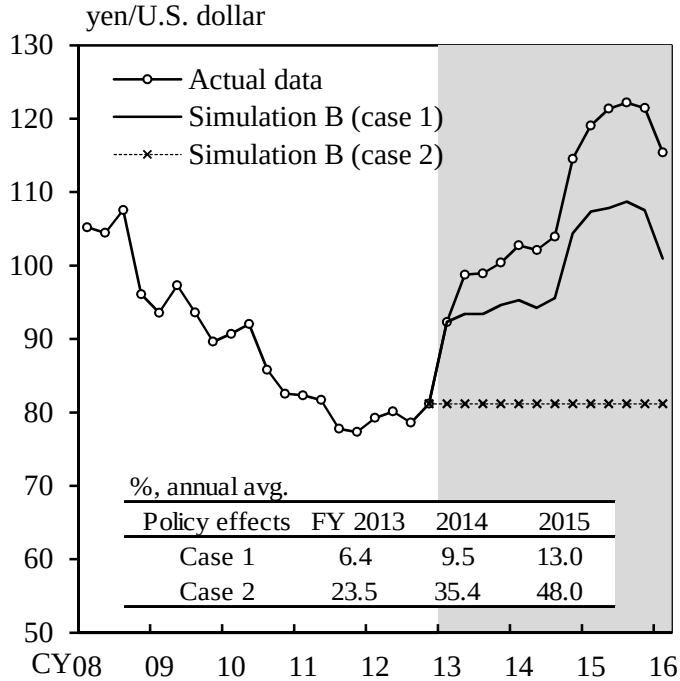
(2) Nominal Long-Term Interest Rate (10 year JGBs)



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.0	-0.2	-0.4
Case 2	0.0	-0.2	-0.4

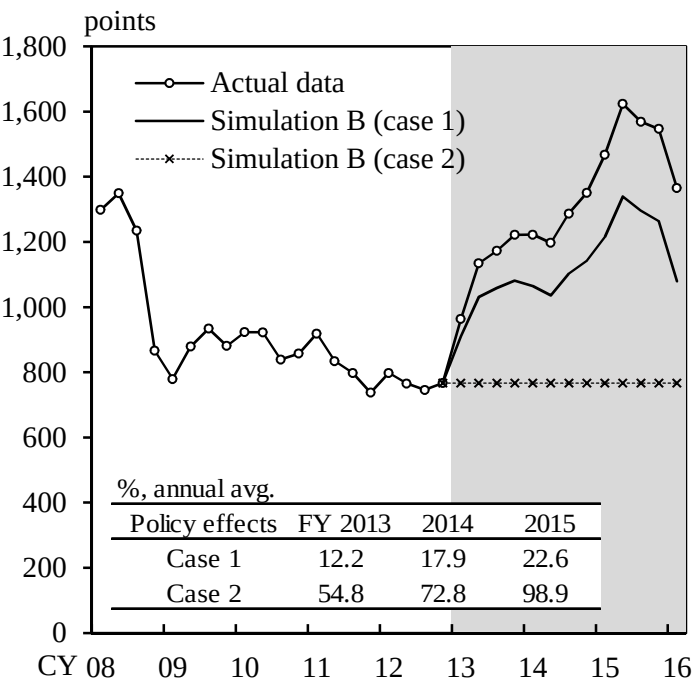
(3) Exchange Rate



%, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	6.4	9.5	13.0
Case 2	23.5	35.4	48.0

(4) Stock Prices (TOPIX)



%, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	12.2	17.9	22.6
Case 2	54.8	72.8	98.9

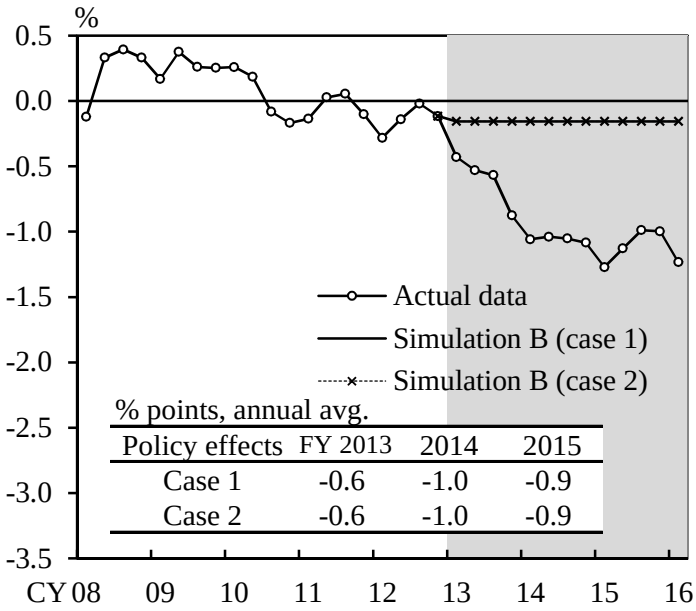
Notes: 1. The policy effects are calculated as the difference between actual values and the simulation results.
2. Shaded areas indicate the simulation period.

Sources: Consensus Economics Inc., "Consensus Forecast"; Nikkei Financial Quest; Bank of Japan.

Assessment of the Policy Effects Based on Simulation B

(In addition to the scenarios in simulation A, changes during the period from Q4 2012 to Q1 2013 in the medium- to long-term inflation expectations, exchange rate and stock prices are assumed to be "monetary policy shocks.")

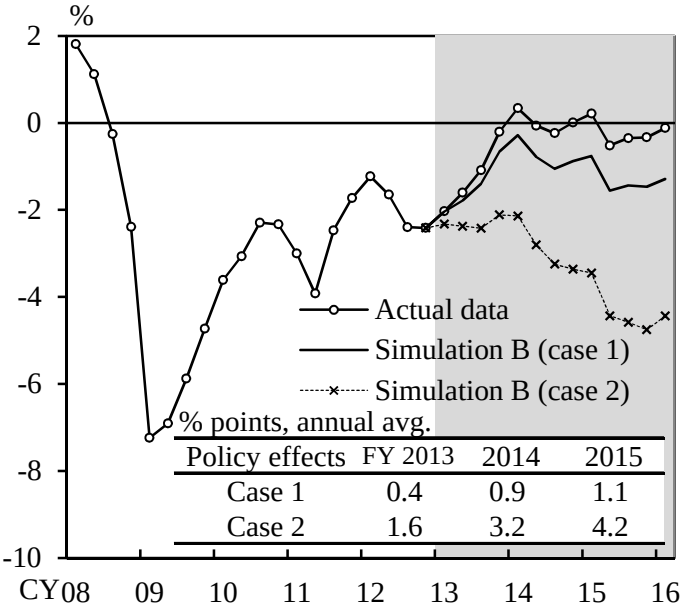
(5) Real Interest Rates



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	-0.6	-1.0	-0.9
Case 2	-0.6	-1.0	-0.9

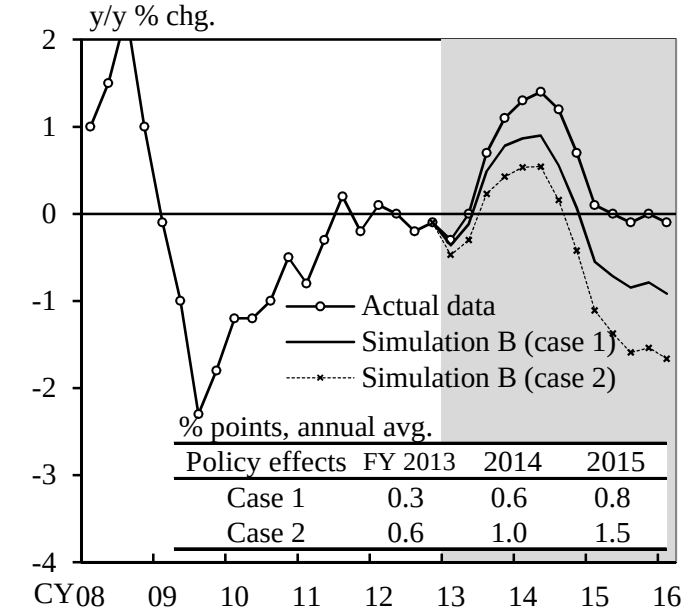
(6) Output Gap



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.4	0.9	1.1
Case 2	1.6	3.2	4.2

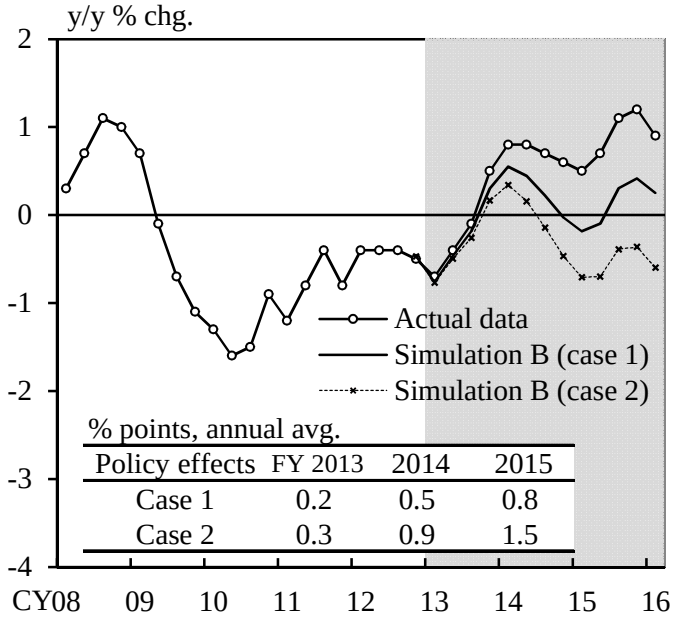
(7) CPI (all items less fresh food)



% points, annual avg.

Policy effects	FY 2013	2014	2015
Case 1	0.3	0.6	0.8
Case 2	0.6	1.0	1.5

(8) CPI (all items less fresh food and energy)



% points, annual avg.

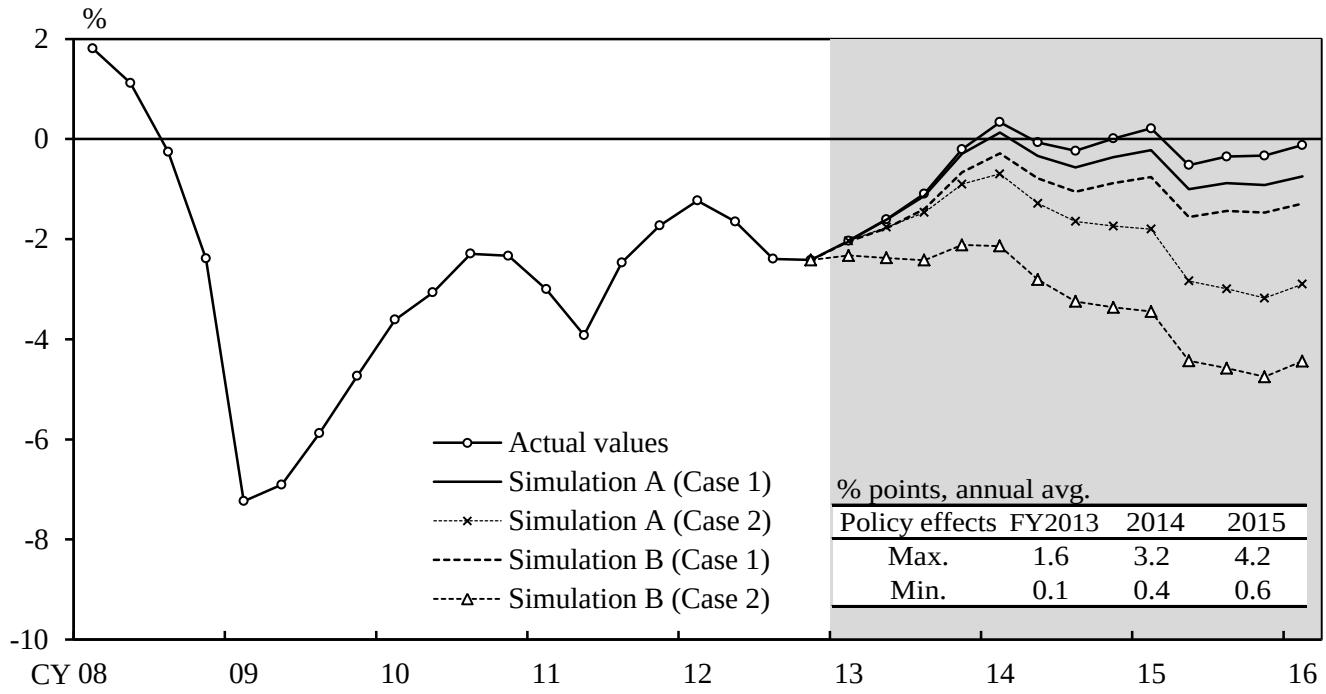
Policy effects	FY 2013	2014	2015
Case 1	0.2	0.5	0.8
Case 2	0.3	0.9	1.5

Notes: 1. The policy effects are defined as the difference between actual values and the simulation results.
2. Shaded areas indicate the simulation period.
3. Real interest rates are defined as the difference between nominal long-term interest rates and medium- to long-term inflation expectations.
4. The output gap is estimated by the Research and Statistics Department, Bank of Japan.
5. Figures for the CPI (all items less fresh food and energy) are calculated by the Research and Statistics Department, Bank of Japan.
6. Figures for CPI are adjusted to exclude the estimated effects of changes in the consumption tax rate.

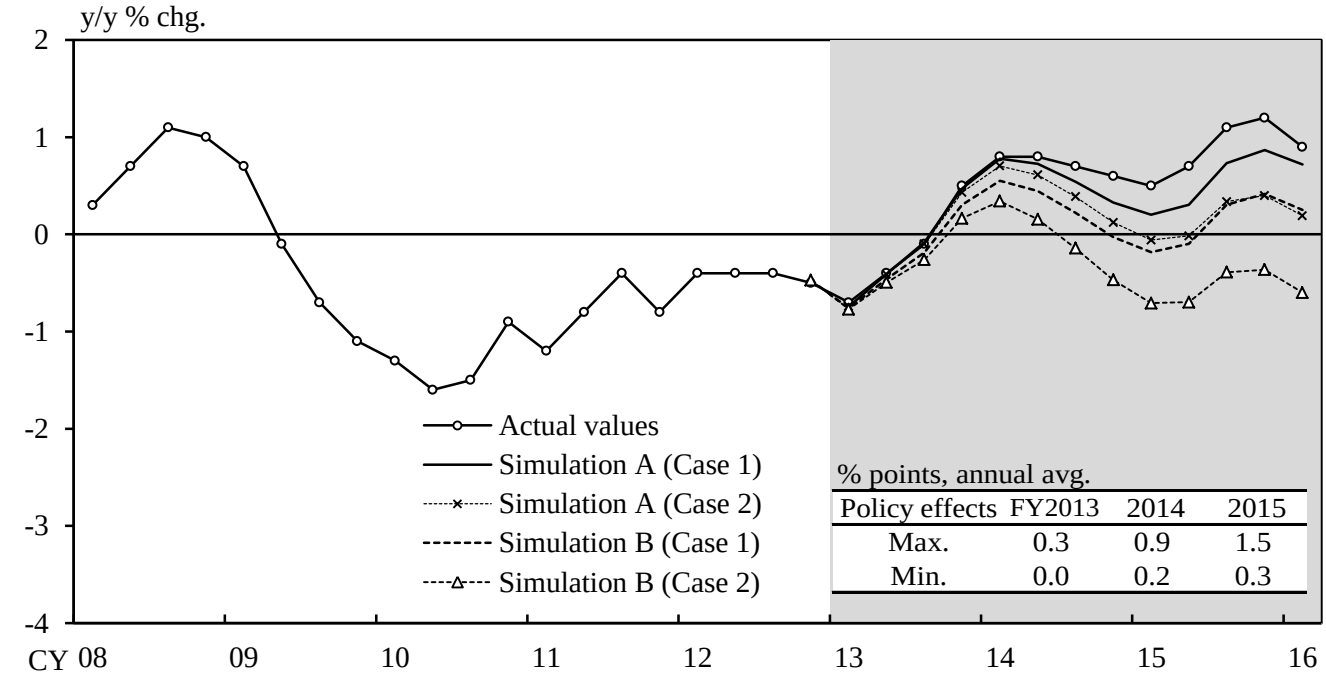
Sources: Consensus Economics Inc., "Consensus Forecast"; Nikkei Financial Quest; Bank of Japan; Cabinet Office; Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry; Research Institute of Economy, Trade and Industry; Ministry of Internal Affairs and Communications.

Summary of Simulation Results

(1) Output Gap



(2) CPI (all items less fresh food and energy)



Notes: 1. The policy effects are calculated as the difference between actual values and the simulation results.
2. Shaded areas indicate the simulation period.
3. The output gap is estimated by the Research and Statistics Department, Bank of Japan.
4. Figures for the CPI (all items less fresh food and energy) are calculated by the Research and Statistics Department, Bank of Japan. These are adjusted to exclude the estimated effects of changes in the consumption tax rate.

Sources: Bank of Japan; Cabinet Office; Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry; Research Institute of Economy, Trade and Industry; Ministry of Internal Affairs and Communications.