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The Effects of Monetary Policy Commitment: Evidence from Time-varying Parameter VAR Analysis

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Abstract

In this paper, we explore the effects of the Bank of Japan's (BOJ's) policy commitment under zero interest rates on the economy, by considering the transmission channel of altering private-sector expectations. To that end, we carry out a structural vector autoregression analysis on macroeconomic variables and private-sector expectations variables, using a time-varying parameters estimation technique with stochastic volatility. We show empirical evidence on two points. First, the BOJ's policy commitment regarding the future course of short-term interest rates, associated with only a small reduction in policy interest rates, succeeded in altering private-sector expectations. Second, the BOJ's policy commitment alone, nevertheless, was not sufficient to restore the previous trends in prices and output.

Keywords: Policy commitment; policy duration effect; expectations management; Bayesian estimation; time-varying parameter vector autoregression with stochastic volatility

JEL classification: C11; C13; E43; E44; E52; E58

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1 Introduction

In this paper, we explore the effect of the Bank of Japan's (BOJ's) policy commitment under zero interest rates on the economy, by considering of the transmission channel of altering private-sector expectations. To that end, we carry out a structural vector autoregression (VAR) analysis on macroeconomic variables and private-sector expectations variables, using a time-varying parameters estimation technique with stochastic volatility.

As highlighted by Woodford (2005), a central bank can influence economic activity by shaping private-sector expectations about the future course of the economy, including short-term interest rates. A central bank thus needs to consider how to manage the expectations in a more effective way when mapping its monetary policy strategy. In particular, when interest rates are at or near zero, a central bank needs to communicate to the public about the duration that the current extremely low interest rates will be maintained. Using a theoretical model, Eggertsson and Woodford (2003) and Jung, Teranishi, and Watanabe (2005) show that by committing to the future zero interest rates in advance a central bank can lower long-term interest rates, and so lower the real interest rate thanks to the inflation expectation to mitigate the deflationary shock. Such a mechanism is often called the "policy duration effect," as in Fujiki, Okina, and Shiratsuka (2001).

The BOJ has two episodes of policy commitment under zero interest rates: the zero interest rate policy (ZIRP) from February 12, 1999 to August 11, 2000 and the quantitative easing policy (QEP) from March 19, 2001 to March 9, 2006, as summarized in Table 1.[1] Under the ZIRP, the BOJ started lowering the overnight call rate initially to around 0.15 percent in February 1999, and subsequently induced a further decline to 0.02 percent in view of market developments. In addition, the BOJ Governor at the time, Masaru Hayami, announced at a press conference in April 1999 that the BOJ would continue zero interest rates "until the deflationary concerns were dispelled." Under the QEP, the BOJ also made a

[1] Such a monetary policy commitment is not restricted to Japan. The Federal Reserve, for example, made an unconditional commitment in the summer of 2003 by using so-called forward-looking language: "policy accommodation can be maintained for a considerable period." In that context, Levin *et al.* (2009) describe such policy measures as "forward guidance."

commitment to targeting the current account balances at the BOJ "until the core consumer price inflation becomes stably zero or above."[2]

The empirical validity of the policy duration effect implied by theoretical studies is still an open question. In that context, Ugai (2007) concludes in his comprehensive survey on empirical studies on the effects of the QEP that the effects of expanding the monetary base and altering the composition of the BOJ's balance sheet, if any, are generally smaller than those stemming from the policy commitment.

More specifically, Fujiki and Shiratsuka (2002) and Okina and Shiratsuka (2004a) focus on the response of the yield curve. They conclude that the policy duration effect was highly effective in stabilizing market expectations regarding the future path of short-term interest rates, although it failed to reverse deflationary expectations in the financial markets, since monetary policy alone could not reverse deflation, coupled with low economic growth. Such easing effects were not transmitted throughout the economy in Japan, since the transmission channel linking the financial and nonfinancial sectors remained blocked. However, their analysis covers only the financial markets using high-frequency data.

Oda and Ueda (2005) employ a macro-finance approach and conclude that the BOJ's monetary policy since 1999 functioned mainly through the zero interest rate commitment, which led to declines in medium- to long-term interest rates. They also note that the portfolio rebalancing effect was not found to be significant. Kimura *et al.* (2003) apply Bayesian VAR analysis to examine the expansionary effect of the increase in the monetary base on the economy in the QEP, which includes the policy duration effect and portfolio rebalancing effect. They conclude that although it is difficult to deny the possibility that such a positive effect induced a change in the portfolios of economic agents and ultimately

[2] The BOJ started releasing Board Members' projections on fiscal year averages of real economic growth and inflation (overall CGPI and core CPI) in October 2000. Projection period was initially just for the current fiscal year, but were gradually extended: from October 2001, October projection included the average figures for economic growth and inflation in the next fiscal year, and from April 2005, April projection also included figures for the next fiscal year. In addition, in April 2008, the BOJ started releasing the distribution of Board Members' projections, as risk-balance charts. In July 2008, the BOJ started releasing projections at the interim assessment in January and July, and decided to extend the projection period for one more year until the two fiscal years ahead from October 2008.

stimulated economic activity, the possibility is highly uncertain and very small at best.

In this paper, we apply a time-varying parameter VAR (TVP-VAR) model with stochastic volatility, thereby examining structural changes in macroeconomic dynamics, including interaction with private-sector expectations. In that context, we should note that stochastic volatility in disturbances plays an important role in improving the estimation precision for the sample period including extremely low interest rates. We have two main findings. First, the BOJ's policy commitment regarding the future course of short-term interest rates, associated with only a small reduction in policy interest rates, succeeded in changing private-sector expectations in the household and business sectors. Second, the BOJ's policy commitment alone, nevertheless, was not sufficient to restore the previous trends in prices and output. That suggests that the monetary policy commitment was not a cure-all measure for structural impediments that induced downward shifts in the trend growth path.

This paper is structured as follows. In Section 2, we explain our empirical framework: a VAR model employing a time-varying parameters technique with stochastic volatility as well as data used in the estimation. In Section 3, we show our empirical results for the effect of the policy commitment regarding the interaction between macroeconomic variables and private-sector expectations variables. In Section 4, we conclude the paper.

2 Empirical Framework

In this section, we explain our empirical framework: a VAR estimation using a time-varying parameters technique with stochastic volatility as well as data used in the estimation.

2.1 Time-varying parameter VAR model with stochastic volatility

To introduce the TVP-VAR model with stochastic volatility, we begin with a basic structural VAR model defined as

$$A\mathbf{y}_t = F_1\mathbf{y}_{t-1} + \cdots + F_s\mathbf{y}_{t-s} + u_t, \quad t = s+1, \ldots, n, \tag{1}$$

where $\mathbf{y}_t$ is a $k \times 1$ vector of observed variables, and A, $F_1, \ldots, F_s$ are $k \times k$ matrices of coefficients.[3] The disturbance u_t is a $k \times 1$ structural shock and we assume $u_t \sim N(0, \Sigma\Sigma)$, where

$$\Sigma = \begin{pmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_k \end{pmatrix}.$$

We then specify the simultaneous relations of the structural shock by recursive identification, assuming that A is lower-triangular,

$$A = \begin{pmatrix} 1 & 0 & \cdots & 0 \\ a_{21} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ a_{k1} & \cdots & a_{k,k-1} & 1 \end{pmatrix}.$$

We rewrite equation (1) as the following reduced-form SVAR model:

$$\mathbf{y}_t = B_1\mathbf{y}_{t-1} + \cdots + B_s\mathbf{y}_{t-s} + A^{-1}\Sigma\varepsilon_t, \quad \varepsilon_t \sim N(0, I_k),$$

where $B_i = A^{-1}F_i$, for $i = 1, \ldots, s$. Stacking the elements in the rows of the B_i's to form $\boldsymbol{\beta}$ ($k^2 s \times 1$ vector), and defining $X_t = I_k \otimes (\mathbf{y}'_{t-1}, \ldots, \mathbf{y}'_{t-k})$, where $\otimes$ denotes the Kronecker product, the model can be written as

$$\mathbf{y}_t = X_t\boldsymbol{\beta} + A^{-1}\Sigma\,\varepsilon_t, \quad t = s+1, \ldots, n. \tag{2}$$

Now, all parameters in equation (2) are time-invariant. We extend it to the TVP-VAR model with stochastic volatility by allowing the parameters to vary over time, following Primiceri (2005).

Consider now the TVP-VAR with stochastic volatility specified by

$$\mathbf{y}_t = X_t\boldsymbol{\beta}_t + A_t^{-1}\Sigma_t\,\varepsilon_t, \quad t = s+1, \ldots, n, \tag{3}$$

[3]Note that we assume an invariant constant term by subtracting a mean from each data series.

where the coefficients $\boldsymbol{\beta}_t$, the parameters A_t, and Σ_t are all time varying. There are many ways to model the process for those time-varying parameters.

Now let $\boldsymbol{a}_t = (a_{21}, a_{31}, a_{32}, a_{41}, \ldots, a_{k,k-1})'$ be a stacked vector of the lower-triangular elements in A_t and $\boldsymbol{h}_t = (h_{1t}, \ldots, h_{kt})'$ with $h_{jt} = \log \sigma_{jt}^2$, for $j = 1, \ldots, k$, $t = s+1, \ldots, n$. We assume that the parameters in equation (3) follow a random-walk process as follows:

$$\begin{aligned} \boldsymbol{\beta}_{t+1} &= \boldsymbol{\beta}_t + u_{\beta t}, \\ \boldsymbol{a}_{t+1} &= \boldsymbol{a}_t + u_{at}, \\ \boldsymbol{h}_{t+1} &= \boldsymbol{h}_t + u_{ht}, \end{aligned} \qquad \begin{pmatrix} \varepsilon_t \\ u_{\beta t} \\ u_{at} \\ u_{ht} \end{pmatrix} \sim N \left(0, \begin{pmatrix} I & O & O & O \\ O & \Sigma_\beta & O & O \\ O & O & \Sigma_a & O \\ O & O & O & \Sigma_h \end{pmatrix} \right),$$

for $t = s+1, \ldots, n$, where $\boldsymbol{\beta}_{s+1} \sim N(\mu_{\beta_0}, \Sigma_{\beta_0})$, $\boldsymbol{a}_{s+1} \sim N(\mu_{a_0}, \Sigma_{a_0})$ and $\boldsymbol{h}_{s+1} \sim N(\mu_{h_0}, \Sigma_{h_0})$.

The TVP-VAR model, combined with stochastic volatility, enables us to take a very flexible and robust specification of parameters to capture the potential time-varying nature of the underlying structure.

2.2 Estimation methodology

The TVP-VAR model can be estimated using the Markov chain Monte Carlo (MCMC) method in the context of a Bayesian inference, even though the likelihood function of the model is intractable.[4] The following priors are assumed for the i-th diagonals of the covariance matrices: $(\Sigma_\beta)_i^{-2} \sim \text{Gamma}(40, 0.02)$, $(\Sigma_a)_i^{-2} \sim \text{Gamma}(4, 0.02)$, and $(\Sigma_h)_i^{-2} \sim \text{Gamma}(4, 0.02)$. For the initial state of the time-varying parameter, the following priors are set as $\mu_{\beta_0} = \mu_{a_0} = \mu_{h_0} = 0$, and $\Sigma_{\beta_0} = \Sigma_{a_0} = \Sigma_{h_0} = 10 \times I$. To compute the posterior estimates, we draw 10,000 samples after the initial 1,000 samples are discarded.

2.3 Data

We employ four categories of data on a quarterly basis. The first category corresponds to general prices: the consumer price index (CPI) and the corporate goods price index (CGPI) for the business sector. The CPI is a core indicator, excluding volatile components

[4]See Nakajima (2009) for a more detailed estimation methodology.

of perishables from the headline, while the CGPI is a headline indicator. The second is output measures for real GDP and investment in the National Accounts. The third is interest rates: the overnight call rate for short-term interest rates and the five-year Japanese government bond (JGB) yield for long-term interest rates. The fourth corresponds to indicators for private-sector expectations: indicators for household-sector expectations are taken from the Consumer Confidence Survey, on consumer perception for overall livelihood over the next six months and that for general prices over the next year. An indicator for business-sector expectations of business conditions is taken from the Short-Term Economic Survey of Enterprises in Japan, the *TANKAN*, on the diffusion index (DI) series of the forecast for business conditions. All data are based on seasonally adjusted series, except for the CGPI, the call rates, the five-year JGB yield, and business-sector expectations for business conditions.[5]

Indicators for general prices, CPI inflation and CGPI inflation, are log-differences from the previous quarter, after adjusting for the impact of changes in consumption tax. As for output indicators, the output gap is computed as deviations from the potential GDP by the BOJ.[6] The investment gap is computed as log-deviations from the HP-filtered trend. Indicators for interest rates as well as private-sector expectations are also computed as log-deviations from the HP-filtered trend. Each variable is multiplied by 100 to be a percent.

3 Empirical Results

We estimate three specifications of the TVP-VAR with stochastic volatility. The first two specifications include the four variables. The first specification employs CPI inflation, the GDP gap, the call rate, and household-sector expectations for livelihood, while the second specification employs CGPI inflation, the investment gap, the call rate, and business-sector expectations for business conditions, respectively. The third specification

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[5] The data sources are shown below: CPI from the Ministry of Internal Affairs and Communications; CGPI, call rates, and the TANKAN from the BOJ; the National Accounts and Consumer Confidence Survey from the Cabinet Office; and the five-year JGB yield from Bloomberg.

[6] For the details, see Hara *et al.* (2006).

includes household-sector expectations for livelihood and general prices, and long-term interest rates. About the sample period, the first two estimations use the data for the period from 1977/Q1 to 2007/Q4, while the third estimation uses the data for the period from 1977/Q1 to 2004/Q1.

3.1 Household-sector activity and expectations

Figure 1 shows the time-varying impulse responses for TVP-VAR with stochastic volatility using the first specification: CPI inflation, the GDP gap, the call rate, and the household-sector expectations for livelihood.[7] The time-varying impulse responses at one-, two-, and three-year horizons are shown over time, indicating structural changes in macroeconomic dynamics, including the private-sector expectations indicator. The columns correspond to the impulse responses of variables to shocks from CPI inflation, the GDP gap, the call rate, and the household-sector expectations for livelihood, respectively. The rows correspond to the impulse responses of CPI inflation, the GDP gap, the call rate, and the household-sector expectations for livelihood to shocks, respectively.

Several points should be noted regarding changes in the impulse responses over time. First, the impulse responses of CPI inflation to the GDP gap shock weakened from the second half of the 1990s when the call rate was lowered to 0.5 percent (the second row in the first column). Especially after the introduction of the ZIRP in 1999, the impulse responses declined further to marginally negative. Similarly, the impulse responses of the GDP gap to the CPI inflation shock continued to decline from 1999 and more recently remained around zero (the first row in the second column).

Second, the impulse responses of the call rate to both the GDP gap and the CPI inflation shocks remained at almost zero from 1999 (the first or second row in the third column). That reflected the fact that additional room for cutting the call rate was exhausted in facing the zero lower bound constraint of short-term nominal interest rates.[8]

[7] We assume two lags for each variable, and the identification ordering of CPI inflation, the GDP gap, the call rate, and the household-sector expectations for livelihood. We give a shock with the same-size, the average of one standard deviation of shocks for the whole sample period, in producing impulse responses.

[8] It should be noted that the size of the estimated shock for the call rates declined significantly from

Third, the impulse responses of both the GDP gap and CPI inflation to the call rate shock were weakened from 1999, especially at the longer horizon, such as two or three years (the third row and first or second column).[9] that suggests that changes in interest rates were unlikely to influence prices and economic activity in the longer term under zero interest rate conditions.

Fourth, by contrast, the impulse responses of the household-sector expectations for livelihood became significant from 1999. The impulse responses to the CPI inflation and the GDP gap shocks became negative and positive, respectively (the first or second row in the fourth column). The impulse responses to the call rate shock became highly negative at a one-year horizon, even though those at the two- and three-year horizons remained close to zero (the third row in the fourth column). In addition, the impulse responses of the household-sector expectations for livelihood to its own shock increased rapidly from 1999 (the fourth row in the fourth column). Those observations suggest the possibility that dynamics in household-sector expectations formation were amplified from 1999.

3.2 Business-sector activity and expectations

We next carry out a similar empirical exercise by using the expectations indicator for the business sector. Figure 2 shows the time-varying impulse responses for TVP-VAR with stochastic volatility using the second specification: CGPI inflation, the investment gap, the call rate, and the business-sector expectations for business conditions.[10] We focus particularly on the investment behavior of the business sector. Compared to consumption with smooth dynamics, investment is more responsive to economic conditions, which plays a major role in business cycles. Thus, the monetary policy effect is more sensitively reflected.

We see results similar to the first specification. The interactions between the investment

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the second half of the 1990s. That suggests that the assumption of stochastic volatility in disturbances contributes a great deal to improving the estimation precision in an extremely low interest rate environment.

[9] The call rate shock includes the effect of the commitment policy in particular after 1999. Thus, both the policy rate change and the commitment to future monetary policy easing generate impulse responses.

[10] We assume two lags for each variable, and the identification ordering of CGPI inflation, the investment gap, the call rate, and the business-sector expectations for business conditions.

gap and CGPI inflation were weakened under a very low interest rate environment (the first row in the second column, and the second row in the first column). The impulse responses of the call rate to both the investment gap and the CGPI inflation shocks became virtually zero from 1999 (the first or second row in the third column). The impulse responses of both the investment gap and CGPI inflation to the call rate shock declined from 1999 (the third row in the first or second column). However, the policy commitment induced larger responses of the business-sector expectations for business conditions to the call rate shock (the third row in the fourth column). The shock in expectations seems to have produced more amplified dynamics in business-sector expectations formation from 1999 (the fourth row in the fourth column).

3.3 Interaction between expectations indicators

To clarify the effect of policy commitment on private-sector expectations, we estimate a TVP-VAR with stochastic volatility using the third specification: the household-sector expectations for general prices, the household-sector expectations for livelihood, and the long-term interest rate.[11] Figure 3 shows the time-varying impulse responses.

We note two points. First, the impulse responses of the household-sector expectations for general prices to the shock from the household-sector expectations for livelihoods became stronger from 1999, especially at two- and three-year horizons, when the BOJ adopted the policy commitment (the second row in the first column). The impulse responses of the household-sector expectations for livelihoods to the shock from the household-sector expectations for general prices also became stronger from 1999 (the first row in the second column). Those two panels imply that the policy commitment induced a positive interaction between prices and livelihood expectations in the household sector. In addition, the impulse responses of both the household-sector expectations for livelihoods and for general prices to their own shocks strengthened from 1999, indicating the possibility that the policy commitment amplified dynamics in household-sector expectations formation (the first row

[11] We assume two lags for each variable, and the identification ordering of the household-sector expectations for general prices, the household-sector expectations for livelihood, and the long-term interest rate.

in the first column for price expectations and the second row in the second column for livelihood expectations).

Second, the impulse responses of the household-sector expectations for livelihood to the long-term interest rate shock increased from 1999 (the third row in the second column). The impulse responses of the household-sector expectations for general prices to the long-term interest rate shock also showed a similar but weaker result (the third row in the first column).

We conclude that the two episodes of the policy commitment by the BOJ did not significantly change dynamics within macroeconomic variables, such as output, investment, prices, and interest rates, even under an extremely low interest rate environment from 1995. Nevertheless, we find some empirical evidence that the policy commitment was more likely to stimulate private-sector expectations when extending our empirical framework to incorporate private-sector expectations indicators. We should add that such stimulative effects on private-sector expectations, however, were not transmitted to economic activity, thus failing to completely reverse deflationary expectations in the economy.

4 Conclusions

Woodford (2005) emphasizes that a declaration of a monetary policy rule as the clearest communication policy enables a central bank to control the real variables as well as the agents' future expectations even under a liquidity trap. In this paper, we investigated the effect of the BOJ's policy commitment under zero interest rates using macro data. We found empirical results suggesting that the BOJ's policy commitment on the future course of short-term interest rates, even with a small reduction in current policy interest rates, succeeded in changing private-sector expectations in a positive direction in the household and business sectors. Such a commitment effect, nevertheless, did not spread throughout the overall economy. That suggests that the monetary policy commitment was not a cure-all measure for structural impediments that induced downward shifts in the trend growth path.

In that regard, the Japanese economy is suffering from a large-scale and quite persistent adverse shock due to insufficient structural adjustments as a consequence of the bursting of the asset price bubble in the early 1990s, as discussed in Okina and Shiratsuka (2004b). What the BOJ faced during the period of the ZIRP and QEP was not a standard stabilization policy around a stable trend growth path, but a policy management in an environment characterized by hampered sustained growth. However, in practice, it is not easy to distinguish the nature of a shock on a real-time basis, given the limited knowledge about economic structures.

References

[1] Eggertsson, Gauti, and Michael Woodford, "The Zero Bound on Interest Rates and Optimal Monetary Policy," *Brookings Papers on Economic Activity*, 1, 2003, pp. 139–211.

[2] Fujiki, Hiroshi, Kunio Okina, and Shigenori Shiratsuka, "Monetary Policy under Zero Interest Rate: Viewpoints of Central Bank Economists," *Monetary and Economic Studies*, Institute for Monetary and Economic Studies, Bank of Japan, 19 (1), 2001, pp. 89-130.

[3] ______, and Shigenori Shiratsuka, "Policy Duration Effect under the Zero Interest Rate Policy in 1999-2000: Evidence from Japan's Money Market Data," *Monetary and Economic Studies*, Institute for Monetary and Economic Studies, Bank of Japan, 20 (1), 2002, pp. 1-31.

[4] Hara, Naoko, Naohisa Hirakata, Yusuke Inomata, Satoshi Ito, Takuji Kawamoto, Takushi Kurozumi, Makoto Minegishi, and Izumi Takagawa, "The New Estimates of Output Gap and Potential Growth Rate," *Bank of Japan Review*, Bank of Japan, No. E-3, 2006.

[5] Jung, Taehun, Yuki Teranishi, and Tsutomu Watanabe, "Optimal Monetary Policy at the Zero-Interest-Rate Bound," *Journal of Money, Credit and Banking*, 37 (5), 2005, pp. 813–835.

[6] Kimura, Takeshi, Hiroshi Kobayashi, Jun Muranaga, and Hiroshi Ugai, "The Effect of the Increase in the Monetary Base of Japan's Economy at Zero Interest Rates: An Empirical Analysis," in *Monetary Policy in a Changing Environment*, *Bank for International Settlements Conference Series*, 19, 2003, pp. 276–312.

[7] Levin, Andrew, David Lopez-Salido, Edward Nelson, and Tack Yun, "Limitations on the Effectiveness of Forward Guidance at the Zero Lower Bound," *International Journal of Central Banking*, 6 (1), 2010, pp. 143–189.

[8] Nakajima, Jouchi, "Time-varying Parameter Structural Vector Autoregression: A Survey of Methodology and Empirical Analyses," manuscript, 2009.

[9] Oda, Nobuyuki, and Kazuo Ueda, "The Effect of the Bank of Japan's Zero Interest Rate Commitment and Quantitative Monetary Easing on the Yield Curve: A Macro-Finance Approach," *Bank of Japan Working Paper*, Bank of Japan, No. E-6, 2005.

[10] Okina, Kunio, and Shigenori Shiratsuka, "Policy Commitment and Expectation Formation: Japan's Experience under Zero Interest Rates," *North American Journal of Economics and Finance*, 15 (1), 2004a, pp. 75–100.

[11] ______, and ______, "Asset Price Fluctuations, Structural Adjustments, and Sustained Economic Growth: Lessons from Japan's Experience since the Late 1980s," *Monetary and Economic Studies*, Institute for Monetary and Economic Studies, Bank of Japan, 22 (S-1), 2004b, pp. 143–167.

[12] Primiceri, E. Giorgio, "Time Varying Structural Vector Autoregressions and Monetary Policy," *Review of Economic Studies*, 72, 2005, pp. 821–852.

[13] Ugai, Hiroshi, "Effects of the Quantitative Easing Policy: A Survey of Empirical Analyses," *Monetary and Economic Studies*, Institute for Monetary and Economic Studies, Bank of Japan, 25(1), 2007, pp. 1-47.

[14] Woodford, Michael, "Central-bank Communication and Policy Effectiveness," in *Inflation Targeting: Implementation, Communication and Effectiveness*, Sveriges Riksbank, 2005.

Table 1: Policy Events

Date	Change in policy guidelines
September 8, 1995	Reduction of the official discount rate (ODR) (from 1.0 to 0.5 percent)
February 12, 1999	Introduction of the ZIRP
April 13, 1999	BOJ Governor Hayami's announcement of the commitment to zero interest rate until deflationary concerns were dispelled
August 11, 2000	Termination of the ZIRP and raising of the target overnight rate (from 0 to 0.25 percent)
February 9, 2001	Reduction of the ODR (from 0.5 to 0.375 percent), and introduction of a new method of liquidity provision
February 28, 2001	Reduction of the targeted overnight rate (from 0.25 to 0.125 percent) and the ODR (from 0.375 to 0.25 percent)
March 19, 2001	Decision to introduce the QEP and a statement on the CPI guideline for the duration of the new procedures
October 10, 2003	Clarification of the commiment to the QEP
March 9, 2006	Change of the operating target for money market operations from the outstanding balance of current accounts to the uncollateralized overnight call rate
July 14, 2006	Termination of the zero interest rate policy and raising of the target overnight rate (to 0.25 percent)

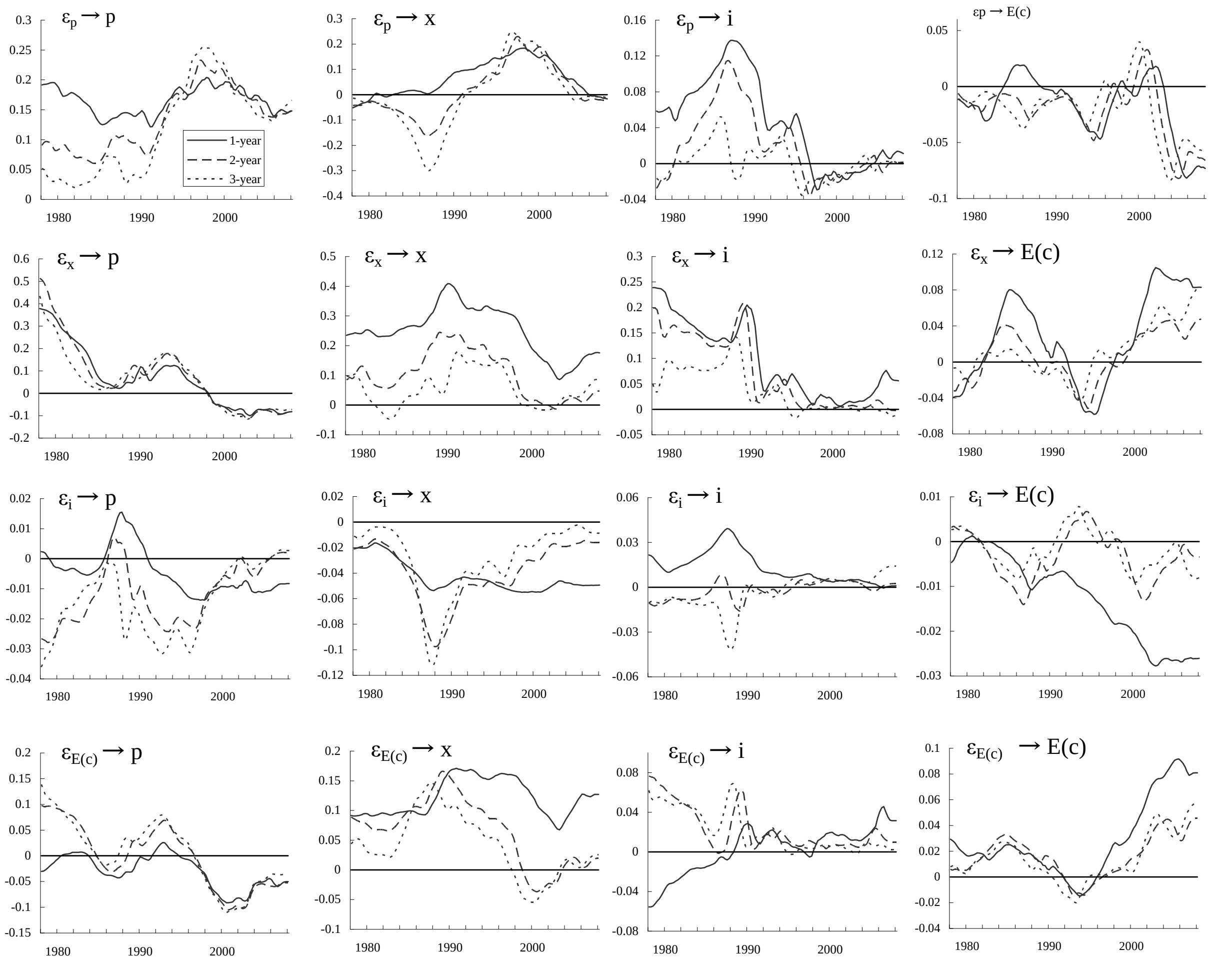

Figure 1: Impulse Responses for the Household Sector

Note: p: CPI inflation, x: GDP gap, i: call rate, $E(c)$: household-sector expectations for livelihood. $\varepsilon_a \rightarrow b$ refers to the impulse response of b to a positive shock of a.

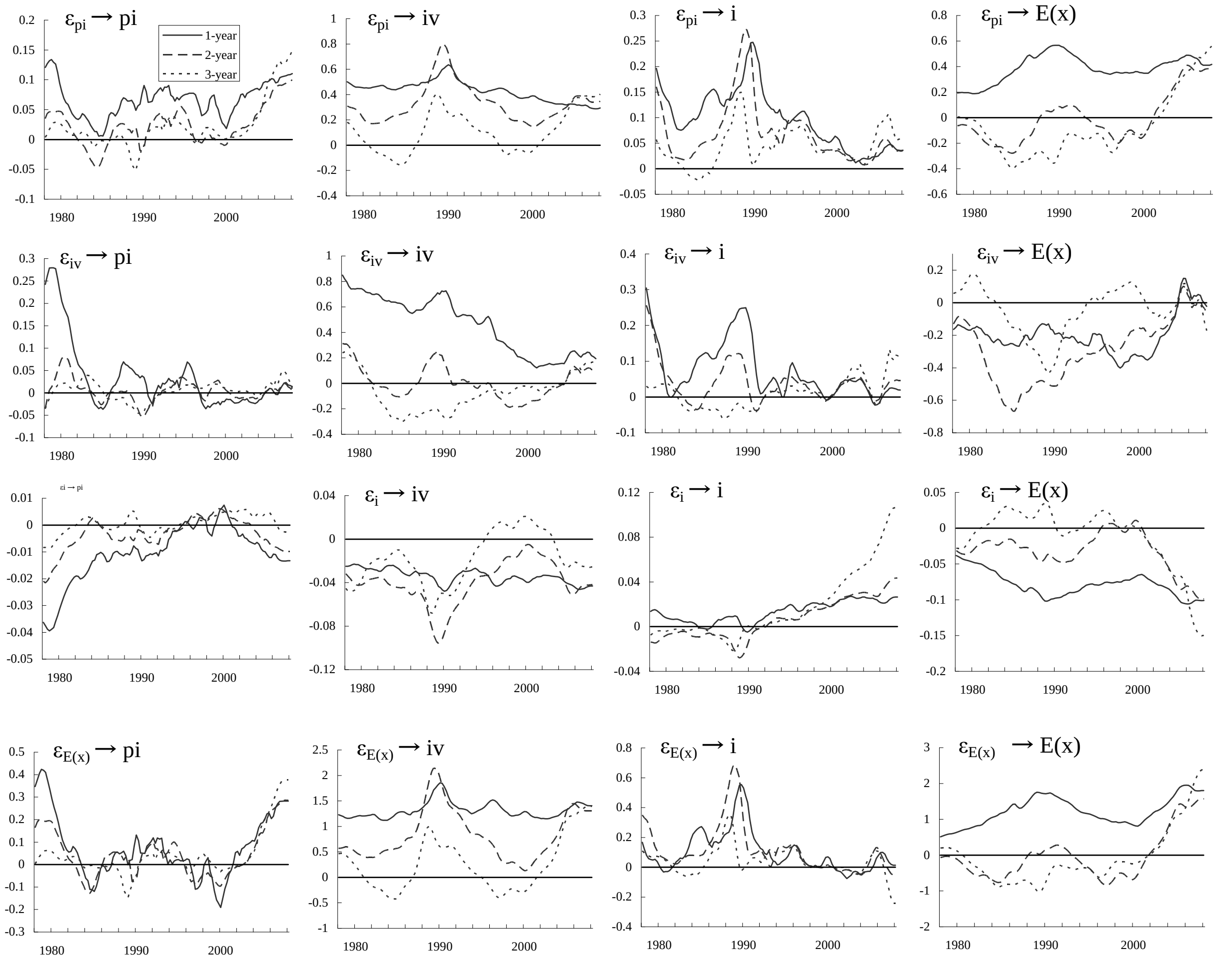

Figure 2: Impulse Responses for the Business Sector

Note: *pi*: CGPI inflation, *iv*: investment gap, *i*: call rate, $E(x)$: business-sector expectations for business conditions. $\varepsilon_a \rightarrow b$ refers to the impulse response of b to a positive shock of a.

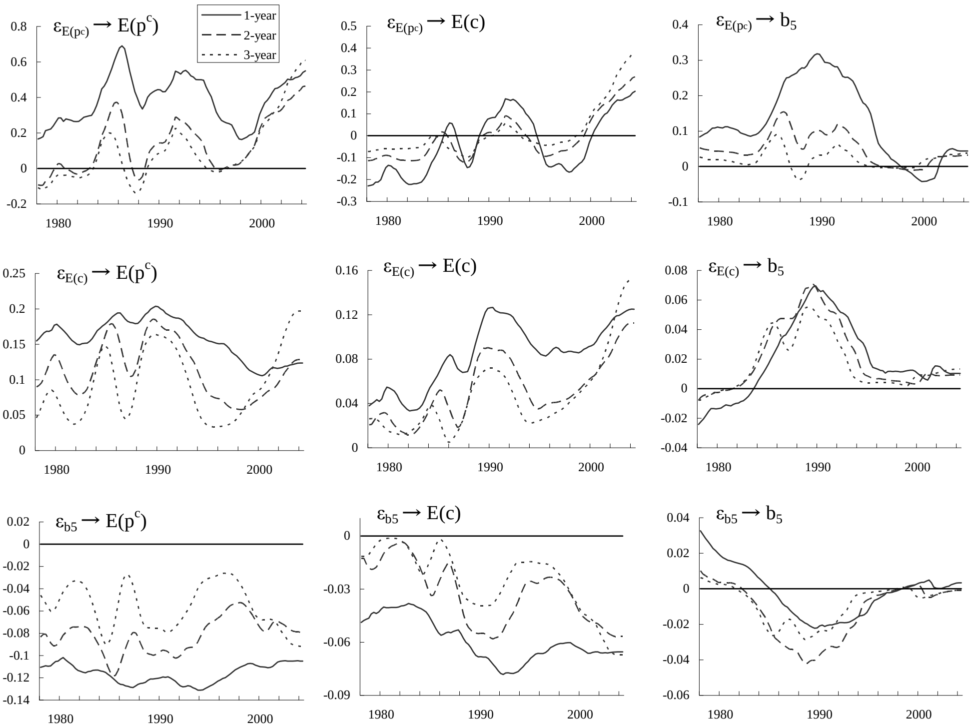

Figure 3: Impulse Responses for Expectations Indicators

Note: $E(p^c)$: household-sector expectations for general prices, $E(c)$: household-sector expectations for livelihood, b_5: long-term interest rate. $\varepsilon_a \rightarrow b$ refers to the impulse response of b to a positive shock of a.