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Transmission mechanisms in Japan's quantitative easing policy (2001–2006)

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Abstract

This study investigates exchange rates and bank lending as the transmission channels for Japan's Quantitative Easing Policy (QEP) during 2001–2006. Using a Time Varying Parameter-VAR model and monthly data to analyze the dynamism of the QEP, this study is the first to show that the exchange rate channel was the effective QEP transmission channel after around 2005, while the bank lending channel was inactive.

Keywords: quantitative easing policy; Bank of Japan; TVP-VAR model; transmission channel
JEL Classification Codes: E44, E52, E58

1. Introduction

The Bank of Japan (BOJ) introduced a Quantitative Easing Policy (QEP) in March 2001 to defeat deflation. It purchased large volumes of Japanese government bonds from financial institutions to achieve the targeted current account balances (CAB) in excess of legal requirements. This target was increased nine times until the termination of the QEP in March 2006. After the financial crisis of 2007–2008, other advanced countries implemented similar programs. While several studies evaluate QEP in Japan, Ijiri's (2016) analysis suggests that most are limited because they adopt a fixed-parameter estimation. QEP was unprecedented, such that financial markets changed their responses to policy actions as they grew to understand QEP. In addition, commercial banks dramatically changed their lending behavior during its implementation as the Japanese government strengthened the prudence policy and forced them to dispose of bad loans actively. These changed the impact of QEP and its effectiveness through its operations.

Earlier studies tried to clarify the QEP transmission channels. QEP might stimulate the economy by raising stock prices, lowering exchange rates, increasing bank lending, and so on. Honda et al. (2013), using a Structural VAR (SVAR) model, find that QEP influenced the real

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economy mainly through the stock prices channel (SP-channel), while the exchange rate channel (EX-channel) and bank lending channel (BL-channel) had almost no effect. Therefore, focusing on the SP-channel, Ijiri (2016) used a Time Varying Parameter-VAR (TVP-VAR) model and found that QEP effectiveness changed over time. This finding suggests that the effectiveness of other channels might also have changed over time. In this study, I investigate the EX- and BL-channels with a TVP-VAR model.

2. TVP-SVAR model

The TVP-SVAR model is similar to that in Primiceri (2005), Nakajima (2011), and Ijiri (2016). The reduced form model is:

$$y_t = X_t\beta_t + A_t^{-1}\Sigma_t e_t, \qquad e_t \sim N(0, I_n), t = s+1, \cdots, T, \tag{1}$$

where y_t is a vector of economic variables $(n \times 1)$, $X_t = I_s \otimes (y_{t-1}' \cdots, y_{t-s}')$, β_t is the matrix of time-varying coefficients, A_t is a lower triangular matrix wherein the diagonal elements are equal to one, and Σ_t is the diagonal matrix[1]. The lower triangular elements of A_t are $a_t = (a_{21,t}, a_{31,t}, a_{32,t}, \cdots, a_{nn-1,t})'$, and the natural logarithm for the diagonal elements of Σ_t are $\sigma_t = (\sigma_{11,t}, \cdots, \sigma_{nn,t})'$. Then, the dynamics of the parameters are:

$$\beta_{t+1} = \beta_t + u_t^{\beta}, \tag{2}$$

$$a_{t+1} = a_t + u_t^{a}, \tag{3}$$

$$\sigma_{t+1} = \sigma_t + u_t^{\sigma}. \tag{4}$$

The error term vector for each variable is:

$$\begin{pmatrix} u_t^{\beta} \\ u_t^{a} \\ u_t^{\sigma} \end{pmatrix} \sim N\left(O, \begin{pmatrix} v_\beta & O & O \\ O & v_a & O \\ O & O & v_\sigma \end{pmatrix}\right), \tag{6}$$

where (v_β, v_a, v_σ) are diagonal matrices.

3. Methodology and results

This study uses monthly data from April 1998 to March 2008. The variables include the index of industrial production (y), the consumer price index for fresh foods (p), CAB (m), bank lending (bl), and the real effective exchange rates (ex)[2]. The study estimates two forms of the model, the exchange rate model (y, p, m, ex) (EX-Model) and the bank lending model (y, p, m, bl) (BL-Model)[3].

This study adopts Nakajima's (2011) TVP-VAR model program (Matlab) to estimate each parameter using a Bayesian estimation using the Markov chain Monte Carlo method, but modifies it to simulate impulse responses. An initial sample of 30,000 is generated and discarded

[1] A_t is a recursive restriction (Nakajima, 2011; Ijiri, 2016). The dimensions of y_t, β_t, A_t, and Σ_t are $(n \times 1)$, $(n^2 s \times 1)$, $(n \times n)$, and $(n \times n)$, respectively.

[2] All data are in log form and de-meaned. The data for p were obtained from the Statistics Bureau, Ministry of Internal Affairs and Communications, and that for ex from the BOJ. All other data were sourced from Datastream. y and p are seasonally adjusted, and bl and m were seasonally adjusted using X-12 ARIMA (Eviews).

[3] This study orders the variables similar to Honda et al. (2013) and Ijiri (2016).

before generating another sample of 30,000. Appendix A describes the initial state of the time-varying parameters and the priors of each model.

Figures 1-2 show the changes in the impulse responses for each model, which illustrate the responses of each variable (columns) to QEP shocks: $\epsilon_m \uparrow$ at specific periods after the shocks (rows) ranging from 1 month to 1.5 years. The horizontal axis represents the period from January 2000 to September 2006; the impulse responses are calculated with parameters estimated for each point. Based on 30,000 samples, the solid lines indicate the posterior medians of the impulse responses, and the dashed lines represent the 25th and 75th percentiles, indicating the significant influences. The two solid vertical lines show the starting and ending dates of QEP, respectively. One standard error in the estimated structural shocks represents a QEP shock, averaged over all periods in each model. The following section focuses only on the QEP implementation period and examines the impulse responses in each model.

Figure 1. Impulse responses: EX-model

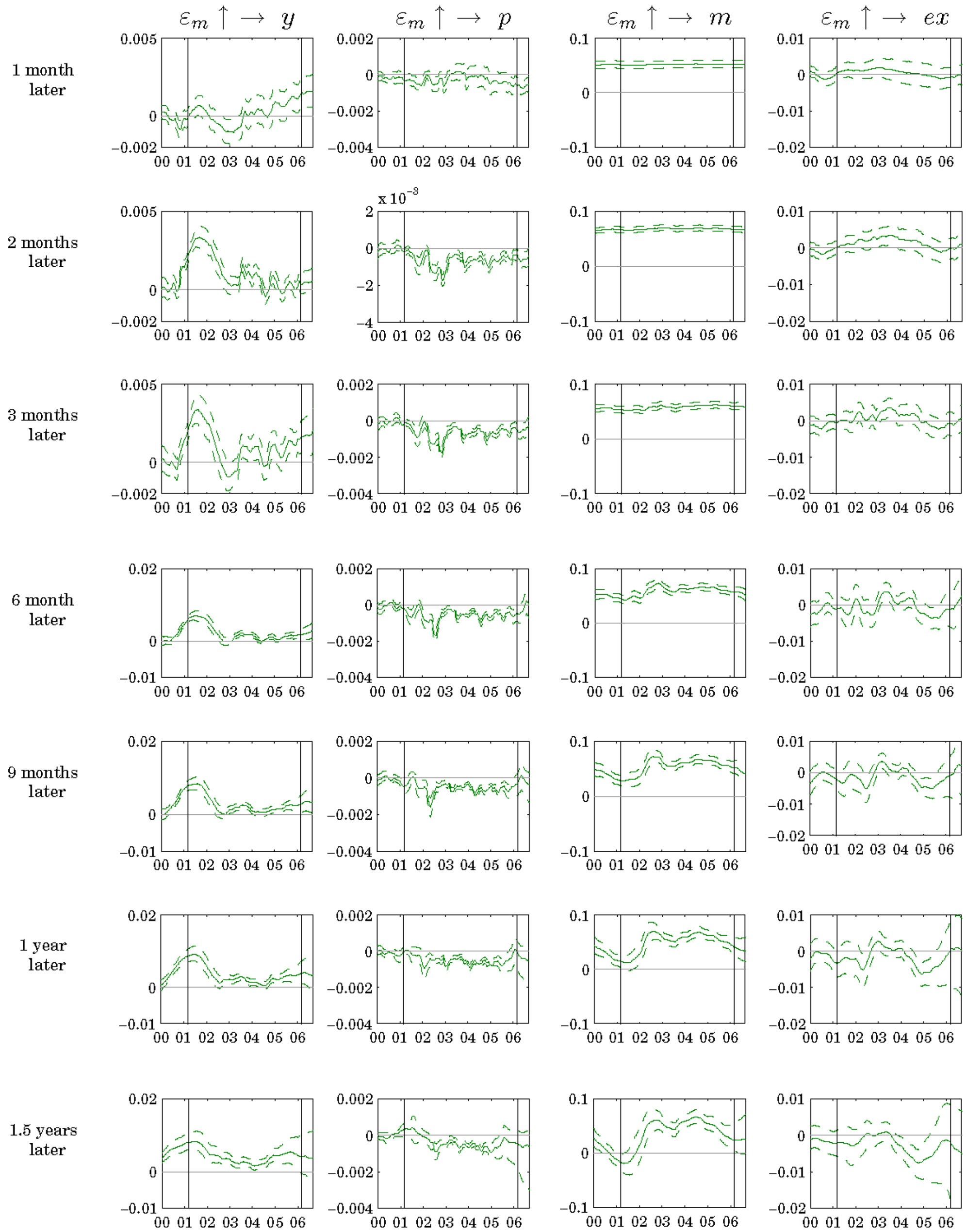


Figure 2. Impulse responses: BL-model

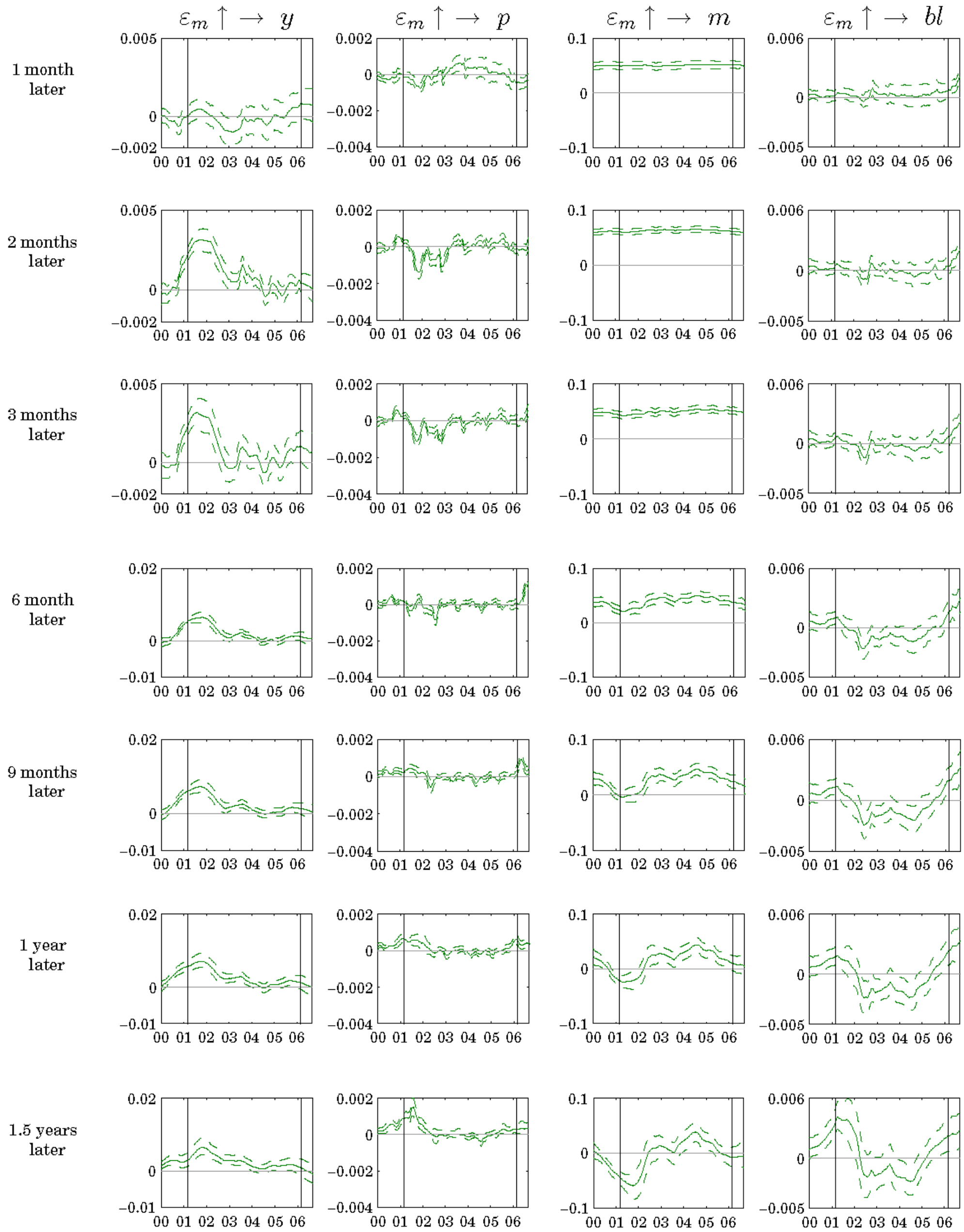


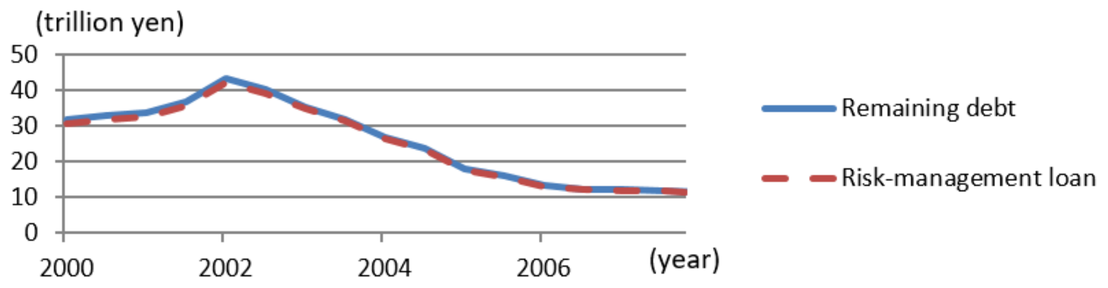
Figure 1 shows the responses to a QEP shock in the EX-Model. Prices show a negative response, similar to the BL-Model, and that in Ijiri (2016) and Honda et al.'s (2013) results. The production responses are positive and significant at "2 months later," while exchange rates show significantly negative responses after around 2005, appearing at "6 months later" after the production response. However, around 2005, production has a significantly positive and greater response than in Ijiri's (2016) basic model (y, p, m)[4]. The EX-channel was the effective transmission channel for QEP after around 2005. In Ijiri's (2016) SP-Model, stock prices have a significantly positive response "1 month ahead." The response is faster than the production response. Therefore, the EX-Model may not have included a variable for the stock

[4] This study and that by Ijiri (2016) use the same data set and TVP-VAR program.

prices, which is important to consider while evaluating QEP[5]. The EX-channel functioned after around 2005, although only weakly as compared to the SP-channel.

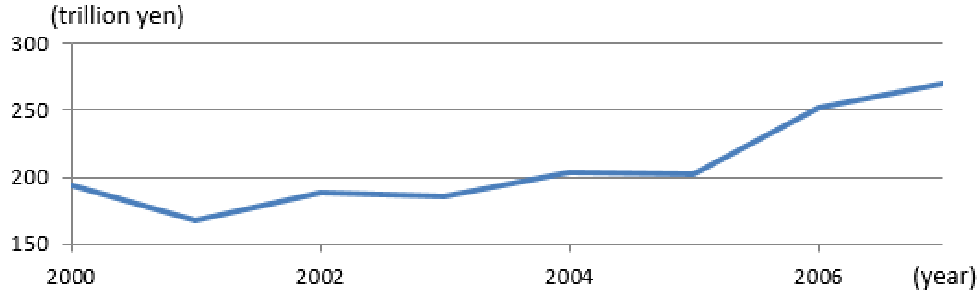
Figure 2 illustrates the responses to a QEP shock in the BL-Model. Again, production and prices respond as in Ijiri (2016) and the EX-Model. Bank lending shows significant positive responses around the QEP implementation and at its termination, when financial institutions worked to dispose of bad loans. Figure 3 shows the changes in the bad loans. After around 2005, the disposal of bad loans stabilized, improving lending attitudes of banks. However, Figure 3 shows that bad loans peaked around the QEP implementation. Under normal circumstances, the response does not adapt to the bad loan condition. The QEP's effects on the real economy were then unknown, because the QEP was undertaken for the first time worldwide. Thus, financial institutions obtained additional money supply and temporarily increased lending. During these periods, production had a significantly positive result, although this is less in the BL-Model than in the EX-Model and in Ijiri's (2016) results. Figure 4 shows that retained earnings increased during Japan's QEP implementation. However, many firms during this time did not depend on bank lending, considering the small bank lending and production responses. These results suggest that the BL-channel was not functional.

Figure 3. Non-performing loan



Source: Financial Services Agency.

Figure 4. Retained earnings



Source: Financial Statements Statistics of Corporations by Industry, annually, special issue 2009.

4. Conclusion

This study found that the EX-channel was the effective transmission channel for QEP in Japan after around 2005, while the BL-channel was inactive during the QEP. No previous study revealed the EX-channel during QEP periods because they do not consider the dynamic nature of QEP. After around 2005, the QEP affected exchange rates, and the weak yen increased exports. This drove Japan's economy, demonstrating the importance of considering the EX-channel for QEP.

[5] The TVP-VAR model contains many parameters: a model with five variables would be difficult to estimate. This study estimates a model with four variables.

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Appendix A
Initial values and robustness check

Initial values. Initial states of the time-varying parameters: $\beta_0 \sim N(0, 10I)$, $a_0 \sim N(0, 10I)$, and $\sigma_0 \sim N(0, 10I)$. $\tilde{v}_{\beta j}^2$, $\tilde{v}_{aj}^2$ and $\tilde{v}_{\sigma j}^2$ are the j-th diagonal elements of the j-th diagonal elements of v_β, v_a, v_σ. The EX-Model begins with these values: $\tilde{v}_{\beta j}^2 \sim IG(50, 0.001)$, $\tilde{v}_{aj}^2 \sim IG(5, 0.001)$ and $\tilde{v}_{\sigma j}^2 \sim IG(5, 0.001)$. The BL-Model begins with these values: $\tilde{v}_{\beta j}^2 \sim IG(70, 0.001)$, $\tilde{v}_{aj}^2 \sim IG(7, 0.001)$ and $\tilde{v}_{\sigma j}^2 \sim IG(7, 0.001)$. Two lags are set in each model[6].

Robustness check. Figure 5 summarizes the autocorrelations of the EX-Model and BL-Model samples. Here, (β, a, σ) is an element $(1, 1)$ of the November 1999 parameters[7]. Moreover, (v_β, v_a, v_σ) are elements $(1, 1)$. The autocorrelation for each parameter is sufficiently attenuating, indicating that the sampling method produces samples with low autocorrelation. Table 1 confirms that the sample converges sufficiently in the posterior probability density function, and shows Geweke's (1992) convergence diagnostics (CD) for numerous parameters for each model. The p-value of the CD statistics take the null hypothesis that the sample converges to the posterior distribution of the parameter in each model. The hypothesis cannot be rejected at the 10% significance level, suggesting that the estimated samples for each model are sufficient.

Figure 5. Estimation results (EX-model and BL-model for selected parameters)

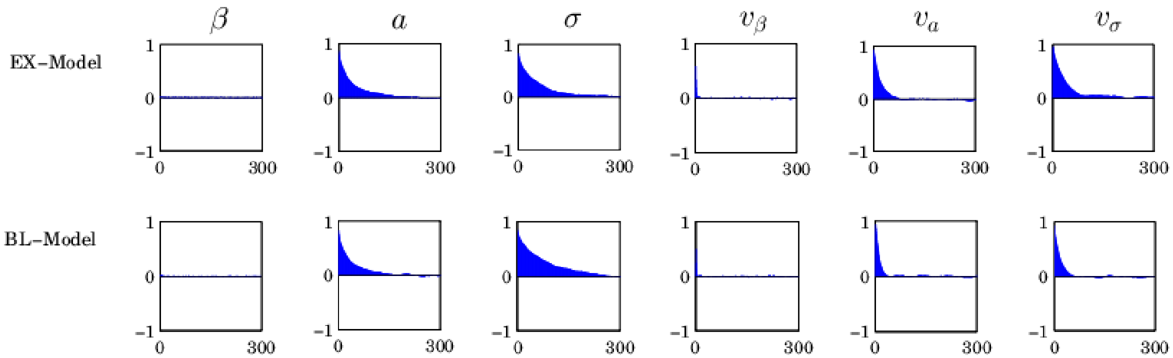

Table 1. CD statistics (p-value)

Parameter	β	a	σ	v_β	v_a	v_σ
EX-Model	0.146	0.138	0.940	0.617	0.735	0.492
BL-Model	0.594	0.211	0.696	0.836	0.953	0.972

[6] In the impulse response analysis, the estimated results when setting three lags are similar to those using two lags.
[7] The vertical line shows the autocorrelation function, and the transverse axis shows the sampling frequency (300 of 30,000 samples).