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Fiscal stimulus effectiveness in Japan: evidence from recent policies*

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This paper examines the effects of Japanese fiscal policy after the 2008 global financial crisis using a mixed vector autoregression/event study approach. We focus on the effects of stimulus packages with environmental benefits. The empirical results show that a tax break and subsidy program designed to promote the adoption of eco-friendly cars helped stimulate automobile production, while a similar program intended to promote the purchase of energy-efficient appliances had no effect on appliance production.

JEL classification: E23, E62, H30

Keywords: Fiscal policy effectiveness in Japan; Environmental stimulus package; Eco Subsidy; A mixed vector autoregression/event study approach

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1. Introduction

In the wake of the 2008 global financial crisis, governments in many developed countries enacted economic stimulus packages. In some countries, including the United States and Japan, these included environment-related policies.

Theoretical research has also pursued the possibility of environmental policies as stabilization tools, as summarized in Bowen and Stern (2010). For example, Bovenberg and Van der Ploeg (1996, 1998) explored the effects of environmental taxation on involuntary unemployment. Using a real business cycle model with pollution externalities and market imperfection, Chang et al. (2009) showed that an optimal environmental tax should be designed to affect the economy pro-cyclically. This result suggests that emission taxes should be lowered to stimulate the economy in a recession and raised during an economic boom caused by a positive productivity shock, when aggregate pollution also rises. From a theoretical viewpoint, environment-related stimulus packages can thus be justified as stabilization tools.

Such approaches have been pursued in practice in Japan. The Japanese government subsidized consumer purchases of energy-conserving home appliances from May 2009 to March 2011, offering refundable “eco points” on energy-efficient appliance purchases. Additionally, a program of tax breaks and subsidies for purchasing “eco-friendly” cars

(henceforth, “the eco-car program”) was also implemented. The eco-car subsidy program was effective from April 2009 to September 2010 after an extension in March 2010; it was then restarted in December 2011 and continued until September 2012.¹ Eco-car tax breaks were implemented between April 2009 and March 2011.² Under these programs, if a consumer bought a new car with emissions below a given threshold or with low fuel consumption, such as a gas-electric hybrid, the automotive tax would be lowered or the price subsidized.³

Unlike most other developed countries, the Japanese government had regularly implemented fiscal stimulus packages including increases in public investment and tax breaks even before the 2008 global financial crisis. As a result, a considerable amount of empirical research has examined the effects of fiscal policy in Japan, such as Ihori et al. (2003), Miyazaki (2009), Miyazaki (2010), Kozuka et al. (2012), Rafiq (2012), Vu (2012), Fujii et al. (2013), Kameda (2014), and Morita (2015). Most of these studies suggest that the “conventional” Japanese fiscal stimulus moves, such as increasing public investment and cutting taxes, are ineffective. On the other hand, eco-friendly policies

¹ The application to eco-car subsidy was ended in September 21, 2012 because it had reached its upper budgetary limit. For details, please see <http://www.cev-pc.or.jp/ECO/>.

² Although the eco-car tax break was initially planned to be end in February 2011, it was extended until March 2011.

³ For information on the fiscal policy response after the global financial crisis in Japan, please see Iwaisako (2010) and Asako (2012). For the details of the eco-car subsidy program, please see Alhulail and Takeuchi (2014).

may be more useful policy instruments for economic stabilization if their policy effects are empirically proven to persistently stimulate the economy.

However, to our knowledge, there has been no research examining the size and persistence of fiscal policy in Japan after the global financial crisis that focuses on these environment-related stimulus packages. Rafiq (2012), Vu (2012), and Morita (2015) examine the size and persistence of Japanese fiscal policy by considering the post-crisis period through Vector Autoregression (VAR) models. However, these studies do not focus on the environment-related policies. Alhulail and Takeuchi (2014) examine the effects of the eco-car program on sales of ten eco-friendly vehicles in Japan but do not examine the size and persistence of the policy's effects.

The purpose of this paper is thus to examine the size and persistence of the impact of fiscal policy in Japan after the 2008 global financial crisis by considering these two environment-related stimulus measures: subsidies for purchasing energy-efficient home appliances (hereafter the “eco-points program”) and two eco-car programs (subsidies and tax breaks). To do so, we examine the policies' effects using VAR analysis in conjunction with an event study. Following this approach, we construct dummy variables based on when the policies were announced or implemented. By using these dummies as variables in the VAR estimation, we can examine the size and persistence

of specific stimulus packages. Our approach thus allows us to examining the size and persistence of fiscal policy impacts by focusing on environment-related stimulus packages implemented after the global financial crisis.

The remainder of the paper proceeds as follows. Section 2 explains the methodology and data, including how dummy variables are constructed and used to identify fiscal shocks. Section 3 then provides the empirical results, reporting that while the eco-car programs had positive and significant effects on the automobile industry, the eco-points program's effect on electrical appliance production was insignificant. Section 4 concludes the paper.

2. Methodology

2.1. Constructing the Dummy Variables

In our empirical approach, we use dummy variables to identify fiscal policy shocks based on official documents. When selecting the dummy variables, we face an identification problem. If we allow the dummy associated with each major policy change to have its own distributed lag effect, we cannot identify the effects of each individual fiscal policy because the times at which they were announced and/or implemented are

too close together. To deal with this, we construct dummy variables that take 1 throughout the time period for which the policy was in effect, as in the case of Blanchard and Perotti (2002) and Miyazaki (2010).

To construct dummy variables capturing the effects of environmental policies, we thus clarify the start and end dates of the policy's implementation periods. The *Eco-point*, *Eco-car subsidy*, and *Eco-car tax break* variables thus indicate the implementation periods for the eco-points and eco-car programs, respectively.

As the periods in which the programs were in effect included March 2011, when the Great East Japan Earthquake occurred, this must also be considered. Whereas the index for electrical appliance production did not drop very much, as shown in Figure 1, Figure 2 shows that the index of automobile production dropped sharply in March 2011 due to the earthquake. If we examine the effects on automobile production using dummy variables that include March 2011, we cannot distinguish between the positive effects of the subsidy or tax break and the negative effects of the devastating earthquake. Therefore, at least for the models examining the effects on automobile production, we decide to exclude March 2011 when constructing the dummy variables.

Eco-Point thus equals 1 from May 2009 to March 2011. *Eco-car subsidy* equals 1 from April 2009 to September 2010 and from December 2011 to September 2012, given the

extension to September 2010 and restart in December 2011. *Eco-car tax break* equals 1 from April 2009 to February 2011 as explained in the previous paragraph.

2.2. Outline of VAR Estimation

We include these variables in our empirical models. As the examined policies are assumed to be targeted at increasing production of specific industries, we focus on the individual industries most directly impacted by each policy. We estimate two separate VAR models that include industry-specific policy dummies and production indexes.⁴ The first (“Case 1”) includes *Eco point* and uses $\log y_t^{El}$, where y_t^{El} denotes electric appliance production. The second model (“Case 2”) includes *Eco-car subsidy* and *Eco-car tax break* and uses $\log y_t^{Auto}$, where y_t^{Auto} indicates automobile production.

Throughout the analysis, we follow the recent convention in the VAR literature and use levels, rather than first or second differences, for all series. As Hamilton (1994) argues, a levels specification yields consistent estimates regardless of whether or not cointegration exists, whereas a difference specification is inconsistent if some variables are cointegrated. The lag length is set as eight in Case 1 and 12 in Case 2 based on the likelihood ratio test of Sims (1980).

⁴ We also estimate our VAR model using the index of industrial production, which denotes the production of all mining and manufacturing industries, instead of y_t^{El} or y_t^{Auto} . However, the impulse response functions are found to be insignificant.

For Case 1, we can set up the structural VAR model $A(L)X_t = \varepsilon_t$, where $X_t = (D_t, \log y_t^j)'$, $A(L) = A_0 - A_1L - \dots - A_pL^p$ is a p th-order lag polynomial of the two-by-two coefficient matrix A_k ($k = 0, 1, \dots, p$), and $\varepsilon_t = (\varepsilon_D, \varepsilon_{y_t^j})'$ is vector of serially uncorrelated structural disturbances with a mean zero and a covariance matrix Σ_ε .

Here D_t is a dummy variable (*Eco Point*) and $\log y_t^j$ is the logarithm of the index of productions ($\log y_t^{El}$). Structural disturbances are assumed to be orthogonalized, the recursive identification procedure implies that A_0 in the structural form becomes a lower triangular matrix, and the ordering in the VAR determines the degree of exogeneity of the variables. We treat the policy dummy variable as being the most exogenous, as it takes policymakers and the legislature over a month to learn of shocks to economic activity, and it is very difficult to make discretionary adjustments to fiscal policy within the space of a month. Therefore, there should be no feedback from the current economic variables to fiscal expansion.⁵ This justifies our treatment approach.

For Case 2, certain identification strategies like structural VAR or Choleski decomposition are not used. The impulse response function of $\log y_t^{Auto}$ is calculated using reduced-form residuals, u_t^{SUB} and u_t^{TAX} (or policy shocks). We use a univariate

⁵ This follows the arguments in Blanchard and Perotti (2002) and Miyazaki (2009).

autoregressive model in which the lagged values of the dummy variables are used to identify fiscal shocks. The estimating equations are as follows:

$$\log y_t^{Auto} = a_0 + \sum_{i=1}^T a_{1i} \log y_{t-i}^{Auto} + \sum_{i=1}^T a_{2i} SUB_{t-i} + \sum_{i=1}^T a_{3i} TAX_{t-i} + u_t^{y^{Auto}} \quad (1)$$

$$SUB_t = b_0 + \sum_{i=1}^T b_{1i} \log y_{t-i}^{Auto} + \sum_{i=1}^T b_{2i} SUB_{t-i} + \sum_{i=1}^T b_{3i} TAX_{t-i} + u_t^{SUB} \quad (2)$$

$$TAX_t = c_0 + \sum_{i=1}^T c_{1i} \log y_{t-i}^{Auto} + \sum_{i=1}^T c_{2i} SUB_{t-i} + \sum_{i=1}^T c_{3i} TAX_{t-i} + u_t^{TAX}, \quad (3)$$

Here “*SUB*” indicates the dummy variable “*Eco-car subsidy*” and “*TAX*” indicates the dummy variable “*Eco-car tax break*.” When we add the contemporaneous dummy variables as regressors, the overidentification restriction test must be done for the contemporaneous dummy variables and $\log y_t^{Auto}$.⁶ However, since the chi-squared

⁶ Two fiscal expansions, eco-car subsidy program and eco-car tax break, affect current automobile industry production. However, it is plausible that there is no feedback from the eco-car tax breaks to the eco-car subsidy program. We thus assume the following relationship between structural form residuals, ε_t , and reduced form residuals, u_t ($Au_t = \varepsilon_t$), and implement the over-identification restriction test:

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -a_{31} & -a_{32} & 1 \end{pmatrix} \begin{pmatrix} u_t^{SUB} \\ u_t^{TAX} \\ u_t^{y^{Auto}} \end{pmatrix} = \begin{pmatrix} \varepsilon_t^{SUB} \\ \varepsilon_t^{TAX} \\ \varepsilon_t^{y^{Auto}} \end{pmatrix}.$$

statistic is 89.02, the p-value of the likelihood ratio (LR) test for overidentification is 0.00, and the null hypothesis is rejected at the 1% significance level, the model is rejected. As such, there is no alternative but to use lagged values of the fiscal policy dummy variables, at least to examine the effects of the eco-car subsidy programs and eco-car tax break.

2.3 Data

We estimate the model using monthly data, as in the case of Miyazaki (2009) and Kozuka et al. (2012). This is motivated by the short duration of the post-crisis sample period, making it difficult to set a certain level of lag length when using quarterly data.

There are two variables that capture production: y_t^{EI} , an indicator of electric appliance production (*minsei-yo denki kikai* in Japanese), and y_t^{Auto} , one for automobile production (*jou-you sha* in Japanese).⁷ They are set equal to 100 in 2000. y_t^{EI} includes the production of air conditioners and refrigerators, which were targeted by the eco-points program.⁸ These data are downloaded from the homepage of the Ministry of

⁷ To capture the effects of each policy, we would ideally focus on production of the items mostly affected by the policies, such as gas-electric hybrid cars, air conditioners, and refrigerators. However, METI data are not available at such a detailed level.

⁸ The eco-points program also targeted LCD televisions capable of receiving digital terrestrial broadcast signals, which are included in the “electric machines for home use” data category (*minsei-yo denshi kikai* in Japanese). LCD televisions are the only items in this category targeted by the policy, whereas y_t^{EI} covers a broader set of target items. Further, the Japanese government encouraged households to purchase this type of television leading up to July 2011, when all of Japan’s TV

Economy, Trade and Industry (METI) (<http://www.meti.go.jp/statistics/>).

In general, since companies must prepare for last-minute surges in demand, they produce goods constantly. As such, the medium-term effects of the subsidy program are better captured by production index than by sales statistics. On the other hand, companies do not restart production when they hold stock merchandise. Stock merchandise is used to initially meet a demand recovery without increasing production. Though we cannot observe these phenomena in the data without knowing about stock levels, the production index, which includes stock levels, enables us to capture these effects.⁹ Therefore, we use the production index.

Both y_t^{El} and y_t^{Auto} are seasonally adjusted using the X12-ARIMA method. We take the logarithm for y_t^{El} and y_t^{Auto} , and the sample period is from January 1980 to December 2012.¹⁰

programming was switched from analog broadcasting to digital terrestrial broadcasting. If we examine the effects on electric machines for home use, it is clear that we cannot disentangle the policy effects of the eco-points program from the increase in the production of LCD televisions before this transition. As such, we use y_t^{El} .

⁹ For details, please see: http://www.meti.go.jp/statistics/tyo/iip/pdf/b2010_mechanism_iipj.pdf.

¹⁰ Another option would be to end the sample period in February 2011 in order to eliminate the influence of the Great East Japan Earthquake. When this is done, however, the impulse response functions are not estimated to be significant.

3. Empirical Results

3.1. Estimation Results

Figures 3a and 3b report the estimation results for Case 1 and Case 2, respectively.

The solid line depicts the estimated response, and the dotted lines represent the 95% confidence intervals based on asymptotic distributions.¹¹

Figure 3a indicates that the effect of the eco-points program is not statistically significant. However, both the eco-car subsidy and the eco-car tax break have positive and significant effects on automobile production, as shown in Figure 3b. This implies that this program was effective at stimulating the production of the automobile industry.

However, the magnitude of the effect is very small. Moreover, it takes several months for eco-car subsidy to have a positive and significant effect on automobile production, and the effect then disappears. The effects of the eco-car tax break become insignificant soon after implementation. Japan's environmental-stimulus packages were temporary and were implemented while announcing the termination date. The reason why even policy measures with positive and significant results are not persistent can be explained

¹¹ Other methods, such as Monte Carlo integration and bootstrap replications, could also be considered to calculate the confidence intervals of the impulse response functions. However, since there is no established method for calculation, we report the results based on asymptotic distributions. For confirmation, we also calculate the confidence intervals with 500 bootstrap replications, but the results and implications are not fundamentally changed.

by the well-known theory that temporary fiscal policies do not produce permanent outcomes.

It should be noted that fuel-efficient and low-emission cars, which likely benefitted from the eco-car programs, accounted for the majority of gasoline vehicles shipped, as shown in Figure 4. Actually, many cars produced at the time were categorized as fuel-efficient and low-emissions cars.¹² Since much of the rise in automobile production can be attributed to the increase in production for cars covered by the environmental stimulus packages, the eco-car subsidy and/or eco-tax tax break had positive effects on automobile production.

However, the indicator of electric appliance production includes products that are not targets of the eco-point program. One reason that effects of the eco-point program are statistically insignificant may be substitution between eco and non-eco goods in the same category.¹³

¹² For more detail on the fuel-efficient and low-emissions cars covered by the eco-car tax break in our sample periods, please see http://www.jama.or.jp/tax/exemption201205/tax_list_old.html.

¹³ There are no monthly datasets that cover only products that benefited from the eco-points program. Therefore, we have no choice but to use the production indicator as an approximation when estimating the macroeconomic effects of the program.

3.2. Alternative Frameworks

We re-run the VAR analysis under alternative specifications. First, we re-estimate the model by changing the ordering such that $X_t = (\log y_t^j, D_t)'$ for Case 1. Second, for both cases we control for the real effective exchange rate (e_t), as foreign events and economic changes can strongly affect production in these two industries. In this specification, the ordering in the VAR is $X_t = (D_t, \log y_t^j, \log e_t)'$ for Case 1 and the lag lengths are set as five and 12 in Cases 1 and 2, respectively. Finally, we limit the sample period to being after January 1990 as, following Christiano (1986) and Cecchetti and Karras (1994), we note a structural change in the data after this month. The lag length is set as four in Case 1 and 11 in Case 2.¹⁴

The results are reported in Figure 5 to Figure 7b, showing that the results do not change compared to those of the original specification: while the eco-points program has no positive effect on $\log y_t^{El}$, the eco-car programs stimulate production in the automobile industry. The effects on the real effective exchange rate are not estimated to be significant.

¹⁴ The lag lengths used for the additional tests in this subsection are also chosen using the likelihood ratio test of Sims (1980).

4. Conclusion

This study examined the effects of Japanese fiscal policy following the 2008 global financial crisis. We focused on two environment-related stimulus packages: the eco-points program for purchases of energy-efficient appliances and the eco-car programs, including tax breaks and subsidies for environmentally friendly vehicles. The impulse response function estimation results show that while the eco-points program had no significant effect, the eco-car subsidy and eco-car tax programs had a positive impact on automobile production. However, these effects were small. When evaluating the effects of Japanese discretionary fiscal policy following the global financial crisis, it must thus be concluded that even a policy with a positive effect generated very limited benefits for the economy.

There are some limitations to our analysis. First, given consumers' optimization problems, purchases of cars and electric goods would likely decrease soon after the end of the policy. To investigate this, we would need to examine the effects on household consumption. Second, although the environment-related stimulus packages were also meant to reduce greenhouse gas emissions, we did not examine this effect. In order to demonstrate that these packages are useful at achieving a double dividend of better environmental quality and economic stimulus, we would need to also examine the

effects on emissions. Furthermore, more recent econometric techniques, such as factor-augmented or time-varying VAR models, could be employed within our approach. These extensions are left for future research.

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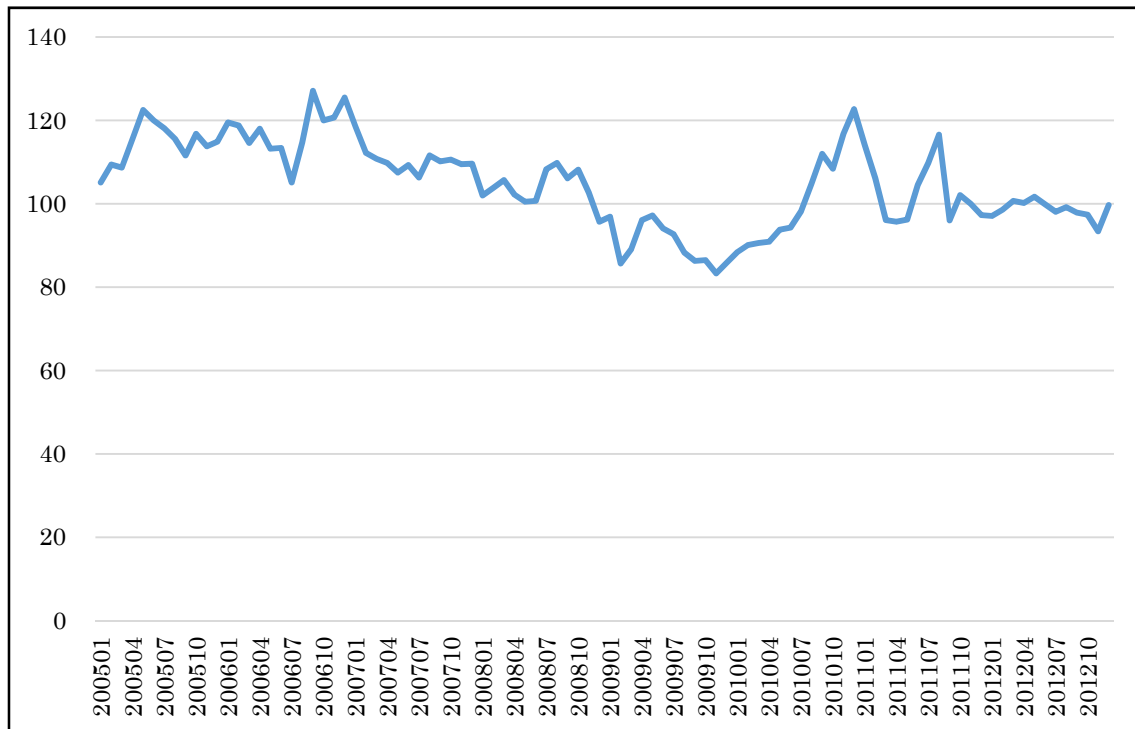


Fig. 1. Trends in the electrical appliance production index (2005:1-2012:12)

Source: METI (<http://www.meti.go.jp/statistics/>)

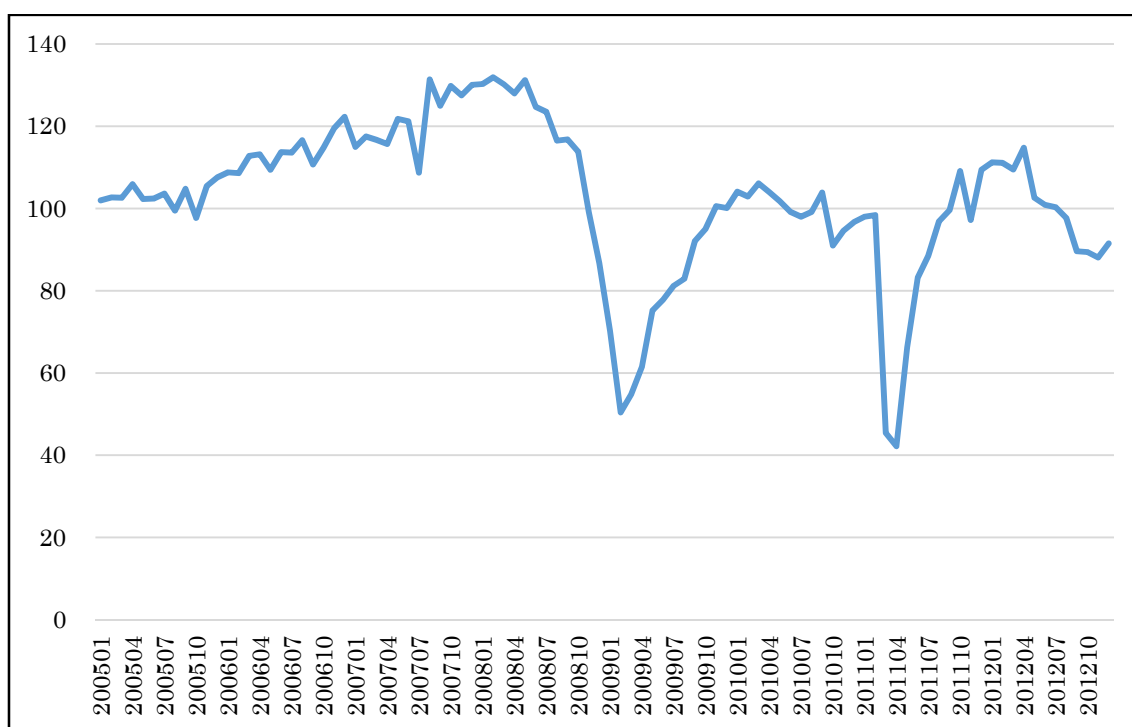


Fig. 2. Trends in the automobile production index (2005:1-2012:12)

Source: METI (<http://www.meti.go.jp/statistics/>)

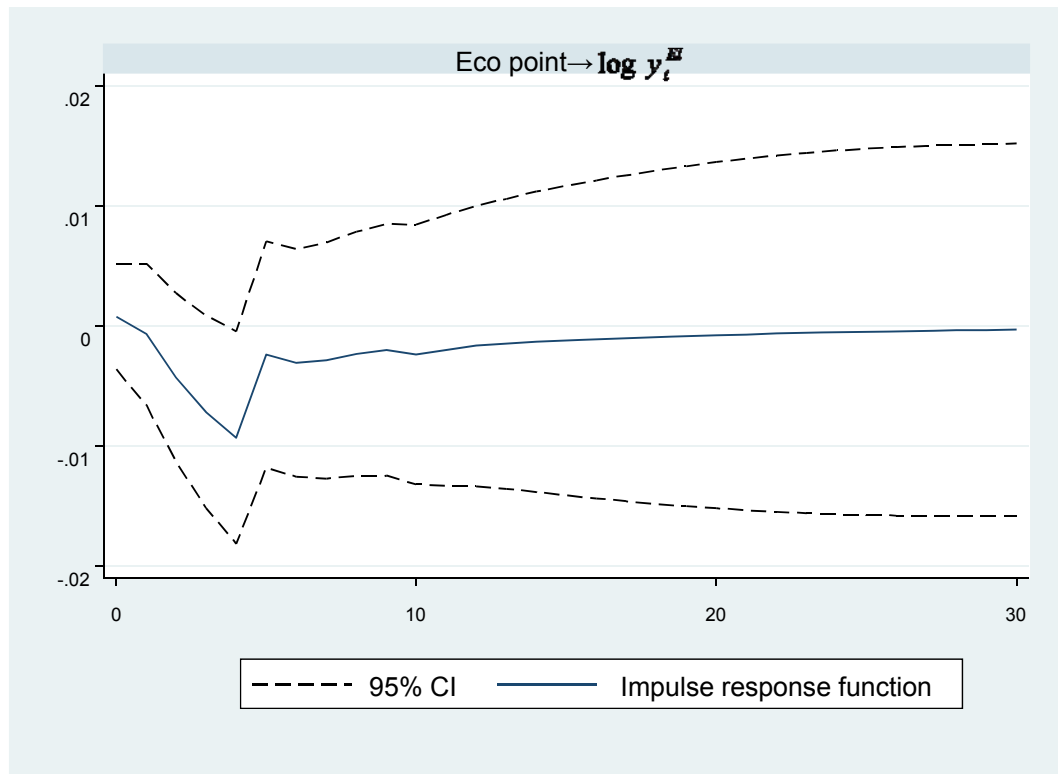


Fig. 3a. Impulse response function for the electrical appliance production index, y_t^{EI}

Note: The solid line indicates the estimated response, and the dotted lines represent the 95% confidence intervals.

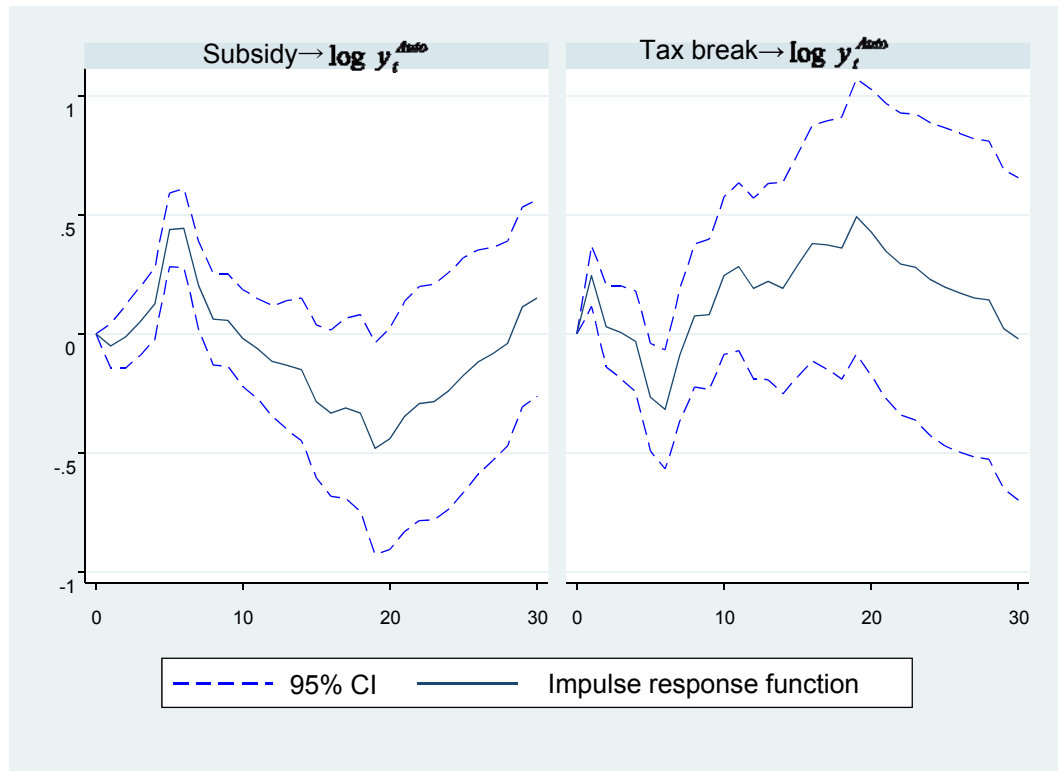


Fig. 3b. Impulse response function for the automobile production index, y_t^{Auto}

Note: The solid line indicates the estimated response, and the dotted lines represent the 95% confidence intervals. “Subsidy” indicates the dummy variable “*Eco-car subsidy*” and “Tax break” the dummy variable “*Eco-car tax break*”.

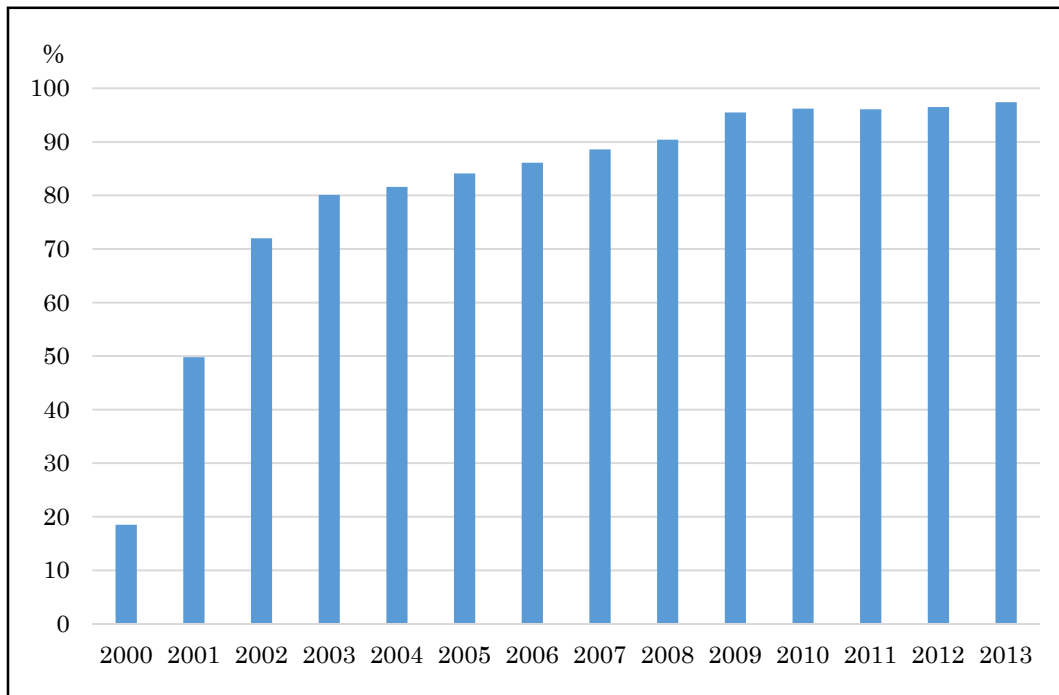


Fig. 4. The shipment ratio of fuel-efficient and low-emissions car to all gas vehicles produced in Japan (FY2000-FY2013).

Source: Environmental Report 2014, Japan Automobile Manufacturing Association (JAMA)

(http://www.jama.or.jp/eco/wrestle/eco_report/pdf/eco_report2014.pdf)

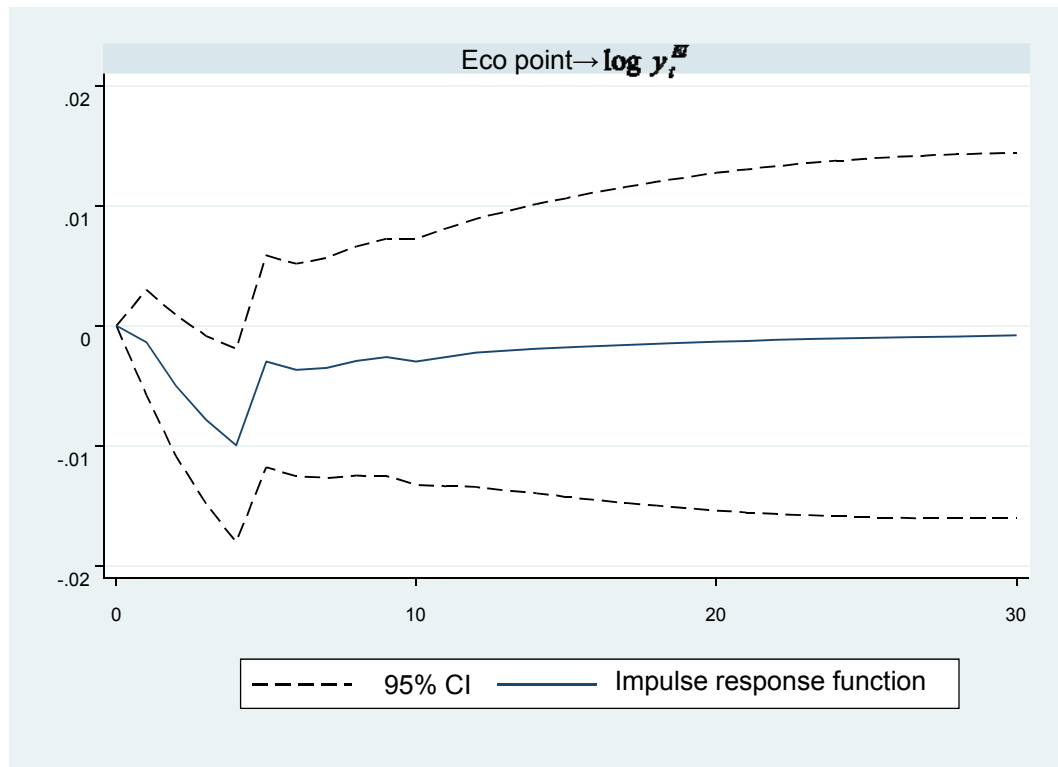


Fig. 5. Impulse response function for the electrical appliance production index, y_t^{El}

(Variable order changed)

Note: The solid line indicates the estimated response, and the dotted lines represent the 95% confidence intervals.

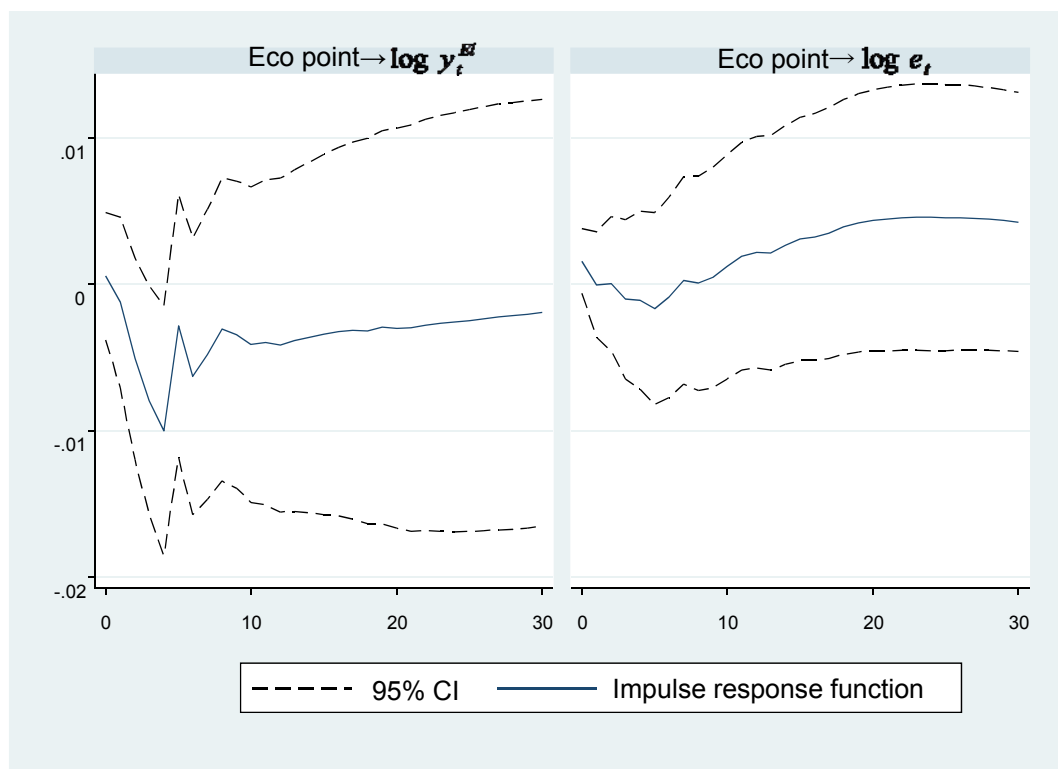


Fig. 6a. Impulse response function for the electrical appliance production index (y_t^{El}) and real effective exchange rate (e_t).

Note: The solid line indicates the estimated response, and the dotted lines represent the 95% confidence intervals.

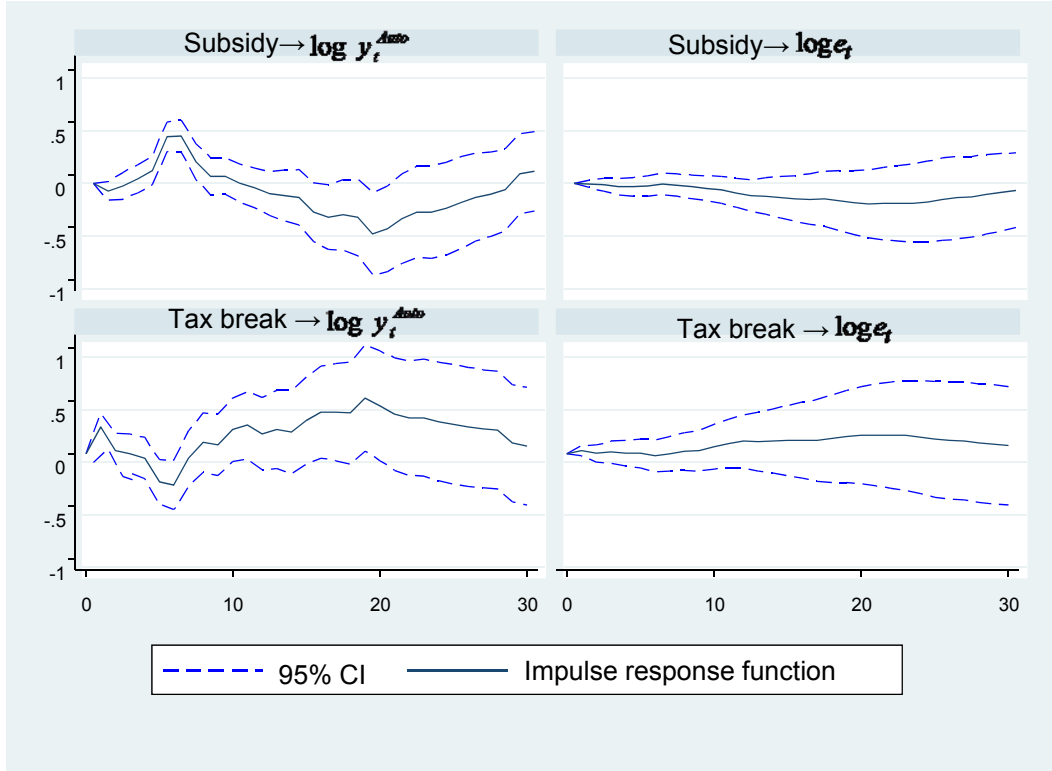


Fig. 6b. Impulse response function for the automobile production index (y_t^{Auto}) and real effective exchange rate (e_t).

Note: The solid line indicates the estimated response, and the dotted lines represent the 95% confidence intervals. “Subsidy” indicates the dummy variable “*Eco-car subsidy*” and “Tax break” the dummy variable “*Eco-car tax break*.”

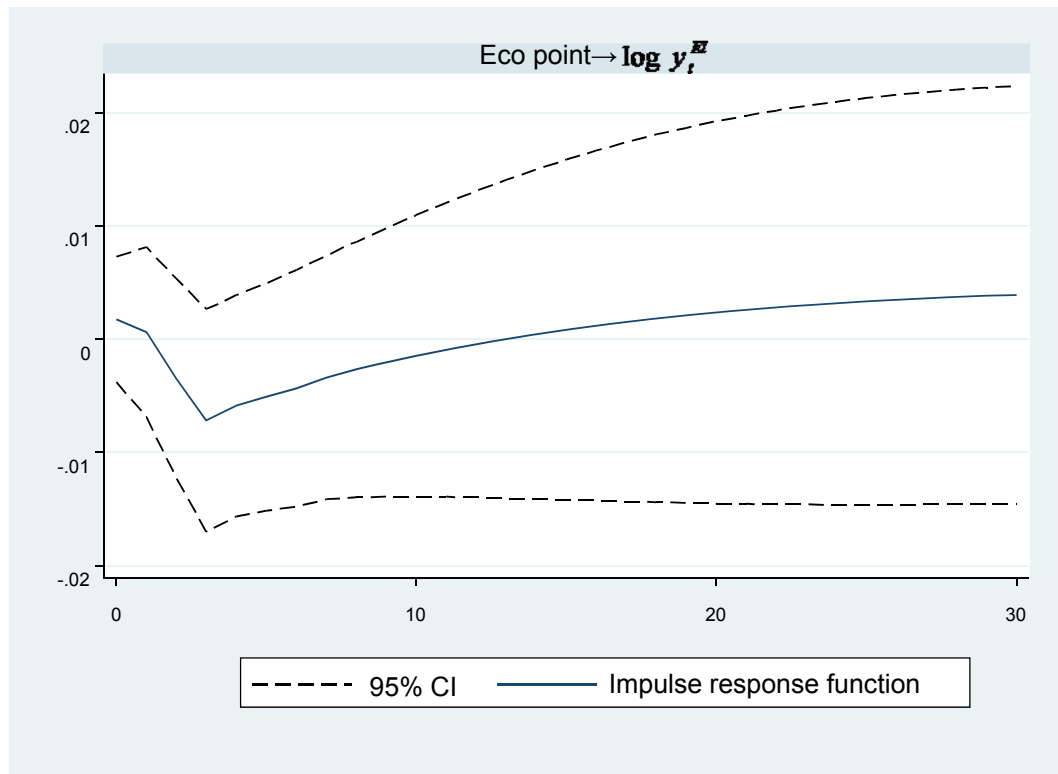


Fig. 7a. Impulse response function for the electrical appliance production index, y_t^{EI}

(Sample period limited to post-January 1990)

Note: The solid line indicates the estimated response, and the dotted lines represent the 95% confidence intervals.

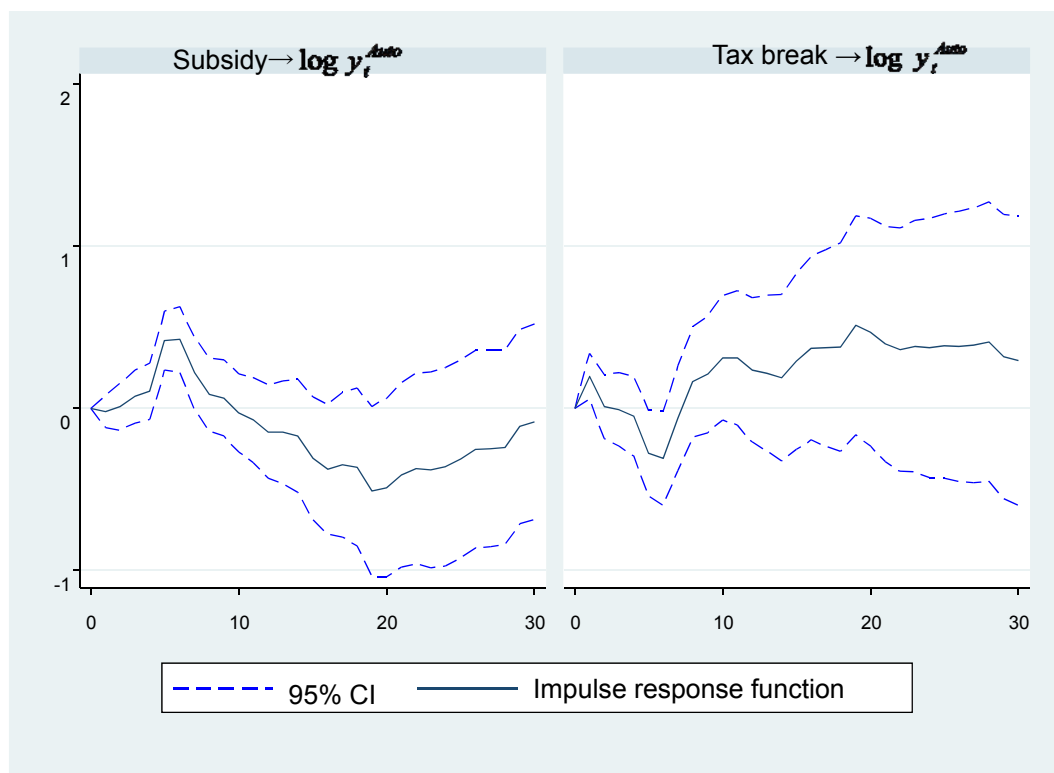


Fig. 7b. Impulse response function for the automobile production index, y_t^{Auto}

(Sample periods limited to after January 1990)

Note: The solid line indicates the estimated response and the dotted lines represent the 95% confidence intervals. “Subsidy” indicates the dummy variable “*Eco-car subsidy*,” and “Tax break” the dummy variable “*Eco-car tax break*,” respectively.