TGU-ECON Discussion Paper Series
#2021-2

International Information Disparity, Sticky Information, and Economic Behavior: Tourist's Response to Region-Specific Shocks

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July 2021

International information disparity, sticky information, and economic behavior: Tourist's response to region-specific shocks*

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July 5, 2021

Abstract

This study investigates how region-specific shocks affect international behavior of individuals when information is partially or scarcely spread across the border. We use both local and international tourist data pertaining to Hakone in Japan, to focus on two exogeneous region-specific shocks of natural disasters: the Great East Japan Earthquake and volcanic activity on Mount Hakone. Hotel guests' response to these shocks is estimated by smooth local projections. We find that the responses of less-informed foreign guests are different from those of domestic well-informed guests. Because of insufficient and sticky information, the Great East Japan Earthquake and its aftermath lead to a decrease in the number of foreign guests at a rate greater and more persistently than domestic guests. Conversely, because of the absence of information, changes in volcanic alert levels have no impact on foreign guests, but they have negative and persistent effects on domestic guests.

Keywords: International information disparity, International behavior, Region-specific shocks, Smooth local projections, Sticky information

JEL classification: D80, F20, F62, Z30

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*The authors would like to thank Sami Dakhlia, Ryohei Hayashi, Yoshiyuki Nakazono, and the participants of the Virtual 96th Annual Conference of Western Economic Association International and workshop at Yokohama City University for their helpful comments and suggestions. Funashima's work is supported by a Grant-in-Aid for Scientific Research by the Japan Society for the Promotion of Science (Nos. 17K03770 and 21K01446). The authors have no conflict of interest to declare.

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1 Introduction

How does international information disparity distort the international economic behavior? This study addresses one aspect of this question, that is, the response of tourism demand to region-specific shocks caused by natural disasters. We investigate the effects of region-specific shocks, which are accompanied by information disparity between the affected region and other regions, on visitors both within and outside the region. As a region-specific shock, we consider natural disasters caused by strong exogeneity. We compare the behavior of individuals living in the neighborhood of disaster-hit area, who have abundant information about region-specific natural disasters, with the behavior of other individuals who have less information and must pay the cost to acquire detailed information. Valuable observations of domestic and foreign visitors to Hakone in Japan, where relevant natural disasters occurred, are gathered to conduct this comparison.

Although the development of globalization and information and communications technology have brought about rapid borderless propagation of news regarding a region, the local population nonetheless has much better accurate knowledge related to region-specific news than those in other regions. This is because, even in the globalization era, local media report news by placing larger emphasis on the local region than other regions. Thus, gathering local information by people from other regions costs money and time. After such a regional information disparity is recognized, sticky information matters in less-informed regions, as argued, for example, in Mankiw and Reis (2002). That is, in less-informed regions, the costs of information-gathering are non-negligible, information diffusion is slow, and the economic behavior in these regions becomes sticky in response to changes in some region-specific conditions. Hence, behavioral differences between regions could be driven by regional information disparity depending on the residence of decision makers.

Observations on visitors to Hakone in Japan, allowing us to assess potentially different responses of Japanese and international visitors to natural disasters, are useful to our investigation. In the 2010s, Japan had experienced two natural disasters, both of which are exogenous, region-specific shocks that could affect international tourist's decisions about where to travel in the country. The first one is the Great East Japan Earthquake (GEJE) on March 11, 2011. The significant direct influence by the GEJE is limited in the east part of the country. However, the transient economic influence through supply chain disruption reaches the entire country, and the GEJE can be regarded as a wider region-specific (almost national) shock. The other natural disaster shock is changes in volcanic alert levels (VALs) of Mount Hakone, which does not affect the regions outside the neighborhood of Hakone and can be regarded as narrower region-specific shocks.

The evident striking difference in information outside Japan between the GEJE and changes in VALs should be emphasized. While both the GEJE and changes in VALs can

be immediately reported both in local and international, information is actually limited outside Japan, especially about narrower region-specific shocks (i.e., volcanic activity on Mount Hakone). In fact, the degree of media coverage outside Japan differs substantially between the GEJE and changes in VALs in Hakone. The GEJE is well-known as a massive earthquake (magnitude 9.0), followed by large tsunamis hitting the Tohoku region and meltdown accidents of Fukushima Daiichi nuclear power plants. The sequence of events triggered by the GEJE shock makes headlines worldwide. In particular, the nuclear disaster attracts intense attention from the media outside Japan; for example,

> "Nearly one month after Japan's devastating nuclear accident, atomic energy experts, regulators and politicians around the world are still puzzling over a basic question: How much danger is still posed by the Fukushima Daiichi nuclear power plant?"—New York Times (April 9, 2011)

> "Japan has decided to raise its assessment of the accident at the crippled Fukushima Daiichi nuclear power plant to the worst rating on an international scale, putting the disaster on par with the 1986 Chernobyl explosion, the Japanese nuclear regulatory agency said on Tuesday."—New York Times (April 12, 2011)

Moreover, this attention remains even after a lapse of several years, not only in Japan and but also in other countries. For example, the following article is circulated after about two years of the GEJE's occurrence:

> "Ever since the nuclear accident in Japan released radiation into the atmosphere, regulators in the United States have been studying whether to require filters, costing as much as $45 million, on the vents of each of the country's 31 boiling water reactors."—New York Times (February 27, 2013)

Unlike such worldwide spread of a portion of information about the GEJE and its aftermath, media reports on volcanic activities in Hakone is equivalent to little or nothing across the border. In other words, information disparity between Japan and in other countries is relatively small in the GEJE case, whereas it is quite large in the case of the volcanic activity in Hakone. Moreover, as explained in the next section, the GEJE had no direct effect on Hakone, while changes in VALs had a direct effect. However, a probability that facts are not sufficiently provided outside Japan exists.

Given the disparity between domestic and foreign information or differences in costs of information acquisition, we analyze how individuals who have much (or less) information behave. We utilize a smooth local projections method of Barnichon and Brownlees (2019) to estimate impulse responses of domestic and foreign visitors to Hakone to these two

natural disaster shocks. Results of our local projection analysis indicate that foreign non-Japanese visitors to Hakone behave quite differently from Japanese visitors. The response of foreign guests to the GEJE shock is negative and remains statistically significant for about a year. Conversely, the negative response of domestic guests remains significant for only about a half year. Overall, the negative response of foreign guests is much larger than that of domestic guests. Such overreactions of foreign guests are due to their insufficient information about the GEJE shock and its aftermath. Consequently, foreign guests avoid traveling to Japan despite that the nuclear disaster is practically less relevant to Hakone. The persistent response of foreign guests would be caused by slow diffusion of information about the GEJE, and this persistence is consistent with the sticky information hypothesis (e.g., Mankiw and Reis, 2002). Moreover, no significant response of foreign guests to the changes in VALs in Hakone was observed, compared to the negative response of domestic guests. These behavioral differences in response to VALs would be because of the fact that foreign guests cannot have access to information about narrow region-specific shocks in Japan.

Related literature

This paper is related to multiple different lines of research. First, and most important, our main results, sticky overreactions of foreign guests to the GEJE shock, connect to the literature on bounded rationality with sticky information. Mankiw and Reis (2002) provide a sticky information model assuming that acquiring information is costly, and, thus, individuals reoptimize their behavior slowly over time. More recently, sticky information is widely examined in various contexts. For example, using international data of professional forecasters, Coibion and Gorodnichenko (2015) present empirical evidence in favor of information rigidities, as reinforced by Bordalo *et al.* (2020). In the present context, acquiring information about circumstances of Hakone by non-Japanese guests requires a higher cost than by Japanese guests. Consequently, the response of non-Japanese guests becomes stickier.

Second, extant literature investigates how different types of information affects the economic behavior. Ahearne *et al.* (2004) examine the relationship between information asymmetries across countries and international investment. They argue that US equity portfolios are underweighted in foreign countries because international differences such as regulatory environments yield information asymmetries. Lorenzoni (2009) considers the model in which each agent can observe noisy public information about aggregate variables of price and quantity, in addition to local variables. Lorenzoni shows that noisy public information causes short-run fluctuations in key macroeconomic variables. Moreover, based on a standard macroeconomic model, Gobbi and Grazzini (2019) examine how

macroeconomic dynamics change when agents' information sets are heterogeneous, and they point out that the dispersed information results in different dynamic behaviors.[1]

In particular, our paper is closely related to a strand of literature indicating that media generate a substantial impact on individual behaviors.[2] In the extant literature, a number of authors test the effect of media reports on voting (e.g., DellaVigna and Kaplan, 2007; Gerber *et al.*, 2009; Chiang and Knight, 2011; Martin and Yurukoglu, 2017; Prat, 2018). Other authors highlight the media's influence in other various types of decision making.[3] For example, Cho *et al.* (2018) explore whether social media affect concert locations in the music industry, and Jiao *et al.* (2020) examine the effect of traditional news media and social media on stock market. Although our paper does not provide direct examination of media coverage, we argue that the international disparity of media coverage distorts the transnational movement of people in the world tourist industry.

Third, the background of this study is linked to the theoretical literature that examines impact of the precision of public information on welfare. Among others, Colombo and Femminis (2008) extend the beauty contest model of Morris and Shin (2002) to allow individuals to choose the precision of their private information. In the framework of Colombo and Femminis (2008), before the choice of private information, a public authority (i.e., a Stackelberg leader) is assumed to choose the precision of public information. Colombo and Femminis show that, if the precision of public information can be improved at less cost than that of private information, enhancing the precision of public information increases welfare. Given this theoretical literature, our findings imply that welfare could be improved by dispersing more precise information about the hosting region (Hakone) worldwide.

Finally, our work is also related to empirical studies of international travel.[4] In particular, it is closest to Rosselló *et al.* (2020) who investigate the effects of natural disasters

[1]See also, for example, Angeletos and Pavan (2009) and Tille and van Wincoop (2014). Angeletos and Pavan (2009) theoretically argue the possible policies under dispersed information. Tille and van Wincoop (2014) investigate international capital flows when information is heterogeneous among agents.

[2]Another strand of literature investigates the role of media as a driving force of fundamental macroeconomic variables, including Lamla and Lein (2014, 2015), Dräger (2015), Lamla *et al.* (2020), and Shapiro *et al.* (forthcoming). Moreover, Brückner and Pappa (2015) focus on bidding for the Olympic Games and investigate whether macroeconomies react to news shocks. Incidentally, while beyond the scope of the present paper, Kennedy and Prat (2019) investigate where and how news are consumed using survey data on media across 36 countries.

[3]The media's influence is widely studied in the literature. See also Benesch *et al.* (2019) who investigate the effect of media coverage of migration on immigration worries.

[4]A large body of literature exists that utilizes econometric methods, including time-series analysis, to examine tourism-related issues. For example, Kulendran and Wilson (2000) provide cointegration and Granger-causality analyses for the relationship between international travel and international trade. Balaguer and Cantavella-Jordá (2002) use cointegration and Granger-causality approaches to test tourism-led growth hypothesis. Further, Gil-Pareja *et al.* (2007) find that tourists in the Economic and Monetary Union increase by a common currency (i.e., euro). A comprehensive review of time-series modeling for tourism demand can be found in Song and Li (2008) and Song *et al.* (2019).

on international tourism flows by estimating gravity model. They find that natural disasters reduce tourist arrivals in general. Our predecessors also discuss how tourism industry copes with natural disasters (e.g., Faulkner, 2001; Tsai and Chen, 2011). However, we are unaware of previous studies that focus on information disparity between domestic and foreign travelers in assessing the effects of natural disasters on international travel. Hence, in this study, we utilize a smooth local projection method to present rigorous quantitative analyses of the different effects of natural disasters on both international and intranational travel, which is beneficial for enriching the debate on tourism in the globalization era.

The remainder of the paper is organized as follows. In Section 2, we describe the background of Hakone tourism by focusing on volcanic activity of Mount Hakone and the effects of the GEJE and resulting disasters on Hakone. In Section 3, we explain our empirical framework, such as the method and data. In Section 4, our main results are reported with some robustness checks. Finally, Section 5 concludes the paper.

2 Hakone tourism and natural disasters

Hakone is known as one of most famous hot spring resorts in Japan. Figure 1 presents the map of Japan and location of Hakone. As shown in this figure, Hakone is a town in Kanagawa Prefecture and is instantly accessible to and from the Tokyo metropolitan area, as well as Mount Fuji. Thus, during all four seasons, Hakone has many Japanese and international visitors.

[Insert Figures 1 and 2 around here]

Figure 2 plots the monthly observations on the number of Japanese and non-Japanese hotel guests to Hakone. In this period, negative spikes stem from several natural disaster shocks. The first shock is the GEJE that occurred in March 2011, whose timing is represented as the black vertical line in the figure. A general visual impression from Figure 2 is that Japanese and non-Japanese hotel guests behave differently in response to the GEJE shock. The number of Japanese guests decrease significantly after the GEJE in 2011, but this decrease appears to be transitory. Conversely, non-Japanese guests appear to decrease more drastically and persistently after the GEJE.

In these negative responses to GEJE shock, a common factor between Japanese and non-Japanese guests is a negative supply shock. Due to this quite strong earthquake, Japan faced insufficient power supply and had to implement rolling blackouts. As a consequence of planned outage, Hakone is forced into business suspension from March to April 2011. From May 2011, the limited express that connects Tokyo and Hakone can

be operated in a situation close to normal operation. Another relevant factor of non-Japanese guests' negative responses to GEJE shock is that multiple countries worldwide had restricted travel to Japan with concerns regarding the accidents in Fukushima Daiichi nuclear power plants.

In this context, the fact that Hakone experienced little direct impact from the GEJE and its aftermath, including tsunami and nuclear power plant accidents, is more noteworthy. Although tsunami damage in the GEJE was severe in coastal areas of several prefectures (such as Iwate, Miyagi, and Fukushima), Hakone was not damaged. As shown in Figure 1, Hakone is located far from the Fukushima Daiichi nuclear power plant. The nuclear power plant accidents, which are triggered by the GEJE and tsunami, released radioactive material into the atmosphere, groundwater, seawater, and soil. However, according to environmental radioactivity monitoring by Japanese prefectural and municipal governments, we cannot find evidence on the fact that Hakone is exposed to a larger amount of radioactive material than normal (e.g., Hirose, 2012; Tsumune *et al.*, 2012). Note also that the Japanese government had prohibited entry within a 20-km radius of the Fukushima Daiichi nuclear power plant, but all the restricted zones are within Fukushima Prefecture. Hakone town is about 298 km away from the nuclear power plant. Thus, direct impacts of the nuclear accident (e.g., radiation contamination) on Hakone town is equivalent to little or nothing.

The resort areas of Hakone are adjacent to Mount Hakone, which is an active volcano.[5] The narrower region-specific shocks are the raises and declines in VALs in Hakone.[6] In Figure 2, the increased timings in VALs are represented as the gray vertical lines, and the decreased timings are depicted as the gray vertical dashed lines. The VALs are raised from 1 to 2 in May 2015 and from 2 to 3 in June 2015. Thereafter, the raised levels are reduced from 3 to 2 in September 2015 and from 2 to 1 in November 2015. Moreover, these levels are raised again from 1 to 2 in May 2019 and are reduced from 2 to 1 in October 2019. It should be noted that, owing to restricted access, commercial operation of the Hakone Ropeway is suspended at levels 2 and 3. From Figure 2, the number of Japanese guests appear to decrease in response to the increase in VALs in 2015 and 2019. However, we find no clear fluctuations in non-Japanese guests when the VALs change.

[Insert Figure 3 around here]

[5]See, for example, Mannen *et al.* (2018) who review the eruption and the post-eruptive volcanic activity and provide a model for the magma-hydrothermal process that caused the unrest and eruption.

[6]VALs have five levels that are transmitted by Japan Meteorological Agency. Level 1 indicates calm volcanic activity. When seismic activity is increased and thermal activity affect the area around the crater, level 2 is transmitted to restrict the entry around the crater. At level 3, mountaineering is restricted, and evacuation is required in specific areas. Although levels 4 and 5 are unprecedented levels in modern history, level 4 indicates the necessity to prepare for evacuation in residential areas that require caution, and level 5 denotes the necessary evacuation from dangerous residential areas.

Moreover, we can observe that the number of non-Japanese guests to Hakone has grown dramatically in the 2010s, as in the lower panel of Figure 2. This rapid growth in the number of non-Japanese guests to Hakone in the 2010s is attributable to the relaxation of visa requirements by the Japanese government. Figure 3 shows the number of foreign visitors to Japan together with the number of visa issuances, where both series are transformed into the natural logarithmic form.[7] We find that, in the 2010s, the number of foreign visitors to Japan rapidly increased with the increasing number of visa issuances by the Japanese government. In the last decade, the relaxation of visa requirements has been implemented, especially for Asian countries, such as China, India, Indonesia, the Philippines, and Vietnam. In fact, correlation coefficient between foreign visitors to Japan and visa issuances is 0.9839, and a strong positive correlation exists between them. Thus, the relaxation of visa requirements appears to account for the bulk of the growth in the 2010s.

3 Econometric framework

Given the preceding background and observations, we investigate the behavior of hotel guests in Hakone in response to natural disasters. As shown in Figure 2, tourist data are monthly observations on the number of hotel guests in Hakone, which is available from January 1999 to December 2019.[8] The number can be separately divided into Japanese and non-Japanese guests. We utilize these data to investigate how economic behavior varies under different types of information, because Japanese guests are considered to have more honest information about Japan's natural disasters than non-Japanese guests, as explained in the Introduction section. The data that we use are seasonally adjusted and transformed into the natural logarithm form. Using the natural logarithm enables us to compare the changes in the number of Japanese guests with those of non-Japanese guests when conducting the impulse response analysis.

We first perform preliminary unit root analysis for the number of hotel guests. The visual inspection presented in Figure 2 suggests the possibility of structural changes. In particular, because of the relaxation of visa requirements, the number of non-Japanese guests rapidly increase in the 2010s, yielding a structural break in the series. As such, following the argument by Perron (1989), we conduct a modified augmented Dickey–Fuller test allowing for different levels and trends across a single break date. The lag lengths are chosen based on the Schwarz information criterion (up to 15 lags). Table 1 reports the results of the unit root test. Consistent with the visual inspection of Figure 2, a

[7]The data were obtained from Diplomatic Bluebook by the Ministry of Foreign Affairs of Japan.

[8]The series can be obtained from the website of Hakone town (`http://www.town.hakone.kanagawa.jp/index.cfm/1,html`).

break is observed around the early 2010s. The results imply that the hotel guest series are stationary, given that the breaks are considered.

[Insert Table 1 around here]

After checking the stationarity of the series, we now present our econometric model. Let y_t and x_t denote the number of hotel guests and a natural disaster shock at time t, respectively. GEJE shock is a dummy variable that takes the value of 1 in March 2011 and 0 otherwise. VAL shocks are the changes in VALs. For each h-step-ahead horizon, we consider the following predictive regressions:

$$y_{t+h} = \alpha_{(h)} + \beta_{(h)} x_t + \boldsymbol{z}_t' \boldsymbol{\gamma}_{(h)} + \varepsilon_{(h)t+h}, \tag{1}$$

where $\boldsymbol{z}_t$ is a vector of control variables. Coefficient $\beta_{(h)}$ is of interest and reflects the structural effect of natural disaster shocks. In our benchmark regressions, $\boldsymbol{z}_t$ includes lags of y_t, real output, real effective exchange rate of Japan, and the other natural disaster shock. Note that real output differs according to which the Japanese or non-Japanese guests are considered y_t. Specifically, when y_t is the Japanese guests, the Japanese real output is used.[9]) Meanwhile, when y_t is the non-Japanese guests, world real output is used. World real output is regarded as an approximate global economic activities, except the Japanese ones. Thus, world real output reflects business conditions of non-Japanese guests and can determine whether they increase consumption (go traveling). Due to the availability of monthly observations, industrial production is used as a proxy of real output. We use the industrial production series that are seasonally adjusted and transformed into the natural logarithm form. Japan's industrial production was obtained from the website of Japan's Ministry of Economy, Trade and Industry. World industrial production is the production used in Baumeister and Hamilton (2019) and can be retrieved from James D. Hamilton's home page.[10] The real effective exchange rate, which is also considered a determinant where to go on a trip, is included to control fluctuations of the relative currency value between Japan and others. The real effective exchange rate of Japan is transformed into the natural logarithm form, and the original series can be retrieved from the website of the Bank for International Settlements.[11]

Following the description in the preceding section, to estimate $\beta_{(h)}$ as capturing individuals' behavior that depends on information structure, $\boldsymbol{z}_t$ further includes other relevant variables. First, following the break dates of unit root test results in Table 1, the

[9]The GEJE and the resultant nuclear accident damaged the Japanese economy, and the earthquake disaster reconstruction boosts the economy. The Japanese tourists' income fluctuations stemming from the GEJE can be controlled by including real income.

[10]`https://econweb.ucsd.edu/~jhamilto/`.

[11]`https://www.bis.org/statistics/eer.htm`

dummy variables of levels and trends are added. Inclusion of such breaks is crucial for controlling the effects of relaxation of visa requirements on the increase in the number of non-Japanese travelers to Hakone. Second, to eliminate the effects of planned outage caused by the GEJE, a dummy variable that takes the value of 1 in March and April 2011 (and 0 otherwise) is added into $\boldsymbol{z}_t$. Third, we consider the fact that countries worldwide have banned travel to Japan because of the effects of the nuclear accident caused by the great earthquake. The travel ban was lifted by June 2011 in most countries, except for some areas, such as Fukushima Prefecture. Thus, when y_t is non-Japanese guests, we add a dummy variable that is equal to the value of 1 from March to June 2011 (and 0 otherwise) into $\boldsymbol{z}_t$. Finally, to eliminate the effects of mountain entry restrictions, $\boldsymbol{z}_t$ includes a dummy variable that takes the value of 1 when VALs are equal to or higher than two and otherwise 0.

Our empirical method for estimating the impulse response is smooth local projections by Barnichon and Brownlees (2019). The smooth local projections utilize penalized B-splines to enhance a popular tool, local projections proposed by Jordá (2005). This method provides moderate variability of the local projections estimator and, accordingly, helps us interpret the estimates.

4 Empirical results

4.1 Benchmark estimates

We now present the empirical results on the described empirical framework. When y_t is Japanese guests, the lag length is selected to be one and three based on the Schwarz criterion and Akaike information criterion, respectively. In the non-Japanese case, both criteria indicate the lag length of three. For a robustness check, we report the results when the lag length is set to one and three.

For the GEJE shock, Figure 4 plots the estimated results using the smooth local projection for the period from January 1999 to December 2019. Panels A and B of Figure 4 show the impulse response of guests when the lag length is set to one and three, respectively. In both Panels A and B, the left and right panels display the responses of Japanese and non-Japanese guests, respectively. The shaded area is the 90% confidence interval.

[Figure 4 around here]

The left panel of Figure 4 indicates that the contemporaneous response to the GEJE is 2% lower Japanese guests. The significant negative response lasts for about a half

year. Meanwhile, the responses of non-Japanese guests to the GEJE (i.e., the right panels of Figure 4) exhibit much larger and more persistent declines. Unlike the Japanese case, the non-Japanese guests' responses remain significant and negative even after 10 months. While such behavioral differences between Japanese and non-Japanese guests are consistent with the visual impression of Figure 2, the revealed difference even when many factors are controlled by $\boldsymbol{z}_t$ is worth emphasizing; for example, $\boldsymbol{z}_t$ includes a dummy variable of restrictions on non-Japanese travel to Japan after the GEJE.

A possible source of such non-Japanese behavior would be because non-Japanese guests have less information about the circumstances of Hakone than Japanese guests. That is, media report on the GEJE and its aftermath is incomplete outside Japan. Consequently, for example, non-Japanese possibly become overly concerned about the meltdown accidents of Fukushima Daiichi nuclear power plants. Owing to this incomplete report, non-Japanese guests are disinclined to travel to Japan. Moreover, similar to the sticky-information model of Mankiw and Reis (2002), the information possibly disseminates more slowly outside Japan than in Japan, and, consequently, the response of non-Japanese guests becomes stickier.

[Figure 5 around here]

In the case of VAL shocks, Figure 5 shows the impulse responses in a similar manner to Figure 4. Note that, unlike the GEJE case, the sample period is from January 1999 to April 2019 because the available data end in December 2019 and the dynamic effects of changes in VALs after April 2019 cannot be captured. Thus, the inclusion of VAL shocks around the end of sample period could lead to estimation bias. The left panels of Figure 5 suggest that the contemporaneous response to the increase in VALs is 1% lower Japanese guests. The negative responses disappear after about half a year, and the estimate becomes zero after a year. As shown in the right panels of Figure 5, the responses of non-Japanese guests are quite small and not significant at all horizons. These results validate the visual impression from Figure 2. Thus, we detect the negative and transient response of Japanese guests to VAL shocks, compared to the unresponsiveness of non-Japanese guests to VAL shocks. Arguably, changes in the VAL of Mount Hakone have certainly no relationship with the non-Japanese decision about whether to travel to Hakone. This would be attributable to the absence of non-Japanese information about Mount Hakone, and non-Japanese would travel to Hakone with no knowledge of the VAL.

If non-Japanese guests had access to as much information about the VAL and Mount Hakone as Japanese guests, then we could provide a different interpretation. That is, the non-Japanese demand for travel to Japan is less elastic than the Japanese demand. On the one hand, domestic tourists can travel to Hakone often and can easily skip a year. On the

other hand, for most international tourists, a trip to Japan might be a one-in-a-lifetime event because it is far and expensive for them. Consequently, a trip to Japan might be desirable for foreigners, even if the Hakone Ropeway (aerial tramway) is not operating, owing to the increased VALs. However, as mentioned in the Introduction section, foreign tourists are not sufficiently informed about VALs for Mount Hakone through media reports originally. Thus, it seems reasonable to consider that different Japanese and non-Japanese responses to VAL shocks originate from information differences.

Note that another popular global economic activity measure exists, that is, the Kilian (2009, 2019) index, while in the benchmark, we use world industrial production index as a control variable for investigating the non-Japanese guests case.[12] Thus, as a robustness exercise, we reestimate the impulse responses of non-Japanese guests when the Kilian index is used, rather than the world industrial production index. The estimated results (unreported) suggest that impulse responses depend minimally on which global economic activity index is used.

4.2 Robustness: Alternative specification

Robustness check using possible alternative frameworks is important. Although we estimate (1) for Japanese and non-Japanese cases separately in the benchmark, alternative specification is the use of the differences between Japanese and non-Japanese guests. That is, we consider y^d_{t+h}, defined as subtracting the natural logarithm of the number of non-Japanese hotel guests from that of Japanese hotel guests in Hakone. Using this as a dependent variable, the alternative specification is similar to (1) such that

$$y^d_{t+h} = \alpha^d_{(h)} + \beta^d_{(h)} x_t + \boldsymbol{z}_t' \boldsymbol{\gamma}^d_{(h)} + \varepsilon^d_{(h)t+h}, \tag{2}$$

where the independent variables are the same to (1), except that $\boldsymbol{z}_t$ does not include dummy variables of planned outage and mountain entry restrictions in (2). This is because both planned outage and mountain entry restrictions can be regarded as common supply shocks for Japanese and non-Japanese guests. Consequently, these terms disappear in the difference specification (2). Incidentally, we conduct unit root with break test. The result rejects the null hypothesis at the 1% level and indicates that the series of y^d_{t+h} is stationary with a structural break (the break date is February 2011). Following such unit root test results, the dummy variables of breaks on level and trend are also included in $\boldsymbol{z}_t$, as mentioned previously.

[12]The Kilian index can be found at Lutz Kilian's home page (`https://sites.google.com/site/lkilian2019/research/data-sets`). See, e.g., Kilian and Zhou (2018), Funashima (2020), Nonejad (2020), and Hamilton (2021), to compare investigation of the Kilian index and world industrial production index.

[Figure 6 around here]

Figure 6 describes the series of y^d_{t+h}. A large negative spike can be observed in the timing of the GEJE. This implies that non-Japanese response to the GEJE is larger than Japanese one. The series seems to rise (or decline) in response to the increase (or decrease) in VALs in 2015. This supports the view that Japanese guests reacts to changes in VALs more strongly than non-Japanese guests.

[Figure 7 around here]

To explore such differences formally, Figure 7 presents impulse responses of y^d_{t+h} to GEJE and VAL shocks. Specifically, Panels A and B show the estimates of impulse responses when the lag length is set to three and four on the Schwarz criterion and Akaike information criterion, respectively. The estimated results have similar implications to the benchmark results, reinforcing the above conclusions in general. The left panels show that the GEJE decreases y^d_{t+h} for about 10 months, implying that non-Japanese guests respond more strongly and persistently to a GEJE shock than Japanese guests. The right panels show that changes in VALs increase y^d_{t+h}. This is consistent with the benchmark results that Japanese guests respond transiently to VAL shocks, whereas non-Japanese guests are unresponsive to VAL shocks.

5 Conclusion

In the globalization age, while economic activities are across borders, acquiring precise information is relevant to a decision maker who attempts to determine the best choice from many options across the world. However, the borderless economy might suffer from international information disparity, which distorts optimal decision making of individuals. In this study, we investigated one aspect of such a distortion in global economic activities, utilizing tourists data of Hakone, Japan, and the related natural disaster shocks. Our analysis confirmed the distorted behavior of non-Japanese guests who have incomplete information, which deviates substantially from the behavior of Japanese guests who have almost complete information. Our findings also suggest that insufficient information could lead to the persistent response consistent with the sticky information hypothesis.

However, more research should be conducted in many directions. First, while the present work uses the Hakone data that allow us to exploit natural experiment on informational differences, as inferred from behavior differences between domestic and foreign tourists, common issues might be found in other regions. If so, and if data are available, similar analyses to this study are meaningful to investigate the role of information in

economic decision making. Moreover, although the present study regards non-Japanese guests as a group because of data availability, disaggregated analyses by country would be fruitful to enrich our understanding. Finally, the differences in international information disparity across regions must be quantified, and the effects of sticky information should be investigated in a more quantitative direction.

References

Ahearne, A.G., Griever, W.L., Warnock, F.E. (2004). Information costs and home bias: An analysis of US holdings of foreign equities. *Journal of International Economics*, 62, 313–336.

Angeletos, A.-M. and Pavan, A. (2009). Policy with dispersed information. *Journal of the European Economic Association*, 7(1), 11–60.

Balaguer, J., Cantavella-Jordá, M. (2002). Tourism as a long-run economic growth factor: The Spanish case. *Applied Economics*, 34(7), 877–884.

Barnichon, R., Brownlees, C. (2019). Impulse response estimation by smooth local projections. *Review of Economics and Statistics*, 101(3), 522–530.

Baumeister, C., Hamilton, J.D. (2019). Structural interpretation of vector autoregressions with incomplete identification: Revisiting the role of oil supply and demand shocks. *American Economic Review*, 109(5), 1873–1910.

Benesch, C., Loretz, S., Stadelmann, D., Thomas, T. (2019). Media coverage and immigration worries: Econometric evidence. *Journal of Economic Behavior and Organization*, 160, 52–67.

Bordalo, P., Gennaioli, N., Ma, Y., Shleifer, A. (2020). Overreaction in Macroeconomic Expectations. *American Economic Review*, 110(9), 2748–2782.

Coibion, O., Gorodnichenko, Y. (2015). Information rigidity and the expectations formation process: A simple framework and new facts. *American Economic Review*, 105(8), 2644–2678.

Chiang, C.F., Knight, B. (2011). Media bias and influence: Evidence from newspaper endorsements. *Review of Economic Studies*, 78(3), 795–820.

Cho, D., Hwang, Y., Park, J. (2018). More buzz, more vibes: Impact of social media on concert distribution. *Journal of Economic Behavior and Organization*, 156, 103–113.

Colombo, L., Femminis, G. (2008). Social value of information with costly information acquisition. *Economics Letters*, 100(4), 196–199.

DellaVigna, S., Kaplan, E. (2007). The Fox News effect: Media bias and voting. *Quarterly Journal of Economics*, 122(3), 1187–1234.

Dräger, L. (2015). Inflation perceptions and expectations in Sweden – Are media reports the missing link? *Oxford Bulletin of Economics and Statistics*, 77(5), 681–700.

Faulkner, B. (2001). Towards a framework for tourism disaster management. *Tourism Management*, 22, 135–147.

Funashima, Y. (2020). Global economic activity indexes revisited. *Economics Letters*, 193, 109269.

Gerber, A.S., Karlan, D., Bergan, D. (2009). Does the media matter? A field experiment measuring the effect of newspapers on voting behavior and political opinions. *American Economic Journal: Applied Economics*, 1(2), 35–52.

Gil-Pareja, S., Llorca-Vivero, R., Martínez-Serrano, J.A. (2007). The effect of EMU on tourism. *Review of International Economics*, 15(2), 302–312.

Gobbi, A., Grazzini, J. (2019). A basic New Keynesian DSGE model with dispersed information: An agent-based approach. *Journal of Economic Behavior and Organization*, 157, 101–116.

Hamilton, J.D. (2021). Measuring global economic activity. *Journal of Applied Econometrics*, 36(3), 293–303.

Hirose, K. (2012). 2011 Fukushima Dai-ichi nuclear power plant accident: Summary of regional radioactive deposition monitoring results. *Journal of Environmental Radioactivity*, 111, 13–17.

Jiao, P., Veiga, A., Walther, A. (2020). Social media, news media and the stock market. *Journal of Economic Behavior and Organization*, 176, 63–90.

Jordá, O. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1), 161–182.

Kennedy, P.J., Prat, A. (2019). Where do people get their news? *Economic Policy*, 34(97), 5–47.

Kilian, L. (2009). Not all oil price shocks are alike: disentangling demand and supply shocks in the crude oil market. *American Economic Review*, 99, 1053–1069.

Kilian, L. (2019). Measuring global real economic activity: do recent critiques hold up to scrutiny? *Economics Letters*, 178, 106–110.

Kilian, L., Zhou, X. (2018). Modeling fluctuations in the global demand for commodities. *Journal of International Money and Finance*, 88, 54–78.

Kulendran, N., Wilson, K. (2000). Is there a relationship between international trade and international travel? *Applied Economics*, 32(8), 1001–1009.

Lamla, M.J., Lein, S.M. (2014). The role of media for consumers inflation expectation formation. *Journal of Economic Behavior and Organization*, 106, 62–77.

Lamla, M.J., Lein, S.M. (2015). Information rigidities, inflation perceptions, and the media: Lessons from the euro cash changeover. *Economic Inquiry*, 53(1), 9–22.

Lamla, M.J., Lein, S.M., Sturm, J.-E. (2020). Media reporting and business cycles: Empirical evidence based on news data. *Empirical Economics*, 59, 1085–1105.

Lorenzoni, G. (2009). A theory of demand shocks. *American Economic Review*, 99, 2050–2084.

Mankiw, N.G., Reis, R. (2002). Sticky information versus sticky prices: A proposal to replace the new keynesian phillips curve. *Quartaly Journal of Economics*, 117(4), 1295–1328.

Mannen, K., Yukutake, Y., Kikugawa, G., Harada, M., Itadera, K., Takenaka, J. (2018). Chronology of the 2015 eruption of Hakone volcano, Japan: geological background, mechanism of volcanic unrest and disaster mitigation measures during the crisis. *Earth, Planets and Space*, 70(68), 1–26.

Martin, G.J., Yurukoglu, A. (2017). Bias in cable news: Persuasion and polarization. *American Economic Review*, 107(9), 2565–2599.

Morris, S., Shin, H.S., (2002). The social value of public information. *American Economic Review*, 92, 1521–1534.

Nonejad, N. (2020). An observation regarding Hamilton's recent criticisms of Kilian's global real economic activity index. *Economics Letters*, 196, 109582.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica*, 57, 1361–1401.

Prat, A. (2018). Media power. *Journal of Political Economy*, 126(4), 1747–1783.

Rosselló, J., Becken, S., Santana-Gallego, M. (2020). The effects of natural disasters on international tourism: A global analysis. *Tourism Management*, 79, 104080.

Shapiro, A.H., Sudhof M., Wilson, D.J. (forthcoming). Measuring news sentiment. *Journal of Econometrics*.

Song, H., Li, G. (2008). Tourism demand modelling and forecasting—A review of recent research. *Tourism Management*, 29, 203–220.

Song, H., Qiu, R., Park, J. (2019). A review of research on tourism demand forecasting: Launching the *Annals of Tourism Research* curated collection on tourism demand forecasting. *Annals of Tourism Research*, 75, 338–362.

Tille, C., van Wincoop, E. (2014). International capital flows under dispersed private information. *Journal of International Economics*, 93, 31–49.

Tsai, C.-H., Chen, C.-W. (2011). The establishment of a rapid natural disaster risk assessment model for the tourism industry. *Tourism Management*, 32(1), 158–171.

Tsumune, D., Tsubono, T., Aoyama, M., Hirose, K. (2012). Distribution of oceanic ^{137}Cs from the Fukushima Dai-ichi Nuclear Power Plant simulated numerically by a regional ocean model. *Journal of Environmental Radioactivity*, 111, 100–108.

Table 1: Unit root with break test

Variable	Statistics	Break date
Japanese guests	$-8.9654(0)^{***}$	March 2011
Non-Japanese guests	$-6.5922(0)^{***}$	February 2011

Note: The tests include a constant and a linear trend (detrended tests) with a change in both level and trend. The lag lengths shown in the parentheses are chosen based on the Schwarz information criterion (up to 15 lags). *** represents the rejection of the null hypothesis at the 1% significance levels.

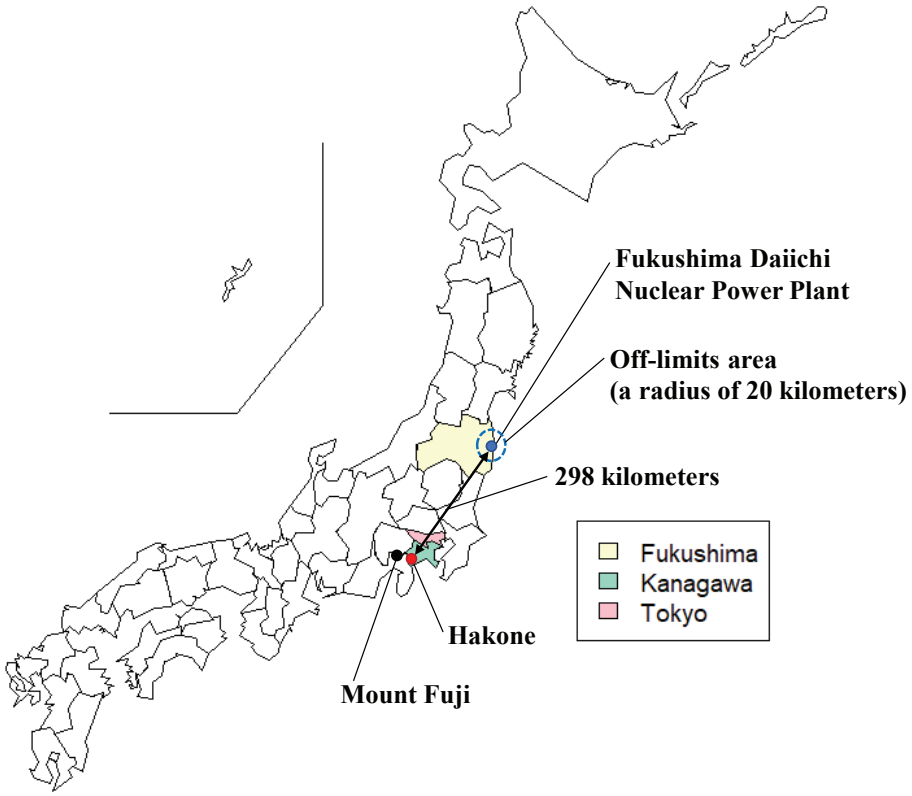

Figure 1: Overview of the relative location of Hakone with Fukushima Daiichi Nuclear Power Plant

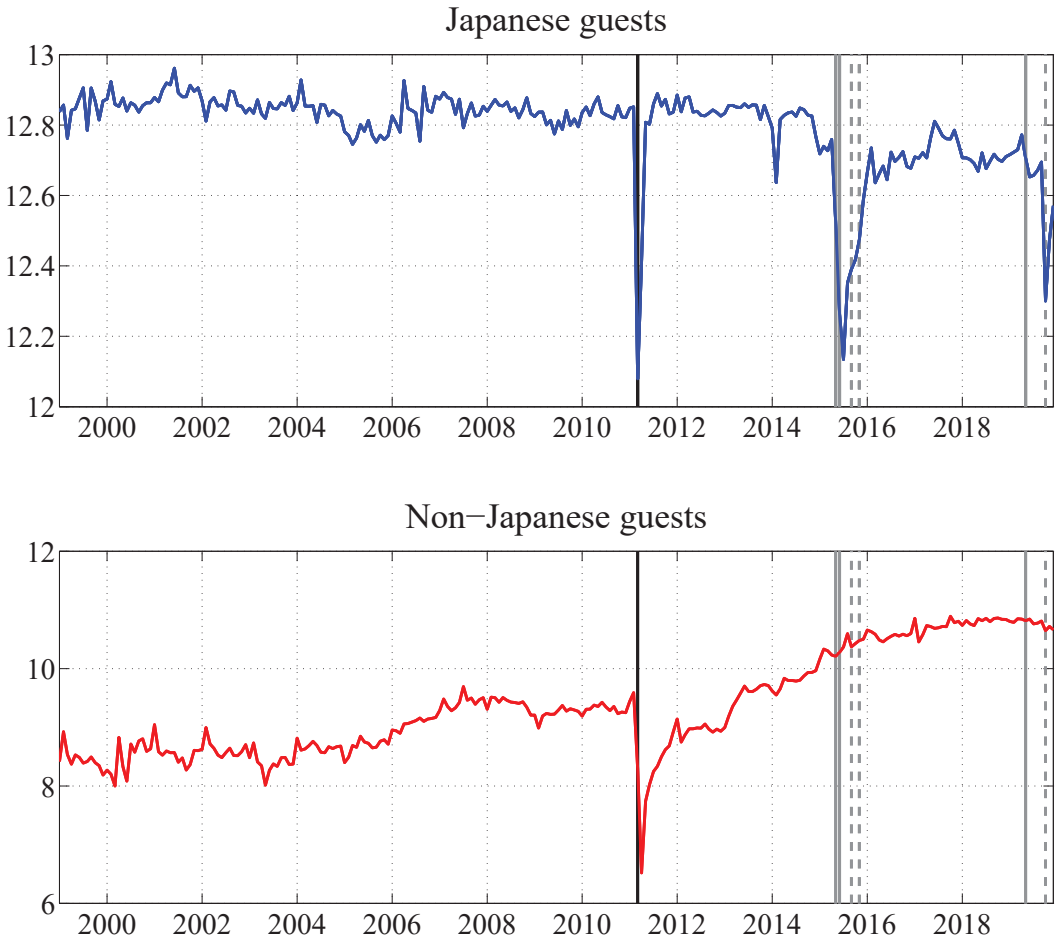

Figure 2: Number of hotel guests in Hakone (seasonally adjusted in log level)

Note: The black vertical line represents March 2011 when the GEJE occurred. The gray vertical lines represent the timings when VALs were raised from 1 to 2 in May 2015, from 2 to 3 in June 2015, and from 1 to 2 in May 2019. The gray vertical dashed lines represent the timings when VALs were reduced from 3 to 2 in September 2015, from 2 to 1 in November 2015, and from 2 to 1 in October 2019.

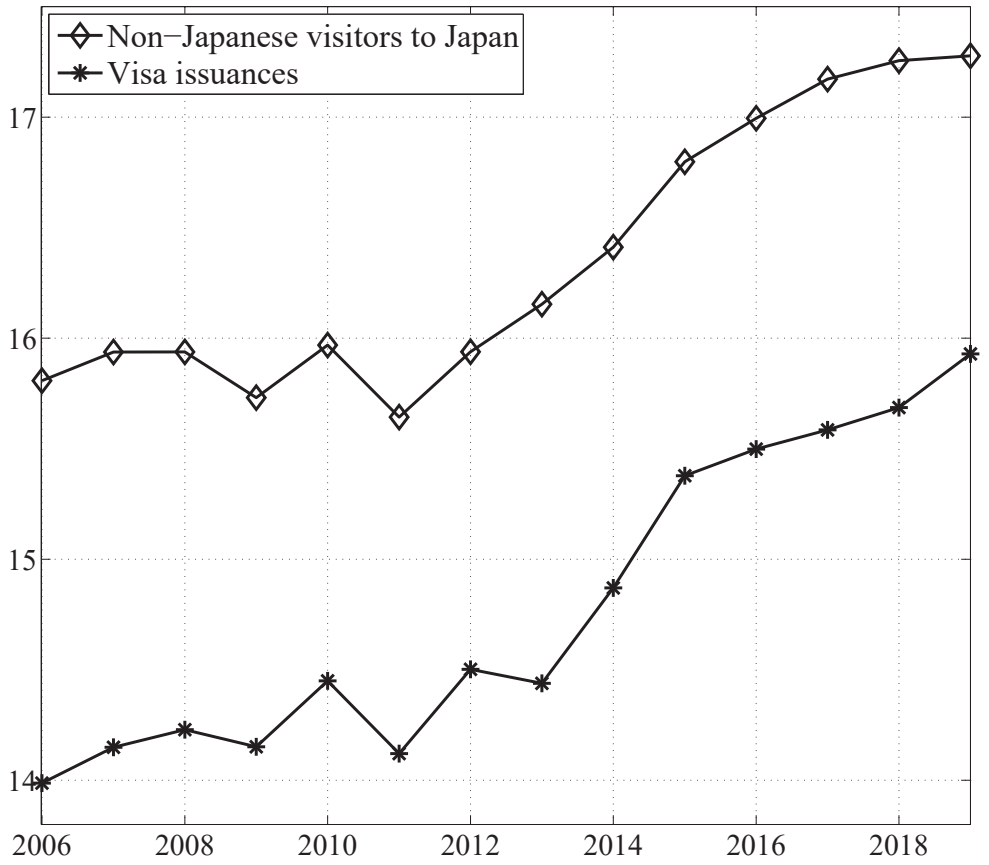

Figure 3: Number of visa issuances and non-Japanese visitors to Japan (log level)

Note: The correlation coefficient is 0.9839.

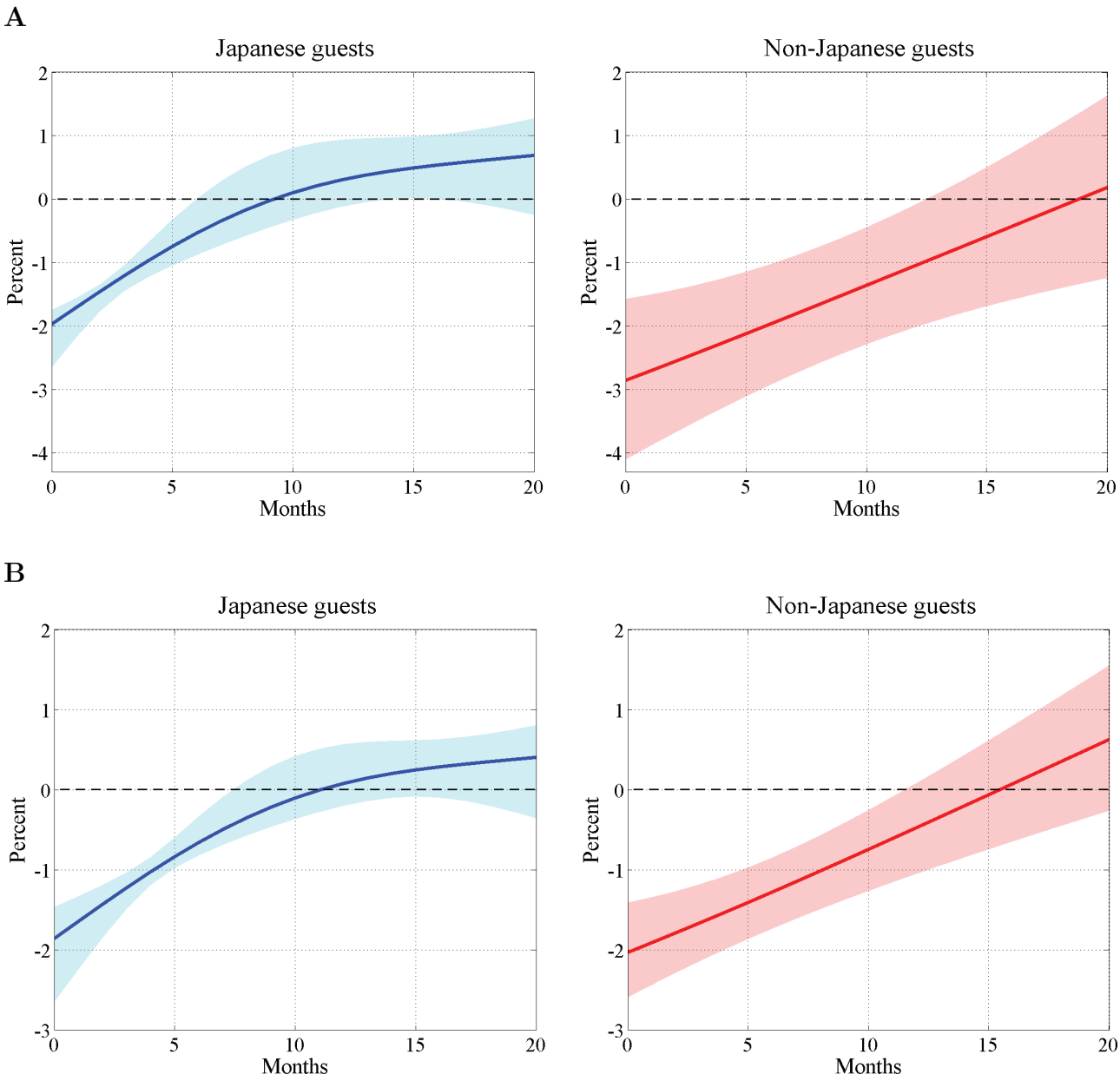

Figure 4: Impulse response of guests to the GEJE shock. (A) The lag length is set to 1. (B) The lag length is set to 3.

Note: The shaded area is the 90% confidence interval.

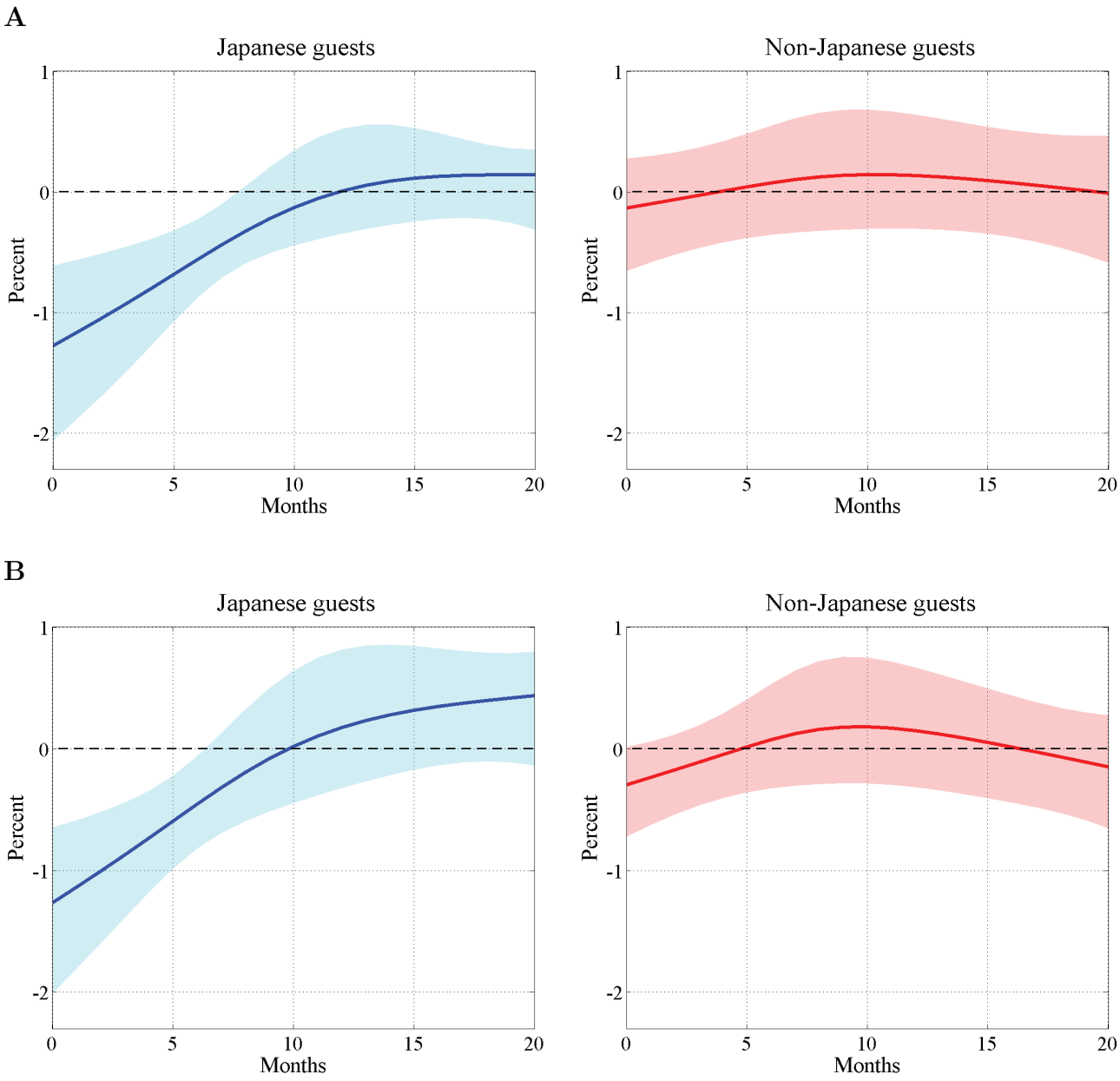

Figure 5: Impulse response of guests to the VAL shock. (A) The lag length is set to 1. (B) The lag length is set to 3.

Note: The shaded area is the 90% confidence interval.

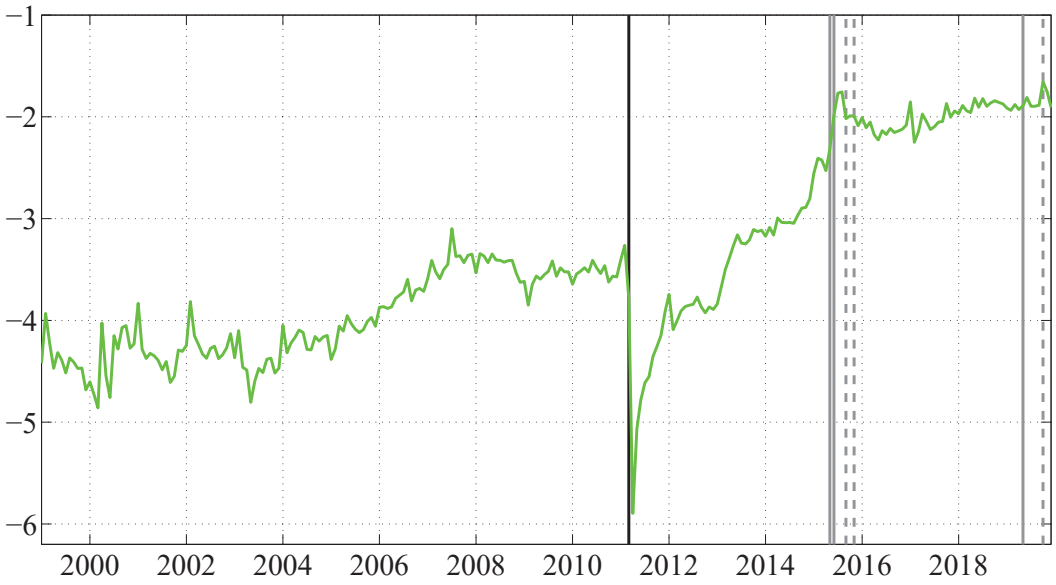

Figure 6: Log differences between the number of non-Japanese hotel guests and that of Japanese hotel guests in Hakone

Note: The log differences between non-Japanese and Japanese guests are calculated by subtracting the natural logarithm of the number of non-Japanese hotel guests from that of Japanese hotel guests in Hakone. The black vertical line represents March 2011 when the GEJE occurred. The gray vertical lines represent the timings when VALs were raised from 1 to 2 in May 2015, from 2 to 3 in June 2015, and from 1 to 2 in May 2019. The gray vertical dashed lines represent the timings when VALs were reduced from 3 to 2 in September 2015, from 2 to 1 in November 2015, and from 2 to 1 in October 2019.

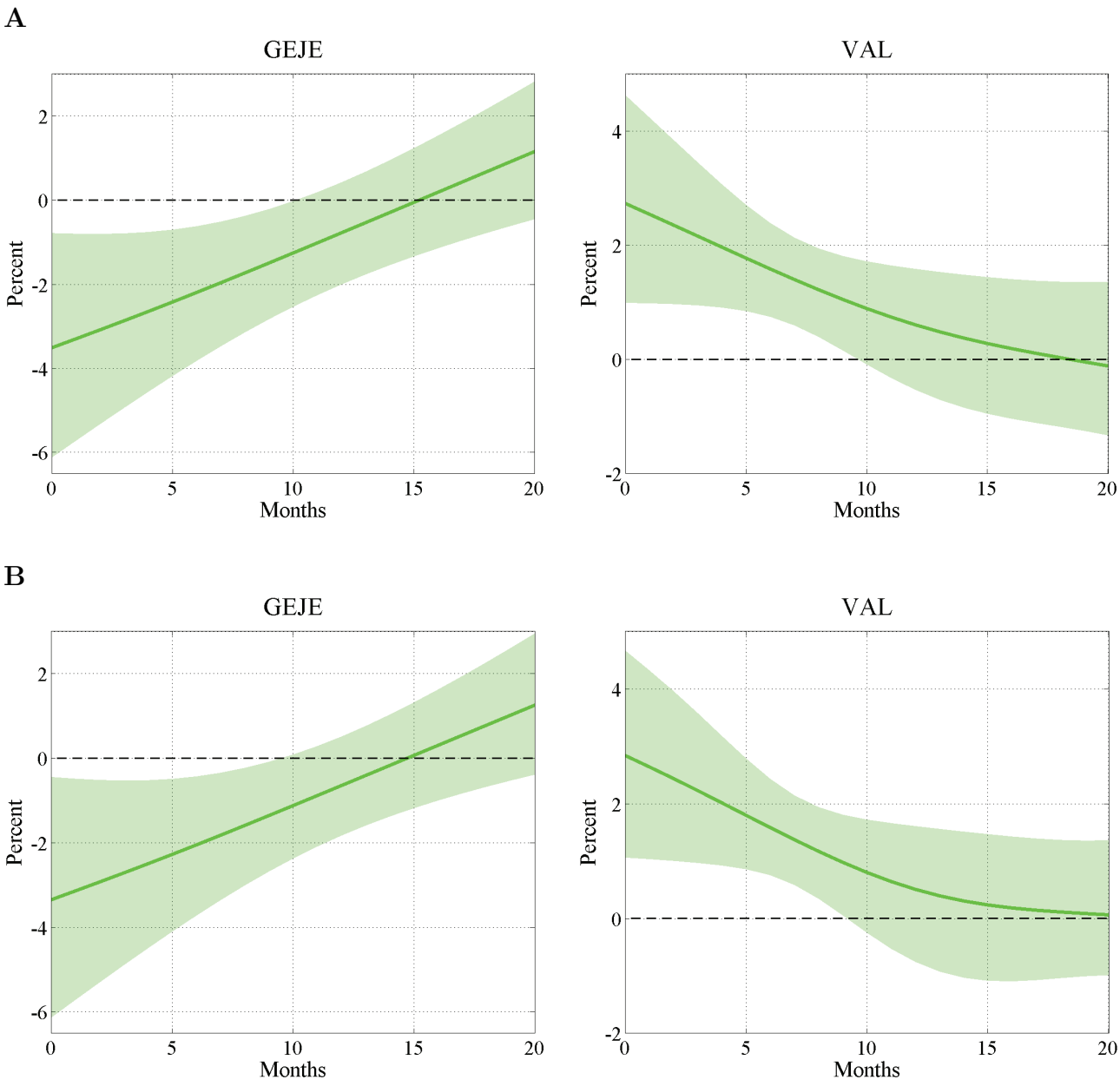

Figure 7: Impulse response of log differences between non-Japanese and Japanese guests to the GEJE and VAL shocks. (A) The lag length is set to 3. (B) The lag length is set to 4.

Note: The shaded area is the 90% confidence interval. The log differences between non-Japanese and Japanese guests are calculated by subtracting the natural logarithm of the number of non-Japanese hotel guests from that of Japanese hotel guests in Hakone.