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Newspaper-Based Measures and Economic Activities

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Abstract

Measuring uncertainty and its economic impact are of major concern during the unprecedented crisis triggered by the coronavirus disease 2019 (COVID-19) pandemic. This paper constructs a newspaper-based measure that captures the uncertainty induced by COVID-19 and examines its economic impacts using a structural VAR model applied to Japanese data. We develop two types of uncertainty indices and identify two types of structural shocks in the VAR model: one measuring an epidemiological uncertainty, the other a policy-related uncertainty. Our findings are summarized as follows. First, the constructed series of uncertainty shows a spike after COVID-19 related events, indicating that our indices work well as a measure of COVID-19 induced uncertainty. Second, stock market variables show statistically significant responses to a policy-related uncertainty shock rather than an epidemiological uncertainty shock. Third, in contrast, real variables such as mobility and consumption tend to respond significantly to an epidemiological uncertainty shock. These findings highlight the importance of considering different types of uncertainty in order to properly assess the impact of COVID-19 induced uncertainty on economic activity.

Keywords: COVID-19, uncertainty, newspaper-based approach, VAR model.

JEL classification: C32, D80, E44,

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1 Introduction

After the outbreak of coronavirus disease 2019 (COVID-19), a great deal of uncertainty surrounds humam activities, causing both economic and non-economic problems worldwide. In the case of Japan, the government declared a nationwide COVID-19 state of emergency multiple times, requesting that people refrain from non-essential outings and that restaurants shorten their business hours and not serve alcohol. In addition, events such as sports matches or concerts, including even the Olympic Games, were canceled, postponed, or held with an attendance cap. Moreover, the state of emergency was repeatedly extended more than planned, and there remained uncertainties until the last minute whether the Olympic Games would be held. Such micro-level uncertainties, which have a significant impact on people and business, also possibly lead to macro-level uncertainty.[1] In fact, real GDP growth in the second quarter of 2020 shrank an annualized 27.8% from the previous quarter, while it grew an annualized 21.4% in the subsequent third quarter.[2] The former figure is the largest shrinkage on record and the latter is the highest recovery since 1968, both these figures have shown considerable volatility and deviated significantly from the private forecasts by the think-tank, such as the *Japan Center for Economic Research*, just before the release of the data.[3]

Amid this unprecedented spike of uncertainty, this paper investigates how COVID-19-induced uncertainty impacts economic activities measured by financial and real variables in the spirit of Bloom (2009) who emphasize the role of uncertainty on economic activity. To this end, we develop a newspaper-based index for quantifying the uncertainty induced by COVID-19 and estimate a VAR model to assess the effect of the uncertainty on economic activities. Our approach is similar to that whereby Baker et al. (2016) construct the economic policy uncertainty (EPU) index, but our procedure makes it possible to extract uncertainty induced by an epidemiological feature of COVID-19 and by government

[1] Miyakawa et al. (2021) estimate the potential number of firm exits during the pandemic. The analysis shows that the pandemic increased the firm exit by 20 percent compared to the previous year under some conditions.

[2] These GDP growth rates are estimates released in the first preliminary estimates of quarterly estimates of GDP.

[3] The first estimates of GDP growth in the second and third quarters of 2020 were published on August 17th and November 16th, respectively. The monthly survey of professional forecasters in Japan, released by the *Japan Center for Economic Research*, reported forecasts of real GDP growth rate of -26.59% for the second quarter on August 13th and of 18.03% for the third quarter on November 11th.

reaction to the pandemic of COVID-19. There are some features of the newspaper-based approach relative to other uncertainty measures.[4] First, since people perceive many situations via newspapers, it reflects households' perceptions about uncertainty. It is not a technical uncertainty measure in the financial market, and it is possible to analyze its connections more broadly. Indeed, we examine the effect of uncertainty induced by COVID-19 on stock market variables, the flow of people, and private consumption by incorporating each variable into a VAR model in turn. Second, the approach can collect daily and more timely data, and the lag between events and their reference is shorter, usually a day. This characteristic allows us to satisfy the request of the government and households for a timely measure of the uncertainty the economy faces under the infection situation and with response by the government unfolding and changing so rapidly. Third, it is easier to identify the source of uncertainty since the approach rests on text mining. We can specify the cause of the uncertainty and how it occurs by selecting terms in newspaper articles. Utilizing this property, we construct two types of uncertainty indices that capture the epidemiological and policy-related uncertainty of COVID-19, and clarify the source of uncertainty.

Although many studies have pointed out the increment in the uncertainty during the pandemic (e.g., Baker et al., 2020b; Chen et al., 2021; Morikawa, 2021), to our knowledge, there have been only two studies of the economic impacts of uncertainty induced by COVID-19, by Baker et al. (2020a) and Caggiano et al. (2020).[5] Even such studies only examine the effects on output or stock prices using existing uncertainty indices. This paper constructs a unique measurement for daily time series of uncertainty induced only by COVID-19 (the Economic COVID-19 Uncertainty index, ECU) and comprehensively examines its economic impact. Notably, we construct the following two types of ECU indices by exploiting a newspaper-based approach: ECU *with* policy and ECU *without*

[4]There are multiple measures of uncertainty, but what uncertainty means differs among them. For example, volatility indices, such as the Nikkei Volatility Index for Nikkei 225 and VIX for S&P 500, reflect uncertainty in the financial market, and what they identify as uncertainty is the near-term price volatility of stock prices. Contrary to the approach incorporated in the financial markets, forecast disagreement is an uncertainty measure based on the dispersion of the point forecast of the macroeconomic variables among experts. Baker et al. (2020b) and Altig et al. (2020) detail the characteristics of each uncertainty measure.

[5]Many studies not limited to uncertainty have examined the impact of COVID-19 pandemic. See Brodeur et al. (2021) and Goldstein et al. (2021) for surveys.

policy. The ECU *with* policy is constructed based on the number of articles that contains "Economics", "COVID-19", and "Uncertainty" terms, while the ECU *without* policy is constructed by removing the articles that contain "Policy" terms from the articles of ECU *with* policy. Moreover, we identify two types of COVID-19 uncertainty shocks by incorporating these two measures of COVID-19-related uncertainty into the VAR model. We refer to each uncertainty shock as a COVID-19-specific uncertainty shock and a COVID-19-related policy uncertainty shock. The former shock is considered to capture the epidemiological uncertainty of COVID-19 in the sense of being independent of policy-related factors, while the latter literally captures the policy-related uncertainty. This more specifically identified source of uncertainty is crucial for real-time data analysis and a more detailed and pertinent policy reaction. To the best of our knowledge, no study has decomposed the source of uncertainty induced by COVID-19.[6]

Our findings in this paper are summarized as follows. First, the constructed series of COVID-19-related uncertainty, both the ECU *with* and *without* policy, shows elevated uncertainty in the early stage of the COVID-19 pandemic, which is consistent with the literature and our intuition. We also confirm that the two indices peak at different time, and the movements of these two uncertainty indices are compatible with specific events that may increase uncertainty. Therefore, the two types of uncertainty indices indeed capture different types of COVID-19-related uncertainty. The comparison with the varying measure of uncertainty reveals that the ECU *with* policy is highly correlated with the EPU, implying that the policy uncertainty and COVID-19-related uncertainty overlap with each other during the pandemic. This implication is also observed in the US, as reported by Baker et al. (2020a). In contrast, the ECU *without* policy seems to be uncorrelated with the EPU index, suggesting that it successfully embeds uncertainty caused by the epidemiological features of COVID-19 rather than policy. In addition, both uncertainty indices are unrelated to the fluctuation of infection status, such as new cases of COVID-19, the number of patients with severe cases, and the number of deaths, which are also regarded as a proxy of COVID-19-related uncertainty. Second, based on the VAR analysis, we find that financial variables are affected significantly by a COVID-19-related

[6] Baker et al. (2020a) argue that the epidemiological feature of COVID-19 cannot explain the stock market reaction to COVID-19, but their discussion is simply derived from a comparison of the lethality with Spanish flu.

policy uncertainty shock while real variables, such as mobility and consumption, are affected by a COVID-19-specific uncertainty shock. Our findings on stock price reactions support the argument of Baker et al. (2020a) that the epidemiological threat of COVID-19 is not a dominant factor in a significant drop of stock prices in the pandemic. The novelty of this paper is that we directly clarify the source of uncertainty that plays a dominant role in the variation of stock prices rather than guessing its source from a comparison with past pandemic events as in Baker et al. (2020a). We also uncover from the analysis of the stock market variables that the volatility index shows a significant response only to a COVID-19-related policy uncertainty shock, thereby indicating that the use of stock market volatility (e.g., as in Caggiano et al., 2020) possibly fails to evaluate the entire impact of uncertainty induced by COVID-19. The real variables, in contrust, chiefly respond to a COVID-19-specific uncertainty shock. In response to a COVID-19-specific uncertainty shock, the flow of people to retail and recreation places, transit stations, and workplaces declines, and the flow of people in residential areas increases. The results are fairly similar to the response of consumption. We can regard a COVID-19-specific uncertainty shock as capturing uncertainty for the epidemiological feature of COVID-19, so the results suggest that people have changed their behavior due to the perceived threat of infection.

This paper is closely related to two strands of literature: one measuring economic uncertainty, especially in the COVID-19 era, and the other measuring the impact of the COVID-19 pandemic. As summarized in Baker et al. (2020b), economic uncertainty is often quantified by stock market volatility, newspaper-based measures, and business expectation surveys. Among these uncertainty measures, this paper employs a newspaper-based approach, originally developed by Baker et al. (2016) and well known as the EPU index. Arbatli et al. (2017) have published the Japan EPU index. Recently, Baker et al. (2019) construct a newspaper-based Equity Market Volatility tracker that harmonizes with the movement of the VIX, and Baker et al. (2020a) apply it to the evaluation of the role of the COVID-19 in the US stock market. Also, there exist some studies that measure uncertainty using a firm-level survey of firms' economic outlook (e.g., Chen et al., 2021; Morikawa, 2021). All these studies, despite their methodological differences, report the same results as in this paper, a massive hike in uncertainty at the early stage of the pandemic. There are also several studies that have examined the impact of the COVID-19 pandemic on economic activities. As comprehensively surveyed in Brodeur et al. (2021), the growing literature on this subject has analyzed not only uncertainty but also the consequences of the social distancing policy and other related policy interventions on infection status, mobility pattern, and economic activities. For example, Coibion et al. (2020) report that the lockdown policy itself has a significant negative impact on consumption, employment, and households' expectation based on survey data in the US. Watanabe and Yabu (2021) indicate that under Japan's state of emergency, which is not legally binding, information about the risk of serious illness and death from COVID-19 is more likely than the government's request to lead older people to voluntarily refrain from going out. Haddad et al. (2021) reveal the impacts of the COVID-19 outbreak and subsequent intervention by the Fed on the corporate bond market. If we limit ourselves to studies that focus on the economic impact of uncertainty induced by COVID-19, Altig et al. (2020) show that increased COVID-19 uncertainty causes declines in US industrial production by 12–19%, and both Baker et al. (2020b) for the US output and Caggiano et al. (2020) for the world output report almost the same results. This paper aims to contribute to the literature by providing two types of uncertainty indices that can identify the source of the COVID-19-induced uncertainty and clarifying its effects on economic activities in Japan.

The rest of this paper is structured as follows. Section 2 explains how to construct both uncertainty indices and discusses the properties of the constructed indices by comparing them with other uncertainty indices and actual events. Section 3 reports our empirical analysis. We first explain our VAR model and identification strategy and then show the impulse responses of stock market variables, mobility data, and consumption to two types of COVID-19-related uncertainty shocks. Section 4 concludes.

2 COVID-19 Uncertainty Index

2.1 Construction of the ECU index

We construct the index of COVID-19-related economic uncertainty in the same manner as the EPU index developed by Baker et al. (2016). The EPU index is a newspaper-based measure of policy-related uncertainty constructed by counting newspaper articles with terms about "economic", "uncertainty" and "policy". Following Baker et al. (2016), our economic COVID-19 uncertainty (ECU) measure is also built based on newspaper coverage frequency, counting articles that contain the terms related to "economic", "uncertainty" and "COVID-19" instead of "policy". However, the outbreak of the pandemic entailed policy uncertainty in addition to its epidemiological uncertainty. For instance, the infectiousness, prevalence, and lethality of COVID-19 reflect uncertainty about the properties of the virus (i.e., COVID-19-*specific* uncertainty), while the issues about the declaration of a state of emergency and vaccine supply are uncertainty about policy reactions in coping with the virus (i.e., COVID-19-*related policy* uncertainty). The collection of the articles containing the terms "economic", "uncertainty" and "COVID-19" does not exclude the articles related to "policy", resulting in a mix of the two types of uncertainty in the constructed index. According to Baker et al. (2020a), more than 90% of US newspaper articles containing "economic", "uncertainty" and "policy" terms also contain "COVID-19"-related terms in March and April 2020. To assess the effects of those two uncertainties on economic activities separately, we also construct a policy-*unrelated* COVID-19 uncertainty measure by eliminating articles with "policy" terms from the articles containing "economic", "uncertainty" and "COVID-19", which mainly captures the epidemiological aspect of COVID-19-induced uncertainty. We name COVID-19-related economic uncertainty with and without policy-related terms, in literal fashion, ECU with policy and ECU without policy, respectively.

The detailed procedure for constructing the indices consists of two steps: a counting step and a normalizing step. In the first step, we collect articles from four leading Japanese newspapers (Nikkei, Asahi, Mainichi, and Yomiuri) that satisfy the following conditions. The condition for selecting an article for ECU *with* policy is that it contains at least one term in all brackets for each of the following three terms: Economy term: {Economy, Economics}, Uncertainty term: {Unclear, Uncertain, Uncertainty}, and COVID-19 term: {Coronavirus, Novel Coronavirus, Novel Pneumonia}.[7] It should be stressed that the articles selected using this condition may well contain policy-related terms. Accordingly, we refer to the uncertainty measure produced by this criterion as ECU *with* policy. In contrust, the condition for inclusion in ECU *without* policy is that article also contains Economy, Uncertainty, and COVID-19 terms, but does not contain any Policy term.[8] In the second step, for each newspaper, we divide the total number of articles satisfying the respective condition by the total number of daily articles, and then normalize this daily coverage ratio to have a mean of 0 and a variance of 1. Finally, these normalized coverage ratios for each newspaper are aggregated with equal weight each day, and further normalized so that the mean of the index equals 100. We follow this procedure for both the morning and evening editions of newspapers for the period from January 1, 2020, to August 31, 2021, and construct the daily frequency measure of COVID-19-related uncertainty.[9]

2.2 The properties of ECU index

In this section, we investigate some properties of the ECU index and discuss certain details. Figure 1 shows the constructed time-series of the ECU without policy (Figure 1a) and the ECU with policy (Figure 1b). Both indices surge from around February 2020, peak in May, and are stable after the rise, while the fluctuations of each index are distinct. We can also see from the figures that the indices show clear spikes around several featuring events. For example, large drops in stock market generate large spikes

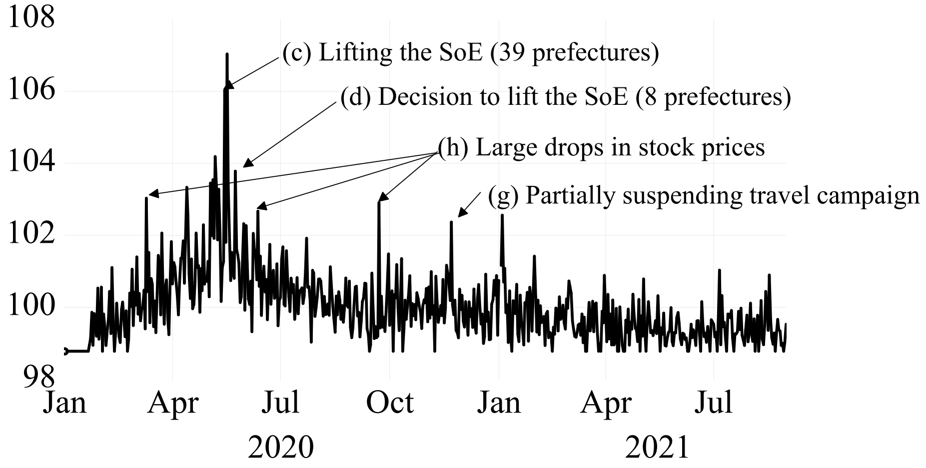
[7]Although we understand that the selection of articles under this condition may include articles that convey the news of "reducing uncertainty", this is a standard approach in the literature (e.g., Baker et al., 2016; Arbatli et al., 2017), and the constructed indices seem to capture well the events associated with the increased uncertainty caused by COVID-19, as shown below. Hence, we adopt this manner to construct our uncertainty indices.

[8]The list of Policy terms is long, so it is summarized in detail in Appendix A.1, along with the Japanese counterparts for each of the English keywords for Economy, Uncertainty, and COVID-19. The Japanese terms that correspond to original English keywords are in accordance with those documented in Arbatli et al. (2017) in constructing the Japan's EPU index. Also, the daily articles for Nikkei, Asahi, Mainichi, and Yomiuri are collected from their online database libraries, Nikkei Telecon, Kikuzo II, Maisaku, and Yomidas-rekishikan, respectively.

[9]During our sample period, January 2 was a newspaper holiday, and all the newspapers used in this paper did not publish either a morning or an evening edition. Therefore, both of the ECU indices are missing for January 2 and are thus excluded from the following estimation.

in both ECU indices. As for the state of emergency, ECU without policy shows spikes only for events related to the lifting of the state of emergency, while ECU with policy tends to react to all the events related to the state of emergency. This suggests that people may fear further spreading the infection with the lift of the state of emergency, inducing uncertainty regarding infectious COVID-19. Interestingly, only the first state of emergency had an impact on the indices. We also find that political transitions, PM Abe's resignation, and the inauguration of the Suga cabinet led to an increment in the policy related uncertainty. Furthermore, it should be noted that the ECU without policy tends to rise a few days after events that raise the ECU with policy (e.g., declarations and extensions of a state of emergency). This is likely because many articles about these events written from a non-political perspective are published a few days after those political events. Overall, our indices capture well the featuring events related to COVID-19 and thus can be regarded as a valid measure of uncertainty.

(a) ECU without policy



(b) ECU with policy

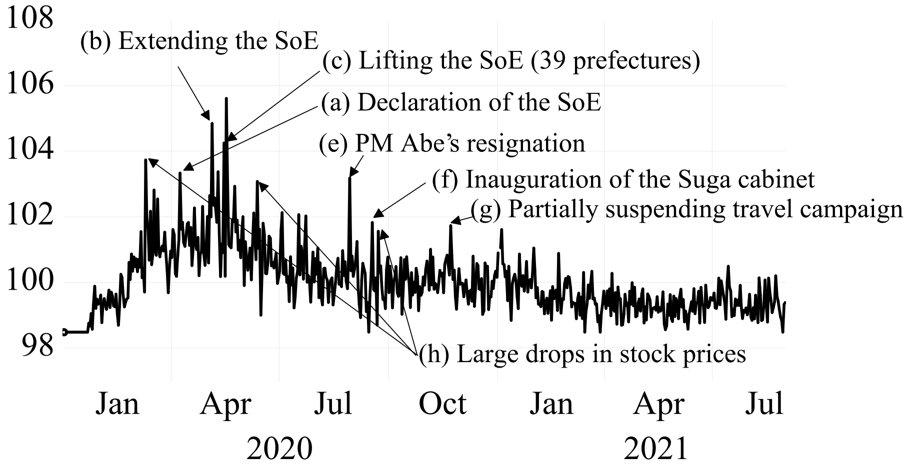


Figure 1: The time series of ECU indices

Notes: This figure shows the time-series of the ECU index without policy (upper panel) and the ECU with policy (bottom panel). The dates when newspapers published articles on the events in the figures are as follows: (a) April 8, 2020.; (b) May 5, 2020.; (c) May 15, 2020; (d) May 24, 2020.; (e) August 29, 2020.; (f) September 17, 2020.; (g) November 22, 2020.; (h) March 10, 2020, June 12, 2020, and September 22, 2020. Note that here we have the dates when the events were published in the newspapers, so the events themselves were possibly considered to have happened the day before.

Table 1 summarizes the calculated correlation coefficients among the ECU indices and other indicators: EPU index, the number of newly infected people (new cases), the number of participants with severe cases (severe cases), and the number of deaths

(deaths).[10] For the EPU index, the sample correlation coefficients between the daily change rates of the ECU index and the EPU index are calculated. For other indicators of infection status, moving averages of the past week are first constructed to remove weekly seasonality, and the correlation coefficients between the daily change rates of the ECU index and of the average of these indicators are calculated.

We first find that the ECU *without* policy index is more highly orthogonal to EPU index than the ECU *without* policy index, with their correlations equal to 0.071 and 0.654 respectively. In this regard, the ECU *without* policy index allows the extraction of the uncertainty induced by COVID-19 itself from COVID-19 economic uncertainty as a whole. Moreover, the results tell us that there is little correlation between the representative indicators of infection status and the ECU indices *with* and *without* policy, implying that our ECU index captures other information than what the infection status measures.

Table 1: Correlation coefficients of the ECU indices and other indicators

	EPU	New cases	Severe cases	Deaths
ECU without policy	0.071	0.030	−0.000	0.030
ECU with policy	0.654	0.031	0.006	−0.005

Notes: This table shows the correlation coefficients between each ECU index and other indicators. Here we chose the EPU index, the number of newly infected people, the number of patients with severe cases, and the number of deaths as the indicators, which are often used as proxies for COVID-19-induced uncertainty. The correlation coefficients with EPU (first column) are computed using the daily change rate of both variables. For the remaining three indicators, because of their weekly seasonality, we first calculate their average value over the past week and then compute the correlation coefficients using the daily change rate of the weekly average values. The daily series of the EPU index is constructed following the procedure by Arbatli et al. (2017), and the indicators for infection situation are collected from the website of Ministry of Health, Labour and Welfare.

[10] We construct the daily series of the EPU index entirely according to Arbatli et al. (2017) because they provide Japan's EPU index only on a monthly basis. The data for the COVID-19 infection status are collected from the database of the Ministry of Health, Labour and Welfare (https://www.mhlw.go.jp/stf/covid-19/open-data.html).

3 Effects of ECU on economic activities

3.1 Structural VAR analysis

We estimate a structural vector autoregressive (SVAR) model to examine the effects of COVID-19-related uncertainties on economic activities. By incorporating two kinds of ECU indices into the VAR system, we can separately identify (i) COVID-19-specific uncertainty shock and (ii) COVID-19-related policy uncertainty shock and assess the role of each uncertainty on economic fluctuation amid the pandemic. Identifying two types of structural shocks allows us to clearly distinguish between the economic impact of these different types of uncertainties induced by COVID-19.

We employ a three-variable VAR model including ECU without policy, ECU with policy, and the variable of interest in this order and identify the structural shocks by recursive restriction. Letting $Y_t = [\text{ECU w/o policy}_t, \text{ECU w/ policy}_t, \text{variable of interest}_t]'$ and $e_t = [e_t^1, e_t^2, e_t^3]'$, our VAR model can be written:

$$Y_t = c + B(L)Y_{t-1} + Ae_t, \tag{1}$$

where c is a constant vector term, $B(L)$ is a polynomial in the lag operator, and A is a lower triangular matrix that specifies the contemporaneous relationship among the variables. Under this specification, the first structural shock (e_t^1) has a contemporaneous impact on both the ECU without policy and the ECU with policy, while the second structural shock (e_t^2) has no simultaneous effect on ECU without policy; thus, we regard the first shock as COVID-19-specific uncertainty shock and the second as COVID-19-related policy shock. This interpretation of structural shocks is based on the notion that the epidemiological uncertainty of COVID-19 can trigger policy uncertainty, but not vice versa. For example, the spread of the delta variant, which is considered highly infectious, would increase uncertainty about the epidemiological feature of the virus as well as policy uncertainty over such issues as the strength of movement restrictions, but it is unlikely that the strength of movement restrictions is not expected to increase uncertainty on the nature of the virus. This parsimonious identification strategy can be justified by the complete removal of policy-related articles in the process of constructing the index of

ECU without policy.

In what follows, we examine the impact of COVID-19 uncertainty on financial market and real activities by incorporating in turn stock market variables, mobility data, and consumption as the third variable in the VAR system. A detailed description of the data is provided in Appendix A.2. As an additional specification issue, we incorporate the natual logarithm of two ECU indices multiplied by 100 into the VAR model. The form of the third variable in the VAR model will be discussed separately below. Also, the lag length is set based on the Schwartz Information Criterion (SIC) by each estimation. The SIC chooses shorter lags than the Akaike Information Criterion (AIC), but our results are robust, with little different qualitative or quantitative difference, when using the AIC.

3.2 Effects on stock prices and volatility

We begin by examining the effect of COVID-19-induced uncertainty shocks the on Nikkei 225 Average (Nikkei Average) and Nikkei Volatility Index (Nikkei VI), both of which are representative measures of stock prices and uncertainty in the Japanese stock market. We estimate the VAR model by including respective variable in the third endogenous variable and compute the impulse response function to two types of uncertainty shocks. Each financial variable is incorporated into the model in term of the natural logarithm of the level, multiplied by 100. The sample period is from January 1, 2020 to August 31, 2021, with weekends, holidays, and newspaper holidays removed.

Figure 2 shows the impulse responses of the Nikkei average and Nikkei VI to a COVID-19-specific uncertainty shock (upper panel) and a COVID-19-related policy uncertainty shock (bottom panel). The solid line denotes the point estimator of the response, and the dashed lines denote 95% confidence intervals calculated analytically. We find from Figures 2 that both Nikkei average and Nikkei VI have statistically significant reactions with the expected signs to a COVID-19-related policy uncertainty shock, but not to a COVID-19-specific uncertainty shock. In response to a COVID-19-related policy shock, the Nikkei VI shows an immediate and persistent positive reaction, and the Nikkei VI shows a permanent negative reaction after an insignificant response on impact. Namely, an unfavorable increase of uncertainty, particularly related to policy, leads to spreading out the distribution of expected returns of stocks and shifts the mean to the left, thereby causing declining stock prices and rising stock market volatility. In contrast, the response of both variables to a COVID-19-related policy uncertainty shock is accompanied by wide confidence intervals.

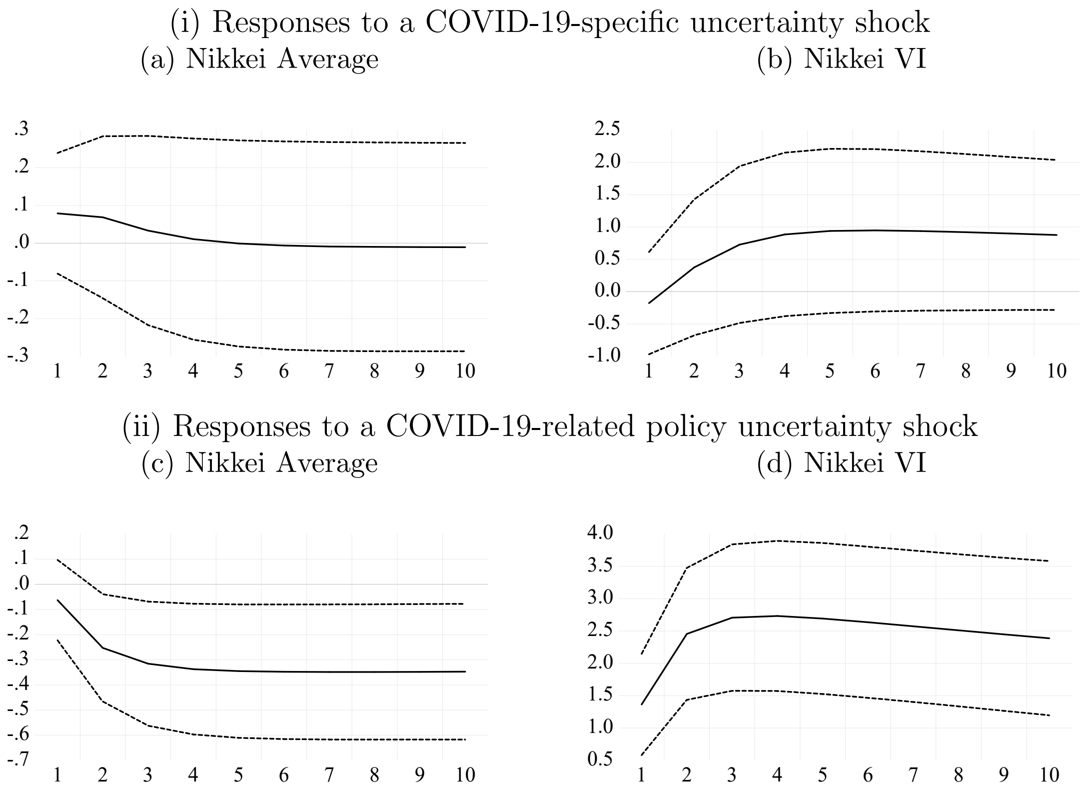


Figure 2: Impulse responses of financial variables to COVID-19-induced uncertainty shocks

Notes: The figures show the impulse responses of Nikkei Average and Nikkei VI to COVID-19-specific uncertainty shock (upper panel) and COVID-19-related policy uncertainty shock (bottom panel). The sample period is from January 1, 2020, to August 31, 2021, adjusted for weekends, holidays, and newspaper holidays, and the scale on the horizontal axis is one business day. The solid line is the point estimate of the responses, and the dashed lines are the 95% confidence intervals, computed analytically.

These results suggest that the policy-related uncertainty may play a chief role in stock market fluctuations during the pandemic, both in terms of prices and volatility, which is in accord with Baker et al. (2020a)'s argument that the US stock market fluctuation during the pandemic cannot be explained by the epidemiological properties of the virus. Our analysis empirically supports Baker et al. (2020a)'s view, derived from comparison with past pandemics, by identifying the source of the uncertainty induced by COVID-19.

A further important implication of this analysis is that uncertainty measures in financial markets (e.g., Nikkei VI) may only capture the policy-related part of all the uncertainty induced by COVID-19. As discussed in detail below, real economic activities tend to be affected by COVID-19-specific uncertainty shock, and thus, the results here indicate that the use of easily accessible financial market uncertainty measures such as Nikkei VI may fail to (or only partially) gauge the true impact of COVID-19-induced uncertainty. Hence, our attempt to construct a different type of uncertainty index related to COVID-19 contributes to assessing the true impact of its uncertainty.

3.3 Effects on the flow of people

We now investigate how the COVID-19-induced uncertainty affects the mobility of people. An increase in the flow of people is possibly considered to lead to the spread of the infection, and therefore, policymakers have consistently monitored changes in the flow of people during the COVID-19 pandemic. For mobility data that can capture the flow of people, we use the *COVID-19 Community Mobility Reports* provided by Google LLC. Since the data are collected daily, they can be included in the VAR model without time aggregation. We should comment on the preparation of the mobility data in the estimation before arguing the results of VAR analysis. In the following estimation, we use the residuals obtained by regressing the original mobility data on the lockdown index, the "stringency index" published by University of Oxford, because the behavior restriction by government possibly affects the mobility of people in addition to the uncertainty that we consider.[11] The sample period in this estimation is from February 15, 2020, to August 31, 2021, due to data availability. Unlike the stock market variables, mobility data are recorded every day over the sample period, so only newspaper holidays are removed in the estimation.

Figures 3 and 4 show the responses of the mobility variables to two types of COVID-19 uncertainty shocks. We consider the responses of the mobility in six categories of places: (a) retail and recreation, (b) groceries and pharmacies, (c) parks, (d) transit stations, (e)

[11] The stringency index is collected from the "COVID-19 Government Response Tracker" website, published by Oxford University (https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker)

workplaces, and (f) residential.

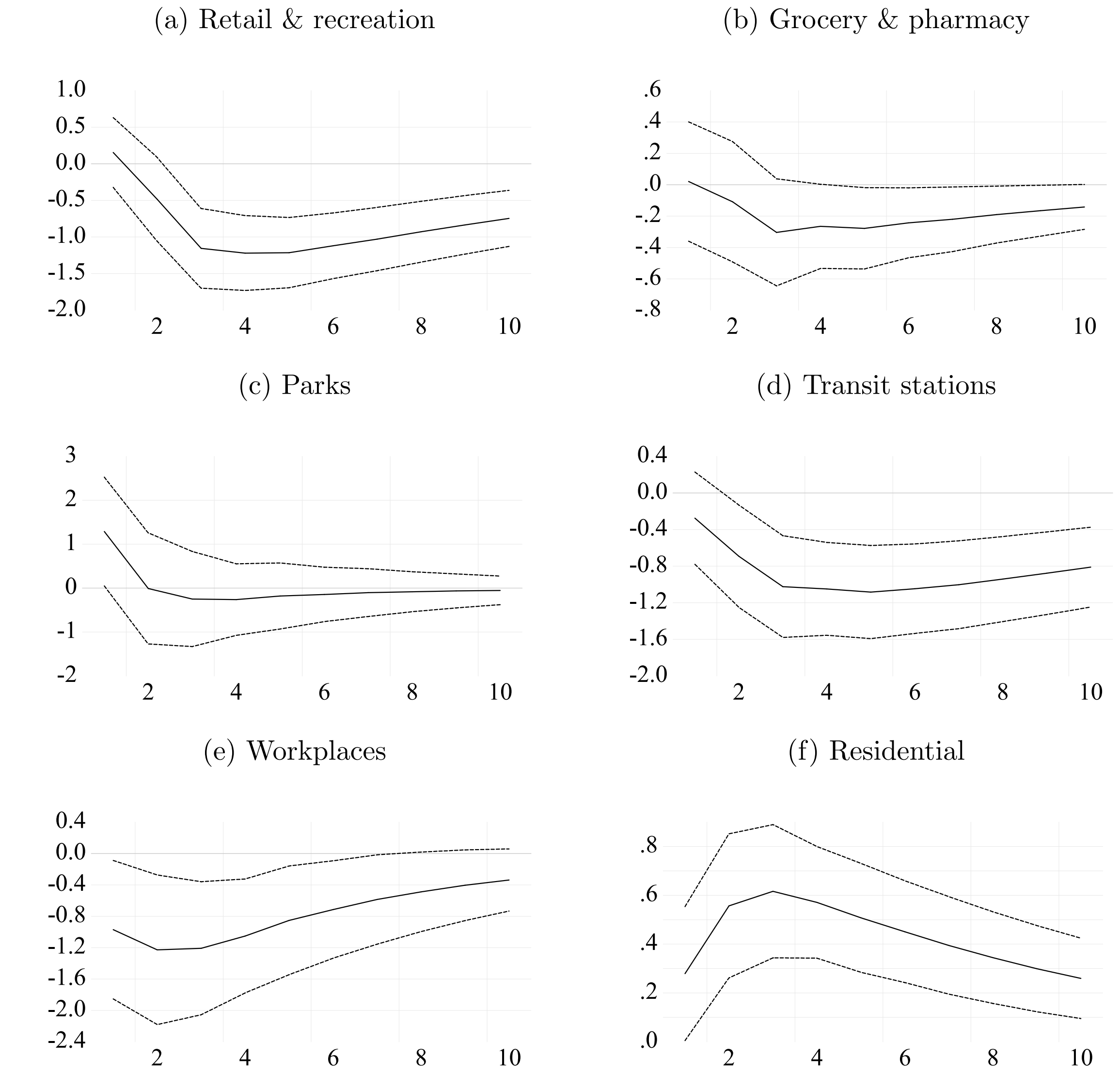


Figure 3: Responses of mobility indices to COVID-19-specific uncertainty shock

Notes: The figures show the impulse responses of mobility indices to a COVID-19-specific uncertainty shock. The sample period is from February 15, 2020, to August 31, 2021, adjusted for newspaper holidays, and the scale on the horizontal axis is one business day. The solid line is the point estimate of the response, and the dashed lines are the 95% confidence intervals, computed analytically.

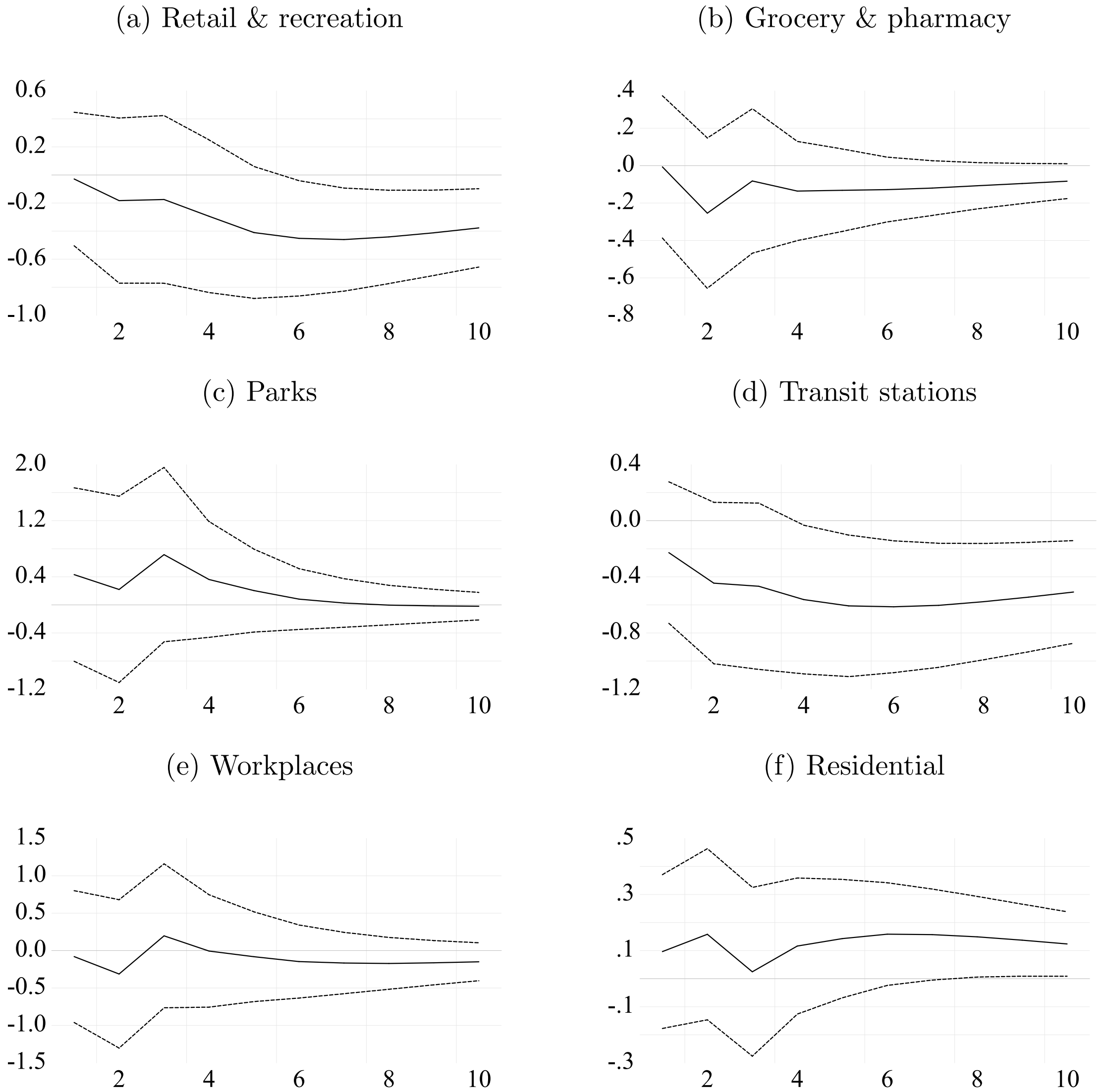


Figure 4: Responses of Mobility indices to COVID-19-related policy uncertainty shock

Notes: The figures show the impulse responses of mobility indices to a COVID-19-related policy uncertainty shock. The sample period is from February 15, 2020, to August 31, 2021, adjusted for newspaper holidays, and the scale on the horizontal axis is one business day. The solid line is the point estimate of the response, and the dashed lines are the 95% confidence intervals, computed analytically.

Figures 3 show the responses to a COVID-19-specific uncertainty shock, revealing that in contrast to stock market variables, the mobility variables tend to respond significantly to this shock. In response to a COVID-19-specific shock, after some initial statistically insignificant responses, the mobility for retail and recreation areas (e.g., restaurant, cafe, museum, and so on) persistently declines (Figure 3a). The results are similar to the responses for transit stations and workplaces (Figures 3d and 3e), though the mobility of workplaces immediately declines after the shock. Not surprisingly, the mobility in residential areas significantly rises after increased COVID-19-specific uncertainty (Figure 3f). Thus, the results can be plausibly interpreted as indicating that epidemiological concerns over COVID-19 lead people to avoid visiting crowded areas with a high probability of infection. However, workplaces and residential areas show a hump-shape response, suggesting that even in the pandemic, workers are likely to return to their workplaces in about ten days. We also find that the mobility for groceries and pharmacies declines after the fifth day, while the mobility to parks increases slightly on impact. People might have reduced their shopping frequency and quickly changed their destinations in holidays from crowded recreation places to parks just after perceiving an increased COVID-19-specific uncertainty.

Figure 4 shows the responses to a COVID-19-related policy uncertainty shock. Unlike Figure 3, mobility to groceries and pharmacies, parks, and workplaces does not show a significant reaction to the shock over the horizon considered (Figures 4b, 4c and 4e). The residential response exhibits a slight statistically significant rise only after a week (Figure 4f). We also observe that retail and recreation areas and transit stations have slower responses to a COVID-19-related policy uncertainty shock than the responses to a COVID-19-specific uncertainty shock, having statistically insignificant responses for approximately three to five days after the shock (Figures 4a, 4d). These responses, however, are totally different from those to a COVID-19-specific shock in terms of the magnitude, speed, and shape of the responses.

In sum, we conclude from Figures 3 and 4 that changes in the flow of people are mainly driven by increased COVID-19-specific uncertainty. In other words, people had concerns about the uncertainty of infection or seriousness of the disease rather than uncertainty in government action when they are going out. This result is compatible with Watanabe and Yabu (2021), who report that the increase in the number of critically ill patients suppressed mobility (especially of the elderly). However, it should be noted that our uncertainty measure is the compound of risk and ambiguity and therefore captures uncertainty induced by COVID-19 in a broader sense than that captured by Watanabe and Yabu (2021), who focuses on the impact of risk on the flow of people. Here, however, recall that we initially control for the effect of lockdown policy, which is exogenously imposed on the behaviors of people. Thus, our analysis highlights how people voluntarily react to changes in their perceived uncertainty stemming from COVID-19, while at the same time the effect of lockdown policy, which is also one of the major concerns in the literature, is outside our scope.

3.4 Effects on consumption

Finally, we examine the effect of COVID-19 uncertainty on consumption. The data for consumption are obtained from the *Family Income and Expenditure Survey*, released by the Statistical Bureau of Japan, which records daily consumption expenditures based on the information of the household account books of about 9,000 households. Although nominal consumption is used in the analysis due to data availability, this is not a serious problem because our sample period is at most one and a half years, and prices hardly fluctuate over the sample period, showing a mean and standard deviation of monthly change of CPI (all item) less than -0.05% and 0.35%. As in the analysis of mobility, we initially control the effect of lockdown policy by regressing consumption on the stringency index and using the residuals in the estimation. The sample period for this estimation is from January 1, 2020, to August 31, 2021, and only newspaper holidays are adjusted because consumption is recorded every day, as in the mobility data. In the following, among the various categories of consumption provided by the data source, we show the results for selected consumptions that yield statistically significant reactions.

Figure 5 shows the responses to a COVID-19-specific uncertainty shock, while Figure 6 shows those to a COVID-19-related policy uncertainty shock. Overall, almost the same argument for the mobility data holds for the analysis using consumption data: Consumption also seems to be affected more by COVID-19-specific uncertainty than a COVID-19-related policy uncertainty. Total expenditure drops significantly in response to a COVID-19-specific uncertainty shock (Figure 5a), but not to a policy-related one (Figure 6a). Thus, we conclude that epidemiological uncertainty included in COVID-19 is a main factor driving the fluctuations in real activity under the pandemic.

Furthermore, we note that there is a close link between flow of the people and consumption. For both types of uncertainty shocks, the responses of consumption for transportation in Figures 5c and 6c plot paths similar to those for transit stations in Figures 3d and 4d, and the responses of culture and recreation in Figures 5d and 6d also seem to be counterparts for the responses of retail and recreation in Figures 3a and 4a. It is reasonable to consider that less frequently visiting to these places results in a decline of expenditure for those categories of consumption.

The expenditure for medical care also exhibits an interesting response to a COVID-19-specific uncertainty shock. Medical service, i.e., medical payments at hospitals, is a dominant part of expenditure for medical care, and thus the negative response in medical care expenditure on impact suggests that people might have been temporarily hesitant to go to the hospital just after receiving information about increased epidemiological uncertainty about COVID-19. Although the VAR analysis cannot yield anything further, we can guess from this finding that people might try to avoid infection by not going to the hospital.

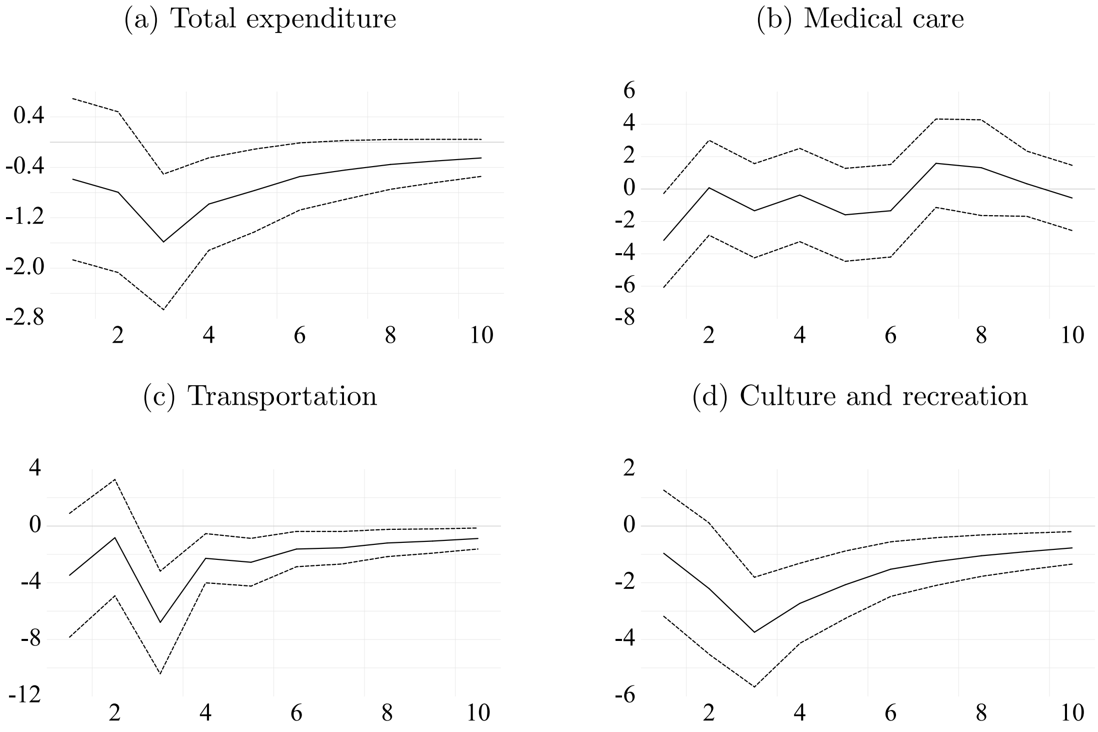


Figure 5: Responses of consumption to COVID-19-specific uncertainty shock

Notes: The figures show the impulse responses of selected consumption categories to a COVID-19-specific uncertainty shock. The sample period is from January 1, 2020, to August 31, 2021, adjusted for newspaper holidays, and the scale on the horizontal axis is one business day. The solid line is the point estimate of the response, and the dashed lines are the 95% confidence intervals, computed analytically.

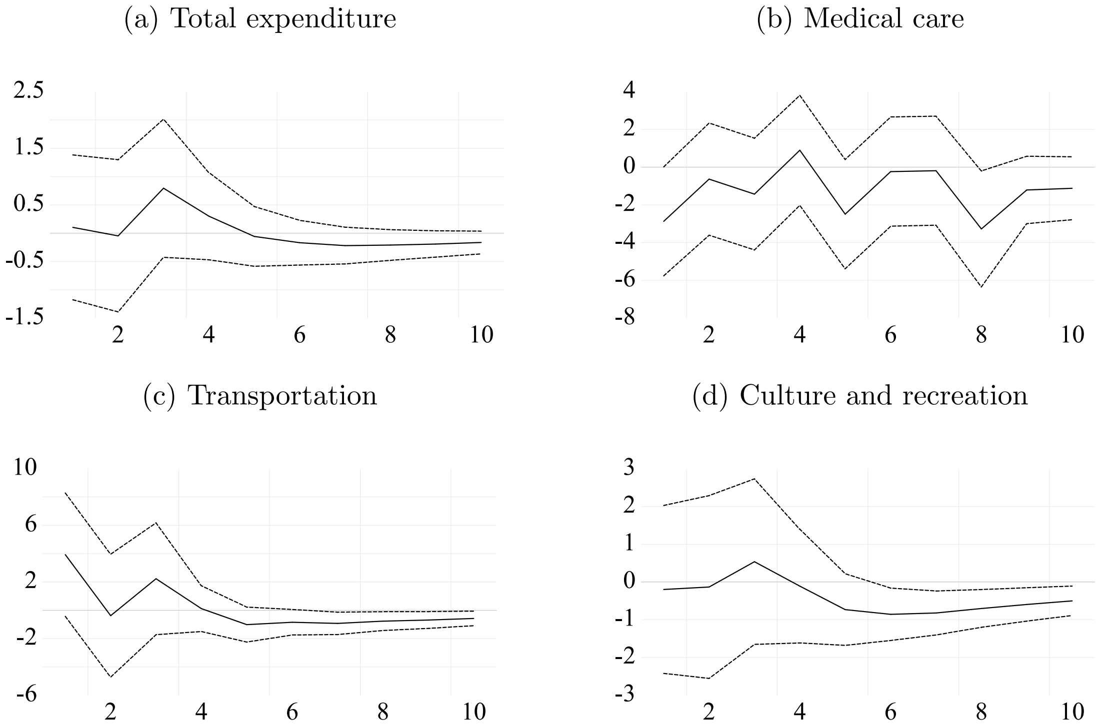


Figure 6: Responses of consumption to COVID-19-related policy uncertainty shock

Notes: The figures show the impulse responses of selected consumption categories to a COVID-19-related policy uncertainty shock. The sample period is from January 1, 2020, to August 31, 2021, adjusted for newspaper holidays, and the scale on the horizontal axis is one business day. The solid line is the point estimate of the response, and the dashed lines are the 95% confidence intervals, computed analytically.

4 Conclusion

We have constructed two types of newspaper-based uncertainty indices induced by COVID-19 and analyzed their connections with financial and non-financial variables. Our results indicate the following. First, the created uncertainty series traces the feature events associated with COVID-19-induced uncertainty well. Second, stock market variables show statistically significant responses to a policy-related COVID-19 uncertainty shock rather than an epidemiological COVID-19 uncertainty shock. Third, in contrast, real variables such as mobility and consumption tend to respond significantly to epidemiological uncertainty shocks in COVID-19. Hence, our findings highlight the importance of considering different types of uncertainty in order to properly assess the impact of COVID-19-induced uncertainty on economic activity. Furthermore, we would like to emphasize that our constructed series of uncertainty can be applied to a wide range of analyses beyond the scope of our empirical analysis in this paper.

An important objective for future work mainly lies in methodology. Even though Baker et al. (2016) indicate the validity of the EPU constructed by computers, showing that the correlation between EPU calculated by computer and humans is relatively high, there is a possibility that our index wrongly captures uncertainty. This is because our approach mainly rests on whether each article contains certain specific terms, and this procedure accidentally includes articles referring to not being uncertain when constructing the index. One possible way to cope with the problem is by applying natural language processing such as a topic model when building the index, which would enable us to evaluate each article more precisely, and the more accurately extracted index would be more valid as an index.

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A Appendix

A.1 Term set for newspaper-based uncertainty index

Table A.1: Terms for EPU

Term Genre	English Term	Japanese Term
Economy(E)	"economy" or "economic"	経済 or 景気
Uncertainty(U)	"unclear"	不透明
	"uncertain" or "uncertainty"	不確実 or 不確定 or 不安
Corona(C)	"coronavirus"	コロナウイルス
	"Novel Coronavirus"	新型コロナウイルス
	"Novel Pneumonia"	新型肺炎
	"Covid-19"	Covid-19
Policy(P)	"tax(es)"	税
	"taxation"	税制
	"government spending" or "government expenditure"	歳出
	"government revenue(s)"	歳入 or 財源
	"government budget"	予算 or 財政
	"policy debt"	公的債務
	"government debt"	国債 or 国の借金 or 国の債務 or 政府債務 or 政府の債務
	"government deficit(s)"	財政赤字
	"BOJ"	日銀
	"Bank of Japan"	日本銀行
	"central bank"	中央銀行
	"The Fed"	連銀
	"Federal Reserve"	連邦準備
	"regulation(s)" or "regulatory" or "regulate" or "deregulation" or "deregulate"	規制 or 自由化
	"structural reform"	構造改革
	"legislation"	法案
	"upper house"	参議院 or 参院
	"lower house"	衆議院 or 衆院
	"Diet"	国会
	"Prime minister"	首相 or 総理
	"Prime minister's office"	官邸

Notes: The Japanese terms corresponding to the original English keywords are in accordance with those documented in Arbatli et al. (2017).

A.2 Data appendix

Newspaper articles

The daily articles for Nikkei, Asahi, Mainichi, and Yomiuri are collected from their online database libraries, Nikkei Telecom, Kikuzo II, Maisaku, and Yomidasu-rekishikan, respectively. We used the data from January 1, 2020, to August 31, 2021. Note that January 2 is a newspaper holiday, on which day all the newspapers used in this paper publish neither morning nor evening editions.

Infection status

The data for the infection status of COVID-19 in Table 1 are collected from the database of the Ministry of Health, Labour and Welfare (https://www.mhlw.go.jp/stf/covid-19/open-data.html). We use the daily nationwide series of the number of newly infected people, the number of participants with severe cases, and the number of deaths.

Stock market variables

Financial data are collected from Nikkei NEEDS-Financial Quest online database. The database provides the daily series of Nikkei 225 average and Nikkei Volatility Index. We used data for the business days from January 1, 2020, to August 31, 2021.

Flow of people

The mobility data are obtained from the *COVID-19 Community Mobility Reports*, released by Google LCC (https://www.google.com/covid19/mobility/), which provides us with the flow of people at six categories of locations: (a) Retail and recreation, (b) Grocery and pharmacy, (c) Parks, (d) Transit station, (e) Workplaces, and (f) Residential, in the form of change rates compared to the baseline values for each day of the week. The baselines are the median values of the flow of people on each day from January 3 to February 6, 2020. The data are released daily from February 15, 2020, and thus the estimated sample period using this mobility data is from February 15, 2020, to August 31, 2021, excluding the newspaper holiday on January 2.

Consumption expenditure

The data on consumption expenditure are drawn from the *Family Income and Expenditure Survey* of the Statistical Bureau of Japan (https://www.stat.go.jp/data/kakei/index.html).[12] This survey provides a daily series of (nominal) consumption figures recorded based on household account books. Although the category of consumption is highly subdivided by item, we show here the results derived from four major categories of consumption for "two-or-more-person households" to obtain statistically significant estimates. The results for the other major categories of consumption are available from the authors on request.

[12] The data themselves are downloaded from the Nikkei NEEDS-Financial Quest online database.