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Abstract

This study, using quarterly, firm-level panel data constructed from government statistics, presents empirical evidence on measurements of firms' business uncertainty and how this is associated with their investments. According to the analysis, first, uncertainty measures calculated from ex post forecast errors have strong seasonal fluctuations because of the respondents choosing "unsure" in the survey. Second, while an "unsure" response positively correlates with stock market volatility and the economic policy uncertainty index, correlation between the forecast error-based measures of uncertainty and these macroeconomic uncertainty indices are very weak. Third, the higher degree of uncertainty observed from firms who responded "unsure" after the 2008 global financial crisis has remained high afterward. Fourth, at the firm-level, the responses "unsure" for the next two quarters have clear negative associations with investments realized in these quarters. These results highlight the importance of paying attention to the design of surveys.

Keywords: Forecast, Business condition, Uncertainty, Forecast error, Investment
JEL Classification: D84, E22

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Measuring Firm-Level Uncertainty: New Evidence from a Business Outlook Survey

1. Introduction

Studies about the impact of uncertainty on economic activity have been advancing rapidly (see Bloom, 2014, for a representative survey). These studies indicate that uncertainty has non-negligible, negative effect on investments, production, and hiring of workers. This study, using firm-level quarterly panel data, presents empirical findings about measuring firms' uncertainty and its association with their investment behavior, which will also shed light on the importance of survey design.

Theoretical and empirical studies on the relationship between uncertainty and real economic activity have a long history. In particular, the negative impact of uncertainty on investments, through the "wait-and-see" mechanism, has been analyzed theoretically (e.g., Bernanke, 1983; McDonald and Siegel, 1986; Pindyck, 1991).[1] When the cost of investments is irreversible, economic uncertainty reduces the amount of these investments, because firms have an incentive to avoid taking action until the uncertainty disappears. Empirical studies largely support the theoretical prediction that uncertainty has a negative effect on investments (e.g., Leahy and Whited, 1996; Guiso and Parigi, 1999; Ghosal and Loungani, 2000; Bloom *et al*., 2007; Bontempi *et al*., 2010; Morikawa, 2016a).

Since uncertainty is not directly observable, various proxies have been developed and used in past studies. Representative macroeconomic uncertainty measures include the volatility of stock prices (volatility index: VIX), prediction errors derived from econometric models, disagreement among professional forecasters, and the frequency of newspaper articles regarding uncertainty. Uncertainty measures at the firm-level used in past studies include (1) firms' subjective uncertainty obtained from surveys (e.g., Guiso and Parigi; 1999; Bontempi *et al*.; 2010; Morikawa, 2016b), (2) ex post forecast errors in a qualitative business outlook (e.g., Bachmann *et al*., 2013; Arslan *et al*., 2015; Morikawa, 2016a), and (3) quantitative, ex post forecast errors about production or investment (e.g., Bachmann *et al*., 2017; Morikawa, 2017).

This study, based on Japanese firm-level quarterly panel data of the Business Outlook Survey (BOS) from 2004Q2 to 2017Q1, presents new evidence on uncertainty measurement and how uncertainty impacts future investments. The uncertainty measures used in this study are the first and the second categories of the abovementioned three proxies of firm-level uncertainty.

The BOS has several unique characteristics compared with other business surveys used in past

[1] However, some theories suggest that uncertainty and investment have a positive relationship (e.g., Hartman, 1972; Abel *et al*., 1996; Lee, 2016).

studies. First, it not only asks respondent firms' outlook for their own business conditions but also for the overall domestic economy's conditions. Second, the BOS asks firms about two quarters-ahead forecasts as well as one quarter-ahead forecasts, allowing comparison of uncertainty by different time horizons of forecasting. Third, different from other business surveys, that of the BOS includes "unsure" as an answer choice, in addition to "improvement," "no change," and "deterioration." Although the choice of "unsure" may undermine the usefulness of ex post forecast error as a measure of uncertainty, this response itself may be a good uncertainty measure.

While numerous empirical studies about uncertainty and its relationship with investments exist, the appropriate measure of uncertainty depends on the survey's design and the specific wording of questionnaires. In this respect, our analysis, which uses a unique firm-level panel data, contributes to the literature. In particular, we consider whether or not the response of "unsure" is a useful firm-level uncertainty measure, a question that has not been analyzed before.

Distinct from other business surveys, such as the Short-Term Economic Survey of Enterprises in Japan (the "Tankan Survey"), conducted by the Bank of Japan, BOS uncertainty measures, calculated from ex post forecast errors, exhibit strong seasonal fluctuations. One reason for this is the existence of the "unsure" option. The percentage of firms choosing "unsure" positively correlates with the volatility of the stock market and the economic policy uncertainty (EPU) index. In contrast, uncertainty measures calculated from ex post forecast errors have very weak correlations with these macroeconomic uncertainty measures. Uncertainty, which is measured as the percentage of firms in the survey choosing "unsure," increased after the 2008 global financial crisis and has remained high afterwards. Investments made one or two quarters in the future significantly decline when a firm is uncertain about its upcoming business condition. The association between lower actual investments and an uncertain forecast is larger and more significant than an expectation of deterioration. The impact of uncertainty on investments is dominated by forecasts related to a firm's own business conditions, sales, or profits, rather than to a forecast of the overall domestic economic conditions.

The rest of this paper is structured as follows. Section 2 explains the BOS used in this study and the measurement of uncertainty. Section 3 reports time-series movements of uncertainty measures and their relationship to investments. Section 4 concludes with implications.

2. Data and Methodology

2.1. Data

This study uses BOS firm-level microdata, compiled jointly by the Ministry of Finance and the

Cabinet Office of Japan.[2] Under the Statistics Act, amassing of this information commenced in 2004 and has been updated quarterly. The survey covers incorporated firms with capital of 10 million yen or more, in all sectors of the economy. About 16,000 firms were sampled in each survey, of which about 13,000 responded. Survey items include both qualitative and quantitative items. The former includes business conditions, sales, profits, and the domestic economy's conditions, among others, for the current and following two quarters. The latter include sales, profits, and investments (in millions of yen). Both past realized values and forecast values are surveyed. The survey's reference periods are January to March (Q1 survey), April to June (Q2 survey), July to September (Q3 survey), and October to December (Q4 survey). Aggregated statistics of the surveys are released in the middle of March, June, September, and December, respectively.

Unlike the Tankan survey, the BOS queries the aforementioned three quarterly periods. While the Tankan survey asks about business conditions ("favorable," "not so favorable," or "unfavorable"), the BOS asks about changes ("improvement," "no change," or "deterioration"). The BOS, unlike many other business surveys, includes "unsure" as a potential response.[3]

This study uses microdata of the BOS from 2004Q2 to 2017Q1 (52 quarters) and constructs a panel data set by linking quarterly data, using firms' identification codes. The total number of observations and firms is about 625,000 and 86,000, respectively. The BOS sent questionnaires to all firms with capital of 1 billion yen or more. The large sample of smaller firms was reshuffled periodically.

2.2. Method of Analysis

We calculate firms' forecast errors as the difference between the ex-ante, forecasted judgments and the ex post, realized judgments, which measures future uncertainty at the time of forecasting. Since judgments are expressed as categorical variables, following the method in Souleles (2004), Bachmann *et al*. (2013), and subsequent studies, we define numerical forecast errors as indicated in **Table 1**. When a firm's realized judgment is the same as the previous survey's forecasted judgment, "0" is assigned to the firm. When the realized judgment improves (deteriorates) by one unit compared with the forecast, "+0.5" ("−0.5") is assigned. When the improvement (deterioration) is two units, "+1" ("−1") is assigned. For example, if the forecasted judgment for

[2] The outline of the BOS is described on the website of the Ministry of Finance (http://www.mof.go.jp/english/pri/reference/bos/outline.htm#02).

[3] More specifically, the choices are "improvement," "no change," "deterioration," and "unsure" for questions about business conditions, domestic economic conditions, and profits. The choices are "increase," "no change," "decrease," and "unsure" for sales questions.

the next quarter is “improvement,” but the judgment on realization is “deterioration,” the forecast error will be -1.

Using these firm-level forecast errors, we calculate the following two uncertainty measures: (1) mean absolute forecast error (*MEANABSFE*) and (2) forecast error dispersion (*FEDISP*). *MEANABSFE* is the sample mean of forecast errors' absolute value, and *FEDISP* is the forecast errors' standard deviation. These two uncertainty measures were developed by Bachmann *et al*. (2013) and used in subsequent studies (e.g., Arslan *et al*., 2015; Morikawa, 2016a). It should be noted that these two measures, by definition, indicate uncertainty at the time of forecasting. For example, when a forecast in Q1 survey and a realization in Q2 survey are used to calculate forecast errors, *MEANABSFE* and *FEDISP* should be interpreted as Q1 uncertainty.

In addition to these measures, based on ex post forecast errors, we also use the “unsure” response as an alternative measure of firm-level uncertainty. As mentioned already, this choice is a distinctive characteristic of the BOS. If this measure represents firms’ future uncertainty at the time of forecasting, it is a practically useful “real time” measure because of its availability in the current quarter. In this study, the percentage of firms responding “unsure” is another uncertainty measure at the aggregate level (denoted as *UNSURE*).

To begin, we simply observe the time-series movements of these three uncertainty measures, one and two quarters in advance. According to studies using uncertainty measures calculated from the Tankan survey and the Survey of Production Forecast (Ministry of Economy, Trade, and Industry), uncertainty of the Japanese economy heightened during large shocks, such as the 2008 global financial crisis and the Great East Japan Earthquake. We anticipate similar uncertainty movements for the BOS. In addition, because the BOS uses the same types of questionnaires about business conditions, sales, profits, and domestic economic conditions, we calculate and compare the uncertainty measures of these alternative variables.

Next, we analyze the relationships of these uncertainty measures with other publicly available macroeconomic measures of uncertainty: (1) the option-implied volatility of the Japanese stock market (Nikkei Stock Average Volatility Index: NIKKEI VI) and the economic policy uncertainty index for Japan (EPU-Japan). Similar to the VIX in the United States, the NIKKEI VI is the index of implied volatility in the Nikkei stock market's average. The EPU indices, developed by Baker *et al*. (2016), are constructed from the frequency of newspaper articles that address economic policy uncertainty. Arbatli *et al*. (2017) explain the construction and properties of the EPU-Japan in detail. Comparing these indicators with the BOS’s uncertainty measures, we convert the monthly NIKKEI VI and EPU-Japan into quarterly data by simply taking three-month averages. Our main interests are the correlations among different uncertainty measures. To preview the result, while measures constructed from ex post forecast errors (*MEANABSFE* and *FEDISP*) have very weak correlations with the NIKKEI VI and EPU-Japan, the percentages of firms that

responded "unsure" (*UNSURE*) have relatively stronger correlations with macroeconomic uncertainty measures, suggesting that *UNSURE* is a practically useful measure of uncertainty, at least when using BOS data.

Finally, we analyze the relationship between uncertainty and investments at the firm-level. Specifically, we estimate investment equations for either one quarter-ahead (t+1) or two quarters-ahead (t+2), with forecasts of business conditions as the main explanatory variable and realized investment amounts (expressed as a logarithm) at time t+1 or t+2 as the dependent variable. [4] Firm fixed-effects and time fixed-effects are included as control variables. We use three dummies ("improvement," "deterioration," and "unsure") for business conditions as the main explanatory variable ($BC^e_{it,\ t+1}$ or $BC^e_{it,\ t+2}$), and "no change" is the reference category. For example, when explaining firms' realized investments in the next quarter ($ln(INV)_{it+1}$), the equation to be estimated is expressed as follows.

$$Ln(INV)_{it+1} = \alpha + \beta BC^e_{it,t+1} + \lambda_t + \eta_i + \varepsilon_{it} \quad (1)$$

In this equation, λ_t and η_i denote time fixed-effects and firm fixed-effects, respectively. When explaining realized investments in the quarter after the next, ($ln(INV)_{it+2}$), $BC^e_{it,\ t+2}$ is used as right-hand side variable. Our main interest here is the sign and the statistical significance of the coefficient for the "unsure" dummy.

In addition to these baseline estimations using business condition forecasts as explanatory variables, forecasts for sales ($SALE^e_{it,\ t+1}$, $SALE^e_{it,\ t+2}$), profits ($PROF^e_{it,\ t+1}$, $PROF^e_{it,\ t+2}$), and domestic economic conditions ($EC^e_{it,\ t+1}$, $EC^e_{it,\ t+2}$) are used as the alternative explanatory variables. Among these four alternatives, an "unsure" forecast, with domestic economic conditions representing uncertainty about macroeconomic movements, is different from the other three "unsure" forecasts, which reflect firms' idiosyncratic uncertainties. Therefore, the estimated impact of uncertainty on investments might differ when the forecast on domestic economic conditions is used as the explanatory variable.

The focus of these estimations is the impact of uncertainty on the quantity of investments. However, in some quarters, small- and medium-sized firms frequently do not make any investments. In such cases, the investment amounts expressed in logarithms are omitted. In fact, the percentage of zero investment in the total firm-quarter observations is 37%. To deal with this problem, we implement a supplementary analysis by adding one to the reported investment

[4] We also conduct regressions using firms' realized investment amount in the current quarter ($ln(INV)_{it}$) as the dependent variable. According to the results of this specification, the coefficients for the "unsure" dummy are insignificant. Hence, we report only results using one quarter- and two quarters-ahead realized investments as dependent variables. A possible reason behind the insignificant coefficients in the current investments is time lag of the decision and execution of investments.

amounts and use the figures ($ln(1+INV)_{it+1}$) as the dependent variable to check the robustness of the baseline estimation results.

Since equation (1) includes firm fixed-effects, time-invariant and unobservable firm characteristics (e.g., firms' tendency to reporting either bullish or weak forecasts) are controlled. In addition, we can eliminate the effects of unusual events common across firms, such as the 2008 global financial crisis, as well as seasonal variations, by including time dummies. Summary statistics about investments (expressed as logarithms) and investment dummies are reported in **Table 2**.

3. Results

3.1. Movements of Uncertainty Measures

As explained in the previous section, we observe time-series properties of uncertainty measures. **Figure 1** depicts the movements of three uncertainty measures, *MEANABSFE* (Panel A), *FEDISP* (Panel B), and *UNSURE* (Panel C), calculated from BOS panel data for the subsequent two quarters. The obvious finding is that all uncertainty measures show strong seasonal fluctuations. For *MEANABSFE* and *FEDISP*, the value is *lower* for the next quarter's Q1 survey forecasts and for the quarter after next's Q4 and Q1 survey forecasts. Such strong seasonality was not observed in Morikawa's (2016a) study, using Tankan survey data. Bachmann *et al*. (2013) use monthly data from Germany (IFO Business Climate Survey) but does not show seasonal fluctuations. In contrast, although seasonal fluctuations are not as strong as the other two measures, *UNSURE*'s, movements show *higher* Q1 forecast values for the next quarter and Q4 forecasts for the quarter after next. For quarters when *UNSURE* is high, *MEANABSFE* and *FEDISP* are low, and vice versa.

To see this negative relationship visually, **Figure 2** depicts the movements of *UNSURE* and *MEANABSFE* in the same diagram. Figure 3 scatterplots the uncertainty measures, where the X-axis indicates *UNSURE* and the Y-axis indicates *MEANABSFE* and *FEDISP*. For forecasts one quarter-ahead, the correlation coefficients of *UNSURE* with *MEANABSFE* and *FEDISP* are −0.295 and −0.267, respectively. Similar negative correlations, of −0.394 and −0.374, respectively, are found in forecasts two quarters-ahead.[5]

These results suggest that the "unsure" choice affects uncertainty measures calculated from ex post forecast errors. In business surveys without the "unsure" choice, such as the Tankan survey,

[5] On the other hand, *MEANABSFE* and *FEDISP* have a strong positive correlation with each other. The correlation coefficients are 0.995 for the next quarter and 0.990 for the quarter after the next.

firms must choose “improvement,” “no change,” or “deterioration,” even when they are highly uncertain about the future. As a result, ex post forecast errors will be large when firms face greater uncertainty. In contrast, since the BOS offers a choice of “unsure,” firms can choose this option when they have difficulty forecasting the future.

Although this interpretation explains the negative relationships between *UNSURE* and *MEANABSFE/FEDISP*, it is not possible to explain systematic seasonal patterns where more firms choose “unsure” for the next quarter’s forecasts in Q1 surveys and in the quarter after next’s forecasts in Q4 and Q1 surveys. We conjecture that fiscal years matter for the observed seasonality. Since second-quarter forecasts (April–June) are those for the different fiscal years at the time of forecasting in most Japanese firms, it might be difficult for them to report a Q2 forecast based on an established annual business plan.[6]

The *UNSURE* forecast is much higher for two quarters in the future than for the next quarter, in line with our expectations, the longer the forecast time horizon, the larger the number of firms responding “unsure.”[7]

Figure 1 shows a time-series movement of *UNSURE* in detail (see Panel C). Forecast uncertainty, which rose after the 2008 global financial crisis, remains high. To check whether this change was biased by a reshuffling of mainly small- and medium-sized firms, we recalculate *UNSURE* for future business conditions by limiting observations to firms that responded to the BOS throughout the sample period (mainly large firms). **Appendix Figure A1** compares the result of this subsample with that of all observations. The two series show similar movements and the *UNSURE* remains high after the global financial crisis for the subsample of firms responding throughout the sample period. If anything, the increase in *UNSURE* is more remarkable for this subsample. The higher observed uncertainty measured by *UNSURE* after the global financial crisis is not driven by a reshuffling of BOS sample firms.

Table 3 segregates the *UNSURE* response for future business conditions by industry and firm size. Although a distinction by industry is unclear, the figures are larger for smaller firms. However, the relationship between *UNSURE* and firm size is non-linear.

To see whether or not some firms continuously responded “unsure,” we calculate the frequency of firms responding “unsure” to queries about future business conditions during the sample period. For example, a firm that responded ten times and chose “unsure” five times has a frequency of 50%. **Appendix Table A1** shows the frequency distribution of firms that chose “unsure.” For the entire sample (Column (1)), the mean frequencies are 16.2% for the next quarter's forecast and 28.9% for the quarter after next. Looking at the 90th, 95th, and 99th percentile figures (respectively,

[6] The fiscal year of most Japanese firms starts in April.

[7] Studies using professional macroeconomic forecasts indicate that uncertainty depends on the length of the forecasting horizon (e.g., Rossi *et al*., 2016; Jo and Sekkel, 2017).

p90, p95, and p99), approximately 5–10% of firms chose "unsure." Considering that some small- and medium-sized firms are not sampled for all quarters, Column (2) in **Appendix Table A1** reports results for firms that responded to the BOS throughout the sample period. The mean frequencies for one quarter-ahead and two quarters-ahead forecasts are 12.2% and 26.4%, respectively. While a small number of firms frequently chose "unsure," this response occurs less frequently among large firms.

Figure 4 depicts the movements of uncertainty measures (*MEANABSFE* (Panel A), *FEDISP* (Panel B), and *UNSURE* (Panel C)) for future business conditions, sales, profits, and domestic economic conditions. It is obvious from these figures that the uncertainty measures of these four categories move in parallel and share the common property of strong seasonality. The level of measured uncertainty is highest for profits in *MEANABSFE* and *FEDISP*, followed by sales, business conditions, and domestic economic conditions. In contrast, *UNSURE* is the highest for domestic economic conditions, with the other three variables being lower and largely the same. Since future economic conditions cannot be judged using only a respondent firm's own prospects, a relatively large number of firms may find it difficult to make prediction and choose "unsure." As a consequence, ex post forecast errors of this variable will be smaller. The variables' ranking reinforces the interpretation that a choice of "unsure" affects aggregate uncertainty measures calculated from the ex post forecast errors (*MEANABSFE* and *FEDISP*).

To reduce the strong seasonality of the uncertainty measures presented above, we estimate seasonally-adjusted uncertainty measures by regressing them on dummies for each quarter. The residuals of this simple regression for the next quarter's forecast are depicted in Panel A of **Appendix Figure A2**. Although *MEANABSFE* and *FEDISP* still show strong seasonality after the 2008 global financial crisis, seasonal fluctuations of *UNSURE* are weakened substantially. The result is essentially similar for the forecasts two quarters-ahead (Panel B). A heightened *UNSURE* after the global financial crisis is clearly seen. The uncertainty measures of sales, profits, and domestic economic conditions show similar patterns (not reported in Figures or Tables).

To summarize the main findings of this subsection, *MEANABSFE* and *FEDISP* are negatively correlated with *UNSURE*, suggesting that a choice of "unsure" undermines the usefulness of the uncertainty measures constructed from the ex post forecast errors. In the following subsections, we explore whether *UNSURE* is a good measure to capture firms' uncertainty.

3.2. Relationships with Macroeconomic Uncertainty Measures

In this subsection, we document the relationship between uncertainty measures constructed from the BOS and the other publicly available macroeconomic uncertainty measures (NIKKEI

VI and EPU-Japan). **Figure 5** scatterplots the relationships of *UNSURE* with NIKKEI VI and EPU-Japan, with the X-axis indicating *UNSURE* and the Y-axis indicating NIKKEI VI and EPU-Japan. Positive correlations with forecast uncertainty are observed for both the next quarter (Panel A) and the quarter after the next (Panel B). **Table 4** presents the correlation coefficients between *MEANABSFE*, *FEDISP*, and *UNSURE* on the one hand and NIKKEI VI and EPU-Japan on the other hand. The coefficients of *UNSURE* with NIKKEI VI and EPU-Japan are positive: 0.327 and 0.608, respectively, for the next quarter's forecasts (Panel A). The coefficients are 0.447 and 0.581, respectively, for the following quarter's forecasts (Panel B). In contrast, *MEANABSFE* and *FEDISP* have very low and sometimes negative correlations with NIKKEI VI and EPU-Japan.

These findings, combined with the results presented in the previous subsection, indicate that *UNSURE* is a better uncertainty measure than *MEANABSFE* and *FEDISP*, at least when using data from the BOS. In addition, *UNSURE* has a practical advantage different from measures based on ex post forecast errors: it is available immediately, when data is released, without having to wait for the release of the next survey.

3.3. Uncertainty and Investments

In this subsection, we use the "unsure" response to estimate the relationship between this proxy of uncertainty for future business conditions ($BC^{e}_{it,\,t+1}$, $BC^{e}_{it,\,t+2}$) and a firm's realized investments ($lnINV_{it+1}$, $lnINV_{it+2}$) in Equation (1). In these estimations, firm fixed-effects and time fixed-effects are included as control variables. Baseline estimation results are reported in **Table 5**. The reference category of forecast for business conditions is "no change," and the estimated coefficients for the "improvement," "deterioration," and "unsure" dummies are reported in the table.

The coefficients for "unsure" are negative and statistically significant, meaning that firms uncertain about future business conditions tend to reduce actual investments in the forecasted quarters. Quantitatively, uncertainty reduces investments by about five percent in the next quarter (Column (1)) and by about four percent in the quarter that follows (Column (2)). Surprisingly, the negative coefficients for "unsure" regarding future business conditions are larger and more significant than those for "deterioration," suggesting that uncertainty reduces investments more than a certain forecast of deterioration.

Since the investment amount is expressed in logarithms, zero investment is treated as a missing value, resulting in the significant reduction in the number of observations. To deal with this issue, we implement regressions by adding one to the reported investments and the logged values ($ln(1+INV)$) are used as the dependent variable. The results are presented in columns (3) and (4)

of **Table 5**. In the estimation for the next quarter investments (column (1)), the coefficient for "unsure" is negative and significant at the 1% level, although the size of the coefficient is somewhat smaller than the baseline estimation. In the estimation for the two quarters-ahead investments (column (2)), the size of the coefficient drops substantially, but still remains negative and marginally significant.

Columns (1) and (2) of **Table 6** compares estimated coefficients for "unsure" for firms' own business conditions, sales ($SALE^e_{it,\,t+1}$, $SALE^e_{it,\,t+2}$), and profits ($PROF^e_{it,\,t+1}$, $PROF^e_{it,\,t+2}$), as well for domestic economic conditions ($EC^e_{it,\,t+1}$, $EC^e_{it,\,t+2}$). Although coefficients for uncertainty about sales and profits are positive and highly significant, the explanatory power of uncertainty over domestic economic conditions is weak. Since domestic economic conditions are not specific to respondent firms, it has a relatively weak impact on firm-level investment decisions. Among all the variables representing uncertainty, sales have the strongest impact on investments. When sales prospects are uncertain, firms tend to scale back on investments. Columns (3) and (4) of **Table 6** presents estimation results using *ln(1+INV) a*s the dependent variable. The results confirm the significantly negative coefficients of "unsure" for firms' own business conditions, sales, and profits. In contrast, the coefficients of "unsure" domestic economic conditions are insignificant.

As indicated earlier in **Figure 4**, firms that responded as "unsure" (*UNSURE*) about business conditions, sales, profits, and domestic economic conditions correlate highly with each other. Therefore, inclusion of these variables simultaneously in the investment equation cannot avoid multicollinearity. Bearing this limitation in mind, we use dummies to forecast firms' own business and domestic economic conditions simultaneously. The results are presented in **Table 7**. While coefficients for uncertainty about firms' own business conditions remain negative and significant, those for domestic economic conditions are insignificant (Columns (1) and (4)). Similar results are obtained when business condition forecasts are replaced by forecasts of sales or profits (Columns (2), (3), (5), and (6)). Appendix **Table A2** is the estimation results of the same specification using *ln(1+INV) a*s the dependent variable. The coefficients of "unsure" for firms' own business conditions, sales, and profits are all negative and significant at the 1% or 5% level, but those of "unsure" domestic economic conditions are insignificant.

These results reinforce the interpretation that firms' idiosyncratic uncertainties are a far more important determinant of investments than overall macroeconomic uncertainty. In other words, uncertainty about macroeconomic conditions do not provide additional information about future investments, once a firm's own business forecast is controlled.

Appendix Table A3 presents estimation results for a balanced panel of firms that responded throughout the sample period. Similar to estimations for all observations, the coefficients for "unsure" about future business conditions ($BC^e_{it,\,t+1}$, $BC^e_{it,\,t+2}$) are negative and significant for this subsample. The insignificant coefficients for "deterioration" also held steady. **Appendix Table**

A4 compares the estimated coefficients for "unsure" regarding the respondent firms' own business condition, sales ($SALE^{e}_{it,\,t+1}$, $SALE^{e}_{it,\,t+2}$), profits ($PROF^{e}_{it,\,t+1}$, $PROF^{e}_{it,\,t+2}$) and domestic economic conditions ($EC^{e}_{it,\,t+1}$, $EC^{e}_{it,\,t+2}$) in this subsample. While these coefficients are insignificant for forecasts of domestic economic conditions, they are both negative and significant for sales and profit forecasts. These results reconfirm the findings obtained from all observations.

Since all the estimations presented above examine the relationship between ex-ante economic uncertainty and ex post realized investments, reverse causality is unlikely. In addition, since the estimations control for the fixed-effects of time, the possibility that macroeconomic shocks, common across firms, affect both forecast uncertainty and realized investments is eliminated. However, we cannot eliminate a possibility that some firm-specific factors influence both forecast uncertainty and actual investments.

4. Conclusion

Using quarterly, firm-level panel data constructed from the BOS, this study presents empirical evidence on the measurement of future business uncertainty and the impact of this uncertainty on firms' investments. The major findings are summarized as follows.

First, different from other business surveys, such as the Tankan survey, the forecast error-based uncertainty measures (*MEANABSFE* and *FEDISP*) calculated from the BOS data exhibit strong seasonal fluctuations. A probable reason behind this seasonality is the survey choice of "unsure." It might be difficult for some firms to forecast for the next fiscal year in advance as annual business plans are generally unavailable at the time of forecasting.

Second, the percentage of firms choosing "unsure" (*UNSURE*) is positively correlated with stock market volatility (NIKKEI VI) and the economic policy uncertainty index (EPU-Japan). In contrast, uncertainty measures calculated from ex post forecast errors (*MEANABSFE* and *FEDISP*) have very weak correlations with these macroeconomic uncertainty indicators. This implies that the "unsure" response itself is a good uncertainty measure, even though the choice "unsure" undermines the usefulness of ex post forecast error.

Third, when measured by the percentage of firms choosing "unsure," uncertainty rose after the 2008 global financial crisis and has remained high.

Fourth, when firms are unsure about business conditions for one or two quarters into the future, their actual investments in these quarters decline significantly. The association between lower investments and an uncertain forecast is larger and more significant than the impact of a certain forecast of deterioration. The impact of uncertainty is dominated by firms' forecasts of their own business conditions, sales, or profits, rather than forecasts of overall domestic economic

conditions.

Taken together, these results indicate that appropriate measurement of uncertainty by firms depends crucially on the design and the specific wording of the survey, in particular whether it includes response choices of “unsure,” “uncertain,” or “I don’t know.” Even when these choices do not exist, the survey’s response rates may reflect firms’ uncertainties. In designing and interpreting surveys of firms to analyze uncertainty, we should bear in mind a possible bias arising from these details.

On the other hand, the response “unsure” can be a practically useful “real time” measure of uncertainty because it is available immediately. For the BOS used in this study, the percentages of “unsure” firms by size (large, medium, and small) and industry (manufacturing versus non-manufacturing) are made public at the time when the survey results are released. Considering the growing importance of capturing uncertainty in analyzing business cycles, it is necessary to pay more attention to these figures.

However, the relatively short forecast horizon (one and two quarters) should be noted as a limitation of this study. We acknowledge that firms’ investment decisions are affected by uncertainty over a longer time horizon.

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Table 1. Quantification of Forecast Errors

		Judgment in the next quarter		
		1. Improve	2. No change	3. Deteriorate
Forecasted judgment in the current quarter	1. Improve	0	-0.5	-1
	2. No change	0.5	0	-0.5
	3. Deteriorate	1	0.5	0

Table 2. Summary Investment Statistics

	Mean	Std. Dev. (overall)	Std. Dev. (within)	Number of observations	Number of firms
ln(INV)	4.355	2.293	1.102	244,984	28,988
ln(INV+1)	2.788	2.754	1.098	389,696	64,462

Note: Original investment figures are expressed in millions of yen.

Table 3. Percentage of Firms Responding "Unsure" about Business Conditions

		One quarter-ahead forecast	Two quarter-ahead forecast
All firms		14.1%	26.9%
By industry	Manufacturing	13.2%	29.3%
	Wholesale & retail	14.1%	26.4%
	Other industries	14.7%	25.6%
By firm size (capital amount)	10 to 20 million yen	21.6%	34.7%
	20 to 50 million yen	17.4%	32.1%
	50 to 100 million yen	12.9%	26.5%
	100 millon to 1 billion yen	10.7%	22.4%
	1 to 20 billion yen	10.4%	21.9%
	20 billion yen or more	13.6%	26.1%

Table 4. Correlation Coefficients among Uncertainty Measures

Panel A. One Quarter-Ahead Forecast

	UNSURE	*MEANABSFE*	*FEDISP*
NIKKEI VI	0.327	0.004	-0.026
EPU-Japan	0.608	0.135	0.138

Panel B. Two Quarters-Ahead Forecast.

	UNSURE	*MEANABSFE*	*FEDISP*
NIKKEI VI	0.447	-0.045	-0.050
EPU-Japan	0.581	0.101	0.118

Note: The quarterly NIKKEI VI and EPU-Japan series are constructed from monthly data by taking the simple averages of three-month figures.

Table 5. Forecasts of Business Conditions and Investments

	(1)	(2)	(3)	(4)
	$ln(INV)_{it+1}$	$ln(INV)_{it+2}$	$ln(1+INV)_{it+1}$	$ln(1+INV)_{it+2}$
Bc^e improvement	0.0223 **	0.0199 *	0.0386 ***	0.0330 ***
	(0.0091)	(0.0109)	(0.0082)	(0.0107)
Bc^e deterioration	-0.0148	-0.0157	-0.0196 **	-0.0147
	(0.0102)	(0.0134)	(0.0083)	(0.0117)
Bc^e unsure	-0.0457 ***	-0.0391 ***	-0.0405 ***	-0.0201 *
	(0.0143)	(0.0122)	(0.0125)	(0.0122)
Firm FE	yes	yes	yes	yes
Time FE	yes	yes	yes	yes
Nobs.	244,141	217,694	388,416	318,472
R^2 (within)	0.0297	0.0319	0.0204	0.0230

Notes: Fixed effect estimations with robust standard errors are in parentheses. *** indicates statistical significance at the 1% level. A forecast of "no change" is used as the reference category. In columns (3) and (4), the dependent variable is *ln(1+INV)*.

Table 6. The Impact of Uncertainty Regarding Business Conditions, Sales, Profits, and Economic Conditions on Investments

	(1) $ln(INV)_{it+1}$	(2) $ln(INV)_{it+2}$	(3) $ln(1+INV)_{it+1}$	(4) $ln(1+INV)_{it+2}$
BC^e unsure	-0.0457 ***	-0.0391 ***	-0.0405 ***	-0.0201 *
	(0.0143)	(0.0122)	(0.0125)	(0.0122)
$SALE^e$ unsure	-0.0552 ***	-0.0601 ***	-0.0521 ***	-0.0448 ***
	(0.0152)	(0.0127)	(0.0135)	(0.0131)
$PROF^e$ unsure	-0.0414 ***	-0.0456 ***	-0.0361 ***	-0.0366 ***
	(0.0142)	(0.0122)	(0.0125)	(0.0124)
EC^e unsure	-0.0125	-0.0263 **	-0.0183	-0.0090
	(0.0130)	(0.0116)	(0.0112)	(0.0113)

Notes: Fixed effect estimations with robust standard errors are in parentheses. *** and ** indicate statistical significance at the 1% and 5% levels, respectively. Explanatory variables include time dummies and dummies for "improvement" and "deterioration" ("increase" and "decrease" for $SALE^e$). In columns (3) and (4), the dependent variable is *ln(1+INV).*

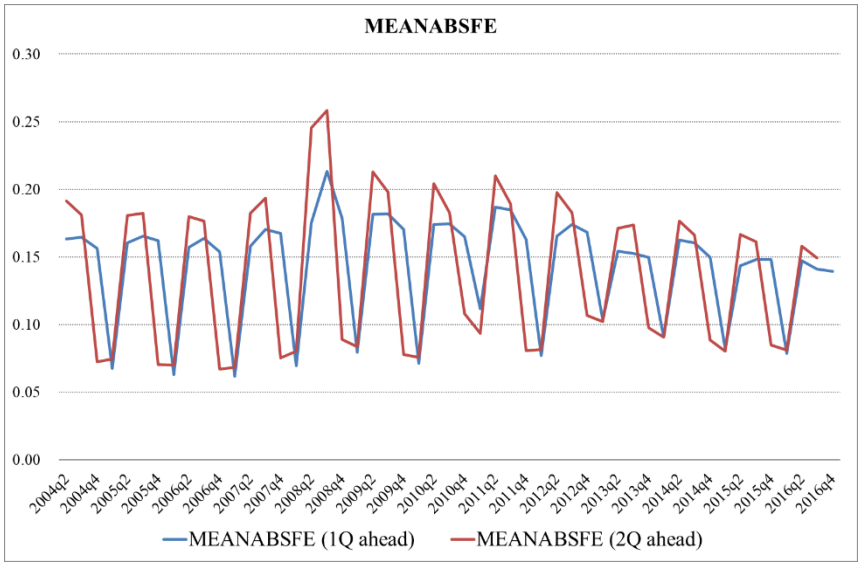
Table 7. The Impact of Uncertainty Regarding Business and Economic Conditions on Investments

	(1) $ln(INV)_{it+1}$	(2) $ln(INV)_{it+1}$	(3) $ln(INV)_{it+1}$	(4) $ln(INV)_{it+2}$	(5) $ln(INV)_{it+2}$	(6) $ln(INV)_{it+2}$
BC^e unsure	-0.0593 ***			-0.0351 **		
	(0.0166)			(0.0139)		
$SALE^e$ unsure		-0.0638 ***			-0.0615 ***	
		(0.0168)			(0.0137)	
$PROF^e$ unsure			-0.0494 ***			-0.0408 ***
			(0.0155)			(0.0131)
EC^e unsure	0.0206	0.0143	0.0126	-0.0046	0.0031	-0.0064
	(0.0150)	(0.0150)	(0.0144)	(0.0132)	(0.0132)	(0.0128)
Firm FE	yes	yes	yes	yes	yes	yes
Time FE	yes	yes	yes	yes	yes	yes
Nobs.	239,889	218,312	230,784	213,841	193,241	205,086
R2 (within)	0.0299	0.0294	0.0295	0.0322	0.0317	0.0319

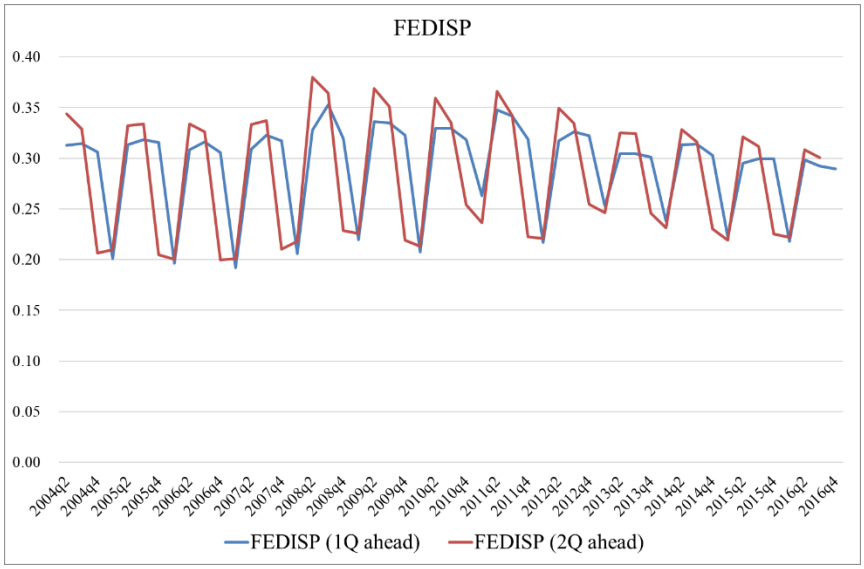
Notes: Fixed effect estimations with robust standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. A forecast of "no change" is used as the reference category. Explanatory variables include dummies for "improvement" and "deterioration" ("increase" and "decrease" for $SALE^e$).

Figure 1. Movements of Uncertainty Measures

Panel A. *MEANABSFE*



Panel B. *FEDISP*



Panel C. *UNSURE*

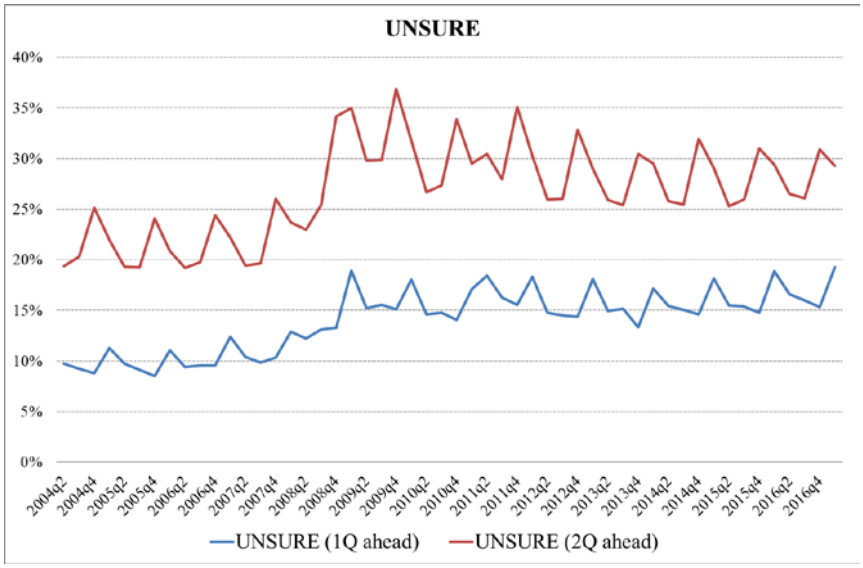


Figure 2. Movements of *UNSURE* and *MEANABSFE*

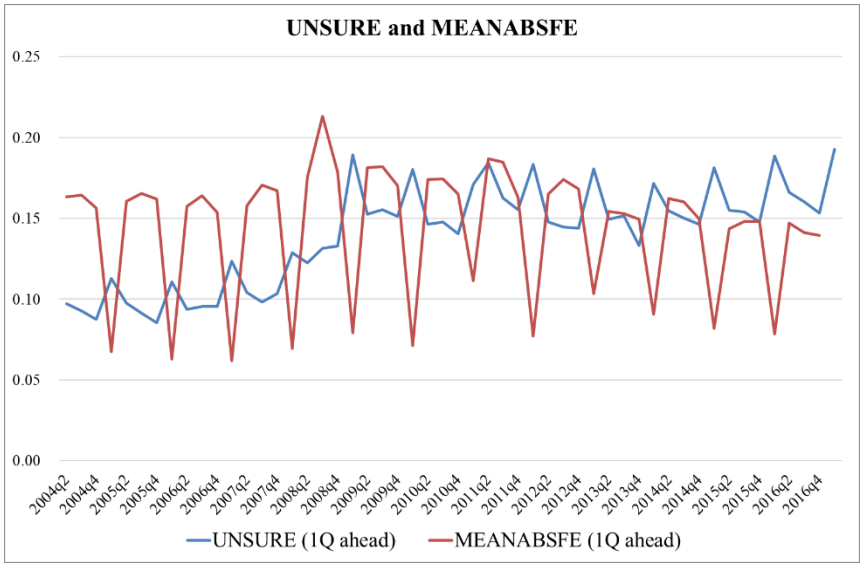
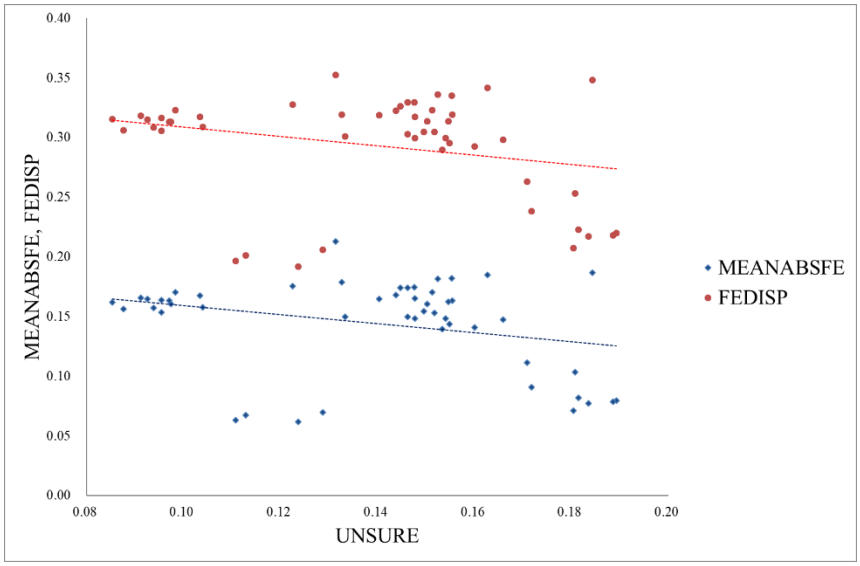


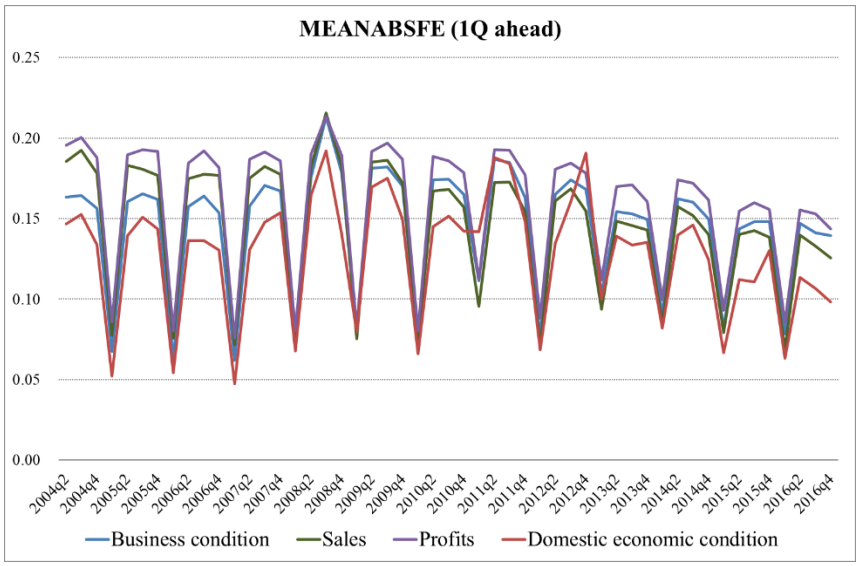
Figure 3. Relationships between *UNSURE*, *MEANABSFE*, and *FEDISP*



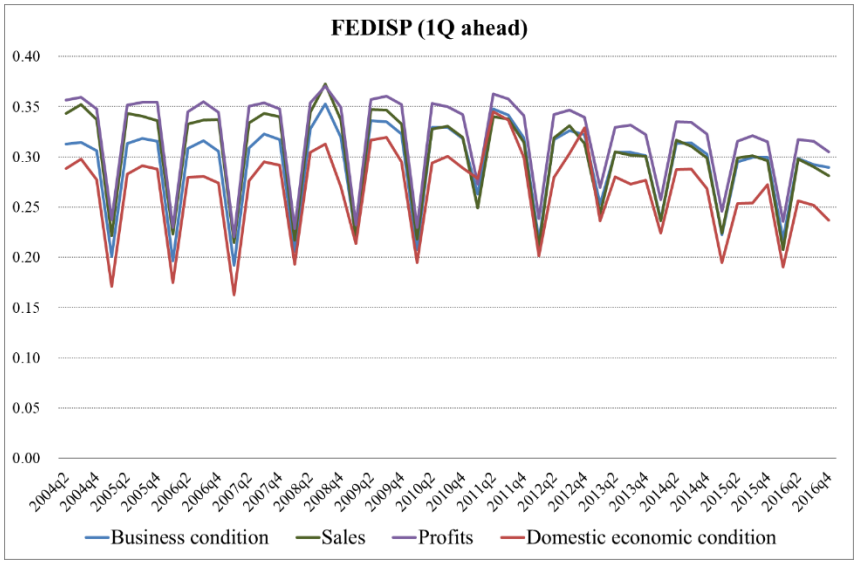
Note: The Figure forecasts business conditions for the next quarter.

Figure 4. Uncertainty about Business Conditions, Sales, Profits, and Economic Conditions

Panel A. *MEANABSFE*



Panel B. *FEDISP*



Panel C. *UNSURE*

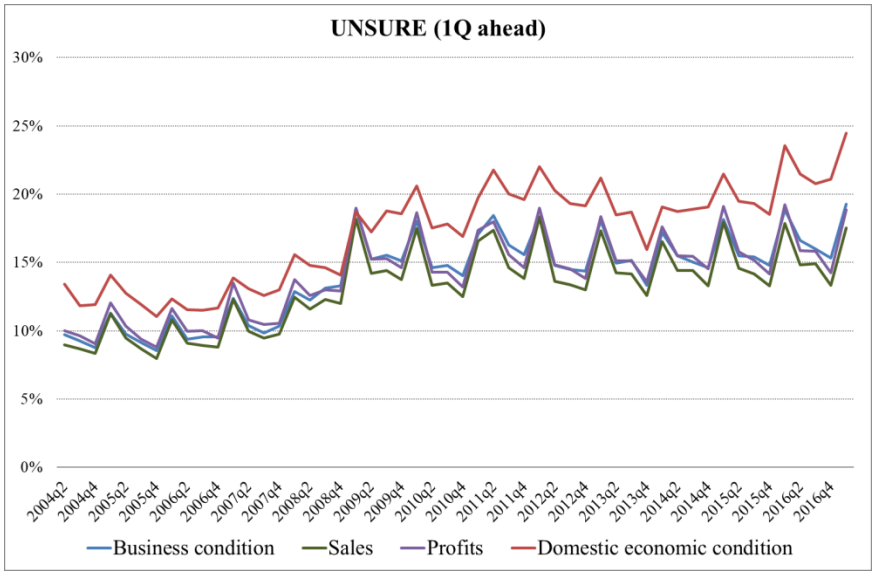
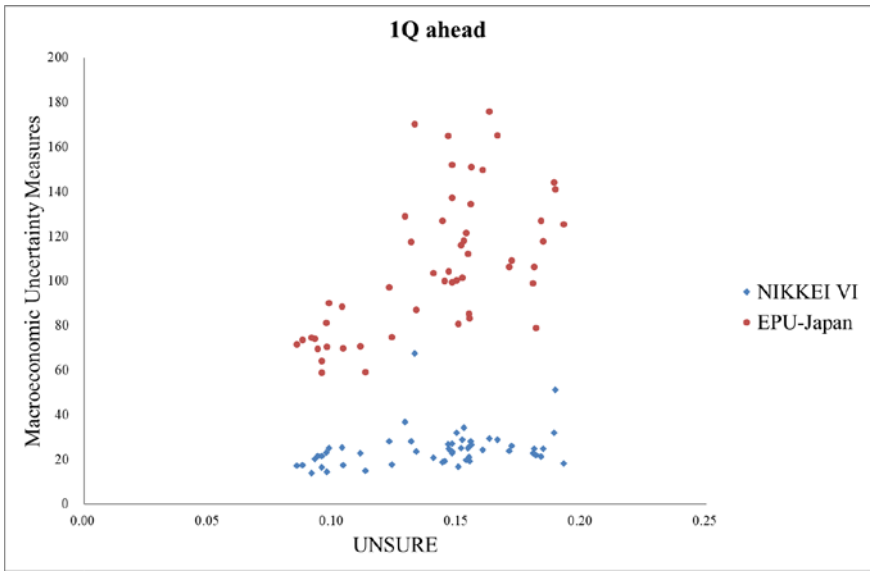


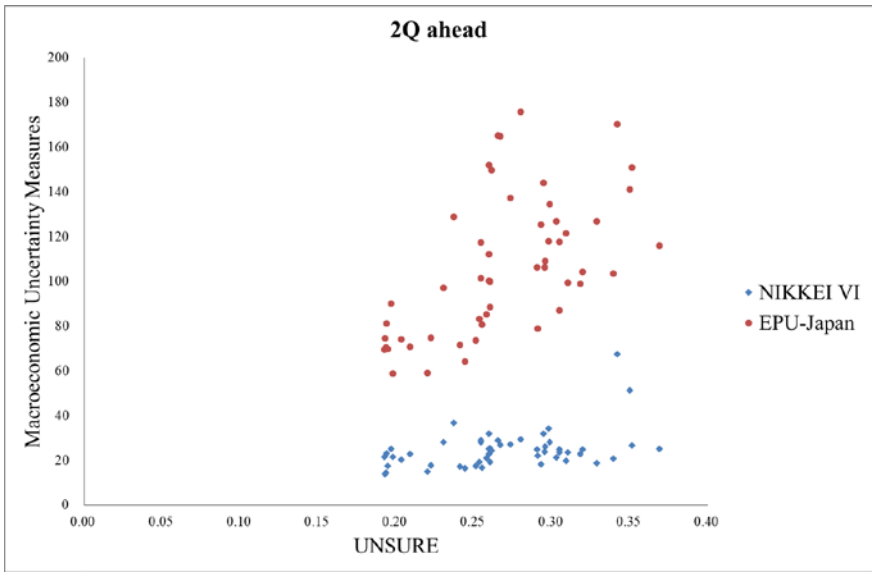
Figure 5. *UNSURE's* Relationship with Macroeconomic Uncertainty Measures

Panel A. One Quarter-Ahead Forecasts



Note: The quarterly NIKKEI VI and EPU-Japan average three-month figures.

Panel B. Two Quarters-Ahead Forecasts



Note: The quarterly NIKKEI VI and EPU-Japan average three-month figures.

Appendix Tables and Figures

Table A1. Frequency of Firms' "Unsure" Responses

	(1) All firms		(2) Firms responding continuously	
	One quarter-ahead forecast	Two quarters-ahead forecast	One quarter-ahead forecast	Two quarters-ahead forecast
mean	16.2%	28.9%	12.2%	26.4%
sd	28.1%	34.6%	20.1%	29.1%
p1	0.0%	0.0%	0.0%	0.0%
p5	0.0%	0.0%	0.0%	0.0%
p10	0.0%	0.0%	0.0%	0.0%
p50	0.0%	13.5%	1.9%	13.5%
p90	61.1%	100.0%	42.3%	73.1%
p95	100.0%	100.0%	59.6%	88.5%
p99	100.0%	100.0%	90.4%	98.1%
N	85,963	85,963	1,833	1,833

Notes: Figures represent firms' frequency of choosing "unsure" during the sample period. "Firms responding continuously" (Column (2)) are those that responded to all BOS surveys from 2004Q2 to 2017Q1 (52 quarters).

Table A2. The Impact of Uncertainty Regarding Business and Economic Conditions on Investments

	(1) $ln(1+INV)_{it+1}$	(2) $ln(1+INV)_{it+1}$	(3) $ln(1+INV)_{it+1}$	(4) $ln(1+INV)_{it+2}$	(5) $ln(1+INV)_{it+2}$	(6) $ln(1+INV)_{it+2}$
BC^e unsure	-0.0430 ***			-0.0186		
	(0.0136)			(0.0133)		
$SALE^e$ unsure		-0.0474 ***			-0.0495 ***	
		(0.0141)			(0.0136)	
$PROF^e$ unsure			-0.0310 **			-0.0370 ***
			(0.0128)			(0.0127)
EC^e unsure	0.0054	(0.0022)	0.0000	0.0030	0.0160	0.0093
	(0.0121)	(0.0125)	0.0000	(0.0120)	(0.0125)	(0.0119)
Firm FE	yes	yes	yes	yes	yes	yes
Time FE	yes	yes	yes	yes	yes	yes
Nobs.	379,014	346,522	365,191	310,704	280,534	297,985
R2 (within)	0.0209	0.0205	0.0204	0.0235	0.0233	0.0233

Notes: Fixed-effects estimations with robust standard errors are in parentheses. *** and * indicate statistical significance at the 1% and 10% levels, respectively. A forecast of "no change" is used as the reference category. The dependent variable is *ln(1+INV)*. Explanatory variables include dummies for "improvement" and "deterioration" ("increase" and "decrease" for $SALE^e$).

Table A3. Estimations for a Balanced Panel of Firms that Responded Continuously

	(1) $ln(INV)_{it+1}$	(2) $ln(INV)_{it+2}$
Bc^e improvement	0.0002	0.0084
	(0.0163)	(0.0191)
Bc^e deterioration	-0.0072	0.0075
	(0.0189)	(0.0241)
Bc^e unsure	-0.0556 **	-0.0591 ***
	(0.0247)	(0.0197)
Firm FE	yes	yes
Time FE	yes	yes
Nobs.	80,321	78,744
R^2 (within)	0.0376	0.0387

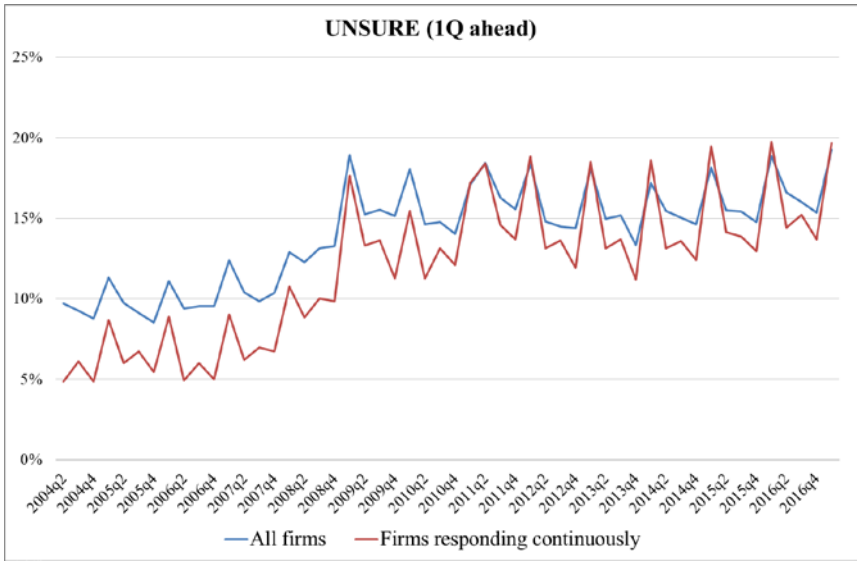
Notes: Fixed-effects estimations with robust standard errors are in parentheses. *** and ** indicate statistical significance at the 1% and 5% levels, respectively. A forecast of "no change" is used as the reference category.

Table A4. Impacts of Uncertainty Regarding Business Conditions, Sales, Profits, and Economic Conditions on Investments (Balanced Panel)

	(1) $ln(INV)_{it+1}$	(2) $ln(INV)_{it+2}$
BC^e unsure	-0.0556 **	-0.0591 ***
	(0.0247)	(0.0197)
$SALE^e$ unsure	-0.0706 ***	-0.0711 ***
	(0.0260)	(0.0206)
$PROF^e$ unsure	-0.0444 *	-0.0400 *
	(0.0241)	(0.0203)
EC^e unsure	0.0119	-0.0095
	(0.0235)	(0.0196)

Notes: Fixed effect estimations with robust standard errors are in parentheses. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. A forecast of "no change" is used as the reference category. Explanatory variables include investments in the previous quarter, time dummies, and dummies for "improvement" and "deterioration" ("increase" and "decrease" for $SALE^e$).

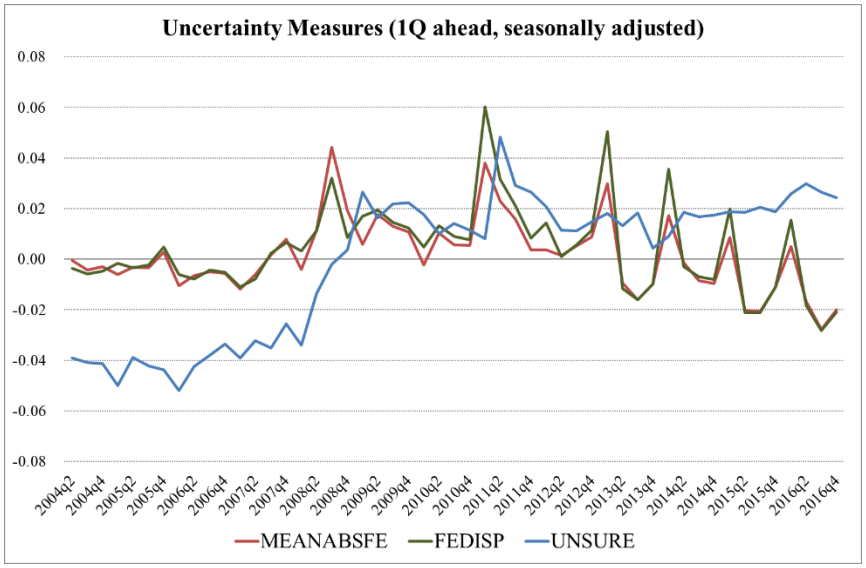
Figure A1. "*UNSURE*" Movements (for Firms Responding Continuously)



Note: "Firms responding continuously" are those that responded to all BOS questions, from 2004Q2 to 2017Q1 (52 quarters).

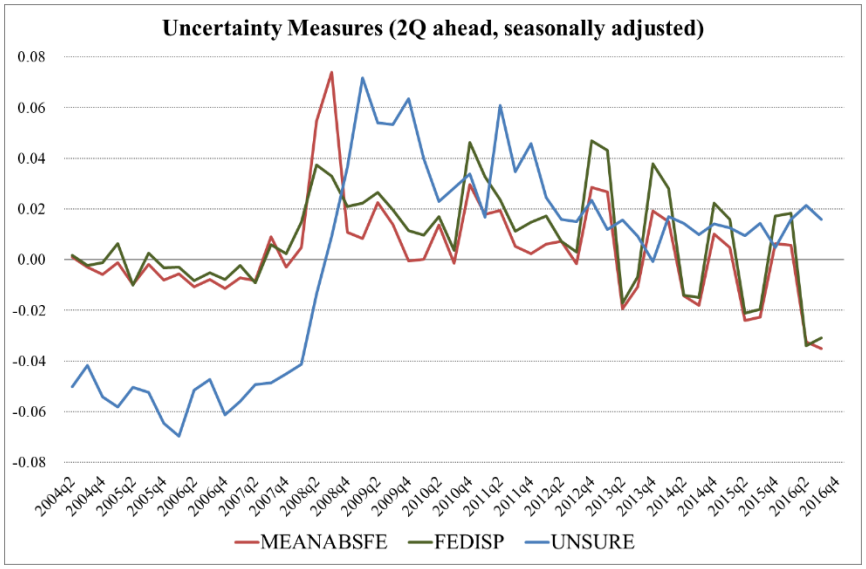
Figure A2. Movements of Seasonally-Adjusted Uncertainty Measures

Panel A. One Quarter-Ahead Forecast



Note: The Figure depicts residuals calculated from the original series, regressed on quarterly dummies.

Panel B. Two Quarters-Ahead Forecasts



Note: The Figure depicts residuals calculated from the original series, regressed on quarterly dummies.