RIETI Discussion Paper Series 23-E-040

Price Setting of Firms under Cost Uncertainty

MORIKAWA, Masayuki
RIETI

The Research Institute of Economy, Trade and Industry
https://www.rieti.go.jp/en/

RIETI Discussion Paper Series 23-E-040

June 2023

Price Setting of Firms under Cost Uncertainty*

Masayuki Morikawa (RIETI and Hitotsubashi University)

Abstract

This study documents firms' input and output price uncertainty over the past 20 years, using made-to-order aggregate data from the Short-Term Economic Survey of Enterprises in Japan (Tankan Survey). The results show that input and output price uncertainty increased markedly in the second half of 2008 when the Global Financial Crisis hit the economy, but subsequently, price uncertainty remained low, even during the COVID-19 pandemic. Output price uncertainty is strongly associated with input price uncertainty, and this relationship is more pronounced than its relationship with demand uncertainty. Input price uncertainty suppresses firms' output prices, suggesting that uncertainty weakens price pass-through.

Keywords: output price, input price, pass-through, forecast error, uncertainty

JEL Classifications: D84, E31

* I am grateful to Masato Ambashi, Takeo Hoshi, Arata Ito, Tomohiko Inui, Naomi Kodama, Yoko Konishi, Daisuke Miyakawa, Tatsuro Senga, Shujiro Urata, and seminar participants at RIETI for their helpful comments and suggestions. I would like to thank Research and Statistics Department, Bank of Japan (BOJ) for processing and providing made-to-order data of the Short-Term Economic Survey of Enterprises in Japan (Tankan Survey). This research is supported by Japan Society for the Promotion of Science Grant-in-Aid for Scientific Research (20H00071, 21H00720).

Price Setting of Firms under Cost Uncertainty

1. Introduction

With rising inflation worldwide, firms' pricing behaviors have attracted attention. Simultaneously, uncertainty shocks for firms have become frequent, such as the Global Financial Crisis, the COVID-19 pandemic, and Russia's invasion to Ukraine. Against this background, this study documents firm uncertainty over input and output prices over the past 20 years using made-to-order aggregate data from a representative quarterly business survey, the Short-Term Economic Survey of Enterprises in Japan (Tankan Survey), conducted by the Bank of Japan.

The main factors determining firm pricing are cost and demand. However, when costs or demand change, firms do not immediately revise their selling prices, and rigidities exist in goods and service prices. Various factors, such as menu costs, rational inattention, strategic pricing behavior in oligopolistic markets, and long-term business relationships with customers, constrain prompt price changes. In addition, not only current costs and demand but also expected future costs and demand affect pricing behavior. Previous studies have shown that the input price outlook is an important determinant of firms' price setting (e.g., Lein, 2010; Boneva *et al*., 2020) and that the demand (or production) outlook affects firms' pricing (e.g., Enders *et al*., 2022). Using unit labor costs rather than input prices, Carlsson and Skans (2012) argue that firms consider current and expected future marginal costs when setting prices.

As uncertainty is inevitable in forecasts of costs and demand, forecasts of selling prices of goods and services are also subject to uncertainty. If price changes entail friction or fixed costs, firms may adopt wait-and-see behavior under uncertainty. Many studies on the relationship between uncertainty and macro-level inflation have indicated that uncertainty shocks are associated with lower inflation (e.g., Leduc and Liu, 2016; Basu and Bundick, 2017; Berger *et al*., 2017; Caggiano *et al*., 2017; Fernández-Villaverde *et al*., 2017; Moran *et al*., 2022). [1] However,

[1] However, some studies show that the relationship between uncertainty and inflation varies across time periods and countries. Jones and Olson (2013) report that the correlation between macroeconomic uncertainty and inflation in the United States changed from negative to positive

regarding the relationship between uncertainty and firm-level pricing behavior, many studies have shown that uncertainty increases the probability of price changes (e.g., Vavra, 2014; Bachmann *et al*., 2019; Koga *et al*., 2019). [2] Chen *et al*. (2020) showed that firms change prices more frequently during recessions, arguing that this is the result of actively gathering information under demand uncertainty. Kumar *et al*. (2022), through a randomized experiment with New Zealand firms, find that firms tend to reduce prices when they perceive uncertainty in the macroeconomic growth rate.

If cost and demand forecasts affect firm pricing, the uncertainty of the forecast is likely to be related to pricing behavior. While there are many studies on the relationship between macroeconomic uncertainty, inflation, and firms' pricing behavior, studies that directly measure firms' purchasing and selling price uncertainty are scarce. Bunn *et al*. (2022) and Yotzov *et al*. (2023), based on surveys of firms in the United Kingdom, are rare examples of studies measuring selling price uncertainty. These studies indicate that price uncertainty in the United Kingdom has increased significantly since 2021 and that firms' subjective price uncertainty is associated with larger ex-post forecast errors. However, these studies do not address purchase price uncertainty, and the sample period is limited to the past six years.

The contributions of this study are that it measures the uncertainty of firms' output (selling) and input (purchase) prices during the past 20 years and examines the impact of input price uncertainty on output price and its uncertainty. The main findings of this study are summarized as follows. First, input and output price uncertainty increased markedly in the second half of 2008, when the Global Financial Crisis hit the economy after a surge in resource and energy prices, but subsequently remained low, even during the COVID-19 crisis. Second, output price uncertainty is strongly associated with input price uncertainty, and this relationship is more pronounced than its relationship with demand uncertainty. Third, input price uncertainty suppresses firms' output prices, suggesting that uncertainty in future costs may contribute to weakening the price pass-

---

in the late 1990s. Choi (2017) finds that the that the response of inflation to uncertainty varies across countries.

[2] Koga *et al*. (2019) show that demand uncertainty increases the probability of firms changing prices but weakens the impact of demand changes themselves on price changes (especially price reductions), and argue that the result is consistent with the wait-and-see mechanism in price setting.

through.

The remainder of this paper is organized as follows. Section 2 explains the Tankan data and the analysis method employed in this study. Section 3 provides an overview of the long-term trends in output and input price uncertainty and then reports the estimation results on the relationship between input price uncertainty and output price. Finally, Section 4 summarizes the results and presents the limitations of the analysis.

2. Data and Methodology

The Tankan Survey is a nationally representative business survey conducted in Japan. The purpose of the survey is to provide an accurate picture of business trends in Japan and contribute to the appropriate implementation of monetary policy. The survey is conducted quarterly, that is, in March (Q1 survey), June (Q2 survey), September (Q3 survey), and December (Q4 survey), and the number of firms responding to the survey is approximately 10,000. The sample firms, including both manufacturing and non-manufacturing firms, are categorized as large (capital of 1 billion yen or more), medium (capital of 100 million yen to less than 1 billion yen), or small (capital of 20 million yen to less than 100 million yen). While the survey questions are wide-ranging, this study uses firms' judgments of output (selling) price, input (purchasing) price, and domestic demand condition.[3] These questions are multiple-choice format with three options, with the options for selling price and purchase price being "1 Rise," "2 Unchanged," and "3 Fall," and the options for domestic demand condition being "1 Excess demand," "2 Almost balanced," and "3 Excess supply." The Bank of Japan calculates and publishes the diffusion index (DI) quarterly by subtracting the percentage of firms that responded "3" from the percentage of firms that responded "1." Tankan DI is regarded as one of the most important indicators for measuring business cycles.

Although the use of firm-level microdata from the Tankan Survey is not permitted, made-to-

[3] The specific wordings of the survey items are "change in output prices of your firm," "change in input prices of your firm," and "domestic supply and demand conditions for products in your industry."

order tabulation can be requested. For this study, we requested a cross-tabulation of the forecast judgment for the next quarter in the previous quarter (e.g., forecast for Q2 in the Q1 survey) and the actual judgment in the current quarter (e.g., Q2 survey) and used the data provided to create uncertainty indices from the deviation between the two judgments (i.e., forecast error). These indices are based on the idea that if many firms' actual judgments differ from their forecasts, there is a high degree of uncertainty at the time of the forecast.

We cross-tabulate the number of firms in each cell (industry × firm size) of the one-quarter-ahead forecast judgments in the previous quarter survey and the actual judgments in the current quarter survey ($3 \times 3 = 9$ categories).[4] Aggregate-level uncertainty indices were created for each judgment item based on the data on the number of firms per cell. The analysis period is from 2013Q4 to 2022Q2. Because made-to-order aggregation is allowed by industry (manufacturing/non-manufacturing) and firm size (large/medium/small firms), the uncertainty indices are calculated by industry × firm size (six categories), as well as for all industries and sizes.

Specifically, we create the absolute forecast error (*ABSFE*) and forecast error dispersion (*FEDISP*), which have been frequently used as uncertainty measures based on firm surveys since Bachmann *et al*. (2013).[5] Although these uncertainty indices have been applied to firm survey data on business and macroeconomic conditions, their use for prices is a unique feature of this study. As noted above, the judgment survey items in the Tankan Survey are qualitative; therefore, they must be converted into quantitative indices.

In the case of input and output price judgments, as shown in **Table 1**, the forecast error (*ERROR*) is defined as "0" if a firm's forecast judgment in the previous quarter is the same as the realized judgment in the current quarter, "1" or "-1" if the realized judgment rises or falls by one step compared to the forecast, and "2" or "-2" if it rises or falls by two steps. For domestic demand condition, similar calculations are made based on the difference between forecast and realized

[4] The made-to-order data requested for this study are published on the Bank of Japan's website.
[5] Studies using similar uncertainty measures based on forecast errors include Arslan *et al*. (2015), Morikawa (2016), and Buchholz *et al*. (2022). Yotzov *et al*. (2023), using survey data on firms in the United Kingdom, state that ex-post forecast errors in selling prices are positively correlated with subjective uncertainty at the time of the forecast. Cascaldi-Garcia *et al*. (2023) present a comprehensive survey of uncertainty measures used in the literature.

judgments of “excess demand,” “almost balanced,” and “excess supply.” Using the number of firms in each of the nine cells of the matrix, *ABSFE* is calculated as the mean of the absolute value of the forecast error (|*ERROR*|) weighted by the number of firms, and *FEDISP* is calculated as the standard deviation of the forecast error (StdDev (*ERROR*)) weighted by the number of firms. We would like to mention the limitation of these indices, in that the underlying data are qualitative and do not contain information on the quantitative magnitude of the changes.

Both *ABSFE* and *FEDISP* represent firm uncertainty at the time of the forecast and take a minimum value of zero and a maximum value of two. The two indices differ in nature: *ABSFE* takes a large value when the number of firms that differ between forecasts and realized judgments is large, regardless of whether the results are upward or downward revision, and when, for example, all firms’ judgments are revised upward. *FEDISP*, on the other hand, is zero when all firms’ judgments are revised upward. However, when applied to the actual data, *ABSFE* and *FEDISP* generally exhibit similar movements.

After constructing the time series of DIs and uncertainty indices (*ABSFE, FEDISP*) for the output price, input price, and domestic demand condition, we run regressions that explain the output price DI by the input price DI, domestic demand DI, and the input price uncertainty index (*ABSFE* or *FEDISP*) (Equation (1)). As panel data for the six categories (industry × firm size) are available, we pool these data and control for seasonal factors (quarter dummies) and the fixed effects of each category (λ_i). Because the consumption tax rate was raised twice during the period under analysis (April 2014 and October 2019), which likely affected the input and output prices, a consumption tax rate hike dummy is assigned to 2014Q2 and 2019Q4.

$$\begin{aligned} \textit{Output Price DI}_{it} = {} & \alpha\, \textit{Input Price DI}_{it} + \beta\, \textit{Demand DI}_{it} + \gamma\, \textit{Input Price Uncertainty}_{it} \\ & + \delta\, X_t + \lambda_i + \varepsilon_{it} \end{aligned} \tag{1}$$

In equation (1), the control variables (X_t) include the quarter and consumption tax hike dummies. Our main interest is in the sign and significance of the coefficient of input cost uncertainty (γ). The same estimations are conducted for the DI of the expected output price ($\textit{Output Price}^{e}_{it+1}$). In this case, the DIs of the expected input price and domestic demand ($\textit{Input price}^{e}_{it+1}$, $\textit{Demand}^{e}_{it+1}$) are used as explanatory variables.

Finally, we run regressions that explain the change in the producer price index (*ΔPPI*) rather than the subjective judgment of the output price DI, where the explanatory variables are the same: the input price and domestic demand DIs, their uncertainty (*ABSFE, FEDISP*), season dummies, and the consumption tax rate hike dummy (Equation (2)). Since we are interested in the sales prices of firms, the price indices are taken from the industrial products of the Corporate Goods Price Index (CGPI) for the manufacturing sector and the Services Producer Price Index (SPPI) for the non-manufacturing sector. [6] As the CGPI and SPPI are monthly data, a simple average of three months is used. As there are no firm-size-specific figures for these price indices, the same figures are used regardless of the size of the firm categories. The same estimations are conducted for the change in the producer price index in the next quarter (ΔPPI_{it+1}). In this case, the DIs of the expected input price and domestic demand ($Input\ price^{e}_{it+1}$, $Demand^{e}_{it+1}$) are used as explanatory variables.

$$\Delta PPI_{it} = \alpha\ Input\ Price\ DI_{it} + \beta\ Demand\ DI_{it} + \gamma\ input\ Price\ Uncertainty_{it} + \delta\ X_t + \lambda_i + \varepsilon_{it} \quad (2)$$

The variables used in this study and their summary statistics are presented in **Table 2**.

3. Results

First, we provide an overview of the time-series movements of the output price DI and input price DI (see **Figure 1**). The output and input price DIs have been rising sharply since 2021, with the output price DI in 2021Q3 exceeding its past peak in 2008Q2 when resource and energy prices surged and rose thereafter. The DI for the input price also exceeded its 2008 peak in 2022Q2. The

[6] Since the non-manufacturing sector in the Tankan Survey includes the wholesale and retail sectors, which sell goods, the use of the SPPI as a measure of selling prices is debatable. However, since the made-to-order aggregation of the Tankan Survey cannot be performed by more disaggregated sector-level, we treat the SPPI as the selling price of the entire non-manufacturing sector.

forecasted DI for output and input prices also showed similar movements, with the forecast DI for the output price in 2022Q4 exceeding the 2008Q2 level.[7]

However, the increase in uncertainty in the output and input price DIs after the COVID-19 crisis was limited, which is very different from that in late 2008 when the Global Financial Crisis severely impacted the economy. **Figure 2** shows the evolution of the forecast error (*ERROR*), obtained by subtracting the percentage of firms whose realized judgments were higher than the forecast from the percentage of firms whose realized judgments were lower than the forecast. Output price judgment is a survey item that generally shows small forecast errors compared with the judgment of business conditions. In fact, the forecast error itself is small and stable, except for 2008Q3 (the difference between the forecast in the Q3 survey and the realized judgment in the Q4 survey), which has a somewhat large negative value (overprediction). By contrast, the forecast error for input price judgments is significantly larger than that for output price judgments and tends to swing to the negative side (overprediction). However, from 2020Q4 onward, it will continue to be positive (underpredicted).

Figure 3 shows the evolution of the price forecast uncertainty indices (*ABSFE, FEDISP*), which had a pronounced peak in 2008Q3 but have been on a downward trend since then. Output price uncertainty increased slightly at the end of the sample period (2021Q4 and 2022Q1) but did not reach a particularly high level relative to the past.[8] As noted above, the input and output price DIs have risen since the end of 2020, but the increase in price uncertainty has been limited, indicating that prices were in a phase of steady increase, parallel with firms' expectations. It is evident from the figure that *ABSFE* and *FEDISP* exhibit similar movements. The correlation coefficients between these measures for the output and input prices were 0.991 and 0.985, respectively.

Table 3 presents the estimation results, in which the output price DI is explained by the input price DI and domestic demand DI. The coefficients of the input price DI and domestic demand

[7] Looking at the output and input price DIs after 2022Q2 onward from the published data of the Tankan Survey, the upward movements have continued at least until 2022Q4.

[8] Bunn *et al*. (2022), based on a survey of firms in the United Kingdom, show that subjective uncertainty in sales increased substantially during the COVID-19 pandemic, while changes in subjective uncertainty in sales prices were limited.

DI are significantly positive at the 1% level in both the current judgment DI (Column (1)) and outlook judgment DI (Column (2)), confirming that both cost and demand factors influence firms' sales price setting. [9] The size of the coefficient is approximately twice as large for domestic demand DI than for input price DI, suggesting that demand factors have a stronger influence on firms' selling price settings. **Table 4** shows the estimation results that explain the output price uncertainty due to uncertainty in the input price and domestic demand. Both *ABSFE* (Column (1)) and *FEDISP* (Column (2)) shows that the relationship between output price uncertainty and input price uncertainty is much stronger than that with demand uncertainty. [10]

Table 5 shows the estimation results explaining the output price DI using input price uncertainty as an explanatory variable in addition to the input price DI and domestic demand DI. When the DI for the current judgment of the output price is used as the dependent variable (Columns (1) and (2) of the table), the coefficients of input price uncertainty are negative but statistically insignificant. However, when the DI for the output price forecast is used as the dependent variable (columns (3) and (4) of the table), the coefficients of input price uncertainty are significantly negative at the 5% or 10% level, and their absolute value is larger than the result for the DI for the current price. The coefficients of DI for the input price (forecast judgment) are significantly positive at the 1% level, indicating that when input prices are expected to rise, firms tend to expect higher selling prices; however, the uncertainty of higher input prices has a deterrent effect on this relationship.[11] In other words, when input price increases are expected, firms try to pass them on to their selling prices, but when the outlook is uncertain, they tend to refrain from passing them on to their output prices.

Finally, **Table 6** presents the results of the same estimation using the quarter-on-quarter change in producer price indices (ΔPPI_{it}) as the dependent variable. In this case, the coefficients of the

---

[9] Although not reported in the table, the coefficient for the consumption tax rate hike dummy is significantly positive at the 1% level.

[10] In this estimation, the coefficient of the consumption tax rate hike dummy is statistically insignificant.

[11] When domestic demand uncertainty is used as an additional explanatory variable, the coefficient is positive and statistically significant (**Appendix Table A1**). Since input price uncertainty and domestic demand uncertainty are quite highly correlated, the influence of multicollinearity is inevitable.

input price DI are significantly positive at the 1% level, but the coefficients of the domestic demand DI are statistically insignificant. The coefficients of input price uncertainty (*ABSFE, FEDISP*) are negative and highly significant, suggesting that input price forecast uncertainty suppresses producer price increases (see columns (1) and (2) of the table). Columns (3) and (4) show the estimation results using the one-quarter-ahead change in producer prices (ΔPPI_{it+1}) as the dependent variable. In this estimation, the input price DI and domestic demand DI are the expected judgment DIs for the next quarter ($Input\ price^{e}_{it+1}$, $Demand^{e}_{it+1}$). Uncertainty in the input price is negative at a high significance level, and its absolute value is larger than the estimate of the current quarter's price relative to the previous quarter.[12] Quantitatively, a one standard deviation larger uncertainty is associated with a 0.3 percentage point lower increase in producer price for the current quarter and a 0.7 percentage point lower increase for one-quarter-ahead. These figures are quantitatively non-negligible.

In summary, the results presented above indicate that uncertainty in input costs works in the direction of decreasing the output price. This means that uncertainty suppresses the pass-through of costs into selling prices during the inflationary phase, which is consistent with the existence of friction in price settings, such as menu costs and wait-and-see mechanisms in firms' pricing behavior.

4. Conclusion

This study uses made-to-order aggregate data from the Tankan Survey, a nationally representative business survey in Japan, to document input and output price uncertainty and the relationship between uncertainty and firms' pricing behavior. The main findings are summarized as follows:

[12] When domestic demand uncertainty is used as an additional explanatory variable (**Appendix Table A2**), the coefficients for demand uncertainty are hardly significant and the sign of the coefficients are not uniform across estimations, while the coefficients for ABSFE and FEDISP of input prices are highly significant and quantitatively almost identical to the results reported in **Table 6**.

First, price uncertainty, especially input price uncertainty, increased in the second half of 2008 in the face of the Global Financial Crisis; however, there was no marked increase thereafter, and price uncertainty remained low, even during the COVID-19 pandemic. However, output price uncertainty has increased somewhat since the end of 2021, possibly because of higher resource and energy prices. Second, output price uncertainty is positively associated with input price uncertainty, which is quantitatively stronger than its relationship with demand uncertainty. Third, input price uncertainty restrains firms from raising output prices. This is consistent with previous studies showing that uncertainty reduces the inflation rate at the macro level. This result is also consistent with the existence of friction in price setting and the wait-and-see behavior of firms under uncertainty. While it is often argued that cost increases should be appropriately passed on to selling prices, the results suggest that uncertainty in input prices may restrict firms' decisions to pass through costs.

This study presents new observations on the uncertainty in firms' input and output prices. However, the measures of uncertainty are based on qualitative judgments that do not contain information on quantitative magnitude. In addition, since the estimates are based on panel data aggregated at the industry × firm-size cell level rather than at the firm level, the results are insufficient for the analysis of firms' price-setting behavior. Therefore, when interpreting the results, these limitations should be considered.

References

Arslan, Yavuz, Aslihan Atabek, Timur Hulagu, and Saygin Sahinoz (2015), "Expectation Errors, Uncertainty, and Economic Activity," *Oxford Economic Papers*, Vol. 67, No. 3, pp. 634-660.

Bachmann, Rüdiger, Steffen Elstner, and Eric R. Sims (2013), "Uncertainty and Economic Activity: Evidence from Business Survey Data," *American Economic Journal: Macroeconomics*, Vol. 5, No. 2, pp. 217-249.

Bachmann, Rüdiger, Benjamin Born, Steffen Elstner, and Christian Grimme (2019), "Time-Varying Business Volatility and the Price Setting of Firms," *Journal of Monetary Economics*, Vol. 101, January, pp.82-99.

Basu, Susanto and Brent Bundick (2017), "Uncertainty Shocks in a Model of Effective Demand," *Econometrica*, Vol. 85, No. 3, pp. 937-958.

Berger, Tino, Sibylle Grabert, and Bernd Kempa (2017), "Global Macroeconomic Uncertainty," *Journal of Macroeconomics*, Vol. 53, September, pp. 42-56.

Boneva, Lena, James Cloyne, Martin Weale, and Tomasz Wieladek (2020), "Firms' Price, Cost and Activity Expectations: Evidence from Micro Data," *Economic Journal*, Vol. 130, April, pp. 555-586.

Buchholz, Manuel, Lena Tonzer, and Julian Berner (2022), "Firm-Specific Forecast Errors and Asymmetric Investment Propensity," *Economic Inquiry*, Vol. 60, No. 2, pp. 764-793.

Bunn, Philip, Lena S. Anayi, Nicholas Bloom, Paul Mizen, Gregory Thwaites, and Ivan Yotzov (2022), "Firming Up Price Inflation," NBER Working Paper, No. 30505.

Caggiano, Giovanni, Efrem Castelnuovo, and Juan Manuel Figueres (2017), "Economic Policy Uncertainty and Unemployment in the United States: A Nonlinear Approach," *Economics Letters*, Vol. 151, February, pp. 31-34.

Carlsson, Mikael, and Oskar Nordström Skans (2012), "Evaluating Microfoundations for Aggregate Price Rigidities: Evidence from Matched Firm-Level Data on Product Prices and Unit Labor Cost," *American Economic Review*, Vol. 102, No. 4, pp. 1571-1595.

Cascaldi-Garcia, Danilo, Cisil Sarisoy, Juan M. Londono, Bo Sun, Deepa Datta, Thiago Ferreira, Olesya Grishchenko, Mohammad R. Jahan-Parvar, Francesca Loria, Sai Ma, Marius Rodriguez, Ilknur Zer, and John Rogers (2023), "What Is Certain about Uncertainty?"

Journal of Economic Literature, Vol. 61, No. 2, pp. 624-654.

Chen, Cheng, Tatsuro Senga, Chang Sun, and Hongyong Zhang (2020), "Information Acquisition and Price Setting under Uncertainty: New Survey Evidence," RIETI Discussion Paper, 20-E-078.

Choi, Sangyup (2017), "Variability in the Effects of Uncertainty Shocks: New Stylized Facts from OECD Countries," *Journal of Macroeconomics*, Vol. 53, September, pp. 127-144.

Enders, Zeno, Franziska Hünnekes, and Gernot Müller (2022), "Firm Expectations and Economic Activity," *Journal of the European Economic Association*, Vol. 20, No. 6, pp. 2396-2439.

Fernández-Villaverde, Jesús, Pablo Guerrón-Quintana, Keith Kuester, and Juan Rubio-Ramírez (2017), "Fiscal Volatility Shocks and Economic Activity," *American Economic Review*, Vol. 105, No, 11, pp. 3352-3384.

Jones, Paul M. and Eric Olson (2013), "The Time-Varying Correlation between Uncertainty, Output, and Inflation: Evidence from a DCC-GARCH Model," *Economics Letters*, Vol. 118, No. 1, pp. 33-37.

Koga, Maiko, Koichi Yoshino, and Tomoya Sakata (2019), "Strategic Complementarity and Asymmetric Price Setting among Firms," BOJ Working Paper, 19-E-05.

Kumar, Saten, Yuriy Gorodnichenko, and Olivier Coibion (2022), "The Effect of Macroeconomic Uncertainty on Firm Decisions," NBER Working Paper, No. 30288.

Lein, Sarah M. (2010), "When Do Firms Adjust Prices? Evidence from Micro Panel Data," *Journal of Monetary Economics*, Vol. 57, No. 6, pp. 696-715.

Leduc, Sylvain and Zheng Liu (2016), "Uncertainty Shocks Are Aggregate Demand Shock," *Journal of Monetary Economics*, Vol. 82, September, pp. 20-35.

Moran, Kevin, Dalibor Stevanovic, and Adam Kader Toure (2022), "Macroeconomic Uncertainty and the COVID-19 Pandemic: Measure and Impacts on the Canadian Economy," *Canadian Journal of Economics*, Vol. 55, No. S1, pp. 379-405.

Morikawa, Masayuki (2016), "Business Uncertainty and Investment: Evidence from Japanese Companies," *Journal of Macroeconomics*, Vol. 49, September, pp. 224-236.

Vavra, Joseph (2014), "Inflation Dynamics and Time-Varying Volatility: New Evidence and an Ss Interpretation," *Quarterly Journal of Economics*, Vol. 129, No. 1, pp. 215-258.

Yotzov, Ivan, Lena Anayi, Nicholas Bloom, Philip Bunn, Paul Mizen, Özgen Öztürk, and

Gregory Thwaites (2023), “Firm Inflation Uncertainty,” *AEA Papers and Proceedings*, Vol. 113, pp. 56-60.

Table 1. Calculation of Forecast Errors

		Realized judgments in the current survey		
		1 Rise	2 Unchanged	3 Fall
Forecast in the previous survey	1 Rise	0	-1	-2
	2 Unchanged	1	0	-1
	3 Fall	2	1	0

Table 2. Summary Statistics

Variables	Mean	Std. dev.	Min	Max	Nobs
Output price DI (current)	-0.066	0.110	-0.340	0.350	444
Output price DI (forecast)	-0.073	0.116	-0.404	0.326	444
Input price DI (current)	0.218	0.160	-0.154	0.788	444
Input price DI (forecast)	0.233	0.151	-0.178	0.745	444
Demand condition DI (current)	-0.211	0.114	-0.597	0.018	444
Demand condition DI (forecast)	-0.221	0.112	-0.585	0.012	444
Output price ABSFE	0.188	0.039	0.094	0.302	444
Output price FEDISP	0.445	0.047	0.318	0.576	444
Input price ABSFE	0.216	0.049	0.112	0.422	444
Input price FEDISP	0.474	0.052	0.343	0.687	444
Demand condition ABSFE	0.150	0.037	0.074	0.290	444
Demand condition FEDISP	0.407	0.053	0.279	0.562	444
Δ Producer price index	0.274	1.289	-4.400	3.367	81

Note: The producer price index is the CGPI (manufacturing products) for the manufacturing industry and the SPPI for the non-manufacturing industry.

Table 3. Estimation of Output Price DI

	(1) Output price DI (current)		(2) Output price DI (forecast)	
	Coef.	Std. Err.	Coef.	Std. Err.
Input price DI (current)	0.293	(0.018) ***		
Demand DI (current)	0.600	(0.078) ***		
Input price DI (forecast)			0.363	(0.021) ***
Demand DI (forecast)			0.661	(0.070) ***
Qtr dummies	yes		yes	
Ctax dummy	yes		yes	
Category FE	yes		yes	
Nobs.	444		444	
R^2 (within)	0.7759		0.8154	

Note: Fixed-effects estimations with robust standard errors are shown in parentheses. ***: $p<0.01$.

Table 4. Estimation of Output Price Uncertainty

	(1) ABSFE		(2) FEDISP	
	Coef.	Std. Err.	Coef.	Std. Err.
Input price ABSFE	0.547	(0.043) ***		
Demand ABSFE	0.220	(0.057) **		
Input price FEDISP			0.633	(0.043) ***
Demand FEDISP			0.230	(0.051) ***
Qtr dummies	yes		yes	
Ctax dummy	yes		yes	
Category FE	yes		yes	
Nobs.	444		444	
R^2 (within)	0.5846		0.6286	

Note: Fixed-effects estimations with robust standard errors are shown in parentheses. ***: p<0.01, **: p<0.05.

Table 5. Input Price Uncertainty and Output Price DI

	(1) Output price DI (current)		(2) Output price DI (current)		(3) Output price DI (forecast)		(4) Output price DI (forecast)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Input price DI (current)	0.280	(0.019) ***	0.285	(0.018) ***				
Demand DI (current)	0.569	(0.103) ***	0.558	(0.108) ***				
Input price DI (forecast)					0.417	(0.018) ***	0.418	(0.017) ***
Demand DI (forecast)					0.581	(0.093) ***	0.569	(0.097) ***
Input price ABSFE	-0.149	(0.138)			-0.352	(0.132) **		
Input price FEDISP			-0.180	(0.149)			-0.362	(0.145) *
Qtr dummies	yes		yes		yes		yes	
Ctax dummy	yes		yes		yes		yes	
Category FE	yes		yes		yes		yes	
Nobs.	438		438		444		444	
R^2 (within)	0.7717		0.7729		0.8249		0.8263	

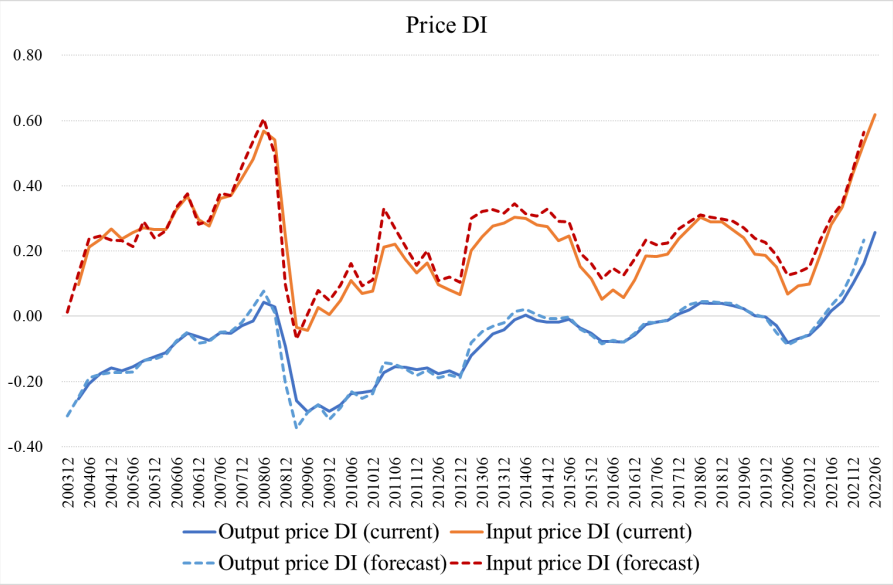
Note: Fixed-effects estimations with robust standard errors are shown in parentheses. ***: p<0.01, **: p<0.05, *: p<0.10.

Table 6. Input Price Uncertainty and Producer Price Index

	(1) $\Delta Price_{t, t-1}$			(2) $\Delta Price_{t, t-1}$			(3) $\Delta Price_{t+1, t}$			(4) $\Delta Price_{t+1, t}$		
	Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.		Coef.	Std. Err.	
Input price DI (current)	3.836	(0.420)	***	3.956	(0.498)	***						
Demand DI (current)	0.580	(0.331)		0.253	(0.264)							
Input price DI (forecast)							4.118	(0.866)	***	3.881	(0.882)	***
Demand DI (forecast)							-1.851	(0.919)		-1.887	(0.974)	
Input price ABSFE	-5.304	(0.847)	***				-14.839	(2.869)	***			
Input price FEDISP				-6.106	(0.872)	***				-13.466	(3.160)	***
Qtr dummies	yes			yes			yes			yes		
Ctax dummy	yes			yes			yes			yes		
Category FE	yes			yes			yes			yes		
Nobs.	438			438			444			444		
R^2 (within)	0.3810			0.3951			0.3995			0.3736		

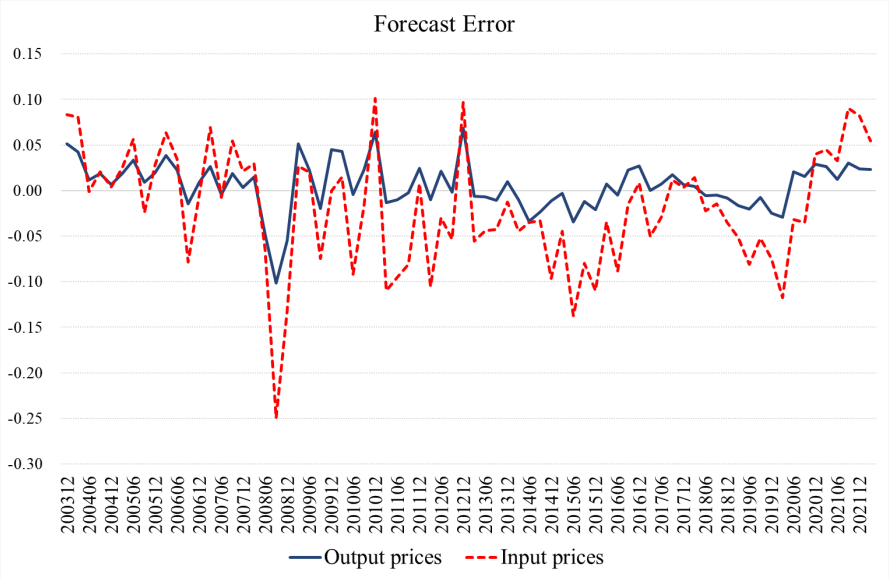
Note: Fixed-effects estimations with robust standard errors are shown in parentheses. ***: $p<0.01$. The producer price Index is the CGPI (manufacturing products) for the manufacturing industry and the SPPI for the non-manufacturing industry. The dependent variable in Columns (1) and (2) is the change in producer price from the previous quarter. The dependent variable in Columns (3) and (4) is the change in the next quarter's producer price from that of the current quarter.

Figure 1. Diffusion Index of Output and Input Prices



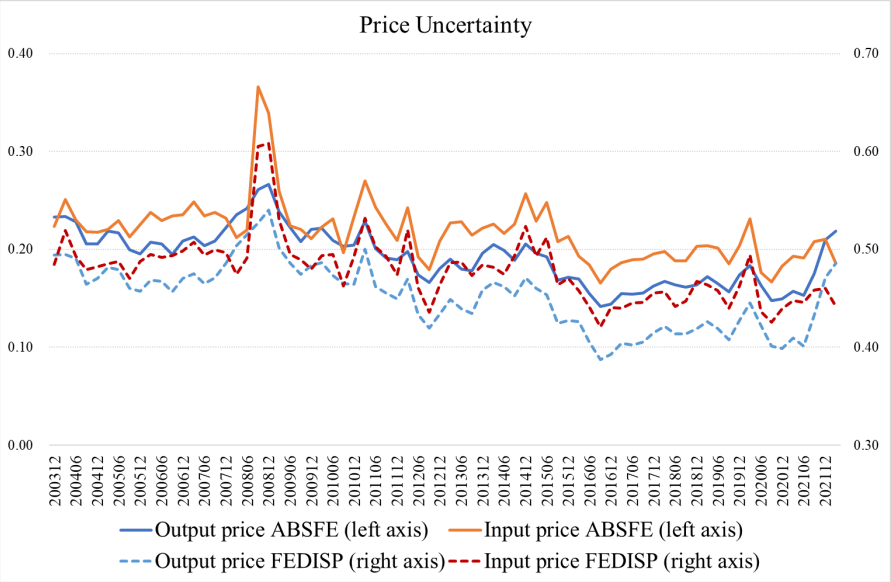
Note: The diffusion index (DI) is calculated by subtracting the share of firms that responded "Fall" from the share of firms that responded "Rise."

Figure 2. Forecast Errors of Output and Input Prices



Note: A negative value indicates that the realized (current) judgment is lower than the forecast in the previous period, whereas a positive value means that the realized judgment is higher than the forecast in the previous quarter.

Figure 3. Uncertainty in Output and Input Prices



Appendix Table A1. Input Price Uncertainty, Demand Uncertainty, and Output Price DI

	(1) Output price DI (current)		(2) Output price DI (current)		(3) Output price DI (forecast)		(4) Output price DI (forecast)	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Input price DI (current)	0.273	(0.018) ***	0.278	(0.019) ***				
Demand DI (current)	0.626	(0.095) ***	0.593	(0.115) ***				
Input price DI (forecast)					0.402	(0.019) ***	0.403	(0.019) ***
Demand DI (forecast)					0.668	(0.083) ***	0.631	(0.105) ***
Input price ABSFE	-0.234	(0.131)			-0.448	(0.114) **		
Demand ABSFE	0.344	(0.068) ***			0.443	(0.065) ***		
Input price FEDISP			-0.213	(0.140)			-0.406	(0.129) **
Demand FEDISP			0.128	(0.070)			0.194	(0.072) **
Qtr dummies	yes		yes		yes		yes	
Ctax dummy	yes		yes		yes		yes	
Category FE	yes		yes		yes		yes	
Nobs.	438		438		444		444	
R2 (within)	0.7783		0.7746		0.8331		0.8292	

Note: Fixed-effects estimations with robust standard errors are shown in parentheses. ***: p<0.01, **: p<0.05.

Appendix Table A2. Input Price Uncertainty, Demand Uncertainty, and Producer Price Index

	(1) $\Delta Price_{t, t-1}$		(2) $\Delta Price_{t, t-1}$		(3) $\Delta Price_{t+1, t}$		(4) $\Delta Price_{t+1, t}$	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Input price DI (current)	3.782	(0.355) ***	3.840	(0.407) ***				
Demand DI (current)	1.035	(0.411) *	0.845	(0.399) *				
Input price DI (forecast)					4.169	(0.923) ***	3.874	(0.887) ***
Demand DI (forecast)					-2.146	(1.126)	-1.857	(0.984)
Input price ABSFE	-5.991	(0.917) ***			-14.513	(2.852) ***		
Demand ABSFE	2.756	(1.373)			-1.508	(1.138)		
Input price FEDISP			-6.677	(0.981) ***			-13.487	(3.176) ***
Demand FEDISP			2.179	(1.015) *			0.094	(0.426)
Qtr dummies	yes		yes		yes		yes	
Ctax dummy	yes		yes		yes		yes	
Category FE	yes		yes		yes		yes	
Nobs.	438		438		444		444	
R2 (within)	0.3861		0.4008		0.4009		0.3736	

Note: Fixed-effects estimations with robust standard errors are shown in parentheses. ***: p<0.01, *: p<0.10. The producer price Index is the CGPI (manufacturing products) for the manufacturing industry and the SPPI for the non-manufacturing industry. The dependent variable in Columns (1) and (2) is the change in producer price from the previous quarter. The dependent variable in Columns (3) and (4) is the change in the next quarter's producer price from that of the current quarter.