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# Strategic Complementarity and Asymmetric Price Setting among Firms *


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**Abstract**

Exploiting a large panel of firm survey data from Japan (Tankan survey), we provide micro evidence of strategic complementarity in firms' price setting. We find that a firm's price adjustment is affected by its competitors' pricing behavior and that this adjustment is larger when the firm is lowering its price, which accords with the theoretical predictions of quasi-kinked demand. Our results also indicate that firms with greater pricing power tend to be less sensitive to their competitors' behavior. Finally, we observe that heightened demand uncertainty mitigates the effect of shifts in demand conditions on the likelihood of price adjustment–evidence of wait and see pricing.



**Keywords:** Demand uncertainty, Firm survey data, Price setting, Strategic complementarity

**JEL Classification:** D22, D84, E31, E32



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# 1 Introduction

Moderate inflation has been a pervasive phenomenon in advanced economies in the past two decades (e.g., Blanchard et al. (2015) , IMF (2013)). Japan is often cited as an illustrative case, having struggled with prolonged deflation for a decade and a half. With this in mind, we investigate firms' price-setting behavior using firm survey data from Japan. Our conjecture is that prolonged deflation may be attributed to firms' conservative price setting: firms refrain from increasing their own prices because their competitors are doing the same. These interactions in pricing attitudes among firms can be described as price setting under a quasi-kinked demand curve. In this setting, theory predicts: (1) a price increase (decrease) by competitors makes it optimal for a firm to increase (decrease) its own price, so that firms' pricing decisions are mutually reinforcing; (2) firms' reactions to their competitors' prices are asymmetric: they tend to be more responsive to price reductions by competitors than to price rises. Consequently, firms are more cautious about decisions to increase prices compared to lowering them.[1] The aim of our paper is to provide micro evidence to support this theoretical setting.

Our analysis is also motivated by an attempt to identify particular sources of real rigidities.[2] Studies on real rigidities describe persistent real effects being generated from nominal shocks. Levin et al. (2008) demonstrate the importance of exploring the mechanisms underpinning these effects, since different mechanisms may lead to different implications for monetary policy even under equivalent New Keynsian Phillips curves.[3] They also argue that utilizing microdata reveals insights

[1]Strategic complementarity also directly affects the slope of the Phillips curve describing the relation between price changes and output; specifically, it acts to weaken this relation. In other words, the greater the degree of strategic complementarity, the less the price responds to an unexpected variation in nominal spending.(Woodford (2011))

[2]Gopinath and Itskhoki (2011) demonstrate that sources of real rigidities can be found at the aggregate level and at the firm level.

[3]Levin et al. (2008) term this situation "macroeconometric equivalence and microeconomic dissonance". Specifically, they compare the case where strategic complementarity arises from a kinked-demand curve with the case where it arises from firm-specific factor inputs. They show that policy makers are more willing to tolerate inflation variations in the kinked-demand setting compared to the firm-specific factor inputs setting.

into the economic structure and implications that could not have been obtained from macroeconomic data alone. We exploit a large set of firm panel data to directly examine the presence and the source of real rigidities at the firm level −− that is, the existence of strategic complementarity in pricing.

**Data and main findings.** Our firm survey data is the "Short-term economic survey of enterprises in Japan" run by the Bank of Japan and known as the "Tankan survey". This covers approximately 10,000 firms in Japan and boasts excellent quality sampling, achieving a response rate of almost 99% from firms across a wide range of sectors. Results from analyzing the data can thus be a reliable source of inference regarding the macroeconomy. Exploiting the data, we find the following results. First, we find that firms' price setting responds to their competitors' prices: evidence of strategic complementarity. Although the assumption of strategic complementarity in pricing is standard in the New Keynesian literature (Woodford (2011)), the empirical evidence to support this is scarce. Our study provides micro evidence in this respect. Second, the degree of strategic complementarity is stronger for price decreases. This asymmetry in the reaction to competitors' prices is consistent with the theoretical predictions for firms' price setting under a quasi-kinked demand curve. Third, we find that when firms hold higher inflation expectations, they are more likely to raise the prices of their own goods. Fourth, by extending our main analysis, we also observe that firms are heterogeneous in the degree of strategic complementarity depending on their market share in an industry. Firms with higher pricing power tend to exhibit less caution in responding to competitors' price changes. Fifth, we find that demand uncertainty also affects pricing. Heightened demand uncertainty mitigates the demand effect on price adjustment probabilities, a phenomenon which we take to be evidence of wait and see pricing.

**Related literature.** Our study is related to three strands of literature. The first of these is the literature on firms' price-setting behavior, where current wisdom basically favors state-dependent pricing over time-dependent pricing (e.g., Klenow and Kryvtsov (2008), Nakamura and Steinsson (2008), Klenow and Malin (2010), Honoré et al. (2012)). These studies demonstrate that price setting depends on *aggregate* variables. For example, Honoré et al. (2012) find that a rise in inflation encourages firms to increase prices.[4] However, there are few studies exploring whether pricing decisions are dependent on *firm-specific states*. Notable exceptions are Lein (2010) and Amiti et al. (2019). Lein (2010) presents evidence from Swiss manufacturing firms that pricing decisions rely on firms' current situations including the cost of intermediate goods . Amiti et al. (2019) find that firms react to competitors' price settings using data on Belgian manufacturing firms. Our contribution to the literature is to provide new evidence of the asymmetric reaction of firms to competitors' prices, consistent with expected behavior under a quasi-kinked demand curve, and to help explain why price increases occur less often than price decreases. This evidence is confirmed across a broad range of industry categories including non-manufacturing firms.

Second, our study is associated with the literature on the kinked demand curve and, more generally, work on variable elasticity of demand. Though constant elasticity of demand is still the most popular setting in macroeconomic models, a growing literature demonstrates that kinked demand, among other forms of variable demand elasticity, is a useful theoretical framework to account for real rigidities in which nominal shocks generate persistent real effects (e.g., Kimball (1995), Klenow and Willis (2016), Shirota (2015), Kurozumi and Van Zandweghe (2018)). However, micro evidence to support this setting is still limited. A notable exception is Dossche et al. (2010) which provide such support using supermarket scanner data for price and quantity at the *goods level*. Our paper contributes to the literature by offering empirical support for the validity of the kinked demand curve at the *firm level*.

Third, our study also builds on a growing literature that uses firm survey data

[4] The authors provide empirical support for the prediction of Ball and Mankiw (1994).

to demonstrate how heterogeneous expectations among firms result in diversified behavior. Bachmann et al. (2013) demonstrate that firm-level uncertainty leads to a significant reduction in production using firm survey data from Germany. Using Japanese firm-level data, Koga and Kato (2017) reveal how heterogeneity in firms' expectations regarding industry demand growth impacts investment decisions. Tanaka et al. (2019) study the relationship between the accuracy of macroeconomic forecasts and firm performance. Morikawa (2016) also demonstrates the negative relationship between subjective uncertainty and investment. In a similar vein, we explore how firms' heterogeneous expectations are reflected in their own pricing decisions.

**Layout.** The rest of the paper is organized as follows. Section 2 sets out the theoretical model and explains its predictions for firms' price-setting behavior under a quasi-kinked demand curve. Sections 3 and 4 describe, respectively, our survey data and the empirical specifications used to test the model. Section 5 provides our main results. In Section 6, our empirical analysis is extended to examine heterogeneous price setting in other contexts. Section 7 concludes.

# 2 Desired price changes under quasi-kinked demand: Theory

Dotsey and King (2005) model the price-setting behavior of firms under the quasi-kinked demand curve proposed by Kimball (1995). As they do not explicitly show how each firm's desired price is affected by relevant factors in a linearized form, we briefly review their model and derive the linear relations among the variables. The relations among variables under multiple goods with a variant elasticity of demand differ from the usual setting employed in a simple New Keynsian framework.

Firms change their prices when the gains from adjusting prices are greater than the costs. Therefore, the probability of a price adjustment depends on the economic state, unlike in the time-dependent pricing framework.

At date $t$, a firm chooses whether to adjust its price to $P_t^*$ or to maintain the price $P_{t-j}^*$ which it set $j$ periods ago. All firms adjust their prices by date $t+J$. If the expected profits of adjusting the price to $P_t^*$ exceed those from maintaining $P_{t-j}^*$, then the firm makes the adjustment. It chooses the relative price level $p_t(p_t = P_t^*/P_t)$ when it adjusts its own price; the price level remains at $p_{j,t}(p_{j,t} = P_{t-j}^*/P_t)$ otherwise. In reaching a decision, the firm considers the following three quantities: the value of expected profits if the price adjustment is made ($v_{0t}$); expected profits if the price is left unchanged ($v_{jt}$); and the fixed cost of making the price adjustment ($\xi_t$).

A value function for each $j$-type firm is given by

$$v(p_t, \xi_t, s_t) = max\{v_{jt}, v_{0t}\}$$

with

$$\begin{aligned} v_{jt} &= z(p_{j,t}, s_t) + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} v\left(\frac{P_t}{P_{t+1}} p_{j+1,t}, \xi_{t+1}, s_{t+1}\right), \\ v_{0t} &= max_{p_t^*, s_t}\left[z(p_t^*, s_t) + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} v\left(\frac{P_t}{P_{t+1}} p_t^*, \xi_{t+1}, s_{t+1}\right)\right] - \xi_t, \end{aligned}$$

where $s_t$ is a vector that captures the economic state firms face at time $t$ including demand and cost conditions, and $\frac{\lambda_{t+1}}{\lambda_t}$ is the ratio of future to current marginal utility. $z(p_{j,t}, s_t) = [p_{j,t} - \psi_{j,t}]c_{j,t}$ is real profit where $\psi_{j,t}$ and $c_{j,t}$ are the real marginal cost and demand, respectively. $\beta \frac{\lambda_{t+1}}{\lambda_t}$ is a stochastic discount factor. The fraction of adjusting firms ($\alpha_{j,t}$) depends on the economic state; this contrasts with the time-dependent pricing framework, where it is constant.

The optimal relative price $p_t^*$ is given by

$$p_t^* = \frac{E_t\left[\sum_{j=0}^{J-1} \beta^j (\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}}) c_{j,t+j}\psi_{j,t+j}\varepsilon_{j,t+j}\}\right]}{E_t\left[\sum_{j=0}^{J-1} \beta^j (\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})(\frac{P_t}{P_{t+j}}) c_{j,t+j}(\varepsilon_{j,t+j}-1)\right]}, \tag{1}$$

where $\frac{\omega_{j,t+j}}{\omega_{0,t}} = (1-\alpha_{j,t+j})(1-\alpha_{j-1,t+j-1})\cdots(1-\alpha_{1,t+1})$ is the probability of non-adjustment from $t$ through $t+j$ and $\varepsilon_{j,t+j}$ is the elasticity of demand.

By taking into account that in the steady state $\psi_{j,t+j} = \psi_j$, $\varepsilon_{j,t+j} = \varepsilon_j$, $c_{j,t+j} = c_j$, $\omega_{j,t+j} = \omega_j$, $\lambda_{t+j} = \lambda$, and $\frac{P_{t+j+1}}{P_{t+j}} = \frac{P_{t+j}}{P_{t+j-1}} = \pi$, we can rewrite the above equation as follows. The change in the optimal price can be decomposed into effects from the expected changes in the real marginal cost ($E_t\mathrm{d}\ \ln\psi_{j,t+j}$), aggregate price ($E_t\mathrm{d}\ \ln P_{t+j}$), demand ($E_t\mathrm{d}\ \ln c_{j,t+j}$), demand elasticity ($E_t\mathrm{d}\ \ln\varepsilon_{j,t+j}$), adjustment probabilities, and discount factor. The derivation is given in the appendix.

$$\begin{aligned}
\mathrm{d}\ \ln P_t^* &= \sum_{j=0}^{J-1}\gamma_j\ E_t\mathrm{d}\ \ln\psi_{j,t+j} + \sum_{j=0}^{J-1}\kappa_j\ E_t\mathrm{d}\ \ln P_{t+j} + \sum_{j=0}^{J-1}(\gamma_j-\kappa_j)\ E_t\mathrm{d}\ \ln c_{j,t+j} \\
&+ \sum_{j=0}^{J-1}(\gamma_j-\eta_j)\ E_t\mathrm{d}\ \ln\varepsilon_{j,t+j} + \sum_{j=0}^{J-1}(\gamma_j-\kappa_j)\ E_t(\mathrm{d}\ \ln\omega_{j,t+j} - \mathrm{d}\ \ln\omega_{0,t}) \\
&+ \sum_{j=0}^{J-1}(\gamma_j-\kappa_j)\ E_t(\mathrm{d}\ \ln\lambda_{t+j} - \mathrm{d}\ \ln\lambda_t),
\end{aligned}$$

where $\gamma_j = \frac{\beta^j\omega_j\varepsilon_j c_j\psi_j}{\sum_{j=0}^{J-1}\beta^j\omega_j\varepsilon_j c_j\psi_j}$, $\eta_j = \frac{\frac{\beta^j\omega_j\varepsilon_j c_j}{\pi^j}}{\sum_{j=0}^{J-1}\frac{\beta^j\omega_j(\varepsilon_j-1)c_j}{\pi^j}}$, and $\kappa_j = \frac{\frac{\beta^j\omega_j(\varepsilon_j-1)c_j}{\pi^j}}{\sum_{j=0}^{J-1}\frac{\beta^j\omega_j(\varepsilon_j-1)c_j}{\pi^j}}$.

As we assume that $\beta$, $\omega_j$, and $c_j$ are all positive and $\varepsilon_j$ and $\pi$ are larger than one, $\gamma_j > 0$, $\kappa_j > 0$, and $\gamma_j - \eta_j < 0$.[5]

[5] $\pi$ represents price changes in the steady state and we assume this to be larger than one; in other words, we assume the steady state inflation rate to be positive. Aggregate price changes during our estimation period were 1.002 (an inflation rate of 0.2%) based on the consumer price index, and this accords with the above assumption.

**Quasi-kinked demand curve.**[6] According to Dotsey and King (2005), the relative demand curve is derived from profit maximization by the final goods firm. It is given by

$$\frac{c_j}{c} = \frac{1}{1+\upsilon}\left[\left(\frac{P_j}{P\Lambda}\right)^{-\gamma} + \upsilon\right]$$

where $c_j/c$ is relative demand and $P_j/P$ is relative price. $\Lambda$ is the lagrange multiplier in the expenditure minimization. The parameter $\gamma$ takes the value $\gamma = \theta(1+\upsilon)$ and parameter $\upsilon \leq 0$ determines the curvature of the demand curve.

With the above setting, the elasticity of demand can be written as

$$\varepsilon_j = -\frac{d(c_j/c)}{(c_j/c)} / \frac{d(P_j/P)}{P_j/P} = \gamma - \theta\upsilon\left(\frac{c_j}{c}\right)^{-1},$$

where $\theta > 1$ denotes the elasticity of substitution between individual differentiated goods.

Looking at the above expression, it is clear that the change in the demand elasticity depends on the relative price changes; this contrasts with the case of the CES demand function, where the elasticity of demand is constant. As Figure 1 shows, the demand elasticity depends on the price of a firm's own price relative to competitors' prices. When a competitor sets a price higher than the firm's own price, demand for the firm's product rises. By contrast, when a competitor sets a price lower than the firm's own price, demand for the firm's product falls. Crucially, the impact of the lost demand in the latter case exceeds the gain from the extra demand in the former. This means that the incentive to follow the competitors price adjustment is stronger in the case of a price reduction.

**Theoretical predictions.** The theoretical predictions derived from the above are as follows. (1) Each firm's desired price depends on firm-specific states including its competitors' prices, real marginal costs, and demand. (2) The desired price is also affected by the aggregate inflation rate. (3) The effect of competitors' prices is

[6] We employ a tractable functional form used in Levin et al. (2008).

stronger for price reductions than for price increases.

The aim of this paper is to examine the above predictions using a large panel of firm survey data.

# 3 Data description and basic facts

## 3.1 Description of the survey

The data we use is from the "Short-term economic survey of enterprises in Japan" (widely known as the Tankan Survey) conducted by the Bank of Japan. The survey aims to provide an accurate picture of business trends at firms in Japan to support the appropriate implementation of monetary policy. The survey is conducted quarterly, in March, June, September, and December, across broad industry categories. The survey population comprises private firms excluding financial institutions in Japan with a capital of 20 million yen or more, and totals approximately 220,000 such firms. Sample firms are selected from the survey population based on industry and size classifications so as to meet the criteria for statistical accuracy, and the number of sample firms is about 10,000.[7] Firms are classified into 31 industry groups and three size groups. Industry groups are based on the Japan Standard Industrial Classification released by the Ministry of Internal Affairs and Communications. Size groups are based on capital size reported by firms: large enterprises (with capital of 1 billion yen or more), medium-sized enterprises (with more than 100 million but less than 1 billion yen in capital), and small enterprises (with more than 20 million yen in capital, but less than 100 million).

Firms report assessments of ten items including business conditions, employment conditions, demand conditions in each industry, changes in output prices, and

[7] As a large number of sample firms are added in regular revisions conducted at three to five year intervals, our original dataset is an unbalanced panel covering approximately 14,000 firms. The number of firms we use in the analysis is trimmed down to about 10,000 through computing the variable for competitors' prices, as explained later.

changes in input prices. Answers are provided for two horizons: for the current quarter; and for the next quarter. They also report annual projections for sales, profit, fixed investment, and so forth. The items on which we focus in this paper are firms' assessments of pricing attitude and related factors. Firms are required to choose from three possible responses; for example, the question on pricing attitude is phrased in the following way.[8]

*Please choose one out of three alternatives which best describes the current (from three months earlier) and forecasted (for the next survey period) conditions, excluding seasonal factors.*

*Change in output prices of your enterprise*

*1. Rise 2. Unchanged 3. Fall*

*Change in input prices of your enterprise*

*1. Rise 2. Unchanged 3. Fall*

The items, response categories, and allocated scores are shown in Table 1. For example, pricing attitude $PriceChange_{i,t}$ takes the values of 1, 0, and -1, when a firm answers "Rise", "Unchanged", and "Fall", respectively. In addition, we adopt items that we presume reflect real marginal cost: namely, firms' views of changes in input price ($Cost_{i,t}$) and changes in employment condition ($LC_{i,t}$). We use employment conditions to represent labor costs on the assumption that firms answering "excessive employment" tend to face lower labor costs. $Demand_{i,t}$ constitutes the demand conditions reported by firms in each industry.

Competitors' price for each firm $ComPrice_{i,t-1}$ is calculated from the survey responses by computing the average score of the pricing attitudes of $N-1$ other firms in the same industry (excluding firm $j$ itself). We then take this figure to capture pricing attitudes of firm $j$'s competitors: that is, $dp_{-i,t} = \Sigma_{j \neq i,t} dp_{j,t}/(N -$

[8] The questionnaire is obtained from the original text in the survey.

1). We then use the one-period lag of competitors' prices $ComPrice_{i,t-1}$ in our estimation. To identify the competitors for a given firm, we produce 636 specific industry categories based on firms' reporting about their main business products and services. This classification is broadly consistent with the 4-digit industry level in the Japan Standard Industrial Classifications.[9] When we compute the variable for competitors' prices, we use a one-period lag of competitors' prices $ComPrice_{i,t-1}$ as the explanatory variable for desired price at time $t$ to mitigate the endogeneity issue, assuming that firms react to competitors' prices one quarter later. As we cannot define competitors' prices for firms with no competitor in their market, such firms are excluded in the estimation.[10]

The Tankan survey has been collecting, since the first quarter of 2014, firms' assessments of the inflation outlook for both general prices and the output prices of their own products or services; it is the former item which we use in this paper. Firms are asked how general prices will have changed relative to current levels one-year, three-years, and five-years ahead on an annual basis. They chose from an incremental series of one percent inflation ranges, starting at $-3\%$ and going up to $+6\%$. We replace each inflation range with its midpoint and label this variable $EInflation_{i,t}^{l_{yr(s)}}$ (l=1, 3, 5).

[9] The average number of competitors per industry is 12.78.

[10] The number of sample firms in this paper is trimmed down to about 10,000 firms. This sample covers 72.7% of the original survey data in terms of firm numbers and 95.7% on a sales basis as of March 2015.

Table 1: Variables from survey data

| Variable name | Item in survey | Response categories (score) |
|---|---|---|
| $PriceChange_{i,t}$ | Change in output price | Rise (1) Unchanged (0) Fall (-1) |
| $Cost_{i,t}$ | Change in input price | Rise (1) Unchanged (0) Fall (-1) |
| $LC_{i,t}$ | Employment conditions | Excessive (1) Adequate (0) Insufficient (-1) |
| $Demand_{i,t}$ | Domestic supply and demand conditions | Excess demand (1) Almost balanced (0) Excess supply (-1) |
| $ComPrice_{i,t-1}$ | (calculated by authors) | Competitors' price |
| $EInflation_{i,t}^{lyrs}$ | Inflation expectations | Numbers [-3,-2,-1,0,1,2,3,4,5,6] |

## 3.2 Basic facts

Table 2 provides summary statistics. The period of data is from 2004/1Q to 2017/4Q. It indicates that on average 26 % of sample firms record price changes, of which 8 % are price increases and 18 % price decreases.

In addition to the variables shown in Table 1, we define $PriceIncrease_{i,t}$ and $PriceDecrease_{i,t}$ as variables taking the value of 1 when a firm increases and decreases its price, and 0 otherwise. $PriceAdj_{i,t}$ takes the value of 1 when either of them takes 1 and 0 otherwise. Definitions of $InflationRate_{i,t}$, $MarketShare_{i,t}$, $MarketConcentration_{i,t}$, and $Uncertainty_{i,t}$ are provided in later sections.

Table 3 shows correlations between the variables. The upper panel indicates that correlations among $PriceChange_{i,t}$, $Cost_{i,t}$, $Demand_{i,t}$, and $ComPrice_{i,t-1}$ are all positive, whereas the correlation between $PriceChange_{i,t}$ and $LC_{i,t}$ is negative. Notably, the coefficient for $ComPrice_{i,t-1}$ is large for both price increases and decreases. For $Cost_{i,t}$ and $Demand_{i,t}$, the size of the coefficient differs somewhat depending on whether prices are increasing or decreasing.

We also compare the average pricing stance of firms represented by the diffusion index in the Tankan survey (share of firms reporting "rise" minus share of firms reporting "fall") with yearly changes in the corporate goods price index (Figure

2).[11] In spite of differences in the sectors covered, the two series show similar development. Figure 3 provides a breakdown of the diffusion index in order to show the shares of firms reporting, respectively, a "rise" and a "fall" in prices. Conspicuously, the share of firms reporting price increases is historically much lower than the comparable share for price decreases. This motivates us to explore the reasons for the asymmetric adjustments in firms' observed price setting.

# 4 Empirical specification

To test the above theoretical predictions, we assume that the pricing rule employed by firms can be expressed as follows. Survey responses are used to capture firms' pricing attitude, and we adopt regression of qualitative variables to specify the pricing rule.

We model the relationship between $P^*_{i,t}$ and $PriceChange_{i,t}$ as in a limited dependent model, where $P^*_{i,t}$ is a latent variable describing changing prices, and we only observe $PriceChange_{i,t}$, which is qualitative response on firms' pricing stances. When $P^*_{i,t}$ exceeds the threshold $\theta_2$, firms report a price increase; when $P^*_{i,t}$ drops below $\theta_1$, they report a decrease; in all other cases, they report that prices are unchanged.[12]

$$PriceChange_{i,t} = \begin{cases} 1 & \text{if } \theta_2 \le P^*_{i,t} \quad (Increase) \\ -1 & \text{if } P^*_{i,t} < \theta_1 \quad (Decrease) \\ 0 & \text{if } \theta_1 \le P^*_{i,t} < \theta_2 \quad (Unchanged) \end{cases}$$

We assume that the desired price is determined in the following way.

$$P^*_{i,t} = \beta_1 Cost_{i,t} + \beta_2 LC_{i,t} + \beta_3 Demand_{i,t} + \beta_4 ComPrice_{i,t-1} + \gamma_1 \mathbf{x}_i + \gamma_2 \mathbf{y}_t + \epsilon_{i,t}$$

[11] The corporate goods price index is issued by the Bank of Japan.

[12] We describe response categories as "Increase", "Decrease", and "Unchanged", while the original categories are "Rise", "Fall", and "Unchanged".

where $P^*_{i,t}$ is desired price. $Cost_{i,t}$ and $LC_{i,t}$ are variables representing the cost of intermediate goods and cost of labor, respectively; we regard these variables as reflecting real marginal cost. $Demand_{i,t}$ describes the demand conditions reported by firms in each industry. All of the above variables are obtained from the survey responses, and take one of three possible values: "1", "0", or "-1". The variable for competitors' price $ComPrice_{i,t-1}$ is calculated from the survey responses as explained in the previous section.[13] Amiti et al. (2019) address the endogeneity issue by estimating the model with instrumental variables. They use imported components of the firm's cost as an instrumental variable for competitors' prices. In our analysis, as we do not have a suitable candidate for instrumental variables, we use the one-period lag of competitors' prices.

Inflation expectations ($EInflation^{lyrs}_{i,t}$) impact the desired price in our setting. However, as inflation data is only available from 2014, we omit this variable in the benchmark case of our estimation and add it later with a more restricted sample.

$\mathbf{x}_i$ is the vector of firm-specific variables. As there may be industry-specific or size-specific factors that affect not only firms' pricing attitudes but also cost and demand factors, $\mathbf{x}_i$ includes industry dummies for the 31 industry categories and size dummies for the three capital size categories. $\mathbf{y}_t$ includes fixed effects for the year and two additional dummies to control for the effects of specific aggregate shocks such as the Lehman crisis (2008/3Q-2009/1Q) and the consumption tax increase (2014/2Q). The estimation is conducted for the period from 2004/1Q to 2017/4Q. As a large sample revision was carried out in 2004/1Q, the quality of the estimation may be impaired when we use longer historical data. In robustness checks, we also consider whether there is a time-dependent pricing factor by adding Taylor dummies. These are dummy variables that denote when the last price change occurred, between one

[13] The use of the one-period lag relies on the assumption that firms react to competitors' prices one quarter later. This specification does not fully measure the effect of competitors' prices, since we do not capture faster or slower reactions to others' price changes. Thus, the effect that we estimate for competitors' prices may be considered a lower bound for observable relations among competing firms.

and eight quarters ago. Quarter dummies are also added to control for price changes occurring in a specific quarter. As shown in Appendix Tables 1 and 2, our main results are robust to these controls for time-dependency.

# 5 Main results

**Baseline.** This section describes the main results. All tables report average marginal effects. Standard errors are clustered at the firm level.

Table 4 shows the regression results for price changes. The dependent variable is $PriceChange_{i,t}$ and the estimation is conducted by the ordered probit model.[14] Variations in columns give the results for alternative measures of marginal costs. Columns (1) and (2) show the results using firms' responses for current input prices and forecast input prices, respectively; column (3) shows the results when using both. Column (4) shows the results of the correlated random effect model that controls for firm-specific heterogeneity, using historical averages of independent variables for each firm.[15] The results listed in column (1) are regarded as the benchmark case hereafter.[16]

The coefficient on current input price is significantly positive in all cases. The coefficient on employment conditions is significantly negative, suggesting that higher labor costs also push up the probability of a price change. The demand factor also contributes to the likelihood of price changes. Even after controlling for these factors, however, competitors' prices are positively related with the firm's pricing stance. Coefficients on all of these variables are statistically significant. As for the magnitude of the impact, the estimates suggest that when average scores of input prices and competitors' prices show a one-unit increase, the probability of an

[14] The dependent variable, $PriceChange_{i,t}$, takes the values of 1 (increase), 0 (unchanged), and -1 (decrease).

[15] The correlated random effect model works as a robustness check when firm fixed effects cannot be controlled for in the probit model. A detailed explanation is provided in Wooldridge (2011).

[16] When we use both current and forecast input price choices simultaneously, the coefficient on the latter is negative. This may reflect the correlation between current and forecast input prices. A similar result is found in Lein (2010).

adjustment in output prices is about 8 and 10 percentage points higher, respectively.

**Asymmetry.** Table 5 shows the results for asymmetric price setting, based on subsamples of firms reporting, respectively, price increases and price decreases, and the estimation is conducted utilizing the probit model.[17] In this specification, the expected signs are reversed in the two halves of the table. For example, an increase in input price pushes up the probability that a firm raises its price, and pushes down the probability of a price reduction. According to our theoretical setup in the previous section, a firm is expected to react asymmetrically to competitors' prices. The empirical results bear out this prediction. The most substantial difference is observed in the average marginal effects of competitors' prices, and the effect of a price decrease is more than double in absolute value the effect of a price increase. These results support the premises of price setting under a quasi-kinked demand curve.[18]

Empirically, a similar asymmetry shows up also for labor costs and demand. The absolute values of the coefficients on $LC_{i,t}$ and $Demand_{i,t}$ are larger for price decreases than for price increases. This is broadly consistent with the implications of the quasi-kinked demand curve: when firms face higher labor costs or demand and their prices are likely to be higher than other firms', they refrain from adjusting their prices upwards to avoid the large concomitant profit loss. As for intermediate good cost factors, these do not exhibit such asymmetry and the differences in coefficients between price increases and decreases are relatively small.[19] This may be the result of cost shocks common to rival firms. In a kinked-demand framework, shifts in demand following changes in relative prices are the source of asymmetric price setting. When

[17]In the price increase (decrease) case, the dependent variable $PriceIncrease_t$ ($PriceDecrease_t$) takes the value of 1 when a firm reports a price increase (decrease) and 0 otherwise.

[18]The results may be sensitive to the difference in the respective numbers of observations for price increases and decreases. By randomly deselecting observations from the price decrease subsample, we confirm that the main results remain unaltered when the number of observations in each subsample is the same.

[19]Likewise, Loupias and Sevestre (2013) show that cost increases are more rapidly incorporated in prices than cost decreases. Fabiani et al. (2007) and Hall et al. (2000) also report similar findings from questionnaire surveys of firms.

firms face a common cost increase, it is unlikely to induce relative price changes, and consequently they do not exhibit asymmetric pricing.

When we add the Taylor dummy variables to control for time-dependent pricing, the above results remain unchanged (Appendix Table 1 and 2). In Appendix Table 2, the coefficients on all Taylor dummies one to eight are significant for both price increases and price decreases. The coefficient on Taylor 1 dummy is the largest in both cases, and is especially large for price reductions, suggesting that once a firm starts reducing its price, it tends to continue the process over two consecutive quarters. As for the results on the quarter dummy variables, the second quarter appears to be the season when firms are likely to make prices adjustments, whether upwards or downwards, suggesting that Japanese firms favor adjusting prices at the start of the new fiscal year.[20]

**Inflation expectation.** Next, we examine the connection between firms' inflation expectations and their price setting stance. Unlike previous studies exploring the relation between expected price changes in firms' own goods markets and their price setting (Boneva et al. (2016)), our focus is on how firms' expectations regarding general inflation affect their price setting, and whether these effects vary depending on the direction of the price change and the time-horizon. Table 6 shows the results. The data on firms' inflation expectations is available only from 2014/1Q, so that our estimation period is limited compared to the baseline case. Here, therefore, we focus only on the price changes. As shown in Table 6, coefficients on firms' outlook for inflation are all significantly positive for one, three, and five years ahead, which is consistent with our theoretical predictions. The connection between higher inflation expectations and a greater likelihood that firms increase their own prices may come from actual inflationary shocks affecting both. We control for this effect by adding

[20] In addition to the tendency to make adjustments in the second quarter, firms also appear to lower prices more often in the first and fourth quarters than in the third quarter. This may be because they generally look to fix profits through stock disposals in the final month of accounting year, i.e. March, as well as at the end of the calendar year, December.

the realized inflation rate on a quarterly basis in annualized terms, and confirm that the result does not change. This suggests that heterogeneity of inflation expectations among firms does matter for their price-setting stances.[21, 22]

# 6 Extensions

In this section, we further investigate heterogeneity in strategic complementarity in pricing by extending the analysis to include market structure, and examine the effect of demand uncertainty on firms' price-setting.

## 6.1 Strategic complementarity and market structure

The effect of strategic complementarity on pricing may differ across markets. Our conjecture is that when firms' pricing power is stronger, they can set their prices without needing to worry about competitors' prices.[23] We add an interaction term for market share and competitors' prices to examine this hypothesis. The market share of each firm is calculated based on annual sales volume as reported in the survey.

Table 7 shows the results (Panel A). Since we examine the effect of market structure on the probability of a price change, our dependent variable takes the value of 1 when firms report either a price increase or decrease, and 0 otherwise. In this case, a factor such as intermediate good cost might positively affect the likelihood of a price increase while reducing the likelihood of a price decrease, and consequently have no overall impact on the likelihood of a price change. To address this, we

[21] We calculate the inflation rate using the consumer price index excluding fresh food and energy, released by the Ministry of Internal Affairs and Communications.

[22] The size of the coefficient on inflation expectations is small compared to those found in the expectation-augmented Phillips curve using aggregate data. In our analysis, the coefficient measures the association between firm-level price setting and their expectations regarding general inflation. By contrast, the Phillips curve measures the relation between actual inflation and inflation expectations, both of which are measures of general prices, so that it is unsurprising that they tend to exhibit a substantial degree of comovement.

[23] Amiti et al. (2019) present a model where the price elasticity of demand depends on market share, and argue that strategic complementarity is stronger when a firm's market share is larger.

estimate separate coefficients for positive and negative values of each independent variable. The interaction term for competitors' prices and market share is negatively significant, suggesting that firms with a high market share do not care greatly about their competitors' pricing stance. The estimates suggest that a 10 percent higher market share means around 3-4 percentage points less impact from competitors' prices on average. As an alternative approach, we replace market share with the market concentration ratio computed using the Herfindahl-Hirschman Index (HHI) for 636 industry categories, thus capturing the degree of competition on an industry basis. Firms in monopolistic industries show a reduced sensitivity to competitors' prices relative to those in competitive industries. In addition to the interaction term, the independent market share and market concentration ratio terms also have negative coefficients, reflecting the fact that firms with higher pricing power or in a monopolistic industry are likely to adjust their prices less often. The results in Panel B show that the above-mentioned effects are all driven mainly by price reductions.

Table 8 shows the results by industry. The effects of competitors' prices are sizable when firms adjust their prices downwards in non-manufacturing industries such as construction, real estate, and services for individuals. These are ranked as 26th, 30th, and 21st respectively out of 31 industries based on the HHI ratio, and thus are highly competitive industries.[24] Large effects are observed on the cost increase term for the materials industry as well as wholesale and retail industry, reflecting the higher share of intermediate products in total costs in these industries.[25]

[24]The ranking score is obtained from the JIP database released by the Research Institute of Economy, Trade and Industry.

[25]A dummy variable for the Lehman crisis is used to control for aggregate shocks occurring in the period from 2008/3Q to 2009/1Q. In this period, abrupt changes in oil prices affect the probabilities of price adjustments in both directions, and the sign on the dummy coefficient can be positive or negative depending on the price and cost structure in each industry. As for the consumption tax dummy, although the coefficient is expected to be positive (negative) for price increases (decreases), the sign on the coefficient is unexpected in some cases. This may be due to sector-specific shocks arising in 2014: for example, in the transportation and postal industries, firms faced tighter demand for transportation during the period leading up to the consumption tax rise, so that price adjustment pressure is greater in 1Q than 2Q. In such cases, the probability of price increases may decline in 2Q, the quarter to which the dummy for consumption tax shock is assigned.

## 6.2 Demand uncertainty

We now turn to the question of whether heightened demand uncertainty affects the probability of changing output prices.

Vavra (2014) argues that a high volatility environment has two contrasting effects on the price setting of firms. He shows that, on the one hand, higher volatility makes price adjustments by firms more likely because large shocks push them outside the "inaction" zones where they leave prices unchanged ("volatility effect"); while on the other hand, heightened volatility encourages firms to adopt a "wait and see" strategy, refraining from immediately adjusting their prices when the volatile environment means they might have to make a further adjustment in the near future. He provides empirical evidence suggesting that the former effect dominates the latter. Bachmann et al. (2019) also demonstrate that higher uncertainty makes firms more likely to adjust prices based on firm-level empirical data on German manufacturing.

We examine the impact of uncertainty on a firm's price-setting behavior in the manner employed in Bachmann et al. (2013) and Bachmann et al. (2019). As our dataset contains the firms' responses to demand changes in both the preceding quarter and the following quarter, we can compute the measure of subjective uncertainty as in their studies. We calculate the difference between the expected demand change in the current period and the realized demand change in the next period, i.e. the forecast error, and take absolute values. The calculation of the uncertainty measure, $|FE_{i,t\to t+1}|$ is described in Table 9. This measure is consistent with the condition that firms cannot predict future changes in demand. Our interest is in whether firms' price-setting behavior at time $t$ is affected by uncertainty $|FE_{i,t\to t+1}|$ regarding demand in the next quarter.

Table 9: Uncertainty measure ($|FE_{i,t\to t+1}|$)

| | | Realized demand change in $t+1$ | | |
|---|---|---|---|---|
| | | Increase | Unchanged | Decrease |
| Expected demand | Increase | 0 | 1 | 2 |
| change in $t$ | Unchanged | 1 | 0 | 1 |
| | Decrease | 2 | 1 | 0 |

Table 10 summarizes the estimation results using this uncertainty measure. In Panel A, the dependent variable takes the value of 1 when firms report price changes, and 0 otherwise. In this specification, as in Table 7, there is a risk that a rise in the probability of a price increase is offset by a fall in the probability of a price decrease, neutralizing the impact on the likelihood of a price change overall. As above, we address this by estimating coefficients separately for positive and negative values of each independent variable.

As shown in the results, the uncertainty measure is significantly positive, suggesting that uncertainty makes price adjustment by firms more likely. This finding is consistent with the existing studies. In addition, we also examine whether demand uncertainty has a significant impact on the responsiveness of firms' price setting to shifts in demand conditions. The results show that when firms face uncertainty the impact of shifts in demand on price setting is reduced. In other words, under uncertainty, they are reluctant to adjust their prices, even when demand conditions change. Our findings, therefore, broadly confirm the results of previous studies, but they also extend these to provide new evidence of "wait and see" pricing in the case of demand uncertainty.

The results in Panel B show that the above-mentioned impacts are generated mainly by cases of price reductions. By dividing the sample and examining price increases and decreases separately, we find that firms' response to demand uncertainty is asymmetric: their greater reluctance to reduce prices is larger in absolute terms than their greater reluctance to increase them.

# 7 Conclusion

Using a large panel of firm survey data from Japan, we examine firms' price-setting behavior. Our paper contributes to the existing literature by providing micro evidence for firms' price setting under a quasi-kinked demand curve. Under such a mechanism, pricing decisions by firms are mutually reinforcing, and firms tend to be cautious about raising their prices. Specifically, we find the following results. First, we find evidence for strategic complementarity in firms' price setting across broad sectors. Second, this strategic complementarity in price setting is asymmetric depending on the direction of price adjustment, in accordance with the theoretical predictions of the quasi-kinked demand curve setting. Third, we find a positive relationship between the inflation expectations of firms and the probability of them increasing prices. Fourth, the degree of strategic complementarity differs across firms: firms with greater pricing power are likely to care less about competitors' prices. Fifth, heightened demand uncertainty promotes price adjustment by firms, and also mitigates the effect of shifts in demand conditions on the likelihood of price adjustment.

Our findings about firms' price-setting behavior imply that strategic complementarity in pricing is one explanation for firms' cautious stance when deciding whether or not to raise prices. This caution may be left behind once some firms start to adjust their prices upwards, as interactive pricing behavior reinforces the upward adjustment. In addition, our results suggest that encouraging firms to expect higher inflation acts to break them out of their conservatism toward price adjustment.

# Appendix

The optimal price level in equation (1) is given by

$$\begin{aligned}\ln P_t^* &= \ln E_t\left[\sum_{j=0}^{J-1}\beta^j(\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})c_{j,t+j}\psi_{j,t+j}\varepsilon_{j,t+j}\right]\\ &- \ln E_t\left[\sum_{j=0}^{J-1}\beta^j(\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})(\frac{1}{P_{t+j}})c_{j,t+j}(\varepsilon_{j,t+j}-1)\right]\end{aligned}$$

We totally differentiate the above equation, yielding

$$\begin{aligned}\mathrm{d}\ \ln P_t^* &= \sum_{j=0}^{J-1}\rho_j\ E_t\mathrm{d}\ \ln\psi_{j,t+j}+\sum_{j=0}^{J-1}(\rho_j-\tau_j)\ E_t\mathrm{d}\ \ln\varepsilon_{j,t+j}+\sum_{j=0}^{J-1}(\rho_j-\delta_j)\ E_t\mathrm{d}\ \ln c_{j,t+j}\\ &+ \sum_{j=0}^{J-1}\delta_j\ E_t\mathrm{d}\ \ln P_{t+j}+\sum_{j=0}^{J-1}(\rho_j-\delta_j)\ E_t(\mathrm{d}\ \ln\omega_{j,t+j}-\mathrm{d}\ \ln\omega_{0,t})\\ &+ \sum_{j=0}^{J-1}(\rho_j-\delta_j)\ E_t(\mathrm{d}\ \ln\lambda_{t+j}-\mathrm{d}\ \ln\lambda_t),\end{aligned}$$

where

$$\begin{aligned}\rho_j &= \frac{E_t\left[\beta^j(\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})c_{j,t+j}\psi_{j,t+j}\varepsilon_{j,t+j}\right]}{E_t\left[\sum_{j=0}^{J-1}\beta^j(\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})c_{j,t+j}\psi_{j,t+j}\varepsilon_{j,t+j}\right]},\\ \tau_j &= \frac{E_t\left[\beta^j(\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})(\frac{1}{P_{t+j}})c_{j,t+j}\varepsilon_{j,t+j}\right]}{E_t\left[\sum_{j=0}^{J-1}\beta^j(\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})(\frac{1}{P_{t+j}})c_{j,t+j}(\varepsilon_{j,t+j}-1)\right]},\\ \textit{and}\ \delta_j &= \frac{E_t\left[\beta^j(\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})(\frac{1}{P_{t+j}})c_{j,t+j}(\varepsilon_{j,t+j}-1)\right]}{E_t\left[\sum_{j=0}^{J-1}\beta^j(\frac{\lambda_{t+j}}{\lambda_t})(\frac{\omega_{j,t+j}}{\omega_{0,t}})(\frac{1}{P_{t+j}})c_{j,t+j}(\varepsilon_{j,t+j}-1)\right]}.\end{aligned}$$

By taking into account that in the steady state $\psi_{j,t+j}=\psi_j$, $\varepsilon_{j,t+j}=\varepsilon$, $c_{j,t+j}=c_j$, $\omega_{j,t+j}=\omega_j$, $\lambda_{t+j}=\lambda$, and $\frac{P_{t+j+1}}{P_{t+j}}=\frac{P_{t+j}}{P_{t+j-1}}=\pi$, we can rewrite the above equation as follows.

$$
\begin{aligned}
\mathrm{d}\ \ln P_t^* \;=\;& \sum_{j=0}^{J-1} \gamma_j\ E_t \mathrm{d}\ \ln \psi_{j,t+j} + \sum_{j=0}^{J-1} (\gamma_j - \eta_j)\ E_t \mathrm{d}\ \ln \varepsilon_{j,t+j} + \sum_{j=0}^{J-1} (\gamma_j - \kappa_j)\ E_t \mathrm{d}\ \ln c_{j,t+j} \\
+\;& \sum_{j=0}^{J-1} \kappa_j\ E_t \mathrm{d}\ \ln P_{t+j} + \sum_{j=0}^{J-1} (\gamma_j - \kappa_j)\ E_t (\mathrm{d}\ \ln \omega_{j,t+j} - \mathrm{d}\ \ln \omega_{0,t}) \\
+\;& \sum_{j=0}^{J-1} (\gamma_j - \kappa_j)\ E_t (\mathrm{d}\ \ln \lambda_{t+j} - \mathrm{d}\ \ln \lambda_t),
\end{aligned}
$$

where $\gamma_j = \frac{\beta^j \omega_j \varepsilon_j c_j \psi j}{\sum_{j=0}^{J-1} \beta^j \omega_j \varepsilon_j c_j \psi j}$, $\eta_j = \frac{\frac{\beta^j \omega_j \varepsilon_j c_j}{\pi^j}}{\sum_{j=0}^{J-1} \frac{\beta^j \omega_j (\varepsilon_j - 1) c_j}{\pi^j}}$, and $\kappa_j = \frac{\frac{\beta^j \omega_j (\varepsilon_j - 1) c_j}{\pi^j}}{\sum_{j=0}^{J-1} \frac{\beta^j \omega_j (\varepsilon_j - 1) c_j}{\pi^j}}$.

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Table 2: Summary Statistics

| Variable name | Description | Unit | Obs. | Mean | Std.Dev. | Min. | Max. |
|---|---|---|---|---|---|---|---|
| $\text{PriceChange}_{i,t}$ | Change in output price | Category[-1,0,1] | 437,205 | -0.10 | 0.49 | -1.00 | 1.00 |
| | = 1(increase) | | 33,679 | | | | |
| | = -1(decrease) | | 77,718 | | | | |
| | = 0(otherwise) | | 325,508 | | | | |
| $\text{PriceIncrease}_{i,t}$ | $\text{PriceChange}_{i,t}$= 1 | Binary[0,1] | 437,205 | 0.08 | 0.27 | 0.00 | 1.00 |
| $\text{PriceDecrease}_{i,t}$ | $\text{PriceChange}_{i,t}$= -1 | Binary[0,1] | 437,205 | 0.18 | 0.38 | 0.00 | 1.00 |
| $\text{PriceAdj}_{i,t}$ | $\text{PriceChange}_{i,t}$= 1 or -1 | Binary[0,1] | 437,205 | 0.25 | 0.44 | 0.00 | 1.00 |
| $\text{Cost}_{i,t}$ | Change in input price | Category[-1,0,1] | 425,441 | 0.20 | 0.50 | -1.00 | 1.00 |
| $\text{ECost}_{i,t,t+1}$ | Expected change in input price | Category[-1,0,1] | 393,535 | 0.23 | 0.52 | -1.00 | 1.00 |
| $\text{LC}_{i,t}$ | Employment condtions | Category[-1,0,1] | 437,076 | -0.05 | 0.50 | -1.00 | 1.00 |
| $\text{ELC}_{i,t,t+1}$ | Expected employment condtions | Category[-1,0,1] | 404,703 | -0.07 | 0.52 | -1.00 | 1.00 |
| $\text{Demand}_{i,t}$ | Domestic supply and demand | Category[-1,0,1] | 434,319 | -0.25 | 0.54 | -1.00 | 1.00 |
| $\text{EInflation}_{i,t}^{1yr}$ | Outlook for inflation rate | Category[-3$\cdots$6] | 111,224 | 1.02 | 1.17 | -3.00 | 6.00 |
| $\text{EInflation}_{i,t}^{3yrs}$ | Outlook for inflation rate | Category[-3$\cdots$6] | 91,659 | 1.29 | 1.23 | -3.00 | 6.00 |
| $\text{EInflation}_{i,t}^{5yrs}$ | Outlook for inflation rate | Category[-3$\cdots$6] | 77,833 | 1.33 | 1.39 | -3.00 | 6.00 |
| $\text{ComPrice}_{i,t-1}$ | Competitors'price | Interval(0,1) | 423,774 | -0.10 | 0.24 | -1.00 | 1.00 |
| $\text{InflationRate}_{i,t}$ | Inflation rate (quarterly basis) | Number | 132,295 | 0.65 | 0.57 | -0.13 | 2.11 |
| $\text{MarketShare}_{i,t}$ | Market share in each industry | Interval(0,1) | 435,876 | 0.08 | 0.18 | 0.00 | 0.98 |
| $\text{MarketConcentration}_{i,t}$ | Herfindahl Hirschman Index | Interval(0,1) | 424,578 | 0.22 | 0.20 | 0.00 | 0.95 |
| $\text{Uncertainty}_{i,t}$ | Uncertainty meaure | Category[0,1,2] | 421,368 | 0.15 | 0.39 | 0.00 | 2.00 |

Table 3: Correlation of variables

Table A: Price change

| | $\text{PriceChange}_{i,t}$ | $\text{Cost}_{i,t}$ | $\text{LC}_{i,t}$ | $\text{Demand}_{i,t}$ | $\text{ComPrice}_{i,t-1}$ | Market $\text{Share}_{i,t}$ | $\text{HHI}_{i,t}$ | $\text{Uncertainty}_{i,t}$ |
|---|---|---|---|---|---|---|---|---|
| $\text{PriceChange}_{i,t}$ | 1 | | | | | | | |
| $\text{Cost}_{i,t}$ | 0.280 | 1 | | | | | | |
| $\text{LC}_{i,t}$ | -0.116 | -0.053 | 1 | | | | | |
| $\text{Demand}_{i,t}$ | 0.235 | 0.023 | -0.178 | 1 | | | | |
| $\text{ComPrice}_{i,t-1}$ | 0.306 | 0.165 | -0.102 | 0.138 | 1 | | | |
| $\text{MarketShare}_{i,t}$ | 0.037 | -0.009 | 0.023 | 0.050 | 0.025 | 1 | | |
| $\text{HHI}_{i,t}$ | 0.027 | 0.024 | 0.032 | 0.015 | 0.055 | 0.471 | 1 | |
| $\text{Uncertainty}_{i,t}$ | -0.011 | 0.038 | -0.008 | 0.032 | -0.003 | -0.017 | -0.004 | 1 |

TableB: Price increase

| | $\text{PriceIncrease}_{i,t}$ | $\text{Cost}_{i,t}$ | $\text{LC}_{i,t}$ | $\text{Demand}_{i,t}$ | $\text{ComPrice}_{i,t-1}$ | Market $\text{Share}_{i,t}$ | $\text{HHI}_{i,t}$ | $\text{Uncertainty}_{i,t}$ |
|---|---|---|---|---|---|---|---|---|
| $\text{PriceIncrease}_{i,t}$ | 1 | | | | | | | |
| $\text{Cost}_{i,t}$ | 0.361 | 1 | | | | | | |
| $\text{LC}_{i,t}$ | -0.047 | -0.053 | 1 | | | | | |
| $\text{Demand}_{i,t}$ | 0.093 | 0.023 | -0.178 | 1 | | | | |
| $\text{ComPrice}_{i,t-1}$ | 0.260 | 0.165 | -0.102 | 0.138 | 1 | | | |
| $\text{MarketShare}_{i,t}$ | 0.025 | -0.009 | 0.023 | 0.050 | 0.025 | 1 | | |
| $\text{HHI}_{i,t}$ | 0.024 | 0.024 | 0.032 | 0.015 | 0.055 | 0.471 | 1 | |
| $\text{Uncertainty}_{i,t}$ | 0.042 | 0.038 | -0.008 | 0.032 | -0.003 | -0.017 | -0.004 | 1 |

TableC: Price decrease

| | $\text{PriceDecrease}_{i,t}$ | $\text{Cost}_{i,t}$ | $\text{LC}_{i,t}$ | $\text{Demand}_{i,t}$ | $\text{ComPrice}_{i,t-1}$ | Market $\text{Share}_{i,t}$ | $\text{HHI}_{i,t}$ | $\text{Uncertainty}_{i,t}$ |
|---|---|---|---|---|---|---|---|---|
| $\text{PriceDecrease}_{i,t}$ | 1 | | | | | | | |
| $\text{Cost}_{i,t}$ | -0.108 | 1 | | | | | | |
| $\text{LC}_{i,t}$ | 0.118 | -0.053 | 1 | | | | | |
| $\text{Demand}_{i,t}$ | -0.240 | 0.023 | -0.178 | 1 | | | | |
| $\text{ComPrice}_{i,t-1}$ | -0.214 | 0.165 | -0.102 | 0.138 | 1 | | | |
| $\text{MarketShare}_{i,t}$ | -0.031 | -0.009 | 0.023 | 0.050 | 0.025 | 1 | | |
| $\text{HHI}_{i,t}$ | -0.017 | 0.024 | 0.032 | 0.015 | 0.055 | 0.471 | 1 | |
| $\text{Uncertainty}_{i,t}$ | 0.044 | 0.038 | -0.008 | 0.032 | -0.003 | -0.017 | -0.004 | 1 |

Notes: Pairwise correlation of variables. Variable definitions are provided in Table 2. $\text{HHI}_{i,t}$ denotes Market concentration ratio defined in the text.

Table 4: Baseline results

| | PriceChange$_{i,t}$: 1, 0, -1 | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Cost$_{i,t}$ | 0.080*** | | 0.084*** | 0.081*** |
| | (0.002) | | (0.002) | (0.002) |
| LC$_{i,t}$ | -0.015*** | | -0.009*** | -0.015*** |
| | (0.001) | | (0.001) | (0.001) |
| ECost$_{i,t,t+1}$ | | 0.038*** | -0.008*** | |
| | | (0.001) | (0.001) | |
| ELC$_{i,t,t+1}$ | | -0.015*** | -0.009*** | |
| | | (0.001) | (0.001) | |
| Demand$_{i,t}$ | 0.042*** | 0.046*** | 0.042*** | 0.041*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| ComPrice$_{i,t-1}$ | 0.099*** | 0.117*** | 0.099*** | 0.100*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Dummy: Lehman crisis | -0.005*** | -0.006*** | -0.005*** | -0.005*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Dummy: Cons.Tax | 0.001 | 0.003** | 0.001 | 0.001 |
| | (0.001) | (0.002) | (0.001) | (0.001) |
| Adj.Pseudo R-squared | 0.136 | 0.117 | 0.136 | 0.133 |
| Observations | 409,736 | 409,736 | 409,736 | 409,736 |
| Number of id | 10,300 | 10,300 | 10,300 | 10,300 |
| Size fixed effect | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | Yes |

Notes:Regression of qualitative pricing attitudes of firms using ordered probit estimation. The dependent variable PriceChange$_{i,t}$ takes the values of 1 (increase), 0 (unchanged), and -1 (decrease). Standard errors (shown in parentheses) are clustered at the firm level. Variable definitions are provided in Table 2. The Lehman crisis dummy takes the value of 1 from 2008:3Q to 2009:1Q, and the consumption tax dummy takes the value of 1 in 2014:2Q, and 0 otherwise. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 5: Asymmetric price setting

| | $\text{PriceIncrease}_{i,t} : 1, 0$ | | | | $\text{PriceDecrease}_{i,t}$: 1, 0 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\text{Cost}_{i,t}$ | 0.095*** | | 0.096*** | 0.095*** | -0.070*** | | -0.074*** | -0.072*** |
| | (0.002) | | (0.002) | (0.002) | (0.002) | | (0.003) | (0.003) |
| $\text{LC}_{i,t}$ | -0.009*** | | -0.006*** | -0.009*** | 0.030*** | | 0.018*** | 0.030*** |
| | (0.001) | | (0.001) | (0.001) | (0.002) | | (0.002) | (0.002) |
| $\text{ECost}_{i,t,t+1}$ | | 0.041*** | -0.002* | | | -0.033*** | 0.007*** | |
| | | (0.001) | (0.001) | | | (0.002) | (0.002) | |
| $\text{ELC}_{i,t,t+1}$ | | -0.008*** | -0.004*** | | | 0.030*** | 0.019*** | |
| | | (0.001) | (0.001) | | | (0.002) | (0.002) | |
| $\text{Demand}_{i,t}$ | 0.020*** | 0.022*** | 0.020*** | 0.021*** | -0.085*** | -0.088*** | -0.085*** | -0.083*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| $\text{ComPrice}_{i,t-1}$ | 0.067*** | 0.074*** | 0.067*** | 0.067*** | -0.149*** | -0.160*** | -0.148*** | -0.150*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.005) | (0.005) | (0.005) | (0.005) |
| Dummy: Lehman crisis | 0.008*** | 0.006*** | 0.008*** | 0.008*** | 0.013*** | 0.014*** | 0.013*** | 0.013*** |
| | (0.002) | (0.001) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| Dummy: Cons.Tax | 0.001 | 0.004** | 0.001 | 0.001 | 0.006 | 0.003 | 0.005 | 0.006 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.004) | (0.004) | (0.004) | (0.004) |
| Adj.Pseudo R-squared | 0.152 | 0.147 | 0.151 | 0.152 | 0.184 | 0.223 | 0.230 | 0.224 |
| Observations | 409,736 | 409,736 | 409,736 | 409,736 | 409,736 | 409,736 | 409,736 | 409,736 |
| Number of id | 10,300 | 10,300 | 10,300 | 10,300 | 10,300 | 10,300 | 10,300 | 10,300 |
| Size fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | Yes | No | No | No | Yes |

Notes: Regression of qualitative pricing attitudes of firms using probit estimation. The dependent variable $\text{PriceIncrease}_{i,t}$ ($\text{PriceDecrease}_{i,t}$) takes the value of 1 when a firm reports a price increase (decrease) and 0 otherwise. Standard errors (shown in parentheses) are clustered at the firm level. Variable definitions are provided in Table 2. The Lehman crisis dummy takes the value of 1 from 2008:3Q to 2009:1Q, and the consumption tax dummy takes the value of 1 in 2014:2Q, and 0 otherwise. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 6: Inflation expectations

| | PriceChange$_{i,t}$ : $1, 0, -1$ | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Cost$_{i,t}$ | 0.094*** | 0.088*** | 0.086*** | 0.094*** | 0.088*** | 0.086*** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| LC$_{i,t}$ | -0.008*** | -0.009*** | -0.008*** | -0.008*** | -0.009*** | -0.008*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Demand$_{i,t}$ | 0.034*** | 0.033*** | 0.032*** | 0.033*** | 0.033*** | 0.032*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| ComPrice$_{i,t-1}$ | 0.088*** | 0.083*** | 0.082*** | 0.087*** | 0.083*** | 0.081*** |
| | (0.005) | (0.005) | (0.006) | (0.005) | (0.005) | (0.006) |
| InflationRate$_{i,t}$ | | | | 0.003*** | 0.002** | 0.003** |
| | | | | (0.001) | (0.001) | (0.001) |
| EInflation$^{1yr}_{i,t,t+1}$ | 0.004*** | | | 0.004*** | | |
| | (0.001) | | | (0.001) | | |
| EInflation$^{3yrs}_{i,t,t+1}$ | | 0.002*** | | | 0.002*** | |
| | | (0.001) | | | (0.001) | |
| EInflation$^{5yrs}_{i,t,t+1}$ | | | 0.002** | | | 0.001** |
| | | | (0.001) | | | (0.001) |
| Adj.Pseudo R-squared | 0.204 | 0.203 | 0.203 | 0.204 | 0.203 | 0.202 |
| Observations | 98,684 | 81,297 | 68,931 | 98,684 | 81,297 | 68,931 |
| Number of id | 7,729 | 7,106 | 6,510 | 7,729 | 7,106 | 6,510 |
| Size fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | No | No | No |

Notes: Regression of qualitative pricing attitudes of firms using ordered probit estimation. The dependent variable PriceChange$_{i,t}$ takes the values of 1 (increase), 0 (unchanged), and -1 (decrease). Standard errors (shown in parentheses) are clustered at the firm level. Variable definitions are provided in Table 2. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 7: Strategic complementarity and market structure

| Panel A: | $\text{PriceAdj}_{i,t}: 1,0$ | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $\text{Cost}_{i,t}+$ | 0.231*** | 0.231*** | 0.232*** | 0.233*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| $\text{Cost}_{i,t}-$ | 0.353*** | 0.353*** | 0.355*** | 0.354*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| $\text{LC}_{i,t}+$ | 0.068*** | 0.067*** | 0.068*** | 0.067*** |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| $\text{LC}_{i,t}-$ | 0.004 | 0.005 | 0.003 | 0.005 |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| $\text{Demand}_{i,t}+$ | 0.076*** | 0.077*** | 0.076*** | 0.077*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| $\text{Demand}_{i,t}-$ | 0.109*** | 0.108*** | 0.110*** | 0.108*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| $\text{ComPrice}_{i,t-1}+$ | 0.191*** | 0.212*** | 0.193*** | 0.231*** |
| | (0.008) | (0.008) | (0.008) | (0.008) |
| $\text{ComPrice}_{i,t-1}-$ | 0.181*** | 0.213*** | 0.183*** | 0.227*** |
| | (0.008) | (0.008) | (0.008) | (0.009) |
| $\text{MarketShare}_{i,t}$ | -0.039** | -0.033* | | |
| | (0.019) | (0.019) | | |
| $\text{ComPrice}_{i,t-1}+$ x $\text{MarketShare}_{i,t}$ | | -0.257*** | | |
| | | (0.032) | | |
| $\text{ComPrice}_{i,t-1}-$ x $\text{MarketShare}_{i,t}$ | | -0.368*** | | |
| | | (0.037) | | |
| $\text{MarketConcentration}_{i,t}(HHI)$ | | | -0.037** | -0.041*** |
| | | | (0.014) | (0.014) |
| $\text{ComPrice}_{i,t-1}+$ x $\text{MarketConcentration}_{i,t}(HHI)$ | | | | -0.374*** |
| | | | | (0.034) |
| $\text{ComPrice}_{i,t-1}-$ x $\text{MarketConcentration}_{i,t}(HHI)$ | | | | -0.434*** |
| | | | | (0.037) |
| Dummy: Lehman crisis | -0.007** | -0.006** | -0.008*** | -0.006* |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Dummy: Cons.Tax | 0.011** | 0.011** | 0.012** | 0.013*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Adj.Pseudo R-squared | 0.157 | 0.157 | 0.154 | 0.154 |
| Observations | 408,649 | 408,649 | 399,533 | 399,533 |
| Number of id | 10,285 | 10,285 | 9,323 | 9,323 |
| Size fixed effect | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | No |

Notes: Regression of qualitative pricing attitudes of firms. Panel A shows the results of probit estimation; the dependent variable $\text{PriceAdj}_{i,t}$ takes the value of 1 when prices increase or decrease, and 0 otherwise. Panel B shows the results of probit estimation; the dependent variable $\text{PriceIncrease}_{i,t}$ ($\text{PriceDecrease}_{i,t}$) takes the value of 1 when a firm reports a price increase (decrease) and 0 otherwise. Standard errors (shown in parentheses) are clustered at the firm level. Variable definitions are provided in Table 2. The Lehman crisis dummy takes the value of 1 from 2008:3Q to 2009:1Q, and the consumption tax dummy takes the value of 1 in 2014:2Q, and 0 otherwise. *, **, *** denote significance atthe 10%, 5%, and 1% levels, respectively.

| Panel B: | $\text{PriceIncrease}_{i,t}: 1, 0$ | | | | $\text{PriceDecrease}_{i,t}: 1, 0$ | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\text{Cost}_{i,t}$ | 0.095*** | 0.095*** | 0.097*** | 0.096*** | -0.070*** | -0.070*** | -0.071*** | -0.071*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) |
| $\text{LC}_{i,t}$ | -0.009*** | -0.009*** | -0.009*** | -0.009*** | 0.030*** | 0.029*** | 0.030*** | 0.030*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| $\text{Demand}_{i,t}$ | 0.020*** | 0.020*** | 0.021*** | 0.020*** | -0.085*** | -0.085*** | -0.087*** | -0.086*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| $\text{ComPrice}_{i,t-1}$ | 0.067*** | 0.072*** | 0.068*** | 0.075*** | -0.148*** | -0.164*** | -0.151*** | -0.176*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.005) | (0.005) | (0.005) | (0.006) |
| $\text{MarketShare}_{i,t}$ | 0.003 | -0.002 | | | -0.037** | -0.043** | | |
| | (0.006) | (0.006) | | | (0.018) | (0.018) | | |
| $\text{ComPrice}_{i,t-1}$ x $\text{MarketShare}_{i,t}$ | | -0.072*** | | | | 0.228*** | | |
| | | (0.010) | | | | (0.028) | | |
| $\text{MarketConcentration}_{i,t}(HHI)$ | | | -0.008* | -0.014*** | | | -0.022 | -0.038*** |
| | | | (0.005) | (0.005) | | | (0.014) | (0.014) |
| $\text{ComPrice}_{i,t-1}$ x $\text{MarketConcentration}_{i,t}(HHI)$ | | | | -0.104*** | | | | 0.285*** |
| | | | | (0.010) | | | | (0.026) |
| Dummy: Lehman crisis | 0.008*** | 0.008*** | 0.008*** | 0.007*** | 0.013*** | 0.015*** | 0.013*** | 0.017*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| Dummy: Cons.Tax | 0.001 | 0.001 | 0.001 | 0.002 | 0.006 | 0.005 | 0.005 | 0.005 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.004) | (0.004) | (0.004) | (0.004) |
| Adj.Pseudo R-squared | 0.152 | 0.151 | 0.150 | 0.149 | 0.231 | 0.231 | 0.228 | 0.228 |
| Observations | 408,649 | 408,649 | 397,839 | 397,839 | 408,649 | 408,649 | 397,839 | 397,839 |
| Number of id | 10,285 | 10,285 | 9,323 | 9,323 | 10,285 | 10,285 | 9,323 | 9,323 |
| Size fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | No | No | No | No | No |

Table 8: Results by industry

| Panel A: | PriceChange$_{i,t}$ : $1, 0, -1$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Manufacturing | | | Non-manufacturing | | | | | |
| | Total | Material | Processed | Total | WHLS RETAIL | CONST RE | TRANS POST | SVC INDIV | Others |
| Cost$_{i,t}$ | 0.073*** | 0.142*** | 0.034*** | 0.084*** | 0.205*** | 0.020*** | 0.017*** | 0.038*** | 0.074*** |
| | (0.003) | (0.006) | (0.003) | (0.003) | (0.004) | (0.002) | (0.003) | (0.004) | (0.006) |
| LC$_{i,t}$ | -0.016*** | -0.029*** | -0.011*** | -0.014*** | -0.012*** | -0.011*** | -0.010*** | -0.012*** | -0.011*** |
| | (0.002) | (0.004) | (0.001) | (0.001) | (0.003) | (0.001) | (0.002) | (0.003) | (0.002) |
| Demand$_{i,t}$ | 0.044*** | 0.064*** | 0.029*** | 0.041*** | 0.044*** | 0.023*** | 0.027*** | 0.035*** | 0.042*** |
| | (0.002) | (0.004) | (0.002) | (0.001) | (0.002) | (0.002) | (0.003) | (0.004) | (0.003) |
| ComPrice$_{i,t-1}$ | 0.098*** | 0.143*** | 0.058*** | 0.098*** | 0.062*** | 0.072*** | 0.079*** | 0.090*** | 0.107*** |
| | (0.004) | (0.008) | (0.004) | (0.003) | (0.004) | (0.007) | (0.015) | (0.011) | (0.008) |
| Dummy: Lehman crisis | -0.002 | -0.002 | 0.002 | -0.006*** | -0.009*** | -0.004*** | 0.002 | -0.004 | -0.000 |
| | (0.002) | (0.005) | (0.002) | (0.001) | (0.003) | (0.001) | (0.003) | (0.003) | (0.003) |
| Dummy: Cons.Tax | -0.000 | 0.005 | -0.003 | 0.001 | -0.001 | 0.003 | -0.008*** | -0.006 | 0.010** |
| | (0.003) | (0.007) | (0.002) | (0.002) | (0.004) | (0.002) | (0.003) | (0.005) | (0.004) |
| Adj.Pseudo R-squared | 0.122 | 0.080 | 0.154 | 0.148 | 0.141 | 0.186 | 0.132 | 0.127 | 0.152 |
| Observations | 155,032 | 57,965 | 97,067 | 254,704 | 81,207 | 64,244 | 29,822 | 29,774 | 49,657 |
| Number of id | 3,762 | 1,551 | 2,236 | 6,601 | 1,979 | 1,704 | 658 | 935 | 1,399 |
| Size fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | No | No | No | No | No | No |

Notes: Regression of qualitative pricing attitudes of firms. Panel A shows the results of ordered probit estimation; the dependent variable PriceChange$_{i,t}$ takes the values of 1 (increase), 0 (unchanged), and -1 (decrease). Panel B and C show the results of probit estimation; the dependent variable PriceIncrease$_{i,t}$ (PriceDecrease$_{i,t}$) takes the value of 1 when a firm reports a price increase (decrease) and 0 otherwise. Standard errors (shown in parentheses) are clustered at the firm level. Variable definitions are provided in Table 2. The Lehman crisis dummy takes the value of 1 from 2008:3Q to 2009:1Q, and the consumption tax dummy takes the value of 1 in 2014:2Q, and 0 otherwise. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively. Abbreviation for industry categories are as follows. WHLS RETAIL is wholesale and retail. CONST RE is construction and real estate. TRANS POST is transportation and postal services. SVC INDIV is service for individuals.

| Panel B: | PriceIncrease$_{i,t}$ : 1, 0 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Manufacturing | | | Non-manufacturing | | | | | |
| | Total | Material | Processed | Total | WHLS RETAIL | CONST RE | TRANS POST | SVC INDIV | Others |
| Cost$_{i,t}$ | 0.096*** | 0.158*** | 0.059*** | 0.094*** | 0.214*** | 0.043*** | 0.016*** | 0.051*** | 0.056*** |
| | (0.003) | (0.006) | (0.003) | (0.003) | (0.004) | (0.004) | (0.003) | (0.005) | (0.005) |
| LC$_{i,t}$ | -0.009*** | -0.018*** | -0.005*** | -0.008*** | -0.006** | -0.004*** | -0.005*** | -0.015*** | -0.007*** |
| | (0.002) | (0.004) | (0.002) | (0.001) | (0.003) | (0.001) | (0.002) | (0.002) | (0.002) |
| Demand$_{i,t}$ | 0.022*** | 0.036*** | 0.013*** | 0.019*** | 0.020*** | 0.012*** | 0.007*** | 0.014*** | 0.019*** |
| | (0.002) | (0.003) | (0.002) | (0.001) | (0.003) | (0.001) | (0.002) | (0.003) | (0.003) |
| ComPrice$_{i,t-1}$ | 0.075*** | 0.121*** | 0.045*** | 0.057*** | 0.050*** | 0.043*** | 0.045*** | 0.057*** | 0.055*** |
| | (0.003) | (0.007) | (0.004) | (0.003) | (0.004) | (0.009) | (0.011) | (0.010) | (0.005) |
| Dummy: Lehman crisis | 0.011*** | 0.032*** | 0.003 | 0.006*** | 0.004 | 0.003 | 0.008** | 0.000 | 0.009** |
| | (0.003) | (0.007) | (0.002) | (0.002) | (0.004) | (0.002) | (0.004) | (0.005) | (0.004) |
| Dummy: Cons.Tax | 0.007* | 0.008 | 0.006 | -0.002 | -0.004 | 0.001 | -0.008*** | -0.005 | 0.014*** |
| | (0.004) | (0.009) | (0.004) | (0.002) | (0.005) | (0.002) | (0.001) | (0.005) | (0.005) |
| Adj.Pseudo R-squared | 0.130 | 0.124 | 0.133 | 0.171 | 0.157 | 0.178 | 0.178 | 0.138 | 0.207 |
| Observations | 155,032 | 57,965 | 97,067 | 254,704 | 81,207 | 64,244 | 29,822 | 29,774 | 49,657 |
| Number of id | 3,762 | 1,551 | 2,236 | 6,601 | 1,979 | 1,704 | 658 | 935 | 1,399 |
| Size fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | No | No | No | No | No | No |

| Panel C: | PriceDecrease$_{i,t}$ : 1, 0 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Manufacturing | | | Non-manufacturing | | | | | |
| | Total | Material | Processed | Total | WHLS RETAIL | CONST RE | TRANS POST | SVC INDIV | Others |
| Cost$_{i,t}$ | -0.056*** | -0.085*** | -0.029*** | -0.082*** | -0.166*** | -0.019** | -0.015*** | -0.025*** | -0.076*** |
| | (0.003) | (0.005) | (0.004) | (0.004) | (0.007) | (0.008) | (0.005) | (0.008) | (0.007) |
| LC$_{i,t}$ | 0.032*** | 0.035*** | 0.031*** | 0.029*** | 0.017*** | 0.062*** | 0.018*** | 0.013** | 0.025*** |
| | (0.003) | (0.005) | (0.004) | (0.003) | (0.004) | (0.006) | (0.006) | (0.007) | (0.005) |
| Demand$_{i,t}$ | -0.077*** | -0.071*** | -0.080*** | -0.090*** | -0.071*** | -0.117*** | -0.059*** | -0.081*** | -0.090*** |
| | (0.004) | (0.005) | (0.005) | (0.003) | (0.004) | (0.007) | (0.008) | (0.009) | (0.007) |
| ComPrice$_{i,t-1}$ | -0.123*** | -0.115*** | -0.113*** | -0.167*** | -0.069*** | -0.335*** | -0.121*** | -0.225*** | -0.153*** |
| | (0.007) | (0.009) | (0.011) | (0.007) | (0.007) | (0.031) | (0.033) | (0.028) | (0.013) |
| Dummy: Lehman crisis | 0.004 | 0.019*** | -0.012** | 0.018*** | 0.019*** | 0.030*** | 0.003 | 0.013 | 0.007 |
| | (0.004) | (0.007) | (0.005) | (0.003) | (0.006) | (0.008) | (0.008) | (0.010) | (0.007) |
| Dummy: Cons.Tax | 0.015** | -0.003 | 0.025*** | -0.001 | -0.008 | 0.001 | -0.012 | 0.013 | 0.010 |
| | (0.006) | (0.010) | (0.008) | (0.005) | (0.008) | (0.016) | (0.010) | (0.016) | (0.010) |
| Adj.Pseudo R-squared | 0.216 | 0.159 | 0.247 | 0.382 | 0.227 | 0.261 | 0.244 | 0.215 | 0.253 |
| Observations | 155,032 | 57,965 | 97,067 | 254,704 | 81,207 | 64,244 | 29,822 | 29,774 | 49,657 |
| Number of id | 3,762 | 1,551 | 2,236 | 6,601 | 1,979 | 1,704 | 658 | 935 | 1,399 |
| Size fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | No | No | No | No | No | No |

Table 10: Price setting under uncertainty

| Panel A: | $\text{PriceAdj}_{i,t}: 1, 0$ | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| $\text{Uncertainty}_{i,t}$ | 0.004** | 0.003 | 0.008*** | 0.005*** |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| $\text{Demand}_{i,t}+$ x $\text{Uncertainty}_{i,t}$ | | | -0.026*** | -0.023*** |
| | | | (0.005) | (0.005) |
| $\text{Demand}_{i,t}-$ x $\text{Uncertainty}_{i,t}$ | | | -0.050*** | -0.045*** |
| | | | (0.004) | (0.004) |
| $\text{Cost}_{i,t}+$ | 0.232*** | 0.215*** | 0.231*** | 0.214*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| $\text{Cost}_{i,t}-$ | 0.357*** | 0.330*** | 0.356*** | 0.329*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| $\text{LC}_{i,t}+$ | 0.069*** | 0.064*** | 0.068*** | 0.063*** |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| $\text{LC}_{i,t}-$ | 0.002 | -0.001 | 0.002 | -0.001 |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| $\text{Demand}_{i,t}+$ | 0.075*** | 0.067*** | 0.077*** | 0.069*** |
| | (0.005) | (0.004) | (0.005) | (0.005) |
| $\text{Demand}_{i,t}-$ | 0.111*** | 0.100*** | 0.115*** | 0.104*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| $\text{ComPrice}_{i,t-1}+$ | 0.033*** | 0.029*** | 0.033*** | 0.030*** |
| | (0.012) | (0.011) | (0.012) | (0.011) |
| $\text{ComPrice}_{i,t-1}-$ | 0.048*** | 0.045*** | 0.047*** | 0.044*** |
| | (0.012) | (0.012) | (0.012) | (0.012) |
| Dummy: Lehman crisis | -0.007** | -0.006** | -0.009*** | -0.008*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Dummy: Cons.Tax | 0.011** | 0.011** | 0.011** | 0.010** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Adj.Pseudo R-squared | 0.161 | 0.151 | 0.160 | 0.150 |
| Observations | 397,839 | 397,839 | 397,839 | 397,839 |
| Number of id | 10,200 | 10,200 | 10,200 | 10,200 |
| Size fixed effect | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes |
| Correlated random effect | No | Yes | No | Yes |

Notes: Regression of qualitative pricing attitudes of firms. Panel A shows the results of probit estimation; the dependent variable $\text{PriceAdj}_{i,t}$ takes the value of 1 when prices increase or decrease, and 0 otherwise. Panel B shows the results of probit estimation; the dependent variable $\text{PriceIncrease}_{i,t}$ ($\text{PriceDecrease}_{i,t}$) takes the value of 1 when a firm reports a price increase (decrease) and 0 otherwise. Standard errors (shown in parentheses) are clustered at the firm level. Variable definitions are provided in Table 2. The Lehman crisis dummy takes the value of 1 from 2008:3Q to 2009:1Q, and the consumption tax dummy takes the value of 1 in 2014:2Q, and 0 otherwise. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

| Panel B: | $\text{PriceIncrease}_{i,t} : 1, 0$ | | | | $\text{PriceDecrease}_{i,t} : 1, 0$ | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\text{Uncertainty}_{i,t}$ | 0.004*** | 0.004*** | 0.004*** | 0.004** | 0.015*** | 0.015*** | 0.007*** | 0.005*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| $\text{Demand}_{i,t}$ x $\text{Uncertainty}_{i,t}$ | | | -0.003*** | -0.003*** | | | 0.038*** | 0.037*** |
| | | | (0.001) | (0.001) | | | (0.002) | (0.002) |
| $\text{Cost}_{i,t}$ | 0.095*** | 0.095*** | 0.095*** | 0.095*** | -0.072*** | -0.073*** | -0.072*** | -0.073*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| $\text{LC}_{i,t}$ | -0.009*** | -0.008*** | -0.009*** | -0.008*** | 0.030*** | 0.031*** | 0.029*** | 0.029*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| $\text{Demand}_{i,t}$ | 0.020*** | 0.021*** | 0.021*** | 0.022*** | -0.086*** | -0.084*** | -0.097*** | -0.094*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.003) | (0.003) |
| $\text{ComPrice}_{i,t-1}$ | 0.067*** | 0.067*** | 0.067*** | 0.067*** | -0.150*** | -0.151*** | -0.148*** | -0.149*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.005) | (0.005) | (0.005) | (0.005) |
| Dummy: Lehman crisis | 0.008*** | 0.008*** | 0.008*** | 0.008*** | 0.013*** | 0.013*** | 0.011*** | 0.011*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| Dummy: Cons.Tax | 0.001 | 0.001 | 0.001 | 0.001 | 0.005 | 0.005 | 0.006 | 0.006 |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.004) | (0.004) | (0.004) | (0.004) |
| Adj.Pseudo R-squared | 0.147 | 0.137 | 0.147 | 0.137 | 0.214 | 0.208 | 0.214 | 0.208 |
| Observations | 397,839 | 397,839 | 397,839 | 397,839 | 397,839 | 397,839 | 397,839 | 397,839 |
| Number of id | 10,200 | 10,200 | 10,200 | 10,200 | 10,200 | 10,200 | 10,200 | 10,200 |
| Size fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Correlated random effect | No | Yes | No | Yes | No | Yes | No | Yes |

Appendix Table 1: Baseline results with time-dependent factors

| | PriceChange$_{i,t}$ : $1, 0, -1$ | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Cost$_{i,t}$ | 0.088*** | | 0.092*** | 0.089*** |
| | (0.002) | | (0.002) | (0.002) |
| LC$_{i,t}$ | -0.014*** | | -0.009*** | -0.014*** |
| | (0.001) | | (0.001) | (0.001) |
| ECost$_{i,t,t+1}$ | | 0.042*** | -0.008*** | |
| | | (0.001) | (0.001) | |
| ELC$_{i,t,t+1}$ | | -0.014*** | -0.008*** | |
| | | (0.001) | (0.001) | |
| Demand$_{i,t}$ | 0.040*** | 0.045*** | 0.040*** | 0.040*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| ComPrice$_{i,t-1}$ | 0.106*** | 0.126*** | 0.106*** | 0.107*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Taylor 1 | -0.054*** | -0.051*** | -0.053*** | -0.053*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Taylor 2 | -0.024*** | -0.022*** | -0.024*** | -0.024*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Taylor 3 | -0.015*** | -0.013*** | -0.015*** | -0.015*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Taylor 4 | -0.014*** | -0.012*** | -0.013*** | -0.013*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Taylor 5 | -0.005*** | -0.005*** | -0.005*** | -0.005*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Taylor 6 | -0.003* | -0.003* | -0.002* | -0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Taylor 7 | -0.002 | -0.002 | -0.002 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Taylor 8 | 0.001 | 0.001 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| First Quarter | -0.003*** | -0.005*** | -0.003*** | -0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Second Quarter | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Fourth Quarter | -0.003*** | -0.003*** | -0.003*** | -0.003*** |
| | (0.000) | (0.001) | (0.000) | (0.000) |
| Dummy: Lehman crisis | -0.003** | -0.004*** | -0.003*** | -0.003** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| Dummy: Cons.Tax | 0.003* | 0.007*** | 0.003** | 0.003* |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| Adj.Pseudo R-squared | 0.109 | 0.095 | 0.109 | 0.108 |
| Observations | 409,736 | 409,736 | 409,736 | 409,736 |
| Number of id | 10,300 | 10,300 | 10,300 | 10,300 |
| Size fixed effect | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | Yes |

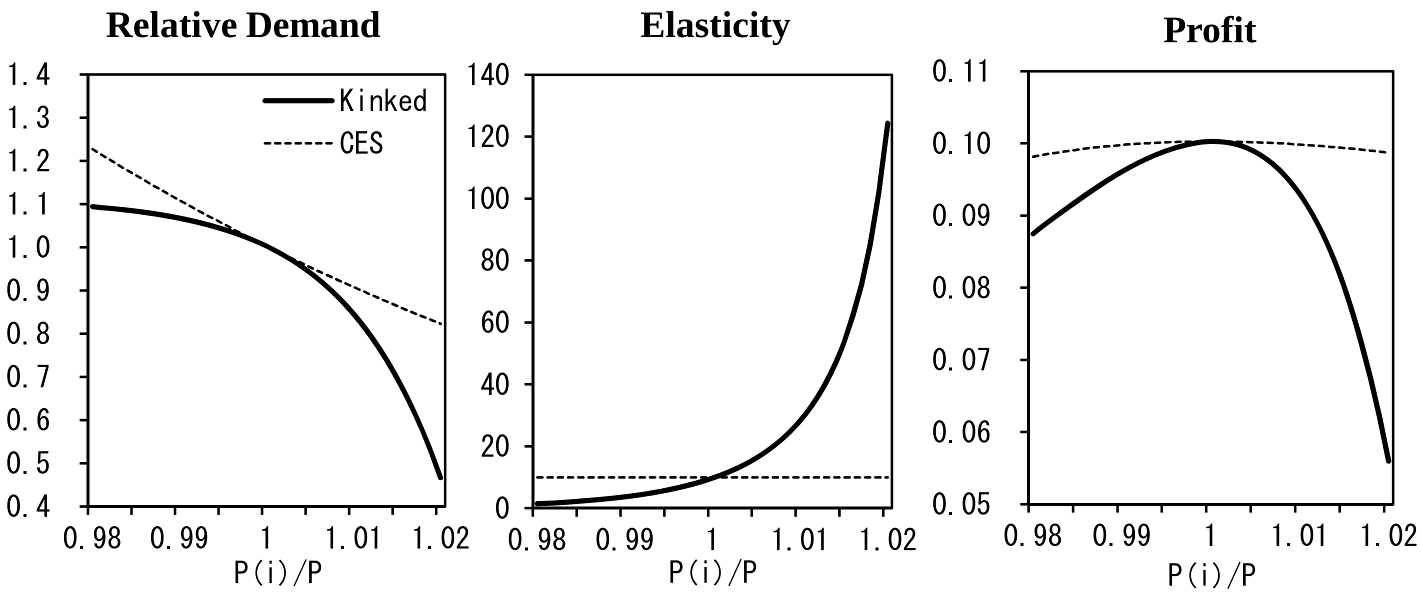
Notes: Regression of qualitative pricing attitudes of firms using ordered probit estimation. The dependent variable PriceChange$_{i,t}$ takes the values of 1 (increase), 0 (unchanged), and -1 (decrease). Standard errors (shown in parentheses) are clustered at the firm level. Variable definitions are described in Table 2. The Lehman crisis dummy takes the value of 1 from 2008:3Q to 2009:1Q, and the consumption tax dummy takes the value of 1 in 2014:2Q, and 0 otherwise. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Appendix Table 2: Asymmetric price setting with time-dependent factors

| | $\text{PriceIncrease}_{i,t}: 1, 0$ | | | | $\text{PriceDecrease}_{i,t}: 1, 0$ | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\text{Cost}_{i,t}$ | 0.096*** | | 0.097*** | 0.096*** | -0.075*** | | -0.078*** | -0.077*** |
| | (0.002) | | (0.002) | (0.002) | (0.002) | | (0.002) | (0.002) |
| $\text{LC}_{i,t}$ | -0.009*** | | -0.007*** | -0.009*** | 0.022*** | | 0.014*** | 0.024*** |
| | (0.001) | | (0.001) | (0.001) | (0.002) | | (0.002) | (0.002) |
| $\text{ECost}_{i,t,t+1}$ | | 0.043*** | -0.003*** | | | -0.037*** | 0.006*** | |
| | | (0.001) | (0.001) | | | (0.002) | (0.002) | |
| $\text{ELC}_{i,t,t+1}$ | | -0.009*** | -0.004*** | | | 0.023*** | 0.014*** | |
| | | (0.001) | (0.001) | | | (0.001) | (0.002) | |
| $\text{Demand}_{i,t}$ | 0.023*** | 0.026*** | 0.023*** | 0.023*** | -0.068*** | -0.072*** | -0.068*** | -0.064*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| $\text{ComPrice}_{i,t-1}$ | 0.063*** | 0.074*** | 0.063*** | 0.063*** | -0.132*** | -0.148*** | -0.132*** | -0.133*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.004) | (0.004) | (0.004) | (0.004) |
| Taylor 1 | 0.065*** | 0.077*** | 0.066*** | 0.066*** | 0.317*** | 0.314*** | 0.317*** | 0.314*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.004) | (0.004) | (0.004) | (0.004) |
| Taylor 2 | 0.025*** | 0.028*** | 0.025*** | 0.025*** | 0.100*** | 0.100*** | 0.099*** | 0.099*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| Taylor 3 | 0.020*** | 0.022*** | 0.020*** | 0.020*** | 0.067*** | 0.068*** | 0.067*** | 0.067*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| Taylor 4 | 0.028*** | 0.029*** | 0.028*** | 0.028*** | 0.076*** | 0.077*** | 0.076*** | 0.076*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.002) |
| Taylor 5 | 0.009*** | 0.009*** | 0.009*** | 0.009*** | 0.030*** | 0.031*** | 0.030*** | 0.030*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| Taylor 6 | 0.006*** | 0.006*** | 0.006*** | 0.006*** | 0.021*** | 0.022*** | 0.021*** | 0.020*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) |
| Taylor 7 | 0.004** | 0.004*** | 0.004** | 0.004** | 0.017*** | 0.017*** | 0.017*** | 0.016*** |
| | (0.002) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Taylor 8 | 0.005*** | 0.006*** | 0.005*** | 0.005*** | 0.014*** | 0.014*** | 0.014*** | 0.014*** |
| | (0.002) | (0.001) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| First Quarter | -0.001 | -0.003*** | -0.001 | -0.001 | 0.010*** | 0.011*** | 0.009*** | 0.010*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Second Quarter | 0.005*** | 0.005*** | 0.005*** | 0.005*** | 0.008*** | 0.009*** | 0.008*** | 0.008*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Fourth Quarter | 0.000 | 0.000 | 0.000 | 0.000 | 0.007*** | 0.007*** | 0.007*** | 0.007*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Dummy: Lehman crisis | 0.006*** | 0.002 | 0.005*** | 0.006*** | 0.014*** | 0.015*** | 0.014*** | 0.014*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| Dummy: Cons.Tax | 0.006*** | 0.012*** | 0.006*** | 0.006*** | -0.005 | -0.009** | -0.005 | -0.005 |
| | (0.002) | (0.003) | (0.002) | (0.002) | (0.004) | (0.004) | (0.004) | (0.004) |
| Adj.Pseudo R-squared | 0.106 | 0.089 | 0.104 | 0.104 | 0.079 | 0.075 | 0.079 | 0.078 |
| Observations | 409,736 | 409,736 | 409,736 | 409,736 | 409,736 | 409,736 | 409,736 | 409,736 |
| Number of id | 10,300 | 10,300 | 10,300 | 10,300 | 10,300 | 10,300 | 10,300 | 10,300 |
| Size fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Correlated random effect | No | No | No | Yes | No | No | No | Yes |

Notes: Regression of qualitative pricing attitudes of firms using probit estimation. The dependent variable $\text{PriceIncrease}_{i,t}$ ($\text{PriceDecrease}_{i,t}$) takes the value of 1 when a firm reports a price increase (decrease) and 0 otherwise. Standard errors (shown in parentheses) are clustered at the firm level. Variable definitions are described in Table 2. The Lehman crisis dummy takes the value of 1 from 2008:3Q to 2009:1Q, and the consumption tax dummy takes the value of 1 in 2014:2Q, and 0 otherwise. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

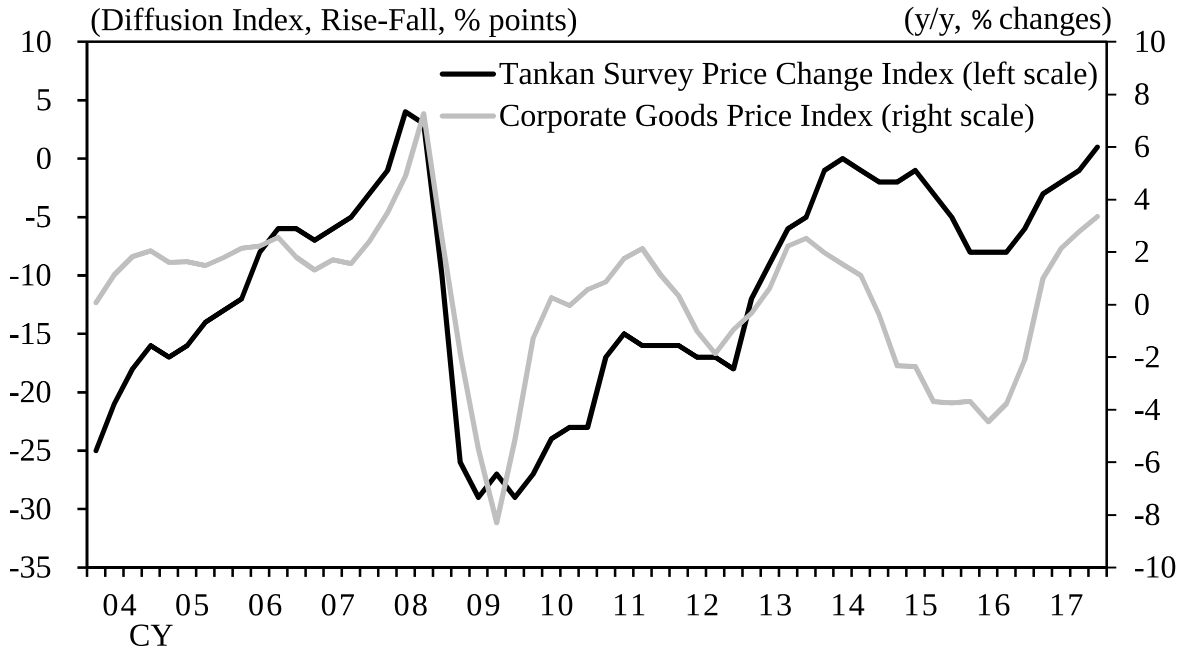
Figure 1 Kinked demand curve




Note: The figures show relative demand, elasticity of demand, and profit for a kinked demand curve ($\upsilon$=-10) and CES demand curve ($\upsilon$=0). $\theta$ is assumed to be 10. The vertical axis shows relative price.

Source: Author's calculations.

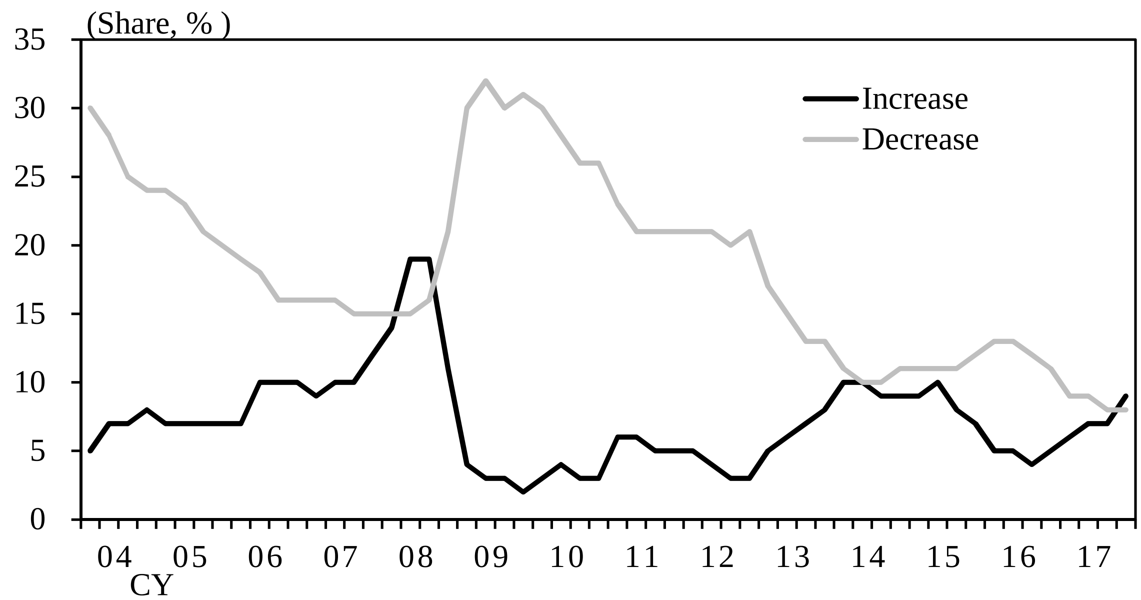
## Figure 2 Tankan survey price change index and corporate goods price index




Note: The thick line denotes the diffusion index of price changes reported by firms, and the gray line shows the aggregate price index for corporate goods excluding the effect of the consumption tax rise.

Source: Short-term economic survey of enterprises in Japan (Bank of Japan)
Corporate goods price index (Bank of Japan)

## Figure 3 Shares of firms reporting increase/decrease in output price




Note: The thick line denotes the share of firms reporting an "increase", and gray line that of firms reporting a "decrease" in price, in response to the questionnaire on output price changes.

Source: Short-term economic survey of enterprises in Japan (Bank of Japan)