Micro Foundations of Price-Setting Behaviour:
Evidence from Canadian Firms[*]

Daniel de Munnik**
Bank of Canada

Kuan Xu
Dalhousie University

Abstract

Building on Amirault et al. (2005), this paper uses data from the Bank of Canada price-setting survey to investigate the marginal effects of firm-specific and market characteristics on Canadian firms' price-setting behaviour. By using a negative binominal regressions model and a series of ordered probit models we are able to explain the intra-sample price-adjustment frequency variation and the relative importance of about a dozen popular sticky prices theories on Canadian firms' price-setting behaviour. Our main findings are as follows: (1) All else being equal, firms tend to adjust prices more frequently if they are state-dependent price setters, firms in the trade sector, firms that operate in central Canada, and firms with larger variable costs and more direct competitors. (2) Firms that recognize coordination failure on price increase, sticky information, menu costs, factor stability, and customer relations, tend to adjust prices less frequently. (3) Among all sticky price theories, coordination failure, cost-based pricing and customer relations are the most supported (in addition to being among the most highly recognized) by Canadian evidence. The recognition patterns of sticky price theories are associated strongly with the micro foundations characterized by industry type, customer type (households, government, or businesses), product destination (domestic or export), information availability, and utilization of contracts. Overall, these new findings not only provide new insight to the price-setting behaviour of Canadian firms but they also point-out new directions for macroeconomic modelling that often assumes exogenous price-setting behaviours for the inflationary dynamics.

Table of Contents

That the price of linen and woollen cloth is liable neither to such frequency nor to such great variations as the price of corn, every man's experience will inform him.
Adam Smith

In view of the fact that practically every business is a partial monopoly, it is remarkable that the theoretical treatment of economics has related so exclusively to complete monopoly and perfect competition.
Frank Knight

There can be no doubt that in this country ever since 1790 our price structure has included a large number of prices that remained unchanged for months or years at a time, side by side with prices that changed monthly, weekly, daily or in recent years even hourly.
Rufus S. Tucker

1 Why Study Price-setting Behaviour?

How do firms adjust prices in the market place? Why do firms tend to adjust prices infrequently in response to changes in market conditions? These remain the central questions in monetary policy research and in macroeconomics more generally in the form of sticky price theories. Recent studies by de Walque et al. (2004) and Amano et al. (2006) demonstrate that the choice of price-setting behaviour has significant implications for the inflations dynamics and the social welfare in dynamic stochastic general equilibrium (DSGE) models. Information on which sticky price theories are closest to actual behaviour is therefore critical for building a model to be used for forecasting and/or policy analysis.

To understand the price-setting behaviours of Canadian firms, the Bank of Canada followed the pioneering framework of Blinder et al. (1998) by designing a price-setting survey and conducting person-to-person interviews with 170 firms (see Amirault et al. 2005 for more details). As a natural extension of the basic statistical analysis in Amirault et al. (2005), we conduct an in-depth analysis using negative binominal regression models and probit and ordered probit models, which are suitable, respectively, to the price-adjustment frequency and the importance ranking of sticky price theories. We attempt to examine the roles of firm and market characteristics in price-adjustment behaviour and to identify microfoundations that motivate firms to recognize some, but not all, sticky price theories. This research helps shed light on micro foundations of price-setting behaviour of Canadian firms, and also provide useful information on how to model price setting behaviour.

The remainder of the paper is organized as follows. In section 2 we first discuss the recent literature on the price-adjustment behaviours, and then we review the existing sticky price-setting theories. We explain our data in section 3. In section 4, the negative binominal regression model and empirical results. We discuss the ordered probit models and regression results in section 5. Lastly, section 6 concludes.

2 Recent Evidence on Pricing Behaviour

How often do firms adjust their prices? Why do some firms change much more often than others? Which sticky price theory is best supported by the empirical evidence? These questions have been the focal point of some recent empirical work. We briefly summarize this literature below.

2.1 Can We Explain the Heterogeneity in Price-adjustment?

Over several decades many sticky price theories have been proposed in the literature to explain the infrequent adjustment of prices to economic shocks. However, these theories were tested primarily based on the prices of individual goods and services with no reference to the behaviour of individual firms (Cecchetti 1986; Carlton 1989) until Blinder's ground-breaking approach (1991) was applied to the firm-level survey data in the United States. This work has spurred a wave of using a firm-level price-setting survey (PSS) by at least twelve central banks around the world (see Table 1 for details). In contrast to the highly flexible and frequently adjusted prices predicted by some theories, the existing firm-based price-setting surveys and corresponding research demonstrate that prices are indeed sticky with varying life span/duration within and across countries (see Table 2 for details). In addition to the findings from the firm-level studies, some economists have adopted the product/service-based approach to gain insight to the sticky price phenomenon (see Table 3 for details).

What causes these variations in the price-adjustment frequency in the firm-based and product-based literature? The literature has suggested, although not unanimous, some common factors such as firm size, firm industry or sector, long-term contracts, the level of competition, specific events that trigger price adjustment, known as pricing triggers and, perhaps most importantly, the role of firm-recognized sticky price theories (see Fabiani et al. 2004 and Amirault et al. 2005 for more discussion). But the literature has not yet addressed the questions of how various factors jointly affect the price-

adjustment frequency; this is one of the issues that this paper will address. Furthermore, this paper will evaluate the roles of existing sticky price theories in price-setting behaviour and identify the micro foundations that motivate a firm to demonstrate a particular behaviour.

2.2 Which Sticky Price-setting Behaviours are Widely Observed?

Which price-setting theory is most important to Canadian firms? To answer this question the Canadian PSS asked firms to evaluate 11 sticky price theories.1 We describe each of these theories in-turn. The first theory, known as the sticky information theory, suggests that because the information used to review (and ultimately change) prices is available infrequently, prices may adjust to economic shocks with some lag.2 Coordination failure theory on price decline and such theory on price increase, the second and third theories, explain price rigidity by the fact that firms will delay price-adjustments (downward or upward) because firms fear that they would initiate a price war if they cut/raise prices first and that they would reduce market share or disturb customer relations by adjusting prices first (see Clower 1965, Cooper and John 1988, Ball and Romer 1991). Cost-based pricing states that prices are determined mainly by production costs and that delays in cost-push inflation in the multi-stage production processes generate aggregate price level inertia (see Gordon 1981 and Blanchard 1983). The fifth and sixth theories included in the PSS are the explicit and implicit contract theories, which suggest that contracts set between buyers and sellers can fix nominal prices over some horizon (see Okun 1981). Generally, buyers and sellers sign contracts to gain certainty, limit risk, and lower search costs that result in price stickiness. The seventh sticky price theory is the menu costs theory which says that firms will delay price adjustment because there is a non-negligible fixed cost for each price

---

[1] In the Canadian survey, firms were read a plain language statement that represented each sticky price theory and then asked, "How important is this to your firm". For the first six theories, firms had to answer very, fairly, slightly, or unimportant, and for the remaining five theories firms simply answered important or unimportant (See Amirault et al. 2005 for a copy of the survey). Because of the differences in allowable responses, we estimate a series of both ordered probit and probit models in Section 5. Later, for reporting purposes, we divided these theories into two groups (see section 3 and 5). Also note: answers were not mutually exclusive.

[2] Unlike Lucas (1974) and Mankiw and Ries (2001), however, the Canadian survey describes this theory as a reason for preventing price adjustment rather than the magnitude of price adjustment (see Amirault et al. 2005 for more discussion).

adjustment (see Barro 1972). 3 The non-price competition theory, the eighth sticky-price theory, argues that market clearing may take place because of factors other than prices, such as delivery time, quality, and warranty (see Carlton 1989).

The following three theories are evaluated only in the Canadian PSS. The first theory is the factor stability theory which states that prices do not need to change more often because factors that determine prices are relatively stable (see Amirault et al. 2005). The second theory is the low inflation theory that argues that firms adjust their prices less frequently because a low, stable, and predictable inflation environment makes real price-adjustments more noticeable to customers (see Engel 1993 and Amirault et al. 2005). The third theory is the customer relations theory. This theory states that firms do not respond to cost and demand shocks because of their concern for customer relations (see Okun 1981 and Rotemberg 2002, 2004).

Which sticky price theories are better supported by empirical evidence? The existing literature has identified coordination failure on price increase or decline, cost-based pricing, and explicit and implicit contracts as the most recognized theories in the U.S., U.K., Japan, Sweden, nine E.U. countries and Canada. However, when analyzing the relationship between sticky prices and recognized theories, only the U.S. study, which is based on regression analysis, suggests that coordination failure and implicit contracts are important for explaining price stickiness (see Blinder et al. 1998). In fact, five of the eleven sticky price theories mentioned above have never been evaluated in the existing literature. Further, studies similar to Blinder et al. (1998) have not been implemented on the recent and rich Canadian PSS data. This paper aims to fill the void of the existing literature by evaluating the roles of, and the micro foundations for, the sticky price theories based on the Canadian PSS data.

---

[3] Blinder et al. (1998) add the idea of the time and effort of collecting information. Amirault et al. (2005) and Fabiani et al. (2004) use the traditional definition of the theory. Wolman (2000) gives an excellent literature review on this theory.

3 Canadian Price-Setting Survey Data

In this section we first describe the key features of the Bank of Canada Price-setting Survey and we then explain the two key variables of this research (a) the frequency of price adjustment and (b) the importance rating of each sticky price theory.

3.1 The Survey

The Canadian Price-Setting Survey, or the Canadian PSS, data was collected by the Bank of Canada from 170 private, for-profit, unregulated, and non-commodity-producing firms across Canada which represents the Canadian economy in terms of industry sector, firm size and, to some extent, regional distribution. This survey can provide a reasonable insight into the price-setting behaviour of Canadian firms (see Amirault et al. 2005). It is worth noting, however, that this survey method is quite limited in a sense that some potential bias inherently with this survey may limit the degree to which inference can be made from the sample for the Canadian economy (see Appendix A for a more information). Nevertheless, the Canadian PSS also has some merits. First, the design of the Canadian PSS takes advantage of the findings from the U.S. and the U.K. surveys by utilizing the previously well received and better defined questions (such as the theory rankings), while discarding those questions that are difficult to interpret (such as questions about marginal cost) (see Amirault et al. 2005). Second, the Canadian PSS data does not contain any missing values (differing from Blinder et al. 1998 and Fabiani et al. 2004); all questions were answered by small, medium and large firms in various industries. This rich dataset permits detailed investigation that was not possible in the existing literature.

The Canadian PSS data contains descriptive measures on each firm's price-setting behaviour, firm's features, and their business environment. The information includes the firm's cost structure, product distribution, sales under contracts, and roles in setting prices (see Appendices B1 and B2 for more information on variable definitions and descriptions).

9

3.2 Price-adjustment Frequency Distribution

The first key variable of interest in this research is the price-setting frequency of Canadian firms that records how many times these firms actually adjusted transaction prices in the past 12 months. As shown in Figure 1, 8 per cent did not change prices at all in the past twelve months, 27 per cent of the firms changed prices once, 18 per cent of the firms changed prices more than 52 times, and 6 per cent of the firms changed prices 365 times. The median number of price changes is four times a year. Unlike many other economic variables, this variable takes on integer values greater than or equal to zero and has a unique distribution. The large number of fewer than two price changes, and the smaller number of highly frequent price changes make the distribution of this variable bounded at zero and stretched to the right, giving a clear sign of a non-normal distribution. As also seen in Figure 1, this distribution is very similar to the results found by Blinder et al. (1998) for the American study. In both cases, the observation of the high price-adjustment frequency indicates that the statistics of the price-adjustment frequency based on the monthly CPI data for products/services are likely to underestimate the actual frequency of price adjustment because the CPI data are collected monthly and may well be incomplete or right-censored.

3.3 Firms' Evaluations of Sticky Price Theories

The second key variable of interest in this research is the importance ranking of each of the eleven sticky price theories from the firm's point of view. According to Amirault et al. (2005), cost-based pricing (67%) and customer relations (55%) are clearly the most recognized theories, while explicit contracts (45%), non-price competition (44%), and coordination failure on price increase (41%) are ranked significantly higher than the remaining six other theories. On the other extreme, menu costs

(21%) and sticky information (14%) are ranked as the least recognized theories. These Canadian findings are similar to those found in other surveys.[4]

In the Canadian PSS, the importance rating for six of the eleven theories where recorded as ordinal multinomial responses such as 0, 1, 2, and 3, while that of remaining five theories are in binary responses such as 0, 1 (see Table 4)[5]. We note that very few firms (7 of 170) found the sticky information theory very or fairly important. To estimate the ordered probit model for the sticky information theory would be technically possible but not desirable as the case lacks enough observations for certain responses. Hence, for this theory we convert the ordinal multinomial responses to binary responses and consider the probit model rather than the ordered probit model.

The frequency of price adjustment and the importance rating of each sticky price theory. The former is regarded as count data (how many times the price has been adjusted in the past twelve months) while the latter are measured as either ordinal multinomial or binary responses (ranging from totally unimportant to slightly, fairly, or very important). Because the count data and ordinal multinomial/binary response data cannot be modeled by the classical linear regression framework, this research will use count data models for the former and probit and ordered probit models for the latter.

4 Modelling Price-adjustment Frequency

In the existing literature, little attention has been paid to the modelling of the price-adjustment frequency in terms of firms' features, their business environments and recognition of various sticky price theories. In this research we use the Canadian PSS data to analyze how the price-adjustment frequency is determined at the firm level. First, we provide motivation for using the negative

---

[4] In particularly, the highly recognized cost-based pricing theory coincides with the finding of Fabiani et al. (2004) that many firms have a mark-up type formula in their pricing. Blinder et al. (1998), Hall et al. (2000) and Apel et al. (2000) all have similar rankings.

[5] For practical purposes, we divide the 11 theories into two groups because of the division in the importance ranking response. The theories that have ordinal multinomial responses will be referred to as group one, and the theories with binary responses will be referred to as group two.

binominal regression model (NBRM). Then, we discuss our covariate selection process. Finally, we report and interpret the estimation results.

4.1 Model and Specification

4.1.1 Factors Affecting the Frequency of Price-Adjustment

The potential explanatory variables for the price-adjustment frequency include some conventionally used variables: variable cost, economies of scale, industry type, competition, contract utilization, customer types, and product destinations. We also consider some other explanatory variables which are unique in this research. First, we include in our model pricing triggers, which are regular price changes, wage changes, price changes of domestic inputs, changes in taxes, fees, or other costs, competitors' price changes, exchange rate changes, changes in demand conditions, changes in economic forecasts, sales campaigns, and parent company directives/incentives. Second, we also add to our model the variables capturing the degree of recognition of all eleven price-setting theories noting the fact that the firm tends to internalize its business conditions described by relevant theories. Third, we include into our model a set of unique market structure variables only found in the Canadian PSS such as information lag in price-setting information, price leadership, price leadership in the industry, and buyer concentration (please see Appendices B1 and B2 for detailed definitions of all variables)[6].

As a preliminary step in our analysis, we evaluate a set of linear and non-parametric pair-wise correlations between our variable of interest and each of potential explanatory variables.[7] The basic statistics show that region, industry type, firm size, contract utilization, competition, price leadership, sales destination, and state-dependent pricing are correlated linearly or nonlinearly with the price-

---

[6] Several other variables are used in Bils and Klenow (2004) (raw vs. processed products, and import share), Dhyne et al. (2004) (seasonality, outlet type, taxes, and product specific inflation), and Blinder et al. (1998) (hierarchical delays theory recognition, judging quality by price theory recognition, and cycle sensitivity), but are not available in the Canadian PSS.
[7] All basic statistical results are available upon request.

adjustment frequency. In addition, the price-adjustment frequency is significantly correlated with some sticky price theories. While it is useful to explore the pair-wise relationship between the price-adjustment frequency and each of its plausible determinants as in Amirault et al. (2005), it is not sufficient, as it ignores some other important determinants and may produce spurious correlation relationships that lead to incorrect conclusions. A more desirable strategy is to consider a large set of covariates that affect the price-adjustment frequency jointly.

4.1.2 Negative Binomial Regressions Model

Because our variable of interest, the price-adjustment frequency, takes on nonnegative integers and demonstrates the properties of a count process, we use count data models because these models can accommodate the non-negativity and non-normality of frequency data and link the data to a set of covariates.

The simplest count data model is the Poisson regression. Let y_i be a draw from the Poisson distribution with parameter m_i. Let x_i be a $k \times 1$ column vector of i th observations of k independent variables. It is known that under the assumption that the probability of Y_i given x_i follows the Poisson distribution; that is

$$\Pr[Y_i = y_i \mid x_i] = P_i = \frac{e^{-m_i} m_i^{y_i}}{y_i!}, \tag{1}$$

for $i = 0, 1, 2, \ldots$. Here $m_i = m_i(x_i, \; b)$, the most-used functional form of which is

$$m_i = \exp(x_i' b) \tag{2}$$

or

$$\ln m_i = x_i' b \tag{3}$$

13

where $\boldsymbol{b}$ is a $k \times 1$ column vector of parameters. It can be shown that the expected number of events per period is

$$E(y_i \mid \boldsymbol{x}_i) = \exp(\boldsymbol{x}_i' \boldsymbol{b}), \qquad (4)$$

which is identical to the variance of the number of events per period

$$(5)$$

$$Var(y_i \mid \boldsymbol{x}_i) = \exp(\boldsymbol{x}_i' \boldsymbol{b}).$$

The latter imposes a strong restriction to the Poisson regression model. The Poisson regression model can be estimated by the maximum likelihood method assuming the observations are i.i.d. and the model is correctly specified. The marginal impact of $\boldsymbol{x}_i$ is not $\boldsymbol{b}$ but

$$\frac{\partial E(y_i \mid \boldsymbol{x}_i)}{\partial \boldsymbol{x}_i} = \exp(\boldsymbol{x}_i' \boldsymbol{b}) \boldsymbol{b} = \boldsymbol{m}_i \boldsymbol{b}. \qquad (6)$$

This implies that when one wishes to interpret the estimation results, the sign of the parameters can be interpreted in terms of the direction of the impacts of the independent variables. But if one wishes to give quantitative information on the marginal impact of one particular independent variable within with $\boldsymbol{x}_i$ on the expected value of counts y_i, the corresponding beta estimate must be multiplied by the expected rate of events period for y_i.

The equal-dispersion is considered the major restriction of the Poisson regression model. The most common alternative count data model is the negative binomial regression model which is more general than the Poisson regression model and can accommodate cross-section heterogeneity. The key change from the Poisson regression model to the negative binomial model is to add a term $\boldsymbol{e}_i$ to $\boldsymbol{x}_i' \boldsymbol{b}$ so that

$$\ln \boldsymbol{m}_i = \boldsymbol{x}_i' \boldsymbol{b} + \boldsymbol{e}_i \qquad (7)$$

where $\ln \boldsymbol{m}'_i = \boldsymbol{x}'_i \boldsymbol{b}$ ($\ln \boldsymbol{m}'_i$ was defined as $\ln \boldsymbol{m}_i$ in the Poisson regression model) and $\ln u_i = \boldsymbol{e}_i$. Now, with this additional structure, the distribution of y_i conditional on $\boldsymbol{x}_i$ and u_i is also the Poisson distribution with conditional mean and variance $\boldsymbol{m}_i$:

$$f(y_i \mid \boldsymbol{x_i}, u_i) = \frac{e^{-\boldsymbol{m}'_i u_i} (\boldsymbol{m}'_i u_i)^{y_i}}{y_i!}. \qquad (8)$$

However, the distribution of u_i must be specified here. The most common practice is to assume that the distribution is the gamma distribution with an additional dispersion parameter $\boldsymbol{a}$ for $u_i = \exp(\boldsymbol{e}_i)$. The variance of $\exp(\boldsymbol{e}_i)$ is normalized to 1, $Var[\exp(\boldsymbol{e}_i)] = 1$, to make the model identified. It can be shown that, with this normalization and the gamma distribution for u_i, $f(y_i \mid \boldsymbol{x}_i, u_i)$ becomes the negative binomial distribution with dispersion parameter $\boldsymbol{a}$. If $\boldsymbol{a} = 0$, the negative binomial regression model becomes the Poisson regression model. The larger the value of $\boldsymbol{a}$, the greater the dispersion of y. The negative binomial regression model can be estimated by the maximum likelihood method. It provides the estimates for $\boldsymbol{b}$ and $\boldsymbol{a}$ and standard errors of these estimates. It is possible to use the likelihood ratio test to verify if $\boldsymbol{a} = 0$.

In order to model the price-adjustment frequency, we must make two decisions.[8] The first decision is to consider which explanatory variables should be included in our model, and the second decision is to set up the baseline case. According to the preliminary statistical analysis (tables are available upon request) and existing findings in the literature, we include in our model the following variables reflecting: region, industry type, the number of employees, variable cost, and firm size, number of competition, contract utilization, price leadership, and information delays. Although buyer concentration, product destination, and consumer type are largely insignificant in the preliminary

---

[8] In addition, we also consider how to scale some of the scale variables to make the model a better fit. For example, we have found that we can improve the fitted models by standardizing scale variables.

statistical analysis, we still consider them in our model on a theoretical basis. In addition, we include the dummy variables for the "very important" response for all ordinal responses theories in the first group and all price triggers. Lastly, we also include the variables for the five theories in the second group in our model.

Second, because of a large number of categorical explanatory variables that are used in the model, we need to select a baseline case. When appropriately transformed, the estimated coefficients of the model must be interpreted as the marginal effects with reference to this baseline case. This baseline case is selected to be a firm with the average number of employees (about 2800), in the service sector in British Columbia, which operates in an industry without a price leader and has about half of its sales contracted and about 30 direct competitors. This firm also has no information delays (less than 24 hours), and has about 60 per cent of its sales to other businesses in its home region. The firm indicated that regular price-adjustments are very important, and are therefore a time-dependent price setter. Lastly, this baseline firm has less than 10 per cent of its sales to its top five buyers, and the firm believes that neither sticky price theory nor pricing trigger (except the variable REGULAR) is very important.[9]

4.2 Empirical Findings

The estimation results of the count data models appear in Table 5. This table presents the unrestricted negative binominal regression model in column three, the restricted model[10] in column four, and the marginal effect of a unit change [see equation 6] on the number of yearly price-adjustments in column five. The indication over-dispersion in each model is given by the level of significance of the constant alpha term at the bottom of the table. An alpha significantly different from zero indicates the presence

---

[9] The variable name in parentheses is used in Appendices B1 and B2 and in the table for estimation results.
[10] The restricted model was selected by eliminating all insignificant variables from the unrestricted model estimating based on likelihood ratio tests.

of over-dispersion. This is what we have in all cases and, therefore, we can conclude that the negative binomial regression model is a suitable choice.

In our unrestricted model, we find that a firm's size, region, industry type, customer type, and product destination are all highly significant. Similarly, recognition of the several theories and pricing triggers, and state-dependent price setters, are also among the most significant variables. Further, cost structure, buyer concentration, competitors and contracted sales are significant to a lesser extent.

To refine our model, we identify the restricted model and report it in columns four of Table 5. The resulting restricted model keeps many explanatory variables that are statistically significant in the unrestricted model. The Akaike's information criterion (denoted "aic" in the tables) of the restricted model is lower than that of the unrestricted model. The likelihood ratio test between the restricted and the unrestricted model supports the specification of the restricted model.

4.3.1 Marginal Effects

Based on the estimation results of the restricted model, we present the marginal effects associated with the parameter estimates in column 5 of Table 5. The marginal effect associated with each coefficient estimate has an intuitive interpretation. If an explanatory variable changes by a unit, the marginal effect gives the additional number of adjustments in prices; in other words, the marginal effect is the change in the estimated count triggered by a change in firms' features or behaviour. In this restricted model, the variables for variable costs, product destination, consumer type, contract utilization, and competitors are standardized. Hence, for these variables, when these variables have a one-standard-deviation change, the marginal effect represents the additional price-adjustment count. The summary statistics for these variables are found in Table 6.

The estimation results of the count model indicate that when setting prices, the Canadian firms respond to a wide range of factors. The estimation results also provide quantitative evidence of the

substantial role of most important factors in Canada. In Table 5, the variables highlighted in dark grey are quantitatively highly important as they can show how the price-adjustment frequency can be changed from the baseline case by these variables. The variables highlighted in light grey are also quantitatively important. We have the following detailed observations about the estimated marginal effects.

First, all selected explanatory variables have positive marginal impacts in terms of counts or fractions of a count relative to the baseline case. This shows that cost structure, firm size, industry sector, sales destination, market structure, input costs and wage changes, information delay, contracts, and the number of competitors are all playing some role in determining the price-adjustment frequency. Second, the market structure affects the price-adjustment frequency of the firms. The largest impact comes from the number of competitors; if the number of competitors experiences a one-standard-deviation change around the mean, then the frequency of price adjustment increases about thirty-three times. If a firm is in retail or wholesale trade, is in Ontario or Quebec, uses contracts, or is a state-dependent price adjustor, it tends to adjust prices about five times more. Third, supplier type (sellers to other domestic customers and exporters), wage and input costs changes, information delays, price leadership, and several sticky price theories (menu costs, factor stability, customer relations, sticky information, and coordination failure on price increase) all have minor impacts of the order of less than three times of price-adjustments. Fourth, some factors do not affect price-adjustment frequency as much with reference to the baseline case. These include firms in goods sector, firms in Atlantic Canada or prairie provinces, firms with sales to the public sector, firms that respond to some price triggers (such as changes in fees and other costs, exchange rates, demand, and forecasts), firms acting as a price leader, firms with some information delay (by day, week, and more than a month), and firms recognizing some sticky price theories (non-price competition, lower inflation theory, coordination failure on price decline, cost-based pricing, and implicit and explicit contract theories).

4.3.2 Sensitivity Analysis

In Table 6 we report the results of the same negative binominal regression models with an alternative baseline case. We undertake this analysis to examine the robustness of the model. Our categorical variables remain the same in this alternative baseline case but we use the raw scale variables rather than their standardized counterparts. By doing so this alternative baseline case becomes a small firm (six employees) in the finance, insurance and real estate industry located in B.C. This firm sells to business in its home region, does not use any contracts and has no direct competitors. As in the original baseline case, this firm also has no information delays and is a time-dependent price adjustor, and it sells less than 10 per cent of its sales to its top five buyers, and believes that neither sticky price theory nor pricing trigger (except the variable REGULAR) is very important.

When we adopt this alternative baseline case, we find that the magnitude of the marginal effects for each of the scale variables is significantly higher, and the constant term is insignificantly different from zero. In essence, moving from the original baseline case to the alternative one is to examine marginal effects from the perspective of a low-frequency price adjustor rather than a high-frequency price adjustor. Note that the sign and level of significance of the parameter estimates in the restricted model of the alternative baseline case are identical to those of the original baseline case. The maximized values of the two log-likelihood functions are also identical. The major difference between these two models, as seen in column five of Table 5 and Table 7, is that in the restricted model of the alternative baseline case, a unit change in a firm's variable cost, sales outside of its home region, sales to household, and contracted sales leads to a smaller/greater number of marginal price-adjustment frequency depending on the negative/positive sign of the beta coefficient estimate. The coefficient estimates associated with other categorical variables remain more or less unchanged. This indicates

that the two baseline cases are both acceptable depending on which will make the interpretation straightforward.

5 Evaluations of Sticky-Price Theories

Having analyzed how the price-adjustment frequency is determined, we now turn to the issue of what motivates a firm to recognize a specific form of sticky price-setting behaviour? In this part of the study, we first analyze the relationship between importance ratings and then we examine how the importance ranking of each sticky price theory is determined by the microeconomic foundations at the firm level.

5.1 Patterns of Sticky Price Theory Evaluation

We begin our analysis by considering correlations and tests of independence among the various patterns of theory recognition to gain some insight as to whether they are necessarily mutually exclusive. For example, firms might indicate that they hold back on a price increase prior to any action of their competitors (i.e., coordination failure) because they fear antagonizing customers (i.e., customer relations).

The variables for theory recognition responses are ordinal (see Table 4); we group those with multinomial responses into the first group of theories and those with binary responses into the second group. To calculate the correlations between all eleven theories we adopt two methods. First, we use the Goodman-Kruskal gamma correlation coefficients [11] to measure the correlations between every pair of all theories including both the first and second groups. Second, we tabulate the Pearson chi-squared tests of independence between every pair of theories in the second group.

---

[11] This method is suggested and used by Blinder et al. (1998). This correlation coefficient takes into account the ordinal nature of the data. We can interpret it roughly as a regular correlation coefficient since its value is bounded between zero and one. See Goodman and Kruskal (1954). Alternatively, we could have used the Spearman's non-parametric rank test for independence - the results almost identical.

We find that many of the gamma correlations are relatively small in value and that all but one of the significant correlation coefficients are positive.[12] This suggests that many of these theories recognized by the Canadian firms are net complements, as opposed to net substitutes. The most recognized theory that is complimentary to other theories is coordination failure on price increase. This theory is positively correlated with three other theories (implicit contracts, consumer relations, and low inflation) and negatively correlated with one (explicit contracts) – the only negatively correlated pair of theories. Non-price competition and factor stability are not significantly correlated with any first-group theories. The highest correlation is between implicit contracts and customer relations.

Similarly, the correlation between coordination failure on price decline and coordination failure on price increase is positive and strong. Firms that recognize the importance of coordination failure on price increase, also identify customer relations, implicit contracts and low inflation as important deterrents of price-adjustments. Customer relations and cost-based pricing are significantly correlated with coordination failure on price decline.

Explicit and implicit contracts are both significantly correlated with sticky information and cost-based pricing, but not with each other among themselves. The near zero correlation between explicit and implicit contracts provides little support for Blinder et al.'s (1998) finding that the two theories are net substitutes. There is also a positive correlation between the importance of sticky information and that of cost-based pricing.

We find that among the theories in the second group the recognition of customer relations and factor stability are related to three other theories of the second group, while low inflation and non-price competition are related to all other theories in the group except menu costs. The interdependent relations among low inflation, factor stability, and non-price competition all point to the difficulty in

---

[12] All basic statisitical results are aviable upon request.

changing sticky prices because price changes are more noticeable (either because of low inflation, economic stability or competition) which may disturb customer relations.

5.2 Model and Specification

In this section we try to identify firm and industry characteristics that explain the relative importance of these sticky price theories to the firm. In order to do so, we identify and evaluate potential explanatory variables that can explain the roles of sticky price theories in the framework of probit and ordered probit models.

5.3.1 Explanatory Variables

We consider a list of firm and market characteristics that may influence a firm's recognition of a given sticky price theory. These variables are the economies of scale, industry type, variable cost, state-dependent pricing, competition, sales destinations, contract utilization, price-adjustment frequency, recognition of other sticky price theories, pricing triggers, buyer concentration, information delay, price leadership, and region (tables are available upon request). Of course, the price-adjustment frequency can be used here to be the proxy for price-setting behaviour.

5.3.2 Econometric Model

The ordered probit model is suitable to the situation where there are two or more ordered choices represented by integers. For simplicity, we let the number of the ordered integer choices be three. This model can be derived from the latent variable model of the following kind:

$$Y_i^* = x_i' b + u_i, \quad u_i \overset{iid}{\sim} N(0, \ 1). \tag{9}$$

However, we cannot observe Y_i^*. Instead, we can observe Y_i, which takes on values according to the following decision rules:

$$
\begin{aligned}
Y_i &= 0 \quad \text{if} \quad\quad Y_i^* < a_1; \\
Y_i &= 1 \quad \text{if} \quad a_1 \leq Y_i^* < a_2; \\
Y_i &= 2 \quad \text{if} \quad\quad Y_i^* \geq a_2.
\end{aligned}
\tag{10}
$$

where $a_1 < a_2$ is required for these threshold parameters for making Y_i observable.

Note that vector $\boldsymbol{x}_i$ in equation (9) does not need to contain a constant. If it had a constant as one of its elements, we would have an intercept term say $\boldsymbol{b}_1$. In this case, the revised decision rules can be written as

$$
\begin{aligned}
Y_i &= 0 \quad \text{if} \quad\quad Y_i^* < a_1 + \boldsymbol{b}_1; \\
Y_i &= 1 \quad \text{if} \quad a_1 + \boldsymbol{b}_1 \leq Y_i^* < a_2 + \boldsymbol{b}_1; \\
Y_i &= 2 \quad \text{if} \quad\quad Y_i^* \geq a_2 + \boldsymbol{b}_1.
\end{aligned}
\tag{11}
$$

That is, we really cannot identify the threshold parameters. It seems reasonable that we should use the simplest way to deal with this problem by forcing $\boldsymbol{x}_i$ to be a vector of variables with no constant term. If this solution is adopted then the number of thresholds (e.g., a_1 and a_2) is the number of ordered choices (e.g., $Y_i = 0, 1, 2$) minus one. For example, if $Y_i = 0, 1$, we will return to the case of the binary probit model. The parameters such as $\boldsymbol{b}$, a_1, and a_2 can be estimated by the maximum likelihood method.

Our baseline case is selected to be a firm with the average number of employees (about 2800), in the finance, insurance, and real estate sector in British Columbia, which operates in an industry without any price leader and has about half their sales contracted and about 30 direct competitors. This firm faces no information delays (24 hours or less) and has the majority (about 60 per cent) of its sales to other business in their home region. This firm considers regular price-adjustments very important,

and is therefore a time-dependent price setter. Lastly, our baseline firm has less than 10 per cent of its sales to the top five buyers, and considers neither any sticky price theory nor pricing trigger (except the variable REGULAR) as important.

5.4 Analysis of Empirical Results

In this section, we analyze the estimation results for all eleven sticky price theories. These estimation results are for the selected models identified via the model selection process. Table 8 gives the estimation results for five ordered probit models. Table 9 presents the estimation results of six probit models. The likelihood ratio tests (shown as "the chi-squared tests" in the tables) and log-likelihood functions are presented at the bottom of the tables. By examining the estimated coefficients of these models, we attempt to answer the following questions: (a) For each theory, what are the statistically significant firm and market characteristics that serve as micro foundations for firms' subscription to the theory? (b) For all theories, what firm and market characteristics constitute the micro foundations in the Canadian context for sticky prices? We shall discuss them in turn.

5.4.1 Ordered Probit Model Results
Table 8 displays the estimation results for the theories of coordination failure on price decline and price increase, cost-based pricing, and explicit and implicit contracts.

Coordination Failure (On Price Decline and Price Increase)
The first interesting finding is that the factors that affect the recognition of two coordination failure theories are similar. For theories, firm size, industries type (construction, retail trade, commercial, business and personal services, information, culture, utility and transportation), location (Prairie Provinces), responsiveness to price changes by competitors, presence of industry price leaders, and

24

firms' subscription to customer relations and cost-based pricing theories determine the recognition coordination failure as an important reason for not adjusting prices often.

As noted earlier, firms' recognition of coordination failure on price increase as very important, not on price decline, is a significant factor in explaining the price-adjustment frequency. To appreciate this asymmetry, it is useful to see how different forces affect the two cases. As shown in Table 8, the significant factors unique to the coordination failure on price decline theory (COFAILDEC) are sales to households and other domestic regions, degree of response to domestic inputs cost changes and parent company's directives, firms experiencing information delay of one month, and firms having high menu costs for changing prices. On the other hand, as shown in Table 8, the significant factors unique to the coordination failure on price increase theory (COFAILINC) are firms with sales to governments, firms selling their 11-25% sales to top five buyers, and firms responding to changes in foreign exchange rates, and the recognition of non-price competition and low inflation theories. As can be seen from the above lists, the two theories have some common determinants, as well as some specific factors of their own.

These results further confirm the findings of Blinder et al. (1998), Amirault et al. (2005), and our own based on the count data model that coordination failure is not universally recognized and has asymmetric impacts on prices. Further, the significant factors in the model identify the micro foundations of firms for subscripting the theories. That is, firms who recognize these theories are more responsive to competitors' price change and regard cost-based pricing and customer relations very important. All of these results are evidently consistent with a very competitive market setting where coordination failure may still occur.

Cost-based Pricing

According to the estimation results in Table 8, the higher level of variable cost that the firm faces, the more likely the firm will recognize cost-based pricing. In addition, cost-based pricing is more recognized by smaller and medium sized firms. Firms in information, culture, technology and transportation industries are more likely to recognize cost-based pricing. Cost-based pricing is more recognized in Quebec than other regions in Canada. The evidence also shows that firms selling more than 50% of their output to a top five buyers, pricing according to the wage bills, domestic inputs and foreign exchange would practice cost-based pricing. The firms that review prices of their own products and services as state-dependent price setters tend to avoid cost-based pricing. The competition pressure forces firms move away from cost-based pricing, but being a price leader induces the cost-based pricing behaviour. The firms that recognize cost-based pricing also recognize the theories of factor stability, sticky information, and coordination failure on price decline but not low inflation.

Two prominent factors serve as the micro foundations of this theory: (a) firms that recognize cost-based pricing are sensitive to cost changes (wages, domestic inputs, and foreign exchange movements) in triggering price-adjustments, and (b) these firms are also more likely to be time-dependent price setters reflecting regular price reviewing practices.

Explicit and Implicit Contracts

For explicit and implicit contract theories, the only common significant factors are the practice of cost-based pricing, the concern with customer relations, and, to a lesser extent, the presence of menu costs, all of which lead to price rigidity. It is found that retail trade is the only industry in which the explicit contract theory is not considered important. But for the firms selling to governments, the explicit contract theory is considered important. Firms selling 11-15% of output to five top buyers also tend to find contract utilization important. If firms adjust prices according to foreign exchange rates, they are more likely to recognize the explicit contract theory. Typically, firms setting prices according to one

day information delays are more likely to identify with this theory. Implicit contracts, on the other hand, are more prominent in the industries other than commercial, personal and business service, and information technology, culture, transportation, and manufacturing sectors. Implicit contracts are also less likely to be used between households and businesses than used among other businesses, and are more important when firms have a more diverse consumer base.

It should be noted that many firms recognize the importance of nominal contracts, customer relations and cost-based pricing simultaneously. This implies that sometimes price rigidity is not entirely caused by the legal or contractual obligations. The consumer relations and cost-based pricing are also important factors that may prevent firms from changing prices promptly in responses to economic conditions. Because of this observation, we cannot always attribute the price rigidity to explicit contracts. We find that consumer relations and cost related considerations can be more important factors in price rigidity. This finding is consistent with that of Amirault et al. (2005).

5.4.2 Probit Models Results

Table 9 provides the estimation results for the theories of stick information, menu costs, factor stability, consumer relations, non-price competition, and low inflation.

Sticky Information

This is one of the least recognized theories. As shown in Table 9, firms who recognize this theory are in the industries of construction, manufacturing, and commercial, business and personal services. They are likely to be located more in Atlantic Canada than in Quebec and the Prairies. These firms primarily sell to the households outside their own region. To these firms, changes in wage, demand, and foreign exchange rates are not very important in price-setting. While subscribing to the sticky information theory, they also recognize information delayed by one day or more than a month delay as important

27

and have a larger number of direct competitors. They are state-dependent price setters, and utilize contracts for more than the average firms in terms of the percentage of sales. These firms also view explicit contracts and cost-based pricing very important to their businesses.

Menu Costs

The menu costs theory is another of the least recognized theories but it is an important explanatory variable in our frequency of price-adjustment model. As noted in Table 9, firms that recognize this theory have high buyer concentration (>50 per cent) and significant information delays (more than a month). These firms are less likely to be contract sellers or time-dependent price setters. They face price leaders in their industries and relate to factor stability and explicit contracts theories. Contrary to the conventional belief, the number of employees is in fact not a factor influencing menu costs. It appears that the combination of the information delays, explicit contracts, and buyer concentration constitute the micro foundations for firms to recognize the menu costs theory.

Factor Stability

As shown in Table 9, firms that recognize factor stability are those in the information technology, culture or transportation industries. These firms are less likely in Quebec than in any other regions in Canada. They primarily sell directly to consumers. To these firms, changes in domestic input prices or in competitors' prices play a lesser role. These firms are more likely to identify with the factor stability theory if they face less information delays. They are more likely to be state-dependent price setters. These firms will be less likely to recognize this theory if they are in the industries where there are price leaders. We also found that these firms also recognized menu costs, non-price competition, low inflation theories, and cost-based pricing as important. The sensitivity of firms to price review and to information delay serves as the important micro foundations for this theory.

Customer Relations

As shown in Table 9, firms that recognize customer relations theory are generally smaller firms in the industries of construction, commercial, business and personal services, and information technology, culture and transportation. The firms are more likely located in Ontario but less likely in Quebec. These firms are likely to provide goods and services across borders. The information delay and contracts sales are less important to these firms. To maintain good customer relations, these firms neither make prompt use of information in price adjustment nor utilize contracts. They view the existence of price leaders in their industries as important. These firms also recognize low inflation, sticky information, and coordination failure on price decline. The above analysis illustrates that the micro foundations of this theory are that firms of the above types are typically more sensitive to customer relations because of the types of industries they are in and the types of clients they serve.

Non-price Competition

Table 9 shows that the recognizing non-price competition is less likely in all sectors except construction (which is in our baseline case). These firms sell their products and services to other domestic regions and pay attention to the price change initiated by their competitors and sales campaigns. These firms also consider low inflation and cost-based pricing important but not so much of coordination failure on price decline and explicit contracts.

Low Inflation

The low inflation theory appears to have its support from a rather limited number of firm and market characteristics. According to Table 9, the firms recognizing this theory are primarily those that sell to governments. They are less likely to sell across borders and less sensitive to the price changes of

competitors. These firms view factor stability, customer relations, and non-price competition as important but sticky information and implicit contracts as less important.

5.4.3 Most Important Factors Common to All Sticky Price Theories

What firm and market characteristics constitute the common micro foundations of all existing sticky price theories? From Tables 8 and 9, we find that industry type, customer type (households, government, or businesses), product destination (domestic or export), information availability, contract utilization are among the most significant firm and market characteristics. In addition, region, buyer concentration, state- vs. time-dependent pricing, and recognition of competitor price change, exchange rate changes are also important factors.

As noted previously, the above factors not only affect firms' subscription to various sticky price theories but also affect their price-adjustment behaviours and hence their price-adjustment frequencies. These two dimensions are all couched in the same environment. These factors constitute the micro foundations of firms' price-setting behaviours and beliefs.

6 Conclusions

Using the data collected by the 2002-03 Bank of Canada Price-setting Survey, we have explored the price-setting behaviours of Canadian firms. The main contribution is that this work adds new empirical evidence from the Canadian firms to the profound literature of price-setting behaviours and sticky price theories in macroeconomics.

In this research, we attempt to address the central question of which firm and market characteristics affect price-adjustment frequencies. We find that firms that are state-dependent price setters, firms in the trade sector, firms with larger variable costs and more direct competitors, and firms located in the provinces of Ontario and Quebec, tend to adjust prices more frequently than other

firms, all else being equal. In addition, when firms recognize the theories of coordination failure on price increase, sticky information, menu costs, factor stability, and customer relations, they tend to adjust prices less frequently.

In this research, we also try to investigate the central question of what kind of micro foundations cause firms to recognize some sticky price theories but not others. We find that industry type, customer type (households, government, or businesses), product destination (domestic or export), information availability, and contract utilization constitute the micro foundations for recognizing most sticky price theories. Furthermore, we find that coordination failure, cost-based pricing and customer relations are the most supported sticky price theories by Canadian data; that is, these highly recognized theories match the empirical findings well.

In this research, we have several more general contributions to the sticky price theory and macroeconomic literature. First, contrary to the findings of Blinder et al. (1998) and Amirault et al. (2005), we find that both the sticky information and menu costs theories are important sources of rigidity as they lower the price-adjustment frequency, albeit in only a small percentage of firms. Second, our findings support Blinder et al.'s (1998) conclusion that sticky price theories are not mutually exclusive, and we conclude that customer relations and cost-based pricing are the most complimentary sticky price theories (as well as the most highly recognized). Third, the theories of customer relations, cost-based pricing and coordination failure (on price increase) are strongly supported by the Canadian data. Fourthly, this research also provides some useful information on firm disaggregation. For example, we find that larger firms are more concerned with coordination failure than using cost-based pricing or worrying about customer relations, and manufacturers recognized sticky information theory more than any other theory, all else held constant. Fifthly, state-dependent price-setting firms change prices much more frequently than time-dependent price setters. According Amirault et al (2005), we know that this is approximately 34 per cent of firms in the private, non-

31

commodity producing sectors of the Canadian economy (much higher than the US results presented by Klenow and Kryvtsov 2005). Overall, this research shows that firms will adjust prices in ways which maximize their interests based on their firm and market characteristics or micro foundations. This firmly shows the importance of how to classify firms into different groups and how to endogenize price-setting behaviour in macroeconomic modelling.

The findings in this paper will no doubt enrich our understanding about the price-adjustment process at the firm level. Among many researched industrial countries, the mean price-adjustment frequency of Canadian firms is the highest. Although there is some sluggishness of price-adjustment among the Canadian firms due to various business practices, it appears that the openness and competitive nature of the Canadian economy will permit firms to react to various economic forces fairly efficiently.

References

Amano, R. S. Amble and N. Rebei. "The Macro Effects of Non-Zero Trend Inflation". Bank of Canada Working Paper. Forthcoming, 2006.

Amirault, D., C. Kwan, and G. Wilkinson. "Price-setting Behaviour of Canadian Firms." Bank of Canada Working Paper. Forthcoming, 2005.

Apel, M., R. Friberg, and K. Hallsten 2001. "Microeconomic Foundations of Macroeconomic Price Adjustment: Survey Evidence from Swedish Firms." Sveriges Riksbank Working Paper No. 128.

Ball, L. and D. Romer. 1991. "Sticky Prices as Coordination Failure." *American Economic Review* 81(3): 539-552.

Barro, R.J. 1972. "A Theory of Monopolistic Price Adjustment." *The Review of Economic Studies* 39: 17-26.

Bils, M. and P.J. Klenow. 2004. "Some Evidence on the Importance of Sticky Prices." *Journal of Political Economy* 112(5): 947-985.

Blinder, A.S. 1991. "Why Are Prices Sticky? Preliminary Results from an Interview Study." *American Economic Review* 81: 89-96.

Blinder, A.S., E.R.D. Canetti, D.E. Lebow, and J.B. Rudd. 1998. *Asking About Prices: A New Approach to Understanding Price Stickiness.* New York: Russell Sage Foundation.

Buckle, R. and J. Carlson. 2000. "Menu Costs, Firm Size and Price Rigidity." *Economics Letters* 66: 59-63.

Calvo, G. A. 1983. "Staggered Pricing in a Utility Maximizing Framework," *Journal of Monetary Economics* 12(3): 383-398.

Carlton, D. 1989. "The Theory and Facts About How Markets Clear: Is Industrial Organization Valuable for Understanding Macroeconomics?" In *Handbook of Industrial Organization*, Vol. 1: 910-943. Amsterdam: North Holland.

Cecchetti, S. 1986. "The Frequency of Price Adjustment: A Study of the Newsstand Prices of Magazines." *Journal of Econometrics* 31: 255-274.

Clower, R. 1965. "The Keynesian Counter-revolution: a theoretical appraisal." In *The Theory of Interest Rates*, 103-125. London: Macmillan.

Cooper, R. and A. John. 1983. "Coordinating Coordination Failures in Keynesian Models." *The Quarterly Journal of Economics* 103(3): 441-463.

de Walque, G. F. Smets and Raf Wouters. 2004. "Price Setting in General Equilibrium: Alternative Specifications". Eurosystem Inflation Persistence Network Conference Paper. < http://www.ecb.int/events/pdf/conferences/inflationpersistence/walquesmetswouters.pdf > (January 24, 2006).

Dhyne, E., L.J. Álvarez, H. Le Bihan, G. Veronese, D. Dias, J. Hoffman, N. Jonker, P. Lünnemann, F. Rumler, and J. Vilmunen. 2004. "Price-setting in the Euro Area: Some Stylised Facts from Individual Consumer Price Data." (November 2004) <URL: http://www.ecb.de/events/pdf/conferences/inflationpersistence/sumamrysession2.pdf > (1 May, 2005).

Engel, C. 1993. "Real Exchange Rates and Relative Prices - An Empirical Investigation." *Journal of Monetary Economics* 32: 35-50.

Fabiani, S., A. Gattulli, and R. Sabbatini. 2004. "The Pricing Behaviour of Italian Firms: New Survey Evidence on Price Stickiness." European Central Bank Working Paper No. 333.

Goodman, L. A., and W. H. Kruskal. 1954. "Measures of Association for Cross Classifications." *Journal of the American Statistical Association* 49: 732-764.

Gordon, R. 1981. "Output Fluctuations and Gradual Price Adjustment." *Journal of Economic Literature* 19: 493-530.

Hall, S., M. Walsh, and T. Yates. 2000. "Are U.K. Companies' Prices Sticky?" *Oxford Economic Papers* 52: 425-446.

Klenow, Peter J. and Oleksiy Kryvtsov. 2005. "State-Dependent or Time-Dependent Pricing: Does It Matter for Recent U.S. Inflation?" Bank of Canada Working Paper No. 2005-04.

Lucas, Robert Jr., 1972. "Expectations and the Neutrality of Money." *Journal of Economic Theory* 4, 103-124.

Lohr, Sharon L., 1999. *"Sampling: Design and Analysis"*. Pacific Grove, CA: Duxbury Press

Martin, M. and C. Papile. 2004. "The Bank of Canada's Business Outlook Survey: An Assessment." Bank of Canada Working Paper No. 2004-15.

Mankiw, N. G., and R. Reis. 2001. "Sticky Information: A Model of Monetary Non-neutrality and Structural Slumps." NBER Working Paper No. 8614.

Nakagawa, S., R. Hattori, and I. Takagawa. 2000. "Price-Setting Behavior of Japanese Companies." Bank of Japan Working Paper.

Okun, A. 1981. *Prices and Quantities: A Macroeconomic Analysis.* Washington, D.C.: The Brookings Institution.

Rotemberg, J.. 2002. "Customer Anger at Price Increases, Time Variation in the Frequency of Price Changes and Monetary Policy." NBER Working Paper No. 9320.

---. 2004. "Fair Pricing" NBER Working Paper No. 10915

Taylor, J. 1980. "Aggregate Dynamics and Staggered Contracts." *Journal of Political Economy* 88(1): 1-23.

Veall, M. R. and K. F. Zimmermann. 1992. "Pseudo R-SQU's in the Ordered Probit Model." *Journal of Mathematical Sociology* 16(4): 333-342.

Wolman, A.L. 2000. "The Frequency and Costs of Individual Price Adjustment." *Federal Reserve Bank of Richmond Economic Quarterly* 86(4): 1-22.

Zbaracki, M. J., M. Ritson, D. Levy, S. Dutta and M. Bergen. 2003. "Managerial and Customer Costs of Price Adjustment: Direct Evidence from Industrial Markets." Bar-Ilan University Economics Working Paper No. 2003.

Table 1: Compariso n between the Bank of Canada Survey and Other Four Existing Studies

	United States	United Kingdom	Sweden	Japan	European Union	Canada
Timing	April 1990 – March 1992	Sept. 1995	March - May 2000	April – May 2000	Feb. 2003 to Nov. 2004	July 2002 – April 2003
Sample size	200	654	626	630	10,583	170
Representative by industry?	Yes	No, mainly manufacturing firms (68%)	No, manufacturing and service sectors only	No, largely manufacturing firms	No, mainly manufacturing. Also construction, trade and services	Yes
Industry Distribution	Manufacturing 35% Services 27% Construction/Mining 11% Trade/Other 27%	Manufacturing 68% Retailing 13% Construction 6% Other services 13%	Manufacturing 45% Services 55%	Manufacturing: 65% Construction and Real Estate: 10% Trade: 13% All other services: 12%	Industry 63% Trade 12% Construction 4% Other services 21%	Construction 10% Manufacturing 26% Trade 14% All other services 49%
Exclusions based on firm size?	Firms with <$10 million in sales excluded	Sample dominated by large firms	Firms with fewer than 5 employees excluded	Firm size unknown	No	Firms with fewer than 20 employees excluded
Firm size distribution	$10 to $24.9 million 23% $25 to $49.9 million 14% $50 million or more 64%	< or = 100 employees 19% 101 to 500 employees 39% 500+ employees 42%	5 to 19 employees 25% 20 to 199 employees 30% 200+ employees 45%	Firm Size Unknown	1-49 employees 47% 50-199 employees 29% >=200 employees 24%	20 to 99 employees 32% 100 to 499 employees 28% 500+ employees 40%
All regions surveyed?	16 states in U.S. Northeast	All regions	All regions	Only companies listed on the First Section of the Tokyo Stock Exchange, excluding financial institutions, insurance and general trading companies. Region unknown.	9 countries (Austria, Belgium, Denmark, France, Germany, Netherlands, Italy, Portugal, and Spain)	All regions

Table 2: Price-setting Survey Literature: Key Features and Most Recognized Theories						
	Blinder et al. (1998)	**Hall et al. (2000)**	**Nakagawa et al. (2000)**	**Apel et al. (2001)**	**Amirault et al. (2005)**	**Fabiani et al. (2004)**
Country	United States	United Kingdom	Japan	Sweden	Canada	The European Union
Number of Price-adjustments per Year Median[Mode]	1.4 [1]	2 [1]	1-2 [1-2]	1 [1]	4 [1]	1[1]
State vs. Time Dependent	Time: 60% (not tested)	Time: 79% (10% Used mixed) (not tested)	Not tested.	Time: 58.9% (under normal condition) (not tested)	Time: 67%- Yes, time dependent price setters adjust less often	
Does firm size matter for price change frequency?	No	No, but firm size influences the number of price reviews	Not tested.	Yes	Yes	No
Does industry or sector matter for price change frequency?	Yes, trade sector is more flexible.	Yes, significant variation across industries	Yes, differences between service and manufacturing	Yes,	Significant variation across industries	Yes,
Do long-term contracts matter for price change frequency?	No, contract length and explicit contracts don't matter, but implicit contracts matter.	No.	No, but suggests that most firms use long-term contracts.	Not tested, but they suggest customer relations and contract theories matter	No, explicit contracts or percentage of sales under contracts, but customer relations theory matters	Not tested, but most firms have long-term agreements.
Does competitive pressure matter for price change frequency?	No, but coordination failure explains price rigidity	Yes, the number of competitors matters.	Not tested.	Not tested, but customer relations and factor stability are cited as reason for firms uses time dependent changes	Yes, the number of competitors matters.	Yes, the level of competition suggested by the firm.
What sticky price theories matter?	Implicit Contracts and Coordination Failure Theories	Not tested.	Not tested.	Not tested.	Customer Relations, Menu Costs, Factor Stability theories.	Not tested.
Results: Highest Recognized Theories of Price Stickiness (by % recognition)	Coordination Failure Cost-based Pricing Non-price Competition Implicit Contracts Explicit Contracts	Constant Mark-up* Cost-based Pricing Implicit Contracts Explicit Contracts Procyclical Elasticity*	Coordination Failure Implicit Contracts Explicit Contracts Pricing Thresholds* Non-price Competition	Implicit Contracts Explicit Contracts Cost-based Pricing Coordination Failure Countercyclical cost of finance*	Cost-based Pricing Customer Relations Explicit Contracts Non-price Competition Coordination Failure (cutting prices)	Implicit Contracts Explicit Contacts Cost-based Pricing Coordination Failure Quality/Reference Points

*These theories were not asked in the Canadian survey.

Table 3: Price-setting Survey Literature: Additional Evidence

	Small and Yates (1999)	Buckle and Carlson (2000)	Owan and Trzapacz (2002)	Bils and Klenow (2004)	Dhyne et al. (2004)
Country	England	New Zealand	United States (New York)	United States	10 E.U. Countries
Timing	September 1995	1986:Q3 -1996:Q1	August –December 1999	1995 -1997	Varying by country; in total between January 1988 -January 2004
Data Source	Bank of England PSS; 654 firms	Micro-survey data; various firms	Micro-data, grocery chain industry: 220 goods in eight different locations	BLS CPI Data 350 categories	50 similar products, and total CPI
Main Results	More competitive product markets increases the propensity to change prices in response to demand shocks; but market structure does not affect the responsiveness to cost shocks. High export intensity reduces responsiveness to cost shocks. Cost increases matter more than decreases.	Menu costs and firms size matter (price duration decreases as firms size increases). Price duration is 6.7 months from survey data (average frequency less than 2).	After controlling for chain-specific effects, higher menu costs are associated with a slight decrease in the probability of a price change and the size of a price change. Firm strategy is more influential in determining the incidence and magnitude of price change.	½ prices last less than 4.3 months. More frequent than Taylor (1999) and Calvo (1983) Prices vary dramatically across categories.	Mean duration is 10.6 months (much higher than the U.S.). The hazard function is decreasing. Mass points identified 1 and 12. Pricing Points common (0.99, 1.99 etc). Price changes are not highly synchronized).

Table 4: Distribution of Firm Responses to Sticky Price Theories

First Group of Theories	Unimportant (set = 0)	Slightly Important (set =1)	Fairly Important (set =2)	Very Important (set =3)
Sticky Information	147	16	6	1
Coordination Failure (on price decline)	117	12	22	19
Coordination Failure (on price increase)	100	25	26	19
Cost-based Pricing	56	23	33	58
Explicit Contracts	94	16	13	47
Implicit Contracts	116	17	23	14

Second Group of Theories	Unimportant (set =0)	Important (set =1)
Menu Cost	134	26
Factor Stability	117	53
Non-price Competition	95	75
Customer Relations	76	94
Low Inflation	113	57

Table 5: Count Data Models Estimated Results: Original Baseline Case

	Variable Codes[a]	Unrestricted Model Estimated Coefficients	Restricted Model Estimated Coefficients	Marginal Effects e^b
% of Variable Cost (standardized)	VARCOST	0.887**	0.715**	2.0435
Number of Employees (standardized)	EMPLOY	-1.094**	-1.121***	0.3261
Goods Sector	GOODS	-0.605		
Trade Sector	TRADE	1.205**	1.713***	5.5458
Atlantic Canada	ATLANTIC	-0.518		
Province of Quebec	QUEBEC	1.497***	1.502***	4.4912
Province of Ontario	ONTARIO	1.378***	1.689***	5.4153
Prairie Provinces	PRAIRIES	-0.379		
% of Households Sales (standardized)	HOUSESL	-0.830***	-0.743***	0.4758
% of Public Sector Sales (standardized)	GOVSL	0.128		
% Sales to Other Domestic Regions (standardized)	OTHSL	0.786***	0.827***	2.2873
% of Exported Sales (standardized)	EXPORT	0.255	0.323**	1.3817
% of sales to the top five buyers: between 11%-25%	FIVEBUYER25	-1.222**	-1.111**	0.3291
% of sales to the top five buyers: between 26%-50%	FIVEBUYER50	-1.391**	-1.139**	0.3202
% of sales to the top five buyers: greater than 50%	FIVEBUYER51	-1.115**	-1.096**	0.3344
Wage costs (recognized as important)	WAGEVI	-0.926**	-0.832**	0.4350
Domestic inputs (recognized as important)	DOMINPTSVI	1.462***	1.294***	3.6470
Fees and other costs (recognized as important)	TFOCVI	-0.460		
Competitor prices (recognized as important)	COMPETITORVI	0.376	0.574**	1.7758
Exchange rates (recognized as important)	FXCHNGVI	0.245		
Changes in demand (recognized as important)	DEMNDCHNGVI	0.183		
Economic forecasts (recognized as important)	FORECASTSVI	-1.225		
Sales Campaigns (recognized as important)	SLSCMPGNVI	-0.264		
Parent Company Directive (recognized as important)	PRNTCMPNYVI	-2.655***	-2.486***	0.0833
Information Delay: Day	INFOLAGDAY	-0.046		
Information Delay: Week	INFOLAGWEEK	-0.254		
Information Delay: Month	INFOLAGMONTH	-1.120**	-1.002***	0.3672
Information Delay: More than a Month	INFOLAGMOREMONTH	-0.567		
% of Contracted Sales (standardized)	CNTRCT	1.945**	1.602**	4.9609
State-dependent Price-setting Indicator	STATE	1.625***	1.598***	4.9422
Number of Direct Competitors (standardized)	COMPET	2.590**	3.507***	33.356
Industry Price Leader Indicator	PLI	0.595	0.556*	1.7436
Price Leadership Indicator	PL	0.103		
Menu Costs Theory (recognized as important)	MENU	-1.666***	-1.723***	0.1786
Factor Stability Theory (recognized as important)	VARY	-0.808**	-0.634**	0.5307
Customer Relations Theory (recognized as important)	CSTRLTN	-0.405	-0.652**	0.5211
Non-price Competition Theory (recognized as important)	NPC	0.144		
Low Inflation Theory (recognized as important)	LOWCPI	-0.385		
Sticky Information Theory (recognized as important)	STICKYINFOYES	-1.007*	-0.911**	0.4019
Coordination Failure on Price Decline Theory (recognized as very important)	COFAILDECVI	0.393		
Coordination Failure on Price Increase Theory (recognized as very important)	CONFAILINCVI	-1.490***	-1.522***	0.2182
Cost-based Pricing Theory (recognized as very important)	CBPVI	-0.196		
Explicit Contracts Theory (recognized as very important)	EXPLICITVI	0.516		
Implicit Contracts (recognized as very important)	IMPLICITVI	0.037		
Baseline Case	Constant	4.640***	4.510***	
Test for Over Dispersion	ln(alpha) Constant	0.557***	0.608***	
Log-Likelihood Function	ll	-650.896	-655.749	
Pearson Chi-Squared Test	chi2	248.133***	238.428***	
Akaike's information criterion	aic	1409.793	1381.497	

Likelihood Ratio Test between the Full Model and Final Selected Model: LR Chi2(19) = 9.7

E^b = exp(b) = factor change in expected count for unit increase in X

* significant at 10% ** significant at 5%   *** significant at 1%

Notes: (a) Scale variables are have been standardized for the estimation [(variable_value – mean)/(standard deviation)] .
(b) High order parameters included in the estimation for fit, their values are not included here because they have no immediate interpretation.

Table 6: Scale Variable Summary Statistics (N=170)	Variable	Medium	Mean	Std. Dev.	Min	Max
Number of Employees	EMPLOY	270	2769	8073	6	55000
% of Variable Cost	VARCOST	70%	63.0%	25.7%	0	98
% Sales to Home Region	HOMESL	60%	59.6%	35.4%	0	100
% Sales to Other Domestic Regions	OTHSL	11.5%	21.2%	24.3%	0	100
% of Exported Sales	EXPORT	0%	19.2%	30.1%	0	100
% of Households Sales	HOUSESL	0%	31.4%	41.7%	0	100
% of Business Sales	BUSSL	82.5%	60.7%	41.3%	0	100
% of Public Sector Sales	GOVSL	0%	8.0%	19.1%	0	100
% of Contracted Sales	CNTRCT	62.5%	52.1%	44.9%	0	100
Number of Competitors	COMPET	6	33	119	0	1000

Table 7: Count Data Model Results: Alternative Baseline Case

Variable Description	Variable Codes	Unrestricted Model Estimated Coefficients	Restricted Model	Marginal Effects
% of Variable Cost	VARCOST	0.035**	0.028**	1.028
Number of Employees	EMPLOY	-0.00014***	-0.00014***	1.000
Goods Sector	GOODS	-0.605		
Trade Sector	TRADE	1.205**	1.713***	5.546
Atlantic Canada	ATLANTIC	-0.518		
Province of Quebec	QUEBEC	1.497***	1.502***	4.491
Province of Ontario	ONTARIO	1.378***	1.689***	5.414
Prairie Provinces	PRAIRIES	-0.379		
% of Households Sales	HOUSESL	-0.020***	-0.018***	0.982
% of Public Sector Sales	GOVSL	0.007		
% Sales to Other Domestic Regions	OTHSL	0.032***	0.034***	1.035
% of Exported Sales	EXPORT	0.008	0.011**	1.011
% of sales to the top five buyers: between 11%-25%	FIVEBUYER25	-1.222**	-1.111**	0.329
% of sales to the top five buyers: between 26%-50%	FIVEBUYER50	-1.391**	-1.139**	0.320
% of sales to the top five buyers: greater than 50%	FIVEBUYER51	-1.115**	-1.096**	0.334
Wage costs (recognized as important)	WAGEVI	-0.926**	-0.832**	0.435
Domestic inputs (recognized as important)	DOMINPTSVI	1.462***	1.294***	3.647
Fees and other costs (recognized as important)	TFOCVI	-0.46		
Competitor prices (recognized as important)	COMPETITORVI	0.376	0.574*	1.775
Exchange rates (recognized as important)	FXCHNGVI	0.245		
Changes in demand (recognized as important)	DEMNDCHNGVI	0.183		
Economic forecasts (recogn ized as important)	FORECASTSVI	-1.225		
Sales Campaigns (recognized as important)	SLSCMPGNVI	-0.264		
Parent Company Directive (recognized as important)	PRNTCMPNYVI	-2.655***	-2.486	0.083
Information Delay: Day	INFOLAGDAY	-0.046		
Information Delay:Week	INFOLAGWEEK	-0.254		
Information Delay: Month	INFOLAGMONTH	-1.120**	-1.002**	0.367
Information Delay: More than a Month	INFOLAGMOREMONTH	-0.567		
% of Contracted Sales	CNTRCT	0.043**	0.036**	1.037
State-dependent Price-setting Indicator	STATE	1.625***	1.598***	4.943
Number of Direct Competitors	COMPET	0.022**	0.029***	1.029
Industry Price Leader Indicator	PLI	0.595	0.556*	1.744
Price Leadership Indicator	PL	0.103		
Menu Costs Theory (recognized as important)	MENU	-1.666***	-1.723***	0.179
Factor Stability Theory (recognized as important)	VARY	-0.808**	-0.634**	0.530
Customer Relations Theory (recognized as important)	CSTRLTN	-0.405	-0.652**	0.521
Non-price Competition Theory (recognized as important)	NPC	0.144		
Low Inflation Theory (recognized as important)	LOWCPI	-0.385		
Sticky Information Theory (recognized as important)	STICKYINFOYES	-1.007*	-0.911**	0.402
Coordination Failure on Price Decline Theory (recognized as very important)	COFAILDECVI	0.393		
Coordination Failure on Price Increase Theory (recognized as very important)	CONFAILINCVI	-1.490***	-1.522***	0.218
Cost-based Pricing Theory (recognized as very important)	CBPVI	-0.196		
Explicit Contracts Theory (recognized as very important)	EXPLICITVI	0.516		
Implicit Contracts (recognized as very important)	IMPLICITVI	0.037		
Baseline Case	Constant	-0.409	-0.055	
Test for Over Dispersion	lnalpha	0.557***	0.608***	
Log-Likelihood Function	ll	-650.896	-655.749	
Pearson Chi -Squared Test	chi2	248.133	238.428	
Akaike's information criterion	aic	1409.793	1381.497	

Likelihood Ratio Test between the Full Model and Final Selected Model: LR Chi2(19) = 9.7

e^b = exp(b) = factor change in expected count for unit increase in X

Table 8: Ordered Probit Models: Estimation Results

Variable Description	Variable Codes	Coordination Failure (on price decline) (COFAILDEC)	Coordination Failure (on price increase) (COFAILINC)	Cost-based Pricing (CBP)	Explicit Contracts (EXPLICIT)	Implicit Contracts (IMPLICIT)
				Estimated Coefficients		
Cost Structure (standardized)	VARCOST			0.317***		-0.285**
Number Employees (standardized)	EMPLOY	0.252*	0.319***	-0.579***		
Industry Type: Construction	CONST	-1.500***	-1.217**			
Industry Type: Manufacturing	MANUF	-1.142***				-0.575
Industry Type: Retail and Wholesale Trade	RWTRADE	-0.701*	-0.915**		-0.765*	
Industry Type: Commercial, Personal, Business Services	CPBS	-1.143***	-0.535*			-0.909***
Industry Type: Information, Culture and Transportation	INFOCULTTRANS	-1.179***	-0.605*	0.712**		-1.327***
Atlantic Region	ATLANTIC					
Province of Quebec	QUEBEC			1.197***		
Province of Ontario	ONTARIO					
Prairie Region	PRAIRIES	0.617**	0.472*			
% of Households Sales (standardized)	HOUSESL	-0.494***				-0.428**
% of Public Sector Sales (standardized)	GOVSL		-0.212*	0.278***	0.215**	
% Sales to Other Domestic Regions (standardized)	OTHSL	-0.236*				
% of Exported Sales (standardized)	EXPORT	-0.262*	-0.321**			0.215
% of sales to the top five buyers: between 11%-25%	FIVEBUYER25		0.655**		0.497*	-1.063***
% of sales to the top five buyers: between 26%-50%	FIVEBUYER50					-0.805*
% of sales to the top five buyers: greater than 50%	FIVEBUYER51		0.43	0.647***		-0.623
Wage Changes	WAGEVI			0.937***		
Domestic Input Cost Changes	DOMINPTSVI	0.365		0.702***		
Changes in Taxes, Fees, or other costs	TFOCVI					-0.697*
Competitor's price change	COMPETITORVI	0.464**	0.748***			
Foreign Exchange Rate Changes	FXCHNGVI		0.797***	0.516**	0.780**	
Demand Changes	DEMNDCHNGVI		-0.398			
Economic Forecast Changes	FORECASTSVI					0.728*
Sales Campaigns	SLSCMPGNVI					
Parent Company Incentives/directives	PRNTCMPNYVI	1.320**				1.202**
Information Delay: Day	INFOLAGDAY		1.042***	-0.55	1.363***	
Information Delay: Week	INFOLAGWEEK					
Information Delay: Month	INFOLAGMONTH	0.922***				

Variable Description	Variable Codes	Coordination Failure (on price decline) (COFAILDEC)	Coordination Failure (on price increase) (COFAILINC)	Cost-based Pricing (CBP)	Explicit Contracts (EXPLICIT)	Implicit Contracts (IMPLICIT)
				Estimated Coefficients		
State Dependent Price-setting	STATE			-0.464**		
Number of Direct competitors (standardized)	COMPET			-0.169*		
Industry Price Leader Indicator	PLI	0.463*				0.590**
Price Leadership Indicator	PL	-1.147***	-0.676***	0.587***		
Menu Costs	MENU	0.415			0.509*	0.423
Factor Stability	VARY			0.369*		
Customer Relations	CSTRLTN	0.815***	0.580**		0.580**	0.791***
Non-price Competition	NPC		-0.534**			-0.406*
Low Inflation	LOW CPI		0.491**	-0.345		
Sticky Information	STICKYINFOYES			0.668**		
Coordination Failure (price increase)	COFAILINCVI			0.672**		0.575*
Coordination Failure (price decline)	COFAILDECVI					
Cost-based Pricing	CBPVI	0.615**	0.617***		0.552**	0.743***
Explicit Contracts	EXPLICITVI		-0.805***			0.483*
Implicit Contracts	IMPLICITVI		1.186***			
Cut Point between Unimportant and Slightly Important	_cut 1	1.095***	0.867***	0.623***	1.158***	0.983***
Cut Point between Slightly important and Fairly Important	_cut 2	1.376***	1.427***	1.184***	1.620***	1.402***
Cut Point between Fairly important and Very Important	_cut 3	2.074***	2.284***	1.920***	1.974***	2.237***
Log-likelihood Function	ll	-131.165	-151.435	-171.361	-128.854	-129.038
Chi-squared Test	chi2	61.961***	80.015***	106.597***	116.999***	70.807***

* significant at 10% ** significant at 5% *** significant at 1%

Note: (a) Scale variables have been standardized. (b) No asterisk indicates significant at the 15% and the model is sensitive to its removal.

Table 9: Probit Models: Estimation Results (N=170)							
	Variable Codes[a]	Sticky Information (SITICKINFOYES)	Menu Costs (MENU)	Factor Stability (VARY)	Customer Relations (CSTRLTN)	Non-price Competition (NPC)	Low Inflation (LOWCPI)
				Estimated Coefficients			
Number Employees (standardized)	EMPLOY				-0.365**		
Industry Type: Construction	CONST	1.640**			0.978**		
Industry Type: Manufacturing	MANUF	1.474**				-0.941***	
Industry Type: Retail and Wholesale Trade	RWTRADE					-0.860**	
Industry Type: Commercial, Personal, Business Services	CPBS	1.374**			0.881***	-0.624**	
Industry Type: Information, Culture and Transportation	INFOCULTTRANS			0.736*	0.857**	-0.846**	
Atlantic Region	ATLANTIC	1.448**					
Province of Quebec	QUEBEC	-0.861		-0.975***	-0.727**		
Province of Ontario	ONTARIO				0.519*		
Prairie Region	PRAIRIES	-1.002*					
% of Sales to Households (standardized)	HOUSESL	0.657**		0.381***			
% of Sales to Public Sector (standardized)	GOVSL				-0.212		0.243**
% Sales to Other Domestic Regions (standardized)	OTHSL	0.440**			0.216	0.190*	
% of Exported Sales (standardized)	EXPORT	0.43			0.281**		-0.310**
% of sales to the top five buyers: greater than 50%	FIVEBUYER51		0.857***				
Wage Changes	WAGEVI	-0.931*					
Domestic Input Cost Changes	DOMINPTSVI			-0.941***			
Competitor's price change	COMPETITORVI			-0.728**		0.521**	
Foreign Exchange Rate Changes	FXCHNGVI	-1.840**					
Demand Changes	DEMNDCHNGVI	-1.023*					
Sales Campaigns	SLSCMPGNVI `					0.720**	
Information Delay: Day	INFOLAGDAY	1.432**	-1.216*		-0.757*		
Information Delay: Week	INFOLAGWEEK			-0.977**			
Information Delay: Month	INFOLAGMONTH			-1.144***			
Information Delay: More than a Month	INFOLAGMOREMONTH	2.312***	1.095***	-0.887**			

	Variable Codes[a]	Sticky Information (SITICKINFOYES)	Menu Costs (MENU)	Factor Stability (VARY)	Customer Relations (CSTRLTN)	Non-price Competition (NPC)	Low Inflation (LOWCPI)
				Estimated Coefficients			
Percentage of Contracted Sales (standardized)	CNTRCT		-0.600***		-0.516***		
State Dependent Price-setting	STATE	0.876*	-0.547*	0.502*			
Number of Direct Competitors (standardized)	COMPET	0.424***					-2.691***
Industry Price Leader Indicator	PLI		0.540**	-0.722**	0.731***		
Price Leadership Indicator	PL			0.870**			
Menu Costs	MENU			0.599*			
Factor Stability	VARY		0.648**				0.512**
Customer Relations	CSTRLTN					0.364	1.040***
Non-price Competition	NPC			0.500*			0.494**
Low Inflation	LOWCPI			0.619**	1.040***	0.603***	
Sticky Information	STICKYINFOYES				0.6		-0.696*
Coordination Failure (price increase)	COFAILDECVI	0.951		0.758*	1.390***		
Coordination Failure (price decline)	COFAILINC					-0.731**	
Cost-based Pricing	CBPVI	1.196***	-0.432	0.455*		0.470**	
Explicit Contracts	EXPLICITVI	1.103**	0.822**		0.503	-0.421*	
Implicit Contracts	IMPLICITVI						
Constant	Constant	-3.534***	-1.644***	-0.247	-1.235***	-0.28	-1.810***
Log-likelihood Function	ll	-35.987	-70.03	-71.868	-78.273	-99.799	-81.943
Chi-squared Test	chi2	62.777	35.477	67.236	77.214	33.713	52.988
The following were all insignificant in all 6 models: VARCOST, FIVEBUYER25, FIVEBUYER50, TFOCVI, FORECASTVI, PARENTCOMPANYVI							

[Scale variables] have been standardized for the estimation.

* significant at 10% ** significant at 5% *** significant at 1%

Figure 1: Price-adjustment Frequency: A Comparison of Canada and the U.S.
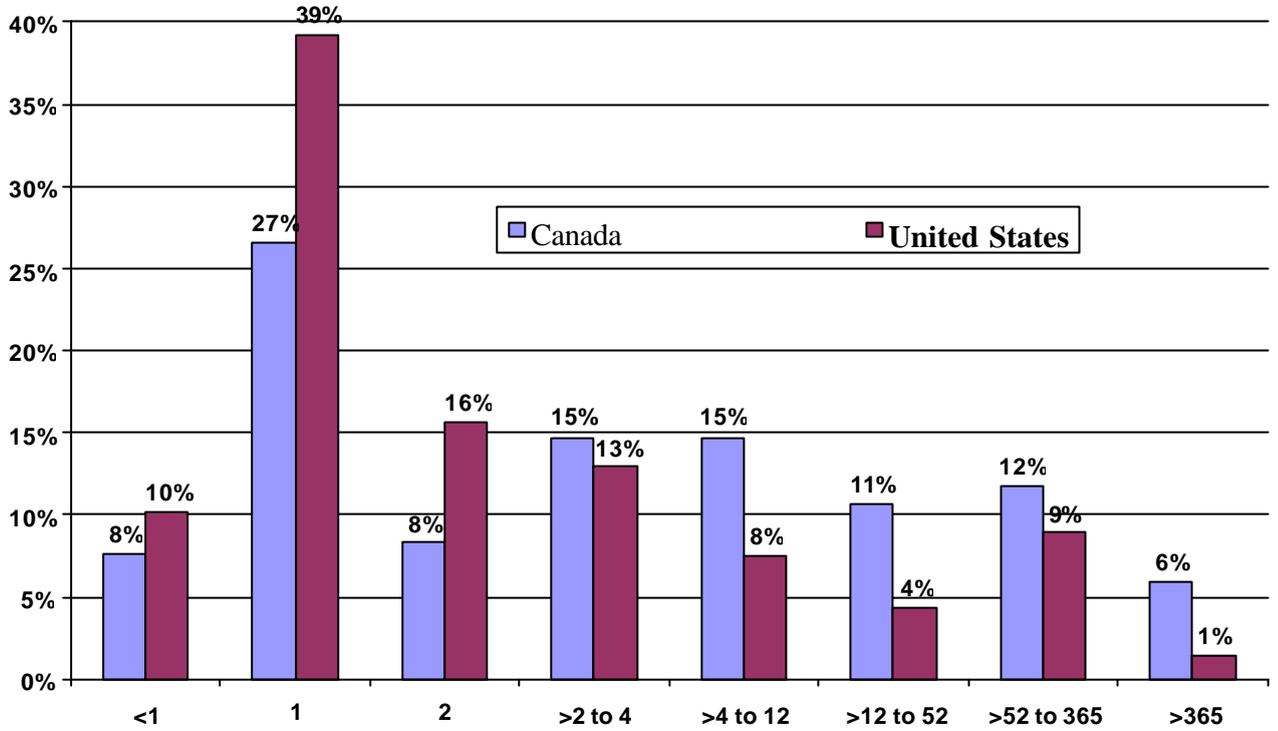
Figure 2: Patterns of Theory Recognition by Firms (%)

Bar chart showing percentages:
- Sticky Information: 14%
- Coordination Failure (decrease): 31%
- Coordination Failure (increase): 41%
- Cost-based Pricing: 67%
- Explicit Contracts: 45%
- Implicit Contracts: 32%
- Menu Cost: 21%
- Factor Stability: 31%
- Non-price Competition: 44%
- Customer Relations: 55%
- Low Inflation: 34%
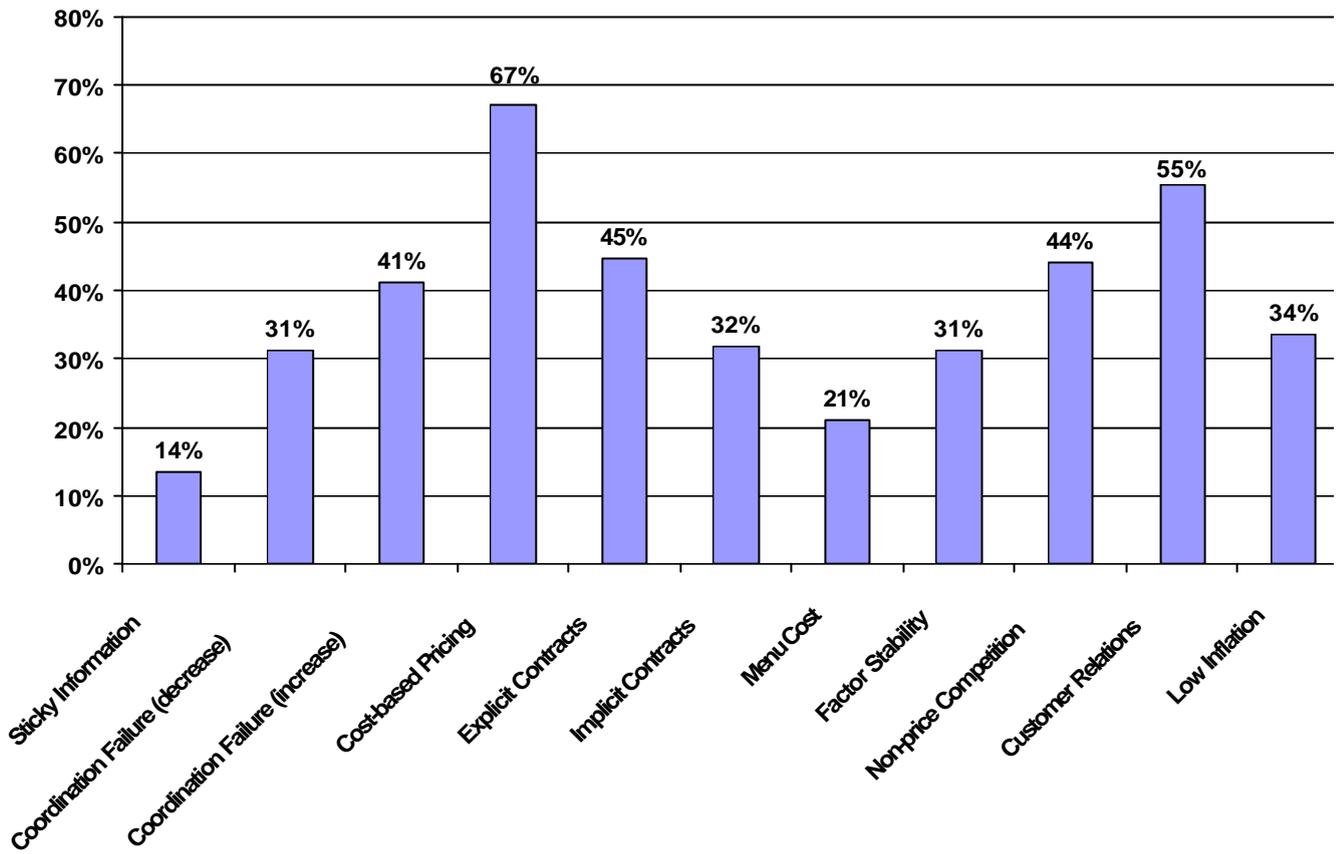
Appendix A: The Survey Method

The Bank of Canada Price-setting Survey was conduced via structured interviews with 170 firms across Canada. The firms selected for the survey had to be able to set their prices autonomously in response to market conditions. Thus, the sample was selected to be representative of the private, for-profit, unregulated, and non-commodity-producing segment of the Canadian economy in terms of industry sector, firm size and, to some extent, regional distribution [see Amirault et al. (2005)]. Drawing upon the experience of the Bank of Canada's regional offices in conducting firm-based surveys, a non-random form of sampling, widely employed in business surveys and known as "quota sampling,"[13] was used to generate a representative sample of firms (Amirault et al., 2005).

The quota sample has many advantages and disadvantages compared to a random probability sample. The benefits to using a quota sampling technique are as follows: (i) a higher response rate; (ii) the sample is 'representative' a priori and weighting for under-represented groups is not necessary; (iii) small firms can easily be represented (therefore not being a source of bias); (iv) the turnaround time of quota samples is generally shorter, and (v) lastly, and perhaps most importantly, the quota sampling method is most cost effective in face-to-face interviews. [14] Because firms were interviewed by the Bank of Canada in all ten provinces, the ability to select the firm based on their location within a region, as well as industry and firm size,

---

[13] See Martin and Papile (2004) for a description of the Bank of Canada's regional offices' survey experience. The non-random sampling used in the regional offices and in the price survey is called "quota sampling" because, for a given subgroup in a target universe, a "quota" of respondents is selected which, when aggregated, is intended to produce a sample that is representative of the target universe. Thus, in instances where an initial company contact chooses not to participate in the survey, another firm with comparable industry or firm size characteristics is selected from commercial business directories to achieve sample targets.

[14] Blinder (1998) note that personal interviews conducted by knowledgeable economic professionals can improve the quality of the survey results. Our experience with missing responses and errors with questionnaires sent in by fax suggests that Blinder's preference for personal interviews is well founded.

was very important in minimizing the resources Used to conduct the survey. If firms were randomly selected, firms could have been selected in relatively isolated areas, which would have greatly increased the difficulty in conducting face-to-face interviews.

Although the quota sampling method has advantages, it inherently has potential biases limiting the degree to which statistical inference can be made in our analysis [see Lohr (1999)]. The sources of potential bias are: (i) familiar firms are more likely to be selected, or selection bias, (ii) firms in more convenient locations are more likely to be selected, or location bias), and (iii) the non-response rate may be non-random, or non-random non-response rate bias.

The potential selection bias is minimized in the survey conducted by the Bank of Canada and hence it is less likely to be a large source of bias. In this survey, firms were selected from a list that was generated from large in-house databases, which include all firms that are familiar or unfamiliar with the Bank. In several cases, firms selected had no previous contact with the surveyors.

The potential location bias is restricted by the fact that firms selected must meet the industry and size stratum requirements. These do have some impact on the prior preference for locations of firms. The Bank is fully aware of this kind of bias and makes every effort to minimize it.

The potential bias caused by non-randomness of the non-response rate is more prominent among the three sources of potential bias. As with the first two sources of bias, the magnitude of the third kind is unknown. Hence the analysis must be interpreted with care and caution.

Appendix B1: Master List of All Variables

Variables Group	Variable Name	Variable Description	Categorical
Cost Structure	VARCOST	% of the firm's total cost that is variable	
Firm Size	EMPLOY	number of employees	
Industry	INDUSTRY	industry: set =1 if construction , =2 if manufacturing, =3 if retail or wholesale trade, =4 if information culture or transportation, =5 if finance, insurance or real estate, and =6 if Commercial, personal, or business services	Yes
Consumer Type: % of sale	HOUSESL	consumers type: % of sales to households	
	BU.S.SL	consumers type: % of sales to businesses	
	GOVSL	consumers type: % of sales to governments	
Product Destination: % of Sales	HOMESL	product destination: % of sales to home region	
	OTHSL	product destination: % of sales to domestic consumers outside of the home region	
	DOMESTIC	product destination: = 100% of sales sold domestically	
	EXPORTS	product destination: % of sales to other countries	
Top Five Buyers: % of Sales	FIVEBUYER	costumer power: set =1 if the top five buyers of represent 0-10% of sales, =2 if 11-25, =3 if 26-50, and =4 if 51-100	Yes
Price Leadership	PLI	price leadership dummy variable: there is a price leader in the industry	Yes
	PL	price leadership dummy variable: the firms believes themselves to be the price leader	Yes
Pricing Triggers/ Motivations to Adjust Transaction Price	REGUALR	price-adjustment trigger: "we routinely change prices at regular intervals", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	WAGE	price-adjustment trigger: "when wages change so does our price", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	DOMESTINPUTS	price-adjustment trigger: "when domestic inputs change so does our price", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	TFOC	price-adjustment trigger: "when taxes, fees or other charges change so do prices", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	COMPETITORS	price-adjustment trigger: "when price changes by competitors so does our price", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	FXCHANGES	price-adjustment trigger: "when exchange rates change so does our price", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	DEMANDCHANGES	price-adjustment trigger: "when demand change so does our price", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	FORECASTS	price-adjustment trigger: "when economic/inflation forecasts change so does our price", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	SALESCAMPAIGNS	price-adjustment trigger: "when sales campaigns change so does our price", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	PARENTCOMANY	price-adjustment trigger: "when directives from parent company change so does our price", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
Contract Sales	CNTRCT	contract sales: % of sales under contracts	
Competitive Forces	COMPET	competitive forces: number of direct competitors	
State Dependent Pricing	STATE	price reviews: reviews prices spontaneously or in response to specific events	Yes
First Group of Sticky Price-setting Theories	STICKINFO	sticky price theory: sticky information theory: "he information used to review (and ultimately change) prices is available infrequently. therefore, prices may be slow to adjustor new conditions", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	COFAILDEC	sticky price theory: coordination failure on a price cut, "firms delay price cuts because they don't want to be the first in the industry to cut prices" ,taking a value 0-3 given level of importance [unimportant(0)	Yes

		to very important(3)]	
	COFAILINC	sticky price theory: coordination failure on a price increase: "firms delay raising prices because they don't want to be the first in the industry to raise prices" ,taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	CBP	sticky price theory: cost-based pricing: "prices depend mainly on the costs of labour and raw materials used in producing goods and services. therefore, prices don't change until costs change"., taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	EXPLICIT	sticky price theory: explicit contracts: "firms would like to adjust prices more often to reflect market conditions, but fixed-price contracts make it difficult to pass on price increase when a contract is active" ,taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
	IMPLICIT	sticky price theory: implicit contracts: "firms delay price increases because they have an implied understanding with customers that they will not raise prices in tight markets", taking a value 0-3 given level of importance [unimportant(0) to very important(3)]	Yes
Second Group of Sticky Price-setting Theories	MENU	sticky price theory: menu costs: "it would be too costly to change prices more often (time, effort, out-of-pocket costs)" ,taking a value 0 or 1 given level of importance [unimportant(0) or important(1)]	Yes
	VARY	sticky price theory: factor stability: "factors influencing prices do not change often enough to warrant changes", taking a value 0 or 1 given level of importance [unimportant(0) or important(1)]	Yes
	CSTRLTN	sticky price theory: customer relations: "prices could not change more often without disturbing customer relations", taking a value 0 or 1 given level of importance [unimportant(0) or important(1)]	Yes
	NPC	sticky price theory: non-price competition: "we are more likely to amend product characteristics (e.g. warranty, delivery lag) than prices", taking a value 0 or 1 given level of importance [unimportant(0) or important(1)]	Yes
	LOWCPI	sticky price theory: low inflation: "low inflation makes large price changes more noticeable", taking a value 0 or 1 given level of importance [unimportant(0) or important(1)]	Yes
Frequency of Price Adjustment	PRICECHANGE	price-adjustment frequency: the number of times a firm actually adjusted their transaction price on their main product in the last twelve months.	

Appendix B2: Derived Categorical Explanatory Variables

Variable Group	Variable Name	Variable Description
Industry Type	MANUF	industry dummy: manufacturing
	CONST	industry dummy: construction
	RWTRADE	industry dummy: retail and wholesale trade
	CBPS	industry dummy: commercial, business and personal services
	FIRE	industry dummy: finance, insurance, and real estate
	INFOCULTTRANS	industry dummy: information, culture, utility and transportation
	GOODS	industry sector dummy: manufacturing and construction
	SERVICE	industry sector dummy: information, culture, utility and transportation, commercial, business and personal services, finance, insurance, and real estate
	TRADE	industry sector dummy: wholesale and retail trade
Top Five Buyers: % of Sales	FIVEBUYER10	costumer power: the top five buyers of represent 0-10% of sales
	FIVEBUYER25	costumer power: the top five buyers of represent 11-25% of sales
	FIVEBUYER50	costumer power: the top five buyers of represent 26-50% of sales
	FIVEBUYER51	costumer power: the top five buyers of represent more than 50% of sales
Price-setting Information Delay	INFOLAGDAY	price-setting information lag: one day
	INFOLAGWEEK	price-setting information lag: less than one week
	INFOLAGMONTH	price-setting information lag: less than one month
	INFOLAGMOREMONTH	price-setting information lag: more than one month
Canadian Regions	ATLANTIC	regional dummies: =1, the firm is located in Atlantic Canada, if not =0.
	ONTARIO	regional dummies: =1, the firm is located in Ontario, if not =0.
	QUEBEC	regional dummies: =1, the firm is located in Quebec, if not =0.
	PRAIRIES	regional dummies: =1, the firm is located in prairies, if not =0.
	BC	regional dummies: =1, the firm is located in British Columbia, if not =0.
First Group of Sticky Price-setting Theories	STICKINFOYES	sticky price theory: sticky information theory: "he information used to review (and ultimately change) prices is available infrequently; therefore, prices may be slow to adjustor new conditions", taking a value 1 if the firm said "important", otherwise set equal to 0.
	COFAILDECVI	sticky price theory: coordination failure on a price cut, "firms delay price cuts because they don't want to be the first in the industry to cut prices", taking a value 1 if the firm said "very important", otherwise set equal to 0.
	COFAILINCVI	sticky price theory: coordination failure on a price increase: "firms delay raising prices because they don't want to be the first in the industry to raise prices", taking a value 1 if the firm said this theory is "very important", otherwise set equal to 0.
	CBPVI	sticky price theory: cost-based pricing: "prices depend mainly on the costs of labour and raw materials used in producing goods and services; therefore, prices don't change until costs change"., taking a value 1 if the firm said this theory is "very important", otherwise set equal to 0.
	EXPLICITVI	sticky price theory: explicit contracts: "firms would like to adjust prices more often to reflect market conditions, but fixed-price contracts make it difficult to pass on price increases when a contract is active", taking a value 1 if the firm said this theory is "very important", otherwise set equal to 0.
	IMPLICITVI	sticky price theory: implicit contracts: "firms delay price increases because they have an implied understanding with customers that they will not raise prices in tight markets", taking a value 1 if the firm said this theory is "very important", otherwise set equal to 0.
Pricing Triggers/ Motivations to Adjust Transaction Price	REGULARVI	price-adjustment trigger: "we routinely change prices at regular intervals", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	WAGEVI	price-adjustment trigger: "when wages change so does our price", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	DOMESTINPUTSVI	price-adjustment trigger: "when domestic inputs change so does our price taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	TFOCVI	price-adjustment trigger: "when taxes, fees or other chargeschange

		so do prices", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	COMPETITORSVI	price-adjustment trigger: "when price changes by competitors so does our price", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	FXCHANGESVI	price-adjustment trigger: "when exchange rates change so does our price", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	DEMANDCHANGESVI	price-adjustment trigger: "when demand change so does our price", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	FORECASTSVI	price-adjustment trigger: "when economic/inflation forecasts change so does our price", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	SALESCAMPAIGNSVI	price-adjustment trigger: "when sales campaigns change so does our price", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.
	PARENTCOMANYVI	price-adjustment trigger: "when directives from parent company change so does our price", taking a value 1 if the firm said this pricing trigger is "very important", otherwise set equal to 0.