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Robert A. Buckle, Michael Ryan, Zhongchen Song

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Reserve Bank of New Zealand
PO Box 2498
Wellington
NEW ZEALAND

www.rbnz.govt.nz

Inflation and the Changing Nature of Firm Price Adjustment: Six Decades Worth of Evidence

Robert A. Buckle
School of Economics and Finance, Victoria University of Wellington, Wellington, New Zealand.

Michael Ryan
School of Accounting, Finance and Economics, Waikato Management School, University of Waikato, Hamilton, New Zealand.

Zhongchen Song
Reserve Bank of New Zealand, Wellington, New Zealand.

Contact author: zhongchen.song@rbnz.govt.nz

Abstract

The frequency with which firms change prices crucially influences inflation dynamics. Using a unique firm-level dataset spanning more than six decades, this paper examines how firm price-setting behaviour has evolved across episodes of high inflation, including the recent COVID-19 inflation episode. Time-series analysis and probit modelling reveal that pricing behaviour has changed markedly since the high inflation episodes of the 1970s and 1980s. In the aggregate, the proportion of firms changing prices has become more highly correlated with inflation. At the firm-level, the probability of price increases, conditional on inflation and cost increases, has risen. At the same time, the probability of price decreases when costs decrease has fallen, making price adjustment increasingly asymmetric. This asymmetry is particularly pronounced among service-sector firms and at higher inflation levels. Furthermore, in the aggregate the average magnitude of price change is smaller than in previous episodes of high inflation. Reasons for these changes are evaluated, including technological and societal changes, as well as the changing industrial structure of firms. Collectively, the findings reveal changes in price-setting by firms that could have important implications for the specification of the Phillips curve and the speed with which inflation changes in response to changes in cost and demand conditions.

JEL Classifications: E31, E52, D4

Keywords: Price change frequency, inflation, price asymmetry, micro firm data, probit modelling, COVID-19.

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Disclaimer

1. Introduction

Episodes of high inflation in the 1970s and 1980s generated a wave of theoretical and empirical research on price flexibility, with particular focus on the frequency and determinants of price adjustment. Amongst that wave of research was evidence using firm-level data from New Zealand showing that the likelihood of firms changing prices increases with inflation, and high inflation can induce asymmetries in firms' pricing responses whereby firms are more likely to raise than lower prices when costs and demand conditions change. The recent return of high inflation, after decades of low and stable inflation in many advanced economies, has renewed interest in this topic. Understanding how general inflation influences the propensity of firms to adjust prices is a crucial micro-foundation for models that feature an inflation accelerator and a nonlinear Phillips curve. More broadly, studying the relationship between inflation and firms' price-setting behaviour is central to the optimal design of monetary policy.

Studies of the COVID-19 inflation period find the frequency of price changes was higher than during the immediately preceding period of low inflation. However, little is known about how pricing behaviour during the recent high-inflation episode compares with earlier periods of elevated inflation in the 1970s and 1980s. Whether pricing behaviour was different during the recent COVID-19 era inflation compared to earlier bouts of high inflation is the more relevant comparison given earlier evidence that pricing behaviour varies systematically with the level of inflation. In view of the potential influence of new technology, societal changes, and changes in institutional settings for monetary policy, this is an important gap in the literature.

This paper addresses this gap using a unique, consistently collected firm-level dataset covering more than six decades of New Zealand firms. The length and consistency of the dataset make it possible to compare firm price-setting behaviour during the COVID-19 high-inflation episode with earlier high inflation episodes. Further, the results of this paper are likely to be applicable to other countries because New Zealand's inflation experience over the past six decades and during the COVID-19 inflation episode, has been like that of many advanced economies around the world.

This paper contributes several important new empirical results on firm price change behaviour. One key finding is that firms' propensity to adjust prices has become increasingly sensitive to inflation over time. The frequency of price changes was much higher during the COVID-19 inflation episode than during similar inflation episodes in the 1970s and 1980s. Further, the probability that firms increase prices in response to cost and demand changes, conditional on inflation, has increased. The results, therefore, suggest the Phillips curve has become more nonlinear at higher levels of inflation and the speed with which inflation responds to increases in costs and demand may have increased.

Another important contribution of this paper is to document that the asymmetry in the response of prices to changes in cost and demand conditions has become more acute: price increases are now more likely, but price decreases are less likely. This shift is especially pronounced among firms in the service sector and at higher levels of inflation. A plausible explanation is a decline in the responsiveness of demand to price changes, making price increases more revenue-enhancing than price reductions. This reduced demand responsiveness may in part be due to greater consumer inattention, reflecting higher labour force participation and, consequently, more time-constrained consumers.

We also find that price adjustments have become smaller in magnitude but more frequent. Smaller, more frequent, price changes are not only more likely to escape the notice of increasingly time-constrained and inattentive consumers but are also more viable from a firm's point of view, as technological advances have lowered menu costs and the costs of price review. The paper also contributes to a diverse literature using business surveys to understand business conditions and the impact of economic conditions on firm behaviour.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature. Section 3 describes the data used in this study. Section 4 assesses the relationship between inflation and the proportion of firms changing prices using time-series analysis. Estimates of the annual frequency (number) and magnitude of price changes are also generated, and the metrics of pricing behaviour are compared across nine different inflation episodes, including the high inflation of the 1970s and 1980s and the COVID-19 era. Section 5 introduces an ordered probit model to estimate conditional probabilities of price adjustment. This model is used to assess how firms' price responses to inflation and to firm idiosyncratic cost and demand conditions have changed, including during the COVID-19-era inflation. Reasons for the observed changes in firm pricing behaviour are discussed and econometrically evaluated in Sections 6 and 7. Concluding remarks are in Section 8.

2. Review of related literature

State-dependent pricing models have been shown to provide a suitable basis for explaining why the frequency of price change covaries with inflation and how this can affect the pass-through of cost or demand changes to prices and inflation. The development of these models goes back to Mankiw (1985) and Ball and Mankiw (1994a). These models predict that in the event of small cost or demand changes shifting their desired prices, firms keep prices constant as the benefit from aligning prevailing prices to these desired prices is less than the menu cost incurred. Therefore, larger cost or demand shocks lead firms to adjust prices, as the gains from realignment outweigh the menu costs. These models imply that if the cost of price adjustment declines, the probability of a price adjustment in response to cost or demand changes increases. They also predict asymmetric behaviour, with firms less likely to adjust prices downwards than upwards as inflation eventually erodes the gap between a firm's prevailing relative price and its desired (lower) relative price.

In a model of a monetary economy in which firms face idiosyncratic shocks, as well as general inflation, they can adjust prices only by incurring a real menu cost, Golosov and Lucas (2007) show that the fraction of firms that reprice in a period increases with the inflation rate. Blanco, et al. (2024a) develop a model of price change whereby firms sell a continuum of products and choose how many, but not which, prices to adjust in any period, subject to an adjustment cost. This choice is determined by balancing the price adjustment costs against the benefits of changing price and reducing resource misallocation within the firm. Higher inflation increases the marginal benefit of adjusting prices, thereby increasing the fraction of prices a firm changes.

These types of models can generate a feedback loop between inflation and the frequency or proportion of firms that change prices, creating an "inflation accelerator" in response to shocks. This results in the slope of the Phillips curve increasing during periods of high inflation (Blanco, et al., 2024a).[1] Using micro data from large panel surveys of UK and US firms, Bunn, et al. (2025) find

[1] Blanco, *et.al.* (2024a, p2) describe the inflation accelerator process as: "On the one hand, an increase in the fraction of price changes increases inflation, more so the higher the inflation rate to begin with. On the other hand, an increase in inflation increases the firms' incentives to adjust prices, further increasing the fraction of price changes." They show that this inflation accelerator effect is responsible for the bulk of the steepening of the Phillips curve for the US during periods of high inflation.

that the response of firm prices to demand shocks is convex, with greater convexity at higher inflation rates. When incorporated into a DSGE model, this pricing behaviour generates a convex aggregate Phillips curve in response to demand shocks. These nonlinearities can have important implications for monetary policy. Karadi, et al. (2024) show that price adjustment frictions introduce nonlinearities in the inflation-output trade-off and, consequently, in optimal monetary policy. For large shocks to desired prices, the optimal monetary policy decision is to react more aggressively against inflation than in the case of small shocks or when firms use a time-dependent pricing rule. Consistent with this, Hakamada and Walsh (2025) find that when agents form either rational expectations or use cognitive discounting, stronger and earlier policy responses to inflation are optimal.

A rich body of evidence using micro-data has accumulated showing that the frequency of price changes varies with inflation. An early investigation by Cecchetti (1986) finds higher inflation led to an increase in the frequency of changes in US newsstand prices of magazines from 1953 to 1979. Cecchetti speculated that while the evidence was for prices in only one industry, "it is extremely likely that the frequency of adjustment for all prices in the economy increased over this period" (p.271).[2]

Subsequent research has corroborated this conjecture. Episodes of high inflation were a focus of several subsequent studies. Lach and Tsiddon (1992) find the monthly proportion of price changes in Israel rose from 46.5 per cent in 1978-79, when inflation was 77 per cent, to 60.4 per cent in 1981-82, when inflation rose to 116 per cent. After controlling for changes in the basket of food products used in Lach and Tsiddon (1992), Eden (2001) and Baharad and Eden (2004) also report a strong relationship between inflation and price change frequency during Israel's high inflation episodes of the 1980s and 1990s. Konieczny and Skrzypacz (2005) find the frequency of price changes covaried with inflation during Poland's transition from a planned to a market economy in the early 1990s. Gagnon (2009) reveals that both the frequency and magnitude of price changes covaried with inflation in Mexico when inflation rose from 6.8 per cent in 1994 to 41.8 per cent in 1995 and when it gradually fell to 4.9 per cent by 2002. Alvarez, et al. (2018) study the frequency of price changes in Argentina during periods of low and very high inflation rates. They find that when inflation is low, price change frequency and magnitude are insensitive to inflation. As inflation increases, price changes become more frequent and larger, and when inflation is very high, it outweighs idiosyncratic shocks in driving price adjustments.

Another important question for inflation dynamics is whether there is asymmetry in the way price changes respond to positive and negative shocks to desired prices and whether this asymmetry is affected by inflation.[3] Studies by Buckle and Carlson (1998, 2000a) reveal the importance of taking account of both price increases and price decreases and show firms in New Zealand in the 1970s and 1980s were more likely to raise prices in response to positive cost and demand shocks at high rates of inflation, but less likely to lower prices in response to negative cost and demand shocks. Using data from large panel surveys of UK and US firms, Bunn et al. (2025) find that firms are more likely to increase prices in response to positive demand shocks than to decrease prices in response to negative demand shocks, and this result is strongest in firms and industries with higher inflation.

[2] Cecchetti's concluding remarks foreshadowed what is now taking place in the development of macro-economic models. He concluded "It is clear from this exercise that the frequency of price adjustment is determined endogenously in the economy. Any attempt to build a macroeconomic model of the inflationary process and macroeconomic adjustment must take account of this endogeneity" (1986, p272).

[3] Several studies find that prices respond differently to increases in input costs than to decreases, though these studies do not evaluate whether the degree of asymmetry is systematically related to inflation. See for instance Pelzman (2000) and the references therein.

Nakamura and Steinsson (2008) find that the frequency of US price increases covary strongly with inflation, while the frequency of price decreases does not. Gagnon (2009) reveals that when inflation was low, the frequency of price increases and decreases for Mexican firms partly offset each other. During high inflation, fewer price decreases occur whereas the frequency of price increases rises.

Since the high inflation episodes of the 1970s and 1980s there have been many changes that may have affected price flexibility. These include advancements in information technology which both lower the costs of price changes and improve the quality and timeliness of cost and demand information for firms. There have been changes in the industrial structure of economies (such as the growing importance of services), and changes to regulation of markets. Societal changes, such as rising labour force participation affecting consumer attention, also may have influenced firm pricing behaviour.

There is an emerging literature studying the frequency of price changes in recent years, including in the years immediately prior to and during the COVID-19 bout of high inflation. Using product-level price changes during the high inflation periods of the late 1970s and early 1980s, Nakamura, et al. (2018) find that the frequency of price change is positively correlated with inflation. Based on data up to 2014, they conclude that the frequency of price change is lower in the latter part of their sample. However, this was a period of consistently low inflation, which they acknowledge may have camouflaged any change in the underlying relationship. Gautier, et al. (2024) also examine pricing behaviour during the relatively low inflation decades prior to the COVID-19 pandemic. Using CPI micro-data for eleven euro-area countries between 2010 and 2019, they find the frequency of price changes "barely" changed with inflation (changes in inflation were mostly attributed to the size of price changes.)

For the recent COVID-19 inflation episode, Montag and Villar Vallenas (2023) find that relative to the two years preceding the pandemic, the frequency of price changes in the US increased as inflation rose, and there were only relatively small increases in the magnitude of price changes. Bilyk, et al. (2024) report similar pricing behaviour in Canada between January 1999 and January 2024. Using UK data, Blanco, et al. (2024b) show that over the period 1998 to 2022, higher inflation was associated with more frequent price changes and only small changes in the magnitude of price changes. Cavallo, et al. (2024) reach similar conclusions using data from several European countries, the UK, and the US.

These studies reveal that during the COVID-19 inflation period the frequency of price changes was higher relative to the recent past when inflation was much lower. But an important gap in understanding remains. Specifically, there is no evidence of how the sensitivity of the frequency of price changes during the COVID-19 inflation period compares with earlier decades of similarly high inflation rates.

This paper draws on a unique database of individual firm data and pricing decisions extending back six decades to the early 1960s to address this gap in the literature. It also contributes to recent broader work by the RBNZ understanding price setting and inflation dynamics and how those dynamics may be changing. Bayarmagnai (2023) shows that New Zealand households tend to pay more attention to inflation when it is high than when it is low. This can result in a non-linear relationship between actual inflation and households' inflation expectations. Kendall and Sing (2025) consider how different measures of price setting behaviour affect the ability of the RBNZ to forecast New Zealand non-tradables inflation. This showed that modelling price setting based on recent inflation rather than more historical inflation experiences, provides a better basis for forecasting non-tradables inflation (see also Reserve Bank of New Zealand 2025, Chapter 4).

3. Firm-level data used to evaluate pricing behaviour

There has been a rise in the use of information provided by surveys of firms' perceptions, expectations, decisions and activity levels. This genre of surveys is being used to understand, for example, how prices respond to positive and negative demand shocks (Bunn, et al., 2025), the characteristics and determinants of firms' inventory contracts and how firms' expectations of inflation influence those contracts (Kumar and Wesselbaum, 2024), how firms form their macroeconomic expectations (Candia, et al., 2023), and measuring and understanding business uncertainty (Altig, et al., 2022; Ryan and Holmes, 2025).

The empirical results reported in this paper are based on individual firm pricing decisions derived from the NZ Institute of Economic Research's (NZIER) Quarterly Survey of Business Opinion (QSBO). This survey has collected information on New Zealand firms' decisions, the characteristics of each firm and their operating conditions, including changes in costs and demand, on a consistent basis since the early 1960s. It is one of the longest-running business surveys in the world.[4] The survey design is based on the "Konjunkturtest" or tendency survey developed by the Institute für Wirtschaftsforschung (IFO).[5] Moreover, since the inception of the survey, the firm-level data have been collected on a consistent basis using an unchanged survey method and set of questions.

The survey sample includes all firms with more than 200 employees, while firms with fewer than 200 employees are sampled to mirror the size distribution of the population of smaller New Zealand firms. Respondent firms represent the building, manufacturing, merchant, and service sectors of the economy and periodic resampling means the sample characteristics evolve with firm population characteristics.[6]

The QSBO collects qualitative data on firm experiences and expectations about various business metrics, including changes in prices, costs, and demand. The various metrics developed in this paper draw on responses to the following question (sic): 'What has been your firm's experience during the PAST THREE MONTHS?' Firms are given the option to respond: `Up', `Same', or `Down'.[7] The survey also collects information on firm characteristics, such as size and principal activity. Firms are classified into six size categories based on the number of employees (20 or less, 21–50, 51–100, 101–200, 201–500, and >500). The dataset is an unbalanced panel. Firms in the services sector were surveyed and identifiable from 1966, but they were not asked about their price change decisions until 1970Q1. Further, there are some quarters early in the sample period where data are missing: 1971Q3 and 1972Q1 for service firms and 1967Q4 to 1969Q2, 1971Q3 and 1972Q1 for merchants.

4 Allen and O'Connor (2011).

5 See Thiel (1992). The design and implementation of the QSBO was also inspired by surveys undertaken by the Confederation of Business Industries and the European Economic Commission (Gillion, 1964). Early research applying firm-level data created by these type of surveys is reviewed by Zimmermann (1999).

6 Allen and O'Connor (2011, p.5) note "[t]he proportion of service firms in the survey has increased over time through resampling as they have become a larger part of the economy."

7 The number of firm responses to the survey questions used in this study are in Table A1 in the Appendix. `Not applicable' is also an option. The firms are also asked their expectations for the future. These responses are not used in this paper.

A key metric for our analysis is the quarterly proportion of firms adjusting prices. Some studies examine the proportions of items or products whose prices are adjusted.[8] For example, Cecchetti (1986) uses the prices of magazines sold at newsstands, Lach and Tsiddon (1992) utilise price quotations for 26 food products reported by a sample of stores collected by the Israel Central Bureau of Statistics to derive the CPI, and Bils and Klenow (2004) use monthly prices of 350 non-shelter categories of US goods and services collected by the Bureau of Labor Statistics (BLS) to construct the CPI. The study of price characteristics in the US by Nakamura and Steinsson (2008) utilises monthly product-level price data gathered by the BLS to construct the Consumers' (CPI) and Producers' (PPI) price indices. Similar types of product-level data are used in Gagnon's (2009) study of price-setting behaviour in Mexico. Recent studies comparing the behaviour of prices quoted in online markets and in physical stores tend to use product-level prices (e.g., Gorodnichenko and Talavera, 2017; Hillen and Fedoseeva, 2021; Brown and MacKay, 2023).

In this study, by moving up a level of aggregation to firm-level data, there is a loss of information about the heterogeneity in pricing across different products in cases where firms sell multiple products or services.[9] On the other hand, the firm-level data used in this study have the advantage that, in addition to price change information, they include characteristics of the firm (e.g., type of industry and firm size) and information about economic conditions experienced by each firm in each quarter (e.g., changes in demand and costs). As these data are reported by each firm, they allow pricing decisions to be linked to their own economic conditions. Recent research suggests that idiosyncratic conditions experienced by firms are likely to be critical to understanding pricing behaviour and the frequency with which firms change prices. Nakamura and Steinsson (2008) observe that most models of price rigidity make the "simplifying assumption that price changes occur only in response to aggregate shocks" (p. 1442). They provide evidence that idiosyncratic shocks are also important determinants of price changes. Gorodnichenko, et al. (2018) find that online prices are not responsive to unanticipated aggregate economic conditions but respond promptly to idiosyncratic shocks.

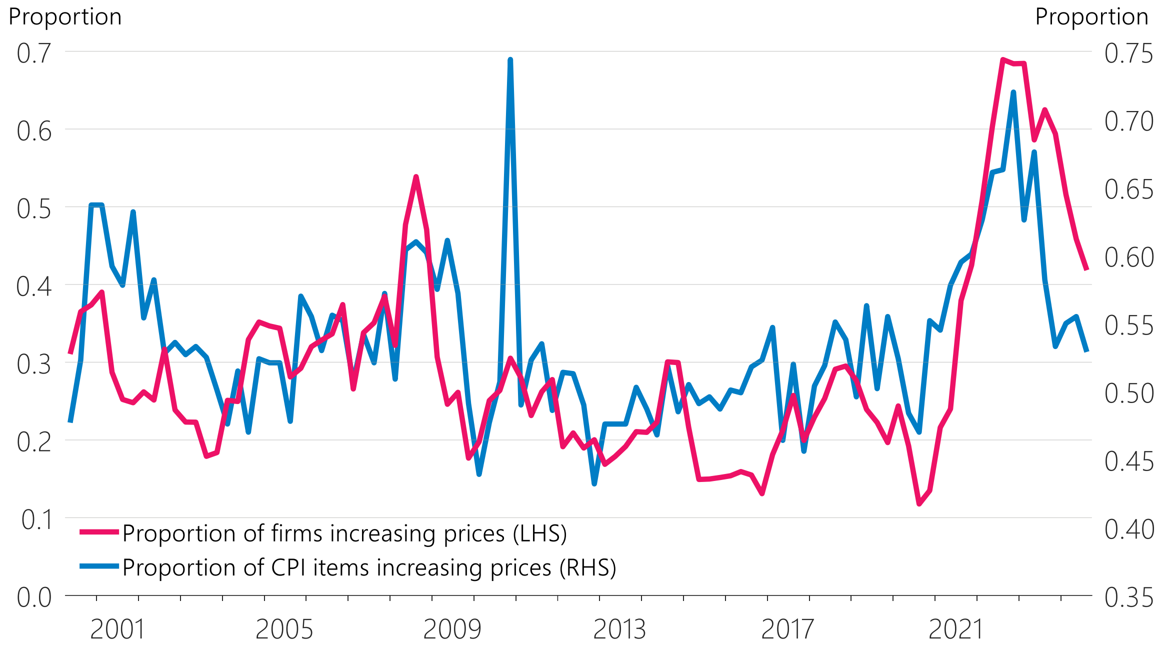
Another advantage of the firm-level data used in this study is the long duration of this survey. This enables analysis of firm pricing behaviour spanning more periods and episodes of inflation than other studies, including item and product level studies. The long duration of the data used in this study contrasts with that of the publicly available metrics based on item-level prices in New Zealand; these are only reported back to 2000Q2 by Statistics New Zealand. Nevertheless, as Figure 1 shows, the proportion of firms reporting price increases in the QSBO and the proportion of items in the CPI increasing in price over the period 2000Q2 to 2024Q3 move together very closely. The covariation of the two series suggests the firm-level measures used in this paper capture key movements in item-level price changes over time. The correlation coefficient between the two series is +0.65. This increases to +0.69 when the 2010Q4 observations are excluded, the quarter when the government increased the rate of Goods and Services Tax (GST) by 2.5 percentage points.[10]

8 Product and item level data are the most disaggregated price data. Statistics NZ class a 600ml soft drink as an item, the differing brands would constitute different products.

9 However, even item or product level price data cannot identify how many times prices for an item change in a period if the data are not continuous or very high frequency.

10 There is a spike in the item-level series in 2010Q4 and no corresponding spike in the firm-level series. In 2010Q4 the rate of GST (a comprehensive value-added tax), was increased from 12.5 to 15 per cent. The difference between the two series in this quarter suggests that when firms answer the question about whether they increased, decreased or did not change their prices, they are implicitly considering pre-tax prices. No other change to the rate of GST has occurred between 2000Q2 to 2024Q3.

Figure 1: Proportion of firms and CPI items that increased price per quarter



Notes: The proportion of firms increasing prices is derived from the NZ Institute of Economic Research QSBO firm data. A value of 0.3 means 30% of firms surveyed in the quarter reported the direction of their prices as 'up'. The proportion of items increasing price per quarter uses data from Statistics NZ's Infoshare, Consumers Price Index, Distribution of national item-level index movements from previous period. In each quarter, it takes the number of CPI items Statistics NZ reports as increasing in price and divides this number by the total number of items in the CPI for that quarter. So, a value of 0.3 means that 30% of items in the CPI increased in price that quarter.

4. Six decades of inflation and price changes by firms

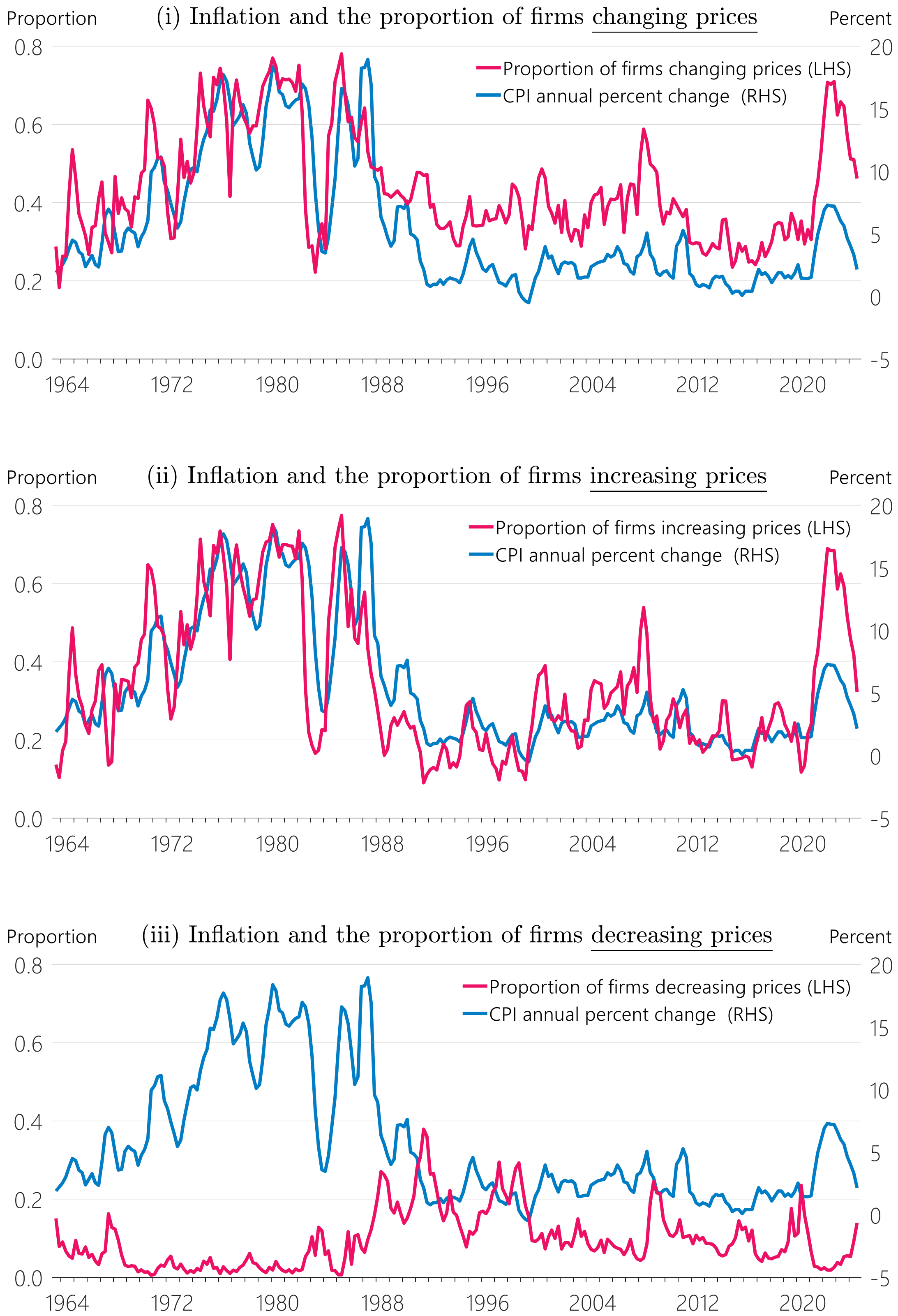
This section examines the temporal behaviour of price changes by firms during the six decades that span the high inflation of the 1970s and 1980s and the most recent bout of high inflation during the COVID-19 era. Of particular interest is the comparison of the co-movement between the proportion of firms changing prices and inflation each quarter across the different inflation episodes.

4.1 Inflation and the proportion of firms changing prices

The time series of the proportion of firms that change prices and annual inflation since the early 1960s are shown in Figure 2. Panel (i) shows all price changes (increases and decreases), Panel (ii) shows the proportion of firms that increased prices, and Panel (iii) shows the proportion of firms that decreased prices.

There are several notable features evident from Figure 2. First, there was a substantial decline in the proportion of firms changing prices after the "Great Inflation" of the 1970s and 1980s. The quarterly proportion of firms changing prices in the last three decades was, in general, substantially lower than in the 1970s and 1980s. That is, until the recent COVID-19 inflation era. The rise in the proportion of firms changing prices during the COVID-19 era is particularly evident in the case of price increases shown in Panel (ii).

Figure 2: Inflation and the proportion of firms changing prices: 1963 to 2024



Notes: Panel (i) shows the proportion of all firms that either increase or decrease prices during the quarter. Panel (ii) is the proportion of firms increasing prices; Panel (iii) the proportion of firms decreasing prices. These proportions were derived using the QSBO data provided by the NZ Institute of Economic Research. Annual inflation in each panel is calculated using the CPI from Statistics NZ's Infoshare.

A second feature is the close relationship between annual inflation and the proportion of firms changing prices. This is consistent with the predictions of menu-cost-based state-dependent pricing models of Ball and Mankiw (1994a), Golosov and Lucas (2007), and Blanco, et al. (2024a). There is a positive correlation between the proportion of firms changing prices (increases plus decreases) and inflation. In general, the proportion of firms that increase prices tends to rise as inflation rises while the proportion of firms that decrease prices tends to fall as inflation rises.

There appears, however, to have been a shift in these relationships since the mid-1990s. Thereafter, a given level of inflation has tended to be associated with a higher proportion of firms changing prices per quarter, especially a higher proportion increasing prices. Panel (iii) shows that the rapid decline of inflation in the early 1990s was also associated with a substantial increase in the proportion of firms decreasing prices. But thereafter, there has been a lower tendency for price decreases.[11]

Also consistent with a change in the relationship between inflation and price changes is the comparison between the COVID-19 period and the 1970s and 1980s high inflation episodes. Though peak inflation in the COVID-19 period was only half that of the 1970s and 1980s, the proportion of firms changing prices was almost as high as it was in the 1970s and 1980s. This is particularly evident with price increases, though a change in the tendency for price decreases vis-à-vis inflation also seems to have occurred.

The evolving link between price changes and inflation is formally assessed by estimating the time-varying relationship between the proportion of firms adjusting prices and inflation using a 30-quarter rolling regression. A 30-quarter window was chosen as sufficiently short to capture persistent structural change in the relationship, yet long enough to smooth through transitory fluctuations in the relationship arising from one-off events.

The empirical specification is given by

$$PF_t^{\Delta} = \beta_{1,t}^{\Delta} + \beta_{2,t}^{\Delta}\pi_t + \epsilon_t^{\Delta} \quad (1)$$

where:

PF_t^{Δ} denotes the proportion of firms changing prices in quarter *t*.

Superscript Δ denotes the direction of change in prices (Δ=up, Δ=dn (i.e. down), or Δ =(up+dn)).

π_t is the annual rate of CPI inflation to the end of quarter *t*;

$\beta_{1,t}^{\Delta}$ is a time-varying coefficient denoting the proportion of firms that change prices estimated using a 30-quarter rolling window, when inflation is zero;

$\beta_{2,t}^{\Delta}$ is a time-varying coefficient capturing the relationship between annual inflation and the proportion of firms that change prices in a given 30-quarter rolling window;

ϵ_t^{Δ} is an error term.

Equation (1) is estimated separately for the proportion of firms increasing prices (Δ=up), decreasing prices (Δ=dn) and all price changes (Δ=(up+dn)). The coefficient $\beta_{2,t}^{(up+dn)}$ for example, estimates movement in the proportion of firms changing prices if inflation increases by one per cent (as measured over the 30 quarter window ending in quarter *t*); an estimate for $\beta_{2,t}^{(up+dn)}$ of 0.2

[11] The correlation coefficient between inflation and proportion of firms changing prices for the full period is +0.77. This is generated by the correlation between price increases and inflation where the correlation coefficient is +0.78. The correlation coefficient between price decreases and inflation is closer to zero in absolute terms at -0.47.

would mean a one per cent higher inflation rate is associated with 20 per cent more firms changing prices in that 30-quarter window.[12]

Figure 3 shows three estimated time-varying relationships: Panels (i), (ii), and (iii) show the time-varying estimates of $\boldsymbol{\beta_{2,t}^{(up+dn)}}$, $\boldsymbol{\beta_{2,t}^{up}}$, and $\boldsymbol{\beta_{2,t}^{dn}}$ respectively. The quarter on the horizontal axis represents the last quarter of the regression window.

A significant change over time in the relationship between the proportion of firms changing prices and inflation is evident from Figure 3. There is a rise in the estimates of $\boldsymbol{\beta_{2,t}^{(up+dn)}}$ from the period when the regression window ends around 2000. This suggests the relationship started to change in the 1990s, but low inflation during the subsequent three decades, the "Great Moderation", masked evidence of a possible change in pricing behaviour, until the COVID-19 episode of high inflation.

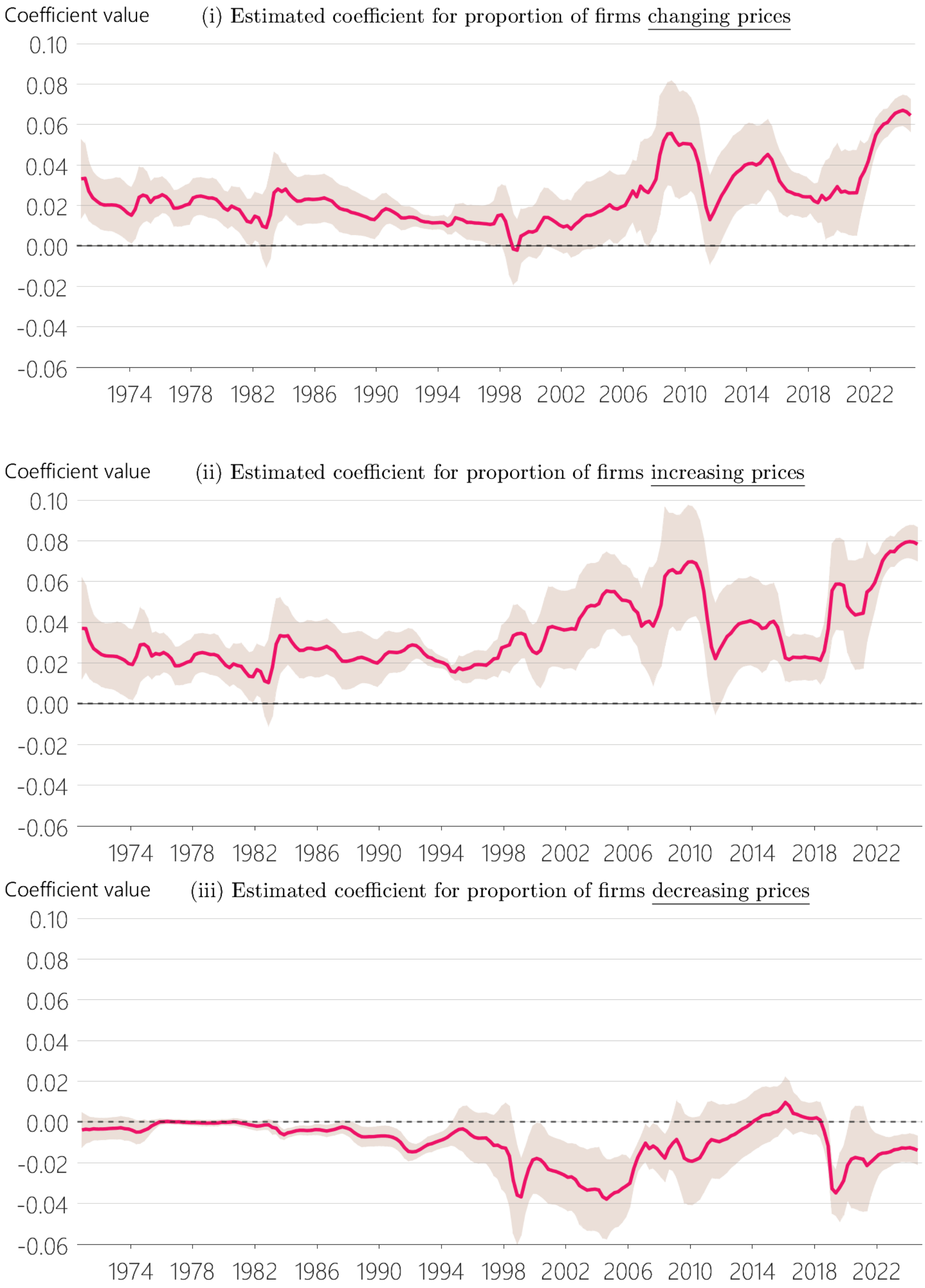
The change in the relationship between inflation and the proportion of firms changing prices is especially evident for price increases. The estimates of $\boldsymbol{\beta_{2,t}^{up}}$ are around 0.03 until the mid-1990s. Thereafter, they start to increase and are, on average, about twice as high as they were for previous decades, including during the high inflation episodes in the 1970s and 1980s.

The estimates of the coefficient for price decreases, $\boldsymbol{\beta_{2,t}^{dn}}$ are considerably smaller than for price increases. This coefficient suggests a change occurring from the early 1990s, drifting from a near-zero value to negative indicating that as inflation increases firms are less likely to drop their prices. During the Global Financial Crisis, the coefficient estimates drifted back toward zero. Thereafter, the estimated negative coefficient $\boldsymbol{\beta_{2,t}^{dn}}$ has again become on average, slightly larger. The respective estimates of $\boldsymbol{\beta_{2,t}^{A}}$ for price increases and decreases suggest an asymmetry in the way price changes respond to inflation, as predicted by Ball and Mankiw (1994a).

The evidence of price asymmetry using firm-level data is consistent with Bunn, et al. (2025) and studies using item-level data (Nakamura and Steinsson, 2008; Gagnon, 2009). Moreover, Figure 3 indicates more acute price change asymmetry during the COVID-19 period compared to the preceding low inflation years (i.e., more frequent price increases and less frequent price decreases occurred during the COVID-19 period). The presence of asymmetric price changes and comparison with comparable high inflation rates during the 1970s and 1980s is further evaluated in Section 5 using ordered probit estimates of the conditional probabilities of price changes.

[12] The inflation rate is endogenous in the model as it is likely related to unobserved variables that influence the outcome variable. Nevertheless, estimation of the time-series model specified by equation (1) provides an indication of how this relationship has evolved over time.

Figure 3: Time-varying relationship between inflation and price changes by firms



Notes: Solid lines are estimates of $\beta_{2,t}^{A}$ from Equation 1 for total price changes ($\beta_{2,t}^{(up+dn)}$), price increases ($\beta_{2,t}^{up}$), and price decreases ($\beta_{2,t}^{dn}$). The estimates are based on 30-quarter rolling regressions and the quarter on the horizontal axis represents the final quarter in the estimation window. Dashed lines are the 95 per cent confidence intervals.

4.2 Magnitude and frequency of price changes and inflation

Additional metrics are constructed using the survey data to compare firm pricing behaviour over the different inflation episodes experienced during the past six decades. These include the average duration of prices, annual frequency (number) of price changes, and average magnitude of each price change.

A measure of average price duration (*PD*) can be obtained by calculating $n/(p_{up} + p_{dn})$ in each quarter, where *n* is the number of months the survey covers (n = 3 in this case as it is a quarterly survey) and where p_{up} and p_{dn} are respectively the proportions of firms that answered they increased or decreased prices in the quarter. If $(p_{up} + p_{dn})$ is 0.5 (i.e., 50 per cent of firms change prices in the quarter), the implied average price duration is six months (3/0.5).[13] Using the average duration of prices, the mean number of times the representative firm changes prices each year (N_p) can be estimated as: $N_p = 12/PD$. If in a given quarter, price duration is six months, this formula implies prices are changed twice a year, on average.

With an estimate of the average duration of prices (PD) and therefore the corresponding value N_p, it is possible to obtain an estimate of the average magnitude of each price adjustment. Recognising $(1 + M)^{Np} = \pi + 1$, where M is the average magnitude of each price adjustment, it is possible to solve for M.[14] This estimate provides an approximation of the average magnitude of the price change by a firm over the 12 months up until the end of the quarter in question. This approach assumes the average annual percentage change in prices by firms for each year is equal to the percentage change in the selected price index used to derive the annual inflation rate (π), in this case the CPI.[15]

The estimated values for average duration of prices (PD), frequency of price changes (N_p), and magnitude of each price adjustment (M) are shown in Table 1 for different inflation episodes since 1963. The time span for each inflation episode is determined by when annual inflation moves between two selected thresholds: 5 per cent and 10 per cent.[16] This results in nine inflation episodes shown in the first two columns. The following metrics are generated for each inflation episode. Columns three to six include, respectively, average annual inflation rates, average quarterly proportion of firms that increased prices (p_{up}), that changed prices (p_{up+dn}), and

[13] This procedure is suggested in Buckle and Carlson (2000b, p61).

[14] Annual inflation reflects firms' price change decisions in the last four quarters, so the actual value for the number of price changes, N_p, used in calculating the magnitude of price adjustment is the average of the estimated number of price changes in the current quarter and the three quarters prior. Quarter-specific estimates that use quarterly inflation show similar trends to what is found with these year-to date measures, but they are much more volatile.

[15] The formula for calculating the magnitude of each price adjustment in a year has two components: N_p (estimate of the number of times prices change per year) and π (annual CPI inflation). The CPI measures changes in consumer goods and services (including housing services) but not the prices of manufactured goods. However, as currently estimated, N_p is based in part on the price changing behaviour of firms in the manufacturing sector. The following alternative estimate of the magnitude of price change is undertaken to understand if the inclusion of manufacturing firms in the dataset to estimate N_p is material. N_p is calculated for each sector and an alternative overall value of N_p is calculated by excluding observations for manufacturing firms and weighting the merchant, services and building sector values of N_p by using the respective weights of goods, services and the purchase of new housing from the 2020 reweighting of the CPI. This alternative value of N_p was then used to calculate an alternative estimate of the magnitude of price changes. The resulting time series of the magnitude of price changes using the CPI weighting is almost identical to the series derived in the baseline analysis.

[16] Some judgement is used for temporary inflation blips to avoid an excessive number of periods containing a small number of quarters. Specifically, if inflation passes through a threshold in one direction, but reverses course for one or two quarters, before continuing in the original direction, this is ignored.

average price duration. Columns seven to eight include period means of the annual number (frequency) and magnitude of each price adjustment.[17] Column nine gives the ratio of N_p to M.

Table 1 supports the conclusions in Section 4.1 that there has been a change in pricing behaviour over time. This change is seen most clearly by comparing the most recent inflation periods VIII and IX with earlier periods of comparable average annual inflation rates. During the most recent high inflation episode of the COVID-19 period (IX), the proportion of firms changing prices was considerably higher than during earlier periods with similar inflation rates (periods IV and VI). This change is particularly noticeable for the proportion of firms increasing prices (p_{up}) which was twice as high in period IX as in periods IV and VI. The proportion of firms raising prices in period IX was even higher than in period II when average annual inflation was about 1.3 percentage points higher. The average annual proportion of firms changing prices (p_{up+dn}) and increasing prices (p_{up}) in period IX is comparable with the much higher inflation periods in the 1970s and 1980s (periods III and V). Consequently, the estimated annual number of price changes during the COVID-19 era was higher and the duration of prices is shorter than earlier periods with similar inflation outcomes. Moreover, the average magnitude of each price change in the most recent period IX at 2.41 per cent, was considerably smaller than in earlier periods with similar average inflation outcomes.

These pricing behavioural changes are not restricted to the COVID-19 inflation episode. The average annual number of price changes during the years immediately prior to COVID-19 (period VIII: 2011Q2 to 2021Q1) when annual inflation averaged 1.45 per cent, is similar to that for periods I (1963Q3 to 1967Q1) and IV (1983Q2-1984Q2) when average annual inflation was more than twice as high at 3.13 and 5.09 per cent, respectively. As indicated by Figure 3, changes in pricing behaviour appears to have been occurring since the mid-1990s. This is illustrated further by taking the ratio of the number of price changes per year to the magnitude of price changes (N_p/M) shown in column 9 of Table 1. The average number of price changes per year has increased relative to the size of each price change after period VI (1988Q4-1990Q3).

[17] As a robustness check, alternative estimates of the annual number of price changes are made by counting the number of price changes each year made by those firms that responded to all four surveys in a calendar year. A disadvantage of this approach is it only creates estimates of the number of annual price changes and the magnitude of price adjustments, for each calendar year rather than on a quarterly basis. Further, it relies on a smaller sample of firms. Nevertheless, there is a strong correlation between the estimated metrics using this method and the method reported in the paper, particularly from period III onward.

Table 1: Firm pricing behaviour by inflation periods

Inflation period	Time span	Average annual inflation rate	Proportion of firms increasing prices (pup)	Proportion of firms changing prices (pup+dn)	Price duration, PD	Average annual number of price changes per firm, Np	Average magnitude of price adjustment, M	Ratio of Np to M
		(%)			(months)		(%)	Np /M
I	1963Q3–1967Q1	3.13	0.28	0.35	9.20	1.40	2.39	0.59
II	1967Q2–1973Q3	6.73	0.40	0.44	7.24	1.75	3.77	0.46
III	1973Q4–1983Q1	14.43	0.60	0.63	5.06	2.51	5.45	0.46
IV	1983Q2–1984Q2	5.09	0.26	0.34	9.61	1.38	4.22	0.33
V	1984Q3–1988Q3	12.67	0.49	0.59	5.24	2.36	5.11	0.46
VI	1988Q4–1990Q3	5.90	0.24	0.41	7.24	1.66	3.45	0.48
VII	1990Q4–2011Q1	2.27	0.24	0.39	7.89	1.56	1.44	1.08
VIII	2011Q2–2021Q1	1.45	0.21	0.30	10.10	1.21	1.15	1.05
IX	2021Q2–2024Q3	5.39	0.54	0.58	5.34	2.32	2.41	0.96

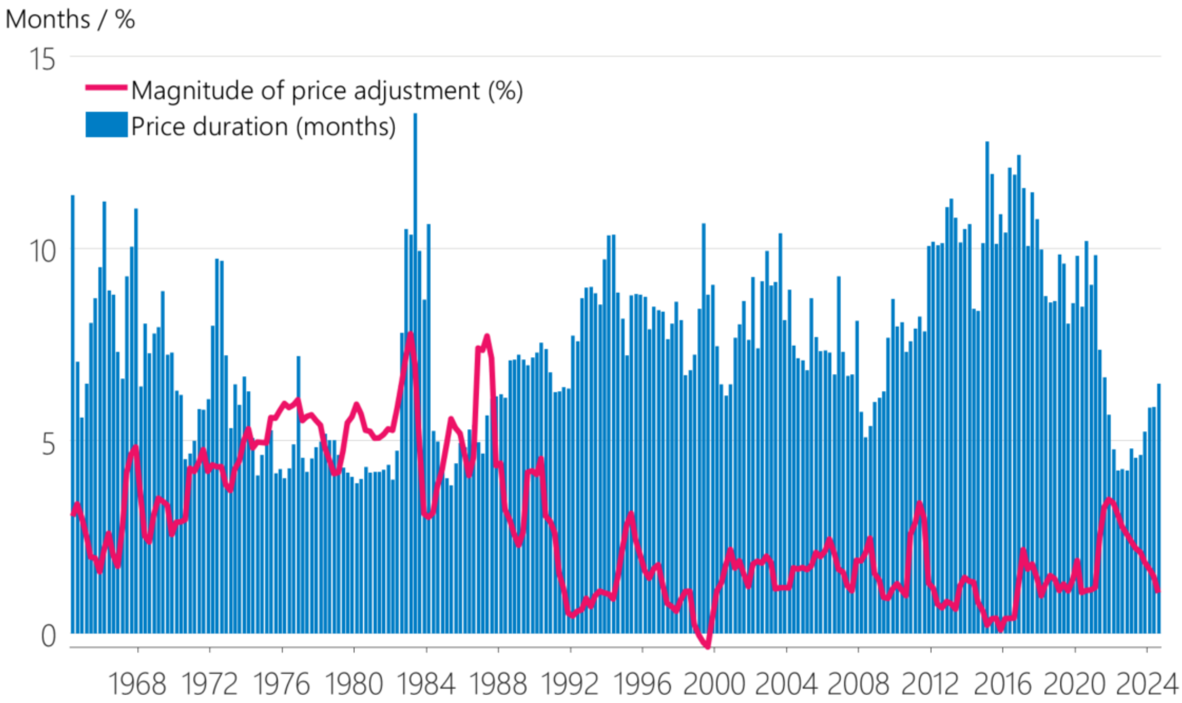
Notes: p_{up} is the average quarterly proportion of firms that increased prices; p_{up+dn} is the average quarterly proportion of firms that either increased or decreased (i.e., changed) prices. Price duration is calculated: $n/(p_{up} + p_{dn})$, where *n* is the number of months each survey covers (3 months). The number of price changes in a year, N_p, is calculated as 12/*price duration*. Magnitude of each price adjustment is calculated by solving the following equation $(1 + M)^{Np} = \pi + 1$ for M each quarter, where π is annual inflation and N_p is the annual number of price changes (for the magnitude of each price adjustment calculation, the four quarter moving average of N_p is used, see footnote 14).

Using Table 1, the frequency and magnitude of price adjustments between Periods VIII and IX can be compared. Table 1 suggests the elevated levels of inflation during the COVID-19 period arose more from an increase in the frequency of price changes than from a rise in the magnitude of price adjustments. This pattern is also evident in the quarterly estimates of the annual frequency of price changes and the magnitude of price changes reported in Figure 4. The quarterly estimates plotted in Figure 4 suggest that the magnitude of price changes was between 1 and 2 per cent over 2019 and 2020 before peaking at 3.7 per cent in 2021Q4. These results are similar to those reported by Montag and Villar Vallenas (2023) for the US derived using item-level prices. They find the magnitude of price changes remained relatively flat through 2019 and 2020, fluctuating between 1.5 and 2 per cent. Montag and Villar Vallenas (2023) report that the magnitude increased through 2021 reaching 4 per cent early in 2022 before subsequently declining. Their measure of frequency implies firms changed prices about every ten months prior to the COVID-19 period, then fell to five months (implying 2.4 price changes per year) during the peak of the COVID-19 inflation, which is similar to that shown in Table 1 (and in Figure 4) for New Zealand firms during the COVID-19 inflation period.[18]

Inflation rates in New Zealand were similar to those in the US during the sample period of Montag and Villar Vallenas (2023), which helps explain why our results are similar. The similarity also suggests that the firm-level data used in this study provide a reliable basis for capturing the key insights obtained from item-level data. By using the firm-level data available since the early 1960s, however, it is possible to extend the comparison beyond the immediate pre-COVID-19 period and provide further insight that studies such as that by Montag and Villar Vallenas (2023) cannot. The further insight is that firms changed prices as frequently during the COVID-19 inflation era as they did during the much higher inflation periods in the 1970s and 1980s, but the average magnitude of price adjustment (the percentage change in price) was much smaller during the COVID-19 period. Price change frequency explains inflation during the COVID-19 episode more than during previous high inflation episodes. Furthermore, this changing pattern of behaviour is evident since the 1990s, but it was previously masked by low inflation.

[18] These results for US and New Zealand differ somewhat from Gagnon's (2009) findings for Mexico during its much larger fluctuations of inflation between 1994 and 2002 which ranged between 4.9 and 41.8 per cent. Gagnon finds that when inflation was relatively low (below 10 to 15 per cent) the frequency of price increases and decreases tended to offset each other, and the average magnitude of price changes correlated strongly with inflation. But when inflation rose above 10 to 15 per cent there were fewer price decreases and both the frequency and magnitude of price changes correlated with inflation.

Figure 4: The duration of prices and the average magnitude of each price adjustment



Notes: Authors' own calculations using QSBO and Statistics NZ data and the method explained in Section 4.2.

5. Estimating the conditional probability of price changes by firms

To understand what might explain the changes in pricing behaviour observed in Section 4, this section draws on the individual firm-level responses of firms to the QSBO survey. Ordered probit models are applied to estimate how inflation influences the propensity with which firms change prices in response to idiosyncratic shocks to demand and cost conditions.

5.1 Specification of an ordered probit model

The estimated probit model is set out in Equation (2). Each firm's quarterly pricing decision (indexed as *j*) in quarter *t* is modelled as follows:

$$V_{jt} = (b_1 + b_2\pi_t)Cup_{jt} + (b_3 + b_4\pi_t)Dup_{jt} + (b_5 + b_6\pi_t)Cdn_{jt} + (b_7 + b_8\pi_t)Ddn_{jt} + Recent_t\,[(a_1 + a_2\pi_t)Cup_{jt} + (a_3 + a_4\pi_t)Dup_{jt} + (a_5 + a_6\pi_t)Cdn_{jt} + (a_7 + a_8\pi_t)Ddn_{jt}] \quad (2)$$

where:

V_{jt} is a latent index of pricing pressure: i.e., higher values imply a greater probability of a price increase;[19]

Cup_{jt} = cost increase (= 1 if the firm reports a cost increase, and = 0 otherwise),

Dup_{jt} = demand increase (= 1 if the firm reports a demand increase, and = 0 otherwise),

Cdn_{jt} = cost decrease (= −1 if the firm reports a cost decrease, and = 0 otherwise),

[19] See the discussion in Kennedy (2011, p258) for the motivation for this interpretation.

Ddn_{jt} = demand decrease (= −1 if the firm reports a demand decrease, and = 0 otherwise).

π_t = annual CPI inflation rate for the year to quarter *t*.

$Recent_t$ takes a value of one from 2011Q2, zero otherwise.

b_i and a_i where $i = 1, 3, 5, 7$ denote the effects on V_{jt} of increases in costs (Cup) and demand (Dup), and decreases in costs (Cdn) and demand (Ddn) respectively, when inflation is zero;

b_i and a_i where $i = 2, 4, 6, 8$ denote the marginal effects on V_{jt} of inflation.

In addition to estimating the parameters of Equation (2), there are two more parameters to estimate, k_1 and k_2 which define the threshold values. These threshold values partition the range of the unobservable index of the pressure to raise prices, V_{jt}, allowing the probabilities of a firm increasing, not changing, and decreasing prices to be defined as $\Pr(V_{jt} > k_1)$, $\Pr(k_1 > V_{jt} > k_2)$, and $\Pr(V_{jt} < k_2)$.

The specification of the ordered probit model is motivated by state-dependent pricing models (Ball and Mankiw 1994a; Golosov and Lucas, 2007; Blanco, et al., 2024a). For example, Ball and Mankiw (1994a) define θ as the desired relative price and $q^* = p + \theta$ as the desired nominal price, where p is the overall price level. Their model predicts that a firm will not change prices if:

$$AC > (\theta + \tfrac{\pi}{2})^2 \quad (3)$$

where AC = costs of price adjustment and π is inflation.[20] Equation (3) suggests that for a given cost of price adjustment AC, as inflation rises the probability of price adjustment will depend on the sign of the shock to the desired relative price. For a shock that increases θ, higher inflation raises the probability of a price increase because at higher inflation the term $\left(\theta + \frac{\pi}{2}\right)^2$ is more likely to exceed AC. For a shock that decreases θ, higher inflation reduces the probability of a price reduction because the fall in θ is offset by higher inflation in the term $\left(\theta + \frac{\pi}{2}\right)^2$, which means the term is less likely to exceed AC. It is assumed $\theta = f(c, d, X)$, where c denotes costs of production and supply of goods and services, d denotes demand for goods and services, and X is a vector of other factors that could influence the desired relative price. Because cost and demand changes are assumed to alter the desired relative price, they are included in the probit model set out in Equation (2).[21]

Further, the preceding discussion suggests positive relative price shocks are more likely to lead to price adjustment than negative relative price shocks, when there is inflation. It follows, therefore, that cost and demand changes should have asymmetric effects on prices: cost and demand increases are more likely to promote price adjustments than cost and demand decreases. Hence, in Equation (2) the response of prices to cost and demand increases is modelled distinctly from the response to cost and demand decreases.[22] The above discussion also suggests that price

[20] Ball and Mankiw (1994a) focus on menu costs as the cost of price adjustment. As suggested in Section 6, it is reasonable to expect that there are more costs to price adjustment than just menu costs, such as information search costs.

[21] In the next section estimates control for firm sector and size which are likely to be correlated with the components of X.

[22] As noted above, the threshold points (k_1 and k_2) in the probit model define a range over which actual price will not change. This maps nicely to the Ball and Mankiw (1994a) model. Rearranging equation (3) means the range over which prices will not change can be defined as: $\left(-\sqrt{AC} - \frac{\pi}{2}\right) < \theta < \left(+\sqrt{AC} - \frac{\pi}{2}\right)$. If θ is above the upper bound, a firm will raise price, and if θ is below the lower bound, a firm will lower price.

adjustment is likely to depend on the level of inflation, therefore in Equation (2) the response of price pressures to cost and demand increases and decreases is conditioned on inflation.[23]

For a given inflation rate, π, and a given value of θ, Equation (3) suggests that as the costs of price adjustment (AC) decline, the probability of a price adjustment increases. This motivates the decision to introduce a time-dependent dummy variable from 2011Q2 to see if declining price adjustment costs (and other factors discussed in Sections 6 and 7) have changed the responsiveness of prices to demand and cost shocks. The decision to introduce a time-dependent dummy variable from 2011Q2 instead of from the start of the COVID-19 inflation period is motivated by interest in understanding how firm pricing behaviour changes across different rates of inflation. If the dummy variable commenced around 2020 there would be too few periods with low inflation. It could also be argued that the time-dependent dummy be introduced in the 1990s given the analysis of Section 4. The reason for choosing the later start date is to ensure changes in the price-demand-cost dynamics captured with the $Recent$ dummy variable can provide insights pertinent to current monetary policy decision-making. The specific choice of 2011Q2 was made to avoid a temporary blip in inflation owing to a GST change in 2010Q4 being included in the recent period.[24]

The probit model is estimated via maximum likelihood using firm-level data from 1963Q3 to 2024Q3. The null hypothesis of homoskedasticity is rejected using the Likelihood Ratio test for Equation (2) estimated on the full dataset, as well as that for sector-specific and firm size-specific datasets (see the test statistics in Tables A2 and A4).[25] Therefore, in the model estimated on the full dataset in Section 5.2 the variance is modelled as a function of firm sector, firm size and the inflation rate. For sector-specific tests, the variance is modelled as a function of firm size and inflation. For firm-size specific tests, the variance is modelled as a function of firm sector and inflation.[26]

5.2 Ordered probit model estimation results

This section presents in Table 2, conditional probabilities of price changes calculated using the ordered probit model specified by Equation (2) and estimated on a dataset containing all firms.[27] As the top and bottom panels of Table A1 illustrate, there is a total of eighteen combinations of cost and demand changes associated with price changes (nine for Pup and nine for Pdn). Conditional probabilities of price changes were estimated for each of the eighteen combinations.

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[23] Kumar and Wesselbaum (2024) imply an additional motivation for the assumption that price adjustment is likely to depend on the level of inflation. They find firms with higher inflation expectations make less use of contracts. If inflation and inflation expectations are correlated, periods of higher inflation should see less contract use, which will make prices more flexible.

[24] In the robustness tests, three alternative constructions of the $Recent$ variable were evaluated: (i) where the $Recent$ variable starts taking a value of one from 2020Q1 onward; (ii) from 2000Q1 onwards; and (iii) 1990Q1 onward. The key qualitative results identified in the subsequent discussion in this section hold under these three alternative constructions. The results of the estimations using these alternative constructions of the $Recent$ variable are available from the authors on request. The broad conclusions concerning evidence of structural change in pricing behaviour are similar for each break-point period, except that the size of the change in the probit estimate of the coefficients for Equation 2 are systematically smaller when $Recent$ is set at 1990Q1. This observation is consistent with the conclusion in Section 4 drawn from the time-series analysis, that changes in pricing behaviour of firms started to take place after the mid-1990s.

25 The Likelihood Ratio test statistic calculates by how much the likelihood improves in the model when heteroskedasticity is allowed for versus a model where the variance is assumed to homoskedastic. The specific formula for the test statistic is $LR = -2(\ln(L_{Heteroskedastic}) - \ln(L_{Homoskedastic}))$. If the null hypothesis is true, the Likelihood Ratio test statistic follows a chi-squared distribution with degrees of freedom equal to the number of additional variance parameters in the heteroskedastic version of the model. To test if the improvement in the likelihood is statistically significant (that is, if the null hypothesis of homoskedasticity can be rejected), the Likelihood Ratio test statistic can be tested against the appropriate critical value from the Chi-squared distribution.

26 The models are estimated using the hetoprobit command in Stata.

27 An explanation of how these conditional probabilities are calculated is provided in Buckle and Carlson (2000a).

The highest estimated conditional probabilities of price increases are those for the three cases of cost increases (Cup) associated with alternative demand changes. The highest estimated conditional probabilities of price decreases are the three cases associated with cost decreases (Cdn) for alternative demand changes. These six cases are shown in Table 2. The estimated conditional probabilities for the remaining twelve cases are shown in Appendix Table A3.

Table 2 reveals that the conditional probability of a price increase, for all cost increase cases, rises as inflation rises, both before and after 2011Q2. For example, Table 2 shows that the estimated conditional probability of a price increase when costs and demand increase for the quarters before 2011Q2 ($Prob[Pup|Cup, Dup, R = 0]$) rises successively from 0.47 to 0.55 to 0.61 as inflation increases from 2% to 7%. This pattern is evident for all estimated conditional probabilities of a price increase, both before and after 2011Q2. Table A3 shows that while the probability of a price increase is lower when costs do not rise, the overall pattern still holds: the likelihood of a price increase rises with inflation across all cost and demand conditions. These results are consistent with the predictions of the menu-cost-based state-dependent pricing models discussed in Sections 2 and 5.1.

Furthermore, Table 2 also reveals a significant increase in the probability of a price increase in response to higher costs during the post-2011 years compared to the previous years, as inflation rises.[28] While the conditional probability of firms increasing prices when costs increase (for any demand situation) is broadly similar before and after 2011Q2 when annual inflation is at 2 per cent, when annual inflation is at 5 or 7 per cent the probability of a price increase is much higher after 2011Q2 than in earlier quarters. The differences between the pre- and post-2011Q2 estimates of conditional probabilities are shown in the right-hand side of Table 2 under the respective inflation rates. The increases in estimated conditional probabilities for the higher inflation rates are economically and statistically significant, providing further evidence of a structural change in pricing behaviour. As Table A3 shows that this pattern whereby conditional probabilities of price increases are higher in the post-2011Q2 period also holds for other combinations of cost and demand changes.

28 The statistical significance of the size of change in the estimated conditional probability of a price change between pre- and post-2011Q2 (and for alternative breakpoints) is evaluated by applying the Delta method (see Wooldridge, 2010) using the "margins" command in Stata.

Table 2: Conditional probabilities of price changes for all firms: pre- and post-2011Q2

Type of conditional probability:	Probabilities:			Change in probabilities $(R=1)-(R=0)$:		
Inflation rates:	2%	5%	7%	2%	5%	7%
Probability firms increase prices:						
$Prob[Pup\|Cup, Dup, R = 0]$	0.47	0.55	0.61			
$Prob[Pup\|Cup, Dup, R = 1]$	0.48	0.73	0.85	*0.01***	*0.17****	*0.24****
$Prob[Pup\|Cup, Dnc, R = 0]$	0.44	0.52	0.57			
$Prob[Pup\|Cup, Dnc, R = 1]$	0.41	0.58	0.69	*- 0.04****	*0.06****	*0.12****
$Prob[Pup\|Cup, Ddn, R = 0]$	0.30	0.39	0.44			
$Prob[Pup\|Cup, Ddn, R = 1]$	0.36	0.60	0.75	*0.05****	*0.22****	*0.31****
Probability firms decrease prices:						
$Prob[Pdn\|Cdn, Dup, R = 0]$	0.29	0.25	0.23			
$Prob[Pdn\|Cdn, Dup, R = 1]$	0.22	0.09	0.05	*-0.07****	*-0.16****	*-0.18****
$Prob[Pdn\|Cdn, Dnc, R = 0]$	0.32	0.28	0.26			
$Prob[Pdn\|Cdn, Dnc, R = 1]$	0.28	0.18	0.13	*-0.03****	*-0.10****	*-0.13****
$Prob[Pdn\|Cdn, Ddn, R = 0]$	0.46	0.41	0.37			
$Prob[Pdn\|Cdn, Ddn, R = 1]$	0.32	0.16	0.09	*-0.13****	*-0.24****	*-0.28****

Notes: These conditional probabilities are derived from the coefficient estimates shown in Table A2 and are evaluated at the specific inflation rates of 2%, 5% and 7%. P=prices, C=costs, D=demand, up=increase, nc=no change, dn=down; hence for example Pup=Prices up, and so on. $R = Recent$ and is the time contingent dummy variable which takes a value =1 from 2011Q2 and zero otherwise. Change in probabilities $(R = 1) - (R = 0)$ is the absolute change in the estimated conditional probability of a price change (under the equivalent cost and demand conditions) between pre- and post-2011Q2. Statistical significance is evaluated using the Delta method by applying the "margins" command in Stata and is denoted by asterisks: *** denotes p <0.01; ** p <0.05; * p <0.10. Small differences between reported change in probabilities $(R = 1) - (R = 0)$ and the respective recorded values of the reported conditional probabilities are due to rounding to the nearest digit at the second decimal point.

In the case of conditional probabilities of a price decrease, there is a degree of symmetry with the patterns observed for price increases. In both periods the conditional probabilities of a price decrease systematically fall as inflation rises. For example, the estimated conditional probabilities of a price decrease when costs and demand decrease for the decades before 2011Q2 $(Prob[Pdn|Cdn, Ddn, R = 0]),$ fall successively from 0.46 to 0.41 to 0.37 as inflation increases from 2% to 7%. The same pattern also is evident for all estimates for the post-2011Q2 quarters $(Prob[Pdn|Cdn, Ddn, R = 1])$. These results are also consistent with the menu-cost-based state-dependent pricing models discussed in Sections 2 and 5.1. Moreover, the estimated probabilities are lower in the $Recent$ period at all inflation rates and are successively lower as inflation rises providing further evidence of structural change in pricing behaviour. Table A3 shows that the estimated conditional probabilities of a price decrease tend to be smaller and that they also fall as inflation rises, for all other combinations of cost and demand conditions.

Table 2 reveals two further important insights. First, it provides strong evidence of pricing asymmetry by firms: price increases are more likely than price decreases when conditions warrant them. This can be seen by comparing the estimated conditional probabilities for price increases and decreases under opposite cost and demand changes. When inflation is at 7%, for example, the conditional probability of a price increase when costs and demand increase simultaneously ($Prob[Pup|Cup, Dup]$) is 0.61 for the pre-2011Q2 quarters, while the conditional probability of a price decrease when costs and demand decline simultaneously ($Prob[Pdn|Cdn, Ddn]$) is 0.37. This asymmetry is also evident in the post-2011Q2 quarters where the equivalent estimated conditional probabilities are 0.85 and 0.09 respectively. The degree of price asymmetry has increased post-2011Q2, providing further evidence of a structural change in firm pricing behaviour. In the 7% inflation case, the conditional probability that prices will be increased by firms reporting both cost and demand rises has increased in absolute terms by 0.24 (0.85 minus 0.61) post-2011Q2. In contrast, the conditional probability that prices will be reduced when costs and demand decline has fallen in absolute terms by 0.28 (0.09 minus 0.37).

These temporal changes in the estimated conditional probabilities allow us to construct a measure of the intertemporal change in price asymmetry by differencing the changes in the relevant price-increase and price-decrease conditional probabilities. For example, when comparing the change in conditional probabilities for simultaneous cost and demand increases and simultaneous costs and demand decreases, at 7 per cent inflation the difference of the changes between pre- and post-2011Q2 is 0.52 (0.24 minus -0.28); at 5 per cent inflation, it is 0.41 (0.17 minus -0.24); and at 2 per cent inflation, it is 0.14 (0.01 minus -0.13). There is a clear pattern of increased price asymmetry as inflation increases in recent years, and this change is more acute as inflation rises, as predicted in menu cost-based pricing models (e.g., Ball and Mankiw, 1994a).

6. Menu costs, information technology, firm characteristics, and pricing behaviour

This section and the next discuss and evaluate possible reasons why there has been a structural change in firm pricing behaviour. These changes include a rise in the tendency for firms to change prices as inflation increases (Figure 3 and Table 2), a fall in the average magnitude of price adjustments, and a rise in the frequency of price changes (Table 1). The other change is an increase in price change asymmetry, whereby firms are more likely to raise prices than decrease prices when demand and cost conditions change desired prices. In other words, prices have become more "flexible" upwards but more "sticky" downwards.

The change in pricing behaviour discussed in Sections 4 and 5, has occurred as the internet has become much more widely available, transforming business and buyer behaviour globally. For example, Hillen and Fedoseeva (2021) report that by 2018 between 30 and 50 per cent of Americans purchased groceries online and online sales tripled between 2013 and 2018. They also report a marked increase in the popularity of online shopping during the COVID-19 pandemic.

The spread of digital capability has also been substantial in New Zealand during the past two decades. In 1994 only 3 per cent of the population had access to the internet. Access had grown to about 50 per cent by 2000, and about 96 per cent by 2022.[29] Adoption of digital technology by firms has been similarly rapid. In 2008, only 51 per cent of small New Zealand firms reported having an internet presence, and by 2020 this proportion had risen to 71 per cent.[30] It is likely that technological developments have lowered costs and enabled prices to be more flexible, and more responsive to inflation and other conditions that change desired prices.[31]

When prices are posted electronically the physical cost of changing prices is negligible. This means menu costs are effectively eliminated as a constraint on price adjustment. However, Ball and Mankiw (1994b, p.114) "suspect that the most important costs of price adjustment are the time and attention required of management to gather the relevant information and to make and implement (pricing) decisions." We refer to the costs associated with collecting information to assess the gap between prevailing and desired prices, and the managerial time to make pricing decisions, as price review costs (see Alvarez et al., 2011).

A more digitally connected world means that the information needed for a price review may be more up to date, and more accessible and cheaper to obtain, thereby lowering price review costs. The result is that firms are willing to undertake price reviews more often, resulting in a dynamic of more frequent but smaller price changes. This dynamic is reinforced by technology reducing information uncertainty. Bhaduri and Falkinger (1990) note that firms are more likely to adjust prices as costs and demand change when the information on costs and demand is more complete and more certain. Improved quality of cost and demand information reduces the propensity to 'wait and see' when considering price adjustment. Better and more complete data may be particularly important for firms dependent on complex supply-chains for sources of production materials. For example, manufacturing and large merchant operations often depend on complex supply-chains and just-in-time delivery processes, which benefit significantly from advanced tracking, automated data capture, and real-time analytics.

Dynamic pricing is an extreme case where firms can adjust prices by small amounts, often according to changing demand conditions owing to better real-time information. It also allows firms to adjust prices to reflect the firm's real-time costs and inventory levels, and competitor pricing decisions as well. Dynamic pricing automates pricing decisions by algorithmically collecting data and then algorithmically setting prices: the marginal time and attention required of managers in each price-setting decision becomes negligible. Using a dataset of high-frequency prices from large online retailers selling brands of allergy drugs, Brown and MacKay (2023) observe that dynamic pricing and the use of pricing algorithms are becoming more prevalent. Cavallo (2018)

[29] A time series of annual usage is available from: Internet users for New Zealand (ITNETUSERP2NZL) | FRED | St. Louis Fed.

[30] These percentages are the authors' calculations based on the Business Operations Survey data provided by the Statistics NZ's Infoshare. Small firms are defined here by those with 6 to 19 employees. An increase in web presence is also observed for larger firms, though for firms with more than 50 employees the percentage point increase is smaller because they had a proportionally higher rate of web presence in 2008.

[31] For example, Nakamura et al. (2018) comment: "Given all of the technological advancement that has occurred over the past half-century, it seems natural to conjecture that some of the costs of changing prices may have fallen, allowing prices to become more flexible." (p. 1969)

reports that the frequency of price changes in multi-channel retailers has been increasing, reducing the average duration of prices (excluding sales and temporary discounts) by around 50 per cent between 2008 and 2017. This was stronger in sectors where online retailers have high market shares, and among goods that can be easily found on Amazon.

Even if price responsiveness to competitor pricing behaviour is not automated, online markets change the competitive characteristics of markets, increasing price flexibility. Online markets reduce consumer search costs and enhance the ability of buyers and sellers to observe the distribution of prices of specific goods and services. Gorodnichenko and Talavera (2017) and Gorodnichenko, et al. (2018) report that price quotes in the US and Canada found on internet marketing sites are more flexible and exhibit a greater rate of pass-through and faster convergence in response to nominal exchange rate changes relative to prices in regular stores.

Earlier studies highlight considerable heterogeneity in the frequency of price-setting across types of products and industrial sectors (see, for example, Nakamura and Steinsson, 2008; Gagnon, 2009; Klenow and Malin, 2010). These differences reflect the diversity of pricing arrangements at the firm and product levels, as reflected for example, in the study by Blinder (1994) and many subsequent studies. While advances in information technology are likely to have influenced pricing behaviour across all firms, their impact may differ by sector and firm size, further accentuating the heterogeneity in firm price-setting behaviour. To explore this, we draw on the Business Operations Survey conducted by Statistics NZ, which provides information on firms' use of digital technologies and online retailing activities relevant to pricing decisions.[32]

Table 3 shows that most firms, regardless of size or sector, use the internet for purchasing and placing orders with suppliers. There are more pronounced differences in internet use for supplying goods to customers and for receiving orders or bookings. Merchant and service firms sell more online than builders or manufacturers. Further, firms in these sectors are more likely to engage in sophisticated data-driven decision-making procedures (final column of Table 3) which increase the speed and lower the cost of price reviews. There is also a tendency for an increased online presence and the application of these sophisticated data-driven decision-making technologies to increase with firm size.

The discussion in this section points to two testable hypotheses. First, if the menu and price review costs of price adjustment have declined, then prices should exhibit greater flexibility in both directions. However, the analysis in Section 5 shows increased upward flexibility, but not downward flexibility. The second hypothesis posits that larger firms, and firms in the service and merchant sectors, exhibit greater price flexibility owing to their stronger online presence and more extensive use of sophisticated data-driven decision-making procedures. To test these hypotheses, the following subsections examine whether pricing behaviour differs systematically across firms of different sizes and sectors.

[32] The Statistics NZ data are from the 2022 Business Operations Survey: https://www.stats.govt.nz/information-releases/business-operations-survey-2022

Table 3: Use of selected technologies by industrial sector and firm size

	Use of the internet for:			Use of:
	Purchasing or placing orders for goods & services	Supplying goods & services to customers	Receiving order reservations or bookings	Data and analytics or machine learning assisted decision making
Industrial sector:				
Builders	0.82	0.24	0.11	0.07
Manufacturers	0.94	0.33	0.26	0.10
Merchants	0.94	0.51	0.51	0.13
Services	0.84	0.49	0.33	0.15
Firm size (employees):				
6-19	0.83	0.38	0.28	0.10[a]
20-49	0.92	0.44	0.34	0.19[b]
50-99	0.93	0.48	0.35	0.21[c]
100+	0.93	0.54	0.38	0.30

Notes: The data columns show the proportion of firms in each category. The results in the first three data columns are drawn from Statistics NZ 2022 Business Operations Survey (BOS). They are Statistics NZ population estimates derived by weighting up responses, where the weights are based on firm population weights. Statistics NZ selected a sample of 9,081 businesses from a total BOS population of 48,092 businesses, and a response rate of 76.1 per cent. The "Education & Training, Health Care & Social Assistance, Arts & Recreation Services, and Other Services" industries were excluded from the calculations to align with the service industries covered by the NZIER's QSBO survey. Results in the final data column are derived from a NZIER/Spark survey in September 2023 with a sample size of 1,071 firm respondents; see Leung and Miller-Moore (2024). The superscripts in the final column a, b, and c indicate the proportions reported are for firms with 1-20, 21-50 and 51-100 employees respectively.

6.1 Conditional probabilities of price changes by industrial sector

This section evaluates whether there are differences in pricing behaviour across industrial sectors. Estimates of conditional probabilities of price adjustment are derived for the pre- and post-2011Q2 periods based on the same scenarios as those of Table 2.

Table 4 shows that for each sector the probability of prices increasing when costs increase (across all demand conditions) rises as inflation rises, both before and after 2011Q2. There are differences in the estimated probabilities of price change between sectors. The estimated conditional probabilities for services and merchants tend to be higher than for manufacturers and builders, especially at higher inflation rates and post-2011Q2.[33]

A striking feature of Table 4 is the change in the estimates of the probability of prices increasing when costs increase for services at higher inflation after 2011Q2. In all demand circumstances, the conditional probability of price increases by service firms increases, whereas the directions of

[33] An exception for Builders is evident in the pre-2011Q2 period for demand increases, where the conditional probability of a price increase for builders is similar to that for merchant and service firms.

change are mixed and much smaller in all other sectors. Thus, the post-2011Q2 price increase probability results in Table 2 are explained by changes in pricing behaviour in the services sector.

For the conditional probability of price decreases, there are differences in behaviour across sectors. For the pre-2011 period, the conditional probabilities of price decreases do not all decline as inflation rises, and in some cases, notably for builders, increase instead. For service firms the estimated probabilities tend to decline as inflation rises in the pre-2011 period.

After 2011Q2, there is a significant decrease in the estimates of the probability of prices decreases when costs decrease for services and merchant firms. This occurs for all considered inflation rates and is especially evident as inflation increases. This implies that the increase in the degree of 'downward stickiness' of prices in response to cost decreases presented in Table 2 is explained by changes in pricing behaviour of services and merchant firms.[34] Further, the proportion of service firms in the economy has grown. In contrast, post 2011Q2, builders are more likely to reduce prices when costs fall compared to pre-2011Q2, though most of the estimated changes are not statistically significant. There is no significant change for manufacturing firms. These results stand in stark contrast to the hypothesis set out earlier that increased digital capability should lead to more downward price flexibility, and this downward flexibility should be most evident in the two sectors making the most use of online markets: services and merchants.

Finally, comparison of the conditional probabilities shown in Table 4 of a price decrease between the non-service sectors and service sectors in the most recent period reveals that the service sector is less likely to drop prices. One of the potential implications of this divergence is that, as aggregate demand declines, the rate at which services price inflation declines may be slower than the rate of decline of goods price inflation. This pattern has been evident during the post-COVID-19 disinflation in many countries, including New Zealand (Antwis, 2024).

[34] This result is similar to Gagnon's (2009) finding for services prices in Mexico between 1994 and 2002. He concluded "services price decreases are much less frequent than price increases, especially when inflation is high." (p 1242).

Table 4: Conditional probabilities of price changes by industrial sector: pre- and post-2011Q2

	Builders			Manufacturers			Merchants			Services		
Inflation rates:	**2%**	**5%**	**7%**	**2%**	**5%**	**7%**	**2%**	**5%**	**7%**	**2%**	**5%**	**7%**
Probability firms increase prices (Pup) when costs increase (Cup) and....												
$Dup, R = 0$	0.50	0.62	0.69	0.38	0.47	0.53	0.52	0.69	0.79	0.54	0.58	0.60
$Dup, R = 1$	0.41	0.55	0.63	0.33	0.50	0.62	0.46	0.66	0.77	0.56	0.83	0.93
Change	0.09***	-0.07***	-0.06	-0.04***	0.04	0.09***	-0.06***	-0.04	-0.02	0.02*	0.25***	0.33***
$Dnc, R = 0$	0.40	0.51	0.58	0.34	0.41	0.46	0.44	0.61	0.71	0.55	0.57	0.58
$Dnc, R = 1$	0.28	0.43	0.54	0.27	0.41	0.51	0.35	0.49	0.59	0.52	0.71	0.82
Change	-0.12***	-0.08***	-0.04	-0.07***	0.00	0.06**	-0.09***	-0.12***	-0.12***	-0.03***	0.15***	0.24***
$Ddn, R = 0$	0.15	0.24	0.32	0.21	0.29	0.35	0.31	0.47	0.58	0.45	0.49	0.51
$Ddn, R = 1$	0.12	0.23	0.33	0.17	0.29	0.38	0.27	0.44	0.56	0.49	0.78	0.91
Change	-0.03**	-0.01	-0.01	-0.04***	0.00	0.04	-0.04**	-0.03	-0.02	0.04***	0.29***	0.39***
Probability firms decrease prices (Pdn) when costs decrease (Cdn) and....												
$Dup, R = 0$	0.36	0.38	0.40	0.22	0.18	0.15	0.34	0.36	0.37	0.33	0.29	0.26
$Dup, R = 1$	0.26	0.49	0.65	0.24	0.17	0.13	0.28	0.18	0.13	0.20	0.06	0.02
Change	-0.09*	0.11	0.25	0.02	-0.01	-0.02	-0.06**	-0.18***	-0.24***	-0.13***	-0.23***	-0.24***
$Dnc, R = 0$	0.46	0.49	0.52	0.25	0.22	0.20	0.42	0.45	0.46	0.33	0.30	0.28
$Dnc, R = 1$	0.40	0.61	0.73	0.30	0.24	0.20	0.38	0.31	0.27	0.24	0.13	0.08
Change	-0.06	0.11	0.22	0.06*	0.02	0.00	-0.04	-0.13**	-0.20**	-0.09***	-0.17***	-0.20***
$Ddn, R = 0$	0.76	0.76	0.76	0.39	0.33	0.29	0.56	0.59	0.61	0.42	0.37	0.33
$Ddn, R = 1$	0.64	0.80	0.88	0.43	0.35	0.30	0.47	0.36	0.29	0.26	0.09	0.04
Change	-0.12**	0.04	0.12	0.04	0.02	0.01	-0.09***	-0.23***	-0.32***	-0.16***	-0.28***	-0.30***

Notes: These conditional probabilities are derived from the coefficient estimates shown in Table A2 and are evaluated at the specific inflation rates of 2%, 5% and 7%. P=prices, C=costs, D=demand, up=increase, nc=no change, dn=down, hence for example Pup=Prices up, and so on. $R = Recent$ is the time contingent dummy variable which takes a value=1 from 2011Q2 and zero otherwise. "Change" is the absolute change in estimated conditional probability of a price change (under the equivalent cost and demand conditions) between pre- and post-2011Q2 [i.e., $(R = 1) - (R = 0)$]. Small differences between recorded "Change" and the respective reported values of the conditional probabilities are due to rounding to the nearest digit at the second decimal point. Statistical significance is evaluated using the Delta method by applying the "margins" command in Stata and is denoted by asterisks: *** denotes p < 0.01; ** p < 0.05; * p < 0.10.

6.2 Conditional probabilities of price changes by firm size

It is apparent from Table 3 that larger firms are more likely to sell online and are more sophisticated in their data-driven decision-making. As noted earlier, price flexibility is therefore expected to have increased in larger firms. Figure 5 shows the differences in the conditional probabilities of price increases for small firms (employees≤20) and large firms (employees>200). The differences in conditional probabilities represent the differences between the periods before and after 2011Q2. They are reported for different annual inflation rates and for each industry sector.[35] The estimated probabilities for all cases are shown in Table A4.

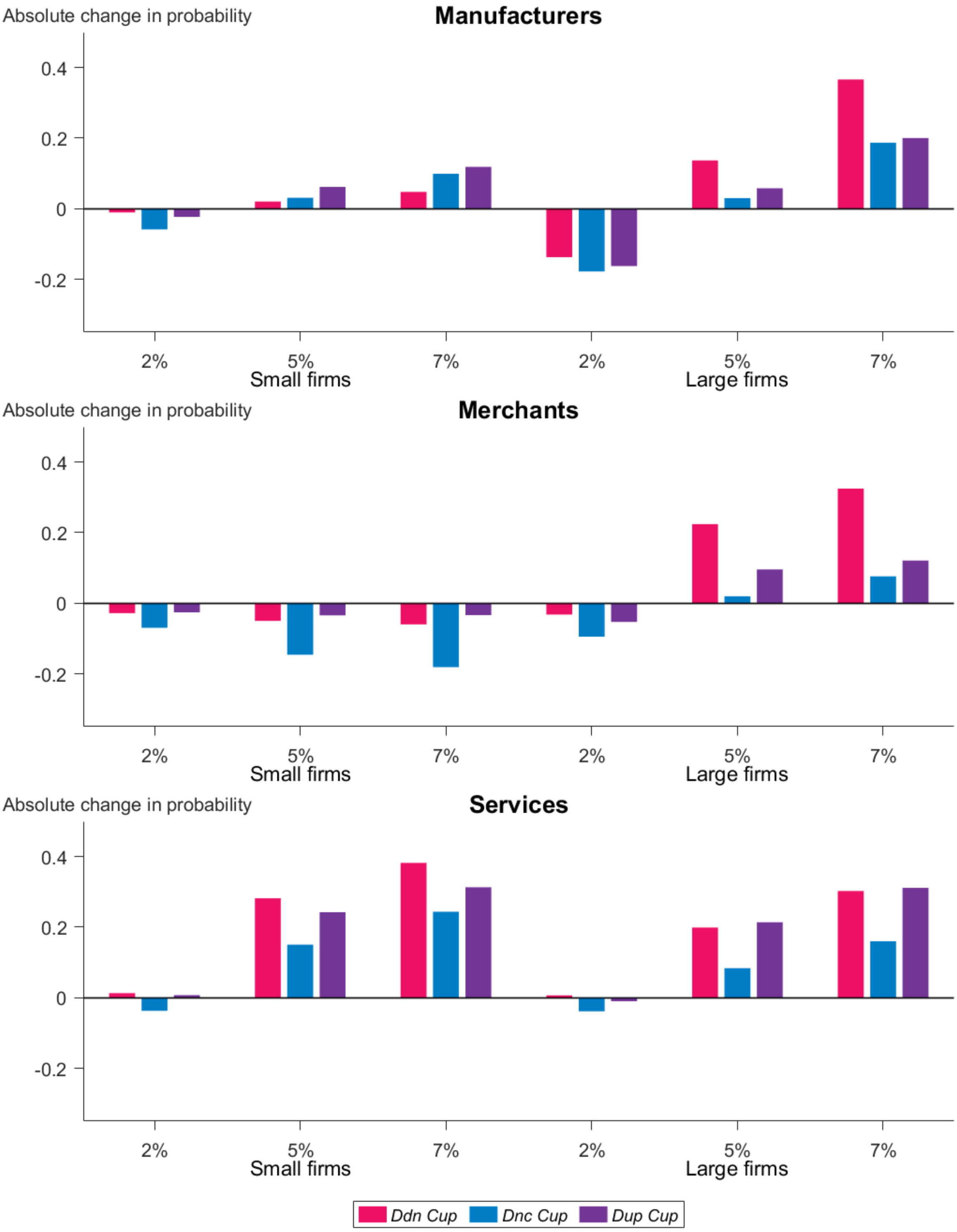
Figure 5 shows that for the Services sector, both small and large firms have experienced an increase in their conditional probability of rising prices post-2011Q2 compared to the earlier years, for inflation rates above 2 per cent. The size of the post-2011Q2 change tends to be larger for small firms. The firm size differences are small, however, and in the situation when both costs and demand increase, there is no discernible difference between large and small firms in the size of the change in conditional probabilities of price change between the two periods. We therefore do not observe the expected relationship between size and price flexibility in the Services sector. Something else might be at play. Specifically, if technology reduces the fixed cost component of price review and menu costs, this will disproportionately benefit smaller firms that adopt digital technology (and digital technology is more widespread in the Services sector).[36] In the Services sector it may be the case that two differing forces regarding digital capability are operating: a higher prevalence of digital capability in larger firms, but a disproportionate benefit from digital capability to smaller firms.

In contrast, for Merchant and Manufacturing firms, larger firms display a more substantial increase in price flexibility in an upward direction than smaller firms; this is consistent with the hypothesis that higher investment in digital technology by larger firms will lower price review and menu costs of price adjustment and increase price flexibility. Larger Merchant and Manufacturing firms manage long and complex supply chains to source their physical goods, meaning the price review process requires more inputs of information and managerial time. By contrast smaller firms in these sectors are more likely to source locally. Consequently, when information technology enhances the timeliness and quality of information on changes in supply chain costs, it disproportionately lowers price review costs for larger firms in these sectors and increases their price flexibility.

[35] The low count of large building firms in our sample means it is not appropriate to do the size analysis for firms in this sector. Hence, Figure 4 excludes Building sector firms.

[36] In the presence of fixed costs for price review and menu costs, the prices posted by smaller firms will still be less sensitive to cost and demand pressures in absolute terms.

Figure 5: Change in conditional probabilities of a price increase by firm size



Notes: Derived from estimated conditional probabilities reported in Table A5. D=demand, C=costs, up=increase, nc=no change, dn=down, hence for example Dup=Demand up, Cup=Costs up, and so on. The changes in probabilities between pre- and post-2011Q2 are shown for periods when annual inflation rates were 2%, 5%, and 7% as denoted along the horizontal axes for small and large firm. Small firms are firms with 20 or fewer employees and large firms are firms with more than 200 employees.

Differences in estimated conditional probabilities of price decreases for large and small firms before and after 2011Q2 at different annual inflation rates and for each industry sector are also provided in Table A5. After disaggregating by sector and firm size, the numbers of reported price decreases by firm size and sector during the post-2011Q2 period are much smaller than during the pre-2011 period. With this caution in mind, the results in Table A5 suggest that both small and large services firms were less likely to drop their prices after 2011Q2. In the merchant sector, smaller firms displayed more downward price stickiness in recent years compared to earlier years, whilst for large firms, an increase in downward price stickiness was only evident when both demand and costs fell. For manufacturing firms, both small and large firms have become more responsive to reductions in costs and demand in recent years (consistent with price review and menu costs being lower) but, excluding the demand down and cost down scenario, larger firms were more likely to drop prices than smaller ones. This is consistent with larger manufacturing firms having more real-time reliable information on supply chain costs and thus being more willing to act on the information.

7. Consumer behaviour and other possible explanations for changes in pricing behaviour

Technological changes are not the only possible explanation for why there have been changes in the conditional probability of price changes and an increase in the use of smaller but more frequent price changes. Moreover, technological change-based explanations predict increased price flexibility in both directions. The full sample results show price flexibility has only increased in the upward, but not downward, direction. In this section, alternative explanations for why pricing asymmetry has become more acute are considered.

7.1 Consumer behaviour, profit increases, and more acute price asymmetry

An alternative explanation draws on the idea of rational inattention by consumers to small price adjustments. People need to be selective in the information they process; otherwise, they risk being overwhelmed (Sims, 2003). In the context of price adjustments, because tracking prices requires time and mental effort, consumers might be inattentive to small price changes. The result of this inattention is to push the elasticity of demand towards zero for small price changes. In such circumstances, Chen et al. (2008) and Levy et al. (2025) note that from a firm's point of view, small price increases might be valuable as they are more likely to escape the notice of the customer and consequently elicit no demand response. By the same logic, small price decreases do not help the firm to increase demand because they too escape the notice of the customer. Levy et al. (2025, p2) states this means "the retailer has an incentive to make more frequent small price increases than decreases." That is, prices will display asymmetric behaviour. Using price scanner data, Chen et al. (2008) and Levy et al. (2025) find that small price increases occur more frequently than small price decreases. In a further test of the idea, Levy et al. (2025) predict that pricing asymmetry should be negatively correlated with unemployment over the business cycle as unemployed people have more time to be attentive to price changes. They present empirical evidence that supports this conjecture.

Increased consumer inattention therefore may play a role in explaining the increased pricing asymmetry observed in our analysis. Owing to the length of the period subsamples (pre- and post-2011Q2), any increase in inattention by consumers is unlikely to reflect business cycle-induced differences in inattention.[37] But perhaps an explanation lies in another labour market indicator: the participation rate.

In New Zealand, and like many other countries, there has been a rise in the percentage of women of child-rearing age in the workforce. In 1986, in New Zealand, approximately 70 per cent of females between 25 and 49 years old were employed. This percentage increased to just over 84 by 2024. Over the same period, the percentage of men working was relatively stable, falling slightly from 96 to 93 per cent.[38] These data suggest there has been a shift toward two-parent working households. Given the competing demands on parental time in dual-income households, it is reasonable to hypothesise that rising rates of two-parent working households may have contributed to greater household inattention to small price changes. In response to this increased inattention, smaller, more frequent price changes during periods of high inflation are optimal from the point of view of firms. Section 3 documents that in recent periods, the magnitude of price increases is smaller and more frequent for a given inflation rate, than in earlier decades. Further, if, as argued above, an increase in inattention pushes the elasticity of demand on small price changes toward zero, it also suggests price increases should become more common, but price decreases less so. Again, this is consistent with what is observed in the more recent period (post-2011Q2). Further, it is notable that this pricing asymmetry has become more acute in the two sectors which are the most household-facing: merchants and services.

The proposition advanced here is that the degree of inattention to price changes can still decline as inflation rises, consistent with Bayarmagnai (2023), but the degree of inattention today is likely to be higher at a given high (or low) inflation rate than in earlier decades owing to increased labour force participation by households.

Another possible explanation for the change in firm price-setting behaviour relates to absolute and relative price confusion. When the price level is more volatile, which it is in periods of higher inflation, customers find it harder to distinguish between absolute and relative price changes. Scanlon (2024) presents a model which shows under such conditions, consumers are more likely to attribute a firm's price change to overall inflation rather than a shift in relative prices. This leads to a smaller demand response when relative price changes do occur and this allows firm markups to increase. In the most recent inflation episode, as a result of lost profits in 2020 when firms' trading was restricted by shelter-in-place (`lockdown') orders, firms may have been more willing than in the past to exploit this information challenge for customers (and perhaps reflecting increased consumer inattention as discussed in the previous paragraph) to restore profits and the firm balance sheet. Glover, et al. (2023) show that for the US, firm markup growth contributed a "substantially larger contribution" to the rise of inflation in 2021 than during the preceding decade (p33).

If firms have exploited consumer inattention or confusion during the recent high inflation, this should manifest in profit margins increasing as inflation rises. This can be tested by evaluating changes in the conditional probability of profits increasing when costs and demand are unchanged (that is, under conditions where there is no change in the desired relative price).[39] The top panel of

[37] Based on unemployment data from the Data1850 data source (https://www.nzier.org.nz/data-1850), the mean unemployment rate is comparable before and after 2011Q2 in our sample period (4.0 and 4.8 per cent, respectively).

[38] The data are sourced from Statistics NZ's Household Labour Force Survey via Infoshare. The figures presented are arithmetic averages across the participation rates reported for 25-29, 30-34,35-39,40-44 and 45-49 age groups by sex. This is reported for 1986 as it is the first year Statistics NZ report age disaggregated data for participation rates.

[39] The QSBO questionnaire explained in Section 3 also asks firms to report their experience during the past three months concerning changes in profitability. This question was first included in 1969Q1 and has been included regularly since that date.

Table 5 shows the results for all firms. There has been a significant change in the conditional probability of profits increasing as inflation rises. For earlier decades, while the probability of an increase in profitability is positive, there is no discernible change as inflation rises. In the post-2011Q2 period there is a systematic and significant rise in the probability of a rise in profitability as inflation increases. The changes between the pre- and post-2011Q2 periods are statistically significant and consistent with the idea firms may be more inclined in recent years to exploit consumer information challenges or inattention (or both).[40]

Table 5: Conditional probabilities of profit increase when firms report no change in cost and demand: pre- and post-2011Q2

Type of conditional probability:	**Probability:**			**Change in probabilities (R=1) - (R=0)**		
Inflation rates:	2%	5%	7%	2%	5%	7%
Probability firms increase profit (all firms):						
$Prob[Prup \| Cnc, Dnc, R = 0]$	0.28	0.29	0.29			
$Prob[Prup \| Cnc, Dnc, R = 1]$	0.29	0.33	0.37	0.00	0.04***	0.07***
Probability Builders increase profit:						
$Prob[Prup \| Cnc, Dnc, R = 0]$	0.26	0.27	0.28			
$Prob[Prup \| Cnc, Dnc, R = 1]$	0.22	0.29	0.33	-0.03**	0.02	0.06
Probability Manufacturers increase profit:						
$Prob[Prup \| Cnc, Dnc, R = 0]$	0.30	0.30	0.30			
$Prob[Prup \| Cnc, Dnc, R = 1]$	0.28	0.30	0.31	-0.02**	0.00	0.01
Probability Merchants increase profit:						
$Prob[Prup \| Cnc, Dnc, R = 0]$	0.31	0.32	0.33			
$Prob[Prup \| Cnc, Dnc, R = 1]$	0.32	0.37	0.42	0.01	0.05**	0.09***
Probability Services increase profit:						
$Prob[Prup \| Cnc, Dnc, R = 0]$	0.27	0.28	0.29			
$Prob[Prup \| Cnc, Dnc, R = 1]$	0.28	0.33	0.36	0.01**	0.05***	0.07***

Notes: These conditional probabilities are derived from the coefficient estimates shown in Table A6 and are evaluated at the specific inflation rates of 2%, 5% and 7%. $\boldsymbol{Pr}$=profitability, $\boldsymbol{C}$=costs, $\boldsymbol{D}$=demand, $\boldsymbol{up}$=increase, $\boldsymbol{nc}$=no change, $\boldsymbol{dn}$=down; hence for example $\boldsymbol{Prup}$=Profitability up, and so on. $R = Recent$ and is the time contingent dummy variable which takes a value=1 from 2011Q2 and zero otherwise. Change in probability $[(R = 1) - (R = 0)]$ is the absolute change in the estimated conditional probability of a profit change (under the equivalent cost and demand conditions) between pre- and post-2011Q2. Small differences between the reported "Change in probability" and the respective recorded values of the reported conditional probabilities are due to rounding to the nearest digit at the second decimal point. Statistical significance is evaluated using the Delta method by applying the "margins" command in Stata and is denoted by asterisks: *** denotes p <0.01; ** p <0.05; * p <0.10.

[40] The inattention and confusion channels posited here are likely enhanced by technology. Abrardi, et al. (2022) note dynamic pricing means consumers face constant price fluctuations. More generally, technology allows the implementation of more complex pricing strategies which make it harder for customers to isolate and respond to relative price movements.

The other panels in Table 5 show the results for different types of firms. They reveal a significant difference in behaviour by firm type. For merchant and service firms there has been a significant increase post-2011Q2 in the probability that profits increase as inflation rises. There is no significant change for builders and manufacturers. The significant effect observed in the merchant and service sectors may arise because transactions in these sectors are typically smaller and involve a large variety of products, reducing consumers' incentive and ability to assess relative prices carefully and be attentive to price changes. In contrast, the larger transactions typical of building and manufacturing sectors encourage customers and firms to gather the necessary information to monitor prices carefully.

7.2 Economic reform and price-setting behaviour

Like many countries, New Zealand had periodic and relatively short periods of price regulations designed to address high inflation from the early 1970s to mid-1980s, including a price-wage freeze from 1982 to 1984. Apart from slight variations during the mid-1980s, there is no clear evidence from Figure 3 that the subsequent deregulation of product markets had a significant immediate effect on the relationship between inflation and the proportion of firms adjusting prices.[41] Changes in the regulatory environment may nevertheless have affected the rate of adoption of new technology and had an indirect effect on pricing behaviour.

Institutional changes to monetary policy have also taken place since the 1980s which might have contributed to the changes in price adjustment behaviour. Figure 3 shows a change in the relationship, in the aggregate, between the proportion of firms changing prices and inflation since the early 1990s. New Zealand implemented formal inflation targeting and central bank operational independence in 1989. If inflation targeting and central bank independence have better anchored inflation expectations, this means that in the event of a negative shock to relative prices, firms are less likely to expect general inflation to eventually restore the prevailing relative price to their desired lower relative price. This would mean firms are more likely to act and lower their relative prices themselves. If this reasoning is correct, inflation targeting and central bank independence should mean firm prices are more flexible in a downwards direction, not less. This is not what we observe.

8. Conclusion

The frequency with which firms change prices has a critical influence on inflation dynamics. Using a unique firm-level dataset, this paper contributes new insights to the literature on price change in three important ways: (i) it reveals that the conditional probability of price change in response to cost and demand changes has changed in recent years; (ii) it documents that during the COVID-19 inflation episode, firms changed their prices more often but by a smaller magnitude compared to previous comparable high inflation episodes; and (iii) it confirms prior findings of asymmetric pricing behaviour, but contributes a new finding that the asymmetry in the frequency of price changes has become more acute as inflation increases.

Time-series analysis reveals there has been an increase in the correlation between inflation and the proportion of firms changing prices since the early 1990s. This change has been masked by the long period of low inflation after the early 1990s. For instance, the proportion of firms changing

[41] Refer to Evans et al. (1996) for a description of the regulatory and institutional policy changes that took place in New Zealand during the mid-1980s to early 1990s.

prices during the COVID-19 inflation episode was much higher than during earlier decades with similar average inflation rates, and it was as high as the proportions observed during periods of much higher inflation during the 1970s and 1980s. This is especially evident with price increases, though a similar (inverse) pattern is evident with price decreases.

Furthermore, during the COVID-19 period the magnitude of price adjustments was on average, substantially smaller than that which occurred during earlier periods of high inflation. They were closer in magnitude to price adjustments during the low inflation of the "Great Moderation." This finding aligns with recent studies of the relative importance of the frequency and magnitude of individual price changes during the inflation experienced by the US in the COVID-19 era.

Ordered probit model estimates provide deeper insights into the reasons for these changes. There is a clear pattern whereby the probability of a price increase conditional on costs increasing (for any demand condition) rises as inflation rises and these conditional probabilities are significantly higher in recent years, as inflation rises above 2 per cent. On the other hand, the conditional probabilities of price decreases in response to cost decreases (for any change in demand) have fallen. Therefore, pricing asymmetry has become more acute in recent years and this is especially evident during the COVID-19 inflation era.

There are significant differences across industrial sectors and firm size in the propensity to change prices. The rise in the conditional probability of price increases during the COVID-19 inflation era compared to earlier episodes of similar inflation rates was much stronger among services sector firms than for firms in other sectors. The probabilities of increasing prices also increased for larger firms in the merchant and manufacturing sectors. The conditional probability of firms decreasing prices in response to decreases in costs has fallen in the services sector, and for small firms in the merchant sector and this change is more evident at higher levels of inflation. Combined with the increasing prominence of services in the overall economy, these changes have led to substantial shifts in aggregate pricing behaviour.

The rise in the conditional probability of increasing prices is consistent with the idea that changes in information technology have the potential to both reduce the costs of price adjustment (both menu costs and price review costs) and reduce firms' propensity to 'wait and see' when considering price adjustment by improving the timeliness and quality of cost and demand information. The changes in pricing behaviour are also consistent with the growing body of evidence that online selling generates competitive pressures that result in more flexible prices and greater pass-through of costs. These technologically based explanations, however, also predict that the conditional probability of decreasing prices when cost and demand conditions warrant, should have increased. That is, prices should have also become more flexible downwards. We do not observe this.

Decreased downward price flexibility, and the increased use of smaller, but more frequent, price increases by firms is consistent, however, with a lower elasticity of demand to price changes. This may reflect greater consumer inattention to small price changes, because of higher labour force participation and, consequently, more time-constrained households. The paper also reports a significant increase during recent years in the propensity for firms to increase profit margins as inflation increases under conditions when costs and demand do not change, and therefore when there should be no change to firms' desired relative prices. This result is consistent with firms taking advantage of consumers' relative and absolute price confusion or inattention (or both) to restore profits after COVID-19 related 'shelter-in-place' orders were lifted.

The results reported in this paper imply that inflation dynamics today, and during the COVID-19 inflation episode, are different to the dynamics of earlier decades. This could have implications for the specification of the Phillips curve and forecasting models of inflation. The tighter correlation between the propensity of firms to change prices and inflation and the rise in propensity to change prices as inflation rises, suggest that the "inflation accelerator" could be operating more strongly than in the past. In view of the importance of price change frequency for understanding inflation dynamics, it would seem important that macroeconomic models, methods of forecasting of inflation, and the decision-making processes of central bank monetary policy committees recognise and adapt to these changes in pricing behaviour.

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Appendix

Table A1: Firm survey response counts by price, cost and demand sets, 1963 to 2024

Period:	1963Q3 to 2010Q4 (R=0)				2011Q1 to 2024Q3 (R=1)				1963Q3 to 2024Q3			
Inflation band:	**%≤3**	**3<%<6**	**%≥6**	**Totals:**	**%≤3**	**3<%<6**	**%≥6**	**Totals:**	**%≤3**	**3<%<6**	**%≥6**	**Totals:**
Price, cost, demand sets												
$Pup\|Cup, Dup$	1906	2095	4822	8823	1191	568	429	2188	3097	2663	5251	11011
$Pup\|Cup, Dnc$	2361	2531	6576	11468	1667	1124	1058	3849	4028	3655	7634	15317
$Pup\|Cup, Ddn$	1263	1340	3893	6496	996	796	663	2455	2259	2136	4556	8951
$Pup\|Cnc, Dup$	823	396	363	1582	558	121	107	786	1381	517	470	2368
$Pup\|Cnc, Dnc$	1008	517	404	1929	899	334	345	1578	1907	851	749	3507
$Pup\|Cnc, Ddn$	428	233	213	874	391	145	185	721	819	378	398	1595
$Pup\|Cdn, Dup$	268	96	98	462	59	16	#	7#	327	112	9#	53#
$Pup\|Cdn, Dnc$	168	67	61	296	63	31	18	112	231	98	79	408
$Pup\|Cdn, Ddn$	138	57	41	236	63	30	25	118	201	87	66	354
Total price increases	**8363**	**7332**	**16471**	**32166**	**5887**	**3165**	**283#**	**1188#**	**14250**	**10497**	**1930#**	**4404#**
$Pnc\|Cup, Dup$	1389	1369	1992	4750	1216	276	67	1559	2605	1645	2059	6309
$Pnc\|Cup, Dnc$	2149	1781	2507	6437	2411	578	278	3267	4560	2359	2785	9704
$Pnc\|Cup, Ddn$	1408	1235	2142	4785	1251	422	205	1878	2659	1657	2347	6663
$Pnc\|Cnc, Dup$	4485	2051	1520	8056	2930	329	99	3358	7415	2380	1619	11414
$Pnc\|Cnc, Dnc$	9416	3890	2496	15802	9141	1545	537	11223	18557	5435	3033	27025
$Pnc\|Cnc, Ddn$	3260	1591	1493	6344	2575	548	173	3296	5835	2139	1666	9640
$Pnc\|Cdn, Dup$	854	286	147	1287	198	21	#	22#	1052	307	14#	150#

Period:	1963Q3 to 2010Q4 (R=0)				2011Q1 to 2024Q3 (R=1)				1963Q3 to 2024Q3			
$Pnc\|Cdn, Dnc$	755	215	132	1102	285	35	7	327	1040	250	139	1429
$Pnc\|Cdn, Ddn$	411	168	106	685	197	49	15	261	608	217	121	946
Total no price changes	**24127**	**12586**	**12535**	**49248**	**20204**	**3803**	**138#**	**2538#**	**44331**	**16389**	**1391#**	**7463#**
$Pdn\|Cup, Dup$	249	123	120	492	154	18	#	17#	403	141	125	66#
$Pdn\|Cup, Dnc$	495	274	229	998	373	70	22	465	868	344	251	1463
$Pdn\|Cup, Ddn$	630	392	409	1431	419	144	44	607	1049	536	453	2038
$Pdn\|Cnc, Dup$	620	168	103	891	208	21	#	22#	828	189	10#	112#
$Pdn\|Cnc, Dnc$	1062	373	180	1615	555	51	9	615	1617	424	189	2230
$Pdn\|Cnc, Ddn$	1060	411	287	1758	474	64	19	557	1534	475	306	2315
$Pdn\|Cdn, Dup$	567	140	74	781	112	10	#	12#	679	150	7#	90#
$Pdn\|Cdn, Dnc$	618	156	90	864	191	15	#	21#	809	171	9#	107#
$Pdn\|Cdn, Ddn$	728	235	156	1119	280	72	15	367	1008	307	171	1486
Total price decreases	**6029**	**2272**	**1648**	**9949**	**2766**	**465**	**12#**	**335#**	**8795**	**2737**	**176#**	**1330#**
Total counts by inflation band	**38519**	**22190**	**30654**		**28857**	**7433**	**4333**		**67376**	**29623**	**34987**	
Total responses per period				**91363**				**40623**				**131986**

Notes: Derived from the New Zealand Institute of Economic Research (NZIER) Quarterly Survey of Business Opinion database. P=prices, C=costs, D=demand, up=increase, nc=no change, dn=down; hence for example, Pup=Prices up, and so on. The two sub-periods list the response counts for the periods 1963Q3 to 2011Q1 $(R = 0)$ and 2011Q2 to 2024Q3 $(R = 1)$ referred to in Sections 5, 6 and 7 for analysis of the change in conditional probabilities of price change and profitability change. # denotes a digit between 0 and 6 and replaces the actual number of observations where that number is <6, to comply with the NZIER's data confidentiality requirements. In the totals columns therefore, # denotes a digit between 0 and 9.

Table A2: Coefficient estimates from estimating equation 2: All firms and by sector

Coefficient	All	Builders	Manufacturers	Merchants	Services
b_1	0.613***	0.634***	0.598***	0.597***	1.115***
	(.013)	(.058)	(.027)	(.032)	(.025)
b_2	6.278***	10.808***	7.75***	18.461***	1.576***
	(.187)	(1.191)	(.33)	(.734)	(.322)
b_3	0.055***	0.284***	0.081***	0.238***	-.057**
	(.013)	(.067)	(.028)	(.042)	(.024)
b_4	0.657***	1.051	2.053***	1.201	1.862***
	(.19)	(1.417)	(.365)	(.753)	(.367)
b_5	0.667***	0.88***	0.514***	0.679***	1.018***
	(.023)	(.149)	(.044)	(.061)	(.045)
b_6	-3.288***	3.583	-4.226***	2.95*	-3.095***
	(.464)	(4.368)	(.774)	(1.551)	(1.181)
b_7	0.388***	1.013***	0.581***	0.442***	0.309***
	(.015)	(.065)	(.031)	(.042)	(.026)
b_8	-1.02***	-2.999***	-2.856***	0.489	-1.836***
	(.191)	(1.113)	(.357)	(.671)	(.428)
a_1	-0.256***	-0.515***	-0.465***	-0.268***	-0.457***
	(.02)	(.087)	(.057)	(.051)	(.036)
a_2	8.123***	5.617**	9.247***	-2.396	18.139***
	(.501)	(2.233)	(1.584)	(1.567)	(.852)
a_3	0	0.234**	0.124*	0.014	-0.033

Coefficient	All	Builders	Manufacturers	Merchants	Services
	(.023)	(.101)	(.066)	(.083)	(.037)
a_4	6.441***	-4.476	-0.081	4.885	9.18***
	(.736)	(3.509)	(2.341)	(3.089)	(1.125)
a_5	0.078*	-0.511*	0.326**	0.106	-0.058
	(.045)	(.304)	(.137)	(.138)	(.074)
a_6	-8.409***	17.045	-4.764	-11.336**	-12.206***
	(1.548)	(11.531)	(6.024)	(5.739)	(2.414)
a_7	-0.136***	-0.258***	-0.159**	-0.096	-0.011
	(.023)	(.1)	(.07)	(.081)	(.038)
a_8	-5.322***	1.533	3.004	-3.998*	-9.22***
	(.621)	(2.804)	(2.14)	(2.419)	(.987)
$k_1\ (down\|nc)$	-1.079***	-1.08***	-1.33***	-.999***	-1.468***
	(.014)	(.039)	(.022)	(.021)	(.016)
$k_2\ (nc\|up)$	0.881***	1.151***	1.28***	1.161***	1.005***
	(.012)	(.038)	(.022)	(.023)	(.013)
Observations	131,986	8,276	41,353	25,500	56,857
Likelihood Ratio chi2	32,647	2,401	9,052	10,165	15,021
Prob>chi2	0.000	0.000	0.000	0.000	0.000
Log likelihood	-104,178	-6,748	-32,976	-19,399	-42,034

Notes: C=costs, D=demand, up=increase, nc=no change, dn=down; hence for example, Cup=Costs up, and so on. Standard errors are reported in parentheses: ∗∗∗p < 0.01; ∗∗p < 0.05; ∗p < 0.1. The model is estimated using the hetoprobit command in Stata which implements a version of the ordered probit model that allows for the variance to be a function of specified explanatory variables. In the model estimated on the full dataset the variance is modelled as a function of firm sector, firm size and the inflation rate; in the models estimated for each sector, the variance is modelled as a function of firm size (number of employees) and the inflation rate. Likelihood ratio chi-square is the Likelihood Ratio test statistic. The Likelihood Ratio test statistic calculates by how much the likelihood improves in the model when heteroskedasticity is allowed for versus a model where the variance is assumed to be homoskedastic. The specific formula for the test statistic is $LR = -2(\ln(L_{Heteroskedastic}) - \ln(L_{Homoskedastic}))$. If the null hypothesis is true, the Likelihood Ratio test statistic follows a chi-squared distribution with degrees of freedom equal to the number of additional variance parameters in the heteroskedastic version of the model. Prob>chi2 is the probability based on the chi-squared distribution and the value of the Likelihood Ratio test statistic that one should accept the null hypothesis that there is no difference between the heteroskedastic version of the model and the homoskedastic version of the model in terms of likelihood.

Table A3: Conditional probabilities of price changes for all firms: pre- and post-2011Q2: Supplementary combinations of changes in costs and demand

Type of conditional probability:	Probabilities:			Change in probabilities (R=1)-(R=0):		
Inflation rates:	2%	5%	7%	2%	5%	7%
Probability firms increase prices:						
$Prob[Pup\|Cnc, Dup, R = 0]$	0.21	0.21	0.22			
$Prob[Pup\|Cnc, Dup, R = 1]$	0.25	0.32	0.37	0.04**	0.10***	0.15***
$Prob[Pup\|Cnc, Dnc, R = 0]$	0.16	0.18	0.20			
$Prob[Pup\|Cnc, Dnc, R = 1]$	0.20	0.32	0.42	0.04***	0.14***	0.21***
$Prob[Pup\|Cnc, Ddn, R = 0]$	0.11	0.11	0.12			
$Prob[Pup\|Cnc, Ddn, R = 1]$	0.16	0.21	0.25	0.05***	0.09***	0.13***
Probability firms decrease prices:						
$Prob[Pdn\|Cnc, Dup, R = 0]$	0.13	0.12	0.12			
$Prob[Pdn\|Cnc, Dup, R = 1]$	0.10	0.07	0.05	-0.02***	-0.05***	-0.07***
$Prob[Pdn\|Cnc, Dnc, R = 0]$	0.17	0.14	0.13			
$Prob[Pdn\|Cnc, Dnc, R = 1]$	0.13	0.07	0.04	-0.04***	-0.07***	-0.09***
$Prob[Pdn\|Cnc, Ddn, R = 0]$	0.24	0.23	0.22			
$Prob[Pdn\|Cnc, Ddn, R = 1]$	0.17	0.13	0.10	-0.07***	-0.10***	-0.12***
Probability firms increase prices:						
$Prob[Pup\|Cdn, Dup, R = 0]$	0.08	0.10	0.11			
$Prob[Pup\|Cdn, Dup, R = 1]$	0.12	0.26	0.40	0.04***	0.16***	0.29***
$Prob[Pup\|Cdn, Dnc, R = 0]$	0.07	0.09	0.10			

Type of conditional probability:	Probabilities:			Change in probabilities (R=1)-(R=0):		
$Prob[Pup\|Cdn, Dnc, R = 1]$	0.08	0.15	0.21	0.01***	0.06***	0.11***
$Prob[Pup\|Cdn, Ddn, R = 0]$	0.03	0.05	0.05			
$Prob[Pup\|Cdn, Ddn, R = 1]$	0.07	0.17	0.27	0.03***	0.12***	0.22***
Probability firms decrease prices:						
$Prob[Pdn\|Cup, Dup, R = 0]$	0.03	0.02	0.02			
$Prob[Pdn\|Cup, Dup, R = 1]$	0.03	0.01	0.00	0.00**	-0.01***	-0.01***
$Prob[Pdn\|Cup, Dnc, R = 0]$	0.04	0.02	0.02			
$Prob[Pdn\|Cup, Dnc, R = 1]$	0.04	0.02	0.01	0.01***	-0.01***	-0.01***
$Prob[Pdn\|Cup, Ddn, R = 0]$	0.08	0.05	0.04			
$Prob[Pdn\|Cup, Ddn, R = 1]$	0.06	0.02	0.01	-0.02***	-0.03***	-0.03***

Notes: This table supplements Table 2. As was the case for Table 2, these conditional probabilities are derived from the coefficient estimates shown in Table A2 and are evaluated at the specific inflation rates of 2%, 5% and 7%. P=prices, C=costs, D=demand, up=increase, nc=no change, dn=down; hence for example Pup=Prices up, and so on. $R = Recent$ and is the time contingent dummy variable which takes a value =1 from 2011Q2 and zero otherwise. Change in probabilities $(R = 1) - (R = 0)$ is the absolute change in the estimated conditional probability of a price change (under the equivalent cost and demand conditions) between pre- and post-2011Q2. Statistical significance is evaluated using the Delta method by applying the "margins" command in Stata and is denoted by asterisks: *** denotes p <0.01; ** p <0.05; * p <0.10. Small differences between reported change in probabilities $(R = 1) - (R = 0)$ and the respective recorded values of the reported conditional probabilities are due to rounding to the nearest digit at the second decimal point.

Table A4: Coefficient estimates from estimating equation 2: Small and large firms

Coefficients	Builders		Manufacturers		Merchants		Services	
	Small	Large	Small	Large	Small	Large	Small	Large
b_1	0.521***	0.418**	0.664***	1.236***	0.482***	1.203***	1.052***	0.887***
	(.091)	(.178)	(.047)	(.191)	(.042)	(.264)	(.033)	(.129)
b_2	13.632***	3.509*	7.633***	16.927***	18.711***	46.33***	1.479***	2.745***
	(2.26)	(1.857)	(.626)	(2.425)	(1.112)	(8.62)	(.405)	(.776)
b_3	0.419***	0.107	0.076	0.182	0.213***	0.499**	-0.056*	0.127**
	(.11)	(.077)	(.051)	(.118)	(.055)	(.207)	(.031)	(.051)
b_4	1.476	1.4	2.171***	4.523***	0.639	2.77	1.93***	0.26
	(2.762)	(1.398)	(.717)	(1.521)	(1.033)	(3.861)	(.497)	(.678)
b_5	1.348***	0.242	0.469***	1.169***	0.681***	1.272***	0.75***	1.052***
	(.264)	(.157)	(.103)	(.205)	(.092)	(.331)	(.07)	(.156)
b_6	-5.1	0.445	0.166	-15.72***	5.006**	5.79	1.637	-5.533***
	(7.604)	(4.014)	(2.09)	(3.273)	(2.157)	(7.027)	(2.082)	(1.912)
b_7	1.185***	0.352**	0.651***	1.227***	0.355***	1.187***	0.239***	0.268***
	(.108)	(.16)	(.054)	(.201)	(.052)	(.3)	(.031)	(.069)
b_8	-2.529	-1.221	-4.215***	-5.528***	0.441	5.451	-0.993*	-2.393**
	(2.125)	(1.175)	(.683)	(1.545)	(.914)	(3.615)	(.533)	(.964)
a_1	-0.263**	-0.431*	-0.445***	-2.841***	-0.071	-1.562***	-0.447***	-0.343***
	(.122)	(.222)	(.081)	(.571)	(.061)	(.468)	(.04)	(.12)
a_2	3.16	5.594	10.888***	58.781***	-7.078***	38.314**	17.605***	11.626***
	(3.191)	(4.836)	(2.025)	(18.198)	(1.801)	(17.223)	(.937)	(4.081)

Coefficients	Builders		Manufacturers		Merchants		Services	
a_3	0.131	0.272	0.174*	0.114	0.018	0.098	-0.041	-0.151
	(.149)	(.184)	(.097)	(.467)	(.098)	(.563)	(.044)	(.097)
a_4	-5.316	-3.624	-1.519	6.021	5.917*	9.73	7.876***	11.613***
	(4.995)	(6.418)	(3.042)	(20.804)	(3.455)	(25.922)	(1.219)	(4.483)
a_5	-1.032**	5.047	0.447*	0.818	-0.242	0.102	0.169*	-0.289
	(.435)	(730.724)	(.246)	(.636)	(.187)	(.813)	(.095)	(.185)
a_6	45.066***	-405.811	-10.664	20.597	-9.312	6.938	-15.44***	-24.601**
	(17.241)	(54713.)	(9.089)	(28.735)	(6.571)	(48.805)	(3.005)	(9.891)
a_7	-0.241*	-0.145	-0.287***	0.621	-0.001	0.289	0.042	0.006
	(.138)	(.171)	(.099)	(.521)	(.091)	(.743)	(.042)	(.129)
a_8	-0.932	1.871	6.307**	-32.041	-5.613**	-36.665	-8.617***	-6.885
	(3.859)	(6.069)	(2.72)	(21.757)	(2.624)	(28.463)	(1.056)	(4.902)
k_1 $(down\|nc)$	-1.301***	-0.334**	-1.489***	-2.663***	-0.927***	-2.232***	-1.42***	-1.111***
	(.073)	(.145)	(.047)	(.336)	(.033)	(.397)	(.027)	(.149)
k_2 $(nc\|up)$	1.277***	0.585**	1.434***	2.566***	1.068***	2.572***	0.897***	1.03***
	(.072)	(.243)	(.046)	(.327)	(.037)	(.451)	(.019)	(.139)
Observations	5438	1011	15168	11185	13868	5516	37792	8215
Chi-squared	1391	369	2980	2581	5234	2379	10229	1916
Prob>chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Log likelihood	-4456	-813	-11264	-9662	-10531	-4226	-26783	-6849

Notes: Large firms are firms with more than 200 employees; small firms are firms with 20 or fewer employees. C=costs, D=demand, up=increase, nc=no change, dn=down; hence for example, Cup=Costs up, and so on. Standard errors are reported in parentheses: ∗∗∗p < 0.01; ∗∗p < 0.05; ∗p < 0.1. The model is estimated using the hetoprobit command in Stata which implements a version of the ordered probit model that allows for the variance to be a function of specified explanatory variables. The variance is modelled as a function of the inflation rate. Likelihood ratio chi-square is the Likelihood Ratio test statistic. The Likelihood Ratio test statistic calculates by how much the likelihood improves in the model when heteroskedasticity is allowed for versus a model where the variance is assumed to be homoskedastic. The specific formula for the test statistic is $LR = -2(\ln(L_{Heteroskedastic}) - \ln(L_{Homoskedastic}))$. If the null hypothesis is true, the Likelihood Ratio test statistic follows a chi-squared distribution with degrees of freedom equal to the number of additional variance parameters in the heteroskedastic version of the model. Prob>chi2 is the probability based on the chi-squared distribution and the value of the Likelihood Ratio test statistic that one should accept the null hypothesis that there is no difference between the heteroskedastic version of the model and the homoskedastic version of the model in terms of likelihood.

Table A5: Conditional probabilities of price changes for small and large firms: pre- and post-2011Q2 for selected inflation rates

			pre-2011Q2			post-2011Q2		
Type of Probability:	Sector	Size	2%	5%	7%	2%	5%	7%
The probability of firms increasing prices (Pup) when costs increase (Cup) and …								
Dup	Manufacturers	small	0.35	0.44	0.50	0.33	0.50	0.61
Change(R=1)-(R=0)						-0.02	0.06**	0.12***
Dup		large	0.41	0.49	0.55	0.24	0.55	0.75
Change (R=1)-(R=0)						-0.16***	0.06	0.20*
Dup	Merchants	small	0.51	0.70	0.80	0.48	0.66	0.77
Change (R=1)-(R=0)						-0.03	-0.03	-0.03
Dup		large	0.52	0.70	0.79	0.46	0.79	0.91
Change (R=1)-(R=0)						-0.05	0.10	0.12**
Dup	Services	small	0.62	0.66	0.68	0.59	0.85	0.95
Change (R=1)-(R=0)						-0.03**	0.20***	0.27***
Dup		large	0.52	0.55	0.57	0.51	0.76	0.88
Change (R=1)-(R=0)						-0.01	0.22***	0.31***
Dnc	Manufacturers	small	0.32	0.38	0.43	0.26	0.41	0.52
Change (R=1)-(R=0)						-0.06***	0.03	0.10***
Dnc		large	0.37	0.44	0.48	0.20	0.47	0.67
Change (R=1)-(R=0)						-0.18***	0.03	0.19*
Dnc	Merchants	small	0.43	0.62	0.73	0.36	0.47	0.55
Change (R=1)-(R=0)						-0.07***	-0.15***	-0.18***

			pre-2011Q2			post-2011Q2		
Dnc		large	0.44	0.62	0.72	0.35	0.63	0.80
Change (R=1)-(R=0)						-0.10***	0.02	0.08
Dnc	Services	small	0.63	0.64	0.65	0.55	0.75	0.85
Change (R=1)-(R=0)						-0.08***	0.11***	0.20***
Dnc		large	0.49	0.51	0.53	0.43	0.59	0.68
Change (R=1)-(R=0)						-0.05*	0.07	0.15**
Ddn	Manufacturers	small	0.18	0.26	0.32	0.17	0.28	0.37
Change (R=1)-(R=0)						-0.01	0.02	0.05
Ddn		large	0.24	0.32	0.37	0.11	0.46	0.74
Change (R=1)-(R=0)						-0.14***	0.14	0.37***
Ddn	Merchants	small	0.31	0.49	0.61	0.28	0.44	0.55
Change (R=1)-(R=0)						-0.03	-0.05*	-0.06
Ddn		large	0.29	0.43	0.53	0.25	0.65	0.86
Change (R=1)-(R=0)						-0.03	0.22**	0.32***
Ddn	Services	small	0.55	0.57	0.59	0.50	0.80	0.92
Change (R=1)-(R=0)						-0.05***	0.22***	0.33***
Ddn		large	0.41	0.46	0.50	0.40	0.64	0.78
Change (R=1)-(R=0)						-0.01	0.18***	0.29***

Table A5 (Cont.): Conditional probabilities of price changes for small and large firms: pre- and post-2011Q2 for selected inflation rates

			pre-2011Q2			post-2011Q2		
Type of Probability:	Sector	Size	2%	5%	7%	2%	5%	7%
The probability of firms decreasing prices (Pdn) when costs decrease (Cdn) and …								
Dup	Manufacturers	small	0.19	0.18	0.18	0.21	0.14	0.10
Change (R=1)-(R=0)						0.02	-0.04	-0.08
Dup		large	0.25	0.19	0.16	0.36	0.34	0.33
Change (R=1)-(R=0)						0.10**	0.15	0.17
Dup	Merchants	small	0.38	0.42	0.45	0.21	0.14	0.10
Change (R=1)-(R=0)						-0.16***	-0.28***	-0.35***
Dup		large	0.33	0.34	0.35	0.32	0.30	0.28
Change (R=1)-(R=0)						-0.01	-0.05	-0.07
Dup	Services	small	0.23	0.23	0.23	0.20	0.06	0.02
Change (R=1)-(R=0)						-0.04**	-0.17***	-0.20***
Dup		large	0.38	0.32	0.29	0.15	0.02	0.00
Change (R=1)-(R=0)						-0.23***	-0.31***	-0.29***
Dnc	Manufacturers	small	0.22	0.22	0.22	0.28	0.19	0.14
Change (R=1)-(R=0)						0.06	-0.03	-0.08
Dnc		large	0.28	0.23	0.20	0.42	0.42	0.41
Change (R=1)-(R=0)						0.14***	0.18	0.21
Dnc	Merchants	small	0.45	0.50	0.54	0.31	0.27	0.24
Change (R=1)-(R=0)						-0.14***	-0.24***	-0.30***
Dnc		large	0.40	0.43	0.44	0.43	0.47	0.50

			pre-2011Q2			post-2011Q2		
Change (R=1)-(R=0)						0.03	0.05	0.06
Dnc	Services	small	0.23	0.24	0.25	0.20	0.11	0.07
Change (R=1)-(R=0)						-0.03*	-0.13***	-0.18***
Dnc		large	0.43	0.37	0.33	0.19	0.05	0.01
Change (R=1)-(R=0)						-0.23***	-0.32***	-0.32***
Dnc	Manufacturers	small	0.37	0.34	0.32	0.39	0.30	0.25
Change (R=1)-(R=0)						0.02	-0.03	-0.06
Ddn		large	0.41	0.34	0.29	0.57	0.43	0.34
Change (R=1)-(R=0)						0.15**	0.09	0.05
Ddn	Merchants	small	0.58	0.63	0.67	0.39	0.30	0.24
Change (R=1)-(R=0)						-0.19***	-0.34***	-0.43***
Ddn		large	0.57	0.61	0.64	0.54	0.45	0.40
Change (R=1)-(R=0)						-0.03	-0.16	-0.24
Ddn	Services	small	0.30	0.30	0.30	0.22	0.08	0.03
Change (R=1)-(R=0)						-0.07***	-0.22***	-0.27***
Ddn		large	0.50	0.42	0.37	0.22	0.03	0.01
Change (R=1)-(R=0)						-0.29***	-0.38***	-0.36***

Notes: These conditional probabilities are derived from the coefficient estimates shown in Table A4 and are evaluated at the specific inflation rates of 2%, 5% and 7%. P=prices, C=costs, D=demand, up=increase, nc=no change, dn=down; hence for example, Dup=Demand up, and so on. Owing to a lack of large building firms in the sample, the size analysis for firms in the building sector is not undertaken. Large firms are firms with more than 200 employees; small firms are firms with 20 or fewer employees. *Change (R=1)-(R=0)* is the absolute change in the estimated conditional probability of a price change (under the equivalent cost and demand conditions) between pre- and post-2011Q2. Small differences between the reported *Change (R=1)-(R=0)* and the respective recorded values of the reported conditional probabilities are due to rounding to the nearest digit at the second decimal point. Statistical significance is evaluated using the Delta method by applying the "margins" command in Stata and is denoted by asterisks: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A6: Ordered probit estimation of equation 2 for profitability changes when firms report no change in cost and demand conditions: pre- and post-2011Q2

Coefficients for	All firms	Builders	Manufacturer	Merchants	Services
Cnc	-0.589***	-0.485***	-0.7***	-0.565***	-0.649***
	(0.016)	(0.06)	(0.03)	(0.036)	(0.025)
$\pi.Cnc$	1.175***	1.224	0.586***	2.123***	1.424***
	(0.227)	(0.979)	(0.386)	(0.549)	(0.43)
Cdn	0.746***	0.309**	1.336***	0.606***	0.586***
	(0.03)	(0.155)	(0.051)	(0.068)	(0.052)
$\pi.Cdn$	1.961***	-5.721	1.131	0.833	0.305
	(0.601)	(3.988)	(0.866)	(1.311)	(1.484)
Dnc	0.957***	0.839***	0.889***	0.923***	1.204***
	(0.019)	(0.065)	(0.031)	(0.037)	(0.027)
$\pi.Dnc$	-0.413**	0.186	-1.232***	-0.409	0.124
	(0.174)	(0.793)	(0.325)	(0.318)	(0.372)
Dnd	-2.212***	-2.094***	-2.079***	-2.036***	-2.732***
	(0.034)	(0.081)	(0.042)	(0.057)	(0.04)
$\pi.Dnd$	1.944***	2.502***	1.848***	1.12**	2.35***
	(0.242)	(0.77)	(0.385)	(0.544)	(0.564)
$Cnc.Recent$	-0.029	-0.141	-0.039	-0.089	0.037
	(0.023)	(0.09)	(0.059)	(0.065)	(0.035)
$\pi.Cnc.Recent$	2.343***	1.033	0.184	1.563	2.172**
	(0.654)	(2.601)	(2.139)	(2.304)	(0.923)

Coefficients for	All firms	Builders	Manufacturer	Merchants	Services
$Cdn.Recent$	-0.081	-0.318	-0.17	0.15	-0.015
	(0.058)	(0.317)	(0.142)	(0.158)	(0.087)
$\pi.Cdn.Recent$	-15.691***	6.956	-10.415	-8.144	-16.766***
	(2.141)	(10.356)	(6.372)	(5.889)	(3.207)
$Dnc.Recent$	-0.053**	-0.113	-0.094	0.013	-0.077**
	(0.023)	(0.09)	(0.058)	(0.053)	(0.035)
$\pi.Dnc.Recent$	2.356***	5.297***	2.59	3.928***	2.175**
	(0.555)	(2.029)	(1.6)	(1.442)	(0.828)
$Dnd.Recent$	0.144***	0.169	0.291***	0.089	0.231***
	(0.032)	(0.111)	(0.075)	(0.094)	(0.048)
$\pi.Dnd.Recent$	-4.235***	-4.597*	-3.921*	-0.589	-6.614***
	(0.793)	(2.6)	(2.153)	(2.289)	(1.193)
$k_1\ (down \mid nc)$	-0.024***	-0.874***	-0.905***	-0.649***	-0.551***
	(0.004)	(0.041)	(0.022)	(0.027)	(0.016)
$k_1\ (nc \mid up)$	0.077***	1.141***	0.88***	1.071***	1.376***
	(0.002)	(0.047)	(0.021)	(0.03)	(0.02)
Observations	125363	7864	36886	24134	56479
Chi-squared	36779	2402	10263	4027	21125
Prob>chi2	0	0	0	0	0
Log likelihood	-111704	-6467	-33573	-22947	-48072

Notes: These estimated versions of equation 2 for profitability changes include the combination of reported demand and cost conditions Cnc, Cdn and Dnc, Ddn, where nc=no change. Standard errors are reported in parentheses: $***$p < 0.01; $**$p < 0.05; $*$p < 0.1. The model is estimated using the hetoprobit command in Stata which implements a version of the ordered probit model that allows for the variance to be a function of specified explanatory variables. In the model estimated on the full dataset the variance is modelled as a function of firm sector, firm size and the inflation rate. Likelihood ratio chi-square is the Likelihood Ratio test statistic. The Likelihood Ratio test statistic calculates by how much the likelihood improves in the model when heteroskedasticity is allowed for versus a model where the variance is assumed to be homoskedastic. The specific formula for the test statistic is $LR = -2(\ln(L_{Heteroskedastic}) - \ln(L_{Homoskedastic}))$. If the null hypothesis is true, the Likelihood Ratio test statistic follows a chi-squared distribution with degrees of freedom equal to the number of additional variance parameters in the heteroskedastic version of the model. Prob>chi2 is the probability based on the chi-squared distribution and the value of the Likelihood Ratio test statistic that one should accept the null hypothesis that there is no difference between the heteroskedastic version of the model and the homoskedastic version of the model in terms of likelihood.