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INFLATION AND ASYMMETRIC PRICE ADJUSTMENT

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Abstract

This paper uses a unique micro data set to test for the presence of price asymmetries at the firm level. We find that firm pricing is indeed asymmetric, as Tobin (1972) suggested long ago. Moreover, there is strong evidence to support Ball and Mankiw's (1994) suggestion that firm price asymmetry is dependent on inflation. However, Ball and Mankiw's theory seems to hold better for changes in costs than for changes in demand, a result which is consistent with the idea that firm pricing is influenced by a desire to preserve customer relations (Okun, 1981) or by information uncertainty (Dixit, 1976, Bhaduri and Falkinger, 1990). There is pervasive evidence of asymmetry in response to changes in costs during high inflation which tends to disappear during low inflation. There is no evidence of asymmetry in response to demand shocks at high rates of inflation. However, there is evidence that price changes are more responsive to demand decreases than to demand increases and this is more notable during low inflation. Thus, the effect of different rates of inflation on the demand asymmetry is broadly consistent with Ball and Mankiw's hypothesis.

Keywords: asymmetric pricing, inflation, menu-costs, ordered probit, survey data.

Journal of Economic Literature Classification: D40, E31

Inflation and Asymmetric Price Adjustment*

I. Introduction

The nature of nominal price rigidity has a crucial influence on the real effects of monetary policy and the characteristics of business cycles. Some economists have argued that these price rigidities are likely to be asymmetric (for example Tobin, 1972) and some textbooks have captured this idea with a convex aggregate supply curve (for instance Lipsey, 1983, Chapter 41). Evidence uncovered by Cover (1988), and corroborated by De Long and Summers (1988), showing that in the USA output has been more sensitive to negative money-supply shocks than to positive money-supply shocks, has heightened interest in the idea of price asymmetries. More recent empirical studies of the inflation effect of output gaps by Laxton, Meredith and Rose (1995), Razzak (1995) and Turner (1995), suggest that price asymmetries may not be limited to the USA.

These empirical studies may have important implications for the validity of the natural rate hypothesis and the role of demand management policies. However, it is difficult to interpret what they imply about price setting behaviour by firms. They are not clearly linked to any theoretical micro-foundation for price setting which would explain price asymmetry and the precise form it should take. They use aggregate data which may conceal the true nature of firm price setting behaviour. Furthermore, they do not provide a direct test of price asymmetry. For instance, the relationships revealed by Cover and by DeLong and Summers may be due to asymmetries elsewhere in the transmission of money to output. The same point can be made about the empirical studies of the relationship between inflation and aggregate output-gaps.

This paper makes use of a unique micro data set to test for price asymmetries at the firm level. Two types of price asymmetry are evaluated. The first type is motivated

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by Ball and Mankiw (1994). They consider a model in which firms make regularly scheduled price changes and, by paying a menu cost, can also make special adjustments in response to demand shocks. In their model, asymmetries in the reponse of prices to shocks arise naturally when there is positive trend inflation and are more pronounced at higher rates of inflation (the BM hypothesis).

The second type is motivated by considerations which may cause an asymmetry in the way firms adjust prices in response to cost compared to demand shocks. While it appears that menu costs of price adjustment may be a significant influence on many firms' decisions to change price, the potential effect on customer relations and the information costs required to deduce optimal price adjustments in an uncertain environment may be more important influences on firm pricing decisions (see Blinder, 1994). Either because of a concern for customer relations (Okun, 1981) or because of information uncertainty (Dixit, 1976 and Bhaduri and Falkinger, 1990), prices may be more sensitive to changes in costs than to changes in demand (the ODBF hypothesis)

The data used in this paper are ideally suited to evaluate these ideas. The data are obtained from a survey of firms which provide information about changes to their selling prices, costs and demand. Furthermore, each firm's response to each question can be identified. This means that we can match changes in a particular firm's output price to the changes in costs and demand reported by that firm. Thus we have an ideal data set to test the relative response of prices to changes in costs and demand (a test of the ODBF hypothesis). It also means that we can easily identify those firms that report increases and those that report decreases in prices, costs and demand in order to compare the relative sensitivity of prices to increases and decreases in costs and demand across different inflation environments (a test of the BM hypothesis).

In the conclusion to their paper Ball and Mankiw comment that "An aspect of our model that might be examined in future empirical work is the relation between price adjustment and inflation" (p 261). This is one of the objectives of this paper. A second objective is motivated by the potential for firms to be concerned with their customer relations and the presence of information costs to generate an asymmetry in the way prices react to changes in costs compared to changes in demand. A

third objective is to evaluate whether the Ball and Mankiw price asymmetry, arising from the interaction of menu costs and inflation, holds for both cost and demand shocks.

The key empirical results to emerge from this paper are:
(i) Prices are typically more sensitive to changes in costs than to changes in demand. This result is consistent with the ODBF hypothesis.
(ii) There is pervasive evidence of pricing asymmetry in response to changes in costs which is systematically related to general inflation. At high rates of inflation the coefficient on increased costs is significantly larger than the coefficient on decreased costs. At low rates of inflation this difference between the cost coefficients tends to disappear. This is strongly supportive of the BM hypothesis when applied to cost shocks.
(iii) There is evidence that price changes are more responsive to demand decreases than to demand increases. This phenomenon is not captured by the Ball and Mankiw model and, contrary to their hypothesis, there is no evidence of asymmetry in response to demand shocks at high rates of inflation.
(iv) However, the demand asymmetry is more notable at low rates of inflation. Thus, the effect of different rates of inflation on the demand asymmetry is broadly consistent with the BM hypothesis.

These results suggest that a model of pricing behaviour that captures both types of asymmetry, i.e., the differential response of prices to cost and demand shocks and the variation in the response of prices to shocks across inflation regimes, would be a more appropriate representation of the pricing behaviour of firms analysed in this paper. The implications for the aggregate inflation and output-gap relationship is outside the scope of this paper, but the results presented here suggest that the relationship may be more complex than is implied by the earlier cited aggregate studies.

The remainder of the paper is structured as follows. Section II describes in more detail the theoretical ideas motivating the potential for price asymmetry, drawing out the distinction between asymmetry emerging from the interaction of menu costs and inflation and illustrating how this asymmetry might be modified to capture other adjustment costs which may cause asymmetry in the reaction of prices to cost and

demand shocks. Section III explains the type and source of the survey data used to empirically evaluate these ideas and also describes the different inflation regimes.

The price change model used to test the various hypotheses was estimated by ordered probit. Section IV describes the way we have arranged the survey data and the estimation procedure. The estimation procedure is in two stages. We first test the ODBF hypothesis by estimating the relative contribution to price changes of changes in costs and demand. These results are discussed in Section IV.1. The second stage is a test of Ball and Mankiw's inflation induced price asymmetry hypothesis, but distinguishing between cost and demand shocks. These results are discussed in Section IV.2. Section V presents concluding comments.

II. Explanations for Price Asymmetries

Some of the most well developed ideas providing microfoundations for nominal price rigidities have followed the "menu cost" approach, as reflected in the collection of papers in Sheshinski and Weiss (1993). A feature of this approach is that if it is costly to change price, firms will delay changes until the private benefits outweigh the private costs. If there is general inflation, a firm's real price will automatically fall thereby possibly offsetting a need to lower its nominal price. In a dynamic setting the properties of nominal price rigidities and the real effects of nominal demand shocks will vary according to whether firms follow time-contingent or state-contingent pricing rules (see Blanchard and Fischer, 1989, Chapter 8, and Romer, 1996, Chapter 6).

Ball and Mankiw (1994) use these ideas to argue that nominal price adjustments are asymmetric. They consider a model which combines elements of time-contingent pricing, where a firm adjusts prices on a regular time schedule, and state-contingent pricing, where a firm has the option of changing prices whenever economic circumstances warrant a change. If mid-way between regular price changes shocks are large enough, the firm will pay a menu cost and make an additional price change. This set-up enables Ball and Mankiw to avoid the complications created by cumulative shocks over several periods and to

concentrate on whether or not a firm should change price in response to a single shock[1].

Formally let θ be an exogenous shock to a firm's desired price in the absence of any menu costs, π the general rate of inflation, and C the menu cost of changing price. In the Ball and Mankiw model, the firm will not change its nominal price between regular changes if $C > (\pi/2 + \theta)^2$, that is if

$$-\sqrt{C} - \frac{\pi}{2} < \theta < +\sqrt{C} - \frac{\pi}{2} \qquad (1)$$

If θ is above the upper bound, the firm will raise price and if θ is below the lower bound, the firm will lower price.

At zero inflation, the range is symmetric and bounded by $\pm\sqrt{C}$. The range becomes asymmetric if the inflation rate π is not zero. For a given distribution of shocks, the larger is the inflation rate the more likely the firm is to make a price increase and the less likely it is to make a price decrease. Ball and Mankiw therefore predict that there will be greater asymmetry in price responses to shocks at higher rates of inflation[2].

Note also the role of menu costs. If C were zero, the interval for not changing price becomes empty for any rate of inflation, and the firm will either lower or raise price, but the inflation asymmetry still holds, even with zero menu costs. A higher π implies a wider range of shocks will be associated with price increases than with price decreases. If some firms do not change prices within an interval of time, such as a quarter of a year, then the implication of this model is that menu costs are non-zero. Thus a sizeable fraction of firms reporting no change in prices during periods of high inflation indicates non-trivial menu costs.

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[1] Carlson and Buckle (1996) consider the time between price changes, whether up or down, when there are idiosyncratic shocks in an environment of general inflation.

[2] In this approach price asymmetry arises endogenously in contrast to the approach in Ball and Mankiw (1995) where the distribution of exogenous relative price shocks is the cause of asymmetry in the relationship between aggregate demand and the aggregate price level.

The results of Blinder's (1994) interview survey show that for those firms that have explicit costs of changing prices, lump sum or "menu costs" appear to be the dominant form of adjustment cost. His survey also shows that concern for customer relations and information costs are perceived by a larger proportion of firms to be even more important considerations in their decisions to change price. These customer relation and information costs may create another type of asymmetry for the following reasons.

Okun (1981) has argued that in order to maintain their stock of customers, firms will be reluctant to make changes to prices that would be viewed as unfair. Since a significant cost to changing price is the disruption of firm and customer relations, pricing decisions should be perceived as "fair" by customers. In this context, Okun argued that firms find it easier to justify price increases on the basis of cost increases than on the basis of demand increases.

The asymmetric impact of cost and demand changes on a firm's optimal price can also arise because a given parametric shift affects marginal cost and marginal revenue differently. An increase in a firm's costs unambiguously increases marginal cost and the optimal price. But, as Dixit (1976) points out, a similar increase in a firm's demand curve may increase or decrease optimal price depending on the how the change in demand affects marginal revenue, which is affected only indirectly.

Dixit's result implies that even in an environment where firms have complete information, in the aggregate the price change in response to an increases in demand could be of indeterminant sign since some firms may raise price while others may decrease price. It also implies that the the mean size of a price change in response to a rise in demand could be small in comparison to the mean price response to a rise in firm costs of the same magnitude.

Bhaduri and Falkinger (1990) argue that the significance of the asymmetric impact of cost and demand shifts is reinforced when firms have incomplete information, especially if firms tend to have harder information about their cost conditions than about their demand conditions. Cost conditions depend on the technological relationship between variable inputs and outputs and the price of those inputs.

Information about the former is internal to the firm while the reliability of information about the latter will depend on the market conditions and contractual relations in factor markets. In contrast, information about demand conditions relevant for determining a firm's optimal price depends on imponderable conditions external to the firm. As a result firms tend to regard cost as 'hard' information and demand as 'soft' information.

The type of pricing rule that can emerge under these conditions is one in which firms will tend to base their prices on cost information. Their reaction in response to changed demand conditions is to adjust prices more gradually as they obtain more reliable information through observations accumulated over time. Accordingly, Bhaduri and Falkinger predict that prices will react more strongly to changes in costs than to changes in demand. Similar ideas can be found in Gordon (1981) and Blanchard (1983).

Concern for customer relations and the availability of more reliable information about costs compared to demand may therefore generate an asymmetry in the way prices react to changes in costs compared to the way they react to changes in demand. In particular, in an interval of time, firms are more likely to make price changes in response to cost changes than in response to demand changes.

In the context of Ball and Mankiw's menu cost model, these ideas suggest that for firms that are additionally concerned with their customer relations or that have more reliable information about costs than about demand, the parameter C will be larger for changes to demand than for changes to costs. The implications for prices can be illustrated by Figure 1 which is drawn assuming a common symmetric distribution of shocks to costs and demand, both with mean zero. With no general inflation, i.e. $\pi=0$, the 'zone of no-price-change' is symmetrically distributed about the mean zero. If C is larger for demand shocks than for cost shocks, ($C^d > C^c$) the zone of no-price-change is larger for demand shocks than for cost shocks.

The effect of inflation is also easily illustrated by Figure 1. As π increases above zero, the zones of no-price-change drift to the left so that, for a given distribution of shocks, there is a higher probability that a firm will raise its price. Inflation generates a potential price asymmetry for both cost and demand shocks, but the

probability of a rise in price in response to a rise in costs remains greater than the probability of a rise in price in response to a rise in demand. If C^d is sufficiently large the probability of a rise in price in response to a rise in demand would remain small thus effectively eliminating the inflation induced asymmetry for demand shocks postulated by Ball and Mankiw.

III Data and Inflation Regimes

III.I The NZIER Business Survey

The data used to evaluate these pricing hypotheses are all categorical consisting of trichotomous responses by New Zealand firms to a survey questionnaire. The individual firm responses are collected by the *Quarterly Survey of Business Opinion* (QSBO) which is managed by the New Zealand Institute of Economic Research (NZIER). The QSBO is similar in style to the 'Business Test' of the IFO Institute für Wirtschaftsforschung, Munich, and there are many other business surveys of this type around the world. Examples are surveys by the National Federation of Independent Business, USA, the Confederation of British Industries, the European Economic Commission, and the Australian Chamber of Commerce & Industry and Westpac Banking Corporation, and there are others documented by Kohler (1995).

For most surveys of this type the aggregate proportions of firms reporting for instance increased prices, unchanged prices, and decreased prices, are typically the only data that are available. There are however important features of this New Zealand survey which set it apart from most others. The NZIER stores the responses to all questions from every respondent firm and, apart from gradual attrition and increases in the sample in 1986:1 and in 1991:4, the sample of firms surveyed remains the same in each quarter, although not all firms respond in every quarter. The survey also asks firms about the change in their costs which many other surveys do not. Previous studies that have exploited these features of this survey data to examine firm price and output behaviour are Jackson and Yeo (1988) and Buckle and Meads (1991).

These features have several important advantages from the point of view of this study. Firm responses to the question about price change can be matched with their responses to other questions about costs, demand, etc. Secondly, the idea that the probability of a price rise and the probability of a price fall will vary systematically with inflation can be readily analysed because we can distinguish between firms that reported increased, decreased, or unchange prices, costs and demand in each quarter. Thirdly, individual firm data provide many more observations than would aggregate proportions data in each of the selected inflation regimes, which have an average time span of just over 3 years.

The NZIER survey involves the distribution to business executives of a standard questionnaire that identifies the firm, its principal activity, location and size, contains a series of questions asking about the firm's operating environment, and a standard question asking executives to report their perceptions of the actual change during the immediate past three months and expected change in the next three months (by reporting 'Up' or 'Same' or 'Down' or 'N/A') for several activity variables.

This paper utilises responses to the following questions which have been unchanged throughout the entire sample period:

> "What has been your experience during the past three months and what changes do you expect during the next three months in respect of the following":
>
> "Average selling prices"
> "Average costs"
> "All new orders received"
>
> "Do you consider the general business situation in New Zealand will improve, remain the same, or deteriorate during the next six months?"

Responses to the first three questions provide individual firm data on actual and expected changes to selling prices, costs and demand which are crucial for testing price responses to particular shocks and the presence of asymmetry. Responses to the fourth question were used to examine whether price responses to changes in costs and demand are conditioned by a firm's view of the business outlook.

This business outlook variable may be interpreted as capturing any one of several potential influences on firm pricing decisions. It may be interpreted as another proxy for perceived demand. Another possible interpretation is that the perceived permanence of cost and demand changes may be reflected in firms' views about the general business situation. If firms believe that the general business situation will improve, presumably they are more likely to raise price, in anticipation that other firms will raise prices, than if they believe the general business situation will stay the same or deteriorate. The principle of 'strategic complementarity' (Cooper and John, 1988) suggests that if firms view the business outlook optimistically, the opportunity costs of raising prices in response to increases in costs or demand may be perceived to be smaller than if the business outlook was not viewed optimistically.

The possibility that menu costs, concern for customer relations and information costs vary across firms warrants some degree of disaggregation by firm type. In this paper we report the results from two broad categories of firms covered by this survey: manufacturers and merchants[3]. The individual respondent data are available for manufacturers in every quarter since 1963:3 and for merchants in every quarter since 1974:3.

III.2 New Zealand Inflation Regimes

New Zealand's annual rate of consumer price (CPI) inflation since 1963 is plotted, at quarterly intervals, in Figure 2. Superimposed on Figure 2 are 10 inflation regimes we selected. These regimes are described in more detail in Table 1. Also shown on Figure 2 is the annual rate of underlying inflation which has been the target of monetary policy since the inception of the Reserve Bank of New Zealand Act 1989 (see Reserve Bank of New Zealand, 1995, p5). Estimates of annual underlying inflation are only available from 1989:4.

The 10 inflation regimes were selected on the basis of New Zealand's annual inflation rate (measured by the percentage change in the price index for quarter (t) compared to the index for quarter (t-4)), the timing of the application of a wide-spread set of price and wage controls from 1982 to 1984 (see Boston, 1984), the

[3] The NZIER survey also covers service firms. However, the questionnaire does not include a suitable demand variable. Analysis of price change by service firms using the reported change in "volume of services" as a proxy for demand gave results very similar to those reported in this paper for manufacturers and merchants.

timing of subsequent widespread market deregulation (see Bollard, 1994), and the period during which the inflation rate was maintained within the Reserve Bank of New Zealand's target range of 0 to 2 %.

Other features of these regimes worth noting:

- The first five regimes are, in general, periods when inflation was on a rising trend, while during regimes 7, 8 and 9 inflation was or had recently been falling.
- During the first five regimes varying degrees of regulation applied to many product and factor markets in New Zealand; regime 6 is the period when extensive price, wage and interest rate controls and the crawling peg exchange rate policy were in place; regimes 7 to 10 cover the period of extensive market deregulation in New Zealand.
- Of the three high inflation regimes 4, 5 and 7, regime 4 covers the commodity price shocks and the first oil price shock of 1973, regime 5 covers the second oil price shock of 1979, while regime 7 covers the period when the extensive price, wage, interest rate and foreign exchange controls were removed.
- During regimes 8, 9 and 10 the Reserve Bank was operating under the auspices of the RBNZ Act 1989 which was introduced in December 1989 specifying price stability as the primary function of the Bank; during regime 8 CPI and underlying inflation were generally falling but remained above the current target range of 0 to 2 %; during regime 9 both CPI and underlying inflation fell and remained within the Bank's target range; in regime 10 both measures of annual inflation steadily increased again to the point where CPI inflation exceeded 2 percent during all but the first quarter while underlying inflation exceeded the upper bound of the Reserve Bank's target range in all of the last four quarters.
- Although regimes 9 and 10 have some distinguishing features, they are both historically low inflation regimes. Only during regime 1 was inflation ever as low as occurred during the last two regimes. It will be of some interest to compare the pricing behaviour of firms during regimes 9 and 10 (when price stability was the primary function of the Reserve Bank) with the pricing behaviour during regime 1 (when the Reserve Bank was operating under different guidelines specified by the Reserve Bank of New Zealand Act 1964).

IV Ordered Probit Analysis of Price Changes

Our samples consist of firms that report the direction of change ('Up', 'Same', or 'Down') in their output prices, costs and demand[4]. The responses are coded as 1 for Up, 2 for Same, and 3 for Down. Occasionally there are missing responses or, for some reason, a firm marks 4 for Not Applicable. All firms with responses other than 1, 2 or 3 were dropped from our sample. We then rescaled the variables by subtracting 2 from every observation and multiplying by -1 so that the variables used in the estimation had the value +1 for Up, 0 for Same and -1 for Down.

The possible influence of strategic complementarities was represented by responses to a question that reads "Do you consider that the general business situation in New Zealand will improve, remain the same or deteriorate during the next six months?". Any responses other than 1 ('Improve'), 2 ('Same') or 3 ('Deteriorate') were recoded as a 2. Then 2 was subtracted from all responses which were then multiplied by -1 to create another +1, 0, -1 variable for business outlook[5].

To estimate the influence of cost changes, demand changes and business outlook on price changes, we chose to use ordered probit regressions (see Carlson and Dunkelburg, 1989, for an example of the application of the ordered probit procedure to business survey data of the type analysed in this paper). The problem with standard regression procedures, such as ordinary least squares, when dealing with qualitative categories is that one has to assign an arbitrary quantitative value to each category. Should a decrease in price be scaled as far below a same response as an increase is above the same response? Or should "up" be given a relatively higher or lower value? With ordered probit, this is not an issue. The idea is to maximise the likelihood of observing the actual pattern of responses in each category without regard to its quantitative value.

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[4] In this paper we report results only for the actual changes. The results for expected changes are very similar. Reporting the analysis of expected changes here would clutter the presentation without adding any essential information.

[5] As a precaution against the possibility of collinearity between demand and business outlook, the price change model was also estimated without the inclusion of the general business situation variable but this made no significant difference to the estimated demand coefficient.

Let $x_{1j}, x_{2j}, ... x_{kj}$, be a vector of explanatory variables for firm j. Define

$$y_j = b_1 x_{1j} + b_2 x_{2j} + ... + b_k x_{kj} + u_j \qquad (2)$$

where u_j is a standard normal variable. If there are three different ordered outcomes (up, same, down), ordered probit will estimate $b_1, b_2, ..., b_k$ plus two parameters, k_1 and k_2, such that for the following probabilities

Pr(firm j reports up) = Pr $(y_j > k_1)$
Pr(firm j reports same) = Pr $(k_1 > y_j > k_2)$
Pr(firm j reports down) = Pr $(y_j < k_2)$

the parameters chosen will maximise the likelihood of the observed sample over $j = 1, 2, ..., n$ firms.

For the price change model estimated in this paper, the category in which y_j falls indicates the predicted change in firm $j's$ own selling price while the $x_{kj}'s$ denote the change to costs, demand and the business outlook.

The results of the ordered probit estimation are presented in Tables 2 and 3. They contain two sets of results for each type of firm (manufacturers and merchants) in each of the ten inflation regimes. The first set of results in the top panel of each table show the estimates of the coefficients, b_k and hence the contribution of changes in costs, demand and the business outlook to changes in firms' selling prices. The relative size of these coefficients pertain to the ODBF hypothesis.

There are two sets of information generated to test the inflation induced asymmetry hypothesis. The first relevant information are the estimates of the parameters k_1 and k_2 which are shown in the last two columns in the top panel of each table. These cut point parameters correspond respectively to the upper and lower bounds, or zone of no-price change, given by expression (1) and illustrated in Figure 1. If the costs of price adjustment were homogeneous k_1 and k_2 could be interpreted as the boundary points for each firm in the economy, otherwise they can be interpreted as the average zone of no-price-change boundary points of all firms.

If the Ball and Mankiw inflation induced price asymmetry proposition holds, the estimates of k_1 and k_2 should vary with inflation. At high rates of inflation the absolute value of k_1 should be smaller than the absolute value of k_2. As inflation falls the value of k_1 should rise and the absolute value of k_2 should fall so that the interval between them shrinks. At low inflation the absolute values of k_1 and k_2 should be similar.

The second set of information used to test the BM hypothesis is shown in the bottom panel of each table. This panel shows price asymmetry in terms of the responsiveness to particular shocks, that is changes in costs, demand and the business outlook. These panels again contain separate estimates of the cost, demand and business outlook coefficients except that now a distinction is made between increases and decreases in the cost, demand and business outlook variables. This was achieved by first identifying firms that reported increased costs, demand and business outlook and those that reported decreased costs, demand and business outlook and then constructing new dummy variables. The bottom panels of Tables 2 and 3 report the resulting coefficients in ordered probit regressions of price changes on these dummy variables. The c, d and b variables have been scaled so that +1 is up, 0 is same and -1 is down. For instance, the variable "c up" is +1 if c is +1 and 0 otherwise. "c down" is -1 if c is -1 and 0 otherwise. The same interpretation applies to the variables constructed for demand and business outlook.

IV.1 The Relative Contribution of Cost and Demand Shocks

The top panels of Tables 2 and 3 show the coefficients on changes in costs, changes in demand and the business outlook estimated by ordered probit for each inflation regime. The coefficients for changes in costs are the largest coefficients for both firm categories in all inflation regimes. The demand coefficients are nevertheless always significant for manufacturers and are significant for merchants in all periods except regime 5. The business outlook is significant for manufacturers in the most recent regimes 8, 9 and 10 but is not significant for merchants in any regime. The ODBF hypothesis that prices will be more sensitive to changes in costs than to changes in demand is strongly supported by these results.

Several other features are apparent from these estimates. It would appear that one of the effects of the price and wage freeze during regime 6 was to reduce the sensitivity of prices to changes in costs, especially in manufacturing. A second feature is the fall in the size of the cost coefficient for both firm categories after regime 7. This coincides with the fall in New Zealand's trend inflation and might therefore be explained by the effect Ball and Mankiw postulate a fall in trend inflation will have on the the degree of price asymmetry. A third feature is the suggestion of an increase in the size of the demand coefficients after regime 6 compared to the periods prior to regime 6, particularly for merchants. This begins prior to the fall in trend inflation and coincides with the introduction of widespread market deregulation which occured after mid-1984 (i.e., after regime 6).

IV.2 Tests of Inflation Induced Asymmetry

So far, the estimates have assumed symmetry in the response of prices (p) to up and down changes to costs (c), demand (d) and business outlook (b). We now examine the possibility of asymmetry. Ball and Mankiw's proposition implies that, for a given menu cost of changing prices, inflation will systematically alter the upper and lower bounds of expression (1) which in turn changes a firm's response to exogenous shocks to either costs or demand or business outlook. We are therefore interested in knowing whether the upper and lower bounds for price change vary with inflation and also whether asymmetry is evident in the response of prices to changes in costs or demand or business outlook.

The estimates of k_1 and k_2 for each firm category, shown in the top panels of Tables 2 and 3, are consistent with the BM hypothesis. The value of k_1 is much closer to the absolute value of k_2 during the lower inflation regimes 1, 2 and 3 (available for manufacturers only) 8, 9 and 10 than during the higher inflation regimes 4, 5 and 7. Moreover, this tends to be due to higher values of k_1 and lower absolute values of k_2 during the lower inflation regimes. During the the price and wage freeze of regime 6, when inflation fell sharply from around 14 percent to around 3 percent, the difference between the value of k_1 and the absolute value of k_2 falls well below the corresponding differences in the preceding and subsequent higher inflation regimes 5 and 7. There is a clear tendency for k_1 and k_2 to vary with inflation in a way that is consistent with the BM asymmetry hypothesis.

Turning now to the bottom panels of Tables 2 and 3, it is clear that there is pervasive evidence of price asymmetry in response to changes in costs. Firms are much more likely to raise prices when costs are higher than to lower prices when costs are lower. An asterisk indicates a statistically significant asymmetry. Hence an asterisk on a "c up" coefficient means that it is significantly larger than the "c down" coefficient.

Moreover, there is evidently less price asymmetry in response to changes in costs in recent periods of low inflation than in higher inflation regimes, although this varies across firm categories. For merchants the asymmetry with regard to costs disappears in the lowest inflation regimes 9 and 10 and in regime 6. For manufacturers it disappears in regime 10. These results are consistent with the BM hypothesis.

There is also some evidence of price asymmetry with regard to demand. For manufacturers and merchants the coefficients on "d down" are typically larger than those on "d up". This means that firms are somewhat more likely to lower price in response to a decrease in demand than to raise price in response to an increase in demand. However, for manufacturers the only statistically significant difference occurs in regimes 1, 2, 8 and 9 while for merchants the only statistical difference occurs in regime 10.

Ball and Mankiw's model does not predict that price changes will be more responsive to demand decreases than to demand increases when there is positive trend inflation. During periods of high inflation, there is no evidence of asymmetric price responses to demand changes. This is contrary to the BM hypothesis. However, in a sense their hypothesis is supported in that when there is high inflation firms are less likely to make price decreases when demand falls than they are in low inflation periods.

There is no overall pattern of asymmetry in the business outlook variable.

V Conclusions

This paper uses a unique micro data set to test for the presence of price asymmetries at the firm level. The results show that firm pricing is indeed asymmetric, as Tobin (1972) long ago suggested. Moreover, there is strong evidence to support Ball and Mankiw's (1994) suggestion that price asymmetry is dependent on the prevailing general inflation rate.

However, Ball and Mankiw's theory seems to hold better for changes in costs than for changes in demand. The explanation for this might be found in a desire for firms to preserve customer relations (Okun, 1981) or because of information uncertainty (Dixit, 1976, Bhaduri and Falkinger, 1990) which underpin the idea that prices are likely to be more sensitive to changes in costs than to changes in demand. The results of Blinder's (1994) recent interview based survey of firm pricing behaviour suggests that these types of costs to price adjustment may be more important than the menu costs of price adjustment that are used by Ball and Mankiw to motivate price asymmetry.

For both manufacturers and merchants prices are more sensitive to changes in costs than to changes in demand across all inflation regimes. This result strongly supports the ODBF asymmetry hypothesis.

Although the demand coefficients are always significant for manufacturers and are significant for merchants in all but one regime, there is no evidence of asymmetry in response to demand shocks at high rates of inflation. However, there is evidence that price changes are more responsive to demand decreases than to demand increases and this tends to be more notable during low inflation. Thus, the effect of different rates of inflation on the demand asymmetry is broadly consistent with Ball and Mankiw's hypothesis. It is also consistent with Okun's hypothesis since reductions in prices in response to demand do not represent the same threat to customer relations that increases in prices in response to demand represent. Evidence in support of this implication of Okun's customer market theory of pricing can be found in Kahneman, Knetsch and Thaler (1986).

Understanding firm pricing behaviour is an important ingredient to understanding the relative impact that monetary policy and other shocks will have on output and inflation. This paper is an empirical contribution toward our understanding of firm pricing behaviour. The nature of price asymmetry revealed by the empirical results presented in this paper suggest that pricing behaviour is more complex than is implied by the aggregate studies of price asymmetry cited at the start of this paper.

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Figure 1: Zone of No-Price-Change for Cost and Demand Shocks

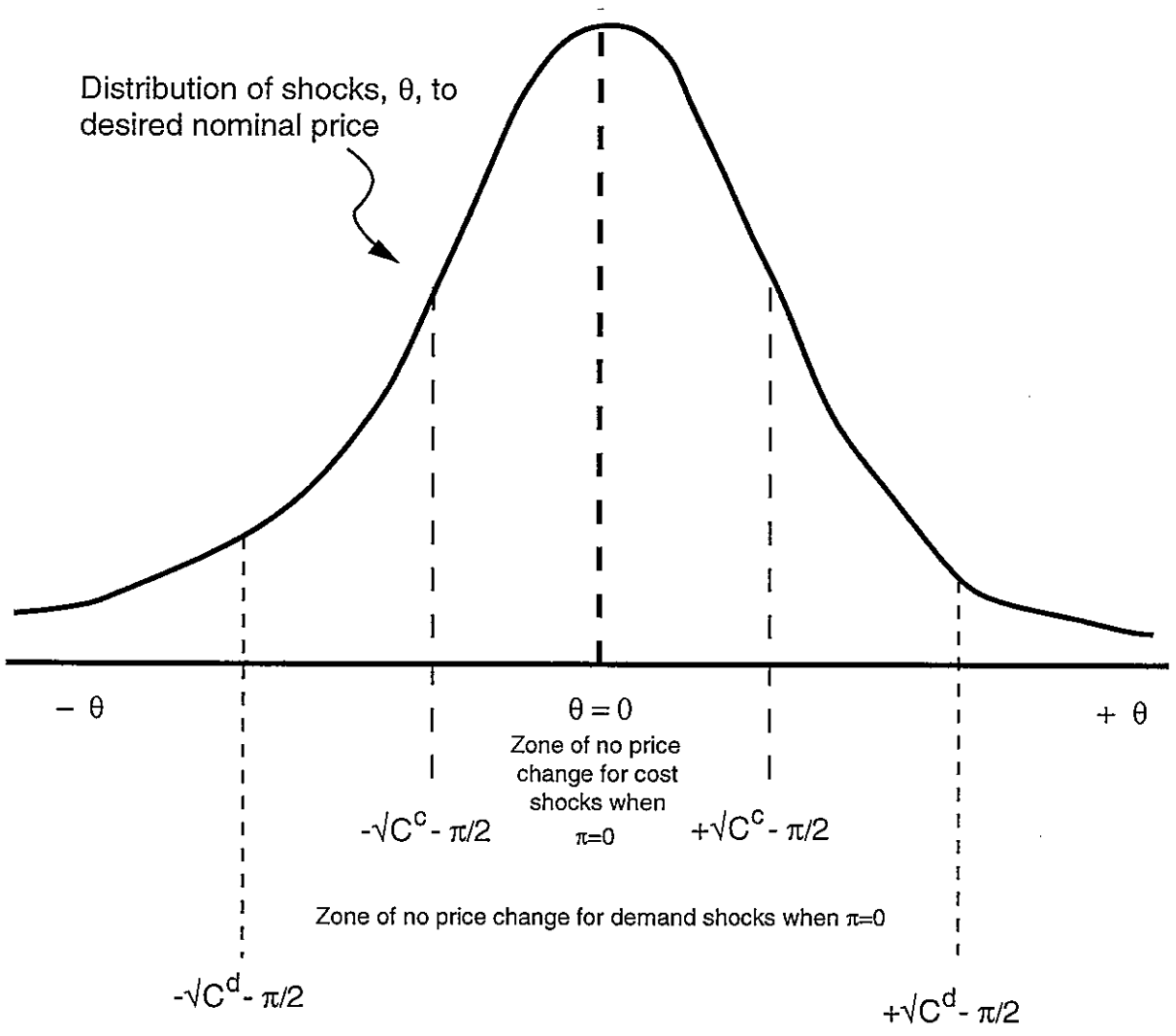

Figure 2: New Zealand Annual Inflation

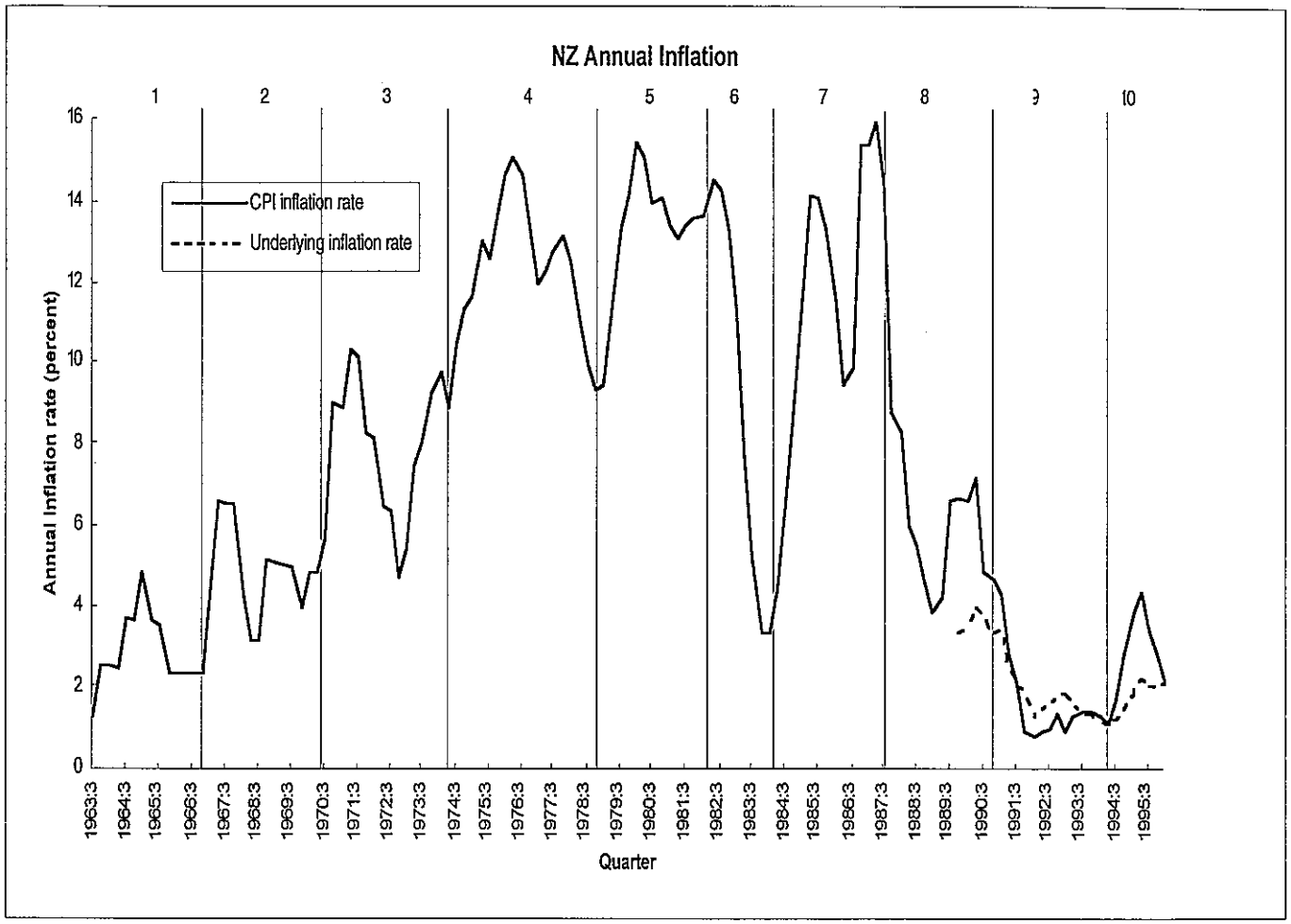

Table 1: Inflation Regimes

Regime	Low inflation	Medium inflation	High inflation	Price controls
1.	1963:3 to 1966:4 (Surveys 10 - 23) 1 - 4 % inflation			
2.		1967:1 to 1970:3 (Surveys 24 - 38) 3 - 7 % inflation		
3.		1970:4 to 1974:2 (Surveys 39 - 53) 5 - 10 % inflation		
4.			1974:3 to 1979:1 (Surveys 54 - 72) 10 - 15 % inflation	
5.			1979:2 to 1982:2 (Surveys 73 - 85) 10 - 15 % inflation	
6.				1982:3 to 1984:2 (Surveys 86 - 93) 3 - 14 % inflation
7.			1984:3 to 1987:3 (Surveys 94 - 106) 10 - 15 % inflation	
8.		1987:4 to 1991:1 (Surveys 107 - 120) 4 - 9 % inflation		
9.	1991:2 to 1994:2 (Surveys 121 - 133) 0 - 2 % inflation			
10.	1994:3 to 1996:1 (Surveys 134 - 140) 2 - 4 % inflation			

Note: The inflation range denotes the range within which the annual rate of consumer price inflation was maintained during that regime.

Table 2: Ordered probit estimation of price changes by Manufacturers

Relative influence of changes in costs, demand, and the business outlook

Reg.	Period	n	c	d	b	k1	k2
1	63:3-66:4	2806	1.00*†	.17*	.06	1.22	-1.33
2	67:1-70:3	3577	.92*†	.30*	-.02	1.07	-1.31
3	70:4-74:2	3291	.96*†	.15*	-.04	1.04	-1.44
4	74:3-79:1	4062	.92*†	.13*	-.00	.51	-1.28
5	79:2-82:2	2510	.88*†	.19*	-.05	.24	-1.37
6	82:3-84:2	1433	.49*†	.29*	-.04	1.02	-1.29
7	84:3-87:3	2960	.71*†	.26*	.01	.43	-1.19
8	87:4-91:1	3135	.52*†	.30*	.07*	.87	-.84
9	91:2-94:2	3375	.39*†	.20*	.24*	1.17	-.76
10	94:3-96:1	1670	.50*†	.18*	.12*	.98	-.90

Test of inflation induced asymmetry

Regime	c up	c down	d up	d down	b up	b down
1	1.16*	.66	.06	.32*	.08	.05
2	1.07*	.39	.16	.45*	-.14	.12*
3	1.10*	.21	.11	.18	-.14	.08*
4	1.23*	-.12	.14	.11	.02	-.01
5	1.15*	-.22	.17	.21	-.07	.03
6	.68*	-.17	.22	.32	-.02	-.05
7	.96*	.04	.23	.29	.15*	-.05
8	.71*	.19	.11	.47*	.15	.02
9	.57*	.21	.07	.37*	.19	.32
10	.58	.36	.09	.29	.10	.16

Notes: * significantly different from zero at 5% level.

† c coefficient is significantly larger than d coefficient at 5% level.

n = sample size; c = coefficient on cost change; d = coefficient on demand change; b = coefficient on business outlook; k1 = cut 1; k2 = cut 2

Table 3: Ordered probit estimation of price changes by Merchants

Relative influence of changes in costs, demand, and the business outlook

Regime	Period	n	c	d	b	k1	k2
4	74:3-79:1	1767	1.51*†	.16*	-.10	.43	-.96
5	79:2-82:2	1043	1.39*†	.07	-.02	.21	-1.11
6	82:3-84:2	587	1.15*†	.16*	.02	.90	-1.24
7	84:3-87:3	989	1.16*†	.32*	.03	.31	-.84
8	87:4-91:1	1042	.82*†	.24*	.03	.86	-.68
9	91:2-94:2	1311	.70*†	.19*	.10	1.01	-.77
10	94:3-96:1	566	.87*†	.37*	.09	1.17	-.71

Test of inflation induced asymmetry

Regime	c up	c down	d up	d down	b up	b down
4	1.65*	.72	.09	.20	-.15	-.07
5	1.51*	.73	.12	.05	-.09	.03
6	1.22	.79	.03	.29	.08	-.05
7	1.31*	.72	.14	.48	.06	.01
8	.95*	.54	.12	.32	-.05	.11
9	.78	.57	.09	.29	.06	.20
10	.98	.73	.16	.61*	-.10	.33*

Notes: * significantly different from zero at 5% level.

† c coefficient is significantly larger than d coefficient at 5% level.

n = sample size; c = coefficient on cost change; d = coefficient on demand change;

b = coefficient on business outlook; k1 = cut 1; k2 = cut 2

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