What makes prices sticky? Some survey evidence for the United Kingdom

By Ian Small,[1] and Tony Yates of the Bank's Monetary Assessment and Strategy Division.

It is now widely accepted that price stickiness—the tendency for prices not to adjust immediately to changes in market conditions—is an important feature of the transmission mechanism of monetary policy. This article uses the Bank's price-setting survey to investigate what might make prices more or less sticky. It discusses the impact of competition; whether price changes are prompted by cost or demand shocks; if price stickiness is related to the characteristics of firm's customers; whether price changes vary if goods are sold abroad or into the domestic market; and, finally, whether prices are more sticky downwards than upwards. The article finds that all of these factors appear to influence how sticky firms say their prices are.

Introduction

In 1776 Adam Smith wrote:
' ...when the quantity of any commodity which is brought to market falls short of... demand... a competition will immediately begin... and the market price will rise more or less... according as either the greatness of the deficiency, or the wealth and wanton luxury of the competitors, happen to animate more or less the eagerness of the competition.'

Much research has been devoted to understanding why prices are sometimes immune to the 'wanton luxury of the competitors' and are, in other words, sticky. This research has been driven by the observation that, if prices are sticky, markets are cleared by changes in quantities. That this is true is crucial for a central bank charged with setting monetary policy. The degree of price stickiness will affect the responsiveness of inflation to changes in the bank's official interest rate, and will also affect the impact of policy changes on the real economy.[2]

In September 1995, the Bank of England conducted a survey of price-setting behaviour by UK firms to find out just how sticky prices were.[3] This article—based on the data that were collected in that survey—tries to shed light on what makes it more or less likely that prices will be sticky in the way Adam Smith described: that they will not respond immediately to changes in market conditions.

The survey enables us to tackle several questions. Are prices stickier when a firm is in a less competitive industry? Do prices respond differently to demand and cost shocks? Are *money* prices stickier in a market where a firm's profits would not change a great deal if the firm changed *relative* prices, ie if there is 'real rigidity'? Does price stickiness vary depending on how long firms have been dealing with their customers? Are prices stickier when goods are sold into foreign markets and denominated in foreign currency? (Is there, in other words, 'pricing to market'?) Do prices respond differently to shocks that would imply that they ought to rise than to shocks that would imply that they ought to fall?

The advantage of using survey data of this sort is that respondents can be asked to answer hypothetical questions, such as 'If this or that occurs, what would you do?'. Conventional applied economics is usually devoid of 'natural experiments', especially natural experiments in which there are sufficiently few things happening simultaneously to identify the effect of the experiment. We could think of our survey questions as artificial experiments. The disadvantage of our data is that we have to assume that firms' responses describe what they would actually do, should this or that happen.

Theoretical background

Our data will enable us to address a number of questions that have concerned economists and policy-makers in recent years. Before describing the results of the survey, we look at each of these theoretical issues in turn.

Real rigidity magnifies nominal rigidity

One proposition, first made by Ball and Romer (1990), is that price stickiness depends on the balance between two things. First, the costs of changing nominal price tags, or 'menu costs'; and second, the benefits from changing prices. Ball and Romer argued that the more sensitive profits are to shocks, with prices unchanged, the more likely it is that firms will change prices; this amounts to arguing that 'nominal rigidity' (the stickiness of observed prices) depends on 'real rigidity'. There are a number of factors affecting the sensitivity of profits that we can proxy in our survey.

(1) Ian Small currently works at Lexecon PLC; this article was based on work done while at the Bank's Structural Economic Analysis Division.
(2) For a full discussion, see 'The transmission mechanism of monetary policy', *Quarterly Bulletin*, May 1999, pages 161–70.
(3) This research was reported in 'How do UK companies set prices?', by Simon Hall, Mark Walsh and Tony Yates, in the May 1996 *Quarterly Bulletin*.

(i) Market structure

The first is market structure. Intuitively, the more competitive an industry is, the more profits would change if firms did not change prices in response to shocks. For a given cost of changing price tags (a given 'nominal rigidity'), competition should make it more likely that prices will change in response to shocks. Most macroeconomic models cannot address this: models of imperfect competition tend to assume a fixed market structure to motivate sticky prices, and then derive the model's responses to different shocks. However, one model that studies exactly this question in a dynamic setting is Martin (1993). He uses the model of price adjustment in Rotemberg (1982). In this model, firms face quadratic/increasing costs of adjusting prices, and set their current price as a weighted average of lagged and future expected prices. In particular, the less profits change when firms set prices away from the market-clearing price, the smaller are the benefits from adjusting more rapidly relative to the costs of adjusting, and so the more slowly firms adjust their price towards the optimum. Martin then employs a model of oligopolistic competition to show how the profit function flattens (and hence prices become more sticky) the fewer firms there are in an industry, and the more collusive is their behaviour.

(ii) Trade unions and technology

We study two types of real rigidity that may flatten the supply, rather than the demand, curve. First, there may be imperfect competition in the labour market: for example, unions may bargain on behalf of workers over wages (eg McDonald and Solow (1981)); or firms may hold wages up to discourage shirking (eg Shapiro and Stiglitz (1984)).(1) These models (of which there are many other examples) will generate what we can loosely term 'real rigidity'—in this case, flatter labour (and therefore product) supply curves. Another possibility is that there are constant or increasing returns to scale. This may not be a plausible assumption for the economy as a whole, but it could be relevant for particular firms producing at particular levels of output. We analyse our data to see whether real rigidity on our measures does indeed magnify nominal rigidity. We have measures of market structure, measures of the presence of trade unions for bargaining purposes, and a measure of the slope of firms' marginal cost curves.

(iii) Customer markets

Another kind of real rigidity might result from customer behaviour, as firms may operate in 'customer markets'. These are markets—perhaps not unlike markets in reality—where customers incur costs in collecting the information they need to make their purchases optimally. These could be the costs of calculating relative real prices (allowing for quality differences): the costs, for example, of walking up and down the high street checking prices and trying out new goods. Such costs might also influence how monopolistic producers set prices. They may, for example, as Okun (1981) argued, trade off the gains from charging monopoly premia against the benefits of encouraging repeat purchases. Repeat customers, as Okun pointed out, may be able to help firms plan ahead by reducing the expected future variance of demand. Firms may have a policy of maximising the continuity of prices from one period to the next, or restrict price changes to times when costs change, when such price changes would be perceived as 'fairer'.

Okun also pointed out that customer markets may lead to a kink in the demand curve. Prices may stick at the kink, because an increase in prices would encourage existing loyal customers to search elsewhere for their products, whereas price cuts, which customers loyal to other firms would not be aware of, would not generate much increase in demand.(2)

So it is possible that when we move away from the stylised view of goods markets as auction markets populated by large numbers of consumers with perfect information, the responsiveness of prices to shocks might change.

Demand and cost shocks

The second broad question that we address is whether prices will respond differently to cost or demand shocks. This has received some attention in the theoretical literature. A classic reference—although there are many others—is Rotemberg and Saloner (1987). They specified a model that compares the relative incentives for monopolists and oligopolists engaged in Bertrand competition(3) to adjust their prices when there are menu costs. They argue that the incentives for a duopolist to change prices in response to a cost shock are greater than those for a monopolist; and that the reverse is true when firms experience a shock to demand.

How do they reach this conclusion? Consider first Rotemberg and Saloner's duopolists. If their costs fall, the incentive to cut prices is very large. To see this, imagine what would happen if one cut prices and the other did not: in this case the price-cutter would take the whole market and the price-fixer would make no profits. Conversely, if costs rise, then as price is now below marginal cost, each firm can reduce its losses by raising its price. The incentive for doing so is large, as if one firm does not raise its price it will end up supplying the whole market and incurring losses on every unit of output. In a monopoly industry, however, leaving prices fixed will not result in these all-or-nothing outcomes. For example, profits will fall if prices do not fall to match cost reductions, but will not disappear entirely.

Now consider a demand shock. Suppose that marginal costs are constant as output rises (ie there are constant returns to scale). In Bertrand competition, the duopolists price at marginal cost, so a demand shock will have no effect on the optimal price. A monopolist, however, chooses the point on the demand curve where marginal revenue equals marginal

(1) Ball and Romer (1990) demonstrate the impact on nominal rigidity of efficiency wages *à la* Shapiro and Stiglitz (1984).
(2) These insights have been made use of by, among others, Stiglitz (1984), and Phelps and Winter (1970).
(3) Bertrand competition is where two firms compete in a market and choose prices simultaneously and independently, and then sell whatever is demanded at those prices. It contrasts with the Cournot model where firms choose quantities, rather than prices.

cost (prices will not necessarily equal marginal cost at this point). So the optimal price may well change if there is a demand shock, and the monopolist will therefore have a greater incentive to change prices (even though the losses from not doing so are second order).[1]

This model—stylised though it is—at least opens up the possibility that we can explain why firms' price responsiveness might differ depending on the source of the shock.

Pricing to market

Another reason why firms may not alter nominal prices in response to shocks is that, because they are selling in foreign markets, they may want to 'price to market'. Models based on this idea are invoked to explain why the (foreign currency) price of products sold abroad does not respond to changes in the nominal exchange rate. These models are potentially important in explaining why nominal exchange rate fluctuations can have large transitory effects on the profitability of the traded sector of the economy. There are two types of pricing-to-market model. One type argues that if firms expect the exchange rate change to be transitory, then they will weigh the costs of incurring losses from not changing prices against the costs of adjusting supply. The latter may include fixed costs of entry into the foreign market (which are assumed to exceed those facing local suppliers to home markets), which the firm could not recoup if it decided to pull out or scale down supply.[2]

The second type of pricing-to-market model focuses on demand-side explanations of price rigidity. For example, Froot and Klemperer (1989) argue that firms' future demand will depend on current market share. If an exchange rate shock is expected to be temporary, the future demand will still be of the same value to the firm; so the current price, which determines current market share, may not change. These models provide an additional source of nominal rigidity which we consider below.

Asymmetries

The literature on sticky prices has also focused on the question of whether prices are more sticky in response to a shock that warrants a price decrease than a price increase. Such asymmetries arise in some models because of strategic or collusive behaviour (see for example Granero (1996), Hansen *et al* (1996) and Kovenock and Widdows (1991)); there are other models (of time-dependent menu costs when steady-state inflation is positive) that generate asymmetries in price adjustment, for example Ball and Mankiw (1994); and there are models that argue that price adjustment will be asymmetric because of capacity constraints: for a discussion see Finn (1996) or Laxton *et al* (1995).

Importantly, there is no theoretical unanimity as to whether prices will be more sticky when warranted prices move up or down.

These theoretical models are quite controversial (see Yates (1998) for a discussion) and perhaps something of a curiosity. Nevertheless, asymmetric rigidity has been used to explain the findings of de Long and Summers (1988), Cover (1992), Ravn and Sola (1995), Debelle and Laxton (1996) and Laxton *et al* (1995), all of whom provide evidence showing that the consequences of monetary shocks for aggregate output differ depending on the direction of the shock.[3]

The survey

The data used in this paper come from a survey of pricing behaviour conducted by the Bank of England in September 1995. The survey, based on a similar survey carried out by Blinder *et al* (1998)[4] in the United States, asked around 670 firms about various aspects of their pricing behaviour, including what factors caused them to change their prices. The sample was drawn from industrial contacts of the Bank's Agents. Hall, Walsh and Yates (1996) describe the survey, the sample characteristics and some of the other results contained within it in more detail.[5]

The variable that we use to gauge the relative stickiness of prices in response to different shocks is based on firms' answers to the question:[6] *'For your main product (or product group), which factors would be likely to cause an increase/decrease in prices?'*. Two of the choices available to firms were *an increase/decrease in the prices of fuel, raw materials or components*, which we assume constitutes a 'cost' (supply) shock, and *a rise/fall in demand*, which we assume represents a demand shock.

We need to sound two notes of caution before reporting our results. First, we have interpreted firms' answers to our questions as referring to *nominal* rather than *real* prices. In other words, we assume that firms have in mind the actual money price of goods, rather than the price of goods relative to all other goods in the economy. Our second word of warning is that we have to interpret these questions as telling us either about the short-run rigidity of prices in response to a permanent shock, or about the rigidity of prices—over an indeterminate period—in response to a temporary shock (or at least a shock not yet known to be permanent). Why so? If firms read 'a rise in demand' to mean a permanent rise in demand, then any answers that did not include a change in prices would not make sense for profit-maximising firms in the long run. To restate the general point: our ability to make inferences from the survey results depends on how correct we are in assuming

(1) To see which effect dominates, Rotemberg and Saloner examine the situation when both cost and demand shocks are affected by changes in the aggregate price level. They find that for small changes in the aggregate price level the cost effect outweighs the demand effect, so their model predicts that monopolists are less likely to adjust their prices than firms in more concentrated industries.
(2) Examples of this type of model include Krugman (1986), Baldwin and Krugman (1987), Dixit (1987 a,b), and Kasa (1992).
(3) In fact, monetary contractions are typically shown to have a larger effect on output than monetary expansions.
(4) Although the Blinder *et al* survey was only published in 1998, Hall *et al* based their questionnaire on one designed by Blinder some years before the Bank survey was carried out.
(5) Hall *et al (op cit)* compare the survey results with other surveys, insofar as this is possible.
(6) In addition to deciding which shocks were likely to cause changes in prices, firms were also asked to rank the statements in terms of their relative importance.

that our interpretation of the survey questions is the same as that of our respondents.

Table A shows the proportion of firms that reported that they would change prices, grouped by different firm characteristics and different types of shock. There are a number of points to note. First, if we take upward and downward demand shocks together, just over half of the sample reported that they would adjust their prices in response to a change in demand. Our survey actually suggests that prices are less sticky—more responsive to shocks—than other microeconomic survey evidence suggests. Haskel *et al* (1997) found that less than 10% of establishments in the 1990 Workplace Industrial Relations Survey (WIRS) would change prices following a change in demand, and less than 13% of Bhaskar *et al*'s (1993) sample of firms said that demand shocks would cause price changes.

Table A
Descriptive statistics

Percentage of firms who would change prices in response to a shock

	Number of firms	Reduce price in response to a fall in demand	Raise price in response to an increase in demand	Reduce price in response a to reduction in costs	Raise price in response to an increase in costs
All firms	**355**	**62.3**	**47.2**	**54.5**	**88.3**
No of competitors:					
1–5	117	56.8	48.3	50.0	89.8
6–10	130	65.4	42.3	54.6	91.5
11–30	61	77.1	49.2	55.7	88.5
More than 30	47	82.3	55.1	63.3	75.5
Own market share:					
1%–10%	140	66.0	50.7	59.7	86.1
11%–20%	47	61.7	42.6	42.6	85.1
21%–30%	52	65.4	50.0	53.9	86.5
> 30%	116	56.5	43.5	53.0	93.0
Main market:					
Region of the United Kingdom	58	56.7	56.7	53.3	80.0
Whole of the United Kingdom	177	66.1	41.7	55.6	92.2
International	120	59.3	50.9	53.4	86.4
Proportion of output exported:					
<11%	167	62.8	45.4	59.9	89.5
11%–50%	107	63.2	46.2	49.1	92.5
>50%	81	60.0	52.5	50.0	80.0
Constant marginal cost	201	60.2	42.8	57.7	92.5
SEARCH	259	61.0	46.7	60.2	90.7
Union recognition	198	64.1	49.0	55.6	92.9

Which survey results should we believe? It is difficult to reach a conclusive answer, but we suggest two reasons why the Haskel *et al* and Bhaskar *et al*'s results might be less informative than those from the Bank survey. First, the WIRS survey on which Haskel *et al* base their research is a survey of establishments and not firms. If pricing decisions are a strategic, company-wide decision in a particular firm, then respondents might report that they will not change prices, simply because they do not have the autonomy to do so. And the Bhaskar *et al* survey is too small and too focused on small firms to be comparable with our result.(1)

Second, Table A provides evidence that prices respond differently to demand and cost shocks, and also as to whether shocks warrant price increases or price decreases; 62% of firms report that they would reduce price in response to a fall in demand, whereas only 47% of firms report that they would raise prices in response to an increase in demand. In terms of cost shocks, 88% of firms report that they would raise prices in response to an increase in costs, while 54% report that they would reduce prices in response to a fall in costs.(2)

We can see that more firms report that they would adjust prices in response to a cost shock—of whichever direction—than would adjust to a demand shock. This finding is consistent with Geroski and Hall (1995).

Estimation and results

In this section we briefly explain the empirical model used to analyse our data and the survey proxies for the theoretical characteristics (real rigidity, customer markets, etc) discussed earlier. Table A provided some descriptive statistics, but does not tell us about the marginal effect of each of the characteristics of firms on price stickiness. This is what we analyse in the rest of the article.

The dependent variable

Our left-hand side or 'dependent' variable reports whether firms said that they would change prices in response to a change in demand or a change in costs. We created four dummy variables to capture the probability that firms would raise prices in response to a change in demand *(pud)*, or lower prices in response to a change in demand *(pld)*; similarly for cost shocks *(puc, plc)*. To illustrate, suppose the question was 'would you raise prices in response to a rise in demand?' then *pud* = 1 if the firm reported that it would, and *pud* = 0 otherwise; if the question was 'would you lower prices in response to a reduction in costs?' then *plc* = 1 if the firm said it would, and *plc* = 0 otherwise. Since we are dealing with discrete, one-zero dummies as our dependent variable, we report probit estimates.(3)

The independent variables

Our first proposition was that nominal rigidity was magnified by real rigidity. We have several proxies for this concept of real rigidity.

We have two different measures of market structure, as shown in Table A. Both are self-reported. The first is a set of discrete dummies (NCP1–5, NCP6–10 and NCP11–30) that measure the number of competitors in the product

(1) Note that we do not find that price stickiness varies according to firm size, when we control for the separate influence of other factors.
(2) Table A also shows how price responsiveness varies according to firm characteristics; the variables that define these characteristics are defined and explained fully below.
(3) Probit estimates are where the standard errors of our estimated coefficients are calculated in a way that takes account of the fact that the observed dependent variable has only two values (change prices or not?) rather than being distributed normally, as is assumed when ordinary least squares regressions are run.

market. The second, (MARKSHARE), is a continuous variable that measures the firm's market share in their 'main' market.

We have a proxy for whether a firm's marginal cost curve is flat, which we call 'CONSTANT MC'. This takes the value one if the firm considered that it has constant marginal costs, and zero otherwise.[1][2]

We also have a variable UNION which takes the value one if the firm recognises trades unions for wage-bargaining purposes, and zero otherwise.

We have a proxy for the likelihood that consumers face search costs in their dealings with firms. This variable, 'SEARCH', tries to capture the size of inflows to and outflows from a firm's customer base. The lower are search costs, the higher we would expect inflows and outflows to be, as the incentives to look around are more favourable.[3]

These were our proxies for real rigidity, the tendency for profits to vary little if firms do not change prices in response to shocks. Note that those real rigidity variables which are meant to proxy the slope of the firm's supply curve—the trade union (UNION) and constant marginal cost (CONSTANT MC) variables—are only used to explain the responsiveness of prices to demand shocks (since, other things being equal, the responsiveness of prices to demand shocks depends on the elasticity of supply). Market structure and customer markets could have implications both for supply and demand, and so also appear in regressions used to explain the responsiveness of prices to changes in supply.

Another question noted earlier was whether or not we can find evidence of prices being more sticky (in foreign currency terms) if goods are sold into foreign markets. We have two sets of variables to control for this possibility. First, we have dummy variables, which we term EXPORTS, that divide firms up by the self-reported export intensity. Second, we have two dummies 'UK' and 'INTL' that record whether respondents considered the market for their main product to be a UK market or an international market, as distinct from a 'regional' market, which is the base case. These variables may also pick up the effects of market structure if it is the case that (other things being equal) the more firms' outputs are traded, the more competitive is the market.

Finally, we include a set of dummies to separate firms from different industries, and another set to distinguish firms of different size. We do not have theories of nominal rigidity that predict that particular industries or firms of a specific size will be more or less likely to change prices. But these dummies help to control for unobserved characteristics of firms, which are correlated with firm size or are prevalent in a particular industry, that might influence price stickiness.

Results

Table B gives the probit estimates of our model for whether firms adjust prices in response to a change in demand, and Table C gives the estimates of whether firms change price in response to a change in costs. The first and third columns in each table contain the estimates when all the market structure and control variables are included in the regressions. The second and fourth columns contain the estimates for restricted versions of these regressions, ie excluding insignificant variables. For both cost and demand shocks we estimate separate regressions for upward and downward shocks. In Table D, we pool the increases and decreases and test for the significance of demand and cost increase dummies.

Table B
Price adjustment in response to a change in demand

Probit estimates

Dependent variable	Reduce price in response to a fall in demand *(pld)*		Increase price in response to a rise in demand *(pud)*	
	(1)	(2)	(3)	(4)
Constant	0.3598	0.5829	0.2605	0.3264
	(0.3727)	(0.1114)	(0.3580)	(0.1443)
NCP1–5	-0.2031		-0.0177	
	(0.2512)		(0.2428)	
NCP6–10	-0.0145		-0.2015	
	(0.2390)		(0.2292)	
NCP11–30	-0.2921		-0.1486	
	(0.2651)		(0.2585)	
MARKSHARE	-0.7815 **	-0.7780 **	-0.5000 *	-0.4721 *
	(0.3143)	(0.2725)	(0.3108)	(0.2657)
EXPORTS >50%	0.1796		0.2397	
	(0.2844)		(0.2747)	
EXPORTS 11%–50%	0.1302		0.2087	
	(0.1960)		(0.1886)	
UK	0.4365 **		-0.2162	-0.2788 *
	(0.2256)	0.3717 * (0.1963)	(0.2192)	(0.1359)
INTL	0.3275		-0.0923	
	(0.3051)		(0.2955)	
UNION	0.1638		0.1910	
	(0.1553)		(0.1506)	
CONSTANT MC	-0.1048		-0.3037 **	-0.2377 *
	(0.1442)		(0.1407)	(0.1366)
SEARCH	-0.2397		0.0213	
	(0.1646)		(0.1577)	
LARGE	-0.1558		-0.0751	
	(0.2207)		(0.2134)	
MEDIUM	-0.1293		-0.1036	
	(0.2105)		(0.2040)	
MIN&CHEM	0.2793		0.1605	
	(0.2098)		(0.2049)	
OTHMF	0.0592		-0.0909	
	(0.1942)		(0.1905)	
NONMPROD	0.0968		0.4988 *	
	(0.3231)		(0.3208)	
RETAIL	0.5162		-0.0669	
	(0.3206)		(0.3052)	
OTHERS	0.4036		0.2423	
	(0.3153)		(0.2972)	
LogL	-225.23	-230.42	-239.57	-237.63
χ^2 (dof)	20.14 (18)	9.76 (2)	20.08 (18)	10.03 (3)
(p-value)	(0.33)	(0.01)	(0.33)	(0.02)
Functional form χ^2 (dof)	4.33 (3)	5.17 (3)	1.29 (3)	0.01 (3)
Heteroskedasticity χ^2 (dof)	26.34 (36)	4.45 (4)	17.98 (36)	5.26 (6)
Normality χ^2 (dof)	3.98 (2)	4.54 (2)	1.09 (2)	0.00 (2)
N	355	355	361	361

Notes: Standard errors in parentheses. ** indicates significance at the 5% level. * indicates significance at the 10% level. The first χ^2 test reported is the cross-section analogue of the F test in time series regressions, which tests for the joint significance of all of the independent variables. The functional form, heteroskedasticity and normality tests are χ^2 score tests for probit models, as described in Chesher and Irish (1987).

(1) In the survey, firms were asked the following question: *'Some companies find that their variable costs per unit are roughly constant when production rises, and because of this they do not change their price when increasing output. Is this true for your company?'.*
(2) Robert Hall (1986) noted that prices would be sticky if marginal costs were constant.
(3) This variable tries to capture inflows and outflows by measuring the proportion of very long-term customers (who have been with the firm for more than five years), relative to the proportion of medium-term customers (who have been with the firm for more than one year).

Table C
Price adjustment in response to a change in costs

Probit estimates

Dependent variable	Reduce price in response to a fall in costs *(plc)*		Increase price in response to a rise in costs *(puc)*	
	(1)	(2)	(3)	(4)
Constant	-0.4332	-0.3885	0.2567	0.5244
	(0.3577)	(0.1478)	(0.4884)	(0.2119)
NCP1–5	-0.2589		0.2938	
	(0.2479)		(0.3292)	
NCP6–10	-0.2343		0.3624	
	(0.2358)		(0.3169)	
NCP11–30	-0.1333		0.4114	
	(0.2648)		(0.3498)	
MARKSHARE	0.2827		1.6093 **	1.7943 **
	(0.3061)		(0.5916)	(0.5299)
EXPORTS >50%	-0.4637 *		-1.4286 **	-0.7910 **
	(0.2814)	-0.2926 **	(0.4725)	(0.2395)
EXPORTS 11%–50%	-0.3222 *	(0.1364)	-0.3738	
	(0.1887)		(0.3155)	
UK	0.2321		0.2918	
	(0.2222)		(0.3160)	
INTL	0.5700		0.8155 *	
	(0.3036)		(0.4782)	
SEARCH	0.5214 **	0.5136 **	0.6374 **	0.6017 **
	(0.1615)	0.1542	(0.2280)	(0.2146)
LARGE	-0.0214		-0.3948	
	(0.2066)		(0.3268)	
MEDIUM	-0.1277		-0.2071	
	(0.2036)		(0.3320)	
MIN&CHEM	0.2187		0.4143	
	(0.2065)		(0.3074)	
OTHMF	0.3742 *		1.1663 **	1.0346 **
	(0.1907)		(0.3846)	(0.3357)
NONMPROD	0.7012		0.2074	
	(0.3293)		(0.4363)	
RETAIL	0.5843 *		-0.0225	
	(0.3195)		(0.4171)	
OTHERS	0.0147		-0.7766 **	-0.9343 **
	(0.3031)		(0.3494)	(0.2929)
LogL	-227.14	-233.75	-94.39	-99.27
χ^2 (dof) (p-value)	28.81 (16) (0.03)	15.59 (2) (0.00)	64.30 (16) (0.00)	54.54 (5) (0.00)
Functional form χ^2 (dof)	4.61 (3)	2.64 (3)	24.67 (2)	8.87 (3)
Heteroskedasticity χ^2 (dof)	18.94 (32)	2.64 (4)	88.48 (36)	18.61 (6)
Normality χ^2 (dof)	3.38 (2)	2.64 (2)	12.84 (2)	3.96 (2)
N	351	351	351	351

Notes: as for Table B.

Our key results are as follows:

First, market structure does appear to affect nominal rigidity. Our measure of market share (but not our measures of the number of competitors in an industry), is associated with a significantly lower responsiveness of prices to a change in demand. This result is also consistent with studies using industry-level data, which mainly find that price adjustment is slower in less competitive industries (for example Geroski (1992)).(1)

However, if we look at the regressions concerning the responsiveness of prices to a change in costs, we find that the competition and market share variables are either 'wrongly' signed and/or insignificant.(2) So though increasing market share reduces the responsiveness of prices to a change in demand, it either does not affect or increases the responsiveness of prices to costs. This is precisely the reverse of the argument put forward by Rotemberg and Saloner (1987).

Table D
Price adjustment in response to a change in demand or costs; pooling upward and downward shocks

Probit estimates

Dependent variable	Change price in response to a change in demand (1)	Change price in response to a change in costs (2)
Constant	0.5120 *	-0.6635 **
	(0.2620)	(0.2855)
Increase dummy	-0.3968 **	1.1800 **
	(0.0957)	(0.3577)
NCP1–5	-0.1082	-0.0115
	(0.1738)	(0.1180)
NCP6–10	-0.1097	-0.0297
	(0.1643)	(0.1935)
NCP11–30	-0.2171	-0.0902
	(0.1841)	(0.1843)
MARKSHARE	-0.6376 **	0.5481 **
	(0.2202)	(0.2071)
EXPORTS >50%	0.2004	-0.7036 **
	(0.1967)	(0.2540)
EXPORTS 11%–50%	0.1653	-0.3077 **
	(0.1349)	(0.1540)
UK	0.1035	0.2699
	(0.1555)	(0.2290)
INTL	0.1185	0.6087 **
	(0.2110)	(0.1772)
UNION	0.1727	
	(0.1000)	
CONSTANT MC	-0.2018 **	
	(0.1074)	
SEARCH	-0.1046	0.5227 **
	(0.1131)	(0.2454)
LARGE	-0.1164	-0.1194
	(0.1525)	(0.1264)
MEDIUM	-0.1151	-0.1329
	(0.1455)	(0.1687)
MIN&CHEM	0.2178	0.2908 *
	(0.1460)	(0.1667)
OTHMF	-0.0180	0.5102 **
	(0.1354)	(0.1655)
NONMPROD	0.2924	0.5201
	(0.2260)	(0.1569)
RETAIL	0.2084	0.3733
	(0.2164)	(0.2609)
OTHERS	0.3123	-0.3403
	(0.2147)	(0.2505)
LogL	-472.36	-339.05
χ^2 (dof)	41.77 (19)	158.97 (17)
(p-value)	(0.00)	(0.00)
N	716	702

Notes: Standard errors in parentheses. ** indicates significance at the 5% level. * indicates significance at the 10% level.

Does the slope of the marginal cost curve affect price stickiness (in response to a demand shock)? We have mixed evidence. Our UNION variable is insignificant and 'wrongly' (ie positively) signed. But the variable indicating whether firms think their marginal cost curve is flat—CONSTANT MC—does significantly reduce the likelihood that prices will rise in response to an increase in demand. This variable is also significant in the pooled demand regressions in Table D.(3)

Do 'customer markets' influence price stickiness? We find that our measure of the size of inflows and outflows of customers (SEARCH) does not significantly affect the responsiveness of prices to a change in demand, but it does significantly increase the responsiveness of prices to a change in costs.

(1) However, it contrasts with what Bhaskar *et al* report. They found that firm market share had no effect on the probability that a firm would adjust its price in response to a change in demand. It also contrasts with Weiss (1993) who found that, in a sample of Austrian manufacturing industries, firms in more concentrated industries adjusted prices more quickly in response to demand shocks (and more slowly in response to cost shocks) than firms in less concentrated industries.

(2) Market share significantly increases the responsiveness of prices to an increase in costs, according to Table C, but these regressions are problematic, as too many of our respondents would in fact increase prices in response to an increase in costs for us to be able to model the variation in responsiveness properly. The pooled regressions in Table D are more appropriate here.

(3) We find that we do not have an explanation for the asymmetry of the effect of the slope of the marginal cost curve on price responsiveness; perhaps the marginal cost curve is flatter above current levels of output than below it, or perhaps respondents have problems hypothesising changes in demand in different directions.

Is there evidence of 'pricing to market'? Since, as we noted above, there were both demand and supply-side explanations of pricing to market, we included our export intensity and self-reported market geography variables both in the change in demand and the change in cost regressions. Looking at the export intensity variables first, we found that these did not significantly affect the responsiveness of prices to a change in demand. However, the export intensity of firms did significantly reduce the price responsiveness to changes in costs (in either direction). This evidence supports demand-side rather than supply-side models of 'pricing-to-market' rigidity; (note that the responsiveness to a change in costs is, of course, a function of the slope of the demand curve). The market geography variables, UK and INTL, which record whether firms think the market for their main product is regional, national, or international, give less readily interpretable results, and are anyway mostly insignificant.

The final question we posed was whether or not there were asymmetries in the responsiveness of prices to changes in cost and demand. Table D brings the asymmetry of the models to the fore. What we find is interesting: whereas a demand increase is significantly less likely to prompt a price response than a demand decrease, a cost increase is much more likely to prompt a price change than a cost decrease. Our first finding, that prices are upwardly rigid in response to changes in demand, contradicts the macroeconometric literature. Our second finding, that price responsiveness to changes in costs is greater when the change in cost is positive, perhaps lends some support to models of downward nominal rigidity that are founded on strategic interaction between firms (see our earlier discussion).(1)

Conclusion

We have used the Bank's recent survey of price-setting behaviour in the United Kingdom to examine a number of questions about the nature and causes of price stickiness. Are prices more sticky in less competitive markets? Does real rigidity magnify nominal rigidity? Do customer characteristics affect price stickiness? Do firms price to market? If so, do supply or demand-side models provide the best explanation? Are there asymmetries in the responsiveness of prices? Do prices respond more to demand than supply shocks?

We have several findings from our survey. The more competitive are firms' product markets, the greater is the propensity to change prices in response to a demand shock; but market structure does not affect the responsiveness of prices to changes in costs. Second, there is some evidence that real rigidity (measured by the flatness of the supply curve) reduces the responsiveness of nominal prices to demand shocks. Third, there is evidence that the lower are search costs in product markets (at least measured by our proxy), the greater is the responsiveness of prices to changes in costs; although search costs seem to have no effect on the responsiveness of prices to changes in demand. Fourth, the export intensity of firms appears to reduce the responsiveness of prices to changes in costs; this supports pricing-to-market models based on rigidities in demand, as opposed to those based on the sunk costs of supply. Fifth, there are significant asymmetries in the responsiveness of prices to the direction of cost and demand shocks. Demand increases appear *less* likely to prompt price changes than demand decreases; but cost increases are *more* likely to prompt price changes than cost decreases.

Our results confirm some theories of price stickiness, but reject others. What weight should we place on these results? The answer depends on how valid we think our research strategy is as a device for testing economic theories. One view that has much currency in modern economics is that economic theories should not be constructed from *ad hoc* relationships, but be judged by how well founded they are in microeconomics; so analogously we might argue that, where possible, we should look for theories to be well founded in micro*econometrics*. So the evidence is a useful complement to macroeconometric studies. Moreover, much of the empirical evidence on price stickiness, based on aggregate or individual firm data, faces the difficulty of identifying natural experiments that correspond to the theories being tested. Our questionnaire, which asks firms what they *would* do in particular situations, sets up those natural experiments explicitly. Clearly, to place any weight on our findings assumes that firms would actually do what they said they would do, if confronted with the situations hypothesised in the questionnaire. We conclude by recalling an old joke, that economists are supposed to be scholars who spend their time investigating whether an idea that works in practice also works in theory. We hope that this article proves that economists sometimes do things the other way round.

(1) We also tested whether the effect of our independent variables on price responsiveness was dependent upon the direction of the demand or cost shock; for both types of shock we found that there were no significant asymmetries in the effects of market structure, export intensity, real rigidity, or customer characteristics.

References

Baldwin, R and Krugman, P (1987), 'The persistence of the US trade deficit', *Brookings Papers on Economic Activity*, No 0(1), pages 1–43.

Ball, L and Romer, D (1990), 'Real rigidities and the non-neutrality of money', *Review of Economic Studies*, Vol 57, pages 183–203.

Ball, L and Mankiw, N G (1994), 'Asymmetric price adjustment and economic fluctuations', *Economic Journal*, Vol 104, pages 247–61, March.

Bhaskar, V, Machin, S and Reid, G (1993), 'Price and quantity adjustment over the business cycle: evidence from survey data', *Oxford Economic Papers*, Vol 45, pages 257–68.

Blinder, A, Canetti, E, Lebow, D and Rudd, J (1998), 'Asking about prices: a new approach to understanding price stickiness', Russel Sage Foundation, New York.

Chesher, A and Irish, M (1987), 'Residual analysis in the grouped and censored normal linear model', *Journal of Econometrics*, Vol 35, pages 33–62.

Cover, J (1992), 'Asymmetric effects of positive and negative money supply shocks', *Quarterly Journal of Economics*, Vol 107, November, pages 1,261–82.

Debelle, G and Laxton, D (1996), 'Is the Phillips Curve really a curve? Some evidence for Canada, the United Kingdom and the United States', IMF, *mimeo*.

de Long, B and Summers, L (1988), 'How does macroeconomic policy affect output?', *Brookings Papers on Economic Activity*, No 2, pages 433–80.

Dixit, A (1987a), 'Entry and exit decisions of firms under fluctuating real exchange rates', Princeton University, *mimeo*.

Dixit, A (1987b), 'Hysteresis, input penetration, and exchange rate pass-through', Princeton University, November, *mimeo*.

Finn, M (1996), 'A theory of the capacity utilisation/inflation relationship', *Federal Reserve Bank of Richmond Economic Quarterly*, No 82/3.

Froot, K and Klemperer, P (1989), 'Exchange rate pass-through when market share matters', *American Economic Review*, pages 637–54, September.

Geroski, P (1992), 'Price dynamics in UK manufacturing: a microeconomic view', *Economica*, Vol 59, pages 403–19.

Geroski, P and Hall, S (1995), 'Price and quantity response to cost and demand shocks', *Oxford Bulletin of Economics and Statistics*, Vol 57, pages 185–204.

Granero, L M (1996), 'Strategic price rigidity', Barcelona University, *Working Paper 361.96.*

Hall, R (1986), 'Market structure and macroeconomic fluctuations', *Brookings Papers on Economic Activity*, No 2, pages 285–322.

Hall, S, Walsh, M and Yates, A (1996), 'How do UK companies set prices?', *Bank of England Quarterly Bulletin*, Vol 36(2), pages 180–92.

Hansen, P, Mollgaard, H, Overgaard, P and Sorensen, J (1996), 'Asymmetric adjustment in menu cost duopoly', Aarhus University, *Department of Economics Working Paper*, No 1996-10.

Haskel, J, Kersley, B and Martin, C (1997), 'Labour market flexibility and employment adjustment: microevidence from UK establishments', *Oxford Economic Papers*, No 49, pages 362–79.

Kasa, K (1992), 'Adjustment costs and pricing to market: theory and evidence', *Journal of International Economics*, Vol 32, pages 1–30.

Kovenock, D and Widdows, K (1991), 'Price leadership and asymmetric rigidity', *Purdue University Working Paper*, No 1008, April.

Krugman, P (1986), 'Pricing to market when the exchange rate changes', *NBER Working Paper*, No 1926, May.

Laxton, D, Meredith, G and Rose, D (1995), 'Asymmetric effects of economic activity of inflation', *IMF Staff Papers*, Vol 2, No 2.

Martin, C (1993), 'Price adjustment and market structure', *Economic Letters*, Vol 41, pages 139–41.

McDonald, I M and Solow, R M (1981), 'Wage bargaining and employment', *American Economic Review*, Vol 71, No 5, pages 896–908.

Okun, A (1981), 'Prices and quantities: a macroeconomic analysis', *Brookings Institute*, Washington DC.

Phelps, E and Winter, S (1970), 'Optimal price policy under atomistic competition', in Phelps, E (ed), *Microeconomic Foundations of Employment and Inflation Theory*, Macmillan, London.

Ravn, M and Sola, M (1995), 'Reconsideration of the empirical evidence on the asymmetric effects of money supply shocks', Southampton University, *mimeo*.

Rotemberg, J (1982), 'Sticky prices in the United States', *Journal of Political Economy*, December, Vol 90, pages 1,187–211.

Rotemberg, J and Saloner, G (1987), 'The relative rigidity of monopoly pricing', *American Economic Review*, Vol 77, pages 917–26.

Shapiro, K and Stiglitz, J (1984), 'Equilibrium unemployment as a worker discipline device', *American Economic Review*, Vol 74, No 3, pages 433–44.

Smith, A (1776), *The wealth of nations*, Penguin.

Stiglitz, J (1984), 'Price rigidities and market structure', *American Economic Review*, Vol 74, pages 350–55.

Weiss, C (1993), 'Price inertia and market structure: empirical evidence from Austrian manufacturing', *Applied Economics*, Vol 25.

Yates, A (1998), 'Downward nominal rigidities and monetary policy', *Bank of England Working Paper*, No 82.

Appendix

Descriptions of variables:

NCP1–5	A 1/0 dummy which is 1 if the firm reports it has between 1–5 competitors.
NCP6–10	A 1/0 dummy which is 1 if the firm reports it has between 6–10 competitors.
NCP11–30	A 1/0 dummy which is 1 if the firm reports it has between 11–30 competitors.
MARKSHARE	Self-reported market share of the firm's main product.
EXPORT >50%	A 1/0 dummy which is 1 if the firm exports more than 50% of its output.
EXPORTS 11%–50%	A 1/0 dummy which is 1 if the firm exports between 11%–50% of its output.
UK	A 1/0 dummy which is 1 if the firm recognises that the United Kingdom is it's main market.
INTL	A 1/0 dummy which is 1 if the firm recognises the international market as its main market.
LARGE	A 1/0 dummy which is 1 if the firm has more than 500 full-time equivalent employees.
MEDIUM	A 1/0 dummy which is 1 if the firm has between 100–500 full-time equivalent employees.
	A set of 1-digit industry dummies.
LTR1-LTR5	A 1/0 dummy which is 1 if the firm has dealt with a higher proportion of its customers for more than one year than it has for five years.
UNION	A 1/0 dummy which is 1 if the firm recognises unions for bargaining purposes.
CONSTANT MC	A 1/0 dummy which is 1 if the firm reports that it has constant marginal cost.