Downward nominal rigidity and monetary policy

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Abstract

This paper asks whether downward nominal rigidities in wages and prices provide a case for targeting positive rates of inflation. It argues that the theoretical restrictions needed to generate downward nominal rigidities are more stringent than has been conceded in the literature; money-illusion and/or fairness considerations are not enough. The paper also assesses the empirical evidence for there being downward nominal rigidities: while the evidence is not conclusive enough to rule out these rigidities entirely, empirical results—including some new results reported in this paper—are not supportive. The paper concludes that there are grounds for targeting positive inflation: the mis-measurement of inflation described in Cunningham (1996) and possibly the desire to leave room for negative (*ex post*) real interest rates (see Summers (1991)). But downward nominal rigidity does not seem to be one of them.

1 Introduction

In 1789, Adam Smith wrote that prices were regulated 'by the proportion between the quantity which is actually brought to market, and the demand of those who are willing to pay the natural price of the commodity'(page 158). In other words, he argued that prices were determined by the balance between demand and supply, and in so doing laid the foundations of classical economics. However, from time to time, economists have argued that there may be barriers to prices adjusting fully. If prices do not adjust, then more of the effects of a shock—a shift in demand or supply—will be felt in quantities. This paper examines the evidence for one possible source of rigidity: that the money (or nominal) price of goods or services or labour may be sticky—and in particular sticky *downwards*.

The argument is most commonly made in connection with wages, and it is usually put in these terms: when the demand for labour falls, the real wage (that is, the amount of goods the wages will buy) has to fall to minimise the effect on employment. But if for some reason the money wage will not fall, then the only way the real wage can fall is if the amount of goods these money wages can buy also falls: in other words, if the price level rises.(1) This simple example gives us our definition of downward nominal rigidity: wages are downwardly rigid if the responsiveness of the money wage to a shock to labour demand is greater when the shock is positive than when it is negative. In this kind of world, if monetary policy holds the price level constant, the real wage cannot fall and the shock to the demand for labour will bring about a fall in employment.

It is for this reason that Akerlof *et al* (1996) recently wrote that 'targeting zero inflation will lead to a large inefficiency in the allocation of resources, as reflected in a sustainable rate of unemployment that is unnecessarily high'. If there are downward rigidities in wages or prices and the aggregate price level is held constant, an economy facing a sequence of negative shocks and positive shocks over time will respond by shifting quantities (ultimately employment) in response to the negative shocks. In this kind of economy, output will be lower at price stability than at some positive rate of inflation. Section 2 of this paper evaluates the theoretical case for downward nominal rigidity. In

(1) For the sake of simplicity, I am assuming that there is no productivity growth. If there is productivity growth, then even if the price level is constant, the real product wage can fall if nominal wages are constant.

my view, this is where the existing literature is weakest. The paper will argue that, contrary to the reasoning implicit in studies by others, a concern over fairness is not sufficient to generate downward nominal rigidities in *wages*. We also need other assumptions: that there are union cartels; or that individuals/unions have no knowledge of outside wages; or that individuals/unions are highly averse to falling behind when wage contracts are staggered. A second possibility raised in the literature is that individuals might suffer from money-illusion. I point out that they must also display what is called *loss aversion* for this to be an explanation of downward nominal rigidities. Section 2 also offers three possibilities for downward nominal rigidities in *product markets*: first, that prices might embody a quality signal; second, that there could be strategic interaction between firms; and third, that consumers also suffer from money-illusion. Assessing the theoretical case for downward nominal rigidities is not simply an intellectual exercise: it is important, since some models of downward nominal rigidity point to an optimal inflation rate that is positive, and some do not.

Section 3 of the paper goes on to look at the empirical evidence for downward nominal rigidity, on the premise that, regardless of how plausible theories of downward nominal rigidity are, we should investigate whether the economy seems to behave as if there are such rigidities. I consider four types of evidence. First, I argue that evidence on the *frequency of wage and price cuts* is not particularly illuminating, since we do not know how frequent wage and price cuts would be in a frictionless world running at a given inflation rate. Second, I look at evidence that examines changes in the *distribution of wage and price changes*. The hypothesis is that downward nominal rigidities should cause the skewness of these distributions to be negatively related to the mean. By and large, I find that this is not the case for the United Kingdom, whether we look at wages or prices. *Survey evidence* (in particular from the Bank) on how firms set prices shows that prices are downwardly rigid in response to some phenomena, but upwardly so in response to others. Fourth, I look at evidence using *aggregate time series*. I explore whether the Phillips curve is convex for the United Kingdom, and argue that it is not significantly so. This section concludes by noting that the problem with this work, and indeed the three other types of evidence, is that we are trying to observe downward nominal rigidities in an era of positive inflation—at a time, in other words, when such rigidities might not 'bite'. The final piece of work therefore extends the Phillips curve estimation back through

time, to see if its slope is different when prices are falling rather than rising. There appears to be no significant difference.

Section 4 draws together the theoretical and empirical evidence, and assesses whether downward nominal rigidities alone make a case for a positive inflation target—notwithstanding that there are other arguments, to do with the bias in measured inflation (which means that true price stability equates to positive measured inflation) and the so-called 'Summers effect' (where price stability may constrain the scope for policy to create negative real rates, since nominal rates are bounded at zero).[2] The empirical case for downward nominal rigidities is at best 'not proven' and at worst, unpersuasive; moreover, because we have theories that predict that at positive inflation there may be an apparent downward nominal rigidity, but one that would disappear in a regime of price stability—for example, Ball and Mankiw (1995) and MacLeod and Malcomson (1993)—much of the evidence is insufficient to support a case for positive inflation. The theoretical arguments are equally inconclusive about the optimal inflation rate. Models of collusion would predict an increase in welfare at price stability. More persuasive is the possibility that individuals might have money-illusion *and* loss aversion—for which there is considerable laboratory evidence. But whether money-illusion would be aggravated or eliminated by prolonged periods of price stability is not clear.

2 Theories of downward nominal rigidity

The paper begins by discussing those factors that affect wages, and then moves on to discuss prices.

Wages

2(i) Relative wage effects

One argument for positive inflation—invoked, for instance, by Akerlof *et al* (1996)—runs as follows: individuals are concerned about relative wages, and will not by themselves concede nominal wage cuts. Inflation is a way of eroding all wages simultaneously and creating room for real wage cuts when necessary. This argument can be traced back at least as far as Keynes' *General Theory*, in which he wrote:

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(2) For a fuller discussion of these factors, see, for example, Summers (1991), Cunningham (1996) and Boskin (1996).

> ‘Since there is imperfect mobility of labour, and wages do not tend to an exact equality of net advantage in different occupations, any individual or group of individuals, who consent to a reduction of money-wages relatively to others, will suffer a *relative* reduction in real wages, which is a sufficient justification for them to resist it. On the other hand it would be impracticable to resist every reduction of real wages, due to a change in the purchasing-power of money which affects all workers alike; and in fact reductions of real wages arising in this way are not, as a rule, resisted unless they proceed to an extreme degree’ (1936; chapter 2, page 14).

This argument has proven very durable, and is embedded in the comments of many distinguished researchers over the succeeding decades, including Schultze (1959), Samuelson and Solow (1960) and Tobin (1972).

This paper argues that believing that individuals are concerned about relative wages does not justify targeting positive inflation *a priori*.[3] Suppose, for example, that I am offered a 10% cut in nominal wages by my employer. If I am concerned about what my peers are earning in a neighbouring factory, and uncertain as to whether they are going to be made a similar offer, I might resist the cut, investing time and energy in strikes, or quitting and searching for another job. Next, suppose that in a different situation, I am offered a 10% nominal wage increase by my employer. If I am concerned about relativities, I should still be worried that I might lose out by accepting the offer: my peers in the neighbouring factory may be offered 15%. In which case I ought to devote just as much effort towards increasing the money wage offer as I did when I was offered a 10% cut.

In this case, the reduction in employment that results from a shock to the demand for labour does not differ when the firms’ desired nominal wage falls by 10% or rises by 10%: in other words, there is no downward nominal rigidity, and the model as it stands does not give us grounds for targeting positive inflation. In each scenario, there is a kind of co-ordination failure: no one party wants to be the first to take what might be a disadvantageous wage offer. In each scenario, real wage cuts could be implemented across the economy by a change in the

(3) Keynes of course was against nominal wage cuts, because he thought they would further reduce aggregate demand.

price level, but this is just as true for when nominal wages are rising as when they are falling.

I would like to argue that for concern about relative wages to generate an argument for positive inflation, we need to make additional—and quite possibly unrealistic—assertions about the determination of wages.

Union cartels

One possibility is that wage-bargainers are part of a cartel. If the labour force were members of competing trade unions (perhaps in the way described in Oswald (1979)), and unions wanted to maintain 'market share' in worker-membership and were concerned about real wages, they could collude by fixing nominal wages (or at least nominal wage bids); and they would do this only if they did *not* have access to cheap means of continuous wage indexation. In this situation, under certain informational assumptions, individual unions would be reluctant to concede nominal wage cuts in the face of an adverse shock to aggregate demand, for fear that other unions would interpret this as beginning a 'price war' over membership that would result in no change in market share and lower nominal (and real) wages. They would feel more inclined to accept nominal wage increases, since other unions would know that by doing so they risked pricing themselves out of the market for worker-members. However, notice the auxiliary assumptions made here: competing trade unions cannot properly infer each others' preferences and therefore cannot interpret each others' wage bids; worker-members are transferable across trade unions and jobs.[4]

If these cartels exist at all, then in a world of price stability, shocks to the demand for labour will lead to shocks to employment. But price stability would also threaten the cartel itself, and its disbandment would (providing that there is no monopsonistic power on the part of employers) yield a benefit for the economy.

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(4) We might ask at this point why we could not think of individuals competing for work forming a cartel, rather than a collection of trade unions. The reasons are these. First, the assumption that individuals cannot interpret others' wage negotiations accurately is less plausible when the others are individuals in the same firm. Second, labour demand is typically 'lumpy' (because of technology and hiring and firing costs), and so competition over 'market share', which in the individuals' case means hours worked, is bound to be limited and of second-order importance.

Staggered wages and no information about outside wage changes

Aside from cartel-like behaviour, another possibility is that wage contracts are staggered and, as before, not indexed to the price level, and that individual workers or unions have no information about outsiders' future wage settlements, and always assume that others' nominal wages are going to remain unchanged when they come up for renegotiation. In this situation, workers will be happier with a 10% nominal wage increase—which, according to their information, will give them a real relative increase of 10%—than with a 10% cut.

Staggered wages and a dislike of 'going first'

Yet another possibility is that wage contracts are staggered and non-indexed, and renegotiation of wages outside the (say annual) wage round is impossible or very costly for workers and firms alike. In these circumstances, workers faced with a 10% nominal wage cut may be reluctant to go first, even if they know that others will follow, because they will lose out in the meantime. But workers will be happy to go first if they are offered a 10% nominal wage increase, because for a short period they will gain. Of course, we also need to rule out the possibility that workers will value the option to 'catch-up' in the next period's negotiations, or assume that they discount this option so heavily that downward nominal rigidity still results.

The argument that wage relativities can justify a positive inflation target thus rests on the plausibility of union cartels; the assumption of no knowledge about outside wages, or the aversion to falling behind others when wage contracts are staggered; the non-indexation of wage contracts, and the notion that zero inflation will not serve to undermine the cartel itself. All possibilities rely on an additional assumption that workers can extract some rent from employers and not be substituted costlessly for a member of the jobless queues; these rents may derive from the monopoly power of trade unions, or search costs, or hiring and firing costs. If they cannot extract these rents, then firms will simply pay workers their real marginal product, whatever that implies in nominal terms.

Fairness reconsidered

Although the artifice needed to maintain that concern about wage relativities can lead to a downward nominal rigidity that is significant for monetary policy is complex and, perhaps, unconvincing, nevertheless, the paper turns next to the question of whether we can find evidence that wage relativities, or fairness, are indeed important concerns in the real world.

In fact, psychologists and sociologists have long recognised the potential importance of fairness in individuals' perception of well-being. We can find this in Adams' (1963) 'equity theory' and Runciman's (1966) 'relative deprivation theory'. There is also a considerable amount of survey, experimental and empirical evidence that fairness is important. For example, a recent paper by Clark and Oswald (1996) studies 5,000 workers surveyed in the first wave of the British Household Panel Study. They find evidence of respondents reporting themselves as being 'happier' when their wages are higher relative to a benchmark comparison. Cappelli and Sherer (1988) report on a survey of around 600 airline employees in the United States, and also find that 'satisfaction with pay' rises significantly as the wage rises relative to a measure of outside market wages. Katz (1986) found that *firms* are concerned with the 'fairness and consistency' of their wage structures, which could indicate that *workers* themselves consider fairness to be important. Di Tella *et al* (1996) find a weak correlation across countries between income inequality (measured by the Gini coefficient) and total reported levels of 'happiness' in country surveys. They also find that happiness rises as individuals move up the income distribution within countries.

However, there are serious problems in interpreting this evidence. It could be that workers are concerned about the differential between themselves and the highest earners, but it could also be that individuals are simply happier with higher levels of income. The two behaviours are observationally equivalent.

Moreover, it is difficult to distinguish between workers who are genuinely concerned about fairness, and workers who are simply monitoring wages relative to their own outside options. If workers are aware of their outside opportunities and are simply weighing up the costs and benefits of staying with their current firm, then this is perfectly consistent with competitive (full-information) behaviour in labour markets. For example, if there is a fall in the demand for x's type of labour across the

whole economy, *x* will see that the outside wage has also fallen and will probably accept a cut in his or her own money (and therefore real) wage. If the outside wage has not fallen, this will send a signal to *x* that there is something amiss with *x*'s firm, and will lead *x* to decide whether or not to stay put, taking into account the chances of getting a job elsewhere. In short, what in empirical studies looks like a concern for 'fairness' could be nothing of the sort, and may not lead to downward nominal rigidity in wages.

One study that takes us a step further along the line to showing that workers are indeed concerned about 'fairness' is Smith (1996). She shows that wage settlements in the UK chemicals industry appeared to correlate with wages offered by a 'pay leader' (in this case ICI), over and above the correlation with outside wages in the industry. However, Smith herself concedes that here too, the high-profile 'pay leader' could be being used as additional information on outside wages by workers with less-than-full information about industry wages in general.

But there is an interesting contradiction here: many of the studies of fairness demonstrate the phenomenon that an individual's happiness or own wage is a function of the outside wage. This comes close to violating one of the scenarios above that linked fairness to downward nominal rigidity—that workers have little or no knowledge of outsiders' wages and assume that a 10% nominal wage cut means that they will lose out by 10%.

Moreover, the discussion so far has taken it as given that concern about relativities reflects *selfish* behaviour: that, for example, *x* feels unhappy if he or she earns less than *y*. It is commonplace in the literature on experimental game theory to observe the opposite. For example, laboratory experiments with people playing competitive games often show that participants will throw away income if it leads to a fairer distribution of the winnings, even if the whole 'pie' is smaller. (See, for example, Guth *et al* (1982), Bolton (1991) and Smith (1996)). Going back to our question about money wages, this could mean that certain groups in companies might turn down a money wage increase, or even accept a money wage decrease that leads to a fairer distribution of earnings. This is not to say that this form of fairness is an important economic phenomenon—it may or may not be—but it does illustrate that concern about wage relativities does not give us *a priori* grounds for believing that there is downward nominal rigidity in wages.

2(ii) Wage bargainers suffer from money-illusion

Another popular argument for positive inflation based on labour market behaviour runs like this: workers suffer from money-illusion, and will resist nominal wage cuts as they assume they amount to real wage cuts; so the employment consequences of negative shocks to labour demand could be mitigated by allowing positive inflation to erode nominal wages and, by stealth, eroding real wages. This paper will argue that money-illusion itself is not enough to justify positive inflation in these terms. We also need real-wage stickiness and *loss aversion*.

To explain, suppose that we compare two worlds. In the first, inflation is 10% and nominal wages are growing at 10%. In the second world, prices and nominal wages are stable. (There is no productivity growth in either case). If wage-earners really do confuse nominal and real variables, then in the world of 10% inflation, they will become 10% happier each year (if, for simplicity, wages translate one-for-one into utility). This itself might, if we believed it to be a genuine long-run phenomenon, and if there were no costs of inflation, be enough to warrant targeting positive inflation. But positive inflation itself would not alleviate the unemployment consequences of a negative shock to the demand for labour. To begin with, if there is no real-wage rigidity—if wage-bargainers are simply price-takers and are paid their marginal products—then a negative shock to the demand for labour will not create any excess supply: workers' money-illusion will not come into the determination of the labour market equilibrium. So we need first some reason why workers can lever the equilibrium real wage above the level that clears the market. The literature offers us many alternatives,[5] but even these are not enough to generate an argument for positive inflation.

To see why, suppose that inflation is 10% in period one, and nominal wages are also growing at 10% (there is no productivity growth). In period two, there is a real aggregate demand shock that means that money wages need to grow by 5 percentage points less than inflation in order to leave employment

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(5) There are many theories of real wage stickiness: there are theories of wage bargaining that posit that unions bargain up wages above the market-clearing wage (McDonald and Solow (1981)); firms might pay an efficiency wage, to minimise turnover (Stiglitz (1985)), shirking (Shapiro and Stiglitz (1984)), or maximise the chance of recruiting new high-productivity workers (Stiglitz (1976)). Or firms and workers might want to insure themselves against market movements, using implicit (or explicit) contracts (MacLeod and Malcomson (1993), for example).

unchanged. Suppose too that workers' efficiency is affected by the real wage—in the manner suggested by, for example, Stiglitz (1985)—and that they are subject to money-illusion, so they calculate the growth in their real living standards from nominal wage growth. In this example, firms (who know about, or perhaps even, share workers' money-illusion) do not cut nominal wage growth by the full 5 percentage points, because of the anticipated effect on efficiency, and employment falls. Now suppose that in period one, inflation and nominal wages are both growing at 0%—there is price (and nominal wage) stability. The real aggregate demand shock arrives as before, and nominal wages need to fall by the same 5 percentage points less than inflation (which implies a nominal wage cut of 5 percentage points). Firms will be no more reluctant to cut wages in this example than they were before: nominal wages would still grow by the same amount less if the employment-preserving offer was made by employers, and their 'efficiency' would suffer by the same amount. So the stickiness of the nominal (and real) wages would lead to the same fall in employment.

To justify positive inflation, wage-earners' happiness (and in this example their 'efficiency') must suffer more when 5% of their money wage is taken away than it improves by having an extra 5% given to them. In other words, not only do we need workers to have money-illusion, and for there to be real wage stickiness, but they must also display what is known as *loss aversion*. This is a phenomenon that Kahneman and Tversky (1979) are credited with having identified. They write, for example, that 'a salient characteristic of attitudes to changes in welfare is that losses loom larger than gains. The aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount'. To see why this would justify a policy of positive inflation, recall the previous example. Firms wish to bring about a 5% cut in real wage growth. When there is price stability, firms compare the anticipated effect on worker-efficiency of leaving wages unchanged, as against cutting nominal (and therefore real) wages by 5%: the efficiency loss is, say, x units. When there is 10% inflation, firms compare the efficiency outcomes from increasing wages by 10% and increasing them by 5%. The efficiency loss here is less than x units, because the elasticity of workers' utility with respect to the nominal wage is smaller for wage changes above the current wage than for wage changes below it. The upshot is that the real wage cut is more likely to take place, and the employment consequences of the shock to labour demand are likely to be smaller.

So is there evidence that money-illusion and loss aversion are pervasive? Keynes himself wrote of 'the psychological encouragement likely to be felt from a moderate tendency for money-wages to rise' (1936; page 271). On the other hand, Tobin (1972) once wrote that 'economic theorists can commit no greater crime than to assume money-illusion' (page 3); but perhaps the evidence persuades us to think differently.

For example, Kahneman, Knetsch and Thaler (1986) report the results of a survey where 78% of respondents said that they would prefer a 7% money wage increase when inflation was 12% to a 5% money wage cut when prices were stable. This is money-illusion: real wages fall by (about) 5% in both examples, but respondents gained satisfaction from having increases in the money wage itself. Shiller (1996) also reports survey evidence of people's dislike of inflation: he says that 'the largest concern with inflation appears to be that it lowers people's standard of living. Non-economists appear often to believe in a sort of sticky-wage model, by which wages do not respond to inflationary shocks' (page 2). No one would dispute the fact that some money wages will not respond to inflationary shocks, nor that over significant time periods, inflation does lower people's standard of living (see Briault (1995) for a discussion of the costs of inflation). But Shiller's observation still sounds very much like a form of money-illusion, not least since in industrialised economies, the *real* wage has risen pretty much in line with productivity. Shiller asked respondents a more direct question about money-illusion–he asked whether they agreed with the statement: *'I think that if my pay went up I would feel more satisfaction in my job, more sense of fulfilment, even if prices went up just as much'.* Only 41% of all respondents disagreed with this. (Worryingly, only 90% of economists disagreed). Other evidence abounds: for example, Shafir *et al* (1994) find experimental evidence of money-illusion; Haldane (1998) conducted a Shiller-style survey in the United Kingdom and finds that '30% of our sample agreed that nominal wage rises increased their sense of job satisfaction'.

However, perhaps we ought not to place too much weight on this kind of information. It relies on individuals' perceptions of *hypothetical* events, rather than reveals their preferences by showing how they respond to *actual* events.

Turning to loss aversion, Dunn (1996) finds evidence of this in wage data from the United States. His observation confirms the

earlier work of Thaler (1980), Knetsch and Sinden (1984), and Kahneman, Knetsch and Thaler (1990), which found that in experimental games, people required more money to give up an object than they were willing to pay to acquire it. There are instances of this kind of behaviour elsewhere in the economy. For example, a substantial literature has grown up around the idea that managers of joint-stock companies set their dividend policies to minimise the chance of ever having to cut dividends. This is presumably because they fear that markets will react more adversely to a cut in dividends than they do positively when dividends increase. This is borne out by survey evidence, for example Lintner (1956), or empirical tests, such as the work by Fama and Babiak (1968).

Loss aversion is not as far-fetched as it sounds. It may be nothing more than the observation that individuals find themselves at a point where the marginal utility of real income falls as income rises. Or it could be that consumption is lumpy. A fall in real income may mean that an individual can no longer service the mortgage on a house of size x, and has to trade down to one of $x - \delta$ and incur transactions costs. Yet a rise in real income of the same size may not be sufficient to warrant paying the transactions costs associated with trading up to a house of size $x + \delta$.

It ought to be evident by now that the task of finding a good explanation for money wages being sticky downward is a very demanding one. To summarise, we need either:

(i) a concern for fairness, real wage-stickiness plus *either*
  (a) union cartels;
  (b) no information about outside wage settlements; *or*
  (c) extreme dislike of 'going first' in the wage round;

or

(ii) money-illusion, loss aversion *and* real wage stickiness.

The case is weakened by two further observations. First, insofar as it rests on money-illusion, it is difficult to believe that wage bargainers' methods of calculating whether their real living standards had fallen or not would not be affected by running the economy at positive, rather than zero inflation: in other words, it is hard to believe that money-illusion would be sustained or persist in the long run. Second, as King (1997) observed, labour

productivity trends upwards (at something over 2% per annum): provided that shocks to the demand for labour in any one year caused changes in firms' wage offers that do not exceed annual productivity growth, there need be no call at all for positive inflation.

However unconvincing or contrived the theory, there are plenty of examples of opinions of practitioners who believe that downward nominal rigidity is a genuine phenomenon. Bewley and Brainard (1993) surveyed employers in Connecticut and wrote: 'The psychological factors are the reaction of employees to the loss of income resulting from a pay cut or short-time. A loss of income hurts morale ... Employers claimed that employees saved little so that their living standards fall as soon as their pay is cut. .... the reduction in living standards put them in a bad mood, ... a pay cut may also be interpreted as a slap in the face, even if the pay of all employees is cut.' (page 3). If this is true, Connecticut would seem to be subject to money-illusion, loss aversion and fairness considerations all at the same time: perhaps proof of the old joke that economists are those who take something that works in practice and prove that it does not work in theory!

Prices

We have seen that there may be reasons why a positive inflation rate could be justified on the grounds of certain labour market features, but are there similar possibilities in the case of product markets? Of course, if firms are price-setters in product markets, and they operate in labour markets with some or all of the features identified already, then there may be a visible downward stickiness in product prices that would be alleviated by positive inflation. But are there features of the goods market, *independent* of the determinants of money wages, that mean that prices will not fall as readily as they should, and so suggest that monetary policy should target positive inflation rates?

2(iii) Price cuts would confuse customers who have money-illusion

One argument is that in an economy that has always had positive inflation in living memory, customers will be used to rising prices; if monetary policy moves to target price stability, consumers will not be able to make sound decisions about how much and what to buy: they will be confused by a situation where prices are stable on average and there are some that rise

and some that fall. This argument relies on a kind of money-illusion: people cannot calculate relative price changes when there are price cuts. In this case, we can probably throw out this theory at the start. Warner and Barsky (1995) study retailing in Michigan and comment that 'there were frequent markdowns in the intensive shopping period prior to Christmas, and a tendency for such sales to occur at weekends' (page 1). But anyone who has shopped does not need academic evidence to corroborate the fact that prices are often discounted. Some prices (for example the prices of calculators, videos and computers) have fallen almost continuously, even leaving aside the improvements in the quality of these goods. And Chart 3 below shows that in January last year, around 20% of prices in the UK RPI had fallen during the previous twelve months. Price cuts are not particularly rare, so it is difficult to believe that customers are not used to them.

Moreover, if there is some possibility of disrupting the allocation of resources by moving to price stability, the disruption must surely be short-run: at some point, the economy would get used to deflating individual prices by a constant general price level, rather than a rising one. It is hard to justify positive inflation on these grounds.

2(iv) Price cuts signal quality cuts

A second argument why firms might be inhibited from making price cuts is that they fear that customers might interpret this as a fall in quality. One possibility is that customers cannot perfectly observe the quality of the good they are to purchase before they buy it; if they assume that firms price at or according to marginal cost, then they might assume that a fall in the price constitutes a reduction in the quality of the (marginal) inputs used to produce it. And if the relationship between the expected quality of the good and utility derived from buying it is discontinuous (below a certain quality threshold the good is useless), then the firm could experience disproportionate falls in demand if the price is reduced. This idea was first suggested by Allen (1988), and presumes that customers have only limited information about the quality of the range of goods from which they are choosing. What little evidence there is suggests that this type of behaviour is rare. For example, Blinder (1995) reports that this theory was considered the 'least important' by firms responding to his survey of 200 firms. Hall *et al* (1996) surveyed some 650 firms in the United Kingdom and, basing their questionnaire on Blinder's, asked: 'If you were to cut the price of your good would some or all of your customers assume that

you had reduced its quality?' They found that this theory was recognised as relevant by only 18% of their respondents, and ranked close to the bottom of 10 competing theories in terms of importance. These survey results still do not rule out the possibility that quality signalling is pervasive enough to be a significant factor in the design of monetary policy.

Yet another possibility is that consumers derive utility from high prices themselves—from the prestige of consuming an expensive product, for example.

Note that even if price cuts signal quality cuts, or if high prices give pleasure to consumers of certain goods, we require additionally that consumers are possessed of money-illusion for this to be relevant for monetary policy: in order to translate a cut in the nominal price into a cut in the real (relative) price, we need to believe that consumers are assuming that the general price level stays unchanged. To the extent that this kind of behaviour is prevalent, however, we could justify positive inflation.

2(v) Prices are sticky downwards because of strategic behaviour between firms

Another barrier to price cuts may be strategic interaction between firms. The argument here is very similar to our discussion of union cartels. Imagine the following set of circumstances. Costs are falling over time—because of process innovation—in an industry with a few large competing firms. Selling prices are set by implicit agreement above the competitive (marginal cost) price and, because cartels cannot costlessly index the agreement, the agreement is made in nominal terms. However, in order to stop new firms from entering, prices have to fall in line with the downward trend in costs. If firms cannot easily monitor whether a firm is cutting prices to gain market share or to preserve price/marginal cost margins, then prices may not fall at all, because no firm wants to be first to break the agreement and risk a price war. In these circumstances, inflation (a rise in the general price level) can bring about simultaneous falls in the relative prices charged by all the firms in the (implicit) cartel. There is a small theoretical literature on this subject. Granero (1996), Hansen *et al* (1996) and Kovenoch and Widdows (1991) all present models that generate nominal price asymmetries due to stratetic interaction.

There is some survey evidence in support of this idea. Hall *et al* (1996) observed that while 186 firms reported that their preferred response to a cost decrease was a cut in prices, 421 firms said that they were most likely to increase prices in response to an increase in costs. One explanation of this is the worry that cutting prices will lead to a price war, because firms cannot easily monitor each others' costs. Against this, however, Blinder (1995) found that when asked 'Do you also delay price cuts because you do not want to be among the first firms in the industry to cut prices?', 61% said 'rarely or never', 14% said 'sometimes' and 25% said 'usually or always'.

Of course, as in the case of the union cartels, this kind of co-operation between firms is not good for the economy as a whole. If this kind of downward rigidity is prevalent, then far from imposing a cost on society, monetary policy targeted at price stability would yield an additional benefit by making such cartels more difficult to sustain, lowering the level of the real

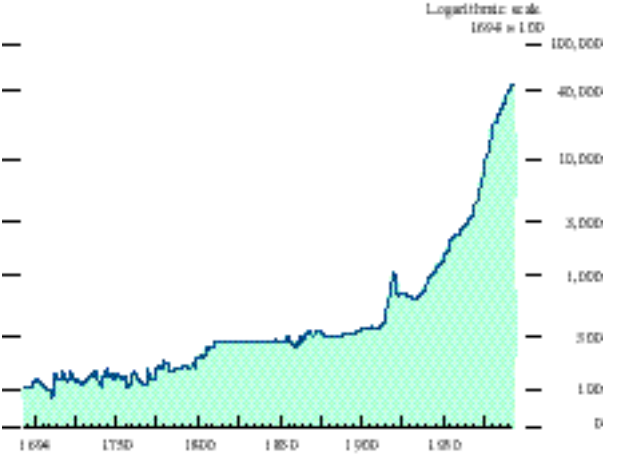
price, increasing quantities and welfare in the way microeconomic textbooks describe.[6]

3 'Outcome'-based evidence of downward nominal rigidity

So far we have argued that some typical arguments for positive inflation—based on either fairness concerns or money-illusion—are not watertight. We have also considered some evidence that sheds light on whether the behaviours embodied in a fuller theory of downward rigidity (money-illusion, loss aversion, cartel behaviour, quality signalling) are detectable. We turn now to look at more indirect evidence on wage and price outcomes to see if the economy behaves in a way that is *consistent with* there being some downward nominal rigidity—even if, as we shall explore later, such evidence cannot *prove* that there is downward nominal rigidity.

3(i) How frequent are wage and price cuts?

Chart 1: The money wage since 1694



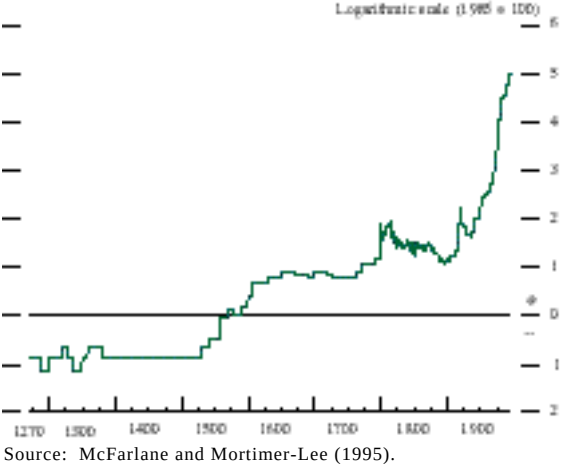
Source: Data compiled at the Bank of England, combining ONS sources and data from Phelps Brown and Hopkins (1956).

How frequent are wage and price cuts? This is perhaps the most obvious question to ask. Surely, if price and wage cuts are common, we cannot claim that the economy behaves as though

(6) Provided, that is, that innovation is no less swift under perfect competition than imperfect competition.

there is downward nominal rigidity. Chart 1 shows that cuts in the aggregate money wage were a lot more common in Adam Smith's time than ours, which perhaps reflects why he wrote that 'the money price of labour rises in the one [year] and sinks in the other' (1789; page 189). In the eighteenth century, wages did just that. Chart 2 makes the same point, but for the aggregate price level.

Chart 2: The aggregate price level since 1270



Source: McFarlane and Mortimer-Lee (1995).

Nevertheless, movements in the *aggregate* price level conceal considerable variation in *individual* prices. Table A offers snapshots of the distribution of (annual) price changes at two-yearly intervals from 1982–96, and Chart 3 plots the proportions of prices within the aggregate index that are falling (year on year) from 1975–96. It is clear that at any one time there are significant proportions of retail prices falling in the economy.

Chart 3: Price cuts in the RPI

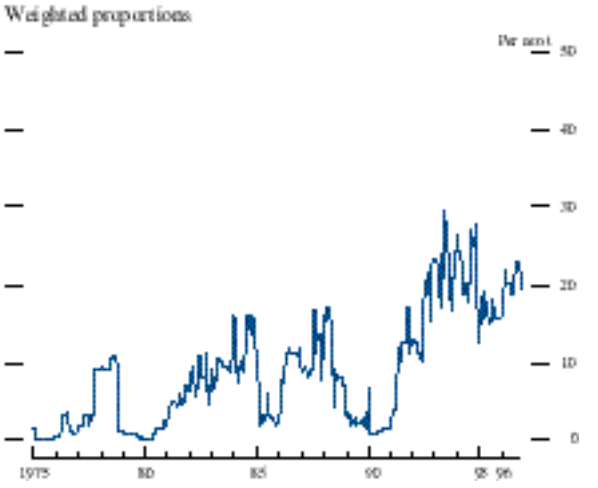


Table A: The distribution of price changes in the RPI

(Per cent)	< -10	-10 ≤ x < -5	-5 ≤ x < 0	0	0 < x ≤ 5	5 < x ≤ 10	> 10
Jan 1976	0.3	0.0	0.3	0.0	5.6	4.2	89.6
Jan 1978	1.2	0.0	8.0	0.0	5.3	6.9	78.6
Jan 1980	0.0	0.0	0.0	0.0	5.0	8.3	86.8
Jan 1982	0.0	0.0	8.9	0.0	16.1	32.5	42.6
Jan 1984	0.0	0.0	16.1	1.4	39.7	40.6	2.3
Jan 1986	0.3	0.0	2.9	0.0	46.9	44.4	5.6
Jan 1988	0.0	0.3	15.7	3.0	40.0	38.0	3.0
Jan 1990	0.0	0.0	6.6	0.4	26.5	50.5	15.9
Jan 1992	7.7	0.5	4.7	0.0	18.2	38.2	30.7
Jan 1994	0.7	8.1	15.7	3.0	42.7	23.9	5.8
Jan 1996	0.0	3.6	14.5	1.1	48.2	32.1	0.5

(Weighted proportions of the index falling into particular inflation ranges, calculated as annual percentage changes; distribution observed across around 65 components of the RPI.)

Similarly, we can look at the distribution of money wages. In the United States, there is some controversy as to whether money wage cuts are frequent or not. Akerlof *et al* (1996) surveyed evidence on this, and Table B reports on the papers they cover

and, in addition, summarises other studies outside the United States. To begin with, Akerlof *et al* review four studies of data from the Panel Study of Income Dynamics (PSID), which follows individuals' labour market experiences through successive jobs in the United States.[7] These studies all found that money wage cuts were quite frequent: Akerlof *et al* report that these data show that 10.6% of wage-earners and 24.3% of salary-earners experienced nominal wage cuts at some time or other. However, they argue that these data are likely to be subject to large reporting errors, for which these studies fail to correct. In support of this claim, Akerlof *et al* cite work by Shea (1996), who matched workers from the PSID to other information from employers and unions on wage changes. He found that 21% of matched workers reported wage cuts in the PSID, but only 1.3% of these had received nominal wage cuts, according to their contracts. Other work[8] confirms that reporting errors on surveys are typically large, and Akerlof *et al* argue that they are large enough to explain all of the observations of nominal wage cuts in the PSID. Akerlof *et al* report the results of a telephone survey of Washington, showing that only 2.7% of people experienced a nominal wage cut. Two points are worth making here: first, Mankiw (1996) argues that this is simply 'because people are often reticent to admit bad things about themselves'. Second, Akerlof *et al* specifically asked respondents to exclude bonus payments when thinking about the question: reducing bonus payments would, in reality, provide scope for significant variation in the total money wage. They report other, more reliable evidence based on wage settlements, which shows that (in the United States) negative settlements are quite rare. A recent study by Crawford and Harrison (1997) elaborates on these themes.

(7) McClaughlin (1994), Card and Hyslop (1995), Lebow, Stockton and Wascher (1995), Kahn (1997).
(8) For example, Mellow and Sider (1983).

Table B: Evidence on nominal wage rigidity: the frequency of wage cuts

Source	Nature of data	Summary
Akerlof *et al* (1996), Bureau of Labor Statistics	Changes in wages by employers (ie settlements) 1959–78 (US)	Negligible fractions of both union and non-union employers making negative changes
Akerlof *et al* (1996), Authors' survey of Washington area	Phone survey of respondents' wage changes in previous year, 1995 (US), excluding overtime and bonuses	1.7% negative pay changes and no change in job characteristics; additional 1% with changes in job characteristics
Akerlof *et al* (1996), Bureau of Labor Statistics	Contract settlements involving more than 1,000 workers (US)	2.3% of contracts with negative changes in first year, average 1970–94
Various studies using the Panel Study of Income Dynamics (PSID)	Wage and salary changes (including bonuses and overtime) (US)	10.6% of wage-earners and 24.3% of salary-earners with pay cuts
Carruth and Oswald (1989)	UK settlements data	Nominal wage cuts rare
Crawford and Harrison (1997)	Canadian SLID data, 1993	10% had hourly wage cuts
Crawford and Harrison (1997)	Sobeco Ernst and Young Survey of wage changes, including bonuses	9%–20% had wage cuts
Crawford and Harrison (1997)	Canadian union wage settlements data units of >500 employees	Negligible number of negative settlements
Pierre Fortin (personal communication with Akerlof *et al*)	Canadian labour contracts without COLAs	0.25% with wage cuts during 1986-88; 5.7% with cuts and 47.2% with wage freezes during 1992–94
Holzer (1996) four-city study	Changes in wages of new employees (excluding of bonuses etc) reported by firms hiring non-college graduates (US)	4.84% of new employees with wage cuts
Ingram (1991)	United Kingdom manufacturing settlements data	Nominal wage cuts rare; wage freezes common in recession
O'Brien (1989), Hanes (1993), and others	Historical data (US)	Considerable wage rigidity in pre-war recessions
Smith (1998)	United Kingdom, gross pay from the BHPS, 1991–1995	30% of job-stayers (per year) had nominal pay cuts
This paper	UK settlements data 1992–97	Very few recorded nominal wage cuts

Evidence for the United Kingdom tends to back this up. Table C shows data compiled by the Bank from various organisations that collect data on wage settlements. Negative settlements are indeed rare: in 1993, when 63% of employees were receiving settlements in the range 0.1%–2.4%, 3% were receiving pay freezes and only 0.2% of employees took pay cuts. In no other years were there any recorded negative settlements. Carruth and Oswald (1989) also find that there are very few negative settlements in the United Kingdom. Ingram (1991) uses manufacturing settlements data collected by the Confederation of British Industry (CBI) and arrives at the same conclusion: negative settlements are extremely rare.

Table C: The distribution of wage settlements in the United Kingdom

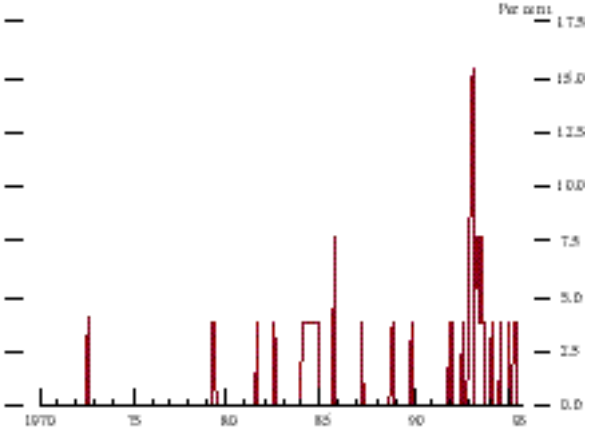
Employees in each pay band as a percentage of the total

	Cuts	Freezes	0.1--2.4	2.5--4.9	5.0--7.4	7.5--9.9	10.0+
1992	0.0	5.8	0.8	78.1	15.2	0.0	0.2
1993	0.2	3.0	63.2	33.3	0.3	0.0	0.0
1994	0.0	0.6	47.7	50.9	0.7	0.0	0.0
1995	0.0	0.7	5.7	92.6	0.8	0.1	0.0
1996	0.0	0.7	11.3	86.1	1.8	0.0	0.1
1997	0.0	0.2	14.1	77.0	8.3	0.0	0.4

Source: Bank wage settlements database, compiled from IDS, LRD, IRS publications.

Of course, negotiated settlements may leave scope for employers to cut nominal earnings by other means. Chart 4, which shows the (unweighted) proportion of industries where average earnings fell over a twelve-month period, reveals that there are rather fewer earnings cuts than price cuts (Chart 3) in the United Kingdom—as we would expect, because money wages rise not only with inflation but also with productivity.

Chart 4: Earnings cuts in the United Kingdom



Source: ONS.

Smith (1998) examines changes in the self-reported, 'usual' gross pay of respondents in the British Household Panel Study: she finds that nominal pay cuts are common. Each year between 1991 and 1995, around 30% of respondents saw their nominal pay fall. Even this figure may conceal some flexibility, since employers could no doubt bring about deviations from 'usual' pay by varying overtime etc.

3(ii) What does the distribution of wage and price changes tell us about downward rigidities?

It is difficult to know what to conclude from these data on the frequency of wage and price cuts, because we do not know the counterfactual. For example, just because we observe some wages and prices falling does not allow us to rule out the possibility that these wages and prices would have fallen by even more in the absence of some downward rigidity.

In order to detect downward nominal rigidity, we need to know more about the distribution of wage and price changes: in this way we can get a grip on the counterfactual.

First, if there is downward nominal rigidity, then we would expect wage and price changes to cluster at zero and therefore to exhibit positive skewness. Of course, there may be other factors causing a cluster at zero—for example, productivity shocks could cluster such that the bargained wage change comes out at zero—

but this is unlikely. Recalling our discussion of the US data, McClaughlin (1994) did find that there was a 'spike' in the distribution of wage changes in the PSID around zero, constituting around 7% of job-stayers. Lebow *et al* (1995) and Kahn (1997) confirm this result, using the same data. Kahn shows that the spike is larger (10.5%) for wage-earners—paid at frequencies greater than monthly—and salary-earners (4.7%), paid monthly. However, Card and Hyslop (1995) point out that the importance of this spike may be exaggerated by the fact that the PSID records the wage only of those who stayed in the same jobs, who are likely to be disproportionately high performers. Low performers, those most likely to have been offered a wage cut, may have changed jobs and will not be picked up by the PSID studies.

Do the UK distributions of wage and price changes also show some signs of skewness? The settlements data are clearly truncated at zero—see Table C. Table A also shows some evidence of a zero-spike and positive skewness in retail prices. However, if we look at Charts 5 to 7, we can see that average skewness does not seem to be positive, and in fact varies a great deal.

Chart 5: Skewness in retail prices

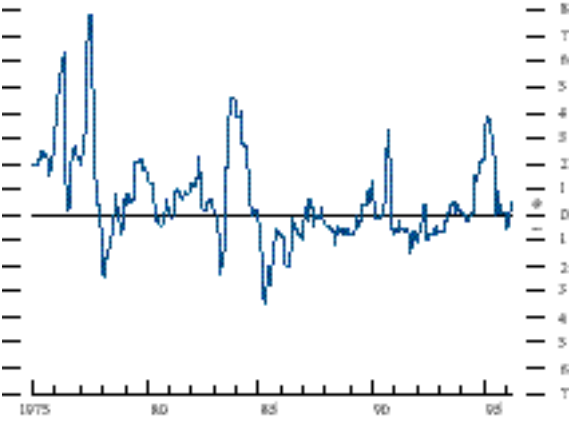


Chart 6: Skewness in producer prices

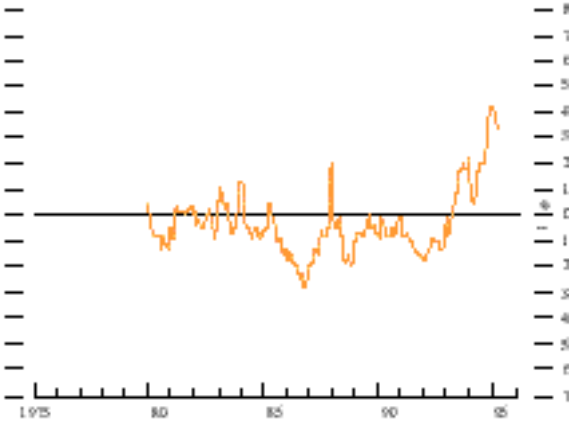
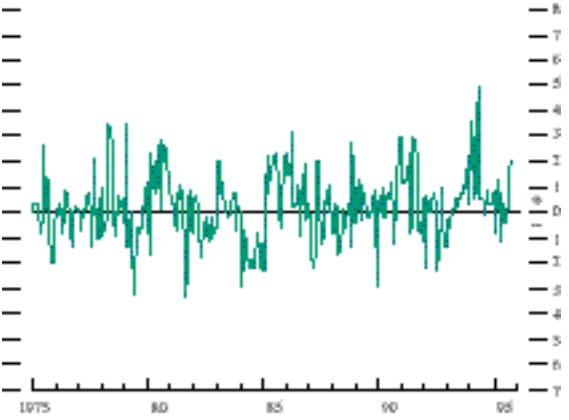


Chart 7: Skewness in wages



Note: All data come from the ONS; distributions are of the annual change in prices or wages, so these are the units of 'skewness'; retail price distribution consists of 65 sub-components; the producer price distribution is a disaggregation of the Producer Price Index, made up of around 300 sub-components; the earnings distribution is of SIC two-digit industries.

Smith's (1998) study of the BHPS reveals that between 6%-7.5% of those who did not change jobs had constant nominal wages (year on year) between 1991-95. The figure falls somewhat when she adjusts for those who report changes in hours worked, and the spike is likewise smaller for 'job-changers' (echoing the point made by Card and Hyslop mentioned earlier, that the US PSID, which records only job-stayers, may exaggerate the spike).

There is also useful information in changes in the distribution over time. Not only ought there to be positive skewness in the distribution of price and wage changes, but skewness should fall as inflation rises: the higher the rate of aggregate inflation, the fewer workers and firms there are who would ideally like to cut wages/prices, and the fewer recorded wage changes there ought to be clustered around zero. In other words, downward nominal rigidity should mean that there is a negative correlation between the mean and skewness of inflation in prices and wages. Once again, we cannot rule out the possibility that there might be other reasons why there is a zero-spike, or that this spike should correlate with the inflation rate, but there are no obvious candidates, so it would seem reasonable to interpret any correlation as revealing downward nominal rigidity.[9]

We can test this straightforwardly. First, Table D below shows the correlation coefficients between different moments of price and wage changes for the United Kingdom. The data run from 1965 to 1995 for wages; from 1975 to 1995 for retail prices; and from 1980 to 1995 for producer prices.[10]

(9) Hall and Yates (1998) point out that a negative relation between mean and skewness could also indicate *upward* nominal rigidity; in which case, we need to use theory to decide whether a negative correlation is indicative of downward or upward rigidity. Kayshap (1995) is the only reference to the possibility that prices might be sticky upward, pointing out that firms may be reluctant to push prices above certain nominal thresholds (eg £2.99 or £3.99) if they expect that demand would fall disproportionately. Hall *et al* (1996) found that 34% of firms thought that threshold pricing was important for their pricing. This argument is of course less relevant for wages.

(10) The evidence on wages is an update of Yates (1995); the evidence on prices cited here draws from Hall and Yates (1998).

Table D: Downward nominal rigidity: correlation coefficients between mean inflation and the other moments

	Skewness	Standard deviations	Kurtosis
Retail prices, 12-month changes (weighted)			
Levels	0.44	0.87	0.29
Changes	0.22	0.46	0.14
Producer prices, 12-month changes (weighted)			
Levels	-0.02	0.76	-0.07
Changes	0.21	0.16	0.08
Wages, 12-month changes			
Levels	0.07	0.41	-0.01
Changes	0.28	0.14	0.02

It is clear that there is no strong negative correlation between the mean and skewness of inflation in retail, producer prices or wage inflation. It is well known that in small samples, skewness and kurtosis are difficult to distinguish (see, for example, Rae (1993)), so we also include mean/kurtosis correlations in the table: there is some evidence of a negative correlation here, but it is small and not robust. We include mean/standard deviation correlations for the following reason: if the correlation between the mean and standard deviation was perfect, and the standard deviation was of the same order of magnitude as the mean, then the downward nominal rigidity would yield constant positive skewness, since some prices would always come up against the downward floor to prices. This possibility reduces the power of our test, although we note that skewness does appear to vary over time and that the mean/standard deviation correlation is a great deal less than one.

Hall and Yates (1998) go on to test more formally for a relationship between the mean and skewness of price changes, using the concept of Granger-causality. We reproduce these results here, together with new results for UK earnings data. If downward nominal rigidity is a significant phenomenon, then we should not only see a significant negative causality, but this causality should run from mean inflation to skewness and not the other way round. In fact, as Tables E–G below show, we find nothing of the sort. In each table, we report the probability that the coefficients on the independent variable and its lags are jointly zero: a probability of less than 0.05 indicates that the hypothesis is rejected at the 5% level of significance.

Table E: Granger-causality tests for downward nominal rigidity: wages

Dependent variable	Independent variable	P	Sign of sum of coefficients on independent variable
skew	mean	0.62	+
mean	skew	0.06	-
kurt	mean	0.66	+
mean	kurt	0.12	+
Δskew	Δmean	0.87	+
Δmean	Δskew	0.03	-
Δkurt	Δmean	0.36	-
Δmean	Δkurt	0.04	+

Table F: Granger-causality tests for downward nominal rigidity: producer prices

Dependent variable	Independent variable	P	Sign of sum of coefficients on independent variable
skew	mean	0.91	+
mean	skew	0.66	-
kurt	mean	0.59	+
mean	kurt	0.92	+
Δskew	Δmean	0.87	-
Δmean	Δskew	0.71	+
Δkurt	Δmean	0.71	-
Δmean	Δkurt	0.89	+

Table G: Granger-causality tests for downward nominal rigidity: retail prices

Dependent variable	Independent variable	P	Sign of sum of coefficients on independent variable
skew	mean	0.24	+
mean	skew	0.10	-
kurt	mean	0.44	+
mean	kurt	0.29	-
Δskew	Δmean	0.33	+
Δmean	Δskew	0.08	_
Δkurt	Δmean	0.43	+
Δmean	Δkurt	0.29	-

These results are quite striking: in no case—for either retail/producer prices or wages—is there any *significant negative*

causality running from mean inflation to skewness. Formally, we can accept the hypothesis that the coefficients on mean inflation are insignificant in a regression of the skewness (or kurtosis) of inflation on its own lags, with a level of confidence greater than 80%. The closest we come to finding a result consistent with downward nominal rigidity is that we find evidence of negative causality running from the skewness to the mean of (i) the level and change in wages, and (ii) the change in retail prices. But the causality goes the wrong way for this to be evidence of downward nominal rigidity.

Hall and Yates (1998) report experiments testing for the impact of the level of aggregation used in the calculation of the moments of these distributions, the weighting procedures used to construct the inflation aggregates, and the sample period: they conclude that this central result is relatively robust. Rae (1993) comes to the same conclusion in his study of New Zealand consumer prices; Lebow *et al* (1992) conduct similar tests for the United States, and also find no evidence of downward nominal rigidities in US consumer prices. Crawford and Dupasquier (1994) also find no evidence of a negative relation between the average and skewness of wage inflation in Canada. In the appendix, we summarise the results from other work using Japanese data on wholesale prices and on wages, which show that there is also no sign of a significant negative correlation between the mean and skewness of wage or price inflation.[11]

A weakness of these studies, however, is that they are not based on data on individual prices and wages. The components of the distribution are either categories of goods or groups of wage-earners in industries. We might observe that wages in an industry as a whole do not change from period to period, when in fact the earnings of some in the industry rose, and the earnings of others fell. For these studies to capture the distribution of wages accurately requires that individual earnings within each industry are highly correlated.

Those studies that do use more disaggregated data have tended to find evidence of downward nominal rigidity. Card and Hyslop (1995) looked at how the distribution of nominal wage changes varied with inflation, using US data on individual earnings from the PSID. They measure the proportions of individuals affected by nominal wage rigidity by looking at the difference between

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(11) These results came out of (unpublished) joint work conducted with the help of Colin Ellis.

the actual distribution of wage changes about the mean, and one constructed by replacing the portion below the mean by the mirror image of the proportion above it. If there is no nominal rigidity, then these should be equal. Or more precisely, the difference between the two (those affected by nominal rigidity) should fall as inflation rises. This is indeed what Card and Hyslop found, although the practical importance of this result is weakened when we recall Card and Hyslop's own criticism of the data source that they used (the PSID) for excluding low-performing job-movers and perhaps biasing the results towards finding evidence of downward nominal rigidity. Using the same PSID data, Kahn (1997) notes that while the spike in the distribution of wage-earners gets larger as inflation falls, this is not the case for salary-earners: regressions of the asymmetry in the wage distribution on the median wage change in Lebow *et al* (1995) confirm this dichotomy.

Brown *et al* (1996) confirm these findings, using CBI manufacturing settlements data for the United Kingdom. They measure wages at the level of the bargaining group, and so include all individuals, low-performing or otherwise (although there may be other selection biases induced by studying only firms who are CBI members). However, the drawback of settlements data, as we have already noted, is that firms can, in practice, achieve nominal earnings flexibility by varying hours worked, or overtime rates, or holiday, or other benefits, or any number of variables that are not measured by Brown *et al*. An apparent downward rigidity in settlements may not imply that total earnings are rigid downwards, so this evidence is not inconsistent with there being no costs associated with moving to zero inflation.

Crawford and Harrison (1997) adopt a slightly different methodology (taken from Donald, Green and Paarsch (1995)), and model how the density at each point in the distribution varies with the inflation rate. They conclude that the predicted mass of settlements ranging from 0%–0.99% is greater at 2% inflation than at 6% inflation; the predicted mass of settlements at 1% is not appreciably different. So this work offers some evidence of downward nominal rigidity, although the drawbacks of using settlements data, discussed above, of course apply here.

A final study of the effects of inflation on the distribution of wage changes that uses 'individual' level data is that by Groshen and Schweitzer (1997). They report findings that inflation has both 'grease' (ie beneficial) and 'sand' (ie harmful) effects on the

wage distribution, based on evidence from a survey of wages carried out by the Federal Reserve Bank of Cleveland from 1927 onwards, in Cleveland, Cincinnati and Pittsburgh. They argue that the fact that inflation increases the standard deviation of wages across *employers* is evidence of a 'sand' effect, while that it simultaneously increases the standard deviation of wages across *occupations* is evidence of a 'grease' effect. My own view is that this interpretation is somewhat heroic. First, the 'grease' effect relies on the fact that the truncation of the earnings distribution at the lower end, brought about by downward nominal rigidity, leads to a truncation at the upper end of the distribution: this comes about as firms choose not to employ fewer at the going wage, but to offer lower wages to others instead. To begin with, there is no real evidence that this is indeed what happens (firms could just as well hire less of the labour for which they are paying inflexible wages). Next, if this mechanism operates at all, it will be observed by looking at the distribution of individual wages within a firm, not the distribution of wage changes across occupations: for the two to be equivalent requires that the occupational composition of firms is identical. Second, the observation that an increase in the dispersion of wages across employers is 'sand' and not also a kind of 'grease' is also controversial, and again relies on assuming that the occupational composition of firms is identical, which is almost certainly not the case in their study; moreover, if high inflation increases the variance of firm-specific demand shocks, this would necessitate a higher variance of wages in the short run, and would not indicate a labour market friction, but a successful signal. Groshen and Schweitzer (1997) did not look to see whether the asymmetry of wage changes across the distribution varied with the rate of inflation, although presumably their data would allow them to.

Table H summarises the evidence on how inflation affects the distribution of wages and prices. There is no unanimity on the question of downward nominal rigidities, and there are clearly problems in interpreting correlations between the moments of a distribution in the way that these studies do. But on the face of it, the evidence for downward nominal rigidity is unpersuasive, whether we are looking at Canada, the United States, New Zealand or the United Kingdom.

Table H: Evidence on nominal rigidity: the effect of inflation on the distribution of wages and prices

Source	Nature of data	Summary
Lebow et al (1992)	US retail prices	No negative correlation between skewness and mean inflation
Rae (1993)	New Zealand retail prices	No negative correlation between skewness and mean inflation
Crawford and Dupasquier (1994)	Canadian retail prices	No negative correlation between skewness and mean inflation
Card and Hyslop (1995)	Panel Study of Income Dynamics data (including earnings)	Inflation reduces the asymmetry between the upper and lower parts of the wage-change distribution
Lebow et al (1995)	As above—PSID	Correlation between asymmetry and inflation for wage-earners but not salary-earners
Brown et al (1996)	UK settlements data, manufacturing	Inflation reduces the asymmetry between the upper and lower parts of the settlements distribution
Crawford and Harrison (1997)	Canadian wage settlements data	Some evidence that the predicted number of settlement freezes is less than the actual number, at zero inflation. But depends on settlement definition
Groshen and Schweitzer (1997)	Federal Reserve Bank of Cleveland Community Salary Survey	Inflation reduces the standard deviation of wage changes across occupations and employers
Hall and Yates (1998) and this paper	United Kingdom: Retail, producer price and average earnings distributions	No negative correlation between skewness and mean inflation
This paper (appendix)	Japan: earnings and wholesale prices	No significant negative correlation between the skewness and mean of wage or price inflation
Smith (1998)	United Kingdom: gross pay of job-stayers in British Household Panel Study	No significant correlation between asymmetry and inflation

3(iii) Asymmetries in the response to shocks

One final broad type of evidence that can shed light on whether there are downward nominal rigidities or not is whether the economy as a whole, or individual industries, or even individual firms respond in the same way to upward demand or supply shocks as to downward shocks.

We have already touched on the surveys by Hall *et al* (1996) and Blinder (1991) and how they comment directly on the theories discussed so far, but there are other results in these surveys that are relevant to whether price cuts are more inhibited than price rises. Small and Yates (1998) use the responses to the Hall *et al* survey to analyse asymmetries in price responses to cost and demand shocks. They find that output prices are downwardly rigid in the face of cost shocks, but upwardly rigid in the face of demand shocks. Arden *et al* (1997) find that prices are quicker to respond to upward than downward shocks, using UK manufacturing prices. Buckle and Carlson (1998) use survey data on New Zealand firms and find that (at high rates of inflation) prices are more likely to respond to demand/cost increases than decreases.

Blinder's (1995) survey also offers very mixed support for theories of downward nominal rigidity. He found that firms take longer to change prices in response to falls in demand and costs than they do to respond to increases in demand and costs. But he also reports that 4.5% of firms prefer to increase prices (rather than production) in response to a rise in demand, while 27% of firms prefer to cut prices in response to a fall in demand.

Another literature that has emerged over the last ten years or so looks at whether output responds symmetrically to upward and downward shocks to money or prices. If there is downward nominal rigidity in wages, for example, then a downward shock to prices will reduce the demand for labour (because the real wage will rise), and output will fall; whereas an upward shock will have no (or at least a smaller) effect on employment or output. De Long and Summers (1988) and Cover (1992) showed that this asymmetry was present in the US data. Positive shocks to the money supply had no effect on output; negative shocks reduced output. Karras (1996) comes to the same conclusion when he looks at the effect of money-supply shocks on a panel of European data. On the other hand, Ravn and Sola (1995), who look at the effect of money-supply shocks on UK output only, find no evidence of asymmetry. Although *some* of these results

are consistent with there being downward nominal rigidity, they are not proof of it: De Long and Summers' work (which spawned the literature) was actually designed to test the 'credit channel' view of monetary policy, where monetary policy tightenings increase the probability of bankruptcy of those borrowing from banks, who then ration credit in order to protect their balance sheets, and in so doing affect real activity. If this is what explains the asymmetry, then there are no implications for the implicit long-term inflation target: a tightening of monetary policy would always have a greater impact on output, regardless of the inflation rate.

Yet another approach has been to estimate the sacrifice ratio—the amount of unemployment generated by (or output lost in) a disinflation of a given size—and to see whether this is higher at lower rates of inflation.[12] If there are downward nominal rigidities, then it could be that inducing a disinflation will lead to more firms coming up against the downward floor to money wages when inflation is lower, and therefore mean that the (temporary) cost in terms of unemployment is higher. Ball, Mankiw and Romer (1988), Ball (1993), and Yates and Chapple (1996) all find that the output-inflation trade-off is higher in countries (or during episodes) with lower rates of inflation. Once again, these results are consistent with, but not proof of, there being downward nominal rigidity: these particular pieces of work were actually designed to test menu cost theories of price-setting, which predict that the trade-off will increase at lower rates of inflation because firms change prices less frequently. If these kind of models do explain the real world, then the optimal inflation rate needs to balance the menu costs of price changes against the expected future cost of increased output variability.

The Ball, Ball *et al* and Yates and Chapple papers look at the correlation between the sacrifice ratio and inflation over a cross-section of countries. Another literature has sought to uncover evidence of non-linearities in the Phillips curve by estimating time-series relationships between inflation and growth, or inflation and unemployment. Certain types of non-linearity in these relationships might be consistent with downward nominal rigidity. For example, Clark *et al* (1996) posit that negative output gaps reduce inflation by less than

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(12) Note that the conventional view is that in the long run there will be no impact on output or unemployment, so here we are really talking about whether the downward nominal rigidity increases the short-run cost of disinflation.

positive output gaps increase it. That could be because negative output gaps do not have the same impact on nominal wages, because of a floor to nominal wages, as positive output gaps do; this in turn would have a short-run effect on inflation (although in the long run, inflation would be determined by monetary policy). Alternatively, we could invert the Phillips curve so that the output gap was on the left-hand side, and posit that negative changes in inflation are more likely to push desired wage changes against the zero constraint, and therefore imply larger shifts in the output gap.

The evidence for non-linearity in the Phillips curve is decidedly mixed. Clark *et al* (1996), using quarterly data from 1964–1990, find that the US inflation-output relationship is non-linear. Laxton *et al* (1995) find, by pooling data from the major seven OECD countries, that the inflation-output trade-off is also non-linear. Debelle and Laxton (1996) find that the unemployment-inflation trade-off is non-linear in the United Kingdom (and in the United States and Canada); Fisher *et al* (1996) also find that the Phillips curve that best fits UK data embodies a mild asymmetry, although they do not test formally to see if the linear restriction is accepted. Laxton *et al* (1997) re-examine the US data and conclude that a mild asymmetry fits the data a little better than a line or model, and note that classical hypothesis tests will be biased towards the linear model. Fillion and Leonard (1997) find evidence of a significant, but, as they warn, imprecise asymmetry in the Canadian Phillips curve. Dupasquier and Ricketts (1997) conduct two tests. First, they look at the correlation between the output gap (squared) and forecast errors from a linear model of inflation: they find no significant correlation for Canada, but the results are consistent with convexity for the United States. Second, they look at the sacrifice ratio and how it varies over inflation states, modelled as a Markov switching process. Using this method, there appears to be no significant state-variation in the trade-off for the United States; for Canada, whether there is or not depends on the output gap measure used. But Turner (1995) looks at each of the OECD countries in turn and finds that the Phillips curve is non-linear in only three of these economies: the United States, Japan and Canada. He finds that the UK Phillips curve is not significantly different from a linear one. Moreover, Gordon (1996a) in a comment on Akerlof *et al* asserts that from his own work that he thinks that 'the Phillips curve is resolutely linear [in the United States]'(page 64). Eisner (1998) has argued that the US Phillips curve is non-linear; but contrary to other authors, he finds the Phillips curve to be steeper at lower rates of inflation (ie that a

disinflation costs less at lower inflation rates) not less steep. And Bean (1996) finds only very weak support for any non-linearity in the Phillips curve for the United Kingdom. Finally, Kimura and Ueda (1997) estimate industry Phillips curves in nominal wages, and conclude that wages are not asymmetrically responsive to shocks in different directions.

The findings differ according to the countries covered, the frequency and length of time-series covered, and the method used to measure the output or unemployment gap.

I present further evidence on the linearity or otherwise of the UK Phillips curve, following the methodology of Clark *et al* (1996), in the hope of resolving—but at the risk of merely adding to—the controversy. I estimate equations (**1**) and (**2**) below. The first is taken from Clark *et al* (1996):

$$\pi_t = \alpha.\pi_{t-1} + (1-\alpha).\pi_t^e + \beta.(y_t - y^* + \gamma) + \delta.[(y_t - y^* + \gamma) > 0] \quad \textbf{(1)}$$

$$\pi_t = \alpha.\pi_{t-1} + (1-\alpha).\pi_t^e + \beta.(y_t - y^* + \gamma) + \delta.(y_t - y^* + \gamma)^2 \quad \textbf{(2)}$$

where π_t is the annual inflation rate, π^e are expectations of inflation formed at time *t*, and $y_t - y^*$ is the output (or unemployment) gap and α, β, γ and δ are all parameters. Equation **(1)** assumes that the Phillips curve is 'kinked': that positive output gaps raise inflation by more than negative output gaps lower it. To capture this effect, the term $(y - y^* + \gamma) > 0$ takes the value zero when the output gap is negative, and equals the output gap itself otherwise. Equation **(2)** assumes that the inflation process is quadratic. The effect of adding the squared term is simply to reduce the impact of a negative output gap shock on inflation, relative to the impact of a positive output gap. How can we explain the parameter γ ? This is set out by Clark *et al* (1996). The intuition is that if the Phillips curve is not linear—if, as in Equations **(1)** and **(2)**, positive gaps raise inflation by more than negative gaps lower it—and the authorities' inflation target is constant over time, the economy would have to operate with a *true* output gap on

average less than zero. Yet the measured output gap ($y - y^*$)—in our case moving averages of actual output—is constructed to average at zero. Some correction is therefore needed to our measured output gap. Clark *et al* show this formally, using **(2)** above.[13]

In common with Clark *et al*, I impose the restriction that the coefficients on expected and lagged inflation sum to unity, so that in the long run there is no trade-off between inflation and the output gap.

In both cases, I proxy inflation expectations using the yields on five-year Government bonds. This is clearly not an ideal

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(13) Suppose that $\alpha = 0$ and the actual output gap is the true measured output gap. We can derive an expression for the expected value of the output gap as follows: we have first that

$$\pi_t = \pi_t^e + \beta(y_t - y^*) + \lambda(y_t - y^*)^2$$

and taking expectations of both sides, we have that:

$$E[\pi_t] = E[\pi^e] + \beta E[y_t - y^*] + \lambda E[(y_t - y^*)^2]$$

If we examine an equilibrium where expectations of inflation are, on average, correct, ie that

$$E[\pi_t] = E[\pi^e]$$

then we have that:

$$\beta E[y_t - y^*] + \lambda E[(y_t - y^*)^2] = 0$$

And, substituting in the definition of the variance of $y_t - y^*$, we therefore have that:

$$\beta E[y_t - y^*] + \lambda(\text{var}(y_t - y^*) + E[(y_t - y^*)^2]) = 0$$

Or that

$$E[y_t - y^*] = -\frac{\lambda}{\beta}(\text{var}(y_t - y^*) + E[(y_t - y^*)^2])$$

In other words, the average output gap, provided that there is some convexity in the Phillips curve (ie that $\lambda > 0$), will depend on the variance of the gap, which will in turn depend on the variance of the stochastic forces disturbing the economy, and on policy itself.

measure: bond yields will vary not only with inflation expectations, but also with the real interest rate, which in turn will include potentially time-varying term, liquidity and even inflation premia. Clark *et al* use an estimated real interest rate to strip out this component, but I feel there is not much to be gained here, particularly since estimation will be complicated by using generated regressors. To the extent that bond yields do measure inflation expectations, they will be moving averages of inflation expectations (and real returns), which could, in principle, cause other econometric problems that I do not address here. There are index-linked bonds in the United Kingdom that give a measure of real yields, and hence of inflation expectations, but the time series is too short for my purposes; for the same reason, I opt not to use survey data on inflation expectations.

I use several different measures of the output/unemployment gap. For output itself, I take the difference between actual output and a number of centred moving averages of output (with windows from 9 to 25 quarters, in common with Clark *et al*). For unemployment, I take these same moving averages, but add other measures derived from unemployment natural rates constructed by Saleheen and Westaway (1997). These include: a measure of the NAIRU derived from a Layard-Nickel wage/price system, which we have called the 'structural' unemployment gap; and a natural rate derived from a Hodrick-Prescott filter of actual unemployment (with a smoothing parameter k equal to the (arbitrarily) popular value of 1600). These other NAIRU measures are all derived from linear estimation methods, so I estimate a correction to the unemployment gap y in the same way as for the equations estimated using unemployment gaps calculated from moving averages.

All parameters are estimated simultaneously, using non-linear least squares. That means that degrees of freedom are scarce, and so the equations are estimated with as parsimonious a lag structure as possible to improve the chances of the models inverting.

The results are shown in Tables J-M.

Table I: Non-linear kinked Phillips curve for the United Kingdom using an output gap

$$\Pi_t = \alpha \Pi_{t-1} + (1-\alpha)\Pi^e + \beta(gap+\gamma) + \delta(gap+\gamma > 0) \quad \textbf{(1)}$$

Moving average window (in quarters)	α	β	γ	δ
25	0.94 (32.17)	0.26 (2.09)	-0.002 (-0.28)	-0.05 (-0.24)
23	0.94 (32.07)	0.22 (2.15)	-0.005 (-.20)	-0.04 (-0.20)
21	0.95 (31.98)	0.22 (2.15)	-0.006 (-.75)	0.09 (0.4)
19	0.94 (32.04)	0.22 (2.10)	-0.06 (-7.5)	0.09 (0.43)
17	0.95 (32.21)	0.26 (2.14)	-0.004 (-0.64)	0.10 (0.40)
15	0.95 (32.22)	0.29 (2.17)	-0.004 (-0.65)	0.11 (0.41)
13	0.95 (32.27)	0.30 (2.13)	-0.004 (-0.72)	0.14 (0.49)
11	0.95 (32.10)	0.28 (1.93)	-0.004 (-0.75)	0.19 (0.6)
9	0.95 (32.70)	0.23 (1.44)	-0.003 (-0.61)	0.27 (0.75)

(T-ratios in brackets)

Table J: Non-linear kinked Phillips curve for the United Kingdom using an unemployment gap

$$\Pi_t = \alpha \Pi_{t-1} + (1-\alpha)\Pi^e + \beta(gap+\gamma) + \delta(gap+\gamma>0) \quad \textbf{(1)}$$

Moving average window (in quarters)	α	β	γ	δ
25	0.90 (27.69)	-0.37 (-1.73)	0.002 (0.40)	-0.38 (-0.82)
23	0.91 (28.27)	-0.41 (-1.79)	0.001 (0.41)	-0.37 (-0.77)
21	0.91 (28.82)	-0.46 (-1.90)	0.001 (0.3)	-0.43 (-0.85)
19	0.89 (27.87)	-0.59 (-2.08)	-0.002 (-0.57)	-0.27 (-0.51)
17	0.90 (26.65)	-0.62 (-2.08)	0.0005 (0.22)	-0.57 (-0.91)
15	0.90 (30.41)	-0.74 (-2.17)	0.0003 (0.19)	-0.70 (-0.95)
13	0.91 (31.03)	-0.90 (-2.17)	0.0004 (0.27)	-0.86 (-1.00)
11	0.91 (31.54)	-1.08 (-2.13)	0.0002 (0.19)	-1.27 (-1.17)
9	0.91 (31.14)	-1.35 (-1.97)	0.0001 (0.11)	-1.74 (-1.17)
Structural NAIRU	0.92 (30.67)	-0.17 (-1.49)	-0.005 (-1.53)	-0.78 (-1.57)
Univariate NAIRU	0.92 (32.08)	-0.71 (-1.78)	0.004 (0.19)	-0.32 (-0.47)

(T-ratios in brackets)

Table K: Non-linear quadratic Phillips curve for the United Kingdom using an output gap

$$\Pi_t = \alpha \Pi_{t-1} + (1-\alpha)\Pi^e + \beta(gap+\gamma) + \delta(gap+\gamma)^2 \quad \textbf{(2)}$$

Moving average window (in quarters)	α	β	γ	δ
25	0.95 (32.07)	0.24 (3.96)	-0.004 (-0.60)	0.02 (0.010)
23	0.94 (31.97)	0.24 (3.94)	-0.005 (-0.78)	0.92 (0.35)
21	0.94 (31.91)	0.26 (3.90)	-0.006 (0.97)	1.907 (0.67)
19	0.94 (31.85)	0.27 (3.90)	-0.06 (-9.62)	2.21 (0.79)
17	0.94 (31.94)	10.31 (3.96)	-0.005 (-1.00)	2.69 (0.76)
15	0.94 (32.09)	0.34 (3.98)	-0.005 (-0.99)	2.90 (0.73)
13	0.94 (32.18)	0.36 (3.87)	-0.004 (-1.07)	3.71 (0.81)
11	0.94 (31.93)	0.38 (3.50)	-0.006 (-1.32)	6.01 (1.14)
9	0.92 (31.87)	0.42 (3.13)	-0.007 (-1.83)	11.51 (1.84)

(T-ratios in brackets)

Table L: Non-linear quadratic Phillips curve for the United Kingdom using an unemployment gap

$$\Pi_t = \alpha \Pi_{t-1} + (1-\alpha)\Pi^e + \beta(gap+\gamma) + \delta(gap+\gamma)^2 \quad \textbf{(2)}$$

Moving average unemployment gap (window in quarters)	α	β	γ	δ
25	0.90 (27.48)	-0.59 (-3.30)	0.001 (0.40)	-13.17 (-1.18)
23	0.91 (28.02)	-0.62 (-3.43)	0.001 (0.44)	-13.10 (-1.03)
21	0.91 (28.52)	-0.70 (-3.52)	0.001 (0.37)	-16.21 (-1.06)
19	0.89 (27.65)	-0.73 (-4.51)	-0.001 (-0.45)	-5.79 (-0.37)
17	0.90 (29.47)	-0.97 (-3.61)	0.0003 (0.20)	-30.08 (-1.21)
15	0.90 (30.21)	-1.17 (-3.72)	0.0003 (0.19)	-42.79 (-1.27)
13	0.91 (30.91)	-1.45 (-3.85)	0.0002 (0.21)	-65.77 (-1.38)
11	0.91 (31.21)	-1.87 (-3.94)	0.0002 (0.17)	-113.3 (-1.56)
9	0.91 (31.34)	-2.44 (-3.87)	0.00004 (0.05)	-208.84 (-1.69)
Structural NAIRU	0.91 (30.24)	-0.42 (-2.73)	0.0003 (0.09)	-9.76 (-1.18)
Univariate NAIRU	0.92 (31.85)	-0.88 (-4.05)	0.0008 (0.42)	-9.41 (-0.32)

(T-ratios in brackets)

First, it is clear that the 'traditional' Phillips curve coefficient β (the coefficient on the linear term in the output gap) is not particularly strong, and in some cases, particularly in the models using the unemployment gap, is only marginally (if at all) significant. This is to be expected with UK data: it is common for the structures that are embedded in Phillips curves like this to be quite badly determined. Second, note that in all bar two of the estimated equations, γ, the amount by which the average output gap differs from zero, is insignificant at the 5% level (the exceptions being the models using a 19-quarter centred moving average of output to derive the output gap). This cannot by itself tell us whether the Phillips curve is non-linear: the authorities could, for example, have had a reaction function that allowed inflation to rise and the output gap to average zero even if there was a convex Phillips curve. But note finally that the coefficients on δ, the coefficient on the kinked output gap in Equation **(1)** and the squared output gap in Equation **(2)** are almost always insignificant. The only exception to this is the value of δ that comes from estimating the equation with a quadratic term in the output gap, using a nine-quarter moving average of actual output to generate the output gap: here the t-ratio is 1.84.

The results are not conclusive. First, they proved quite sensitive to the choice of initial values for parameters. (This is to be expected with data where even a linear model would be quite badly determined.) Second, I have not experimented with other measures of inflation expectations. Third, to improve the chances of convergence, I estimated parsimonious models with perhaps unreasonably restrictive dynamics. Fourth, there are an infinity of other non-linear functional forms that I could have taken to the data. Fifth, as Laxton *et al* (1997) point out, in an economy where cycles in inflation are relatively modest, it may be hard to uncover a statistical convexity even if the underlying economy possesses one. Nevertheless, these results are indicative and suggest that the case for there being a non-linearity in the UK Phillips curve is not particularly strong.

This is additional, if slight, evidence against there being downward nominal rigidities in product or labour markets. But even if there were a non-linearity in the United Kingdom, such a finding would only be consistent with, not proof of there being, downward nominal rigidities in an economy. Other explanations abound. For example, Debelle and Laxton (1996) motivate their non-linear Phillips curve by arguing that 'as the unemployment rate falls below the NAIRU, bottlenecks start to develop which

result in further increases in demand having even larger inflationary consequences'(page 8): the idea being that, in the very short run, capacity is fixed, or at least prohibitively costly to expand.

One telling criticism of all these pieces of evidence is that they do not study economies experiencing periods of falling prices or even price stability (perhaps with the exception of the evidence we have presented on Japan). It remains to test formally Gordon's (1996a) remark that 'one can take the entire post-Civil War era of deflation as evidence that prosperity and rapid economic growth are compatible with *falling* prices, not to mention *constant* prices' (page 66).

I go some way towards addressing the first of these criticisms. I estimate Phillips curves on annual data from 1800–1938 for Denmark, France, Italy, Sweden, the United Kingdom and the United States.(14) I look to see whether the slope of the Phillips curve varies according to whether prices are rising or falling. I estimate a system of seemingly unrelated regressions of the following form:

$$\pi = \alpha + \beta\pi_{t-1} + \gamma\pi_{t-2} + \delta_0\pi^+.gap + \delta_1\pi^+.gap_{t-1} + \delta_2\pi^+.gap_{t-2} + \varphi_0\pi^-.gap + \varphi_1\pi^-.gap_{t-1} + \varphi_2\pi^-.gap_{t-2} \quad \textbf{(3)}$$

where π^+ is a dummy variable that takes the value 1 when inflation is positive, and 0 otherwise, while π^- takes the value 1 when inflation is falling, and zero otherwise. Note that there were no satisfactory proxies for inflation expectations available for 1800–1938, and so lags of inflation are used to capture shifts in the curve due to expectational effects! In all cases, the output gap used was derived from a Hodrick-Prescott filter of actual output with a smoothing parameter set equal to 1600. The estimated equations are shown in Table M.

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(14) The data are taken from Mitchell (1993). Time series vary from country to country as follows: United States (1800–1938); United Kingdom (1830–1938); Italy (1861–1938); Sweden (1864–1938); Denmark (1818–1938); France (1830–1938). I am grateful for some insightful conversations with Andrew Haldane, out of which came the idea for this exercise.

Equation **(3)** allows us to test whether the coefficients on the output gaps and its lags are equal in periods of rising or falling prices: if they are, this would be consistent with there being no downward nominal rigidities.

Table N shows that many of the Phillips curves are quite badly determined, with few significant coefficients. This could be telling us something about the determination of pre World War II inflation, or simply about the hazards of using such old data. Note that I do not impose long-run neutrality on the system. Although theoretically preferable, the restriction is not accepted by the data, and by imposing it, the fit of the equations would be reduced and standard errors larger, loading the dice against finding significant differences between the Phillips relation in times of rising and falling prices. I test for downward nominal rigidities by examining the coefficients on the output gaps when prices are rising and when they are falling. Table O below presents these tests, formally of:

$$H_0: \delta_0 + \delta_1 + \delta_2 = \varphi_0 + \varphi_1 + \varphi_2 \qquad \textbf{(4)}$$

In other words, the test is whether the sum of the coefficients on the lags of the output gap terms when inflation is negative equals the sum of the coefficients on the output gap terms when inflation is positive. I perform the test separately for each country, and then jointly for all countries.

Table M: Testing to see if the output gap coefficient in the Phillips curve (3) is the same whether prices are rising or falling

$H_0: \delta_0 + \delta_1 + \delta_2 = \varphi_0 + \varphi_1 + \varphi_2$ **(4)**

	p-value
Sweden	0.44
United Kingdom	0.31
Italy	0.45
United States	0.31
Denmark	0.93
France	0.67
All countries together	**0.78**

Table N: ‘Seemingly unrelated’ Phillips curves: dummies for rising and falling prices

	α	π_{-1}	π_{-2}	rise*gap	rise*gap$_{-1}$	rise*gap$_{-2}$	fall*gap	fall*gap$_{-1}$	fall*gap$_{-2}$
Sweden	0.00	0.60	-0.23	-0.61	0.73	0.02	0.00	0.23	0.14
	(0.54)	(6.54)	(-2.63)	(-2.76)	(2.52)	(0.09)	(-0.02)	(0.66)	(0.53)
United Kingdom	0.01	0.14	0.05	0.26	0.12	0.30	0.44	-0.09	0.13
	(1.45)	(1.68)	(0.54)	(1.77)	(0.55)	(1.74)	(2.82)	(-0.50)	(0.83)
Italy	0.01	0.47	-0.08	-0.17	-0.30	0.05	0.07	-0.20	0.08
	(1.63)	(4.60)	(-0.70)	(-0.62)	(-0.90)	(0.17)	(0.16)	(-0.49)	(0.17)
United States	0.00	0.23	-0.03	-0.44	0.24	0.11	-0.07	0.33	-0.21
	(0.24)	(3.04)	(-0.39)	(-2.85)	(1.11)	(0.72)	(-0.47)	(1.66)	(-1.42)
Denmark	0.00	0.39	-0.12	-0.39	0.58	-0.08	-0.41	0.87	-0.33
	(0.82)	(4.63)	(-1.45)	(-1.74)	(2.36)	(-0.42)	(-1.45)	(2.30)	(-0.89)
France	0.01	0.27	-0.01	-0.22	0.18	-0.01	-0.11	0.07	0.13
	(1.30)	(3.24)	(-0.06)	(-1.13)	(0.78)	(-0.06)	(-0.51)	(0.30)	(0.56)

We can see from Table N above that all countries easily accept the hypothesis that the π^+ and π^- coefficients are equal, as shown by the high p-values. Moreover, the joint test that these coefficients are equal in all countries is accepted, with a p-value of 0.78. (We would need a p-value of less than 0.05 to reject at the 5% significance level).

Table O summarises evidence on whether there or not there is a kink in the Phillips curve that could indicate downward nominal rigidity. Taking stock, the evidence for convexities in Phillips curves is rather mixed; such as there is points to convexity being weaker in the United Kingdom than elsewhere. We need to be wary of the econometric problems mentioned: of measuring inflation expectations, and of constructing an output gap that is consistent with convexities. And we also need to be mindful of Clark *et al*'s (1996) point that recent history may have been such that any convexity in the economy is masked in the data. However, it is also worth restating that even if we decide that the existing evidence does point to the Phillips curve being convex, such convexity is only consistent with, and not proof of, the existence of downward nominal rigidities: it is therefore not *prima facie* evidence in favour of positive inflation.

Table O: Evidence on non-linearities in the Phillips curve

Authors	Country, time period, frequency	Method	Measures of output gap and expectations	Conclusion
Evans (1992)	United States, quarterly, 1953-91	SVAR with time-varying parameters	Output gap and inflation expectations system–determined	Trade-off higher at low rates of inflation
Laxton *et al* (1995)	Pooled sampled major 7 OECD countries, annual, 1967-1991	Cubic, quadratic, fractional functional forms, pooled estimation	HP-filtered output gap; proxy of inflation expectations based on lagged values of inflation and other variables	Linear model rejected by the data
Turner (1995)	OECD, annual data, early 1960s to 1994 approximately	Kinked functional form	HP-filtered output gap, lagged inflation used instead of expectations	Linear model preferred for the United Kingdom; Phillips curve is non-linear in the United States, Japan and Canada
Clark *et al* (1996)	United States, 1964q1-1990q4, quarterly	Kinked functional form	Moving average output gap, survey inflation expectations	Significant non-linearity
Bean (1996)	OECD, sample period varies from 1951/1983-1992, annual	Pooled estimation, no correction for convexity in measurement of output gap; quadratic and exponential functional forms	Transform of capacity utilisation measure of output gap, lagged inflation proxy for inflation expectations	Mild non-linearity but not significant at 10% level
Debelle and Laxton (1996)	United States, Canada, United Kingdom, 1971 q2-1995 q2, quarterly	Fractional functional form	Unemployment gap, bond market inflation expectations	No nested test, but argue that nonlinear model fits data better under certain restrictions on the volatility of the NAIRU
Gordon (1996b)	United States quarterly, 1955-96	Kinked functional form	Lagged inflation proxy for inflation expectations; time-varying NAIRU estimated jointly with Phillips curve	No significant non-linearity
Fisher *et al* (1996)	United Kingdom, 1977 q1-1995 q1, quarterly	Exponential functional form	Production function output gap, survey inflation expectations	Asymmetric Phillips curve fits the data better, but no nested test
Fillion and Leonard (1997)	Canada, 1968 q4-1994 q4, quarterly	Not known	Not known	Significant but imprecise asymmetry
Dupasquier and Ricketts (1997)	Canada, United States, quarterly, 1963-1995	(i) correlation of errors from linear model with the output gaps (ii) correlation of trade-off with Maskeov inflation states	Multivariate filters/SVAR output gaps; lagged inflation and Kalmar Filter inflation expectations	Method (i) linear for Canada, non-linear for United States Method (ii) opposite to (i) above
Kimura and Ueda (1997)	Japan, industry data, quarterly from 1976-95	Kinked functional form for each industry	Actual unemployment, inflation proxy for expectations	No downward nominal rigidity in wages
Laxton *et al* (1997)	United States, quarterly, 1968 q1-1997 q1	Fractional functional form, Kalmar Filter; and estimation of Phillips curve and NAIRU	Michigan Survey expectations	Mild asymmetry fits the data better
Eisner (1998)	United States, quarterly, 1956-94	Kinked functional form	Moving average of unemployment; lagged inflation proxy for expectations	Phillips curve is non-linear, but the curvature is opposite to that suggested by other papers, ie concave, not convex
This paper	United Kingdom, 1966 q1-1994 q4, quarterly	Kinked and quadratic functional form, model consistent output gap	Moving average output and unemployment gaps, filters, bond market expectations	No significant non-linearity
This paper	United Kingdom, United States, Sweden, France, Italy, Denmark, sample varies from 1800-1938, annual data	Kinked functional form, SURE estimation	Moving average output gap	No significant non-linearity

This completes Section 3: my review of the various types of evidence on downward nominal rigidity. To sum up: price and wage cuts are quite frequent in the United Kingdom. At a glance, this would suggest that downward nominal rigidity is not a problem. However, we cannot rule out that there have been fewer such cuts than were warranted by economic conditions. Evidence on how the skewness of prices and wages evolves as mean price or wage inflation changes is, on balance, indicative that there are no significant downward nominal rigidities. However, this evidence too should be treated with caution as, for a variety of reasons, it does not offer us a powerful statistical test of our hypothesis. Survey evidence (from the Bank's price-setting survey) showed that prices were upwardly rigid in response to some phenomena and downwardly rigid in response to others. Evidence based on macroeconomic time series was similarly equivocal: there is not a strong case for arguing that the UK Phillips curve is convex, and anyway any such convexity would not necessarily prove that there were downward nominal rigidities.

This final point is important, and should colour our interpretation of the evidence we have seen, for we do have theories that predict that at positive rates of inflation, there could be an apparent downward nominal rigidity that would disappear in a zero-inflation environment. For example, Ball and Mankiw (1995) present a model in which firms change prices costlessly at specific intervals, and can change prices if they pay a menu cost between these intervals; whether they find it worthwhile to do so depends on whether the desired price moves outside some upper and lower tolerance bounds. With positive inflation, and symmetric shocks to relative desired prices, a firm is more likely to find it worthwhile to make occasional upward rather than downward adjustments to prices, as the passage of time will have caused the desired price to drift closer to the upper tolerance bound than the lower tolerance bound. At zero inflation, however, this apparent asymmetry would disappear. Another example is offered by MacLeod and Malcomson (1993), who present a model where nominal wages are negotiated between the employer and employee; the wage is then fixed until one party decides to re-open negotiations. Because of the costs of finding another job for the employee and the costs of finding another person to fill the vacancy, there is a gap between the lowest wage the employee would tolerate before leaving and the highest wage that the employer would pay before looking elsewhere. This gap means that negotiations over the wage, even if the outside options are rising (which they will in a world of rising prices and increasing productivity), will not re-open until the current wage hits one of these 'boundaries', at which

point it will track the lowest wage tolerated by the worker, dictated by the state of the cycle, until it flattens out again. So in a world most like the real one, when the outside options rise roughly in line with productivity plus prices (in logs), the wage will be flat for a period of time and then be buffeted up by cyclical shocks, but rarely buffeted down by downward cyclical shocks. In other words, it will look as if there is an asymmetry even when there is not, or more precisely, the response of nominal wages to shocks will be asymmetric when inflation is positive, but less so when inflation is zero (and symmetric if there is no trend in productivity).

In short, there are two broad reasons for being cautious about our evidence on downward nominal rigidities. First, genuine models of downward nominal rigidity tell us that at high rates of inflation, the rigidity might not bite (this after, all, is the justification for positive inflation), so finding that there are no such rigidities may not be conclusive proof that the theories are not valid. Second, evidence of convexities is consistent with models of apparent downward nominal rigidity at high rates of inflation, which need not imply that there would be any adverse consequences from a move to price stability.

4 Conclusions: downward nominal rigidities and monetary policy

This paper has examined the theoretical and empirical evidence on downward nominal rigidities. It remains to draw together what the evidence implies for the design of monetary policy.

In discussing the theory, I argued that there might be grounds for targeting positive inflation if the labour market were described by the following:

(i) a concern for fairness, real-wage rigidity plus *either*

- (a) union cartels
- (b) no information about outside wage settlements, or
- (c) extreme dislike of 'going first' in the wage round,

and/or

(ii) money-illusion, loss aversion *and* real-wage stickiness.

The conclusion was that if zero inflation acted to undermine union cartels—if such things exist in a meaningful sense—this would yield a positive benefit for the economy. As an argument for positive inflation, therefore, (i) rests on there being a genuine concern over relative wages, plus either no information about outside wage settlements or an extreme dislike of 'going first'. No strong evidence of any of these behaviours presents itself. Turning to (ii), real-wage stickiness is a plausible enough phenomenon (and must contribute to an explanation of unemployment); loss aversion appears to be consistent with experimental evidence; money-illusion seems to be equally so, but what is less convincing is the idea that individuals would continue in the long run to equate nominal changes to real changes, if the inflation rate was set high enough to ensure that negative labour demand shocks never required changes to real wages large enough to warrant a nominal wage cut. The case is weakened significantly when we observe—as did King (1997)—that labour productivity is trended upwards: provided that shocks to the demand for labour in any one year cause changes in firms' wage offers that do not exceed annual productivity growth, there need be no call at all for positive inflation.

The discussion of product market phenomena suggested three possibilities for arguing for positive inflation:

(i) Price cuts would confuse customers used to an era of positive inflation (a form of money-illusion).
(ii) Price cuts signal quality cuts (and buyers are subject to money-illusion).
(iii) Firm cartels could lead to prices being sticky downwards.

We could uncontroversially put aside (i) on the grounds that customers would, in the long run, adjust to price stability and that there are anyway many price cuts at today's inflation rate. Argument (iii) actually predicts a possible benefit of price stability, namely, as in the labour market case, that of undermining product market cartels. The case for positive inflation therefore rests on the significance of the 'price means quality' argument, about which we remain agnostic.

Turning to the evidence presented, we observed that:

(i) there is little or no significant evidence of downward nominal rigidity in prices or wages based on observations on how the distributions of prices and wages evolve over time; and

(ii) there is no evidence of a significant non-linearity in the Phillips curve in the United Kingdom.

Both (i) and (ii) are weakened by accepting that evidence collected during a period of positive inflation may not be proof against there being downward nominal rigidities that would bite if the economy moved to literal price stability. Nevertheless, since we also have theories that predict that at positive rates of inflation there can be apparent downward nominal rigidities that disappear at zero inflation, we can be equally sceptical of researchers who use reduced-form evidence that does show some significant convexity in the economy as an argument for positive inflation.

A fair conclusion would therefore be as follows: that the case for positive inflation based on there being downward nominal rigidities is theoretically unconvincing and, as far as the evidence goes, is at best 'not proven' and at worst unpersuasive. It is possible to find grounds on which to argue that the optimal inflation rate for the United Kingdom is above zero: for example, measurement problems in the RPI (Cunningham (1996)); the constraint that if nominal interest rates cannot fall below zero inflation allows real cuts in interest rates (Summers (1991)). But downward nominal rigidity does not seem to be one of them.

Appendix: Downward nominal wage rigidity in Japan

This appendix details tests for downward nominal wage rigidity in Japan, based on work I did with the assistance of Colin Ellis, whose efforts I gratefully acknowledge. The motivation for the tests is set out in the main text. The data are for wholesale price indices, and two measures of wages by industry, taken from the 'Maikin' and 'Chinko' surveys. All data are annual and run from 1971 to 1995. The Maikin survey is a monthly survey of around 33,000 establishments in Japan. The Chinko survey is an annual survey of around 70,000 such establishments. Following the methodology set out in Hall and Yates (1998), we looked at the correlation between the mean of these distributions and their skewness.

Table A1: Downward nominal rigidity in Japan: correlation coefficients between mean inflation and the other moments

	Skewness	Standard deviation	Kurtosis
Wholesale prices, 12-month changes			
Levels	0.191	0.860	-0.054
Changes	-0.205	0.367	-0.251
Maikin wages, 12-month changes			
Levels	-0.084	0.730	-0.072
Changes	-0.088	0.383	-0.194
Chinko wages, 12-month changes			
Levels	-0.080	0.567	0.259
Changes	-0.362	0.182	0.125

Table A2: Granger-causality tests for downward nominal rigidity in Japan: wholesale prices

Dependent variable	Independent variable	P	Sign of sum of coefficients on independent variable
skew	mean	0.41	+
mean	skew	0.64	+
kurt	mean	0.50	+
mean	kurt	0.91	-
Δskew	Δmean	0.62	-
Δmean	Δskew	0.63	-
Δkurt	Δmean	0.03	+
Δmean	Δkurt	0.77	-

Table A3: Granger-causality tests for downward nominal rigidity in Japan: Maikin wages

Dependent variable	Independent variable	P	Sign of sum of coefficients on independent variable
skew	mean	0.33	-
mean	skew	0.09	-
kurt	mean	0.34	+
mean	kurt	0.29	-
Δskew	Δmean	0.42	-
Δmean	Δskew	0.05	-
Δkurt	Δmean	0.54	+
Δmean	Δkurt	0.26	_

Table A4: Granger-causality tests for downward nominal rigidity in Japan: Chinko wages

Dependent variable	Independent variable	P	Sign of sum of coefficients on independent variable
skew	mean	0.30	+
mean	skew	0.44	+
mean	kurt	0.27	+
kurt	mean	0.48	+
Δskew	Δmean	0.16	-
Δmean	Δskew	0.79	_
Δkurt	Δmean	0.38	-
Δmean	Δkurt	0.10	-

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