What Determines The Short-Run Output-Inflation Trade-Off?

Anthony Yates
Bank of England

Bryan Chapple
*Department of Labour, New Zealand**

* The paper was based on research done while working at the Bank of England.

The authors would like to Andrew Brigden, Timothy Ridge and Kay Taylor for research assistance; Kerry Faulkner and Karen Adams for typing; and, for helpful comments received: Francis Breedon, Clive Briault, Andrew Haldane, Jennifer Smith and Glenn Hoggarth. We would also like to thank the anonymous referee for comments and guidance. Any errors remaining are our own. The views expressed in this paper are those of the authors and not those of either the Bank of England or the Department of Labour in New Zealand.

Issued by the Bank of England, London, EC2R 8AH to which requests for individual copies should be addressed: envelopes should be marked for the attention of the Publications Group. (Telephone: 0171-601 4030.)

Bank of England 1996
ISSN 0142-6753

Contents

Abstract

This paper examines the robustness of the findings of Ball, Mankiw and Romer (1988) that the inflation-output trade-off is higher at lower rates of inflation. Using a cross-section of 43 countries we find that this result is indeed quite robust to a number of different experiments. We also use this data to infer whether faster disinflations are more or less costly than slow ones. We find that 'gradualism', or slow disinflation, does not pay, in common with other research in the literature.

1 Introduction

The commitment to price stability is based on the premise that in the long run there are no permanent output gains to be had by inflating the price level and that inflation may in fact impose real costs on the economy. This premise is no longer controversial.[1] What is less clear is how an economy should approach price stability and what factors determine the costs of doing so.

This paper examines two propositions. First, is it the case that reducing inflation costs more, in the short run, at lower rates of inflation? Second, does it make any difference how fast the economy approaches price stability? Theory offers conflicting answers to these questions; this paper aims to test for robustness some evidence offered by Ball, Mankiw and Romer (1988)[2] that tries to distinguish between different theories of the real effects (or otherwise) of monetary policy. We explore the correlation between a measure of the output-inflation trade-off and the level of inflation itself in a sample of 43 countries. We also extend the BMR framework to infer whether short-run output costs vary according to the speed of change of inflation.

(1) See, for example, Briault (1995).
(2) Hereafter BMR.

2 Theory

2.1 Theory: inflation and the output-inflation trade-off

Real effects of monetary policy - which we might call an output-inflation trade-off - have found respectability in models based on optimizing behaviour by individual agents. This has meant not only that the microfoundations of models with inertia are more fully understood, but that it is possible to look for predictions about how these rigidities vary (if at all) with macroeconomic phenomena.

Our focus here is on product market rigidities that give rise to an output-inflation trade-off. The 'international evidence' offered by Lucas (1973) appeared to support the idea that the transmission of real shocks to the monetary economy came about because individuals were unable to distinguish general from relative price increases. The problem for suppliers in the Lucas world is to decide what proportion of changes in individual prices to attribute to changes in general prices (which warrant no change in output) and to changes in relative prices (which may well warrant a change in output). Agents do not know the general price level itself. They know the past history of general prices, in that they can calculate the moments of its distribution; its mean, P^* and its variance σ^2; suppliers also observe prices in their own markets, $Pt(z)$, where z denotes the suppliers' market. Suppliers then form an expectation of the general price level based on the current price level in their own market and knowledge about the past distribution of the general price level, weighting each piece of information in the following way:

$$E[P_t I(z)] = (1-\theta)P_t(z) + \theta P_t^* \qquad (1)$$

Where θ is given by:

$$\theta = \tau^2/(\sigma^2+\tau^2) \qquad (2)$$

and τ^2 is the variance of prices in the suppliers' own market.

The higher the variance of the general price level, the greater is the probability that the movement in the market price $P_t(z)$ reflects a change in the general price level, and therefore the less will the suppliers' own output respond to it, since output responds only to a change in relative, not general prices. In short, Lucas posits that high variance of nominal demand leads to a reduction in the output-inflation trade-off.

Lucas estimated output-inflation trade-offs for 18 countries, using regressions of the following form:

$$Y_t = \alpha + \beta\Delta X_t + \gamma Y_{t-1} + \delta T + u_t \qquad (3)$$

where Y_t is the level of real output, X_t is nominal output (in logs), β is the output-inflation trade-off (literally the proportion of a shift in nominal GDP that shows up in real GDP one period later), T is a linear time trend and u_t is a white-noise error term. He found that stable inflation countries tend to have higher trade-offs than variable inflation countries, though he had insufficient degrees of freedom to conduct a formal test of this. Note that Lucas' model would predict the inflation rate itself to have no effect on the trade-off (unless we invoke from outside the model the observation that high inflation means more variable inflation).

Ball, Mankiw and Romer (1988) estimated trade-offs using the same time-series specification, and subsequently ran cross-section regression with the trade-off as the left-hand side variable (which we will discuss later). But they presented a model which, they argued, offered different predictions about the determinants of the trade-off than those identified by Lucas.

Theirs was a time-dependent model of menu-costs; price setting in the economy is discrete and staggered, with an equal proportion of firms changing prices at each instant in time. Firms choose the interval at which they change prices as a result of profit maximisation under imperfect competition. The interval is positive because firms face a fixed cost of changing prices. This is commonly called the 'menu cost', though it will include not only the physical cost of changing prices but all costs associated with calculating and monitoring the optimal price. Profit maximisation involves balancing the losses from deviations of the actual price from the optimal price, and from the costs of adjusting prices.

Firms' profits depend on aggregate spending, y, the firm's relative price, p_i-p, and a shock which is firm specific and could relate to either demand or costs, θ_i (all variables in logs). BMR assume that the elasticity of the firm's profit-maximising relative price p^*_i-p with respect to y is a positive constant, v. When the elasticity of the relative price with respect to the shock, θ_i is assumed to be unity and that shock has zero mean, the profit-maximising real price can be written as:

$$P^*_i(t) - P(t) = v\,[y(t) - y^*(t)] + \theta_i(t),\ v > 0 \quad (4)$$

where y^* is the natural rate of output. At the natural rate of output and with no shocks (ie $\theta_i = 0$, its mean) the firm desires a relative price of one. Since each price change incurs fixed costs F, and prices are changed at interval λ, adjustment costs per period are F/λ. BMR show that this results in a pricing rule of the form:

$$p_i = \frac{1}{\lambda}\int_{s=0}^{\lambda} E_t p_i^*(t+s)ds \quad (5)$$

Equation (5) says that a firm sets its price to the average of its expected profit-maximising prices for the period when the price is in effect. BMR make assumptions about the process for nominal demand, which, in logs, follows:

$$x(t) = gt + \sigma_x W(t) \quad (6)$$

where $W(t)$ is a Wiener process, and an assumption that the natural rate of output grows at some rate m. They also assume that shocks to nominal demand are composed of aggregate shocks and some firm-specific shocks, (by construction) uncorrelated across firms; these firm-specific shocks follow random walks with mean zero and some finite variance σ_j. BMR solve numerically for the equilibrium interval between price changes, λ, which is found to be decreasing in average inflation, p, the variance of aggregate nominal demand, σ_x and of the firm-specific shocks σ_j. This is the crux. If firms adjust prices at shorter intervals when inflation is higher, then, other things being equal, the amount of any nominal shock that is felt in real variables will be smaller.

BMR offer a test to distinguish between their model of time-dependent menu costs and Lucas' price misperceptions model. They run a cross-section regression as follows:

$$\beta_k = a + b.\pi_k + c.\pi^2_k + d.\sigma_{xk} + e.\sigma_{xk}^2 + v_k \quad (7)$$

Where β_k is the estimated trade-off for country k derived from equation (3) above, π_k is the average inflation rate in country k, σ_{xk} is the standard deviation of nominal demand (x) in country k, and v is the cross-section error term. If b and c are not significantly different from zero, while d and e are both positive, then Lucas' theory is vindicated. Alternatively, a positive a

and *b* would be consistent with (though not conclusive proof of) BMR's time-dependent menu-costs model.

It is worth pointing out from the start that BMR's model is not the only model of menu-costs on the shelf. There are also a variety of 'state-dependent' rules, known as 'Ss rules': for example, see Caballero and Engel (1991, 1993a, 1993b). In these models, firms also face a fixed menu cost, but the decision to change prices is based purely on the size of the shock to desired prices. Such models would not predict that inflation necessarily has any effect on the trade-off.[3] In these models the optimal rate of inflation is zero, since this is the rate of inflation that will lead firms to change prices least often and spend the minimum amount of real resources on changing prices. Models with fixed contract lengths like Phelps (1978) and Taylor (1983) would also predict no relationship between steady-state inflation and the output-inflation trade-off.

Seen in this way, BMR's empirical tests offer a way to distinguish their model not only from Lucas', but also from state-dependent models of menu costs.

2.2 Theory: optimal speeds of changing inflation

Supposing that there were some optimal inflation rate, what does theory have to say about the speed at which the economy should approach it? If inflation is running at ten per cent a year and we think welfare will be higher in a world of price stability, does theory offer any guidelines as to how quickly inflation should be brought down?

---

(3) Ss rules imply that firms leave actual prices unchanged unless desired prices breach some upper or lower bound. The immediate effect of a shock to desired prices (perhaps caused by a money supply shock) will not depend on the rate of inflation, but just on whether the shock takes the desired price outside the Ss bounds. Subsequently, though, if the shock to desired prices is in the same direction as the trend in the general price level, the Ss bounds will be breached *sooner*, the higher the rate of change of prices. Alternatively, if the shock to desired prices is in the opposite direction to the trend in the price level, the shock will make itself felt on actual prices *later*. Of course it may be the case, for reasons exogenous to the determination of the Ss bands, that higher rates of change in general prices, imply more and larger shocks to individual desired prices, in which case the Ss bounds will be breached more often, actual prices will change, and real quantities will not. But the effect of any *given* size of nominal shock on the real economy will still not vary with inflation.

There are two broad - but, as we shall see interrelated - considerations here: first, are there rigidities in contract formation and, if so, what form do they take? Second, how are expectations formed?

Nominal rigidities

Models incorporating various types of nominal rigidity in factor or product markets now have a long history of support from the literature. Broadly, there are two types of model we need to consider: first, those that posit some arbitrary form of rigidity, where contracts are set for some fixed length of time that is exogenous to the model. Second, there are those models that derive rigid prices as a result of optimising behaviour on the part of firms who face costs of contract renegotiation: here, whether prices are rigid or not depends on factors within, or endogenous to the model.

- exogenous contract setting

Phelps (1978) and Taylor (1983) have argued that nominal rigidities in the labour market will mean that fast disinflations incur the risk of output losses, since agents need time to adjust contracts typically denominated in nominal terms and geared towards persistent inflation. As noted by Howitt (1990) and King (1993), the same argument applies to debt contracts; in principle, it should carry over to any market where contracts are rigid. But we might dispute this, or at least qualify it: if contracts are denoted in levels, faster disinflations will be less costly: the faster the economy moves towards a situation where there is no trend in aggregate prices, the better. If contracts are denoted in rates of change, however, then faster disinflations may not be any less costly.

The intuition behind this is that when contracts are denoted in levels, then the change in the desired, real, relative price (and hence the change in quantities brought about by actual prices remaining fixed) will be directly proportional to the change in the general price level during the life of the contract. So the minimum impact on real quantities will be achieved by the fastest possible transition to stability in the general price level. If, however, contracts are denoted in terms of rates of change - that is, if they are indexed to the expected change in the general price level - the impact of a change in the rate of inflation on the desired real price (increase) - and hence quantities - will be proportional to the difference between the inflation indexation built into the contract and the actual increase in the price level that materialises. Provided expectations are rational and the disinflation is credible - and these are provisos that we will discuss shortly - the ideal timing for the disinflation would be to have no disinflation while the contract is enforced and achieve all of it in one go at the time of renegotiation. Since, in reality, there will be a continuum of contracts of different lengths and due for renegotiation at different times, it seems likely that the real costs imposed by disinflation will not be related to how fast the disinflation happens, but simply to the duration of contracts. In this situation, other things being equal, disinflations should be fast (since we are supposing that inflation imposes long run costs on the economy) but if contracts are indeed denoted in terms of rates of change then we might not expect to find any relation between the speed of disinflation and its impact on the real side of the economy.

As empiricists, therefore, we have two options: either (i) work out whether levels or rates of change denoted contracts predominate to figure out whether faster disinflations are beneficial or not or (ii) use a finding about the output cost of faster disinflations to infer something about the predominant contract type.

- endogenous contract setting

But the models we have discussed so far assume that contract-formation takes place according to a rule that is invariant to other processes in the model. If contracts are formed according to some endogenous procedure, we may end up with different results. Two types of endogenous rules for price-setting are state-dependent (Ss) rules and time-dependent rules: each of these are typically articulated such that contracts are set in terms of levels, rather than rates of change.[4]

Caplin and Spulber (1987) show that state-dependent rules for setting the price level imply that the output effect of a disinflation is not dependent on the speed of the disinflation. This makes sense. A state-dependent rule implies that once the shock to desired prices is sufficiently large to offset the fixed menu cost, prices will be changed: at any point in time, the chance of having a price change is proportional to the likely profit loss from not changing, which is also proportional to the likely output loss if prices are unchanged. The upshot is that faster disinflations will lead to similar output costs. We say 'similar' because it may be that slower disinflations force firms to spend more resources on changing prices; since the general price level will be rising faster, for longer. We would expect this to lower long-run

(4) As an aside, Hall, Walsh and Yates (1996) survey over 650 companies in the United Kingdom and find that 79% operate some kind of time-dependent pricing rule; 11% of companies operated what appeared to be a state-dependent rule, while 10% followed both types of rule for price-setting.

aggregate demand and output marginally, relative to the slower disinflation case. The same amount of price changes will be needed anyway, so in the long run, output will be unaffected.[5] For our purposes, we suspect that the costs of faster or slower disinflations would be 'similar' enough for the differences to be empirically undetectable.

The outcome from time-dependent rules of the Ball, Mankiw and Romer variety is not so clear and not, so far as we can discover, discussed in the literature. Recall from the description above that firms set the optimal interval for changing prices as a function of the inflation rate. A key question (unanswered by BMR) is how often this rule is reappraised when the inflation rate itself is changing. Suppose that the rule was not reappraised at all during the disinflation. In this case, we would be in a situation like that posited by Phelps and those who followed him: contracts are set at fixed intervals and faster disinflations (provided they do not subsequently lead to falling prices) are less costly than slower disinflations.

Next, suppose that half way through the disinflation (either when inflation crosses a certain threshold, or after a particular interval of time), the firm reappraises its optimal price-setting interval and discovers that, since inflation is lower, it ought to change prices less frequently. The effect of this is to reduce somewhat the benefits of any given disinflation. But some primitive simulations show that faster disinflations still appear to be more beneficial, although the result in general will depend on how severe is the reappraisal of the optimal interval at which prices are changed, and on whether the interval is reappraised at fixed time intervals or whether its reappraisal is state-dependent.[6] Moreover, the results will depend on how great are the resource costs of making price changes themselves.

Expectations formation and time consistency

The models discussed so far assume that expectations are rational, and fulfilled, but that acting on these expectations is costly. Sargent (1983) argued that errors made in forming expectations about prices can cause

(5) Unless there is some relation between the speed of change in inflation and the variance of relative prices.

(6) These simulations looked at disinflations from 20% per period to 0% per period, assumed that output costs were equal to the deviation of actual price from desired price; that the interval at which prices were changed was (i) every two periods for inflation above 10% and (ii) every three periods for inflation below 10%; they did not account for the output cost of changing prices themselves. We compared the results for disinflations achieving a one and two percentage point reduction in inflation every period.

disinflation to be costly. The question then is what causes expectational errors. There are several options here.

The first is that we might drop the assumption of rational expectations that lies behind the nominal rigidity models. We could assume that expectations are backward looking and adaptive; we could posit some kind of learning process for expectations. Either way, there is an analogy with our discussion of contract formation: our conclusions about the least costly speed of disinflation will depend on whether expectations are formed about the price level or the rate of increase of the price level, and on how frequently - and under what circumstances - they are revised.

A second possibility is that we might go back to models of the Lucas type, where expectations are still 'rational' in that they make best and unbiased use of the information available, but may not be accurate. In this type of model, would faster disinflations be more or less costly? Sargent (1983) has something to say on this. He argues that in a Lucas world the least costly disinflation is an immediate and well-publicised one. This makes sense, but only in the following way: output variations in this model are caused by agents mistaking changes in desired relative prices for changes in the aggregate price level. So if there are no other nominal shocks in the economy, and the government makes public the change in the mean rate of inflation intended, then an immediate disinflation can be costless: but so can a slow disinflation. If the speed of disinflation does not affect output, yet we know inflation itself to be a public 'bad', a fast disinflation is the best policy.

A third aspect of expectations formation to consider is credibility. A disinflation that is not believed by the private sector will be costly. If agents do not believe in the disinflation, expectations will not be adjusted when contracts are negotiated and the economy will incur output costs. The question then is what kind of disinflation allows credibility to be established as soon as possible. And the answer may depend on the role of announcements or institutions. The task of convincing the general public that there has been a change in regime may mean that the government has to announce a rapid disinflation; a slow disinflation may not look like anything other than discretionary (high inflation) policy. Alternatively, if announcements are not credible in themselves, and the only way a government can gain a reputation for prudence is by inflation outcomes matching inflation promises, the best policy may be to announce a slow disinflation that, at each and every point in time, the authorities have a better chance of meeting.[7] But the most credible disinflation may also be the one that minimises output costs - especially if the public thinks that the government cares about output, which in turn will depend on contract-formation. In which case our discussion of the optimal speed of disinflation has come full circle.

Whether fast disinflations are more or less costly therefore depends on what it takes to establish credibility, how expectations are formed, and the extent and nature of nominal inertia in contracts in the economy.

We turn now to the empirical focus of the paper; the investigation of the impact of inflation and the speed of disinflation on the short-run, output-inflation trade-off. Our empirical work updates and extends the results of BMR and is intended as a comment on the robustness of their conclusions.

3 The BMR data

A common criticism of empirical work based on cross-country data is that since the institutions and mechanisms that govern the economies are so different, and since these countries evolve differently over time, it makes no sense to test theoretical propositions as if there were a common data generating process at work in the world. The selection of countries made by Ball, Mankiw and Romer is an attempt to get round this problem, though a quick glance at the list of countries (in Table A) reveals that BMR would be hard pushed to argue that their selection had eliminated all unobserved heterogeneity in the data! Notwithstanding, the selection was made on the following criteria, applied at 1965: countries had to have a population greater than 1 million; at least 10% of output had to be in manufacturing; not more than 30% of output could be in agriculture; data had to be available at least back to 1963; and the economy had to be largely unplanned.[8]

---

(7) For a formal discussion of these issues, see the game-theoretic literature on private information in monetary policy-making, for example Stein(1989), Canzoneri (1985) and Garfinkel and Oh (1990).

(8) This selection of criteria is, of course, arbitrary. And applying the test at one point in time does not allow for variation in country characteristics that might be important for the trade-off. Moreover, if the objective is to control for all those variables that might also determine the output-inflation trade-off, then BMR's list of criteria is clearly not complete; we might want to control for anti-inflation credibility by selecting according to (or including in our regressions) measures of fiscal stance, central bank independence or political democracy.

We have proceeded using the same sample of countries, using time series for real and nominal GDP that cover varying periods between 1948 and 1992. For some countries we were not able to get data going back as far as BMR; more often, we were able to extend the time series, since BMR's estimation was based on data only up to 1986. Where we were unable to satisfy BMR's criteria for length of time-series (ie back to 1963) we went ahead and included the country in estimation anyway. A list of sample periods for selected countries is given in Table A.

Descriptive statistics are presented in Table B. The table shows means and standard deviations for inflation and growth in the 43 countries, comparing the BMR data to our own. All figures are calculated as log differences. There are some clear differences between the two data sets. For example, take Argentina. Whilst we report that the average inflation rate for Argentina was almost 90% per annum, BMR report an average of 54%; BMR report an annual growth rate of 2.62% but we calculate the average at 1.65% per annum. In fact, most of the largest differences are for countries with high average annual rates of inflation - Bolivia, Brazil, Columbia, Ecuador, Nicaragua. There are two reasons for the differences. First, the late 1980s, not covered by BMR, was a period of exceptionally high inflation for many of these countries. Second, in the course of compiling the data we noticed that for many countries the late 1980s had seen repeated, wholesale revisions of historical real and nominal GDP data. The experience of many countries during the late 1980s provides us with another good reason for updating and assessing the basic findings of BMR.

4 Results

4.1 The output-inflation trade-off

The β's estimated from equation (3) represent the proportion of shocks to nominal GDP that show up in real GDP one year later. This is what is meant by the short-run, output-inflation trade-off. They are listed in Table C. Leaving aside the problems we know about using ordinary lead squares with non-stationary variables, what do these trade-offs tell us? The figures under column YC show the β's estimated using our full data set; those under BMR1 are those estimated using as close a match to the BMR time-series as possible; the column headed BMR2 reproduces the estimates published by BMR in 1988. The estimated coefficients and standard errors appear to differ widely. But the differences are not particularly significant, in the following sense; there are only seven countries where the significance of the estimated trade-off (at the 5% level) is affected by the experiments conducted under YC and BMR1: Peru, Nicaragua, Mexico, Japan, Iceland, Bolivia and Australia. Casual inspection of the trade-offs themselves suggests a negative relationship between the (absolute) size of the trade-off and average inflation. Countries with typically low inflation appear to have higher trade-offs. We shall explore this correlation further.

At this point we should introduce a health warning to these results. We, like BMR, do not attempt to take account of non-stationarity in the data, largely because of the constraint imposed by our often short and annual time series. The only defence here is that we are not necessarily interested in the values of the β's themselves but in how they correlate with inflation and the speed of disinflation. Our hope is therefore that any correlation observed is not induced (or obscured) by the breach of Gaussian assumptions that happens when we estimate equation (3). The results are of interest in so far as these problems are insuperable: with so few observations for each country, we cannot hope to deal effectively with non-stationarity with any kind of cointegration analysis.

But one problem we can do something about is the clear simultaneity in equation (3). The final column in Table C ('IV plus lags') shows the trade-offs we generate by estimating using generalised instrumental variables. Lags of changes in nominal GDP and lags of levels of real GDP were used as instruments. In the final equation, we included significant lags as regressors, which puts our results further away from those of BMR since they did not include lags.

The trade-offs that come out of the IV experiment look quite different from BMR's results; there are seven countries for whom our IV trade-offs become significant when the BMR1 trade-offs (our data, BMR's specification) were insignificant or vice versa; and in nine countries the trade-off changes sign from one experiment to the other.

Table D gives correlation coefficients for all the trade-offs shown in Table C. It shows how the correlation with BMR's trade-offs deteriorates once we depart from their base regression. For example, the correlation between BMRs published results (BMR2) and our replication (BMR1) is 0.882; using our extended time series reduces the correlation to 0.801, and using instrumental variables takes the correlation to 0.733.

But the more pressing question is not whether the numerical estimates of the trade-off are sensitive to specification - a fact that is hardly surprising given the quality of the data and the inevitable parsimony of the time-series models

- but whether the primary finding of BMR, that higher inflation lowers the trade-off, stands up to this kind of experimentation.

4.2 Does high inflation reduce the output-inflation trade-off?

Comparing BMR's results with our own

BMR reported a series of six cross-section regressions, with the estimated trade-offs as the dependent variable, and a selection from the following as explanatory variables: mean inflation, the square of mean inflation, the standard deviation of nominal demand and its square. Recall that the objective was to provide a joint test of the hypothesis that inflation and the variance of nominal demand affects the output-inflation trade-off. The results reported by BMR are reproduced in Table E. They support the notion that there is a significant and negative correlation between the average level of inflation and the output-inflation trade-off. They also reveal that the effect of the variance of nominal demand on the trade-off is either insignificant or of the wrong sign. They appeared to have provided evidence in support of their own model of price setting, and counter to the models of Lucas and, as we pointed out earlier, others: most notably, the state-dependent models of menu costs which predict that the trade-off is invariant to the level of inflation (provided that higher inflation is not associated with a greater variance of nominal shocks).

Comparable results based on our own data are reported in Table F. Our results suggest that this correlation is robust, though the coefficients on mean inflation in our regressions are smaller than those of BMR by a factor of ten; our estimates vary around -0.02 compared to around -0.3 for BMR. But although the numerical size is smaller, the significance of the coefficients, (especially when tested using heteroskedasticity-robust standard errors) is, if anything, greater. Our explanation for this recalls the earlier discussion of the data in section 4. Comparing BMR's results with our own, the observation that our coefficients are numerically smaller implies that the variance of our independent variables has increased relative to that of our dependent variable (the trade-off). Specifically, the variances of the standard deviation of nominal demand and the average level of inflation are higher, relative to the variance of the trade-off in our own results. This is exactly what we would expect to happen by including the post-1986 period in our estimation, since this was a time when, although the majority of countries saw inflation rise, several countries saw a period of hyperinflation.

Table G reports results using the trade-offs estimated using instrumental variables. These do not significantly affect our conclusions. Once again we have a numerically small, but significant correlation between mean inflation and the trade-off, and a negative relationship between the variance of nominal GDP and the trade-off. For the work that follows, we use exclusively this instrumental variables trade-off.

Note that in all of these cross-section regressions we report White's standard errors: this is to allow for heteroskedasticity caused by the fact that our regressions use a dependent variable that is measured with some error (proportional to the numerical size of the trade-off coefficient). In the 1988 article, BMR asserted that measurement error was not a problem that would have materially affected their results. Our results cast doubt on this: the White's standard errors have a considerable impact on the probability of making type two errors (of concluding that a coefficient is significant when in fact it is not). The use of White's errors turns out to be not so crucial for the first set of regressions in Table F, but when we go on to look at the correlation between the output-inflation trade-off and the speed of change of inflation, White's errors often change our inference about the significance of particular coefficients. White's standard errors are also important to accommodate cross-section estimates averaged over non-stationary, time series data: this is explained in Pesaran and Smith (1995).

Experimenting with functional form

Since BMR's specification has no precise grounding in theory, (their model tells us only which are our independent and dependent variables), the next step was to experiment with different functional forms. The results of these experiments are shown in Tables H and I.

Table H shows regressions using the square of the trade-off as the dependent variable. We can see that the sign and the significance of the correlation between mean inflation and the trade-off is not affected; the coefficient on mean inflation is invariably negative and significant. This functional form seems more likely to generate failures of tests for the normality of the residuals; less of the data are explained, although this is to be expected since we have squared the variation in the dependent variable; and we can see that the standard error of the regression is somewhat lower.

Table I shows regressions using the reciprocal of our IV trade-offs as the dependent variable, and it is clear that this has a dramatic effect on the results. The coefficients on all independent variables are made insignificant, and the standard error of the regressions is multiplied by a factor of something like 150; all regressions fail normality tests. Without guidance from theory, we would take this as reason enough to reject this specification.

Notwithstanding our findings regarding the reciprocal of the trade-off, it seems that the negative relation between the sacrifice ratio and the rate of inflation is relatively robust over changes in the sample period, the time series specification of the trade-off, and the functional form of the cross-section regressions.

How do these results compare with other work?

Aside from the study by BMR (1988), Ball (1993a) studies the effect of inflation on the output-inflation trade-off. The study contrasts with our own approach in this paper. He defines and identifies episodes of disinflation in 19 OECD countries. He calculates sacrifice ratios comparing the reduction in inflation with the sum of the deviations of output from trend. His conclusions about the effects of the initial rate of inflation on the subsequent cost of disinflation are ambiguous. For quarterly data, he finds that higher inflation tends to be associated with lower sacrifice ratios. But his regressions using annual data do not support this; the coefficient on the initial rate of inflation is insignificant and wrongly signed. The value of Ball's work turns on two issues: (i) are the real effects of nominal shocks different for periods of increasing and decreasing inflation, either in theory or in the data? (this is an issue we touch on below); and (ii) how sensitive are the results to changes in the mechanistic definition of a period of disinflation?[9]

Cozier and Wilkinson (1990) examine the costs of disinflation in Canada. They conclude that there is no evidence that disinflations lead to larger deviations from potential output at lower rates of inflation. Their work hinges on the specification used to identify potential output; the authors do not experiment. Laxton, Meredith and Rose (1995) show that these results can be overturned with appropriate experimentation.

But since our own research was begun, it turns out that using the results of Ball, Mankiw and Romer has become something of an industry. For example, Walsh (1994) carries out an exercise quite similar to our own: he attempts to explain the variation in the trade-off by variation in the degree of independence in the central bank. He uses estimates of the trade-off

---

(9) As an aside, we have reservations about Ball's definitions of the trade-off, which for one thing embody an assumption that output is on trend when inflation peaks. For some countries, the sacrifice ratios are indeed very sensitive to the definition of the disinflation period. On this score, see for example Mayes and Chapple (1994).

provided by BMR and others[10] and uses a variety of measures of independence borrowed from other researchers. Walsh runs regressions on the trade-off, controlling for the level of inflation, and finds that the indices of independence are still positively correlated with the trade-off. Moreover, the sign on the coefficient on mean inflation is reversed and its significance unreliable, apparently casting some doubt on BMR's results. When Walsh includes the standard deviation of inflation as an explanatory variable for the trade-off, however, the significance of the coefficient on independence disappears. Although in our opinion Walsh is unduly faithful to BMR's specification of the trade-off, it is worth recording his rationalisation of the sometimes result that independence increases the trade-off. He presents a model whereby inflation and the costs of disinflation are determined by a game played by central bankers who set the aversion to inflation for a given degree of wage indexation, and wage-setters who set indexation for a given degree of inflation aversion. Walsh argues that independence increases inflation aversion and, in expectation, wage-setters decide to invest less in indexation and the output consequences of subsequent nominal shocks are increased as a result. The omissions from Walsh's results are that (i) he does not consider time-varying trade-offs, (ii) he does not consider the effect of the speed of disinflation and (iii) he misspecifies his tests by including both independence *and* the level of inflation as an explanation of the trade-off. Finally, his results are confined to a much smaller set of countries than that covered by ourselves.

Posen (1994) also makes use of the trade-offs generated by BMR[11] without testing them for robustness. His task is also to discover whether central bank independence affects the costs of disinflation. His findings match those as Walsh: independence is correlated with a higher output-inflation trade-off. However, unlike Walsh, Posen does not control for the level of inflation. Like Walsh, Posen does not attempt to test BMR's results for robustness. But Posen does proxy for the speed of disinflation - we discuss this below.

Finally, we should mention Defina (1991), who confirms the broad thrust of BMR's results, using a time-varying trade-off. We will discuss time-varying trade-offs later in the paper.

---

(10) Schelde-Anderson (1992) and Ball (1993a)
(11) And those of Ball (1993a).

4.3 The costs of disinflation: does it matter whether inflation changes quickly or slowly?

The second thrust of our empirical investigation was to use the BMR framework to test whether the output cost of a given disinflation is affected by the speed at which it is conducted. The empirical framework we have allows us to do this only in a roundabout way; that is, we can add to our list of regressors explaining the variation in the trade-off across countries the average, absolute change in inflation. We are therefore not isolating periods of disinflation; we are assuming that the nominal inertia that gives rise to the trade-off in the first place brings about as large an affect on real output when inflation is rising as when it is falling. As the earlier discussion hinted, this may not be realistic.(12) We have taken this approach mainly because the short time series available for some countries prohibits accurate, distinct estimates of inflation and disinflation speeds.

Tables J and K show the affect of adding in the average change of inflation to the regressions reported in Table G. We used two measures of the speed of change of inflation in a given country: the average, absolute inflation change from period to period (calculating inflation using log differences) and the average absolute inflation change deflated by the average rate of inflation. (In the tables we have called this the *proportional* inflation change). Should the degree to which nominal shocks have real effects be related to absolute or proportional changes in inflation? We have no strong priors on this, and there is not much guidance from existing theory. We suspect that our choice might depend on whether we thought contracts were denoted in levels or rates of change terms. If contracts were denoted in levels, the absolute speed of disinflation would be the most appropriate measure since this would capture the deceleration in the price level, or the convergence to price stability that would be required for there to be no impact on quantities from period to period. If contracts were denoted in terms of rates of change, however, we might think that intuitively, a given disinflation would be of proportionately smaller import at higher rates of inflation. But from our discussion earlier recall that we suspect that the speed of disinflation should not affect the output cost if contracts are denoted in terms of rates of change, so it perhaps ought not to make a difference which measure we choose.

Table J shows that the absolute speed of inflation change appears to have a weak, but negative effect on the trade-off. Table K confirms this for the

(12) For instance, Laxton, Meredith and Rose (1995) find that 'high levels of activity [raise].... inflation by more than low levels decrease it.'(page 1)

proportional measure, although here the relationship seems to be weaker still. There appears to be some colinearity between the measures of inflation change and mean inflation (and its square); the inflation change variable shows up as more significant when we leave out mean inflation and/or its square. Although we would not put too much weight on what we have found, it does seem as though fast disinflations are not harmful in terms of increasing the output costs of a disinflation; and indeed they may be beneficial. Note also that the negative and significant effect of mean inflation on the trade-off is also robust to controlling for the speed of change of inflation.

What do we know from other empirical work?

There has been little rigorous empirical work on whether fast disinflations cost more or not. Sargent (1983) compares the experience of Poincaré in reducing inflation in France in the 1920s with that of Thatcher in the early 1980s. He argues that the cost of the UK disinflation was directly attributable to the credibility problems associated with the gradualism adopted (though many would contest that the disinflation could be described as gradualist). Poincaré disinflated at a time when there was unanimity behind the objective of lowering inflation, and, Sargent argues, could thus deflate more quickly and at consequently lower cost. Schelde-Anderson (1992) also adopts a case-study approach, finding that disinflation is more costly when done slowly.

The only systematic study is that by Ball (1993a): recall that he identifies separate periods of disinflation in 19 OECD countries. He finds that faster disinflations are associated with lower sacrifice ratios. This lends some support to our contention above, that our preferred, instrumental variables estimates of the trade-off are lower when disinflations are faster. Ball also makes the point that it is empirically difficult to isolate the effect of the level and the change in inflation on the trade-off, since these variables are not orthogonal. This problem undoubtedly affects our results.

We have already noted that the work of Posen (1994) touches on the question of disinflation speeds. In a regression using alternately BMR's and Ball's (1993a) trade-off as the independent variable, Posen includes, besides central bank independence, the total change in inflation and the length of the disinflationary episode as explanatory variables. Our view is that this is an odd thing to do with Ball's trade-offs, since these are calculated with the total inflation change in the denominator, suggesting that Posen has the same variable on the left and the right hand side of his regressions. Nevertheless, Posen finds that the episode length is positively and significantly correlated with the trade-off, but that the coefficient on the total inflation change is either insignificant or negative, depending on whether he uses annual or quarterly data. Posen also conducts other regressions to test for correlations between central bank independence and the speed of disinflation and finds no significant correlation.

Broadly speaking, the consensus from previous literature is that faster disinflations are either beneficial, or at least not more costly than slower ones. Our results are consistent with this finding and therefore add weight to the case for faster disinflation. They could also be interpreted as consistent with (though not proof of) contracts being set in levels, rather than rates of change, which would probably accord with most people's experience of product and labour markets.

4.4 Sample sensitivity: what happens if we take out high or low inflation countries?

We conducted one final set of experiments to see if the significance and the sign of the correlation between inflation, the speed of change of inflation and the output-inflation trade-off is dependent on the particular sample of countries chosen. It should be clear that some of the value added by the work of BMR and ourselves is in looking at a fairly large set of countries, amongst which we have several who have experienced something approaching hyperinflation at one time or another. We sought to test whether our results were peculiar to high or low inflation countries.

In particular, we ranked countries according to average inflation and re-ran the cross-section regressions excluding, alternately, the ten countries from the top and bottom of this ranking. This amounts to excluding all those countries with an inflation rate above 13.8 per cent a year, or those with inflation rates of less than 5.9 per cent.[(13)]

The results from this experiment are reported in Tables L-Q. Taking Tables L and M together first, these show the effect of excluding high and low inflation countries (respectively) from the regressions in Table G. And we can see that in both cases the negative and significant relation between

(13) In these experiments, we report only Huber standard errors, which are equivalent to White's standard errors, and we do not report any diagnostics. This is only for convenience: the software which allowed us to vary the sample of countries most easily was STATA, which does not offer many of the standard diagnostics.

inflation and the trade-off is more or less intact; for low inflation countries, the effect is numerically much larger.

Tables N-Q show the effect of varying the country sample on the regressions with measures of the speed of inflation change included: N and O use the absolute measure, and P and Q the proportional measure. Two points are of interest here. First, our correlation between inflation and the trade-off is again robust. Second, our conclusions about the beneficial effect of fast inflation changes are strengthened. Oddly, excluding high or low inflation countries appears to increase the significance of the coefficients on both absolute and proportional measures of inflation change. The results are most dramatic for the proportional measure, when we exclude high inflation countries (Table P). We also discover that when we use the absolute measure of inflation change, the benefits of faster inflation changes are greater for lower inflation countries. But when we use the proportional measure, the reverse is true. This is reminiscent of Ball's (1993a) results. He looked at only OECD (ie broadly 'low' inflation) countries and used an absolute measure of disinflation, finding that faster disinflations were less costly.

4.5 Some health warnings

Before we conclude, it is worth setting out some caveats to these results. We have already drawn attention to problems that arise in the time-series estimation of the trade-off and argued that we have to waive problems of stationarity due to having insufficient degrees of freedom for many of the countries that we cover. But there are also points to note about the cross-section results. We cannot rule out the possibility that our independent variables are to some extent endogenous. For example, it might be the case that countries disinflate quickly precisely because they have low output-inflation trade-offs. Yet those with high inflation-output trade-offs will also want to inflate quickly. To account for this simultaneity we would need to (i) split up the analysis into periods of inflation and periods of disinflation and (ii) find an instrument for the speed of change of inflation. Unfortunately (i) is not feasible for our data. And regarding (ii), no obvious (and available) instrument presented itself, so we are left to place faith in our reduced form correlations, which we do not find so unreasonable since they are so robust.

Another point to consider is the following. BMR and ourselves estimate cross-section regressions that by construction allege that the output inflation trade-off is a function of the level of inflation, the variance of nominal demand and the speed of change of inflation. The regression holds the trade-off constant over time and yet posits that it varies according to phenomena which are inherently time-varying. This assumption is sustainable if the rigidities which are assumed to generate the nominal/real-side pass through are immune to all but very long term changes in the independent variables. But if the behaviours that generate the trade-off vary more quickly than the 20-30 years in our sample then we ought to find a way of estimating a time-varying trade-off.

The problem relates to a conundrum in the theoretical model of Ball, Mankiw and Romer. Recall that the optimal interval for price changes is derived numerically as a function of the rate of inflation; recall further that the pricing rule was derived taking the optimal interval as given. The BMR model has no mechanism for updating the optimal interval, which, conceptually, ought to vary over time as inflation itself varies. We might want to think of the model as valid only for individual, discrete intervals between price changes. When the time for price changes arrives, firms collect data on inflation and market conditions and the cost of changing prices and, in addition to deciding on the price for the next *n* months, decide how long it will be before prices are changed once more.

Allowing for a time-varying trade-off involves estimating a panel regression

$$Y_{kt} = \alpha + K_k + K_t + \beta \Delta x_{kt}(1 + \pi_{kt} + \Delta\pi_{kt} + \sigma x_{kt}) + u_{kt} \qquad (9)$$

Where, as before, Y denotes real and X nominal output, subscripts k and t denote country and time respectively; where K_k are the country-specific dummies and K_t are the time-specific dummies and u_{kt} is a country and time-specific error term. This model essentially assumes that the constant term varies across countries and over time; that the slope coefficients are fixed across countries and over time. Equation (9) amounts to substituting in our cross-section regressions into equation (3). The technique differs from the work of Defina (1991) which estimates single-equation, time-varying trade-offs. We do not consider that there are enough degrees of freedom to calculate such trade-offs, and that we need to combine countries into a panel to give us enough data-points to estimate these parameters.

But work by Pesaran and Smith (1995) has shown that estimating dynamic models with non-stationary data, and where coefficients differ across (in our case) countries,[14] can lead to very large biases in the estimated coefficients.

(14) Something surely established by our individual time-series regressions.

We have not reported the detail of these results because of this econometric problem.[15] But their qualitative message is interesting: we find that the data accepts country-specific constant terms and the time effects. We find that the coefficient on mean inflation is negative and significant. We find, in line with Ball (1993a) and our own cross-section results, that the coefficient on the absolute inflation change is also negative; the faster the change in inflation, the smaller is the proportion of changes in nominal demand that shows up in real output one period later. These results hold regardless of dynamics included in the equation. They are also robust to the use of an instrumental variables estimator.

Smith and Pesaran suggest that in panels with non-stationary variables, the coefficient on the lagged dependent variable is biased towards one and the other coefficients are biased towards zero. We take some comfort from the fact that our regressions nevertheless identify significant inflation effects on the output-inflation trade-off, (which ought to be pushed towards zero) and suspect that unbiased estimates of all coefficients would reveal significant speed of inflation effects also.

(15) Details can be provided on request.

5 Some conclusions

Our empirical investigation shows that the finding of Ball, Mankiw and Romer (1988) - that high rates of inflation reduce the output-inflation trade-off - is almost invariant to the choice of model; although in our work the effect of high inflation is numerically a great deal smaller than in the BMR study. The significance of this for policy is twofold. First, taken at face value, the results suggest that at low rates of inflation, eliminating variance in the rate of inflation will cost more in terms of increased variance in output growth. But these costs have to be set against the considerable benefits to be had from lower inflation, which ought to mean that mean output growth will be higher forever. Moreover, the appropriate policy response to our results, even leaving aside the benefits of low inflation - may not be to choose a higher inflation outcome, but to pursue other microeconomic policies aimed at changing the underlying price-setting behaviour that appears to be generating this result. Second, our results might also be used to suggest that the final stages of a disinflation will be more costly than the initial stage. This would be true if the interval at which prices were adjusted lengthened during the disinflation. Our results using the time-varying trade-off are consistent with this story.

Our second finding is that faster disinflations are at worst no more harmful than slow disinflations, and quite possibly beneficial in terms of incurring lower short-run output costs. Our results are consistent with the findings of the literature so far, that 'cold-turkey' (faster) disinflations are less painful than gradual ones. Our results beg other questions. Is an infinitely fast disinflation infinitely less costly? (We think this unlikely). Or is there some optimal speed of disinflation? Our linear correlations cannot answer these questions, and they remain open for future research.

Of course it should be clear that all our results are sensitive to the Lucas critique. If governments were to attempt to act on any of the conclusions reached in our paper, there is no guarantee that their economies would behave in the future as these 43 economies appear to have done in the past.

Table A - Sample periods

Country	Yates & Chapple (YC)	Ball, Mankin & Romer (BMR)
Argentina	1951-90	1963-81
Australia	1949-91	1949-85
Austria	1964-91	1950-86
Belgium	1953-91	1950-85
Bolivia	1960-91	1958-83
Brazil	1963-91	1963-84
Canada	1948-92	1948-85
Colombia	1968-91	1950-85
Costa Rica	1960-92	1960-86
Denmark	1950-91	1950-85
Dominican Republic	1963-91	1950-86
Ecuador	1965-91	1950-85
El Salvador	1951-92	1951-86
Finland	1960-91	1950-85
France	1950-91	1950-85
Germany	1960-92	1950-86
Greece	1948-91	1948-86
Guatemala	1951-91	1950-83
Iceland	1941-91	1948-85
Iran	1964-90	1959-85
Ireland	1948-91	1948-85
Israel	1968-91	1953-82
Italy	1960-91	1950-85
Jamaica	1960-89	1960-85
Japan	1952-91	1952-85
Mexico	1948-86	1948-85
Netherlands	1956-91	1950-85
Nicargua	1960-91	1960-83
Norway	1949-92	1950-86
Panama	1950-91	1950-86
Peru	1960-91	1960-84
Philippines	1948-92	1948-86
Portugal	1960-90	1953-82
Singapore	1960-91	1960-84
South Africa	1948-91	1948-86
Spain	1954-91	1954-84
Sweden	1950-91	1950-86
Switzerland	1948-92	1948-86
Tunisia	1968-92	1960-83
United Kingdom	1948-91	1948-86
United States	1948-92	1948-86
Venezuela	1957-92	1950-85
Zaire	1970-90	1950-84

Table B - Growth and inflation

	YC				BMR			
	Inflation		Real Growth		Inflation		Real Growth	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Argentina	89.98	0.89	1.65	2.63	54.39	0.77	2.62	1.62
Australia	6.68	0.71	3.87	0.70	6.77	0.74	4.16	0.59
Austria	4.10	0.48	4.05	0.59	5.26	0.90	3.96	0.66
Belgium	4.20	0.63	3.23	0.63	4.24	0.71	3.29	0.68
Bolivia	46.45	2.11	3.19	1.02	20.12	1.45	3.76	1.02
Brazil	74.26	1.02	5.59	0.97	42.37	0.61	6.33	0.87
Canada	4.49	0.70	4.07	0.64	4.80	0.69	4.36	0.60
Columbia	15.68	0.47	4.52	0.37	13.71	0.50	4.65	0.40
Costa Rica	13.21	0.92	4.53	0.77	12.41	1.06	4.59	0.83
Denmark	5.93	0.52	2.98	0.84	6.34	0.45	3.18	0.77
Dom. Republic	8.98	1.38	4.27	1.21	5.34	1.41	4.93	1.03
Ecuador	13.78	1.05	4.70	0.99	8.77	1.15	5.69	0.74
El Salvador	6.41	1.28	3.20	1.21	5.07	1.59	3.28	1.26
Finland	6.83	0.58	3.73	0.90	7.49	0.75	4.29	0.78
France	6.34	0.59	3.91	0.48	6.75	0.56	4.15	0.48
Germany	3.47	0.50	4.10	0.76	3.74	0.57	4.55	0.78
Greece	9.83	0.66	5.06	0.77	9.15	0.72	5.49	0.71
Guatemala	6.65	1.36	3.91	0.70	3.74	1.37	4.25	0.66
Iceland	19.76	0.65	4.17	1.20	19.77	0.75	3.53	1.60
Iran	11.76	1.01	3.96	2.49	9.37	1.30	5.75	1.44
Ireland	6.71	0.80	3.46	0.69	7.41	0.73	3.19	0.74
Israel	29.12	1.29	7.23	1.35	21.19	1.15	7.45	0.58
Italy	8.07	0.69	4.27	0.63	7.96	0.72	4.33	0.64
Jamaica	11.26	0.72	2.02	2.10	11.13	0.79	1.53	3.02
Japan	2.22	6.80	8.76	1.72	4.72	0.80	7.16	0.51
Mexico	15.30	1.06	5.36	0.87	13.92	1.08	5.77	0.53
Netherlands	4.29	0.77	3.85	0.74	4.93	0.69	3.88	0.75
Nicaragua	73.58	1.88	1.80	4.62	8.06	1.16	3.77	2.30
Norway	6.15	0.91	3.00	1.18	5.64	0.92	4.16	0.39
Panama	2.77	1.48	4.70	1.00	2.99	1.19	5.37	0.62
Peru	62.23	1.51	2.72	2.01	25.54	0.89	3.54	1.23
Philippines	7.60	1.06	4.58	0.75	7.20	1.14	4.84	0.66
Portugal	9.46	0.82	4.48	0.65	7.39	0.98	5.10	0.54
Singapore	3.14	1.15	8.05	0.47	3.56	1.34	8.61	0.54
South Africa	7.96	0.70	3.58	0.66	7.18	0.76	3.83	0.60
Spain	8.87	0.64	4.89	0.81	9.92	0.47	4.55	0.68
Sweden	6.45	0.55	2.81	0.64	6.35	0.59	3.01	0.60
Switzerland	3.69	0.62	2.88	1.03	3.87	0.69	2.86	1.19
Tunisia	6.20	0.62	5.47	0.73	6.21	0.93	6.21	0.71
United Kingdom	6.75	0.70	2.44	0.81	6.64	0.75	2.43	0.78
United States	4.11	0.58	3.00	0.85	4.15	0.61	3.15	0.85
Venezuela	9.85	1.39	4.40	0.91	5.26	1.57	4.59	0.82
Zaire	44.64	0.74	-0.59	-11.27	20.02	1.12	3.34	1.27

Table C - Output-inflation trade-offs in 43 countries

	YC	t	BMR1	t	BMR2	t	IV+lags	
Argentina	0.005	0.525	-0.006	-0.667	-0.005	-0.147	0.014	0.939
Australia	0.214	2.455	0.176	1.814	0.138	1.605	0.622	3.541
Austria	0.625	8.807	0.612	5.720	-0.020	-0.187	0.693	7.586
Belgium	0.668	6.883	0.653	6.279	0.497	4.779	0.598	5.275
Bolivia	-0.013	-2.585	-0.044	-1.419	-0.053	-1.262	0.012	1.401
Brazil	-0.042	-1.491	-0.074	-0.712	-0.095	-0.913	0.031	0.762
Canada	0.494	6.328	0.448	4.978	0.473	5.256	0.790	8.460
Columbia	-0.062	-0.955	0.049	0.557	0.055	0.625	0.049	0.523
Costa Rica	-0.241	-3.210	-0.252	-2.769	-0.230	-2.527	-0.412	-3.717
Denmark	0.696	5.435	0.803	5.777	0.849	6.108	0.643	4.157
Dom. Rep	0.248	2.701	0.416	5.547	0.399	5.320	0.459	3.210
Ecuador	0.134	1.311	0.214	1.861	0.198	1.722	0.276	1.836
El Salvador	0.305	3.716	0.343	4.183	0.343	4.183	0.162	1.514
Finland	0.588	6.533	0.525	6.402	0.242	2.951	0.422	2.750
France	-0.054	-0.633	-0.038	-0.422	-0.065	-0.722	0.019	0.106
Germany	0.767	12.998	0.778	7.703	0.614	6.079	0.788	14.566
Greece	0.245	2.748	0.256	2.639	0.258	2.660	0.318	3.614
Guatemala	0.152	2.575	0.387	5.026	0.397	5.156	0.141	2.166
Iceland	0.189	2.627	0.125	1.068	0.015	0.128	0.219	2.971
Iran	0.468	4.335	0.418	3.800	0.379	3.445	0.439	3.465
Ireland	0.152	2.490	0.240	3.380	0.273	3.845	0.115	1.248
Israel	0.012	0.225	-0.092	-1.082	0.002	0.024	0.028	0.238
Italy	0.206	2.366	0.272	2.693	0.204	2.020	0.476	3.624
Jamaica	0.124	0.784	0.136	0.855	0.140	0.881	0.150	1.200
Japan	1.012	1.360	1.130	7.434	0.507	3.336	0.470	3.910
Mexico	-0.130	-1.509	-0.131	-2.472	-0.110	-2.075	0.006	0.058
Netherlands	0.551	5.676	0.582	4.694	0.455	3.669	0.550	5.030
Nicaragua	-0.020	-1.102	0.549	3.542	0.583	3.761	-0.039	-1.164
Norway	0.023	0.168	-0.011	-0.175	-0.045	-0.714	-0.028	-0.122
Panama	0.609	8.583	0.573	6.663	0.597	6.942	0.473	3.840
Peru	-0.052	-4.000	0.021	0.179	-0.071	-0.607	-0.036	-1.057
Philippines	0.004	0.046	-0.010	-0.111	0.042	0.553	-0.136	-1.300
Portugal	0.177	1.244	0.253	1.480	0.177	1.047	0.431	2.670
Singapore	0.558	9.449	0.542	6.452	0.602	4.394	0.464	2.986
South Africa	0.216	2.881	0.207	2.588	0.202	2.658	0.258	2.721
Spain	0.309	2.075	0.319	1.933	0.351	2.786	0.311	1.705
Sweden	0.016	0.179	0.000	0.000	0.007	0.072	0.087	0.328
Switzerland	0.796	9.472	0.823	9.144	0.826	7.246	0.977	11.184
Tunisia	0.531	4.967	0.541	3.360	0.525	3.088	0.576	4.081
United Kingdom	0.044	0.488	-0.030	-0.313	-0.020	-0.208	0.320	1.190
United States	0.649	9.407	0.669	8.577	0.671	8.714	0.814	6.520
Venezuela	0.005	0.037	0.089	1.508	0.115	1.855	-0.066	-0.515
Zaire	-0.017	-0.358	*	*	0.016	0.390	-0.180	-3.43
No of trade-offs significant (at 5%)		26		24		24		22

*not estimated because of the limited time series available

Table D - Correlation between the trade-offs

	BMR1	YC	IV
BMR2	0.882	0.801	0.733
BMR1	—	0.939	0.790
YC	—	—	0.864

Table E - Determinants of the output-inflation trade-off
(i) BMR's results

Independent Variable	Equation (1)	(2)	(3)	(4)	(5)	(6)
Constant	0.384	0.388	0.389	0.600	0.516	0.589
	(7.25)	(6.81)	(6.82)	(7.59)	(5.80)	(6.85)
Mean inflation	-1.347		-1.119	-4.835		-5.729
	(-3.66)		(-1.22)	(-4.5)		(-2.9)
Square of mean inflation				7.118		8.406
				(3.41)		(2.18)
Standard deviation of nominal GNP growth		-1.639	-0.322		-4.242	1.241
		(-3.4)	(-0.27)		(-2.81)	(0.50)
Square of standard deviation of nominal GDP growth					7.455	-2.380
					(1.81)	(-0.34)
Summary statistics:						
R-bar squared	0.228	0.201	0.210	0.388	0.243	0.359
Standard error	0.241	0.245	0.244	0.215	0.239	0.219

Numbers in brackets are *t*-ratios.

Table F - Determinants of the output-inflation trade-off
(ii) new data, BMR's specifications

	Equation					
Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	0.369	0.452	0.393	0.554	0.615	0.660
	(7.079)	(5.004)	(4.416)	(8.125)	(3.023)	(3.788)
	(6.650)	(5.411)	(4.951)	(7.555)	(3.175)	(3.763)
Mean inflation	-0.007		-0.006	-0.032		-0.038
	(-3.57)		(-2.383)	(-4.519)		(-4.435)
	(-4.57)		(-3.165)	(-4.811)		(-4.966)
Square of mean inflation				0.0003		0.0004
				(3.650)		(3.853)
				(3.875)		(3.365)
Standard deviation of nominal GNP growth		-0.310	-0.053		-0.748	-0.255
		(-2.489)	(-0.333)		(-1.480)	(-0.585)
		(-3.728)	(-0.509)		(-1.739)	(-0.682)
Square of standard deviation of nominal GDP growth					0.217	0.204
					(0.895)	(1.023)
					(1.194)	(1.307)
Summary statistics:						
R-bar squared	0.219	0.110	0.201	0.399	0.106	0.403
Standard error	0.271	0.290	0.274	0.238	0.290	0.237
Diagnostics:						
Functional form test (F=Fail)	F	F		F		F

Numbers in brackets are *t*-ratios: calculated using standard errors and White's adjusted standard errors respectively.

Table G - Determinants of the output-inflation trade-off
(iii) using instrumental variables

	Equation					
Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	0.400	0.505	0.453	0.565	0.709	0.744
	(7.523)	(5.592)	(5.012)	(7.834)	(3.503)	(4.003)
	(7.237)	(6.242)	(5.592)	(8.818)	(4.061)	(4.496)
Mean inflation	-0.007		-0.006	-0.030		-0.319
	(-3.518)		(-2.096)	(-3.919)		(-3.537)
	(-4.788)		(-3.095)	(-5.067)		(-4.966)
Square of mean inflation				0.0003		0.0003
				(3.083)		(3.053)
				(3.972)		(4.321)
Standard deviation of nominal GNP growth		-0.346	-0.117		-0.893	-0.465
		(-2.780)	(-0.723)		(-1.778)	(-1.001)
		(-4.248)	(-1.180)		(-2.268)	(-1.224)
Square of standard deviation of nominal GDP growth					0.217	0.204
					(1.124)	(1.215)
					(1.614)	(1.654)
Summary statistics:						
R-bar squared	0.213	0.138	0.204	0.348	0.144	0.342
Standard error	0.277	0.289	0.278	0.252	0.288	0.253
Diagnostics:						
Functional form test (F=Fail)	F		F	F		F

Numbers in brackets are *t*-ratios: calculated using standard errors and White's adjusted standard errors respectively.

Table H - Experimenting with functional form
(i) the square of the output-inflation trade-off

Independent Variable	Equation (1)	(2)	(3)	(4)	(5)	(6)
Constant	0.244	0.316	0.289	0.345	0.459	0.485
	(6.149)	(4.819)	(4.285)	(6.174)	(3.112)	(3.349)
	(5.579)	(4.978)	(4.894)	(5.295)	(3.565)	(3.808)
Mean inflation	-0.004		-0.003	-0.018		-0.018
	(-2.785)		(-1.497)	(-3.071)		(-2.626)
	(-4.252)		(-3.179)	(-3.618)		(-3.045)
Square of mean inflation				-0.0002		0.0002
				(2.436)		(2.311)
				(3.042)		(2.848)
Standard deviation of nominal GNP growth		-0.220	-0.099		-0.602	-0.370
		(-2.437)	(-0.817)		(-1.646)	(-1.024)
		(-3.632)	(-1.600)		(-2.358)	(-1.444)
Square of standard deviation of nominal GDP growth					0.189	0.185
					(1.076)	(1.114)
					(1.818)	(1.788)
Summary statistics:						
R-bar squared	0.139	0.105	0.132	0.231	0.109	0.216
Standard error	0.207	0.210	0.207	0.195	0.210	0.197
Diagnostics:						
Functional form test	F			F		F
Normality test	F	F		F	F	F
(F=Fail)						

Numbers in brackets are *t*-ratios: calculated using standard errors and White's adjusted standard errors respectively.

Table I - Experimenting with functional form
(i) the reciprocal of the output-inflation trade-off

	Equation					
Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	4.966	1.512	4.367	1.268	-0.356	1.747
	(0.795)	(0.147)	(0.409)	(0.135)	(-0.015)	(0.071)
	(0.969)	(0.139)	(0.349)	(0.160)	(-0.016)	(0.072)
Mean inflation	0.325		0.310	0.833		0.925
	(1.388)		(0.966)	(0.845)		(0.770)
	(1.154)		(0.986)	(0.631)		(0.732)
Square of mean inflation				-0.006		-0.007
				(-0.531)		(-0.533)
				(-0.382)		(-0.431)
Standard deviation of nominal GNP growth		13.789	1.330		18.807	-1.796
		(0.976)	(0.070)		(0.325)	(-0.029)
		(0.707)	(0.052)		(0.280)	(-0.029)
Square of standard deviation of nominal GDP growth					-2.485	-0.578
					(-0.089)	(-0.020)
					(-0.068)	(-0.015)
Summary statistics:						
R-bar squared	0.022	-0.001	-0.003	0.004	-0.026	-0.048
Standard error	32.491	32.865	32.890	32.789	32.270	33.620
Diagnostics:						
Functional form test				F	F	F
Normality test	F	F	F	F	F	F
(F=Fail)						

Numbers in brackets are *t*-ratios: calculated using standard errors and White's adjusted standard errors respectively.

Table J - The effect of the speed of inflation change (i)

Independent Variable	Equation (1)	(2)	(3)	(4)	(5)	(6)
Constant	0.410	0.412	0.420	0.563	0.612	0.731
	(7.619)	(4.293)	(4.242)	(7.665)	(3.094)	(3.898)
	(7.293)	(4.879)	(4.955)	(8.076)	(3.695)	(4.386)
Mean inflation	-0.002		-0.002	-0.028		-0.028
	(-0.400)		(-0.410)	(-2.713)		(-2.723)
	(-0.858)		(-0.933)	(-4.156)		(-4.345)
Square of mean inflation				0.0003		0.0004
				(2.820)		(2.946)
				(3.902)		(4.260)
Standard deviation of nominal GNP growth		-0.008	-0.023		-0.547	-0.437
		(-0.040)	(-0.118)		(-1.085)	(-0.933)
		(-0.052)	(-0.158)		(-1.446)	(-1.136)
Square of standard deviation of nominal GDP growth					0.266	0.282
					(1.157)	(1.305)
					(1.666)	(1.632)
Average inflation change	-0.012	-0.016	-0.011	-0.003	-0.016	0.010
	(-1.100)	(-2.229)	(-0.823)	(-0.293)	(-2.230)	(-0.771)
	(-2.028)	(-2.531)	(-1.344)	(-0.393)	(-2.159)	(-1.531)
Summary statistics:						
R-bar squared	0.217	0.214	0.197	0.333	0.221	0.335
Standard error	0.276	0.276	0.279	0.255	0.275	0.254
Diagnostics:						
Functional form test:	F	F	F	F	F	F

Numbers in brackets are *t*-ratios calculated using standard errors and White's adjusted standard errors respectively.

Table K - The effect of the speed of change in inflation

(ii) a *proportional* measure

Independent Variable	Equation (1)	(2)	(3)	(4)	(5)	(6)
Constant	0.424	0.491	0.462	0.608	0.697	0.761
	(5.370)	(4.753)	(4.613)	(6.560)	(3.377)	(4.042)
	(5.659)	(5.339)	(5.374)	(6.906)	(3.837)	(4.451)
Mean inflation	-0.007		-0.006	-0.030		-0.034
	(-3.506)		(-2.061)	(-3.958)		(-3.590)
	(-4.695)		(-2.973)	(-4.817)		(-4.759)
Square of mean inflation				0.0003		0.0003
				(3.121)		(3.127)
				(3.823)		(4.210)
Standard deviation of nominal GNP growth		-0.349	-0.107		-0.921	-0.380
		(-2.765)	(-0.633)		(-1.800)	(-0.792)
		(-4.382)	(-1.069)		(-2.426)	(-0.999)
Square of standard deviation of nominal GDP growth					0.282	0.237
					(1.152)	(1.097)
					(1.740)	(1.505)
Proportional average inflation change	-0.041	0.031	-0.024	-0.067	0.044	-0.073
	(-0.409)	(0.300)	(-0.235)	(-0.741)	(0.425)	(-0.756)
	(-0.530)	(0.784)	(-0.389)	(-1.112)	(1.247)	(-1.273)
Summary statistics:						
R-bar squared	0.197	0.118	0.185	0.340	0.126	0.335
Standard error	0.279	0.293	0.282	0.253	0.292	0.254
Diagnostics:						
Functional form test	F		F	F		F

Numbers in brackets are t-ratios calculated using standard errors and White's adjusted standard errors respectively.

Table L - Using instrumental variables, excluding high inflation countries

Independent Variable	Equation (1)	(2)	(3)	(4)	(5)	(6)
Constant	0.774	0.581	0.826	0.965	0.855	1.494
	(6.764)	(4.323)	(5.153)	(4.036)	(1.096)	(2.216)
Mean inflation	-0.058		-0.056	-0.117		-0.134
	(-3.574)		(-3.474)	(-1.646)		(-1.858)
Square of mean inflation				0.004		0.005
				(0.779)		(1.031)
Standard deviation of nominal GNP growth		-0.405	-0.132		-1.403	-1.600
		(-1.791)	(-0.590)		(-0.496)	(-0.717)
Square of standard deviation of nominal GDP growth					0.813	1.149
					(0.357)	(0.636)

Numbers in brackets are *t*-ratios calculated using Huber standard errors.

Table M - Using instrumental variables, excluding low inflation countries

Independent Variable	Equation (1)	(2)	(3)	(4)	(5)	(6)
Constant	0.259 (4.770)	0.314 (4.305)	0.291 (4.178)	0.366 (5.018)	0.442 (2.806)	0.474 (2.962)
Mean inflation	-0.004 (-3.879)		-0.003 (-2.502)	-0.016 (-3.601)		-0.018 (-3.174)
Square of mean inflation				0.0001 (2.961)		0.0002 (2.880)
Standard deviation of nominal GNP growth		-0.208 (-3.240)	-0.072 (-0.902)		-0.540 (-1.545)	-0.267 (-0.738)
Square of standard deviation of nominal GDP growth					0.161 (1.089)	0.140 (0.981)

Numbers in brackets are *t*-ratios calculated using Huber standard errors.

Table N - Using instrumental variables, adding the speed of inflation change, and excluding high inflation countries

Independent Variable	Equation (1)	(2)	(3)	(4)	(5)	(6)
Constant	0.786 (6.955)	0.513 (3.899)	0.716 (4.869)	1.128 (4.864)	0.698 (1.091)	1.571 (2.494)
Mean inflation	-0.042 (-2.957)		-0.039 (-2.784)	-0.138 (-2.084)		-0.154 (-2.421)
Square of mean inflation				0.007 (1.320)		0.008 (1.685)
Standard deviation of nominal GNP growth		0.337 (0.985)	0.189 (0.677)		-0.342 (-0.151)	-1.462 (-0.714)
Square of standard deviation of nominal GDP growth					0.550 (0.302)	1.373 (0.811)
Average inflation change	-0.036 (-1.809)	-0.089 (-2.666)	-0.048 (-2.069)	-0.050 (-2.248)	-0.089 (-2.696)	-0.067 (-2.793)

Numbers in brackets are *t*-ratios calculated using Huber standard errors.

Table O - Using instrumental variables, adding the speed of inflation change, and excluding low inflation countries

	Equation					
Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	0.267 (4.956)	0.259 (3.468)	0.262 (3.376)	0.359 (4.855)	0.374 (2.416)	0.457 (2.874)
Mean inflation	-0.0005 (-0.264)		-0.0004 (-0.237)	-0.013 (-2.430)		-0.014 (-2.471)
Square of mean inflation				0.0001 (2.619)		0.0002 (2.835)
Standard deviation of nominal GNP growth		0.016 (0.135)	0.012 (0.102)		-0.284 (-0.801)	-0.234 (-0.652)
Square of standard deviation of nominal GDP growth					0.143 (1.020)	0.157 (1.049)
Average inflation change	-0.009 (-1.936)	-0.011 (-2.218)	-0.010 (-1.487)	-0.005 (-0.843)	-0.010 (-1.986)	-0.009 (-1.947)

Numbers in brackets are *t*-ratios calculated using Huber standard errors.

Table P - Using instrumental variables, adding the *proportional* speed of inflation change, and excluding high inflation countries

	Equation					
Independent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	0.881	0.580	0.885	1.337	0.855	1.872
	(6.371)	(4.201)	(5.300)	(4.863)	(1.097)	(2.762)
Mean inflation	-0.063		-0.063	-0.187		-0.204
	(-3.688)		(-3.713)	(-2.452)		(-2.808)
Square of mean inflation				0.008		0.009
Standard deviation of nominal GNP growth		-0.406	-0.014		-1.408	-1.726
		(-1.859)	(-0.062)		(-0.497)	(-0.805)
Square of standard deviation of nominal GDP growth					0.815	1.375
					(0.357)	(0.786)
Proportional average inflation change	-0.128	0.001	-0.126	-0.201	0.003	-0.203
	(-2.149)	(0.037)	(-2.240)	(-2.996)	(0.090)	(-3.386)

Numbers in brackets are *t*-ratios calculated using Huber standard errors.

Table Q - Using instrumental variables, adding the *proportional* speed of inflation change, and excluding low inflation countries

Independent Variable	Equation (1)	(2)	(3)	(4)	(5)	(6)
Constant	0.417 (4.302)	0.350 (3.513)	0.421 (4.379)	0.487 (4.576)	0.445 (2.734)	0.493 (3.163)
Mean inflation	-0.004 (-4.274)		-0.006 (-2.538)	-0.015 (-3.164)		-0.023 (-4.391)
Square of mean inflation				0.0001		0.0002
Standard deviation of nominal GNP growth		-0.188 (-2.568)	-0.090 (0.698)		-0.513 (-1.507)	0.411 (0.874)
Square of standard deviation of nominal GDP growth					0.151 (1.090)	-0.069 (-0.398)
Proportional average inflation change	-0.324 (-1.736)	-0.105 (-0.461)	-0.417 (-1.624)	-0.275 (-1.400)	0.033 (-0.147)	-0.562 (-1.953)

Numbers in brackets are *t*-ratios calculated using Huber standard errors.

References

Ball, L (1992), 'Disinflation with imperfect credibility', *NBER Working Paper,* No 3,983.

Ball, L (1993a), 'What determines the sacrifice ratio?', *NBER Working Paper,* No 4,306.

Ball, L, Mankiw, N and Romer, D (1988), 'New Keynesian economics and the output-inflation trade-off', *Brookings Papers on Economic Activity,* 1.

Briault, C (1995), 'The costs of inflation', *Bank of England Quarterly Bulletin,* Vol 35, No 1, February.

Caballero, R and Engel, R (1991), 'Dynamic Ss economies', *Econometrica,* Vol 59, No 6.

Caballero, R and Engel, R (1993a), 'Microeconomic rigidities and aggregate price dynamics', *European Economic Review 37.*

Caballero, R and Engel, R (1993b), 'Microeconomic adjustment hazards and aggregate dynamics', *Quarterly Journal of Economics,* Vol 108, May.

Canzoneri, M B (1985), 'Monetary policy games and the role of private information', *American Economic Review,* Vol 75, No 5, December.

Caplin, A and Spulber, D (1987), 'Menu costs and the neutrality of money', *Quarterly Journal of Economics,* Vol 52, September.

Cozier, B and Wilkinson, G (1990), 'How large are the costs of disinflation in Canada?', *Bank of Canada Working Paper,* No 90-6.

Defina, R (1991), 'International evidence on a new Keynsian theory of the output-inflation trade-off', *Journal of Money, Credit and Banking 23 No 3,* August.

Garfinkel, M and Oh, S (1990), 'Strategic considerations in monetary policy with private information: can secrecy be avoided?", *Federal Reserve Bank of St Louis Review*, July/August.

Hall, S, Walsh, M and Yates, A (1996), 'How do UK companies set prices?', *Bank of England Quarterly Bulletin*, Vol 36, No 2, May.

Howitt, P (1990), 'Zero inflation as a long-term target for monetary policy in zero inflation: the goal of price stability' Ed R G Lipsey Toronto, *C D Howe Institute.*

King, M (1993), 'Debt deflation: theory and evidence', Presidential Lecture to EEA, August, Helsinki.

Laxton, D, Meredith, G and Rose, D (1995), 'Asymmetric effects of economic activity on inflation', *IMF Staff Papers*, Vol 42, No 2, June.

Lucas, R (1973), 'Some international evidence on output-inflation trade-offs', *Journal of Political Economy*, No 83.

Mayes, D and Chapple, B (1994), 'The costs and benefits of disinflation: a critique of the sacrifice ratio', *Reserve Bank Bulletin*, Vol 57, No 4.

Pesaran, M and Smith, R (1995), 'Estimating long-run relationships from dynamic heterogeneous panels', *Journal of Econometrics*, Vol 1.

Phelps, E (1978), 'Disinflation without recession: adaptive guideposts and monetary policy' in Phelps, *Studies in Macroeconomic Theory*, Vol 1, Chapter 4. Academic Press.

Posen, A (1994), 'Central bank independence and disinflationary credibility: a missing link', *Brookings Discussion Papers in International Economics*, No 109.

Sargent, T (1983), 'Stopping moderate inflations: the methods of Poincaré and Thatcher' in Dornbusch and Simonsen (eds), *Inflation, debt and indexation*, Cambridge, Massachusetts, MIT Press.

Schelde-Anderson, P (1992), 'OECD country experiences with disinflation' in Blundell-Wignell (ed) *Inflation, disinflation and monetary policy.* Reserve Bank of Australia: Ambassador Press.

Stein, J C (1989), 'Cheap talk and the Fed: a theory of imprecise policy announcements' *American Economic Review, Vol 79, No 1*, March.

Taylor, J (1983), 'Union wage settlements during a disinflation', *The American Economic Review*, Vol 73, No 5.

Tobin, J (1965), 'Money and economic growth', *Econometrica*, 33.

Walsh, C (1994), 'Central bank independence and the costs of disinflation in the EC', *University of California Working Paper.*

Walsh, C (1995), 'Is New Zealand's Reserve Bank Act of 1989 an optimal central bank contract?', *Journal of Money, Credit and Banking,* Vol 27, No 4, November.

Bank of England Working Paper Series

Publication date in italics

1	Real interest parity, dynamic convergence and the European Monetary System *(June 1992)*	Andrew G Haldane Mahmood Pradhan
2	Testing real interest parity in the European Monetary System *(July 1992)*	Andrew G Haldane Mahmood Pradhan
3	Output, productivity and externalities—the case of banking *(August 1992)*	R J Colwell E P Davis
4	Testing for short-termism in the UK stock market *(October 1992)*	David Miles
5	Financial deregulation and household saving *(October 1992)*	Tamim Bayoumi
6	An investigation of the effect of funding on the slope of the yield curve *(January 1993)*	D M Egginton S G Hall
7	A simple model of money, credit and aggregate demand *(April 1993)*	Spencer Dale Andrew G Haldane
8	Bank credit risk *(April 1993)*	E P Davis
9	Divisia indices for money: an appraisal of theory and practice *(April 1993)*	Paul Fisher Suzanne Hudson Mahmood Pradhan
10	The effect of official interest rate changes on market rates since 1987 *(April 1993)*	Spencer Dale
11	Tax specific term structures of interest rates in the UK government bond market *(April 1993)*	Andrew J Derry Mahmood Pradhan
12	Regional trading blocs, mobile capital and exchange rate co-ordination *(April 1993)*	Tamim Bayoumi Gabriel Sterne
13	Temporary cycles or volatile trends? Economic fluctuations in 21 OECD countries *(May 1993)*	Gabriel Sterne Tamim Bayoumi
14	House prices, arrears and possessions: A three equation model for the UK *(June 1993)*	F J Breedon M A S Joyce

15	Tradable and non-tradable prices in the UK and EC: measurement and explanation *(June 1993)*	C L Melliss
16	The statistical distribution of short-term libor rates under two monetary regimes *(September 1993)*	Bahram Pesaran Gary Robinson
17	Interest rate control in a model of monetary policy *(September 1993)*	Spencer Dale Andrew G Haldane
18	Interest rates and the channels of monetary transmission: some sectoral estimates *(September 1993)*	Spencer Dale Andrew G Haldane
19	The effect of futures trading on cash market volatility: evidence from the London stock exchange *(December 1993)*	Gary Robinson
20	M0: causes and consequences *(December 1993)*	F J Breedon P G Fisher
21	An empirical analysis of M4 in the United Kingdom *(December 1993)*	P G Fisher J L Vega
22	A model of building society interest rate setting *(June 1994)*	Joanna Paisley
23	Deriving estimates of inflation expectations from the prices of UK government bonds *(July 1994)*	Mark Deacon Andrew Derry
24	Estimating the term structure of interest rates *(July 1994)*	Mark Deacon Andrew Derry
25	Potential credit exposure on interest rate swaps *(August 1994)*	Ian Bond Gareth Murphy Gary Robinson
26	New currencies in the Former Soviet Union: a recipe for hyperinflation or the path to price stability? *(September 1994)*	C L Melliss M Cornelius
27	Inflation, inflation risks and asset returns *(November 1994)*	Jo Corkish David Miles

28	The construction of RPIY *(February 1995)*	R Beaton P G Fisher
29	Pricing deposit insurance in the United Kingdom *(March 1995)*	David Maude William Perraudin
30	Modelling UK inflation uncertainty: the impact of news and the relationship with inflation *(April 1995)*	M A S Joyce
31	Measuring core inflation *(April 1995)*	Danny T Quah Shaun P Vahey
32	An assessment of the relative importance of real interest rates, inflation and term premia in determining the prices of real and nominal UK bonds *(April 1995)*	David G Barr Bahram Pesaran
33	Granger causality in the presence of structural changes *(May 1995)*	Marco Bianchi
34	How cyclical is the PSBR? *(May 1995)*	Joanna Paisley Chris Salmon
35	Money as an Indicator *(May 1995)*	Mark S Astley Andrew G Haldane
36	Testing for convergence: evidence from nonparametric multimodality tests *(June 1995)*	Marco Bianchi
37	Wage interactions: comparisons or fall-back options *(August 1995)*	Jennifer C Smith
38	The microstructure of the UK gilt market (*September 1995*)	James Proudman
39	Valuation of underwriting agreements for UK rights issues: evidence from the traded option market (*September 1995*)	Francis Breedon Ian Twinn
40	Rules, discretion and the United Kingdom's new monetary framework (*November 1995*)	Andrew G Haldane
41	Optimal commitment in an open economy credibility vs flexibility (*December 1995*)	Sylvester Eijffinger Eric Schaling