Quantifying some benefits of price stability

By Hasan Bakhshi, Andrew G Haldane and Neal Hatch of the Bank's Monetary Analysis Divisions.

This article[1] quantifies some of the costs of inflation in the United Kingdom. It focuses in particular on tax distortions under an imperfectly indexed tax system and distortions to money demand. In the United States, a similar study found that lowering inflation by 2 percentage points could generate welfare benefits of as much as 1% of GDP per year forever. In the United Kingdom, the benefits are found to be smaller but still substantial, at 0.2% of GDP per year.

Introduction

Policy-makers pursue price stability because they believe that high and variable inflation rates are costly to the economy. A recent survey in the United States by Shiller (1996) found that the general public shares this aversion to high inflation. The costs that inflation imposes have been clearly identified and widely discussed. For example, the first London School of Economics Bank of England Lecture (1992), by Governor Leigh-Pemberton, articulated the following costs of fully anticipated inflation:

- the costs of operating a less than perfectly indexed tax system;
- the costs of economising on real money balances ('shoe-leather' effects);
- the costs of 'front-end loading' nominal debt contracts; and
- the costs of constantly revising price lists ('menu costs').

But quantifying these costs and their welfare implications is no easy matter.

Recent work in the United States by Feldstein (1996) has shed some quantitative light on the first two of the above costs. Feldstein calculated the benefits arising from an unindexed tax system and money demand distortions of a fall in US inflation from 4% to 2%.[2] He found that these benefits amounted to 1% of GDP each year. Since these benefits accrue into the infinite future, their present value—the sum of all future gains, suitably discounted—is potentially very significant indeed.

This article replicates Feldstein's analysis for the United Kingdom. It finds that the welfare benefits of a 2 percentage point reduction in inflation, though smaller than in the United States, are still material. They are equivalent to around 0.2% of GDP each year. Moreover, because these estimated benefits take no account of other well-known welfare costs of inflation—in particular the costs of unanticipated inflation, which many economists believe to be more important—they provide a strict lower bound on the benefits of reducing inflation.

The article begins with some general observations on the costs of inflation and how these costs can be identified analytically and quantified empirically. Later sections discuss the quantification of these costs in greater detail.

The costs of inflation: theory and evidence

(a) The permanent benefits and temporary costs of price stability

There are many theoretical studies of the costs of inflation.[3] But there is much less quantitative evidence about these costs. And what evidence there is does not give a clear indication that the costs of inflation are significant. For example, in a cross-section study of over 100 countries, Barro (1995) finds little relationship between inflation and economic growth at inflation rates below 10%, though at inflation rates above this there is evidence that inflation significantly hinders growth. Judson and Orphanides (1996) and Sarel (1996) reach similar conclusions.

But irrespective of the effect of lower inflation on an economy's *growth* rate, it can still lead to a permanent increase in the *level* of GDP. The resulting welfare gain may then have a large present value, even if its effect in any one year appears small. To give an example, consider Feldstein's estimate that reducing inflation by 2 percentage points generates a welfare benefit in the United States equivalent to 1% of GDP per year. To calculate the present value of this welfare gain, a rate at which to discount future

(1) The results in this article are drawn from a paper produced for a US National Bureau of Economic Research (NBER) conference on the Costs and Benefits of Price Stability held at the Federal Reserve Bank of New York in February 1997. A forthcoming Bank of England *Working Paper* will contain further details of the calculations described here.
(2) When account is taken of measurement bias in price indices this corresponds roughly to a fall in true inflation from 2% to 0%.
(3) Fischer and Modigliani (1975) is a classic treatment, and useful surveys are provided by Fischer (1981), Driffill, Mizon and Ulph (1990) and Briault (1995).

welfare benefits must be chosen, and allowance must be made for the fact that the level of GDP on which the welfare cost is being calculated grows over time.(1)

Assuming a real discount rate (r) of 5% and a trend rate of output growth (g) of 2.5%,(2) the present value of the annual welfare benefit (B) expressed as a percentage of GDP is calculated as:

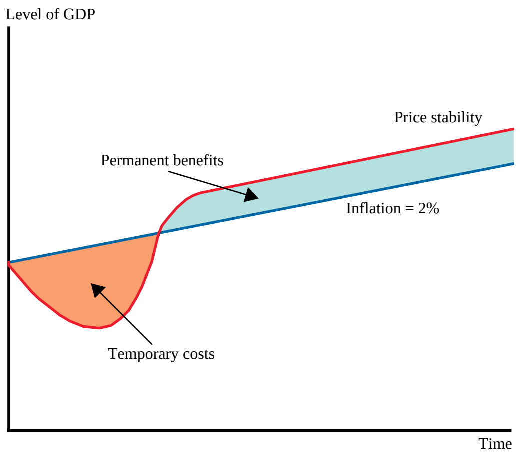
$$\begin{aligned} \text{Present value} &= B / (r - g) \quad \quad \textbf{(1)} \\ &= 1 / (0.05 - 0.025) \\ &= 40\% \text{ of initial GDP} \end{aligned}$$

So, suitably discounted, a welfare gain of as little as 1% of GDP per year can generate a total welfare benefit with a present value of 40% of initial annual GDP. Of course, there are uncertainties in such present value calculations. In particular, there is little consensus among economists on the appropriate rate at which to discount the welfare of future generations. But if anything, r = 5% is likely to be on the high side.(3) So 40% of initial GDP may be a conservative estimate of the welfare benefits that Feldstein finds for the United States.

Another factor supports the argument that the benefits of price stability could be significant: the benefits are *permanent*, but the disinflationary costs of achieving it are likely to be *temporary*. This is because disinflationary monetary policy is not thought to have any lasting impact on the level of output in the economy: money is neutral in the long run. So any welfare analysis of the costs and benefits of price stability is inevitably a comparison between the *static* or one-off costs of disinflation and the *dynamic* or permanent benefits of price stability. This stacks the cards heavily in favour of the pursuit of price stability. Using the US example above, reducing inflation by 2 percentage points would need to result in a cumulative loss of output of more than 40% of GDP to offset the benefits. Empirically, such an outcome is highly implausible.

Chart 1 illustrates these costs and benefits. The blue line plots the level of GDP on the assumption that inflation remains at 2% throughout: GDP grows steadily over time. The red line shows the path of the level of GDP assuming that inflation is reduced by 2 percentage points. This is associated with a temporary fall in the level of GDP. But in the long run, though the growth rate of GDP returns to trend, its level is permanently higher, reflecting the permanent welfare benefits of the reduction in inflation.(4) The undiscounted *net* welfare benefit is given by the sum of the shaded areas on either side of the blue line. Because the welfare benefit is permanent, and the cost temporary, this undiscounted welfare gain will be infinite, summing up into the indefinite future.

Chart 1
The costs and benefits of price stability



It is, however, necessary to allow for discounting of the welfare of future generations. Then the net welfare benefit is no longer infinite, reflecting the effects of discounting. Nor, indeed, is it necessarily positive. But as the example above made clear, for plausible discount rates and using the welfare benefits estimated by Feldstein for the United States, the total shaded area is likely to be positive: reducing inflation by 2 percentage points will yield a net welfare benefit.

(b) Inflation as a tax

The costs of inflation are typically divided into costs due to *anticipated* inflation and costs due to *unanticipated* inflation. Of these, the latter are often believed to be the more significant. For example, inflation ‘surprises’ and uncertainties are likely to increase relative price variability, distorting resource allocation; to cause arbitrary redistributions of income, for example from savers to borrowers; and to lead holders of long-maturity nominal assets to demand higher risk premia, increasing the cost of capital for firms.(5) But Feldstein’s work has shown that the welfare costs of fully anticipated inflation can also be significant.

The literature on the costs of fully anticipated inflation views its welfare effects as operating as a tax. This occurs through two channels. First, inflation acts like a tax because of its interaction with the less than fully indexed tax system. Second, inflation is a direct tax on holdings of money balances. Considering these in turn:

(i) Most tax systems around the world operate in nominal terms. As a result, assuming that *headline* tax rates are unchanged, *effective* tax rates alter as inflation changes, typically rising as inflation rises. A simple example illustrates this. Consider the *real* (that is, inflation-adjusted) return that investors receive after

(1) This is because the welfare benefit is calculated as a percentage of *initial* GDP.
(2) These are close to the values used by Feldstein (1996) in his US study.
(3) Microeconomic studies of discount rates often arrive at lower estimates; and some economists have argued that the welfare of future generations should not be discounted at all. This article presents some sensitivity analysis of the welfare benefits to the discount rate in a later section.
(4) Welfare gains are calculated as a percentage of GDP. But this does not mean that GDP necessarily changes by that amount in order to generate the increase in welfare.
(5) See the article on pages 285–91 for further details.

tax, where taxes are levied on the nominal amount they receive. The real post-tax return (ρ) is:

$$\rho = (r + \pi)(1 - \tau) - \pi \qquad (2)$$

where r is the real pre-tax return that investors receive, π is inflation and τ is the rate of tax investors pay on their return. Now substitute some numbers into (**2**) and consider the effects of inflation. Let the real pre-tax return be 2% and the tax rate be 20% (τ= 0.2).

At price stability (π = 0), investors earn a post-tax real return of 1.6%. But if inflation rises to 8% (π= 8) the investors' real return is wiped out: nothing is earned on the investment. In this way, inflation raises the effective tax rates faced by economic agents in countries with unindexed tax systems. This distorts the return on saving, which in turn distorts private sector saving decisions, with corresponding welfare costs.

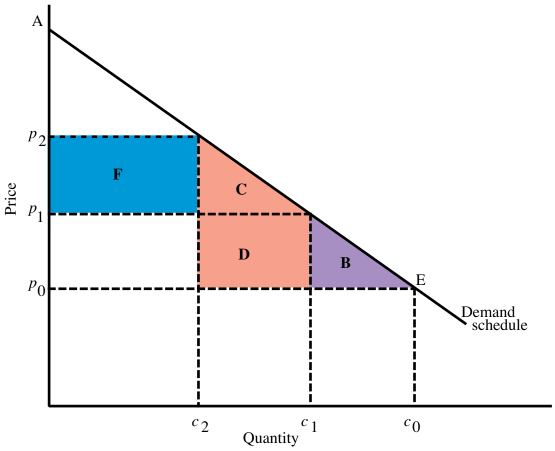
(ii) Inflation is a direct tax on holders of cash balances, because it erodes the real value of these balances. This induces the public to hold less currency than they otherwise would, which is costly in a welfare sense. This is often dubbed a 'shoe-leather' cost, because agents need to make more trips to the bank to replenish their currency holdings.

(c) Calculating direct welfare losses

Viewing inflation as a tax has one great advantage. It allows the welfare losses arising from inflation to be calculated directly using simple demand curve analysis. Welfare losses are captured by the area of unsatisfied demand underneath the demand curve, whenever the observed price of a good or service is different from what it would have been in the absence of the tax. This is easiest to illustrate graphically.

Chart 2 plots the demand curve for some good or service with demand on the horizontal axis and price on the vertical axis. In later sections the article will consider the specific examples of demand for retirement consumption, residential investment and money. But it is useful to start with a general example. In the absence of taxes and inflation, the price is p_0. Demand is then c_0 and market equilibrium is given by the point E. At this market equilibrium, agents earn a 'consumer surplus' equal to the triangle p_0 - E - A. This measures the excess that consumers would be willing to pay for that quantity over the amount they have to pay.

Chart 2
Calculating welfare losses



Now allow a direct tax to be levied that raises the price to p_1, while inflation remains at zero. Demand falls to c_1. The welfare loss is given by triangle B. This measures the amount of consumer surplus forgone as a result of the tax being imposed. It is a 'deadweight loss' of welfare, because the welfare loss that consumers suffer does not benefit anyone else.

Finally, imagine that inflation is allowed to rise and that this raises the effective tax rate on the good or service. The price now rises to p_2 and demand falls to c_2. This eats further into the consumer surplus, by the amount $C + D$. There is an additional deadweight loss, but it is a trapezium rather than a triangle. This deadweight loss trapezium measures the welfare loss consumers suffer as a result of the inflation tax, when it is operating in tandem with the unindexed tax system.

The calculations below quantify the welfare trapezium $C + D$. If the demand curve is a straight line, then simple geometry gives the area $C + D$ as:

$$C + D = (p_1 - p_0)(c_1 - c_2) + 0.5(p_2 - p_1)(c_1 - c_2) \quad (3)$$

In the calculations below, a modification of this formula is used that allows the welfare trapezium in Chart 2 to be expressed in terms of the three prices (p_0, p_1 and p_2), the slope (or elasticity, ε) of the demand curve, and the quantity demanded when there is both inflation and taxes, c_2:

$$C + D = \left[(p_1 - p_0) + 0.5(p_2 - p_1)\right] c_2 \varepsilon \left[\frac{(p_1 - p_2)}{p_2}\right] \qquad (4)$$

So by calculating the three prices in Chart 2 and the slope of the associated demand curve, it is possible to calibrate the likely welfare losses arising from the interaction between inflation and the unindexed tax system.

(d) Accounting for government revenue effects

Taxes do not simply alter the prices and quantities of goods demanded; they also raise revenue for the government. By changing the effective tax rate, reducing inflation will have implications for government revenue. If this change in government revenues could be offset by raising (or lowering) other taxes that have no effect on agents' behaviour at the margin, then the total welfare effect of a change in inflation would still be captured by the trapezoidal area outlined above.

But in practice most taxes, such as income tax and value-added tax, distort economic decisions. This means that a change in inflation that alters government revenues will have wider welfare implications than just the deadweight loss trapezium.(1) In Chart 2 the inflation tax ($p_2 - p_1$) yields extra revenue to the government equal to the area F, owing to the effectively higher tax *rate*. But the higher tax rate also raises the price and hence reduces demand, lowering the tax *base*: there is an offsetting revenue loss equal to the area D. The net revenue gain from inflation is simply the area $F - D$, which is given by:

$$F - D = (p_2 - p_1)\, c_2 - (p_1 - p_0)\,(c_1 - c_2) \qquad \textbf{(5)}$$

This change in revenue can be either positive or negative, reflecting the opposing effects of lower inflation on the tax rate and the tax base. As with the trapezium calculation, it can be computed using the three prices and the slope of the demand schedule.(2)

To calculate the *welfare loss* (or *gain*) associated with this change in government finances, the revenue change needs to be scaled. The scaling variable measures the loss of welfare resulting from every extra pound of taxation that needs to be raised to fill any financing gap induced by lower inflation. This is termed the deadweight loss parameter. In the central case below, this parameter is set at 0.4.(3) This implies that if a fall in inflation lowers government revenues by £1, then in raising other taxes to make good this shortfall there will be an associated welfare loss of 40 pence. This indirect welfare loss needs to be offset against the direct welfare gain to arrive at the *net* welfare change arising from lower inflation.

In the following sections, the direct welfare losses and revenue changes are calculated for consumption, housing investment and money demand behaviour. The welfare effects of a change in inflation on government debt servicing are also considered. In line with Feldstein, the following policy question is posed in each section: what are the welfare implications of a 2 percentage point reduction in inflation?

Quantifying the effects of inflation on consumption

The direct welfare benefits of reducing inflation

Households have two main expenditure decisions to make in each period: how much to consume in goods and services and how much to invest in housing. This section quantifies distortions to consumption behaviour, and the next considers distortions to housing investment. Consumption distortions arise because inflation reduces the real post-tax return that savers receive, as the earlier example illustrated. Put differently, inflation raises the effective price of consuming when retired, through its effect on the return to saving. This then lowers consumption when retired, which has a welfare cost.

In this framework, saving can be thought of as investment expenditure when young to finance consumption expenditure when retired. The price of this 'retirement consumption' is then inversely related to the rate of return on saving: an increase in the rate of return on saving permits more retirement consumption for a given level of saving, which is equivalent to a fall in the price of retirement consumption. So calculating the price of retirement consumption requires estimates of the rate of return on saving. Three estimates of the rate of return are needed: with no taxes and no inflation, with taxes and no inflation, and finally with taxes and inflation.

So, from (**4**), the welfare cost of this consumption distortion can be calculated from the three rates of return on saving and from an estimate of the interest elasticity of saving (the slope of the saving demand schedule). The saving channel captured here is the flow of investment funds from domestic households to domestic companies.(4) Domestic households are assumed to own all the capital of domestic firms. So the return on households' saving is a reflection of firms' return on capital. This flow-of-funds channel is reflected in the choice of rates of return on saving used in calculating welfare costs.

In a world with no taxes, the rate of return on firms' capital would exactly equal the rate of return that households earn on their saving, since domestic households own all domestic firms. There would be no distortionary 'tax wedge' between these two returns. So a proxy for the rate of return on saving in the no-tax world (which can be used to calculate the price of retirement consumption—the equivalent of p_0 in Chart 2) is provided by the pre-tax real rate of return on capital among industrial and commercial companies. Between 1970 and 1995, the period used in this study, this real average rate of return was 8.2%.

Now consider a world with taxes and with 2% inflation. Calculating the return on saving in this world requires some adjustment for various tax wedges between the pre-tax return earned by companies and the post-tax real return received by individuals. There are two such wedges: the first reflecting *corporate* taxes on companies' profits; the second *personal* taxes when these profits are dispersed to households.

Some countries, notably the United States, operate a 'classical' tax system. Under this system, dividend payments are taxed twice, at the corporate level and at the personal level. By contrast, the United Kingdom operates an 'imputation' tax system which provides protection against the double taxation of dividends through Advance Corporation Tax (ACT) credits. So the estimate of the

(1) This is a point first emphasised by Phelps (1973).
(2) The analytical expression is presented in the forthcoming *Working Paper* version of this article.
(3) The estimate of 0.4 is based on a previous study (Ballard *et al* (1985)) and on a small calibrated general equilibrium model. A higher value is used below as part of a sensitivity analysis. A value of 1.5 is selected to maintain consistency with Feldstein (1996). Again, further details are in the forthcoming *Working Paper*.
(4) This article does not consider open economy distortions. These are discussed in Desai and Hines (1997).

corporate tax rate used here measures the additional tax paid by companies over and above ACT payments.[1] In 1995, the base year for the computations, this tax was around 22% of firms' pre-tax profits. Netting this off the pre-tax rate of return gives a rate of return, after corporate taxes, of 6.4%.

The personal tax wedge paid by households depends on how saving income is received—as dividends, capital gains or bond interest income—and on the tax status of the individual. To arrive at the average marginal tax rate, the marginal tax rates for each of the three types of income are weighted together.

At this stage no adjustment is made for tax-exempt saving, which is important in the United Kingdom. In effect, it is assumed that marginal saving flows into taxable assets. This assumption is discussed further below and alternative estimates based on different assumptions about the importance of tax-exempt saving at the margin are presented. Making no adjustment for tax-exempt saving gives an estimated average marginal individual tax rate of 23%.[2] This implies a real post-tax rate of return to UK savers of around 4.9% (which can be used to calculate p_2 in Chart 2). The estimated wedge between pre and post-tax returns in the United Kingdom (3.3 percentage points) is around two thirds of that in the United States (5.1 percentage points). This largely reflects the difference between the United Kingdom's imputation tax system and the classical system in the United States, and it has important implications for the estimated welfare costs.

Finally, it is necessary to calculate how the post-tax return on saving would be affected by a 2 percentage point reduction in inflation. There are inflation non-neutralities in both the corporate and personal tax systems in the United Kingdom. For companies, these have three sources:

- Since 1984 UK companies have received no stock relief: any nominal capital gains made on stocks as a result of general price level rises are treated as taxable profit. This means that the effective corporate tax rate rises with inflation.

- Depreciation allowances are based on historic cost asset valuations and so are reduced in real terms by inflation. This also raises the effective corporate tax rate with inflation.

- Acting against the first two effects, nominal debt interest payments are tax-deductible, thereby lowering the effective corporate tax rate with inflation.[3]

Bond, Devereux and Freeman (1990) calibrate these inflation non-neutralities using micro-level data drawn from company accounts, and a modified version of their corporate tax ready-reckoner is used here.

On the personal sector side, inflation non-neutralities in the tax system depend crucially on the debt-equity-deposit composition of the household sector's portfolio. For deposit and corporate bond income, there are significant inflation non-neutralities, because *nominal* interest income is taxed. But that is not the case with equity, as UK capital gains tax has been indexed since 1985. This effectively neutralises any effect from inflation on equity income—unlike, for example, in the United States. The relatively high weight of equity in the UK household sector's balance sheet means that the effect of inflation on the personal sector tax wedge is somewhat smaller in the United Kingdom than in the United States.[4] Nonetheless, a 2 percentage point reduction in inflation is still estimated to raise the post-tax rate of return to individuals by around 0.25 percentage points to around 5.2%, owing to personal and corporate sector tax non-neutralities. (This estimate can be used to calculate p_1.) By comparison, in the United States the rise in the return to saving is double that, at around 0.50 percentage points.

Having identified the three rates of return, all that is now required to calculate the welfare loss is an estimate of the interest elasticity of saving—the slope of the saving schedule. There is a good deal of academic controversy about this parameter. Most studies of UK saving behaviour point to elasticities close to zero, where the income and substitution effects of an interest rate change are broadly offsetting. This is the central estimate used in this analysis, though calculations have also been made using a range of saving elasticities. Note that a zero saving elasticity does not eliminate the potential welfare benefits from price stability. Even if a higher return does not induce additional saving, it will still serve to increase income receipts on existing saving, thereby boosting consumption and welfare.

Using the central assumption of a zero saving elasticity and the three rates of return in (**4**), the direct welfare gain from reducing inflation by 2 percentage points is estimated at 0.35% of GDP (see the table). Making a comparable assumption for the United States, the gain is around 0.75% of GDP. This difference is largely because the UK tax system is less susceptible to inflation-induced distortions, especially as regards equity income. The table also shows estimates of the welfare gain using different values for the saving elasticity.

The indirect revenue and net welfare effects

Because reducing inflation alters effective corporate and personal tax rates, it also has implications for tax revenue. Lower inflation reduces effective tax rates (with a negative effect on revenues) but raises the tax base as saving rises (with positive revenue effects). It is an empirical question which of these two offsetting factors dominates.

(1) The effective corporate tax wedge is not zero because corporate tax rates are generally higher than household sector tax rates and because not all profits are distributed as dividends.
(2) Further details of the tax rates and the weights attaching to them are contained in the forthcoming *Working Paper*.
(3) In the United States, only the second and third of these effects are relevant.
(4) Pension fund and insurance company holdings are included in the household sector's balance sheet.

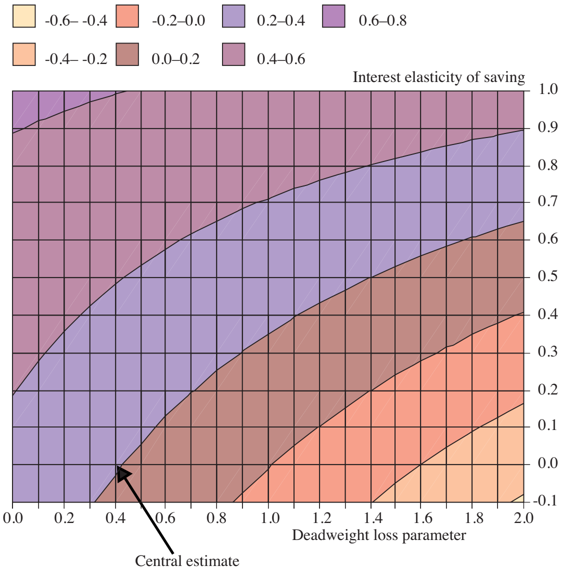
The welfare effects of a 2 percentage point reduction in UK inflation

Measured as a percentage of GDP

Source of change		Direct welfare effect of reduced distortion	Indirect welfare effect of revenue change		Net welfare effect	
			$\lambda = 0.4$	$\lambda = 1.5$	$\lambda = 0.4$	$\lambda = 1.5$
Consumption timing	$\eta_{sr} = 0.2$	0.40	-0.12	-0.43	0.29	-0.03
	$\eta_{sr} = 0.0$	0.35	-0.14	-0.51	0.21	-0.17
	$\eta_{sr} = 0.4$	0.46	-0.09	-0.35	0.37	0.11
Housing demand		0.04	0.07	0.27	0.11	0.30
Money demand		0.02	-0.05	-0.17	-0.02	-0.15
Debt service		n/a	-0.09	-0.33	-0.09	-0.33
Total	$\eta_{sr} = 0.2$	0.47	-0.18	-0.67	0.29	-0.20
	$\eta_{sr} = 0.0$	0.41	-0.20	-0.75	0.21	-0.34
	$\eta_{sr} = 0.4$	0.52	-0.16	-0.59	0.37	-0.06

Notes:
n/a = not applicable.
η_{sr} is the interest elasticity of saving.
λ is the marginal deadweight loss parameter.

Chart 3
Net welfare benefits from consumption (as a percentage of GDP)



Substituting the estimated rates of return to saving and the central estimate for the interest elasticity of saving into (**5**), the reduction in inflation by 2 percentage points results in a loss of government revenue of around 0.34% of GDP. This revenue loss is scaled using the deadweight loss parameter of 0.4 discussed earlier, giving a welfare loss of 0.14% of GDP. So the *net* welfare gain from a 2 percentage point reduction in inflation is 0.21% of GDP, evaluated with a zero saving elasticity and a deadweight loss parameter of 0.4. The results are shown in the table, together with estimates based on alternative estimates of the saving elasticity (0.2 and 0.4) and deadweight loss parameter (1.5).

Chart 3 illustrates more generally the sensitivity of the welfare calculations to different assumptions about the saving elasticity and deadweight loss parameter. For any given pair of parameter values, there is a point on the contour map that shows the size of the net welfare gain from a 2 percentage point reduction in inflation. It is evident that relatively small adjustments to the central assumptions—in particular regarding the deadweight loss parameter—can markedly alter the estimated net welfare gain. But the net welfare benefit in the central case is still non-trivial, at around 0.2% of GDP, even when the saving elasticity is assumed to be low.

Clearly, there are a number of uncertainties about such an estimate. For example, the calculations take no account of the role of non-savers (which would increase the estimates); they make no allowance for the effects of social security income during retirement (which would reduce the estimates); and they make restrictive assumptions about the pattern of company financing by banks (which, if altered, would also reduce the estimates).(1) Perhaps most importantly, the calculations make no allowance for tax-exempt saving vehicles.

The analysis so far has assumed that all marginal saving flows into taxable assets. In practice, a relatively high proportion of personal sector saving is held in a tax-exempt form. Only just over one third of equity holdings are estimated to be held directly and subject to tax. Another two fifths are tax-exempt because they are held via pension funds, pension business of life assurers and in Personal Equity Plans. The remainder are held via non tax exempt unit trusts and non-pension business of life assurers. The average marginal individual tax rate on (weighted) dividends, bond interest, deposit income and capital gains was 23% before adjusting for tax-exempt saving. This falls to just under 15% after allowing for tax-exempt saving, on the assumption that marginal saving flows follow existing average portfolio shares. This fall in the effective tax rate is sufficient to reduce the net welfare gain by 0.07% of GDP to 0.14%. So the choice of destination for marginal saving is important to the welfare calculations. Indeed, if all saving flowed into tax-exempt vehicles then the welfare gain arising from the effects of lower inflation on saving behaviour would be zero.

But this would almost certainly overestimate the effects of tax-exempt saving vehicles. There are restrictions on the quantity of saving allowed to flow into tax-exempt assets. For example, there are ceilings on the amount that can be invested in Tax Exempt Special Saving Accounts (TESSAs), and restrictions on the Additional Voluntary Contributions (AVCs) that can flow into a personal pension. Further, ACT credits to pension funds were abolished with immediate effect in the July 1997 Budget. These institutional features help to justify the main case, under which saving flows into taxable assets.

(1) The forthcoming *Working Paper* version of this article quantifies each of these effects.

Quantifying the effects of inflation on housing investment

The direct welfare effects of reducing inflation

The deadweight loss calculations carried out for housing investment use the same basic tools as for consumption. But the distortions to behaviour are subtly different. These distortions arise because of the availability of interest relief on mortgage payments in the United Kingdom, which is normally implemented through Mortgage Interest Relief At Source (MIRAS). Similar distortions exist in the United States. By reducing mortgage costs, tax relief serves as a subsidy on housing investment in the United Kingdom. This induces over-investment in housing by the public. And this distortion, in turn, gives rise to a welfare loss.

Moreover, because tax relief is levied on *nominal* interest payments, the effective extent of this subsidy—and hence welfare loss—rises with inflation. The real value of the mortgage subsidy in the United Kingdom has actually been eroded since a limit was first introduced in 1974: the nominal ceiling for the subsidy has risen only once over the period but the rate of tax relief was cut on a number of occasions, reaching 15% in financial year 1995/96.(1) In the July 1997 Budget, the rate of MIRAS was reduced again, to 10% effective from April 1998. This would further reduce the distortions identified here since our calculations are based on the 1995 tax system. But the potential welfare loss associated with this tax distortion may nonetheless be non-trivial.

To calculate the welfare loss it is necessary to estimate the 'user cost' of housing for agents: the cost of the service flow agents receive from housing investment. As with the earlier calculations, this user cost needs to be calculated with and without taxes and inflation. In the absence of taxes, the user cost of housing comprises: an interest rate, reflecting the cost of the mortgage or, equivalently, the opportunity cost of investing in housing; the continuing cost of maintaining the house; transactions costs; and an allowance for housing depreciation. Using estimates for these components(2) gives a user cost of 9.6 pence per pound of housing investment in a world with no taxes.

Now consider a world with both taxes and inflation. For owner-occupiers who are able to claim full MIRAS on their mortgages, the user cost of housing is reduced by the amount of the mortgage scaled by the rate of tax relief. This yields a user cost of housing of 6.9 pence per pound of housing capital, using the average rate of MIRAS prevailing in 1995 (16%). Predictably, this user cost is lower than that in the no-tax world.

Finally, consider the user cost when taxes remain but inflation is reduced by 2 percentage points. This increases the user cost of housing, because the effective extent of the housing subsidy is reduced. The reduction in this subsidy occurs through two channels: a direct channel whereby lower inflation reduces the real value of MIRAS; and an indirect channel as lower inflation increases the opportunity cost of housing (post-tax return on alternative non-housing investments). Together these have the effect of raising the user cost of housing to around 7.2 pence per pound of housing capital when inflation is reduced by 2 percentage points.

In practice, the ceiling for mortgage interest relief is well below the average price of a house. This means that relatively few owner-occupiers are able to claim tax relief on the full value of their house. But it is possible to derive a user cost for the part of the owner-occupied housing stock that lies above the MIRAS ceiling. This yields an estimated user cost of 7.5 pence per pound of housing capital with inflation, rising to 7.6 pence when inflation is 2 percentage points lower. Not surprisingly, the distortion to the user cost is smaller than for loans eligible for MIRAS. But there is still some distortion because of the effect of inflation on the opportunity cost of non-housing assets. These MIRAS and non-MIRAS components of the housing stock can then be weighted together to give an average user cost for all owner-occupiers following a 2 percentage point reduction in inflation.(3)

Completing the welfare calculation requires an estimate of the elasticity of the housing stock with respect to the user cost. A value of 0.4 is used, in line with a previous study (King (1980)). Using this and the three user cost estimates, the direct welfare gain associated with a 2 percentage point reduction in inflation is calculated to be 0.04% of GDP (see the table). This is around one quarter of the size of Feldstein's estimate for the United States. The difference reflects the somewhat smaller mortgage interest relief available under the current UK tax system, with its relatively low nominal ceiling and low rate of tax relief.

The indirect revenue and net welfare effects

The reduction in inflation, through its effect on housing demand, also affects government revenue in the following four ways:

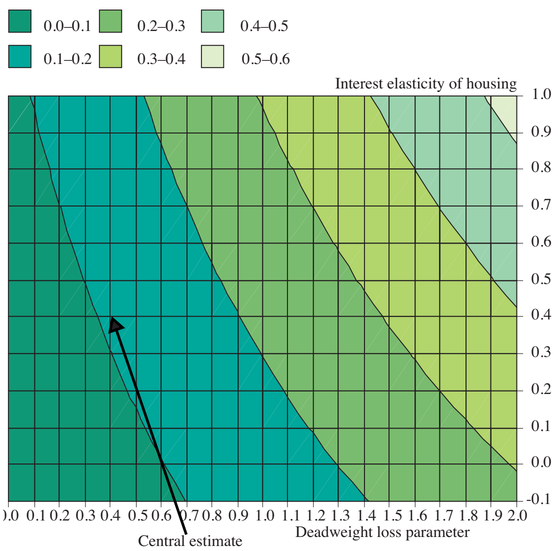
- A reduction in inflation lowers nominal mortgage interest payment *flows* and hence the value of the tax relief subsidy.
- A reduction in the nominal *stock* of mortgages (compared with what it would have been had inflation been higher) reduces the cost of tax relief.
- A reduction in the stock of properties lowers council tax receipts.
- A transfer of capital from residential housing to the business sector increases tax revenue, because the increase in business capital yields a return that is subject to tax.

(1) Relief was first given at source in 1983, when the limit was raised to £30,000.
(2) Based on Robinson and Skinner (1989) and the 1995 RPI Advisory Committee Report.
(3) The rental sector is also considered in the calculations and is discussed in detail in the forthcoming *Working Paper*.

The estimated net effect of these changes is to *raise* revenue by around £1.25 billion per year. Multiplying this by the deadweight loss parameter and adding it to the direct welfare gain produces a net welfare gain of 0.11% of GDP (see the table), less than half Feldstein's estimate of the corresponding figure for the United States. This is not surprising given the gradual erosion in the real value of mortgage subsidies in the United Kingdom over the past 20 years.

Chart 4 offers some sensitivity analysis of the results, plotting welfare gains against the housing user cost elasticity and the deadweight loss parameter. As in Chart 3, any combination of the two parameters is associated with a point on the contour map that indicates the size of the welfare gain. These welfare gains are positive in every case.

Chart 4
Net welfare benefits from housing investment (as a percentage of GDP)



Quantifying the effects of inflation on money demand

The direct welfare effects of reducing inflation

The most widely studied deadweight loss of fully anticipated inflation derives from distortions to money demand, so-called 'shoe-leather' costs. These costs refer to *non-interest-bearing* money, principally currency. They capture the transactions time agents spend in replenishing cash balances, the stock of which is held at a sub-optimally low level at any positive nominal interest rate.

The gain in consumer surplus that results from a fall in inflation is given by a trapezium under a money demand schedule, and can be calculated in much the same way as for consumption. In this case the price is the opportunity cost of money balances, approximated here by the nominal post-tax return on a debt-equity portfolio. The calculation requires an estimate of the change in opportunity cost when inflation is reduced by 2 percentage points and an estimate of the interest elasticity of money demand. Earlier calculations provided an estimate of the post-tax real interest rate at 2% inflation (4.9%), and when inflation is 2 percentage points lower (5.2%). These can be used, together with the inflation rate, to provide estimates of the nominal post-tax rate of return. The money demand calculations are based on the stock of non-interest-bearing M1.

The Bank's work on narrow money demand suggests a steady-state interest elasticity of demand of around 0.3 (Breedon and Fisher (1993)). On this estimate, the direct 'shoe-leather' welfare gain from 2% inflation is 0.02% of GDP (see the table). This is of the same order of magnitude as Feldstein's estimate for the United States. Although small, this estimate is similar in size to that found in previous studies. For example, Fischer (1981) and McCallum (1989) both arrive at a figure of around 0.3% of GDP when moving from 10% inflation to zero inflation. Linearly interpolating, this would deliver a gain of around 0.06% of GDP when inflation is reduced by 2 percentage points.

The indirect revenue and net welfare effects

Three government revenue effects arise from a reduction in inflation of 2 percentage points and the associated rise in real money holdings:

- Lower direct seigniorage revenues as the inflation rate falls, on account of lower nominal interest rates.
- Less revenue as assets are switched from taxed capital assets to non-taxed money balances.
- Lower debt-servicing costs as money balances substitute for interest-bearing debt.

These effects are estimated to reduce government revenues by 0.11% of GDP. Given a deadweight loss parameter of 0.4, this implies that the welfare cost associated with the loss of revenue more than offsets the direct welfare gain from reduced shoe-leather costs. The overall net welfare loss is estimated at around 0.02% of GDP.

Chart 5 shows the sensitivity of this net welfare loss to the interest elasticity and the deadweight loss parameter. This shows that it is difficult to make a strong case for a positive net welfare contribution from money demand distortions. The net welfare effects are also small in every case. This reflects the small size of the outstanding money stock (around 5% of GDP) compared with the owner-occupied housing stock (around 160% of GDP).

Quantifying the effects of inflation on debt servicing

The final cost of inflation to be quantified is the effect of reducing inflation by 2 percentage points on the government's debt-servicing costs. Lower inflation reduces tax receipts on nominal interest payments by the

Chart 5
Net welfare benefits from money demand (as a percentage of GDP)

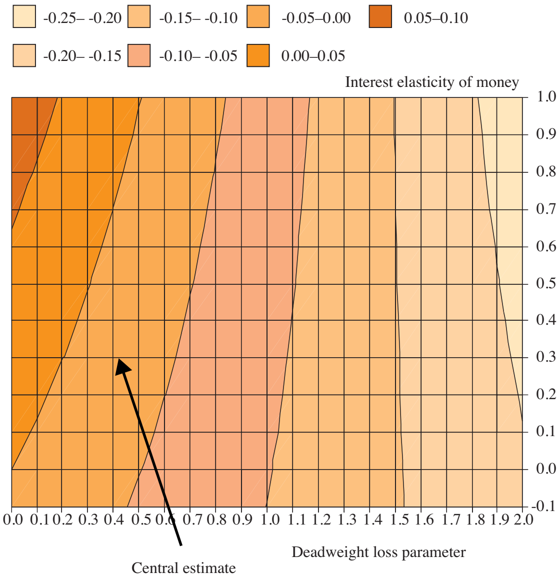
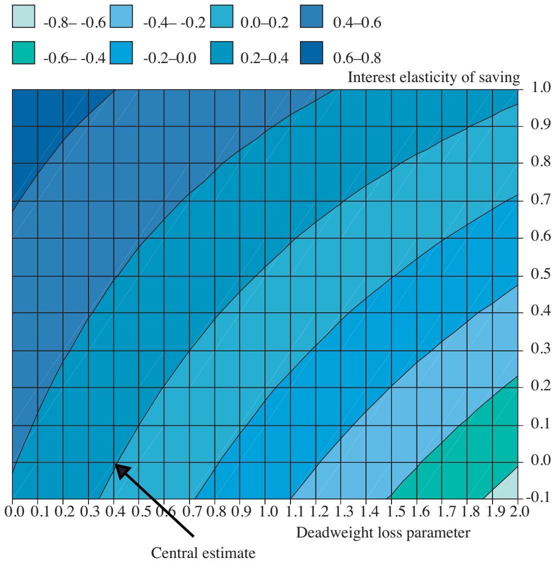


Chart 6
Aggregate welfare benefits (as a percentage of GDP)



government when servicing its debt. This in turn raises its real cost of debt servicing. Feldstein shows that the increase in taxes necessary to maintain a stable debt:GDP ratio in the face of this higher debt-servicing cost is the product of the effective tax rate on interest payments, the stock of government debt and the percentage point change in inflation.

Allowing for the fact that some holders of government debt are tax-exempt and that most debt held overseas is not taxed, the revenue loss associated with higher debt-servicing costs when reducing inflation by 2 percentage points is estimated at 0.22% of GDP. So with an estimated deadweight loss parameter of 0.4, the welfare cost of this revenue loss is 0.09% of GDP (see the table). Again this is slightly lower than Feldstein's US estimate.

Conclusions

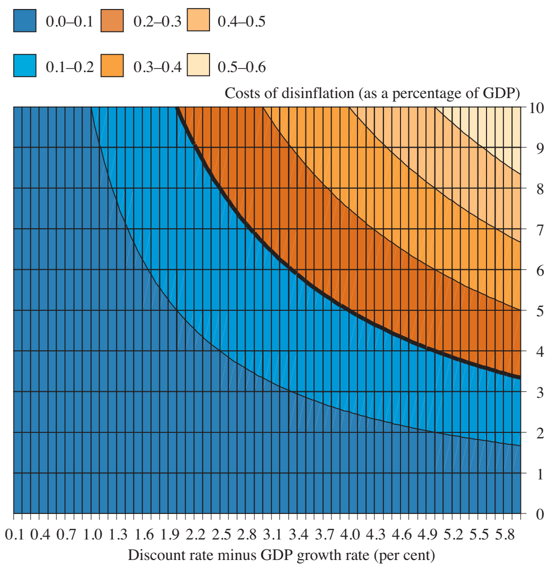
Adding together the net welfare gains arising from consumption, housing investment, money demand and debt-servicing distortions gives an aggregate welfare benefit of around 0.2% of GDP, using central estimates of the key parameters (see the table). This annual net welfare gain is translated into a present value using the formula in (**1**). Given an estimated discount rate of 5.3% and growth rate of 2%,[(1)] the net present value of an annual welfare gain of 0.2% of GDP is equivalent to around 6.5% of GDP.

There are of course uncertainties on both sides of this central estimate, not least about the magnitude of the key parameters, most importantly the parameter measuring the welfare loss resulting from an extra pound of taxation and the saving elasticity. Chart 6 considers the sensitivity of the aggregate net welfare benefit to both of these parameters.

Any combination of the two parameters is associated with a point on the contour map indicating the size of the net welfare gain. High values of the deadweight loss parameter, such as 1.5, eliminate the aggregate benefits entirely. But a higher saving elasticity increases the estimated welfare benefits.

The welfare benefits of lowering inflation must be set against any potential disinflationary output costs. One way of doing this is to calculate the level of welfare benefit that would be needed to counterbalance these costs, given values for the discount rate and the growth rate of the economy. This 'breakeven' welfare benefit is plotted against output costs and the discount rate in Chart 7. Intuitively, the more GDP that is lost for each percentage point reduction in

Chart 7
Breakeven welfare benefits (as a percentage of GDP)



(1) The calculation of these estimates is discussed in the forthcoming *Working Paper*.

inflation, the higher the welfare benefit required to make disinflation worthwhile. Similarly, the higher the discount rate, the higher the welfare benefit that is required. A welfare gain of 0.2% of GDP corresponds to the line between the lighter shaded blue area and the darkest shaded orange area on the chart. For any pair of parameter values lying in the blue areas below the line, welfare benefits are sufficient to offset disinflationary costs. And even with high estimates of the output costs of disinflation—say, 4%–6% of a year's output lost for a 2 percentage point reduction in inflation—the welfare benefits of reducing inflation exceed the output costs of doing so.

This comparison clearly understates the benefits of reducing inflation. In Chart 7 a *subset* of the benefits of reducing inflation is being compared with *all* of the costs of achieving price stability. Other benefits of price stability, such as those associated with the—possibly much larger—welfare costs of unanticipated inflation, are not quantified. Because these costs are positive, they would increase the permissable breakeven range of discount rates and output costs. All in all, the costs of inflation quantified here go some distance towards justifying and explaining the aversion to inflation that is shared by the public, economists and policy-makers alike.

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