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4 Some Costs and Benefits of Price Stability in the United Kingdom

Hasan Bakhshi, Andrew G. Haldane, and Neal Hatch

4.1 Introduction

There is now widespread acceptance of price stability as a macroeconomic objective among policymakers. This price stability consensus appears to extend to the public at large and, to lesser extent, to professional economists too. That is the good news from Shiller's (1997) survey of these two sets of agents. The bad news from the survey is the reason the public gave for disliking inflation: it was thought to have eroded real wages over time, something that is patently at odds with the facts. There are two ways to interpret Shiller's results. The pessimistic interpretation would be to take Shiller's findings at face value and conclude that the costs of inflation are, literally, illusory—they derive from money illusion. The optimistic interpretation would be that policymakers and academics have, to date, done a poor job of identifying, quantifying, and ultimately advertising the costs of inflation to the public.

With the optimistic interpretation in mind, this paper aims to identify and quantify some such costs for the United Kingdom. Much has been written on the *theoretical* justification for stable prices (Fischer and Modigliani 1975 is a classic treatment; for surveys, see also Driffill, Mizon, and Ulph 1990; Fischer 1981; Briault 1995). But there is less *empirical* work quantifying the costs and benefits of price stability and, particularly, placing them in a welfare context.

One of the few previous attempts by the Bank of England to articulate con-

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cretely some of the costs of inflation (Leigh-Pemberton 1992) listed the following costs of a *fully anticipated* inflation:

Cost of economizing on real money balances—so-called shoe-leather effects;
Costs of operating a less than perfectly indexed tax system;
Costs of "front-end loading" of nominal debt contracts;
Cost of constantly revising price lists—so-called menu costs.

Feldstein (1997b) seeks to quantify the first two of these costs when moving from 2 percent inflation to price stability in the United States. That is the primary aim of this paper too. It focuses on distortions to saving, (housing and business) investment, and money demand decision making brought about by a fully anticipated 2 percent inflation tax, operating either unilaterally or, more often, in tandem with the tax system in the United Kingdom.[1] The paper also explores the indirect effects on the government's period-by-period budget constraint of a shift to price stability. We end up with estimates of the costs of inflation in the United Kingdom that work through the channels identified by Feldstein in the United States. Exercises such as this inevitably require simplifying assumptions. So we also conduct some sensitivity analysis on our results. The analysis is clearly restrictive, as it ignores many of the other welfare costs of inflation—for example, those associated with *un*anticipated inflation. Because of this, the paper is best seen as quantifying a subset of the feasible range of welfare benefits that lower inflation might engender; it is strictly a lower bound. In other words, we calculate *some* of the benefits of lower inflation and then compare those with an estimate of the *total* cost of disinflating. This is rather a tough test.

Focusing on the effects of fully anticipated inflation means that the welfare costs we consider are the deadweight loss triangles familiar from public finance economics.[2] Until recently, many economists have believed that the costs of fully anticipated inflation are relatively unimportant, or at least that they are less important than the costs of unanticipated inflation. In a celebrated quote, Tobin summarized this view in "it takes a heap of Harberger triangles to fill an Okun gap." And on the face of it, there is little in the aggregate time-series or cross-sectional data to question this view at the levels of inflation currently prevailing within developed economies.

For example, in a cross-sectional study of over 100 countries, Barro (1995) finds little relationship between inflation and growth at rates of inflation below

1. Physical menu costs and front-end loading have generally been found to have small effects: E.g., survey evidence in Blinder (1992) for the United States and Hall, Walsh, and Yates (1996) for the United Kingdom does not support menu costs as an important influence on firms' price-setting behavior. Schwab (1982) finds that the welfare costs of front-end loading are not large for reasonably sized changes in inflation.

2. Bailey (1956) was one of the first exponents of such micro-to-macro welfare analysis in the context of money demand distortions.

10 percent—though at rates of inflation above this there is evidence that inflation is a significant drag on growth. Likewise, Sarel (1996) finds no evidence of inflation inhibiting growth at rates of inflation below 8 percent—but, again, that there are significantly adverse effects on growth at rates of inflation above this.[3] Looking at one level of disaggregation, Rudebusch and Wilcox (1994) find a significant inverse relationship between productivity growth and inflation in the United States over the period 1955–93. But even that relationship appears to disintegrate in the United Kingdom at levels of inflation below 5 percent (Bianchi and Smith 1995).[4] Taken together, there is little from this aggregate evidence to strongly support a move from single-digit inflation figures to price stability.

There are at least three reasons why these empirical studies are, by themselves, insufficient to close the case for price stability. First, even if lower inflation has little or no effect on an economy's *growth* rate, it can still generate a permanent boost to the *level* of GDP, with potentially infinitely lived effects on welfare (Feldstein 1979). The resulting welfare gain may well then have a large present value even if, at first blush, its first-round effect appears trivial. By contrast, in a world of policy neutrality, the welfare costs of disinflating are likely to be one-off and transient. So welfare analysis of the costs and benefits of inflation is inevitably a comparison between *static* costs and *dynamic* benefits—with the odds correspondingly weighted in favor of the latter (see King 1994). Importantly, such effects may well go undetected by empirical studies looking at secular growth rates over long runs of data.

Second, aggregate time series may simply be too crude a tool to pick up some of the distorting effects of inflation, especially as such distortions are likely to be smaller and more subtle at lower rates of inflation. One response to this mixed bag of macroempirical results would therefore be to look directly at the microlevel decisions that inflation is thought likely to be distorting. That has been the response most recently among general equilibrium real business cycle theorists (inter alia, Cooley and Hansen 1989; Dotsey and Ireland 1996). By viewing inflation as a tax on microlevel decisions, these authors have been able to identify explicitly, and quantify empirically, some sizable welfare costs of inflation at the macroeconomic level. This is broadly our approach too, though within a partial rather than general equilibrium setting.

Third, in a world of existing distortionary taxes, the consumer surplus forgone by the interaction of taxes and inflation is not just the conventional Harberger deadweight loss triangle, but a *trapezoid*.[5] Or, put differently, adding a distortion (inflation) to an existing distortion (taxes) is likely to lead to welfare

3. See also Fischer (1993), Smyth (1994), and Fry, Goodhart, and Almeida (1996) for cross-sectional evidence on inflation-growth correlations.

4. On the relationship between investment and growth in the cross section, see Barro (1995) and Fischer (1993).

5. This is the adjustment suggested by Tower (1971) to the original money demand welfare analysis presented by Bailey (1956).

losses that are first rather than second order in a world of unindexed tax systems. Because these first-order distortions derive inherently from the interaction between inflation and taxes, we cannot then uniquely ascribe these welfare costs to a failure of monetary policy. Fiscal policy could equally well step into the breach. But what we can identify is the welfare benefits monetary policy, acting via lower inflation, might bring. And in the absence of a response from fiscal policy, these effects will be first rather than second order, or trapezoids rather than triangles.

So what is the precise experiment we simulate? Much of the existing literature focuses on comparative static comparisons of low and moderate inflation—for example, the costs of moving from 10 percent to zero inflation. That type of experiment seems less apposite in today's low-inflation environment. For example, in the United Kingdom RPIX inflation—retail prices excluding mortgage interest payments, the government's targeted measure of consumer prices—averaged 12.7 percent in the 1970s, 7.0 percent in the 1980s, but has fallen to an average 4.4 percent in the 1990s so far. Feldstein's (1997b) study draws data from the period 1960–94 in the United States, during which time inflation averaged 4 to 5 percent. Making an allowance for the measurement bias in the U.S. CPI of 2 percent,[6] a shift to price stability would then be equivalent to a 2 percentage point fall in inflation from its historical levels in the United States. That is the policy experiment Feldstein simulates.

In the United Kingdom, RPIX inflation is currently around 3 percent. It is widely thought that available price indexes overstate inflation, but estimates of the extent of the overstatement are highly uncertain. Cunningham (1996) quotes a possible range of central estimates of 0.35 to 1.3 percent per year. It is possible that starting from its current position, a 2 percentage point reduction in inflation would deliver approximate price stability in the United Kingdom. So this is the experiment we consider for the United Kingdom: a 2 percentage point fall in inflation, as in Feldstein's U.S. study. Historically, of course, U.K. inflation has been rather higher than 3 percent, averaging 6 to 7 percent between 1970 and 1995.[7]

The paper is organized as follows. Section 4.2 quantifies the output costs of disinflationary transition, and it quantifies the discounted flow of future benefits needed to offset this cost. Section 4.3 calculates distortions to rates of return—and hence to the price of retirement consumption—resulting from

6. Recent estimates by Shapiro and Wilcox (1996) suggest that this adjustment may be on the high side. They estimate that there is a one-in-ten chance that the bias in the U.S. CPI is greater than 1.5 percent. The Shapiro-Wilcox estimates accord closely with Canadian evidence (Crawford 1994). But measurement biases remain an area of great uncertainty, in particular with regard to new goods and quality biases (see, e.g., Nordhaus 1997 and, indeed, Shapiro and Wilcox's 1996 Medicare example). See also Boskin (1996).

7. We select 1995 as the base year for our calculations because it is the most recent year for which a (near) full set of data is available. Because we are simulating the effect of a change in inflation from current levels, we use the effective marginal tax rates in operation during 1995, rather than historical averages.

Table 4.1 U.K. Estimates: Welfare Effects of a 2 Percentage Point Reduction in Inflation (percent of GDP)

Source of Change	Direct 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

Note: λ is the marginal deadweight loss of an across-the-board tax increase that raises one extra pound of revenue. η_{SR} is elasticity of private saving with respect to the posttax real rate of return. n.a. = not applicable.

inflation. Sections 4.4 and 4.5 look at similar distortions affecting owner-occupied housing and money demand; while section 4.6 considers the impact on government debt servicing. Finally, the concluding section draws these estimates together and suggests some policy conclusions and extensions.[8] These estimates are summarized in table 4.1 for the United Kingdom; table 4.2 provides the equivalent estimates for the United States as a counterpoint.

4.2 Costs of Disinflation

4.2.1 Ball's Sacrifice Ratio for the United Kingdom

We begin by calculating some estimates of the output cost of a 2 percentage point reduction in inflation in the United Kingdom. Feldstein uses Ball's (1994) well-known work on the sacrifice ratio. Ball's approach is to estimate the cumulated loss in output required for each percentage point reduction in inflation. The resulting event-study sacrifice ratio estimates for the United Kingdom, based on two events in the 1960s, one in the 1970s, and a further two in the 1980s, are summarized in table 4.3. They suggest numbers that are typically smaller than those found by Ball for the United States, averaging less than 1 percent compared with 2 to 3 percent in the United States.

But just how robust are these estimates? One reason to be skeptical is that

8. An appendix provides some analysis of inflation effects on business investment.

Table 4.2 U.S. Estimates: Welfare Effects of a 2 Percentage Point Reduction in Inflation (percent of GDP)

Source of Change	Direct 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					
$\eta_{SR} = 0.4$	1.04	−0.07	−0.27	0.97	0.77
$\eta_{SR} = 0.0$	0.75	−0.18	−0.67	0.57	0.07
$\eta_{SR} = 1.0$	1.49	0.09	0.33	1.58	1.82
Housing demand	0.11	0.14	0.51	0.25	0.62
Money demand	0.016	−0.05	−0.19	−0.03	−0.17
Debt service	n.a.	−0.10	−0.38	−0.10	−0.38
Total					
$\eta_{SR} = 0.4$	1.17	−0.09	−0.33	1.09	0.84
$\eta_{SR} = 0.0$	0.87	−0.19	−0.73	0.68	0.14
$\eta_{SR} = 1.0$	1.61	0.07	0.27	1.69	1.89

Note: See note to table 4.1.

Table 4.3 U.K. Sacrifice Ratios

Period of Downturn	Ratio
1961:1–63:3	1.9[a]
1965:2–66:3	0.0[a]
1975:1–78:2	0.9[a]
1980:2–83:3	0.3[a], 0.8[b]
1984:2–86:3	0.9[a]
Average	0.8[a]
1990:3–94:4	2.8[b]

Note: Quarterly data. One reason for the difference between the two estimates for the 1980 downturn is that we use RPIX inflation rather than the RPI series used by Ball.

[a]From Ball (1994).

[b]Authors' estimates.

structural reforms in the United Kingdom in the 1980s—in particular in the labor market—may have led to a change in the short-run trade-off between inflation (wages) and output (unemployment).[9] Ball's last estimate for the United Kingdom relates to the period 1984–86 and is thus unlikely to capture these changes. Moreover, his latest estimates may be distorted by two supply shocks at either end of the sample: the 1984 miners' strike and the 1986 oil price shock. Further, the estimated trade-off might be different—less favor-

9. Other methodological questions are raised in Cecchetti (1994) and Mayes and Chapple (1995).

able—at the lower rates of inflation prevailing in the 1990s, compared to the 1970s and 1980s.[10] Recognizing this, we used Ball's approach to calculate an updated estimate of the sacrifice ratio for the most recent disinflationary episode in the United Kingdom, 1990:3–94:4. As shown in table 4.3, the ratio is considerably higher than earlier estimates, suggesting around a 3 percent output loss for each percentage point reduction in inflation. This is consistent with the notion of a flatter Phillips curve at lower rates of inflation and is more in line with the U.S. evidence.

4.2.2 Breakeven Benefits from Price Stability

If we take these estimates at face value, the cost of reducing inflation by 2 percentage points in the United Kingdom would be around 6 percent of annual output, close to Ball's U.S. estimates. With this cost estimate, we can then calculate the welfare gain (as a percentage of initial GDP) necessary to counterbalance this cost on the assumptions (a) that the welfare gain accrues indefinitely into the future, (b) that any future gains are discounted to give us a present value, and (c) that following Feldstein (1979) we make an allowance for growth effects—the fact that the level of the GDP base on which the welfare cost is being calculated grows over time. The net benefit (B, as a percentage of initial GDP) that ensures that disinflationary costs (C, also as a percentage of initial GDP) are exactly counterbalanced—the breakeven benefit—is given by

$$(1) \qquad B = C*(r - g),$$

where r is the discount rate and g is the steady state growth rate of the economy. Real growth in the U.K. economy over the past 25 years has averaged around 2 percent ($g = 0.02$).[11] For the discount rate, following Feldstein (1997b), we take the average net-of-tax real rate of return that an individual investor earned on a risky equity portfolio (the FT-SE All-Industrials Index) between 1970 and 1995.[12] Over this period, the FT-SE All-Industrials Index rose by 10.6 percent in nominal terms, with an average dividend yield of 4.9 percent. We need to adjust both dividend and capital gains income for taxes. For dividends, we assume an average marginal tax rate of 28.7 percent over the period.[13] For capital gains, we assume that realized gains are subject to the higher capital gains tax rate of 40 percent—that most capital gain investment income accrues

10. We discuss in greater detail below the evidence on such Phillips curve convexities.

11. Real growth should perhaps be defined on a per capita basis, but that would make little difference to our estimate here because the U.K. population has been steady over the period.

12. The choice of period over which to average is in some sense arbitrary.

13. To simplify calculations we use the 1995 tax system as a base. The marginal tax rate is calculated using Inland Revenue data for this year and the methodology in Robson (1988). It would have been costly to calculate an average of marginal tax rates operating in every year between 1970 and 1995. Our approach is likely to lead to a conservative estimate of the discount rate if, on average, tax rates in 1995 were lower than those over the period as a whole. However, this approach may provide a better estimate of the discount rate to apply when discounting *future* welfare gains.

to higher rate income tax payers. But we need to make two further adjustments to the marginal tax rate on capital gains to arrive at an *effective* marginal tax rate. First, capital gains tax is indexed in the United Kingdom, so it is only *real* capital gains that are subject to tax. Second, we need to make an adjustment for the £6,000 annual exemption limit on capital gains and for the fact that gains accrued but unrealized at death are exempt from capital gains tax.[14] The Inland Revenue publishes estimates of the tax revenue lost through the two exemptions and the indexation allowance. Adding these to actual capital gains tax revenue and using the 40 percent marginal tax rate allows us to derive an estimate of the underlying total capital gain. When combined with the actual figure for capital gains tax revenue, this provides an estimate of the effective capital gains tax rate. Using data for financial year 1994/95 gives an effective tax rate on capital gains of 14.1 percent, which is similar to Feldstein's estimate of 10 percent. Finally, note that RPIX inflation averaged 8.6 percent over the period 1970–95. Netting off the measurement bias thus gives a "true" inflation rate of 7.3 percent. Our estimate of the discount rate is then $r = 5.3$ percent $((1 - 0.141)10.6 + (1 - 0.287)4.9 - 7.3)$, again not too different from Feldstein's U.S. estimate.

From equation (1), this higher estimate of the discount rate, taken together with the United Kingdom's lower average real growth rate than the United States, raises the breakeven benefit, B, necessary to offset disinflationary costs. For the United Kingdom the breakeven benefit is 0.18 percent of GDP, compared with 0.16 percent in Feldstein's study.

4.2.3 Some Sensitivity Analysis

There are obviously risks to this present value calculus; it is sensitive to the underlying assumptions regarding r, g, and C. Particular risks attach to estimates of r and C. On discount rates, at one extreme Ramsey (1928) argued that any discounting of the utility of future generations was "ethically indefensible"—in which case the net benefits of moving to price stability would be infinite. At the other extreme, it is well known that firms in the United Kingdom often discount future income streams at much higher rates than would be implied by returns on the stock market (Wardlow 1994). Our discount rate estimate steers a—conservative—middle course between these extremes by taking a risky real return as a benchmark.

Just how conservative this discount rate estimate is can be gauged by looking at two alternatives. For example, it could be argued that the appropriate real return is one on a debt and equity, rather than a pure equity, portfolio. Over the period 1970–95, the real after-tax return to government bonds in the United Kingdom was only 0.2 percent.[15] That would drag down markedly the implied discount rate for any plausible personal sector asset-gearing ratio. Alternatively, following Feldstein (1995), we might derive a discount rate directly

14. Though not from inheritance tax; but this has a much higher exemption limit.
15. Calculated using redemption yields rather than holding period returns.

from the utility function. For example, assuming constant elasticity of substitution (CES) preferences and equating the discount rate with the marginal rate of substitution of consumption over time, it follows that

$$(2) \qquad 1 + r = (1 + w - n)^{\gamma},$$

where γ is the elasticity of marginal utility and w and n are steady state aggregate wage and population growth. Taking $\gamma = 2$ from Feldstein (1995) and plugging in values for w and n gives $r = 3.2$ percent, similar to Feldstein's U.S. estimate of 3.0 percent. This again would imply a much larger—and potentially infinite—present value of welfare gains. In sum, the risks to our welfare estimates from the discount rate appear clearly to lie on the upside.

Another area of particular uncertainty—most likely working in the opposite direction—is the cost estimate, C. There are theoretical arguments, and some empirical evidence, to suggest Ball's estimates may understate the costs of transitioning to price stability. There are at least two such transition costs. First, as illustrated in table 4.3, temporary disinflationary costs may be higher at lower rates of inflation. That would imply that even the 1990s sacrifice ratio for the United Kingdom may be an understatement of the true output costs of achieving price stability. Several strands of empirical evidence point in this direction. For example, Laxton, Meredith, and Rose (1995) find strong evidence of Phillips curve convexities among G-7 countries. And a similar result emerges from the work of Ball, Mankiw, and Romer (1988), looking at a cross section of 43 industrialized countries.[16] Indeed, Ball's (1994) own work finds some (albeit weak) evidence of the initial level of inflation affecting the size of the sacrifice ratio.

It is unclear, theoretically, why such asymmetries may exist, and hence whether they are likely to survive a shift in inflation regime. For example, rigidities in prices and wages—due, say, to psychological or legal impediments to nominal wage cuts—could explain Phillips curve convexities.[17] But these may well disappear if a shift to price stability is deemed credible. Other—real—rigidities may be more entrenched. One way of gauging possible Phillips curve convexities in a regime approximating price stability is to look at pre–World War II historical evidence. Figure 4.1, for example, is a simple scatterplot of inflation-growth outcomes over the period 1831–1938 in the United Kingdom, together with a second-order polynomial line of best fit.[18] While

16. E.g., table 8 of Ball et al. (1988) suggests that the output-inflation trade-off (and hence the implied sacrifice ratio) doubles between inflation rates of 5 percent—close to the historical mean for the United Kingdom over the sample—and zero. Yates and Chapple (1996) confirm this result using a more general formulation of the empirical output-inflation relationship.

17. Though North American and U.K. evidence on the distribution of prices and earnings finds mixed support for such a proposition: see Yates (1995) for a summary. Akerlof, Dickens, and Perry (1996) present evidence to suggest that the distribution of wage settlements in the United States is truncated below zero.

18. Higher order polynomial terms added nothing to the fit. Because we are attempting to fit an aggregate supply curve, we have crudely attempted to purge the data of supply shocks by removing observations where the changes in price level and output are oppositely signed.

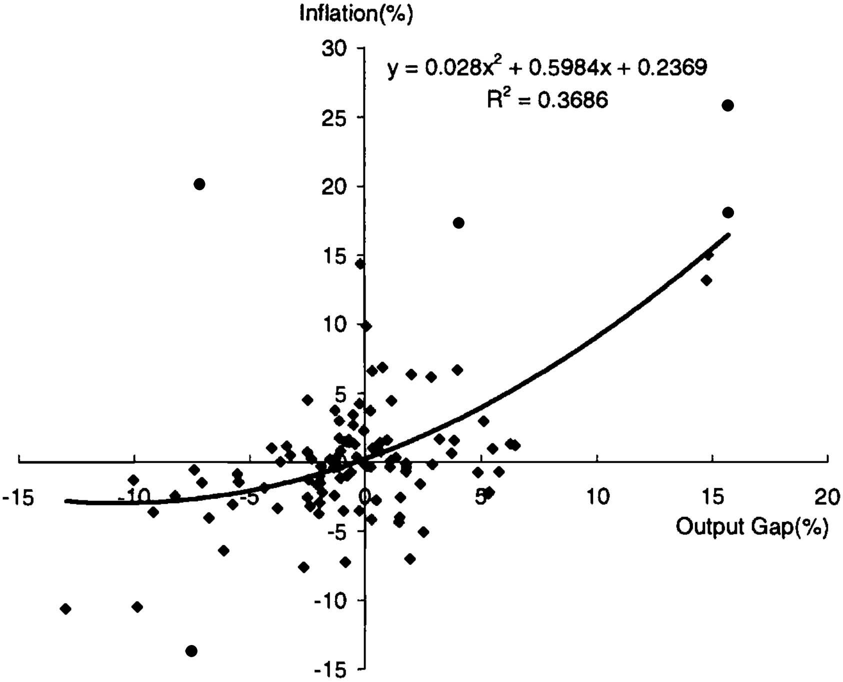

Fig. 4.1 U.K. Phillips curve, 1831–1938

there is some evidence of convexity, the degree of curvature is not great enough to suggest that our transitional cost estimates are a significant understatement.

A second potential cost of transitioning to price stability, which goes unquantified by Ball's (1994) analysis, is hysteresis—*permanent*—effects on output.[19] The empirical evidence on hysteresis effects has been equivocal. But a recent paper by Ball (1997) himself presents cross-sectional evidence to suggest that hysteretic effects on the NAIRU may have been both commonplace and large during recent disinflations among the OECD countries. On the assumption that any disinflation has a permanent effect on the *level* of output, the breakeven benefit becomes

$$B = C*(r - g) + D, \qquad (3)$$

where D is the effect of a disinflation on the natural level of output. If we take Ball's (1997) cross-sectional estimates at face value, each percentage point of disinflation is associated with a 0.42 percentage point rise in the NAIRU (Ball 1997, table 4.2). Taking a (conservative) estimate of Okun's law coefficient of 2, this would imply a 1.7 percent fall in the level of output for a 2 percentage

19. See, e.g., Layard, Nickell, and Jackman (1991) and more recently Akerlof et al. (1996).

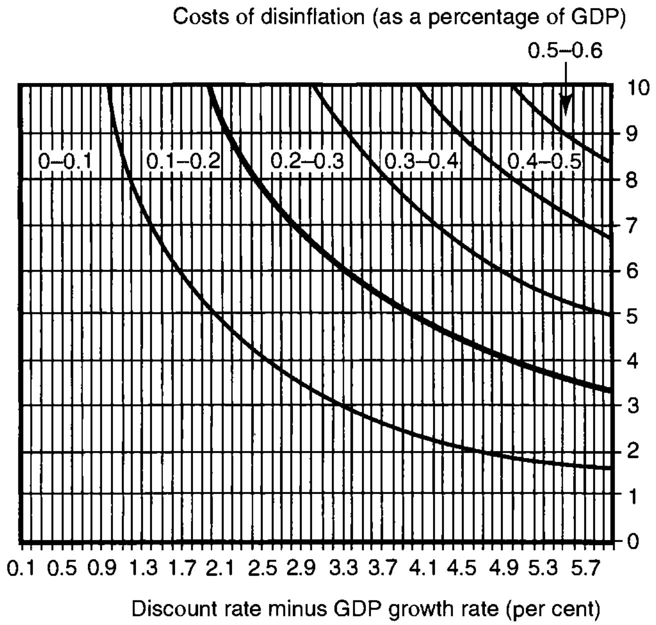

Fig. 4.2 Breakeven welfare benefits (percent of GDP)

point disinflation.[20] This then raises the breakeven benefit to around 1.9 percent, possibly exceeding the benefits Feldstein finds for the United States. This hysteresis estimate is no doubt an upper bound. Over the 1980s, Ball's estimate of the U.K. NAIRU rose by 1.1 percentage points, while inflation fell by 8.5 percentage points over the same period. This would imply a much lower hysteresis coefficient of maybe 0.1 in the United Kingdom, though even this would raise the breakeven benefit to just under 0.6 percent. Further, it could be that Ball is picking up highly persistent, rather than permanent effects from disinflation on the NAIRU.[21] The present value of these losses would then be overstated. But notwithstanding these caveats, it is clear that hysteresis effects, even if modest, have the potential to alter radically any cost-benefit evaluation of price stability.[22]

The above are indicative of the risks to the cost-benefit calculus. Figure 4.2

20. Ball (1997) also allows for multiplicative effects with the duration of unemployment benefits (table 4.4). Making an allowance for this effect raises the effect of disinflation on the level of output to 2 percentage points in the United Kingdom because of the greater duration of U.K. unemployment benefits.

21. E.g., because even discouraged and deskilled workers will exit the labor force at some stage, through death or retirement.

22. There may be costs to operating at, as well as transitioning to, price stability, such as the nonnegativity constraint imposed on real interest rates (Summers 1991). What little evidence there is suggests that the Summers constraint only rarely binds in a costly way (Fuhrer and Madigan 1994).

conducts some sensitivity analysis of the breakeven benefit under different assumptions about the disinflationary costs, C, and the discount rate, r. Intuitively, the more GDP lost for each percentage point reduction in inflation, the higher the welfare benefit required to make disinflation worthwhile. Similarly, the higher the discount rate, the higher the welfare benefit required. To take a specific example, assume welfare gains of 0.2 percent of GDP (as we calculate later in the paper). A welfare gain of 0.2 percent of GDP corresponds to the second thick line from the left. For any pair of parameter values lying in the two areas below the line, welfare benefits of 0.2 percent would suffice to offset disinflationary costs. So even with high estimates of the output costs of disinflation—say, 6 percent 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.

4.3 Inflation and the Intertemporal Allocation of Consumption

4.3.1 Distortions to Saving Behavior

Households make two main expenditure decisions: how much to consume and how much to invest in each period. This section focuses on how household consumption decisions are affected by inflation; the next section considers the impact of inflation on housing investment decisions.

Feldstein (1997b) derives the welfare gain from reducing inflation in a two-period consumption model. Individuals are given an initial endowment and then decide how much to save in the first period in order to consume when they retire in the second period. Agents' first-period savings earn a real rate of return. So the period 1 price of retirement consumption (p) can be thought to be inversely related to this rate of return; the higher the return on savings, the cheaper the effective price of retirement consumption. It is here that inflation and the tax system come into play. Taxes drive a wedge between the pretax rate of return—which is assumed to be invariant under inflation—and the posttax return that households earn. Higher inflation raises the tax wedge and reduces the effective (real) posttax return to saving. This lowers retirement consumption from its (zero tax, zero inflation) optimum, with corresponding welfare implications. Rather than reproduce the basic arguments and calculations here, the gain to households from increased retirement consumption resulting from a reduction in inflation is simply stated here as equation (4) (see Feldstein 1997b, eq. [4] and fig. 3.1):

$$G_1 = C + D = [(p_1 - p_0)/p_2 + 0.5(p_2 - p_1)/p_2] \times [(p_2 - p_1)/p_2]S_2(1 - \eta_{Sp} - \sigma), \tag{4}$$

where p_0 is the price of retirement consumption at zero inflation with no distortionary taxes, p_1 is the retirement price evaluated under the current tax regime

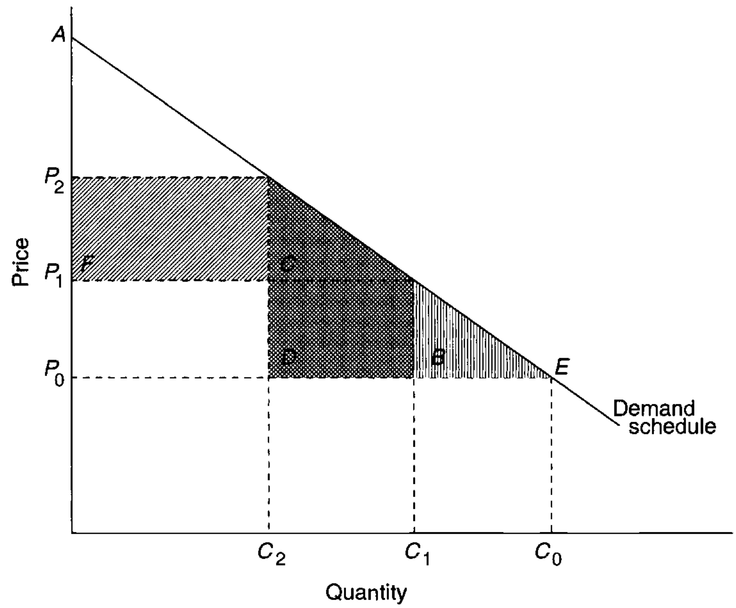

Fig. 4.3 Calculating welfare losses

with zero inflation, and p_2 is the price evaluated under the current tax regime with 2 percent inflation; S_2 represents the initial gross saving of individuals at the early stage of their life cycles; η_{S_p} is the uncompensated elasticity of saving with respect to the price of retirement consumption; and σ is the propensity to save out of exogenous income. The welfare gain associated with a reduction of inflation (and hence with a reduction in the retirement price $p_2 - p_1$) is the area under the compensated demand curve, the trapezoid C + D in figure 4.3. To evaluate equation (4), we first need a measure of the price of retirement consumption. Feldstein (1997b) calculates this as $(1 + r)^{-T}$, where r is the real posttax rate of return and T is the number of years that agents engage in saving for retirement. Following Feldstein, we take $T = 30$ years.[23]

To calculate p_0 we require a pretax rate of return to capital for U.K. industrial and commercial corporations. Such data are published by the U.K. Office for National Statistics. Between 1970 and 1995, this real rate of return averaged 8.2 percent. It is slightly below returns in the United States.[24] Using OECD data as a cross check confirms that returns to capital in the United Kingdom

23. All subsequent calculations are based on estimates up to and including 1995, the last year for which we have a full set of data. A number of changes to the tax system have been announced since 1995 but have not been taken into account.

24. As in Feldstein, the capital stock is defined net of depreciation; pretax profits are gross of interest payments, but unlike Feldstein, no attempt has yet been made to gross up for property taxes.

Table 4.4 Advance Corporation Tax (ACT) and Mainstream Corporation Tax (MCT)

Taxable profits	£100
Corporation tax (CT) rate	33%
Liability to CT	£33
ACT rate	25%
Dividend paid	£40
Payments of ACT	£10 (0.25*40)
Payments of MCT	£23 (33−10)

have on average been below those in the United States over the past 30 years. Translating the estimated pretax return into a price of retirement consumption in the absence of taxes, $p_0 = (1.082)^{-30} = 0.094$.

To estimate a real return to saving in a world of taxes and inflation, we need to adjust the above figures for both corporate and personal sector taxes. The United States operates a "classical" tax system under which dividends are taxed twice, once as profits at the corporate level and again as income at the personal level. By contrast, the United Kingdom operates an imputation tax system that provides protection against the double taxation of dividends through a system of advance corporation tax (ACT). When dividends are paid to individuals the companies pay ACT, currently 20 percent of gross dividends (25 percent of net dividends), but can use this payment to offset their later liability to mainstream corporation tax (MCT).[25] Individuals can then use this payment against their total tax liability at the end of the financial year. Individuals who have marginal tax rates above or below the ACT rate will incur a credit or debit accordingly. An example illustrates the imputation system (see table 4.4).

In our calculations we take payments of MCT having netted off ACT payments (to prevent double counting). We then deal with the taxation of dividends at the personal level. These MCT payments amounted to some 22 percent of firms' pretax profits in 1995. This tax ratio is not zero because not all profits are distributed and because corporate tax rates are on average generally higher than personal tax rates. Ceteris paribus, this leads to higher tax payments the lower the dividend payout ratio. But the effective tax rate is still much lower than the corresponding U.S. figure, reflecting the difference between the U.S. (classical) and U.K. (imputation) systems of dividend taxation. Netting off this ratio leaves a posttax rate of return of 6.38 percent. (For further details of the U.K. corporate tax system, see Kay and King 1990.)

To arrive at a real posttax return for savers, we also need to take account of personal taxes. What we need for our policy simulations are measures of the

25. This means that a number of firms each year have ACT credits outweighing their taxable income: they are "tax exhausted" (see, e.g., Devereux 1987). This tax credit typically gets carried forward. This gives rise to an asymmetry in the corporate tax system, but one that we ignore here.

currently effective marginal tax rates on capital income. But these effective marginal tax rates depend on how this income is received (dividends, capital gains, interest income) and the tax status of the individual. Feldstein proxies these effects by assuming an individual marginal tax rate of 25 percent across all sources of income. We look at one level of disaggregation, identifying separately average marginal tax rates on interest income, dividends, and capital gains and then weighting these to give an individual marginal tax rate. At this stage we make no allowance for tax-exempt savings, which are important in the United Kingdom. We assume, in effect, that marginal savings flow into taxable assets. But we return to this issue below, when we conduct some sensitivity analysis assuming a different—tax-exempt—margin.

For dividends we begin by calculating an average marginal tax rate on dividends using Inland Revenue individual data for financial year 1994/95 and the methodology in Robson (1988). This gives a headline tax rate of 28.7 percent. For interest income on corporate bonds we use a headline marginal tax rate of 31.1 percent, again based on Inland Revenue figures for 1994/95. The headline marginal tax rate on capital gains (on equity and bonds) is that used earlier when calculating the discount rate, 14.1 percent.

For the weights on dividends, capital gains, and bond interest income, Feldstein assumes the same debt-equity split for persons as for companies. That amounts to assuming that the corporate sector is owned directly by households. This assumption is, in turn, only valid under three conditions: first, when open economy considerations are unimportant; second, when there are no debt-equity transformations through financial intermediation; and third, when personal sector net banking assets are counterbalanced by their net banking liabilities, so that bank loans to companies are not backed by household saving. For the United States, a relatively closed economy where many debt and equity holdings are direct, these are reasonable approximations.

But the U.K. situation is rather different. Overseas holdings of U.K. company securities amounted to over 18 percent of these companies' balance sheets in 1995; while around 5 percent of the personal sector's equity holdings were with overseas companies. Further, the majority of households' equity and debt holdings are indirect—through pension funds, unit trusts, and the like—which may transform corporate debt to equity or vice versa. To overcome these problems, we take the debt-equity split directly from the personal sector's balance sheet by explicitly identifying their (direct and indirect) holdings of U.K. companies' capital using sectoral flow-of-funds data. That negates the problems of overseas holdings of company capital and possible debt-equity transformations of assets as they pass from the corporate to the personal sector. Doing this gives a 95/5 split of personal sector *nonbank* assets between equity and debt.[26] We then use this asset split when accounting for the incidence of

26. If we use instead the U.K. corporate sector's balance sheet to infer a equity-debt ratio for companies' nonbank liabilities, we get a ratio of around 8 percent in 1995.

personal taxation on corporate bonds and equity. For the split between dividends (interest) and capital gains of equity (bond) income, we assume that individuals receive income from dividends (interest) and capital gains in broadly the same ratio used in our discount rate calculation, roughly 60/40.

But to the extent that the personal sector's net *banking* assets are also indirectly financing U.K. companies' bank loans, we need to take account of these too.[27] Feldstein sidesteps this problem by assuming that household bank deposits and bank loans are offsetting. U.K. companies held net banking liabilities of around £60 billion in 1995. Because of the nature of banking, it is impossible to say which of these were financed from personal sector deposits and which from other sources; but if we assume that net bank loans to companies were effectively financed from personal deposits, we can calculate a marginal effective personal tax rate inclusive of the banking sector.[28] The weights in the personal sector's balance sheet are then 5/89/6 for corporate bonds, equity, and deposits, respectively.[29] For the average marginal tax rate on deposits we apply a rate of 23.6 percent, comprising a 26.2 percent tax rate on interest-bearing deposits and, trivially, a zero rate on non-interest-bearing deposits.

Using these weights and our adjusted average marginal tax rates gives us a total effective marginal individual tax rate of 23.0 percent. This implies a real net rate of return to savers in the United Kingdom of around 4.9 percent, which corresponds to a price of retirement consumption of 0.237 evaluated at 2 percent inflation. The wedge between pre- and posttax returns in the United Kingdom (3.3 percent) is around two-thirds that in the U.S. case (5.13 percent). This largely reflects the effects of ACT.

We now calculate the effect on the posttax real return to saving—and hence on the price of retirement consumption—of a reduction in inflation of 2 percentage points. Work in the United Kingdom, along similar lines to that in the United States, has shown that inflation tends to increase effective tax rates for both the personal and corporate sectors. For companies, this inflation nonneutrality in the U.K. tax system has three sources. First, since 1984 U.K. companies have received no stock relief; that is, any nominal capital gains made on inventories as a result of general price level rises are treated as taxable profit. Second, depreciation allowances are based on historic cost asset valuations and are thus reduced in real terms by inflation. And, third, acting against the first two effects is the fact that nominal debt interest payments are tax deductible.[30]

Bond, Devereux, and Freeman (1990) calibrate these inflation nonneutralities using microlevel data drawn from company accounts. They estimate that

27. We are only interested here in the savings channel running from households to companies, so personal sector assets that are backing non-U.K.-corporate liabilities are not included in the calculations—e.g., household holdings of government debt or foreign debt and equity.

28. We discuss variants on this assumption in the sensitivities section below.

29. There is an argument for basing the weights on gross rather than net banking liabilities. Using gross liabilities changes the weights to 4/81/15, but this does not appear to have a very significant effect on the estimates of the welfare gain.

30. In the United States, only the second and third of these effects is relevant.

moving from 10 percent inflation to price stability is associated with a decrease in companies' effective tax rate of over one-third. Making an assumption about the initial pretax rate of return and assuming a fixed capital stock, we can translate this ready-reckoner into an effect of inflation on companies' profit rates. The rule of thumb we use, based on Bond et al. (1990), is that a 1 percentage point fall in inflation is associated with a 0.37 percentage point rise in the taxable profit rate.[31] We take the average marginal corporation tax rate to be 32 percent, based on Inland Revenue data.[32] The effect of a 2 percentage point reduction in inflation is hence to raise the posttax return to savers by 0.32*0.37*0.02 = 0.0024 (0.24 percentage points) as a result of corporation tax nonneutralities. That is, the rate of return after corporate taxes is raised from 6.38 to 6.62 percent.

The effect of inflation on households' effective tax rates depends on the debt-equity-deposit composition of their asset portfolios. We assume the same weights as earlier. For equity holdings, one key difference from the United States is that since 1985 capital gains in the United Kingdom have been indexed. This effectively neutralizes any effect from a change in inflation on equity income.[33] Taken alongside the higher proportion of equity in U.K. households' portfolios, this reduces substantially the fall in effective tax rates—and hence the rise in posttax saving rates—induced by a fall in inflation.

But a change in inflation *does* affect marginal tax rates on deposits and corporate debt because it is nominal interest income that is taxed. For deposits and for debt, we use our earlier average marginal effective tax rates of 23.6 and 31.1 percent, respectively. Taking these debt and deposit nonneutralities together, this gives a 0.06 percentage point reduction in the effective tax rate for a 2 percentage point fall in inflation. This then raises the posttax rate of return to individuals to 5.16 percent and implies that the price of retirement consumption falls to $p_1 = 0.22$ when inflation is zero. In the United Kingdom the move to price stability has less effect on the posttax saving rate (around 0.24 percentage points) than in the United States (around 0.49 percentage

31. If a 1 percentage point rise in inflation lowers tax liabilities by 3.7 percent, then, for fixed capital stock, this is equivalent to a 3.7 percent rise in the profit rate. The pretax return to capital in 1989—the year when Bond et al. (1990) do their analysis—was around 10 percent. Hence, a 1 percentage point rise in inflation implies an increase in the profit rate of 0.37 percentage points. This ready-reckoner takes account of all three tax nonneutralities simultaneously, whereas Feldstein looks at them separately. We can identify separately the debt interest deductibility effect to ensure our estimates are not too wayward. With debt 21 percent of Industrial Commercial Companies' capital and a marginal corporate tax rate of 32 percent, a 2 percentage point fall in inflation raises the effective corporate tax rate by 0.32*0.21*0.02 = 0.0013 (or 0.13 percentage points). That would imply an effect on the effective tax rate from the lack of indexation of depreciation allowances and stock relief of 0.5 percentage points, not too dissimilar to the 0.57 percentage point depreciation nonneutrality used by Feldstein.

32. This is a weighted average of the 33 percent headline MCT rate and the 25 percent reduced rate for small firms.

33. Dividend income taxation is immune to inflation effects.

Table 4.5 Saving Ratios in the United States and United Kingdom, 1990

Age Cohort	United States	United Kingdom
31–35	7.1	8.0
36–40	9.4	12.0
41–45	9.8	12.0
46–50	11.2	11.0
51–55	13.9	10.0
56–60	16.6	13.0

Sources: Attanasio (1994) and Banks and Blundell (1994).

points). This is due largely to the indexation of capital gains and the greater importance of equity as a source of personal sector income in the United Kingdom.

The price of retirement consumption under the various tax and inflation assumptions (p_1, p_2, and p_0) can now be substituted into equation (4) to give

$$G_1 = 0.038S_2(1 - \eta_{Sp} - \sigma). \tag{5}$$

To evaluate equation (5), we need an estimate of the saving of the young at an inflation rate of 2 percent (S_2). Feldstein derives an estimate from the steady state relationship between savers and dissavers implied by the two-period model. He shows that the saving of the young is $(1 + n + g)^T$ times the saving of the older generation, where n is the rate of population growth and g is the growth in per capita wages. If we follow that approach, real aggregate wage growth in the United Kingdom between 1970 and 1995 was 2 percent, somewhat lower than in the United States. Taking $n + g = 0.02$ and $T = 30$ implies that the saving of the young is around 2.23 times the *net* personal saving rate. Given an average U.K. personal saving rate of 9.2 percent of GDP between 1970 and 1995, this implies that S_2 is around 21 percent of GDP, more than double the U.S. figure.

This figure for gross saving seems high.[34] So we also considered some complementary microevidence from the U.S. Consumer Expenditure Survey and the U.K. Family Expenditure Survey (FES). Table 4.5 shows the saving ratios in 1990 of a set of population cohorts spanning the age range 30–60 in the United States (from Attanasio 1994) and the United Kingdom (Banks and Blundell 1994). This is the age range likely to match most closely with the theoretical notion of first-period savers because the very young are likely to be net borrowers and the very old gross dissavers.

34. Two possible reasons for this are, first, that our aggregate real wage growth assumption is too low—certainly, real wage growth is higher (around 2.5 percent) if we extend our data back to the 1960s—and, second, that our net saving ratio is too high. One cause of the latter is that our saving ratio is not inflation adjusted and average inflation over the sample has been higher than our 2 percent benchmark. An inflation-adjusted saving ratio would, over the 1980s, have been nearer to 4 percent.

Table 4.5 suggests two things.[35] First, there is little difference between saving ratios in the United Kingdom and the United States over the 30–60 age range; they both average around 11 percent. And, second, the U.K. saving ratio of the young is nearer to 10 percent than to the 21 percent implied by the macroestimates above. In what follows we use a lower implied estimate of gross saving ($S_2 = 0.11$), which seems more consistent with micro- and international evidence. Feldstein further assumes that the propensity to save out of exogenous income is the same as that out of earned income and that average and marginal saving propensities can be conflated. On these assumptions, given that earnings from employment are some 63 percent of GDP in the United Kingdom and $\sigma = S_2/0.63$, it follows that $\sigma = 0.17$.

The final piece in the jigsaw is the elasticity of saving with respect to real interest rates.[36] There is a good deal of academic controversy over this issue. Feldstein uses Boskin's (1978) work in the United States, which finds the elasticity to be around 0.4. Boskin's approach is to take the interest semielasticity from a standard consumption function and then infer from this the full interest elasticity of saving. On the assumption of fixed income, the full and semielasticities are linked by

$$\eta_{SR} = -(\bar{R} * \bar{C})/\bar{S}\xi_{CR}, \tag{6}$$

where C, S, and R denote consumption, saving, and the real interest rate, respectively, a bar denotes a mean value, and ξ_{CR} is the real interest rate semielasticity of consumption. To arrive at an estimate of η_{SR} for the United Kingdom, we take ξ_{CR} from a range of recently estimated consumption functions in the United Kingdom (Muellbauer and Murphy 1993; Bayoumi 1993; Fisher and Whitley, forthcoming)[37] and then convert them using equation (6) into saving elasticities. Most of the above studies imply saving elasticities fairly close to zero. So we take $\eta_{SR} = 0$ as our central guess but also consider $\eta_{SR} = 0.2$ and $\eta_{SR} = 0.4$ for comparability with Feldstein.

While our central assumption may seem extreme, there is a good deal of theoretical as well as empirical support for it. With CES preferences, a positive saving elasticity only obtains in a two-period model when the intertemporal elasticity of substitution exceeds unity.[38] And most empirical studies of the elasticity of substitution put it closer to zero than to unity (e.g., Hall 1988); certainly, there is little to suggest it is greater than unity. This implies that a zero saving elasticity—where income and substitution effects are broadly offsetting—is a reasonable central guess. Moreover, while a zero saving elasticity

35. One potential problem with the FES data set is that it is known to undersample high-income households. That, in turn, would depress the average saving ratio. But in 1990 the aggregate saving ratio in the United Kingdom was in line with the average reported by the FES.

36. It can be shown that $\eta_{SR} = -RT\eta_{Sp}/(1 + R)$.

37. Though only the first of these studies uses *post*tax real interest rates.

38. E.g., with Cobb-Douglas preferences in a two-period model, $\eta_{Sr} = 0.4$, and $r = 4$ percent, the implied elasticity of substitution is 1.7.

lowers the direct welfare costs calculated below, it certainly does not eliminate them. A larger part of the welfare gain is the result of a direct price effect of cheaper retirement consumption on the quantity of consumption purchased.

Using the above estimates of the saving elasticity, adjusted so that it is expressed as an elasticity of the price of retirement consumption,[39] together with our previous calculations, we can compute the overall gain from moving to price stability. Using equation (5), we estimate the gain to be $G_1 = 0.35$ percent of GDP with $\eta_{SR} = 0$ when $S_2 = 0.11$. At $\eta_{SR} = 0.2$, $G_1 = 0.40$ percent of GDP; at $\eta_{SR} = 0.4$, $G_1 = 0.46$ percent of GDP. All of these direct welfare costs are considerably smaller than in Feldstein. For example, if one makes the comparable assumption of $\eta_{SR} = 0$ for the United States, the gain would be some 0.75 percent of GDP. In large part this is due to the lesser susceptibility of the U.K. tax system to inflation-induced distortions.

4.3.2 Indirect Revenue Effects

Next we consider the effect on government revenue of the above experiment. The working assumption here, as in Feldstein (1997b), is that any effect of a move to price stability on government revenues cannot be made good by a rise in lump-sum taxes. Instead, distortionary taxes are required to fill any financing gap, with corresponding welfare implications.

Assume we start from a price of retirement income p_2 and consumption level C_2 (see fig. 4.3) with inflation at 2 percent and the current tax system in place. Now consider lowering the inflation rate to zero. There are two offsetting effects on revenue. First, lower inflation raises the real return to saving and hence lowers the price of retirement consumption to p_1. This results in a loss of revenue equal to $(p_2 - p_1)C_2$. Against this, the lower price of retirement consumption stimulates higher consumption $(C_1 - C_2)$ that is in turn revenue generating by an amount $(p_1 - p_0)(C_1 - C_2)$. The aggregate change in revenue is

$$(7) \qquad d\text{REV} = S_2\{[(p_1 - p_0)/p_2][(p_2 - p_1)/p_2](1 - \eta_{Sp}) - (p_2 - p_1)/p_2\}.$$

This expression can in principle be either positive or negative. But with $\eta_{SR} = 0$, and substituting in earlier parameter values, we get a net revenue *loss*, dREV $= 0.34$ percent of GDP. The corresponding net revenue losses at $\eta_{SR} = 0.2$ and $\eta_{SR} = 0.4$ are 0.29 and 0.23 percent of GDP, respectively. These are typically much larger than Feldstein's U.S. numbers, in part owing to the United Kingdom's higher gross saving ratio and in part the result of our lower assumed interest elasticity of saving.

We can map this change in revenue into a change in welfare by scaling it using a deadweight loss coefficient, λ. This measures the marginal deadweight loss of an across-the-board tax increase that raises one extra pound of revenue. Feldstein bases his estimate of λ on Ballard, Shoven, and Whalley's (BSW

39. This involves scaling by $-(1 + R)/RT$, where R is some benchmark saving rate. We take R to be the posttax saving rate at 2 percent inflation, 4.9 percent.

1985) computable general equilibrium model of the United States. BSW concluded, "The welfare loss from a 1 per cent increase in all distortionary taxes is in the range of 17 to 56 cents per dollar of extra revenue." There are many reasons why such a λ-range might be inaccurate for our exercise. For example, the BSW estimates refer to the United States and are based on a model that is calibrated on data drawn from 1973. More generally, λ can only really be pinned down by simulating the effects of a specific tax experiment in a general equilibrium model in which the existing configuration of distortionary taxes is fully set down (see Ballard and Fullerton 1992): λ is not a fixed, policy-invariant parameter. But in the absence of such estimates for the United Kingdom, we take as our benchmark two values of λ (λ = 0.4, 1.5) as in Feldstein. This broadly covers the range of estimates found in other recent studies of specific tax simulations (inter alia, Stuart 1984; Hansson and Stuart 1985; Fullerton and Henderson 1989).

We can go a little further toward justifying these values. Abel (1997) uses Sidrauski's (1967) general equilibrium model to compute the welfare effects of eliminating inflation in the United States. He extends the model to include both housing and nonhousing capital, includes a government budget constraint, and endogenizes labor supply. We take Abel's model and recalibrate it for U.K. data. It is then possible to arrive at an estimate of the deadweight loss parameter by simulating the effects of a tax change on utility, subject to the government budget constraint being satisfied. We conduct two experiments. In the first experiment, all three tax rates (on labor income, housing capital, and nonhousing capital) are raised by 10 percent. There is a rise in overall tax revenue and a fall in consumption. Using the utility function, we then calculate the change in consumption necessary to maintain the new level of utility, with money and labor income (the other two arguments in the utility function) held at their base values. This yields an estimate of around £0.40 of welfare loss for every pound in revenue gained—a λ of around 0.4. As a second experiment, we raise all three taxes by 1 percentage point. The resulting estimate of the deadweight loss parameter is 0.37. Although the general equilibrium model we use is small and the calibrated results depend on a number of key parameters, there appears to be some support for a λ estimate of around 0.4. This is taken as our central estimate below.

The total welfare gain from the reduced distortion to consumption timing resulting from a 2 percentage point reduction in inflation is then

$$G_2 = G_1 + \lambda \, d\text{REV}. \tag{8}$$

As table 4.1 illustrates, assuming $\lambda = 0.4$ the net welfare gain from price stability operating through saving distortions is bounded between 0.21 and 0.37 percent of GDP. This is around a quarter the size of Feldstein's U.S. estimates. Much of the difference is due to offsetting revenue effects. This is shown up clearly when we raise the deadweight loss coefficient to $\lambda = 1.5$. All net welfare gains are then sacrificed.

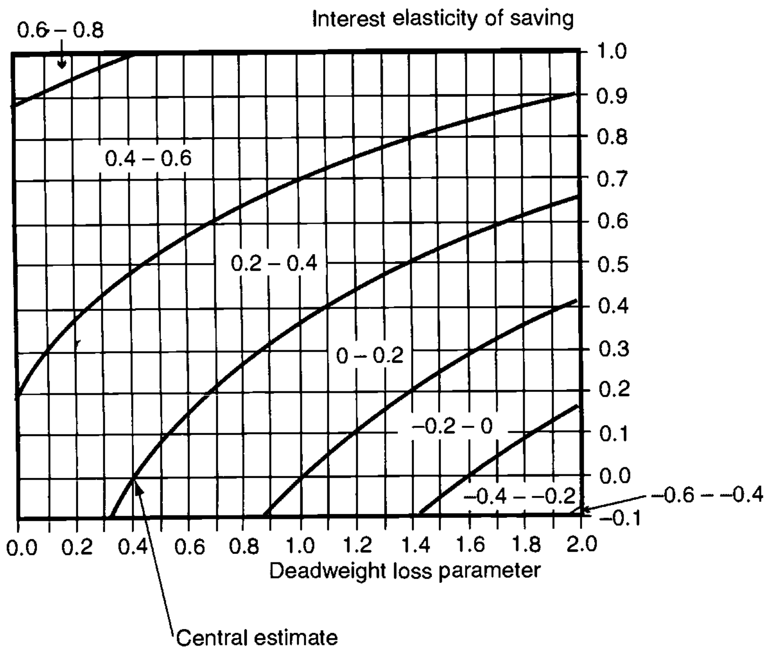

Fig. 4.4 Net welfare benefits from consumption (percent of GDP)

4.3.3 Some Sensitivity Analysis

Figure 4.4 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 nontrivial, at around 0.2 percent of GDP, even when the saving elasticity is assumed to be low.

There are further extensions and risks we might consider. First, Feldstein (1997b) points out that his calculations exclude current nonsavers. This is a potentially important omission if, first, nonsavers are a significant proportion of the population and, second, they are responsive to changes in real interest rates. Were both conditions to be satisfied, the estimated welfare costs above could be a significant understatement, as they would miss the effect of higher real interest rates in inducing previous nonsavers to save.

Using data from the 1991/92 Financial Research Survey of 6,600 households in the United Kingdom, Banks, Dilnot, and Low (1994) found that over half of the households in the survey held gross financial assets of less than £455 (net assets of less than £180) while around 10 percent had no gross savings whatsoever. These results suggest that as in the United Savers, nonsavers are nontrivial in number. How responsive these agents might be to changes in real interest rates is less clear. That depends on whether nonsaving is a voluntary decision (e.g., among young "life cycle" savers) or an involuntary one (e.g., among credit-constrained "Keynesian" consumers). The former set are likely to be interest sensitive; the latter set much less so. In fact, the saving elasticity we derived from the aggregate consumption functions already implicitly embodies the average effect of real interest rates on both savers and nonsavers. And since our central case has $\eta_{SR} = 0$, this nonsaver effect is in any case likely to be quantitatively small.

Second, the above calculations take no account of the depressing effect of increased saving on the marginal product of capital. This would tend to reduce estimated welfare gains; but the effect is small. For example, assuming Cobb-Douglas technology, the implied fall in the marginal product of capital is only 0.06 percentage points when $\eta_{SR} = 0.2$ and 0.1 percentage points when $\eta_{SR} = 0.4$. Of course, when $\eta_{SR} = 0$, our central case, the marginal product of capital is unchanged. These effects in turn translate into small welfare changes: for example, a fall of 0.0027GDP when $\eta_{SR} = 0.2$. Moreover, these losses are almost exactly counterbalanced by the rise in the marginal product of labor resulting from the rise in the capital stock. For example, this leads to an offsetting welfare gain of 0.0025GDP when $\eta_{SR} = 0.2$. So the net welfare effect of these production mix adjustments seems likely to be negligible.

Third, more substantively, the stylized life cycle model makes no allowance for social security income received during retirement. Recognizing this exogenous source of second-period income lowers the implied interest elasticity of saving by an amount $(C - B)/C$ (see Feldstein 1997a), where C is retirement consumption and B social security benefits. Taking $B/C = 0.25$, as in Feldstein, lowers the direct welfare gain by around 30 percent: for example, with $\eta_{SR} = 0$ direct welfare gains fall from 0.35 to 0.25 percent of GDP.

Fourth, our central case assumes that all net company bank loans are effectively financed from personal sector deposits. Assuming instead that company bank loans are financed from elsewhere—that is, stripping out the banking system from our calculations—lowers the welfare gain from around 0.21 to 0.19 percent with $\eta_{SR} = 0$.

Finally, the analysis so far has assumed that all marginal saving flows into taxable assets. In practice, a relatively high proportion of U.K. personal sector saving is held in tax-exempt forms. We estimate that around 38 percent of personal sector equities are tax exempt (including pensions funds, pension business of life assurers, and personal equity plans—PEPs).[40] Direct holdings of equity that are taxed account for 37 percent. The remainder are equities held

40. The tax treatment of PEPs and pensions is not the same: in the former case, final receipts are tax deductible, whereas in the latter, initial contributions are tax deductible. We ignore that complication here.

indirectly via non-tax-exempt unit trusts and the nonpension business of life assurers (25 percent). Direct shareholdings are assumed to be taxed at the headline rate of 28.7 percent, and the remaining 25 percent of taxable holdings are taxed at 20 percent. Tax-exempt equity holdings are obviously taxed at a zero rate. So assuming that the marginal tax rate on equity holdings is the same as its average, this would give an adjusted average marginal tax rate of dividend income of 15.7 percent (0.38*0 − 0.37*28.7 + 0.25*0.20).

Doing the same thing for deposits, we need to make an adjustment for tax-exempt special savings accounts (TESSAs). These made up 6 percent of total personal sector bank deposits in 1995. So the marginal tax rate on deposits, inclusive of tax-exempt funds, would fall to 22 percent. Finally, for interest income on corporate bonds, we estimate that around 26 percent of personal sector holdings of corporate bonds are held in tax-exempt vehicles (pension funds, corporate bond PEPs, etc.). A further 68 percent are held by taxed institutions, and 6 percent are held directly. Direct bondholdings are taxed at the 31.1 percent headline rate, and non-tax-exempt unit trusts and the nonpension business of life assurers are assumed to be taxed at the basic rate of income tax.[41] This gives an adjusted average marginal tax rate on bond interest of 19.0 percent (0.26*0 + 0.06*0.311 + 0.68*0.25).

The headline marginal tax rate on capital gains (on equity and bonds) is that used earlier when calculating the discount rate, 14.1 percent. But again, these capital gains will be earned on securities held in a range of saving outlets, and we assume the same distribution of holdings across these outlets as for dividends and bonds. Direct holdings are taxed at 14 percent, indirect holdings via non-tax-exempt unit trusts and the nonpension business of life assurers at the basic rate (25 percent in 1994/95), and tax-exempt holdings are tax free. This gives an adjusted marginal effective capital gains tax rate of 11.6 percent on equities and 17.9 percent on bonds.

The effects of the tax-exempt saving adjustments are significant. For example, the effective marginal individual tax rate after weighting dividends, bond interest, deposit income, and capital gains was 23.0 percent before adjustment for tax-exempt saving. This falls to 14.8 percent after adjusting for tax-exempt saving. At $\eta_{SR} = 0.2$ and $\lambda = 0.4$, the effect of tax-exempt saving is to reduce the net welfare gains by 0.07 percent of GDP to 0.14 percent; at $\eta_{SR} = 0.2$ and $\eta_{SR} = 0.4$, the reductions are 0.08 percent (to 0.21 percent) and 0.13 percent (to 0.27 percent) of GDP, respectively. So the choice of destination for marginal saving is clearly crucial to the welfare calculus. Indeed, if all saving flowed into tax-exempt vehicles, the welfare gain arising from the effects of lower inflation on saving behavior would be zero.

41. Policyholder and shareholder funds actually have different tax treatments in the United Kingdom: bond interest and capital gains on the former are taxed at the basic rate of income tax (and at a lower rate of 20 percent from April 1996), whereas the latter are taxed at the higher corporation tax rate of 33 percent. In the absence of disaggregated data, our calculation assumes that all bondholdings are taxed as policyholder funds.

But this would almost certainly overestimate the effects of tax-exempt savings vehicles. For example, there are restrictions on the quantity of marginal saving that is allowed to flow into tax-exempt assets. And there are ceilings on the amount that can be invested in a TESSA and restrictions on the additional voluntary contributions (AVCs) that can flow into personal pensions. 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.

4.4 Inflation and Residential Investment

4.4.1 Distortions to Housing Investment

House prices in the United Kingdom have been around 25 percent more volatile than the general level of prices since 1970. And U.K. house price inflation has outstripped general price inflation by 2 percent per year on average over this period. Without question, the tax environment has played a role in this. The availability of mortgage interest relief—which in the United Kingdom is normally implemented through "mortgage interest relief at source" (MIRAS)—has meant that the tax system has consistently favored housing over alternative real and financial assets. More recently, there has been a progressive scaling back of the tax benefits available for owner-occupiers. The nominal ceiling on which relief is available has been raised only once since it was first introduced in 1974, while the effective rate of tax relief has also come down progressively over this period to its current rate of 15 percent (table 4.6). Indeed, one irony is that much of the reduction in the effective impact of mortgage tax relief in the 1980s was achieved through the rise in house prices itself. This took the average value of a mortgage well above the £30,000 ceiling for mortgage relief.

While it is widely perceived that distortionary tax benefits have led to a switch of resources toward housing, investment in dwellings is actually lower as a percentage of GDP, and the capital stock lower, in the United Kingdom

Table 4.6 Changes in Mortgage Interest Relief

Pre-1974/75	Mortgage interest relief given on the full amount of any loan
1974/75	Limit introduced of £25,000
1983/84	Limit raised to £30,000, and relief given at source (MIRAS)
1988/89	Tax relief on new loans for home improvement withdrawn; limit of one claim on each property (home sharers were previously able to claim double tax relief)
1991/92	Higher rate relief abolished; relief restricted to basic rate (25%)
1994/95	Rate of tax relief reduced to 20%
1995/96	Rate of tax relief reduced to 15%

Table 4.7 **Value of Housing Stock, 1992**

	Gross[a] (billion \$)	Net[a] (billion \$)	Net Stock per Capita (\$)
United Kingdom	1,425	919	15,845
Australia	361	252	14,376
United States	8,086	5,190	20,314
Germany[b]	3,280	2,252	36,286

Sources: Organization for Economic Cooperation and Development, *Flows and Stocks of Fixed Capital* and *Main Economic Indicators.*

[a]Calculations based on market exchange rates: £1.512 per U.S. dollar, \$1.6139 per deutsche mark, and \$1.4513 per Australian dollar.

[b]Estimate for Western Germany.

than in many other countries (table 4.7). That perhaps suggests that tax-induced distortions to housing investment are not obviously more serious in the United Kingdom than elsewhere—a conclusion borne out by the welfare analysis that follows.

The tax incentives offered by the MIRAS system in the United Kingdom lower the effective user cost of housing to owner-occupiers. Moreover, because relief is given on nominal interest payments, the effective extent of this tax relief rises with inflation, further lowering the user cost. This is identical to the situation in the United States. Its effect is to induce an overinvestment in housing compared to a situation of zero inflation—where tax distortions would be minimized—or one where tax distortions were eliminated entirely. Figure 4.5 illustrates these three situations. A "0" subscript denotes the no-tax outcome, a "1" subscript the zero-inflation outcome, and a "2" subscript the current (2 percent inflation) outcome. As in the previous section, the deadweight distortion is equal to the area C + D. And the resulting gain from a reduction in inflation is (see Feldstein 1997b, eq. [19])

$$(9)\quad G_2 = \varepsilon_{HR}\{[(R_0 - R_1)/R_2][(R_1 - R_2)/R_2] + 0.5(R_1 - R_2)^2 R_2^{-2}\}R_2 H_2,$$

where the elasticity of housing with respect to the user cost, $\varepsilon_{HR} = -(R_2/H_2)(dH/dR)$.

To evaluate this expression we need to determine the three user costs, R_0, R_1, and R_2. In a zero-tax world, the implied rental cost of housing per pound of housing capital is reduced to $R_0 = \rho + m + \delta + t$, where ρ is the pretax rate of return (8.2 percent), m is the maintenance cost per pound of housing capital, t are transactions costs, and δ is the rate of housing depreciation.

For depreciation and maintenance costs, we assume 0.8 percent per annum.[42] We assume transactions costs are around 0.6 percent per annum (Rob-

42. This is based on the figure of 1.4 percent contained in the 1995 report of the Retail Prices Index Advisory Committee, representing the average annual expenditure on renovation—ex-

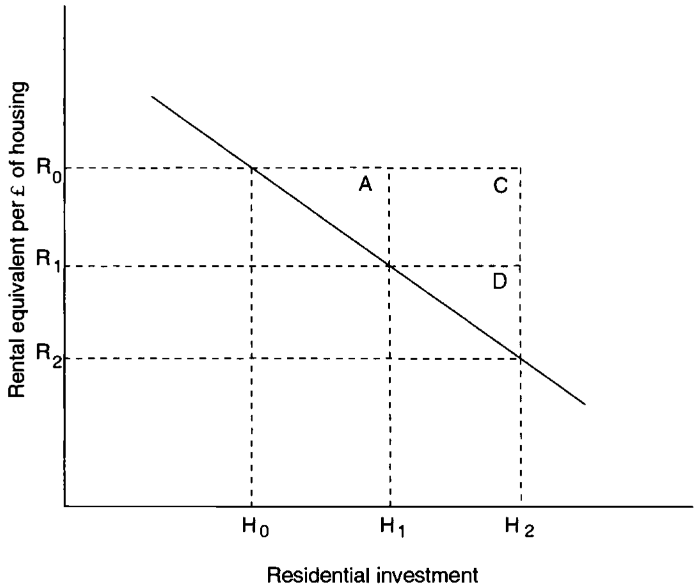

Fig. 4.5 Residential investment

inson and Skinner 1989; Woolwich Building Society 1996). This takes account of stamp duty, legal and estate agent fees, and removal costs, written off over the lifetime of a mortgage. So in sum we arrive at a figure of 1.4 percent, covering miscellaneous housing costs. This estimate is in line with those used by Henry and Pain (1994), Miles (1994), and Pain and Westaway (1996) for the United Kingdom. Using these values gives $R_0 = 0.096$ for the United Kingdom, a user cost of 9.6 pence per pound of housing investment. This is somewhat lower than calculated by Feldstein for the United States.

Turning to a world with taxes, Feldstein uses an itemizer/nonitemizer classification of owner-occupiers in the United States. The situation in the United Kingdom is somewhat different, but it is useful (as we demonstrate below) to make a similar distinction—between that part of the mortgage stock subject to MIRAS below the £30,000 ceiling and that proportion not.[43] The non-MIRAS mortgage stock will largely reflect the value of the outstanding mortgage stock that falls above the £30,000 MIRAS ceiling. But it will also include mortgages

pressed as a percentage of the value of the dwelling *excluding* land—needed to make good deterioration and obsolescence. But the value of land may be as much as half of the total price of a dwelling. This would tend to lower the percentage cost of maintenance and depreciation by around half, to around 0.7 percent. There is also some expenditure necessary to maintain the value of the land for each dwelling of, say, 0.1 percent per annum.

43. The U.S. and U.K. distinctions are different. In the United States, nonitemizers get a lump sum of interest relief, whereas in the United Kingdom the non-MIRAS component gets no relief of any kind. Feldstein is able to ignore the lump-sum benefit to nonitemizers because it has no effect at the margin.

on second properties, which are not eligible for tax relief. The MIRAS/non-MIRAS distinction we make is clearly artificial but is nonetheless useful analytically.[44]

The average price of a house in the United Kingdom is £55,000 according to Halifax Building Society figures. Even assuming a low mortgage-to-value ratio, this means that the majority of new mortgages in the United Kingdom will exceed the ceiling. But it takes some time for the mortgage stock to turn over. So mortgages that do not exhaust the tax relief fully are still nontrivial in number and an important factor in the calculations below. For loans subject to MIRAS, the user cost of housing is

$$R_{\text{MIRAS}} = \mu(1 - \theta)i_{\text{m}} + (1 - \mu)(r_{\text{n}} + \pi) + (1 - \varphi)\tau_{\text{p}} + m + \delta + t - \pi, \qquad (10)$$

where μ is the mortgage-to-value ratio, θ is the effective rate of tax relief, r_{n} is the real posttax rate of return on saving (calculated in the previous section), i_{m} is the interest rate paid on the mortgage, τ_{p} is the rate of property tax, and π is house price inflation.

The rate of tax relief (θ) used in the calculations was 16 percent, which was the marginal rate of MIRAS prevailing in 1995 for the value of mortgages under the £30,000 ceiling.[45] The interest rate paid on building society mortgages (i_{m}) averaged 7.5 percent in 1995, when the (bias-adjusted) inflation rate was 1.6 percent. Thus the mortgage rates that would apply under zero and 2 percent inflation would be 5.9 and 7.9 percent, respectively, on the assumption that the Fisher effect holds exactly. On property taxes (τ_{p}), the ratio of council tax payments to the value of the housing stock was around 0.8 percent per annum in 1995. There is no tax relief on these payments, so $\varphi = 0$.

Finally, on the expected house price inflation term (π), Feldstein assumes that house prices grow in line with the general price level. We do the same for consistency. It could be that a premium should be added to the inflation term, to reflect the fact that U.K. house prices have tended historically to grow faster than retail prices. But adding a constant to the user cost would have little impact on our calculations at the margin.

In order to calculate the implicit rental rate, we need an estimate of the mortgage-to-value ratio. For new business, this is around 70 percent. But

44. There are various alternative ways of capturing the MIRAS limit. E.g., presentationally it might appear preferable to make a distinction between those households who claim MIRAS and those who do not. E.g., Hills (1991) calculates that 90 percent of the mortgage stock and some 22 percent of all mortgages were above the £30,000 ceiling at the end of 1988. These figures will of course have increased since 1988, since when the MIRAS ceiling has been fixed in nominal terms. It is possible to use these as weights to calculate an effective rate of tax relief for all those who claim MIRAS, but the effective rate of tax relief would then vary systematically with the mortgage stock in response to any change in the rental price.

45. I.e., one-fourth of the tax rate in financial year 1994/95 (20 percent) and three-fourths of the rate in 1995/96 (15 percent).

the average mortgage-to-value ratio for the *outstanding* mortgage stock will clearly be lower as, for example, loans are repaid through time. Aggregate mortgage and housing stock data suggest that the ratio is 35 percent. For loans qualifying for MIRAS, the ratio is likely to be higher than this average. We make a somewhat arbitrary assumption that the ratio is 60 percent. And using equation (10), this then suggests that a combination of 2 percent inflation and the current tax regime would reduce the rental cost of housing from around 9.6 pence to around 6.9 pence ($R_2 = 0.069$) per pound of housing capital.

Next we consider the effect of inflation on the user cost. From equation (10) we can see that the change in rental cost for a given change in inflation is

$$(11)\quad dR_{\text{MIRAS}}/d\pi = \mu(1-\theta)(di_m/d\pi) + (1-\mu)[d(r_n+\pi)/d\pi] - 1.$$

Assuming $di_m/d\pi = 1$,[46] we calculate that $dR_{\text{MIRAS}}/d\pi = -0.15$. A 1 percentage point rise in inflation reduces the implicit rental rate on housing by 0.15 pence per pound of housing capital. This occurs through two channels: a direct channel, whereby higher inflation increases the real value of MIRAS, and an indirect channel, as the fall in the real savings rate reduces the opportunity cost of the owner-occupier's equity stake in the house. Hence, the rental rate of 6.9 pence per pound of housing capital at 2 percent inflation rises to 7.2 pence ($R_1 = 0.072$) at zero inflation.

The implicit rental rate on the non-MIRAS part of the owner-occupied mortgage stock is given by

$$(12)\quad \begin{aligned} R_{\text{NON-MIRAS}} &= \mu_{\text{NON-MIRAS}} i_m + (1-\mu_{\text{NON-MIRAS}})(r_n+\pi) \\ &\quad + \tau_p + m + \delta - \pi. \end{aligned}$$

The only differences are that we drop the tax relief terms and assume a different mortgage-to-value ratio. Despite the disappearance of the direct tax wedge, inflation still affects the user cost because of its impact on the opportunity cost of housing equity. We would expect the mortgage-to-value ratio to be lower for non-MIRAS mortgages and set it to be 35 percent. Using this estimate in equation (8), we calculate the rental price to be 7.5 pence ($R_{\text{NON-MIRAS}_2} = 0.075$) at 2 percent inflation and 7.6 pence ($R_{\text{NON-MIRAS}_1} = 0.076$) at zero inflation. Not surprisingly, both are higher than the MIRAS user costs.

Finally, we consider the private rented sector.[47] A significant proportion of the value of the private rented sector housing stock is likely to be owned outright and rented out. But there are also some landlords who let their properties

46. It is unclear whether we would expect the pretax Fisher effect to hold exactly.

47. We exclude any effects from the public or housing association sectors and concentrate on the private rented sector. Together, public sector housing (19 percent) and housing associations (4 percent) account for 23 percent of the housing stock by tenure. Given an owner-occupied rate of 67 percent, the residual of 10 percent reflects the proportion of households in the private rented sector. We assume that the value of the housing stock is divided in the same proportion as tenure rates. This is likely to underestimate the value of the owner-occupied sector.

but who have mortgages outstanding. Further, there is tax relief available on these loans at the rate of income tax; and there is no ceiling on this relief. Hence, inflation and the tax system again introduce wedges into the rental user cost. The user cost for the rental sector, equation (13), is similar to the MIRAS user cost, equation (10):

$$R_{\mathrm{RENTAL}} = \mu_{\mathrm{RENTAL}}(1 - \theta_{\mathrm{RENTAL}})i_m + (1 - \mu_{\mathrm{RENTAL}})(r_n + \pi) + (1 - \varphi)\tau_p + m + \delta + \tau - \pi. \tag{13}$$

There is likely to be a different mortgage-to-value ratio (μ_{RENTAL}) for the rental sector than for MIRAS owner-occupiers. We can deduce this by residual. This gives us a 25 percent mortgage-to-value ratio for the rental sector, which, as we would expect, is low. The second difference from the MIRAS calculation is that the rate of tax relief (θ_{RENTAL}) is levied at the individuals' rate of income tax. We calculate this to be 32 percent. This reflects the average effective rate of relief claimed by taxpayers in the three income tax bands (20, 25, and 40 percent).[48] Not surprisingly, this is higher than the basic rate because of the preponderance of landlords in the higher rate tax bracket. So despite the smallness of the rental sector in stock terms and its low mortgage-to-value ratio, the sector is still important because of the size of the tax wedge. From equation (13), the implied user cost is 7.1 pence with inflation at zero and 6.7 pence with inflation at 2 percent. Not surprisingly, these figures differ little from those obtained for MIRAS mortgages.

We next identify the outstanding stock of loans for each sector and the corresponding value of their housing stocks. Inland Revenue figures show that the value of MIRAS tax deductions in 1995 was £2.9 billion. Given a 16 percent average rate of tax relief, this implies total mortgage interest payments of around £18 billion. Using the average building society mortgage rate of 7.5 percent in 1995 implies that the value of the mortgage stock on which these MIRAS deductions were made was around £239 billion. If the mortgage-to-value ratio is around 60 percent, as we assumed earlier, this makes the value of the housing stock on which MIRAS deductions are claimed worth around £398 billion. For the rental sector, the current market value of their housing stock was around £113 billion in 1995. With a 25 percent mortgage-to-value ratio, this implies an outstanding stock of mortgages of around £28 billion held by the rental sector. We also know that the total stock of lending secured on dwellings in 1995 was some £390 billion. So we can determine the non-MIRAS mortgage stock by residual. This was around £124 billion (£390 − £239 − £28 billion) in 1995. The value of the non-MIRAS housing stock also drops out by residual at £356 billion (£753 − £398 billion).[49]

48. Inland Revenue figures suggest that 8 percent of individuals' rental income is taxed at 20 percent, 44 percent at 25 percent, and 48 percent at 40 percent.

49. Hence, the aggregate mortgage-to-value ratio is 35 percent (123/345*100), as above.

We can now evaluate equation (9). See figure 4.5. With no taxes, the rental price is R_0 and the housing stock is H_0. With existing tax rules and zero inflation the rental price drops to R_1 and the housing stock increases to H_1. Finally, with inflation at 2 percent the rental cost drops further to R_2 and the housing stock increases to H_2. The additional deadweight loss of 2 percent inflation is the area C + D. By substituting values for the user cost into equation (9) and adding subscripts to distinguish MIRAS, non-MIRAS, and rental variables, we have

(14) $$G_{\text{MIRAS}} = 0.0154\varepsilon_{HR}R_{\text{MIRAS}\,2}H_{\text{MIRAS}\,2},$$

(15) $$G_{\text{NON-MIRAS}} = 0.0059\varepsilon_{HR}R_{\text{NON-MIRAS}\,2}H_{\text{NON-MIRAS}\,2},$$

(16) $$G_{\text{RENTAL}} = 0.0205\varepsilon_{HR}R_{\text{RENTAL}\,2}H_{\text{RENTAL}\,2}.$$

Adding these terms together gives us our estimate of the aggregate welfare gain G_3.

To evaluate equations (14), (15), and (16) we now only need an estimate of the compensated elasticity of housing demand with respect to the user cost. Feldstein (1997b) assumes $\varepsilon_{HR} = 0.8$. We take an estimate of the uncompensated elasticity of 0.53 from King (1980), a unit income elasticity, and a budget share of housing of 13.5 percent.[50] This gives an estimated compensated elasticity of around 0.4.

But the assumption that this elasticity holds for all three categories of housing seems implausible. In practice, changes in the user cost are more likely to affect the fraction of housing investment that lies above the £30,000 MIRAS ceiling. To account for this, we assume that the elasticity of MIRAS housing investment is closer to zero—say, around 0.1—while the elasticity of non-MIRAS investment is correspondingly higher at around 1.0.[51] This leaves the average aggregate elasticity unchanged at 0.4. Substituting these values into equations (14), (15), and (16) and summing gives an estimated total welfare gain of around 0.038 percent of GDP. This is around a quarter the size of Feldstein's U.S. estimate. This difference reflects the somewhat smaller mortgage interest relief distortions under the current U.K. tax system.

4.4.2 Indirect Revenue Effects

The fall in the housing capital stock associated with a move to price stability totals around £12 billion. There are four main channels through which this change in housing demand affects government revenues. First, there is a flow effect as the reduction in inflation lowers the value of the tax relief subsidy to MIRAS holders and to those claiming relief outside of MIRAS (the rental sector). This translates into increased revenues of £0.96 billion. Second, there are

50. Which is the average share of housing costs in the RPI in the 1990s.
51. The elasticity of the private rental sector is still set equal to 0.4.

direct stock effects on tax revenue. The reduction in the stock of mortgages reduces mortgage payments, thus reducing the value of tax relief and increasing net tax revenues. This is worth £0.03 billion. It is small because we have assumed a low elasticity for the MIRAS mortgage stock. Third, there will also be a loss of revenue from property taxes, estimated at £0.09 billion. Finally, the transfer of capital to the business sector affects tax revenue. The extra business investment yields a return—which is subject to tax—and this is worth around £0.36 billion.[52] The overall change in revenue is

$$(17) \quad d\mathrm{REV}_2 = £0.96 + £0.03 + £0.36 - £0.09 = £1.25 \text{ billion.}$$

The overall gain from lower inflation on housing investment is the sum of these effects:

$$(18) \quad G_4 = G_3 + \lambda\, d\mathrm{REV}_2 .$$

With these adjustments and $\lambda = 0.4$, the overall gain is around 0.11 percent of GDP. This estimate is less than half Feldstein's U.S. estimate (table 4.2). That is not too surprising given the gradual erosion in the real value of MIRAS over the past 20 years in the United Kingdom. For example, the cost of mortgage relief was reduced from a peak of over £6 billion per annum at the end of the 1980s to under £3 billion in 1995.

4.4.3 Sensitivity Analysis

Figure 4.6 offers some sensitivity analysis on the results, plotting net welfare gains against ε_{HR} and λ. Here the risks to net benefits are more clearly on the upside, searching across the two parameters. The plane is everywhere positive and is increasing in both parameters. The gains themselves are never that large over reasonable parameter ranges: they are very unlikely to exceed 0.3 to 0.4 percent of GDP. But they are nonetheless tangible. Indeed, given the risks that attach to achieving such gains via monetary policy, it might plausibly be argued that a strong case can be made for fiscal reform. Unlike monetary policy, the abolition of MIRAS could be targeted explicitly at extracting the welfare gains in figure 4.6; it would have few downside (potentially negative welfare) risks, unlike monetary policy, and it could be achieved without incurring transient output costs, again, unlike monetary policy.

Counterbalancing these upside risks, however, is the fact that our compara-

52. However, this calculation only includes the revenue gained from the existence of the wedge between the rate of return earned by companies and the posttax real rate of interest earned by households. Following Dolado, González-Páramo, and Viñals (chap. 3 in this volume), there is also a value-added tax (VAT) effect. With a capital share of value added assumed fixed at 37 percent in 1995 and a pretax return of 8.2 percent, value added will be around 22 percent of the capital stock per year. Given our estimated £10.4 billion rise in the business capital stock, this generates an additional £2.3 billion of value added, which in turn generates £0.4 billion (0.06 percent of GDP) of VAT receipts with VAT at 17.5 percent. To maintain consistency with other countries' calculations this additional revenue effect has not been added to the results in the main table.

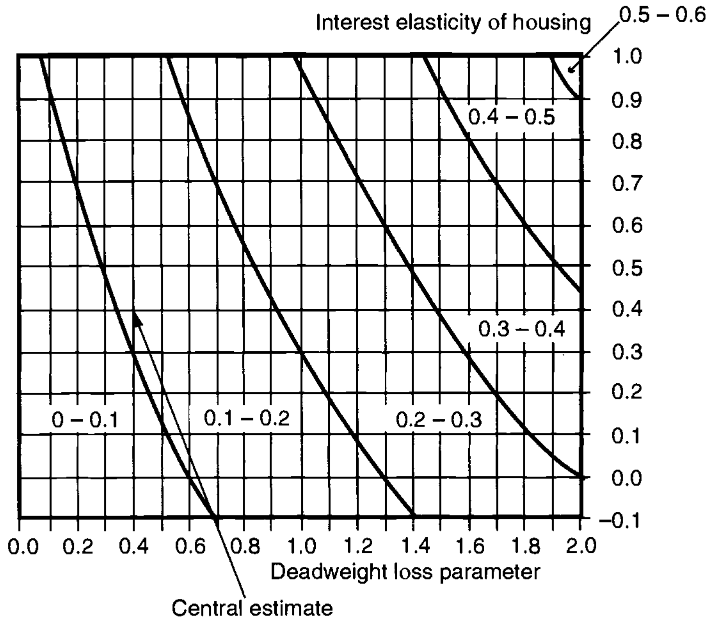

Fig. 4.6 Net welfare benefits from housing investment (percent of GDP)

tive static analysis implicitly assumes that the MIRAS/non-MIRAS split of mortgages would remain constant if 2 percent inflation were to persist indefinitely. That is clearly implausible if the MIRAS ceiling were to remain unchanged in nominal terms, as historically it largely has. Inflation then increases over time the stock of mortgages ineligible for MIRAS; it denudes the real value of MIRAS relief. This dynamic effect is not taken into account in the above calculus and would act to reduce net welfare benefits over time.[53]

4.5 Inflation and the Demand for Money

4.5.1 "Shoe Leather" Costs

Following Bailey (1956), the most widely studied deadweight losses of a fully anticipated inflation derive from distortions to money demand, so-called shoe leather costs. In essence, these costs capture the transactions time agents expend in replenishing money balances, the stock of which is held at a suboptimally low level at any positive nominal interest rate.[54]

53. We can gauge its size—and put a lower bound on welfare gains—by assuming all of the mortgage stock is effectively ineligible for MIRAS. The welfare gain would then fall to 0.04 percent of GDP.

54. On the assumption that the marginal cost of money creation is close to zero.

The gain in consumer surplus that results from a fall in inflation from π_2 to π_1 is given by the trapezoid underneath a conventional money demand schedule. This is associated with a fall in the opportunity cost of money balances (proxied here by the nominal net return on a debt-equity portfolio) equal to $(r_n + \pi_2) - (r_n + \pi_1)$. Friedman's welfare optimum, where the marginal cost and marginal benefit of money balances are equalized at zero, is given by the point $r_n + \pi_0 = 0$. On the assumption of linearity of the money demand curve, the trapezoid of lost consumer surplus (G_5) can be approximated by

$$(19)\quad G_5 = 0.5[(r_n + \pi_2) - (r_n + \pi_1)](M_2 - M_1) + (r_n + \pi_1)(M_2 - M_1).$$

From earlier we have $r_n = 4.9$ percent at 2 percent inflation and $r_n = 5.1$ percent at zero inflation, given $dr_n/d\pi = -0.12$. Observing that, again under the linearity assumption, $M_2 - M_1 = -\varepsilon_M[(r_n + \pi_2) - (r_n + \pi_1)][M/(r_n + \pi)]$, then $G_5 = 0.00109\ \varepsilon_M[\overline{M/(r_n + \pi)}]$, where a bar denotes a mean value and ε_M is the interest elasticity of money demand. We take $\overline{(r_n + \pi)} = 6.9$. For M we take the stock of non-interest-bearing M1 in the United Kingdom. This was equivalent to 4.9 percent of GDP in 1995.[55]

As in the United States, there are a range of estimates for ε_M in the United Kingdom. But the Bank of England's work (Breedon and Fisher 1993) suggests a steady state interest elasticity of around 0.3. This is very much a conservative estimate. Others have arrived at higher elasticities looking at longer and more recent runs of data.[56] But on these conservative assumptions, $G_5 = 0.023$ percent of GDP. This is similar to Feldstein's estimate of 0.016 percent of GDP. Moving to the Friedman optimum—of deflation equal to the real rate of interest—yields a welfare gain of $G_5 = 0.051$ percent of GDP. The gains are larger here than in Feldstein (0.02 percent of GDP) but remain small quantitatively. And although small, these estimates are of the same order of magnitude as those found in previous partial equilibrium studies, when measured over the same interest rate interval. For example, Fischer (1981) and McCallum (1989) both arrive at a figure of around 0.3 percent of GDP when transitioning from 10 percent to zero inflation. Linearly interpolating, this would deliver a gain of around 0.06 percent of GDP when moving from 2 percent to zero inflation, which is in the same ballpark as the estimates here.[57]

55. Most authors use an M1 measure of the money stock. This will lead to an *over*statement of money demand distortions because much of the M1 stock is interest bearing. Feldstein (1995) takes the stock of currency and reserves, which will be an *under*statement because it omits non-interest-bearing bank deposits.

56. Chadha, Haldane, and Janssen (1998) look at narrow money demand relationships between 1870 and 1994 and find an interest elasticity of around 0.8. Janssen (1996) looks at the behavior of M0 during the 1990s and finds that its interest elasticity has risen markedly compared with the 1980s.

57. Neither of these studies takes account of tax effects that mean that the interest rate opportunity cost falls less than proportionately with inflation. They also use a broader (M1) measure of the money stock. This largely accounts for the differences. See also Feldstein (1979) and, more recently, Dotsey and Ireland (1996).

4.5.2 Indirect Revenue Effects

Feldstein (1997b) considers three government revenue implications of the higher real money balances held by agents at lower rates of inflation: (a) the reduction in direct seigniorage revenues as the (inflation) tax rate falls (the Phelps 1972 effect), (b) the revenue loss as assets are switched from (taxed) capital assets to (nontaxed) money balances (a kind of Mundell-Tobin effect), and (c) the reduction in debt service costs as money balances substitute for interest-bearing debt.

On (a), Feldstein shows that the marginal response of seigniorage to a change in inflation is

$$(20) \qquad dSEIG/d\pi = M_2\{1 - \varepsilon_M[d(r_n + \pi_2)/d\pi_2]\pi_2/(r_n + \pi_2)\}.$$

The term $\varepsilon_M[d(r_n + \pi_2)/d\pi_2]$ captures the direct price effect of the fall in the tax rate (inflation); and the term $\pi_2/(r_n + \pi_2)$, the offsetting effect on revenues of the rise in the tax base as money balances increase. Using the assumptions from earlier gives a net revenue loss equal to 0.09 percent of GDP.

On (b), the fall in business capital is equal to the rise in money balances $(M_2 - M_1)$. The gross real rate of return to capital in the United Kingdom between 1970 and 1995 averaged 8.2 percent with a net return of 4.9 percent, giving a tax wedge of 3.3 percent points. The revenue loss is 0.012 percent of GDP.

Finally on (c), we calculate the reduction in government debt service costs as $r_{ng}*(M_2 - M_1)$, where r_{ng} is the real return on government debt, net of the tax the government receives on those interest payments. Proxying gross *nominal* interest payments by the ratio of debt interest payments to national debt in 1995 (6.8 percent), a 1995 inflation rate of 1.6 percent (netting off the measurement bias), and assuming a marginal tax rate of 31.1 percent gives $r_{ng} = (1 - 0.31)*(0.068) - 0.016 = 0.031$. The reduction in debt servicing is 0.012 percent of GDP.

Bringing these estimates together, we have a shoe leather gain of 0.023 percent of GDP and revenue losses totaling 0.11λ percent of GDP. So at $\lambda = 0.4$ we have a net welfare loss of around 0.022 percent of GDP. These net welfare losses are smaller than in Feldstein but are still negative. In all of our cases, the Phelps effect dominates the Bailey effect.

4.5.3 Risks to the Calculus

Figure 4.7 conducts some sensitivity analysis, plotting net shoe leather gains against ε_M and λ. From this it is clear that it is quite difficult to make a case for a positive net welfare contribution from money demand distortions. The net welfare gains are also everywhere small. This reflects the smallness of the aggregate currency stock compared with the housing stock.

But there may also be some upside risks—in particular to the assumed interest elasticity—that are not captured by figure 4.7. We have assumed throughout linearity of the money demand function. But Lucas (1994) has recently argued,

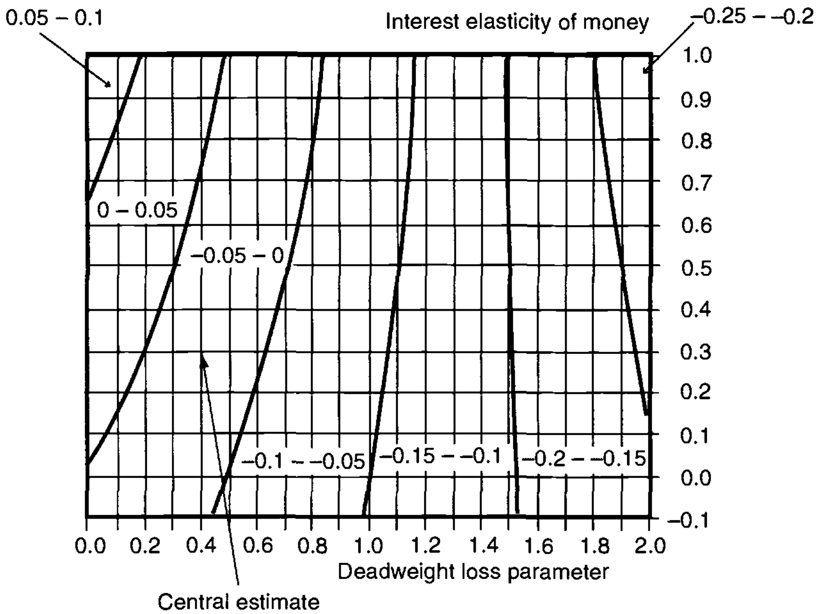

Fig. 4.7 Net welfare benefits from money demand (percent of GDP)

on theoretical and empirical grounds, that money demand functions are best viewed as a *log*-linear representation. Such an assumption can have a dramatic impact on welfare cost calculus. As we approach nominal interest rates of zero, money demand asymptotes on the zero axis, raising the size of the welfare triangle. Lucas (1994) suggests that deadweight losses could then amount to as much as 1 percent of GDP when moving to zero nominal interest rates; and Chadha et al. (1998) arrive at similar numbers for the United Kingdom also using a logarithmic specification.

Against this, the Lucas specification does imply that the largest welfare gains accrue—the interest elasticity is largest—near the Friedman optimum. That is not our experiment here. Moreover, neither the United Kingdom nor the United States has very much time-series evidence on money demand at near-zero interest rates to shed light on the plausibility of Lucas's thesis. Indeed, Mulligan and Sala-i-Martin (1996) argue, contrarily, that money demand is likely to be largely interest *in*elastic at low nominal interest rates. This follows from the fact that at low interest rates, the incentive to shift into interest-bearing assets is reduced for a large fraction of the population. They present some cross-sectional evidence to support their thesis. And Chadha et al. (1998) ultimately reject a log specification over a conventional semilog form as a description of steady state (if not dynamic) money demand behavior in the United Kingdom.

Another uncertainty concerns the use of a partial rather than general equilibrium framework. The latter approach often appears to have yielded larger welfare benefits (Cooley and Hansen 1989; Dotsey and Ireland 1996). The source of these higher costs is the explicit recognition of labor/leisure choices. So, for example, if—as in Cooley and Hansen (1989)—lower inflation lowers the tax on consumption goods and leads agents to supply extra labor, income will rise. The money demand schedule will then shift outward. And welfare gains will be correspondingly greater than when income is held fixed, as under the partial equilibrium approach. Likewise, the conventional Mundell-Tobin effect of moving to price stability—a fall in capital accumulation as agents switch into money balances—need not arise in a general equilibrium setting. Because investment is simply deferred consumption and since inflation acts as a consumption tax, lower inflation may actually increase investment and the capital stock. That would, in turn, reduce some of the revenue losses described above.[58]

But even after allowing for these effects, Cooley and Hansen (1989) and Dotsey and Ireland (1996) still arrive at welfare costs that are similar to those here over the same inflation rate range. For example, a fall in inflation from 4 to 2 percent in Dotsey and Ireland (1996) still yields a welfare benefit of only around 0.045 percent of GDP.[59] Moreover, and perhaps most important, neither of the above papers recognizes distortionary taxes. Cooley and Hansen (1991) do explicitly introduce labor and capital taxes into their earlier equilibrium framework. They conclude that while adding in taxes doubles the gross welfare costs of inflation, these gains are more than counterbalanced by the need to raise distortionary taxes elsewhere to satisfy the government's budget constraint. So the upshot is a net welfare loss—as here and in Feldstein (1997b)—and for the same reasons. So the risks to the above analysis seem to be broadly counterbalancing; and they do not clearly imply that the net distortions to money demand are anything other than negligible and quite possibly negative.

4.6 Debt Service and the Government Budget Constraint

Lower inflation lowers tax receipts on the nominal interest payments made by the government when servicing its debt. Using the government's cash-flow identity and a steady state condition of a stable debt-GDP ratio, Feldstein (1997b) shows that the increase in taxes necessary to maintain a stable debt-GDP ratio in the light of this higher debt servicing cost is[60]

58. Other effects might be introduced into a general equilibrium setup that would aggravate inflation's distortions. E.g., Dotsey and Ireland (1996) have a model where higher inflation leads to an employment redistribution from production toward financial intermediation, where the returns to the latter are smaller.

59. Using a currency specification—as in Feldstein—and switching off the endogenous growth channel. The benefits are, however, much greater as we approach the Friedman optimum.

60. Assuming no change in the inflation risk premium on government debt.

$$dT = d\pi\,\theta_i H, \tag{21}$$

where T denotes taxes (as a percentage of GDP), θ_i is the effective tax rate on interest payments, and H denotes government debt (again as a percentage of GDP).

The calculus is complicated slightly in the United Kingdom because, first, some large-scale holders of U.K. government debt are tax exempt—in particular pension funds and charities—and, second, some domestic debt is also held by overseas residents, on most of which the U.K. government levies no tax.[61] At the end of 1995, pension funds held 21 percent of the stock of government debt and the overseas sector around 14.5 percent. Deducting these tax-exempt holdings from the stock of debt gives $H = 0.355$ (as a percentage of GDP in 1995, using Maastricht definitions). We take $\theta_i = 0.31$, the marginal personal tax rate on debt interest income used earlier, and $d\pi = 0.02$. So the welfare costs associated with higher net debt-servicing costs—and hence higher taxes—when moving to price stability are 0.221λ. Hence, at $\lambda = 0.4$ the welfare cost is 0.088 percent of GDP, and at $\lambda = 1.5$ it is 0.33 percent of GDP. Both of these welfare losses are slightly lower than in Feldstein (1997b), though not by much.

4.7 Conclusions

Adding together the net welfare gains arising from consumption, housing investment, money demand, and debt-servicing distortions gives an aggregate welfare benefit of 0.21 percent of GDP, using central estimates of the key parameters (see table 4.1). This annual net welfare gain is translated into a present value using formula (1). Given an estimated discount rate of 5.3 percent and growth rate of 2 percent, the net present value of an annual welfare gain of 0.21 percent of GDP is equivalent to around 6.5 percent of GDP.

There are of course uncertainties on both sides of this central estimate, not least about the magnitude of the key parameters, and in particular the parameters measuring the welfare loss resulting from an extra pound of taxation and the saving elasticity. Figure 4.8 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 parameters, 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 costs. In section 4.2 it was shown that the breakeven benefit is

61. A third complication comes in the tax treatment of index-linked debt. Coupons are taxed in nominal terms and so changes in inflation do have revenue implications, but this is not true generally of the capital gains component. We ignore this effect here.

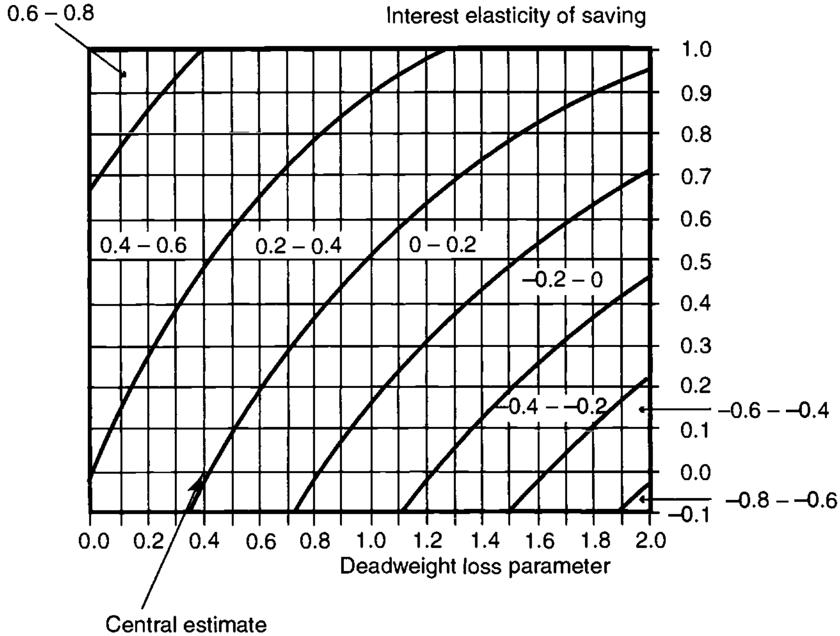

Fig. 4.8 Aggregate welfare benefits (percent of GDP)

0.18 percent of GDP. So on our central estimates of the key parameters, the benefits of reducing inflation exceed the costs.

A major uncertainty concerns the marginal tax rates used in the study. For example, when discussing saving, the crucial question is whether marginal funds are invested in proportion to their existing share of households' saving (average and marginal tax rates are equal), or whether instead they flow exclusively into either taxable or tax-exempt vehicles.

Notwithstanding this caveat, we would make the following observations on the basis of our welfare comparisons: First, it is clear that aggregate welfare gains in the United Kingdom are much smaller than those of Feldstein for the United States—perhaps around one-quarter the size. Idiosyncrasies in the two countries' tax systems largely account for these differences. Tax wedges tend to be smaller in the United Kingdom than the United States. And the sensitivity of tax rates to inflation is likewise less in the United Kingdom than in the United States—for example, because of indexation of capital gains. The gradual erosion of MIRAS and the indexation of capital gains, to take two examples, mean that some of the welfare benefits identified by Feldstein for the United States have already been realized in the United Kingdom.

This leads on to the second point: can we say whether the welfare benefits we have identified are best secured through monetary or fiscal policy? The identified distortions are the result of the interaction between taxes and inflation, rather than the result of one or the other acting in isolation. So it is unclear a priori whether monetary or fiscal policy is best suited to reaping these benefits. A full discussion of that issue would take us beyond this paper and into the realms of optimal fiscal policy. But the Institute for Fiscal Studies in the United Kingdom has already put forward proposals that would all but eliminate inflation-induced distortions to corporate taxes, at little administrative cost (Institute for Fiscal Studies 1995). Likewise, the complete abolition of mortgage interest relief would not be a difficult administrative step, though there are clearly political economy implications. Upping the limit, or extending the range, of tax-exempt savings vehicles would be a third option.

Third, our analysis takes as given the fact that we are currently operating at a second best. It is conceivable—if not perhaps likely—that the existing configuration of taxes and subsidies is already close to optimal. Adjustments to taxes around this point—in either direction—would not then be Pareto improving. This is equivalent to saying that the direct welfare benefits we identify may in fact be triangles rather than trapezoids, and that λ would, in general equilibrium, be high enough to counterbalance these direct welfare gains. More generally, the only foolproof way of simulating the welfare effects of a specific change in taxes (and their interaction with inflation) is in a fully general equilibrium model in which λ is endogenous to the tax experiment. That is the task of another—and very different—paper.

Finally, the welfare costs we identify are only a subset of the total costs of inflation, and there are a variety of possible extensions to the existing analysis. A complete treatment of business investment is one. An initial attempt has been made in the appendix. A formal treatment of front-end loading, as it relates to household and corporate debt, is another. And capital flow effects may be considered, as in Desai and Hines (chap. 6 in this volume). A fourth is an analysis of inflation's effect on the financing and investment mix of firms. A fifth is an analysis of distortions to that part of household savings that is not financing U.K. companies—for example, holdings of government bonds. Hence, the calculations in the paper clearly understate the benefits of reducing inflation. 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 permissible breakeven range of discount rates and output costs. All in all, the costs of inflation quantified here go some distance toward justifying and explaining the aversion to inflation that is shared by the public, economists, and policymakers alike.

Appendix
Inflation and Business Investment

Distortions to Business Investment

In the main text we considered the effects of a reduction in inflation on household consumption and saving, on residential investment, on money demand, and on government financing. One area that remains is business investment. But because households do not consume—at least directly—the capital stock, it is more difficult to conduct welfare analysis on business investment. Capital services are not strictly speaking demanded by individual households. So the estimates below have a less direct mapping into welfare than those from previous sections. That said, it is plausible to think that the physical capital stock could enter into agents' utility functions *in*directly, for much the same reasons as might the money stock or the human capital stock. Physical capital, like human capital and money, is time saving and is thereby leisure and utility enhancing. That is one way to interpret the thought experiment below.

There are a variety of channels through which inflation, operating in tandem with the tax system, might affect investment and the capital stock. The most widely studied effect of inflation on investment is through the cost of capital (in a U.K. context see, inter alia, King 1974, 1977; King and Fullerton 1984; Devereux 1989). With no taxes, the return on a hypothetical investment project and the return on the savings used to finance this project will be equalized. There is no "tax wedge" between the returns to saving and investment. But once distortionary taxes are admitted, the returns to saving and investment will differ. There is a tax wedge. The effect of the wedge, for a given saving rate, is to increase the effective pretax rate of return that a project must earn to make it worthwhile to undertake: it raises the effective cost of capital. This tax wedge depends on both the corporate and personal tax systems and their interaction with inflation, as well as on the nature of the investment project and its method of finance. Higher (personal and corporate) taxes increase the tax wedge and hence the cost of capital. So too does higher inflation as it raises effective personal and corporate tax rates. Both taxes and inflation will hence lower the capital stock below its no-tax equilibrium.

The distorting effects of taxes and inflation, acting through business investment, can be analyzed using the residential investment framework described earlier. Let r_0 be the cost of capital in the absence of taxes (a zero-tax wedge), with corresponding capital stock K_0. With taxes and zero inflation, the cost of capital rises to r_1 (a wedge of $r_1 - r_0$) and the capital stock falls to K_1. With taxes and 2 percent inflation the corresponding cost of finance and capital stock are subscripted with a "2": the cost of capital is suboptimally high and the capital stock suboptimally low. The resulting distortion from inflation is the conventional trapezoid, approximated by

(A1) $G_6 = \varepsilon_K\{[(r_1 - r_0)/r_2][(r_2 - r_1)/r_2] + 0.5(r_2 - r_1)^2 r_2^{-2}\}r_2 K_2,$

where ε_K is the elasticity of the capital stock with respect to the cost of capital.

Calculating the cost of capital at different tax and inflation rates requires a detailed breakdown of the components of the existing capital stock and its sources of financing, as well as knowledge of the tax system itself (see, e.g., Cohen, Hassett, and Hubbard, chap. 5 in this volume). But our earlier calculations, based on the saving-investment nexus, contain most of the basic ingredients. For example, the Hall and Jorgenson (1967) tax-adjusted formula for the real cost of capital is

(A2) $$r = (\rho + \delta - dq/q)(1 - \tau_c z)/(1 - \tau_c),$$

where ρ is the cost of (debt and equity) financing, δ is the depreciation rate, q is the relative price of capital goods, τ_c is the rate of corporation tax, and z is the present value of depreciation allowances. We devise a proxy for this cost of capital at 2 percent inflation (r_2) by adding $\delta[(1 - \tau_c z)/(1 - \tau_c)]$ to the pretax real rate of return to capital among U.K. companies between 1970 and 1995. This proxy can be reconciled with equation (A2) as follows.

As is conventional (King and Fullerton 1984), we assume that providers of capital—savers—demand a fixed posttax return. We set this posttax return equal to its historic value at 2 percent inflation, 4.9 percent.[62] But the cost of this capital to firms is affected by taxation at both the personal and corporate levels. This is embodied in the tax wedge calculated earlier, which explicitly takes account of the historical debt-equity split of investment financing and the personal and corporate tax rates attaching to returns as they are passed down from firms to households. This tax wedge is equal to 3.3 percent. Adding this to the posttax return demanded by providers of capital gives us the cost of funds for firms (ρ); it tells us the pretax returns available for distribution to holders of debt and equity. Our measure of pretax returns already embodies the direct effect of depreciation allowances (z) on the cost of funds; these are captured directly in the corporation tax wedge. We assume throughout that $dq/q = 0$ and is invariant under inflation.

But the pretax real return to capital is insufficient by itself to capture fully the cost of capital for firms. This is because both the numerator (profits plus interest payments) and the denominator (the capital stock) are defined net of depreciation. So this measure of the pretax return makes no adjustment for the cost of depreciation. We take the average depreciation rate, $\delta = 5.5$ percent, from Bond, Denny, and Devereux (1993). We then need to make a further adjustment for the interaction between depreciation and z.[63] This gives $r_2 = 14.3$

62. The assumption here is that the supply of international capital is perfectly elastic at this rate, which is not unreasonable in an open economy setting. To prevent double counting of the capital stock effects from section 4.3, we are also effectively assuming $\eta_{SR} = 0$, i.e., that private saving is interest inelastic at the domestic level.

63. Investment in vehicles and plant and machinery made up around 75 percent of gross domestic fixed capital formation in 1995, with buildings making up the further 25 percent. Applying

percent. This constructed measure captures quite accurately the cost of capital in equation (A2). We arrive at a rate of return that takes full account of tax distortions at the corporate and personal level, of depreciation and depreciation allowances, and of the debt-equity financing split of firms.[64]

We can now simulate the effects of moving to zero inflation. This has the effect of narrowing the tax wedge between the returns to saving and investment because of the nonneutralities associated with both personal taxation (of bond interest) and corporate taxation (bond interest deductibility and the nominal value of depreciation allowances). Our earlier estimates provided ready-reckoners for these nonneutralities. To these we add a further adjustment to reflect the depreciation allowance nonneutrality embodied in the extra depreciation term. Their combined effect is to narrow the tax wedge—and hence lower the effective user cost of capital—by 0.18 percent points for every percentage point fall in inflation. This gives $r_1 = 13.9$ percent. Note also that with no taxes, the cost of capital equals the return on saving plus depreciation, $r_0 = 10.4$ percent—the minimum posttax return that savers are willing to accept to finance a project. Thus we have values for the three costs of capital necessary to evaluate equation (A1).

For the elasticity of the capital stock with respect to the cost of capital, we take $\varepsilon_K = 0.5$. This is in line with the estimates set out in Mayes and Young (1993) for the United Kingdom and is consistent with the international evidence in Cummins, Hassett, and Hubbard (1996). The net stock of capital held by firms at the end of 1995 (K_2) was around £664 billion. Plugging in these estimates, the fall in the cost of capital from r_2 to r_1 as we move to price stability raises the capital stock by around £17.5 billion. Evaluating equation (A1), this then gives a direct "welfare" gain of $G_6 = 0.05$ percent of GDP.

Indirect Revenue Effects

Again, there are revenue effects associated with this rise in the capital stock. In particular, extra tax receipts accrue on the additional investment income generated by the higher equilibrium capital stock. These have further positive effects on welfare as distortionary taxes elsewhere are lowered, though these effects are relatively small, equal to 0.03 percent of GDP with $\lambda = 0.4$. This gives a total net "welfare" gain from the removal of distortions to business investment of around 0.08 percent of GDP with $\varepsilon_K = 0.5$ and $\lambda = 0.4$.

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these weights to capital allowance rates of 25 percent for vehicles and plant and machinery and 4 percent for buildings gives a weighted average capital allowance rate of 19.7 percent. Assuming a declining balance method of depreciation and discounting at the rate of return demanded by investors plus the inflation rate provides a measure of z.

64. One restriction that the analysis imposes is that the market value of a company's capital and its capital stock are equal, that Tobin's q is unity.

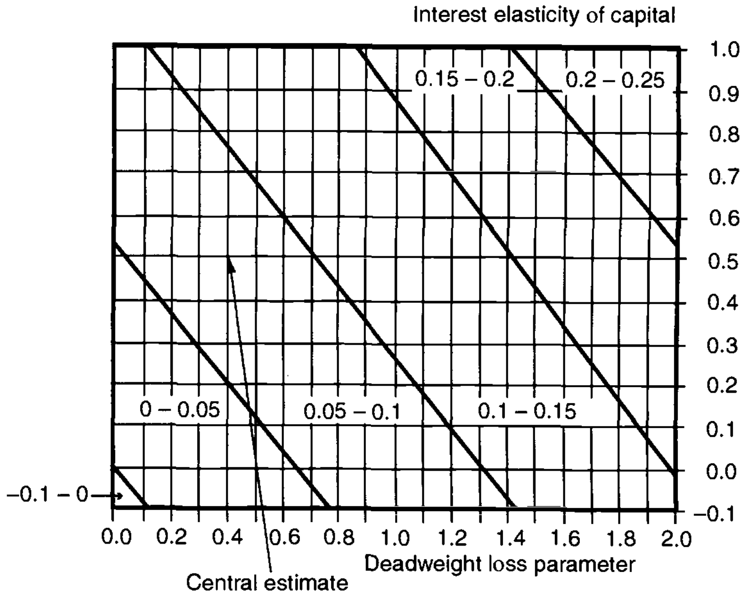

Fig. 4A.1 Net welfare benefits from business investment (percent of GDP)

Sensitivity Analysis

Figure 4A.1 plots net benefits arising from reduced distortions to business investment against ε_K and λ. As with residential investment, the net gains are almost everywhere positive, though they are generally smaller than with residential investment. But as well as the cost of capital there are other channels through which inflation might affect investment. Information asymmetries may mean that corporate cash flow has a direct impact on investment, over and above cost-of-capital effects (Fazzari, Hubbard, and Petersen 1988). Since corporate cash flow is affected by inflation through higher effective tax rates, inflation may have further direct effects on investment spending. Blundell et al. (1992) report evidence of just this in a study of U.K. manufacturing companies, as do Cummins et al. (1996) in an international context. Because of this, the above calculations probably underestimate the benefits of price stability arising from business investment distortions.

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Comment on Chapters 2, 3, and 4

Andrew B. Abel

The case studies of Germany, Spain, and the United Kingdom—chapters 2, 3, and 4—calculate the costs and benefits of moving from a low rate of inflation to a zero rate of inflation using the framework developed by Feldstein (1997). This framework emphasizes fiscal channels, both direct and indirect. The direct fiscal channels arise because the tax codes in these countries are not neutral with respect to inflation. In particular the taxation of capital income is sensitive to the rate of inflation. The indirect fiscal channels arise through the government's budget constraint, which requires that any changes in seigniorage associated with a reduction in inflation be offset by changes in other taxes or government expenditures.

All three case studies adhere to the framework developed in Feldstein (1997), though the details of tax codes and differences in institutions require some modification of the framework for each country. The adherence to a common framework simplifies comparisons among these three countries and with

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the United States, which was studied by Feldstein (1997). In addition, it simplifies my task as a discussant of three papers because I have already published a comment on Feldstein (1997). In that comment (Abel 1997) I developed and calibrated a suitably modified version of the Sidrauski (1967) model to provide an alternative set of calculations of the welfare effects of eliminating inflation in the United States. Here I will apply this modified Sidrauski model to Germany, Spain, and the United Kingdom. The presentation of the model is taken largely from Abel (1997). I will present the basic model so that all of the notation and definitions are contained in this comment, and I will present the first-order conditions to give a flavor of the analytic results. However, I will not include the details of the solution procedure but instead refer interested readers to Abel (1997).

An Extension of the Sidrauski Model

The fiscal channels analyzed in the case studies can be incorporated into the Sidrauski model with three modifications. First, the model will include two types of capital, which are to be interpreted as housing capital and nonhousing capital. Second, the model will include a government budget constraint that integrates monetary and fiscal policy. This budget constraint will capture the effects of various distortionary taxes and will take account of changes in distortionary tax rates needed to offset any change in seigniorage when inflation is eliminated. Third, labor supply will be endogenized so that taxes on labor income are distortionary. In the standard version of the Sidrauski model with exogenous labor supply, taxes on labor income do not distort labor supply and thus are lump sum. The presence of lump-sum taxes would provide a nondistortionary way of offsetting changes in seigniorage revenue, which would violate the spirit of Feldstein's (1997) analysis and the analyses in the case studies.

Consider a closed economy with N_t identical consumers in period t. The population grows at rate n so that $1 + n \equiv N_t/N_{t-1}$. There are two types of capital: nonhousing capital (type 1) and housing capital (type 2). Let $K_{i,t}$ be the aggregate capital stock of type $i (i = 1, 2)$ at the beginning of period t, L_t be the aggregate labor input in period t, p_t be the price of goods in terms of money, M_t be the aggregate nominal money supply at the beginning of period t, and B_t be the aggregate nominal stock of government bonds at the beginning of period t. The real per capita values of these variables are $k_{i,t} \equiv K_{i,t}/N_t$, $l_t \equiv L_t/N_t$, $m_t \equiv M_t/(p_t N_t)$, and $b_t \equiv B_t/(p_t N_t)$.

The Consumer's Problem

Asset accumulation of an individual consumer is described by

$$\text{(C1)} \quad \begin{aligned} &c_t + (1 + n)(k_{1,t+1} + k_{2,t+1}) + (1 + n)\pi_{t+1}m_{t+1} + (1 + n)\pi_{t+1}b_{t+1} \\ &\quad = (1 - \tau_w)w_t\ell_t + R_{1,t}k_{1,t} + R_{2,t}k_{2,t} + (1 + i_t^b)b_t + m_t. \end{aligned}$$

The right-hand side of equation (C1) represents the consumer's real disposable resources in period t, which consist of (a) after-tax wage income, where w_t is the real wage rate and τ_w is the tax rate on wages; (b) the value of capital held at the beginning of period t plus any earnings on the capital, where $R_{i,t}$ represents the real after-tax gross return (i.e., principal plus income, after tax) on capital of type i; (c) the value of government bonds held at the beginning of period t plus after-tax interest earnings on the bonds, where i_t^b is the after-tax interest rate on bonds; and (d) the real value of money balances held at the beginning of period t. The left-hand side of equation (C1) represents the consumer's spending in period t, which consists of (a) consumption c_t; (b) capital to carry into period $t + 1$; (c) real money balances to carry into period $t + 1$, where $\pi_{t+1} \equiv p_{t+1}/p_t$ is the gross rate of inflation; and (d) bonds to carry into period $t + 1$.

The utility function of the consumer is

$$\text{(C2)} \qquad \sum_{t=0}^{\infty} \beta^t u(c_t, m_t, \ell_t) \equiv \sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\rho}}{1-\rho} + \phi \frac{m_t^{1-\delta}}{1-\delta} - \psi \frac{\ell_t^{1+\eta}}{1+\eta} \right),$$

where ρ, δ, η, ϕ, and ψ are positive constants. The consumer chooses consumption, each type of capital, real money balances, bonds, and labor supply to maximize utility in equation (C2) subject to the budget constraint in equation (C1). Letting $\beta^t \lambda_t$ be the Lagrange multiplier on the constraint in equation (C1), the first-order conditions are

$$\text{(C3a)} \qquad (c_t): \qquad c_t^{-\rho} = \lambda_t,$$

$$\text{(C3b)} \qquad (k_{i,t}): \qquad \beta \lambda_t R_{i,t} = \lambda_{t-1}(1 + n), \qquad i = 1,2,$$

$$\text{(C3c)} \qquad (m_t): \qquad \beta \phi m_t^{-\delta} + \beta \lambda_t = \lambda_{t-1}(1 + n)\pi_t,$$

$$\text{(C3d)} \qquad (b_t): \qquad \beta \lambda_t (1 + i_t^b) = \lambda_{t-1}(1 + n)\pi_t,$$

$$\text{(C3e)} \qquad (\ell_t): \qquad -\psi \ell_t^{\eta} + \lambda_t (1 - \tau_w) w_t = 0.$$

I will focus on the steady state in which all of the time-subscripted variables in equations (C3a) through (C3e) are constant. Solving these equations yields the following steady state relations

$$\text{(C4a)} \qquad R_i = \frac{1 + n}{\beta}, \qquad i = 1,2,$$

$$\text{(C4b)} \qquad 1 + i^b = \frac{1 + n}{\beta} \pi,$$

$$\text{(C4c)} \qquad \frac{\phi m^{-\delta}}{c^{-\rho}} = i^b,$$

(C4d) $$\frac{\psi \ell^{\eta}}{c^{-\rho}} = (1 - \tau_w)w.$$

In the steady state, the real after-tax gross return on all nonmonetary assets is $(1 + n)/\beta$. According to equation (C4a), the real after-tax return on both types of capital is $(1 + n)/\beta$.[1] The real after-tax return on bonds is $(1 + i^b)/\pi$, which, according to equation (C4b), is also equal to $(1 + n)/\beta$. Money offers a lower pecuniary rate of return than bonds (if $i^b > 0$), but consumers willingly hold money because money offers a nonpecuniary return $\phi m^{-\delta}$. The optimal holding of money is reflected in equation (C4c). Finally, equation (C4d) shows that the consumer supplies labor to the point that the disutility of working an additional unit is just offset by the additional utility made possible by earning additional after-tax wage income.

The debt service channel analyzed by Feldstein (1997) and the case studies is absent in the Sidrauski model. As noted above, equation (C4b) implies that the steady state real after-tax rate of return on bonds is invariant to the rate of inflation. Thus the real cost of financing debt, net of taxes levied on interest income, is invariant under changes in the rate of inflation. Therefore, no debt service channel is reported for the results of the Sidrauski model (summarized in table 4C.4, below).

The Production Function

The production function is a Cobb-Douglas function of labor and each type of capital. Under the assumption of constant returns to scale, the production function can be written (omitting time subscripts) in intensive form as

(C5) $$y = A k_1^{\alpha_1} k_2^{\alpha_2} \ell^{1-\alpha_1-\alpha_2},$$

where $y \equiv Y/N$ is output per capita and the factor shares α_1, α_2, and $1 - \alpha_1 - \alpha_2$ are all positive. In a competitive economy, factors are paid the value of their marginal product. Thus the wage rate equals the marginal product of labor

(C6) $$w = (1 - \alpha_1 - \alpha_2)y/\ell.$$

The marginal product of type i capital is $\alpha_i y/k_i$. Thus, assuming that capital does not depreciate, the after-tax gross rate of return on type i capital is

(C7) $$R_i = (1 - \tau_i)\alpha_i \frac{y}{k_i} + 1,$$

where τ_i is the tax rate on the (net) return to capital of type i.

1. The rate of return on each type of capital is determined endogenously by eq. (C7) below. In the absence of any taxes, the condition that the gross rate of return on capital equals $(1 + n)/\beta$ is simply the "modified golden rule."

Government Budget Constraint

Monetary and fiscal policy are integrated by the government budget constraint. In the steady state the government budget constraint is

$$\text{(C8)}\quad \begin{aligned}&\tau_w(1-\alpha_1-\alpha_2)y+\tau_1\alpha_1 y+\tau_2\alpha_2 y+[(1+n)\pi-1]m\\&\quad = g+[1+i^b-(1+n)\pi]b.\end{aligned}$$

The four terms on the left-hand side of equation (C8) are the sources of government revenue: (a) wage tax revenue, (b) tax on income accruing to k_1, (c) tax on income accruing to k_2, and (d) seigniorage revenue. The right-hand side of equation (C8) contains two types of government spending: (a) real purchases of goods and services in the amount of g per capita and (b) interest payments on government debt, net of taxes on interest and rollover of debt. Now divide both sides of equation (C8) by y, and use equation (C4b) to obtain

$$\text{(C9)}\quad \begin{aligned}&\tau_w(1-\alpha_1-\alpha_2)+\tau_1\alpha_1+\tau_2\alpha_2+[(1+n)\pi-1]\frac{m}{y}\\&\quad = \frac{g}{y}+(\beta^{-1}-1)(1+n)\pi\frac{b}{y}.\end{aligned}$$

The government chooses the values of inflation π, the tax rates on capital τ_1 and τ_2, the ratio of government purchases to output g/y, and the ratio of government bonds to output b/y. The tax rate on wages τ_w is determined endogenously by equation (C9).

Steady State Equilibrium

The steady state is characterized by equations (C4a) through (C4d), (C5), (C6), (C7), (C9), and the goods-market-clearing condition

$$\text{(C10)}\quad c+n(k_1+k_2)=(1-g/y)y.$$

It is straightforward to derive closed-form expressions for the steady state values of k_1, k_2, c, m, and l. These expressions are presented in equations (11a) through (11e) in Abel (1997).

Calibration of the Model

The values of parameters used in the initial calibrations of the model for Germany, Spain, and the United Kingdom are presented in table 4C.1. Many of the parameter values are the same as in the baseline calibration for the United States in Abel (1997). The sensitivity analysis in table 3C.4 in Abel (1997) indicates that the general results are fairly robust to variations in parameter values.

Of the six preference parameters, four are set exogenously. In the absence

Table 4C.1 Initial Calibration of the Model

	Germany	Spain	United Kingdom	Source
Preference parameters				
β	0.95	0.95	0.95	Exogenous
ρ	4	4	4	Exogenous
η	10	10	10	Exogenous
δ	4	4	4	Exogenous
ϕ	3.08E-5	1.04E-4	2.84E-6	Chosen to match m below
ψ	7.44E-11	8.18E-15	8.67E-9	Chosen to make $\ell = 1$
Production parameters				
A	235.855	1722.52	71.662	Chosen to match y below
α_1	0.233	0.233	0.233	Exogenous
α_2	0.067	0.067	0.067	Exogenous
n	0.01	0.01	0.01	Exogenous
Government policy variables				
g/y	0.22	0.19	0.24	Exogenous
b/y	0.60	0.65	0.50	Exogenous
π	1.02	1.02	1.02	Exogenous
τ_1	0.6074	0.3866	0.4024	Exogenous
τ_2	−0.4020	−0.3778	−0.2583	Exogenous
τ_w	0.1926	0.2230	0.2700	Residual: government budget constraint
Empirical aggregates to be matched				
y	2,881	57,138	598	GDP minus depreciation
m	299	8,271	33	Noninterest money

of compelling evidence to the contrary, and to facilitate comparisons across countries, the values of these four exogenously chosen preference parameters do not vary across countries. The time preference discount factor β is 0.95, which implies a rate of time preference of about 5 percent per year. Calibration studies typically choose values of ρ greater than one but generally not much larger than 5, though there are examples of much larger values of ρ in the asset-pricing literature. Here I choose $\rho = 4$. The value of η is even less well established. Here I set $\eta = 10$. The interest elasticity of money demand equals $-1/\delta$. Estimates of this elasticity are small, so I choose $\delta = 4$, which implies an interest elasticity of money demand equal to -0.25. The value of ϕ is chosen so that the value of the money supply m produced by the model equals the value shown at the bottom of table 4C.1. The value of ψ is chosen so that the model produces a value of $l = 1$ in its initial calibration.

The values of the parameters α_1 and α_2 in the production function are the same as those used in the calibration for the United States in Abel (1997). The total factor productivity parameter A is chosen so that y matches the value of actual output. The assumption that capital does not depreciate can be interpreted to mean that all depreciation is a reduction in output, and thus the production function can be viewed as a function that yields gross domestic prod-

Table 4C.2 Tax Rates on Capital

	Germany	Spain	United Kingdom
Nonhousing			
τ_1 (π = 1.02)	0.6074	0.3866	0.4024
τ_1 (π = 1.0)	0.5491	0.3513	0.3707
Δ_1	−0.0583	−0.0353	−0.0317
Housing			
Category 1 (share)		(0.3771)	(0.4591)
τ_2 (π = 1.02)	−0.4020	−0.4901	−0.2813
τ_2 (π = 1.0)	−0.3858	−0.4540	−0.2500
Δ_2	0.0162	0.0360	0.0312
Category 2 (share)		(0.4308)	(0.4106)
τ_2 (π = 1.02)		−0.2689	−0.2188
τ_2 (π = 1.0)		−0.2404	−0.2083
Δ_2		0.0286	0.0104
Category 3 (share)		(0.0551)	(0.1303)
τ_2 (π = 1.02)		−0.2484	−0.3021
τ_2 (π = 1.0)		−0.2286	−0.2604
Δ_2		0.0199	0.0417
Category 4 (share)		(0.1370)	
τ_2 (π = 1.02)		−0.4634	
τ_2 (π = 1.0)		−0.4298	
Δ_2		0.0335	
Weighted average			
τ_2 (π = 1.02)	−0.4020	−0.3778	−0.2583
τ_2 (π = 1.0)	−0.3858	−0.3462	−0.2342
Δ_2	0.0162	0.0316	0.0241

Note: Categories of housing capital for Spain are owner occupied with tax advantages (1), owner occupied withöut tax advantages (2), non–owner occupied (3), and rental (4). Categories for the United Kingdom are owner occupied, MIRAS (1), owner occupied non-MIRAS (2), and rental (3).

uct less depreciation. The model is calibrated to match GDP less depreciation in each country (shown as y in table 4C.1).

Of the six variables representing government policy in table 4C.1, three are chosen to match the data directly: the ratio of government purchases to output (g/y), the ratio of government debt to output (b/y), and the gross rate of inflation (π). The tax rates on the two types of capital are based on the calculations in the case studies as shown in table 4C.2. Consider, for example, nonhousing capital in Germany. The pretax rate of return, $R_1 - 1$, on this capital is 10.8 percent per year, and the after-tax rate of return is 4.24 percent per year, when the rate of inflation is 2 percent per year. Thus the tax rate on nonhousing capital when inflation is 2 percent is $\tau_1^{\pi=1.02} = 0.6074$. The case study of Germany calculates that at zero inflation the after-tax rate of return on nonhousing capital is 4.87 percent so that the tax rate on type 1 capital is $\tau_1^{\pi=1} = 0.5491$. Thus the change in the tax rate that results directly from a reduction in inflation is $\Delta_1 = -0.0583$. Similar calculations yield the tax rates on housing capital in table 4C.2. For Spain and the United Kingdom there are multiple categories of housing capital, and I have computed tax rates for each type of housing capital and then computed a weighted average tax rate using the shares reported in table 4C.2. Finally, the tax rate on wage income, τ_w, is a residual that makes the government's steady state budget constraint in equation (C9) hold.

Effect of Eliminating Inflation

The effective tax rates on both types of capital depend on the rate of inflation. Therefore, the elimination of inflation changes these effective tax rates. Let Δ_i be the direct effect on the tax rate τ_i of reducing the rate of inflation from 2 percent per year to zero (i.e., reducing π from 1.02 to 1.00). In addition, there are indirect effects on the tax rates that are needed to satisfy the government's budget constraint. The new set of tax rates, incorporating both the direct effect of inflation (including the possibility of a direct effect, Δ_w, of inflation on the labor income tax rate) and the indirect effect of the government's budget constraint, are

(C11a) $$\tau_w = (\tau_w^0 + \Delta_w)\theta,$$

(C11b) $$\tau_1 = (\tau_1^0 + \Delta_1)\theta,$$

(C11c) $$\tau_2 = (\tau_2^0 + \Delta_2)\theta,$$

where the superscript 0 denotes the initial values of the tax rates and θ is the amount by which all three tax rates must be multiplied in order to satisfy the government's steady state budget constraint. The direct effects, Δ_i, are exogenous, but the indirect effect, captured by θ, is endogenous.[2]

To measure the welfare effects of eliminating inflation, I compare the initial equilibrium in which the steady state value of the triplet (c, m, l) equals $(c^0, m^0, 1)$ and the new steady state equilibrium in which the triplet equals $(c^{new}, m^{new}, l^{new})$. To express the change in welfare in terms of a change in consumption, define c^* to be the level of consumption, combined with the initial values of real money balances and labor, that yields the same level of utility in the steady state as the zero-inflation steady state equilibrium. That is,

(C12) $$u(c^*, m^0, 1) \equiv u(c^{new}, m^{new}, \ell^{new}).$$

I will use $(c^* - c^0)/c^0$ as a measure of the benefit of eliminating inflation.

Tables 4C.3A, 4C.3B, and 4C.3C present the effects of reducing the inflation rate from 2 percent per year ($\pi = 1.02$) to zero ($\pi = 1$) in Germany, Spain, and the United Kingdom, respectively. Column (1) in each table ignores the direct effect of inflation on the effective tax rates on the two types of capital and takes account only of the indirect effects on tax rates arising as a result of the change in seigniorage revenue when inflation is reduced. This channel corresponds most closely to the "money demand" channel. Column (2) focuses

2. In all policies examined here, the values of g/y and b/y are held constant.

Table 4C.3A **Effects of Policy Changes: Germany**

	(1)	(2)	(3)	(4)
Government policy variables: exogenous				
Δ_w	0	0	0	0
Δ_1	0	−0.0583	0	−0.0583
Δ_2	0	0	0.0162	0.0162
π	1	1.02	1.02	1
Government policy variables: endogenous				
θ	1.0055	1.0576	0.9957	1.0586
τ_w	0.1936	0.2037	0.1917	0.2039
τ_1	0.6108	0.5807	0.6048	0.5813
τ_2	−0.4042	−0.4252	−0.3841	−0.4084
Steady state effects (%) Change in				
k_1	−1.08	8.72	0.75	8.44
k_2	−0.07	3.49	−1.19	2.14
y	−0.23	1.81	0.08	1.67
c	−0.21	1.64	0.09	1.53
m	7.30	1.64	0.09	9.17
l	0.04	−0.55	−0.02	−0.53
$(c^* - c^0)/c^0$	−0.17	2.09	0.11	2.04

Table 4C.3B **Effects of Policy Changes: Spain**

	(1)	(2)	(3)	(4)
Government policy variables: exogenous				
Δ_w	0	0	0	0
Δ_1	0	−0.0353	0	−0.0353
Δ_2	0	0	0.0316	0.0316
π	1	1.02	1.02	1
Government policy variables: endogenous				
θ	1.0096	1.0387	0.9905	1.0383
τ_w	0.2252	0.2316	0.2209	0.2316
τ_1	0.3903	0.3649	0.3829	0.3648
τ_2	−0.3814	−0.3924	−0.3429	−0.3595
Steady state effects (%) Change in				
k_1	−0.77	4.52	0.57	4.35
k_2	0.10	2.02	−2.56	−0.58
y	−0.16	0.95	−0.03	0.76
c	−0.15	0.82	0.00	0.68
m	7.36	0.82	0.00	8.26
l	0.01	−0.31	0.02	−0.28
$(c^* - c^0)/c^0$	−0.06	1.06	−0.01	1.00

Table 4C.3C Effects of Policy Changes: United Kingdom

	(1)	(2)	(3)	(4)
Government policy variables: exogenous				
Δ_w	0	0	0	0
Δ_1	0	−0.0317	0	−0.0317
Δ_2	0	0	0.0241	0.0241
π	1	1.02	1.02	1
Government policy variables: endogenous				
θ	1.0020	1.0286	0.9940	1.0243
τ_w	0.2705	0.2777	0.2684	0.2766
τ_1	0.4032	0.3813	0.4000	0.3797
τ_2	−0.2588	−0.2657	−0.2328	−0.2399
Steady state effects (%) Change in				
k_1	−0.18	4.47	0.37	4.66
k_2	0.00	1.51	−2.07	−0.65
y	−0.04	0.91	−0.04	0.83
c	−0.04	0.79	−0.01	0.74
m	7.49	0.79	−0.01	8.32
l	0.00	−0.30	0.02	−0.27
$(c^* - c^0)/c^0$	0.00	1.02	−0.03	0.98

on the direct effect of inflation on the effective tax rate on nonhousing capital, which corresponds most closely to the "consumption timing"—that is, "nonhousing capital"—channel. Column (3) focuses on the direct effect of inflation on the effective tax rate on housing capital, which corresponds most closely to the "housing" channel. Column (4) considers all three effects together.

Table 4C.4 summarizes the results of the various calculations for all three countries using the modified Sidrauski model and compares these results with those reported in the case studies. It is important to keep in mind that the welfare costs calculated using the Sidrauski model are expressed as a percentage of steady state consumption, whereas the welfare costs reported in the case studies are expressed as a percentage of GDP. Since consumption is roughly two-thirds of GDP, the overall welfare cost of 2.04 percent of consumption resulting from the application of the Sidrauski model to Germany is remarkably close to the overall welfare cost of 1.41 percent of GDP reported in the case study of Germany. The results of the Sidrauski model for Germany are close to those of the case study in three additional ways: First, the benefits arising through the money demand channel are very small and slightly negative. Second, the benefits arising through the housing channel are also very small but are positive. Third, the largest benefits arise as a result of reducing the distortions in the effective tax rate on nonhousing capital.

The Sidrauski model and case study for Spain produce very similar results

Table 4C.4 Summary

	Germany	Spain	United Kingdom
Parameter			
τ_1 (π = 1.02)	0.6074	0.3866	0.4024
Δ_1	−0.0583	−0.0353	−0.0317
τ_2 (π = 1.02)	−0.4020	−0.3778	−0.2583
Δ_2	0.0162	0.0316	0.0241
m/y	0.104	0.145	0.055
Effect on consumption			
Nonhousing capital channel	2.09	1.06	1.02
Housing channel	0.11	−0.01	−0.03
Money demand channel	−0.17	−0.06	0.00
Overall	2.04	1.00	0.98
	Findings of Case Studies[a]		
Effect as a percentage of GDP			
Nonhousing capital channel	1.48	0.55–0.88	0.21–0.37
Housing channel	0.09	1.33	0.11
Money demand channel	−0.04	−0.07	−0.02
Overall[b]	1.41	1.71–2.04	0.21–0.37

[a] λ = 0.4 for Spain and the United Kingdom.
[b] Includes debt service.

for the effects operating through the nonhousing capital channel (1.06 percent of consumption computed by the Sidrauski model is comparable to the 0.55 to 0.88 percent of GDP reported by the case study) and through the money demand channel (both the Sidrauski model and the case study report a tiny negative effect). The major difference between the Sidrauski model and the case study concerns the effect operating through the housing channel. According to the calculations using the Sidrauski model, this effect is negligible, whereas the case study reports this effect to be 1.33 percent of GDP. Not only is the value of 1.33 percent reported by the case study much higher than that calculated using the Sidrauski model, it is also an order of magnitude higher than the effects reported for the housing channel in the case studies of Germany and the United Kingdom. One might expect the housing channel effect to be larger in Spain than in Germany and the United Kingdom because elimination of inflation changes the tax rate on housing capital by more in Spain than in either of the other two countries. However, Δ_2, the change in the tax rate on housing capital, is only about a third larger in Spain than in the United Kingdom, so it is surprising that the effect operating through the housing channel is 12 times as large in Spain as in the United Kingdom.

For the United Kingdom the results of the Sidrauski model and the case study are somewhat closer than for Spain, though not as close as for Germany. Both the Sidrauski model and the case study report very small effects for the housing channel and for the money demand channel. Although the Sidrauski model and the case study disagree about the signs of these effects, the effects are all so small as to be essentially zero anyway. As in the case of Germany, the largest effect for the United Kingdom operates through the nonhousing capital channel according to both the Sidrauski model and the case study. However, the effect reported for the Sidrauski model is about two or three times the size of the effect reported in the case study. The nonhousing channel in the case study of the United Kingdom is also smaller than in the case studies of Germany and Spain. One might expect a smaller effect in the United Kingdom because Δ_1, the change in the tax rate on nonhousing capital, is smaller in the United Kingdom than in Germany or Spain. However, Δ_1 is only 10 percent smaller in the United Kingdom than in Spain, so one might not expect the calculated effect operating through the nonhousing channel to be only half as large in the United Kingdom as in Spain.

The Sidrauski model used here has served as a helpful diagnostic tool for examining the calculations reported in the case studies. When the Sidrauski model and a case study produce different results, there is no presumption that one set of results is more reliable than the other. However, in the instances in which the Sidrauski model and a case study have produced different results for a particular country, the case study results for that country also differ from the case study results for the other countries. Thus we are left having to explain why, for example, the housing channel effect in the case study of Spain is so much larger than in the case studies of Germany and the United Kingdom as well as being larger than in the Sidrauski model. Further investigation is needed to resolve these differences.

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Comment on Chapters 2, 3, and 4

Rudiger Dornbusch

The comparative evaluation of the case for reducing inflation invites two kinds of comments. First, here is an outstanding, and successful, effort, which provides a new kind of public finance research effort. Second, the case for reduc-

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Table 4C.5 International Cost-Benefit Comparison of 2 Percent Inflation Cut (percent of GDP)

	Spain	Germany	United Kingdom	United States
Consumption timing	0.6	1.4	0.2	0.6
Housing	1.3	0.1	0.1	0.2
Money	−0.1	−0.0	−0.0	−0.0
Debt	−0.1	−0.1	−0.1	−0.1
Benefit per annum	1.7	1.4	0.2	0.7
Annual cost	0.6–1.0	0.3	0.2	
Sacrifice ratio	0.6–1.0	4.0	3.0	2.0–3.0

Sources: Chapters 1 through 4 in this volume.
Note: All numbers rounded to the next decimal.

ing inflation is intriguing but far from made: the painstaking detail in the public finance research is matched by the coarsest summing of evidence from macroeconomics. The two do not mix well.

The cross-country evaluation is refreshing in highlighting differences in tax structures, interacting with differences in the environment, and thus fertilizes our thinking about the welfare costs of distortions. The benefits of such cross-country comparisons, within the discipline of a unified framework, come in a number of ways. First, they are missionary work. They spread their practice of rigorous public finance analysis of distortions to countries where little or no work may have been done in the past. Not in the least, they create the benefit of public finance networks, which are an important ingredient for research.

The cross-country comparisons are also immediately useful in highlighting instances where a particular country's estimates are far out of line with what is reported elsewhere. Table 4C.5 summarizes from the various papers the cost-benefit analyses of disinflation using the Feldstein setup. The point about the great merit of cross-country research is immediately made by the very fact that such a table can be created, including sensitivity tests and the resulting ranges of estimates.

Such a comparison will highlight immediately that in Spain, for example, the welfare cost of inflation in the housing sector is unusually large relative to the other countries. Similarly, in Germany inflation has a relatively large welfare cost in affecting consumption timing.

For the question at hand—do public finance considerations warrant disinflating by 2 percentage points to alleviate the welfare cost arising from the interaction of the tax system and inflation?—the answer is 3:1. The central banks of Germany and Spain come out strongly in support of low inflation—no surprise here. The U.S. analysis, in Feldstein's hands, yields the same result. Interestingly, the preferred estimate of the Bank of England passes the test only by a hair's breadth. Across the wider range of estimates reported in chapter 4, the net benefit of moving to price stability may be positive or negative. The reason for the difference resides in the relatively small distortion of consumption choices. But 3:1 is a victory. So let us assume that the public finance case for reducing inflation in countries with U.S.-style tax distortions in interaction with inflation is made. Does that mean the public policy debate is finished and we should just move ahead, make the necessary recession, get it over with, and enjoy the better allocation of resources forever after?

The issue, of course, is to take more seriously two problems. The first is whether there is some benefit from moderate inflation in making markets function better. The second is whether disinflation sacrifice ratios are a good public finance tool.

It is common sense that extreme inflation, if only because of its instability, is destructive to productive activity. Beyond that, it is deeply destructive of social relations more generally, from property to peace. No more need be said on that. But when it comes to the distinction between 2 and zero percent inflation per year—fully anticipated and stable—does the professional bias against inflation still apply and does it go all the way to zero? There is very little modeling of this issue, but a few ideas have been around. One strand, coming from the 1950s, argues that relative price adjustment needs to happen in a dynamic economy and that it is more easily done when there is an ever so slight upward trend in the general price level. The idea is that it is easier to raise some prices than to cut some wages. The idea has been picked up again by Akerlof, Dickens, and Perry (1996) in their influential case against deflation. The analysis remains crude, but a more careful micromodeling of the productivity issues in the workplace (à la Solow) that arise from wage policy is surely possible. If it is easier not to give a wage increase in an environment of rising prices than to administer a wage cut in an environment of stable prices, the case is made. The evidence of Shiller (1997) powerfully supports the contention that people do have illusions, and there is every reason to believe that their productivity is linked to their perception of what is happening to them and how "just" they think it is. All of this remains mushy, but it is worth exploring even if it is far away from public finance and dangerously close to "human resource management."

A second strand is the interaction between inflation and search in monopolistic markets. Some modeling suggests that via signal extraction problems, inflation has an impact on the intensity of search effort and hence on the elasticity of demand facing an oligopolist. More search is better—though it comes at a resource cost too—because oligopoly represents a welfare cost. Hence, what is the optimal rate of inflation? Not zero! If these considerations are valid, the presumption for price stability that comes from the interaction of distortionary taxes and inflation is incomplete and there may be reasons pushing in the direction that a bit of inflation is a good idea.

Even more important is the whole discussion of a short recession to harvest the lasting benefits of better resource allocation. True, the authors do not belittle the fact that there will be an output loss to disinflation, and there is no attempt to lick the lowest sacrifice ratios. But there is nevertheless a temptation to claim that credibility might just come into play and make the entire disinflation effort far less costly. It is worth pointing out that there is no evidence to support this notion. Argentina is a case in point. Interest differentials on peso and dollar assets show that there is no expectation of a regime change; yet in the face of 18 percent unemployment, disinflation proceeds at a minimal pace. We may not understand why wages and prices do not fall more rapidly, but we surely have no right to believe that a credible strategy (whatever that means) may not be far more costly than historical experience suggests.

But there is more important criticism. The sacrifice ratio does a very poor job of measuring the costs of disinflation. Not only are the numbers extraordinarily crude to serve as a benchmark, with, possibly minor, extra questions of revenue lost during a recession that needs to be made up by distortionary taxes and of capital accumulation not having taken place while the recession lasted. There is also the much more important question of whether loss in output is a good measure of the cost. The most obvious reason for doubt is that the incidence of a recession is borne very unequally across individuals. The cohort that enters the labor market during a recession is very unlikely to have the same lifetime performance as other cohorts. There is obviously no compensation for this since nobody imagines that we use neutral lump-sum taxes to make compensation payments (beyond unemployment insurance) to the losers. For something as important as a recession, glossing over the distribution issue is bad public economics.

Consider the case of Germany. Unemployment is high and has been rising for a decade. It is proposed to make a recession at the cost of a 11.8 percent loss in output to reach the benefits of better resource allocation. It is difficult to believe that this is a priority project compared to restructuring, which is at least as controversial as recession but presumably carries far larger benefits. In the United States, likewise, there is surely little enthusiasm for ending the exploration of just where full employment is in favor of a program of recession and the inevitable social fallout it brings. And if one puts the two together, and all the other countries, the idea of making a world recession to cure the welfare cost of tax distortions interacting with inflation seems outright preposterous. There are simply more pressing economic agendas with more clearly identified benefits.

The setup in the comparative exercise is to assume that tax distortions cannot be changed—just take it for granted as an accepted fact of public finance—and if that is so, let us at least reduce some of the welfare costs of these distortions by eliminating inflation. I would submit that making a world recession to get at these costs meets just the same opposition. There is just no enthusiasm for recessions, perhaps even less than for tax reform. Economists should concentrate on first-best policies rather than create a dubious backdoor case and a crude one at that.

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Discussion Summary for Chapters 2, 3, and 4

In response to Dornbusch's discussion, *Gerhard Ziebarth* noted that the policy implications of his paper can be interpreted in two ways: both as an argument for disinflation and as an argument against more inflation. *Rudi Dornbusch* replied that he would applaud the paper as support for an explicit inflation target but that the argument made in the paper is really an argument for disinflation, not just an argument against more inflation.

José González-Páramo conjectured that a reason for the discrepancy between Andrew Abel's estimate of the housing distortion in Spain and his own estimate may be that housing capital does not directly enter into the utility function in Abel's model whereas it does in his own model.

Abel concurred but also noted that Spain looks very different from Germany and the United Kingdom when Feldstein's partial equilibrium framework is used. *Mervyn King* added that it is striking that Abel's calculations do match the other authors' calculations for Germany and the United Kingdom.

Neal Hatch remarked that the consumption distortion effect in the different country case studies are not fully comparable because the U.K. case study assumes that tax-exempt savings vehicles affect the marginal returns to saving whereas the other studies assume that tax-exempt savings is mainly inframarginal.

José Viñals agreed with Rudi Dornbusch that one should pay more attention to the microeconomics of the labor market and to how inflation affects search behavior. He also noted that the benefits of going to price stability may still outweigh the costs even if the capital income tax is lowered in the future, as the payback time for price stability is short. He noted further that Spain recently experienced disinflation, apparently without an increase in unemployment, indicating that the sacrifice ratio may be lower for Spain than was assumed in the paper. Viñals then acknowledged the importance of political economy considerations. It seems politically very difficult to remove the underlying distortions in the housing market, so disinflation may be the best way to effectively reduce these distortions. The same point may not apply to the labor market because there are now so many unemployed that there may be enough political support to change labor market institutions.

Stephen Cecchetti remarked that the sacrifice ratio estimates do not seem to be very reliable but are rather like glorified back-of-the-envelope calculations.

In particular, the estimates have three main problems. First, they do not take into account that some component of a recession may permanently decrease output. Second, one has to be careful about the underlying source of shocks, which seems unlikely. Third, standard econometric techniques are ill suited to dealing with policy shifts to new regimes, leading to estimates of sacrifice ratios that are very imprecise. He concluded that there is still a long way to go before we obtain useful estimates of the costs of disinflation.

James Hines noted that the nature of the model is important for the estimated housing distortion. In a one-good model the only possible distortion is to the total quantity consumed, but in a multigood model there are also possible distortions in the allocation of consumption.

Rudi Dornbusch wondered how the housing distortion in Spain as calculated by Dolado et al. can be five times as large as the housing distortions in the other country studies. *Martin Feldstein,* while agreeing that the difference seems very large, suggested that the tax rules and other subsidies for housing in Spain may be different enough to explain the greater distorting effect of inflation. *Andrew Abel* agreed with Rudi Dornbusch and stated that he does not want to argue whether or not his estimates for Spain are more accurate than those of Dolado et al. but remarked that the real puzzle is why Spain differs so much from the other countries. *José González-Páramo* suggested that a nonlinearity may account for Spain's apparent anomaly. *Abel* acknowledged that a nonlinearity may explain something but said that he remains unconvinced and surprised by the difference of an order of magnitude.

Edmund Phelps inquired how disinflationary costs, as measured by the sacrifice ratio, are compared to the infinite stream of welfare benefits. In particular, does the calculation take into account that the marginal utility of consumption declines as per capita GDP rises. Why is the discount rate $r - g$ instead of r? *Martin Feldstein* responded that the discounting by the real net-of-tax return that individuals receive has the effect of taking into account the decline in the marginal utility of consumption (since individuals equate the ratio of the marginal utilities to $1 + r$). He noted further that g, the growth rate of GDP, is subtracted from r, the real net-of-tax return on risky assets, in order to take into account the growth of the welfare gains, which increase in proportion to GDP.

Mervyn King asserted that the virtue of the four case studies is that they all use the same framework, which focuses on interactions between inflation and taxes. This make the studies comparable and very interesting. The real contribution of the papers is the analysis of the tax-inflation interaction, not their analysis of the costs of disinflation. Sacrifice ratios are endogenous policy choices, and hence, it is not obvious that past experiences are relevant for the future. The estimates of the sacrifice ratio could be over- or underestimates. Estimation of sacrifice ratios is a fruitful area for future research. Another key question raised by the papers is which margin for savings should be examined. How should one take forced savings, pension benefits, and other tax-preferred savings vehicles into account? What are marginal savings and what are inframarginal savings? This is a very hard issue to determine.

Martin Feldstein emphasized the great potential gains from the interaction of macroeconomics and public economics of the type provided by this conference. He expressed his delight with Andrew Abel's contribution and agreed with Abel's assessment of his paper as a useful start at analyzing the issue from a general equilibrium macroeconomic perspective.

Feldstein said that he was puzzled that Abel's calculation for the United Kingdom shows that the increase in nonhousing capital causes a steady state consumption gain of 0.75 percent of GDP, which is much larger than the gain calculated in chapter 4. This difference might be traced to the different ways of calculating the welfare costs of the revenue effect. In principle, it is good to derive λ, the marginal cost of public funds, endogenously, but we really need to use marginal tax rates to derive λ rather than the average tax rates that Andrew Abel chose in order to calibrate the government budget constraint. The implicit marginal cost of public funds may therefore be too low in his comment, which would mean that revenue effects are undervalued.

In response to Rudi Dornbusch's point about the possibility of a future capital income tax reduction, Feldstein noted that he is more pessimistic about this prospect. He agreed with the earlier remarks about the importance of correctly incorporating tax-favored savings but said that he thinks that many of these tax-favored savings are inframarginal. He agreed with the authors of the British case study that the effects of inflation on business investment should not be part of the main welfare calculation. Finally, he emphasized that the role of VAT can be important: If housing consumption falls and nonhousing consumption rises, VAT revenues increase which increases welfare.

Rudi Dornbusch argued that the fiscal effects of the recession caused by the reduction in inflation should be part of the welfare calculation. *Martin Feldstein* responded that these fiscal effects can be seen as a perpetual increase in the national debt and that a simple calculation shows that the welfare costs of this increase are small enough to ignore.

Philip Cagan noted that the estimates of sacrifice ratios used in the conference papers lie significantly below Arthur Okun's U.S. estimates of 6 to 18. An often-used methodology involved interpolating GDP between peaks and measuring the cumulative difference between actual GDP and interpolated GDP. The problem with this method was that GDP at the peaks was not sustainable because it was too high. Could the method used here to calculate sacrifice ratios suffer from the same problem?

Benjamin Friedman offered a clarification of Okun's original methodology. Arthur Okun estimated an increase in unemployment of 2 to 6 percentage points (with a median of 3 percentage points) per percentage point of disinflation. He and others then multiplied these figures by 3, from Okun's law, to convert them into percentage points of forgone output. However, present estimates of Okun's law are lower, so our estimates of sacrifice ratios are lower as well, but in terms of unemployment our estimates are similar to estimates from Okun's time.

Frederic Mishkin observed that policymakers often think about the uncertainty that is created by high levels of inflation. It is an open question whether inflation uncertainty would indeed go down if inflation levels were lower. In the past five years, there has been very little variability with a level of inflation around 3 percent. Would inflation variability decrease if we went to price stability, or would variability increase because there would be less political support to combat inflationary shocks if the level of inflation is close to zero anyway?

Stephen Cecchetti asserted that more work is needed to determine the frontier relating inflation variability to output variability. One could also measure whether this frontier depends on the level of inflation. Variability is ultimately an issue of how policies respond to shocks. The stability of the past couple of years may simply be due to the absence of significant shocks.