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2 Price Stability versus Low Inflation in Germany: An Analysis of Costs and Benefits

Karl-Heinz Tödter and Gerhard Ziebarth

Are the benefits of disinflation worth the costs?
—Croushore (1992)

2.1 Price Stability: Too Much of a Good Thing?

The notion that price stability should be the priority target of monetary policy has nowadays become widely accepted. This is due to the perception that high and volatile inflation rates distort economic allocation and reduce long-term growth potential (Barro 1995), whereas lasting monetary stability is conducive to economic growth, social welfare, and social cohesion alike. By contrast, the consensus regarding assessment of the "excess burden" associated with a moderate inflation rate, and of the cost (the "sacrifice ratio") of correcting such a rate, is much more fragile.[1] In other words, are the benefits of price stability and the costs of disinflation still in reasonable proportion to one another, or should a moderate pace of inflation—rather than undue zeal in fighting inflation—be tolerated or even aimed at by economic policymakers?[2]

In the context of an in-depth analysis of the functions of money, Konieczny

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1. In this connection, it should not be entirely overlooked that the costs of a disinflation could at bottom be charged to the preceding inflation and would have to be offset against its gains.

2. Stanley Fischer, for instance, argues: "The evidence points to an inflation range of 1–3% as being optimal. . . . Once lower inflation is attained, the challenge for policy is to preserve those gains" (1994a, 40). Akerlof, Dickens, and Perry argue along similar lines: "Comparing low inflation rates with a zero inflation rate, we are convinced that the unemployment costs outweigh the costs of tax distortions. We fully appreciate the benefits of stabilizing inflation at a low rate, and advocate that as an appropriate target for monetary policy. But the optimal inflation target is not zero" (1996, 52).

comes to the following conclusion regarding the optimality of an inflation rate of zero: "The review of the theoretical arguments leads me to conclude that the optimal rate of inflation is zero" (1994, 34). He emphasizes especially the adverse effects of inflation on the role of money as a unit of account:

> The uniqueness of zero arises from the accounting role of money: it is, simply, infinitely easier to divide by one than by any other number. Only when the price level is stable can money perform properly its role as a stable unit of account and standard of value. The desirability of a stable standard of measurement is evident from other arrangements: without exception, societies have chosen all other units of measure to be of constant value. Uniquely among all numbers, the credibility of zero can be defended on the grounds that "it makes a pound (£) just like a pound (lb)." (32)

What is to be understood by "price stability" has been expressed in different ways. Alan Greenspan, chairman of the Federal Reserve Board in the United States, defines stable prices as "price levels sufficiently stable so that expectations of [price level] change do not become major factors in key economic decisions" (1989). Decisions with a very short time horizon would probably turn out no different with an inflation rate of 2 to 3 percent from what they would be with price stability. On the other hand, decisions involving a long-term commitment or a long planning horizon must indeed take due account of the effects even of moderate inflation rates, and an average inflation rate of zero will actually impinge on decision making if that rate is accompanied by high volatility. It also has to be borne in mind that the threshold for the perception of inflationary processes depends on past experience and therefore may differ from country to country.

Anyway, inflation rates have been declining all over the world for a number of years. As measured by the consumer price index, the inflation rate in the G-7 countries averaged 3.9 percent per annum between 1960 and 1973. In the wake of oil price hikes and an accommodating monetary policy on the part of some central banks, it rose to 9.7 percent per annum between 1973 and 1979. During the eighties the average inflation rate still came to 5.5 percent per annum. But by 1995 the inflation rate of the G-7 countries was averaging 2.5 percent, and of the 27 OECD nations, 18 registered an inflation rate of less than 3 percent in 1995. Besides the globally higher sensitivity to inflation as a result of the globalization of the financial markets (Issing 1996a), in the member states of the European Union this trend probably also owes something to the envisaged monetary union.

Against this background, and in the light of the forthcoming debate on the operative objectives of monetary policy in the context of a monetary union in Europe, the important economic policy question arises for many countries: *Do the benefits of price stability warrant the costs of any further disinflation?* In a comprehensive study for the United States, Feldstein put this question into concrete shape as follows: "If the true and fully anticipated rate of inflation (i.e., the measured rate of inflation minus 2 percentage points) has stabilized at 2%, is the gain from reducing inflation to zero worth the sacrifice in output and employment that would be required to achieve it?"[3]

Even though our experience of inflation in the Federal Republic of Germany is different from that in the United States and the institutional framework here shows specific features, monetary policy in this country has to face the same issue. The purpose of this paper is therefore to provide an empirically supported answer for Germany to the question raised by Feldstein. Against the background of the monetary policy strategy pursued by the Bundesbank, we first consider, in section 2.2, the *costs of disinflation;* in quantifying the sacrifice ratio we draw on recently published empirical investigations. With regard to the *benefits of price stability,* there have hitherto been no analyses for Germany as detailed as that by Feldstein for the United States. The focal point of this paper is therefore section 2.3, in which, building on the methodological foundation of Feldstein's approach, we examine the implications for macroeconomic welfare of the interaction of even moderate rates of inflation with the distorting effects of the tax system.[4] First of all, we address, as part of an intertemporal approach, the impact of inflation on the allocation of consumption and saving. Then we investigate the implications of inflation for demand for owner-occupied housing. Thereafter, we consider the distorting effects of inflation on money demand, which ever since Bailey's (1956) paper have been at the center of the literature on the welfare effects of inflation. Finally, we contemplate the effects of inflation on public revenue from the money creation process (seigniorage) and on government debt service. Section 2.4 offers a summary and some concluding remarks.

> Economists should be circumspect when attempting to estimate the costs of reducing the inflation rate.
> —Lucas (1990)

2.2 On the Costs of Disinflation

The costs of a lasting reduction in the rate of inflation depend on nominal and real rigidities in the overall goods and labor markets. Other significant factors are the stance of fiscal policy, the monetary policy strategy pursued by the central bank, and the degree of stability already reached. The Bundesbank's monetary policy has been based on a monetary targeting strategy for over 20 years. With the aid of this policy stance, it has proved possible (despite oil price hikes, monetary upheavals, and tensions in the wake of German unification) to

3. Feldstein (1997, 123–24). In the following we refer to this paper without any further details.

4. The fact that, for various reasons, the underlying tax systems play a particular part in the assessment of inflation effects has been stressed in a number of papers; see, e.g., Feldstein, Green, and Sheshinski (1978), Tanzi (1980), King and Fullerton (1983), Sinn (1987), and Sievert et al. (1989).

limit the average rate of inflation in those two decades to about 3 percent per annum, and thus well below the average level of the other industrial countries (5.5 percent).

2.2.1 Monetary Growth and Inflation

Partly owing to deregulation of the financial markets and to financial innovations, a number of countries have dispensed with the traditional monetary aggregates as indicators and intermediate targets of monetary policy. Even so, there continues to be a broad consensus that over the long term, inflation is a monetary phenomenon.[5] Pursuant to the quantity equation, the product of the money stock (M) and the velocity of circulation (V) equals the product of the price level (P) and the real gross domestic product (Y). Written logarithmically, the following applies:[6]

$$m + v = p + y. \tag{1}$$

On the basis of this quantity equation, Hallman, Porter, and Small (1989) define the equilibrium price level (P^*) as the money stock per unit of real production potential (Y^*) at the equilibrium velocity of circulation (V^*):

$$p^* = m + v^* - y^*. \tag{2}$$

If a stable long-term money demand function

$$m - p = \beta_0 + \beta y + \varepsilon \tag{3}$$

exists,[7] with β_0 being either constant or a function of stationary variables and the random variable ε, with expectation zero, measuring deviations from long-term money demand, then the equilibrium velocity of circulation can be expressed as[8]

$$v^* = -\beta_0 + (1 - \beta)y^*. \tag{4}$$

The equilibrium price level can now be written

5. In the shorter to medium term, trends in the general price level may certainly depart from the path marked out by the growth of the money stock. Nonmonetary price stimuli, temporary changes in the velocity of circulation of money, or cyclical fluctuations in real income may be superimposed on the key relationships for a considerable period. But this does not alter the basic fact that a process of sustained erosion of the purchasing power of money is a monetary phenomenon, for which economic policy is accountable.

6. In this subsection, lowercase letters denote logarithms of variables and the symbol Δ stands for differences, i.e., $x = \ln X$ and $\Delta x = x - x_{-1}$.

7. For Germany it can be assumed that even after unification, there is a stable long-term money demand function; see Issing and Tödter (1995), Scharnagl (1996a, 1996b), and the references therein.

8. Issing and Tödter (1995) estimate the income elasticity of money demand (β) in Germany at 1.43. Given a growth rate of real production potential averaging 2.2 percent per annum, this implies a trend decline in the velocity of circulation of just under 1 percent per annum.

Table 2.1 **Monetary Growth and Inflation in Germany (average growth rates of M3, in percent per annum)**

Period	Δm3	Δy^*	Δp^{*a}	Δp
1970:1–79:4	10.4	3.2	5.8	5.5
1980:1–89:4	6.1	2.1	3.1	2.8
1990:1–96:2[b]	7.6	3.6	2.5	2.5

Source: Issing and Tödter (1995) and authors' calculations.

[a]$\Delta p^* = \Delta m3 - 1.43\, \Delta y^*$.

[b]Including the increase in M3 and in potential production due to unification.

$$p^* = m - \beta_0 - \beta y^*. \tag{5}$$

As table 2.1 shows, the growth rates of equilibrium prices over fairly long periods agree pretty well with the actual inflation rates. The price gap, that is, the difference between the equilibrium price level and the actual price level, is composed of two components, viz., the degree of utilization of production potential (output gap) and the degree of liquidity (velocity gap):

$$p^* - p = (y - y^*) + (v^* - v) = \beta(y - y^*) + \varepsilon. \tag{6}$$

In other words, pressure on prices is felt whenever production capacities are being heavily utilized or whenever cash holding is higher than is consistent with long-term money demand.

As empirical investigations for Germany show, the equilibrium price level and the actual price level are cointegrated (see Tödter and Reimers 1994; Scharnagl 1996a). It follows from this that differences between the two variables are of a temporary nature and that disequilibria that have arisen will disappear again over time. The course of price movements can then be described (as is done here in stylized form) by an error correction equation:

$$\Delta p = \Delta p^e + \lambda(p^* - p) = \Delta p^e + \lambda\beta(y - y^*) + \lambda\varepsilon. \tag{7}$$

The smaller the parameter λ, the more sluggishly prices respond to (goods and money market) disequilibria, and the higher real rigidity is. The expected inflation rate may be specified in this connection as a learning process in which inflation expectations adjust to changes in equilibrium prices,

$$\Delta p^e = \gamma\, \Delta p_{-1} + (1 - \gamma)\Delta p^*, \tag{8}$$

where the parameter γ is a measure of nominal rigidity.

2.2.2 The Bundesbank's Monetary Targeting Strategy

The Bundesbank's monetary targeting strategy primarily serves the objective of price stability. This strategy is geared to the long-term relationship between money and prices, a relationship that is soundly based on the quantity theory and supported empirically.[9] Since 1988 the Bundesbank has used the money stock in the definition M3 as the indicator and intermediate target of its monetary policy.[10] The annual target for the growth rate of the money stock (μ) is derived in accordance with a normative figure for the rate of inflation aimed at over the medium term (π), after taking due account of forecasts of the growth of production potential (Δy^*) and of the trend change in the velocity of circulation (Δv^*):

$$\mu = \pi + \Delta y^* - \Delta v^* = \pi + \beta \Delta y^* . \tag{9}$$

If the Bundesbank succeeds in getting the money stock to grow in line with this target ($\Delta m = \mu$), then the equilibrium price level and—after the expiration of dynamic adjustment reactions—the actual price level increase at the rate $\Delta p^* = \Delta p = \pi$.

If the Bundesbank wanted to reduce the target inflation rate from π to zero, it would durably have to lower the growth rate of the money stock to $\mu = \beta \Delta y^*$. In the event of uncertainty about the level of inflation, however, a distinction must be made between an *inflation target* and a *price level target.* To illustrate the difference between the two targets, let it be assumed that the central bank manages to attain the inflation target of zero, except for an identically and independently distributed random variable v_t with expectation zero and variance σ_v^2. The price level ($p_t = p_{t-1} + v_t$) then follows a random walk process with variance $\sigma_v^2 T$ after T periods. Even though the expected inflation rate for the next period is zero, the uncertainty about the price level in the more distant future may be very high. If, by contrast, the central bank is pursuing the target of stability of price level, the variance of the price level is σ_v^2, regardless of the time horizon. The difference between the two strategies resides in the fact that in the case of an inflation target, the central bank does not need to respond to a temporary positive price shock, whereas in the case of a price-level target, it is forced to usher in a period of deflation (see also Scarth 1994; Fischer 1994a; Hagen and Neumann 1996).

2.2.3 Evidence on the Sacrifice Ratio

The potential costs of disinflation consist in output and employment losses during the period of running down inflation. The level of the costs depends on the slope of the Phillips curve (or the slope of the macroeconomic supply function). If the long-term Phillips curve has negative slope, any reduction in inflation results in lasting losses of output and employment; if the curve is vertical, the output and employment losses are temporary.

9. On the theoretical and empirical foundations of monetary policy, see Issing (1992); on past experience of the monetary targeting strategy, see Issing (1995) and König (1996).

10. M3 is currency in circulation and sight deposits, time deposits for less than four years, and savings deposits at three months' notice held by domestic nonbanks—other than the federal government—at domestic credit institutions.

In the above P^* model, just as in neoclassical models, there need not be any disinflation costs at all if the central bank announces the target of disinflation credibly and if expectations respond immediately. Monetarist and neoclassical models exhibit a vertical Phillips curve in the long run, and thus temporary disinflation costs. The Keynesian models of the sixties postulated a lasting negative trade-off. According to neo-Keynesian theory, too, changes in monetary policy exert effects in real terms on account of rigidities in wage and price movements.[11] The idea of a permanent trade-off between inflation and unemployment is, however, nowadays rejected by most economists: "There is a general acceptance among economists that the medium, and longer, term Phillips curve is vertical. Hence, there is no trade-off in the longer run between growth and inflation. Consequently, there is now also a consensus that the primary macro-policy objective of a central bank should be price stability."[12]

In the literature, it is customary to express the costs of disinflation in terms of what is known as the "sacrifice ratio." The "output sacrifice ratio" (σ) measures the cumulative output loss associated with a decline in the inflation rate. The "unemployment sacrifice ratio" (σ_u) denotes the corresponding rise in the unemployment rate. A link between the two concepts can be effected by the "Okun gap." The simplest way of determining sacrifice ratios is to measure for concrete historical periods of disinflation the cumulative output loss in relation to its trend movement or to the cumulative change in the unemployment rate. By this method, Schelde-Andersen (1992) computes sacrifice ratios for 16 OECD countries. He selects the time span from 1979 to 1982 as a common period of disinflation in all countries. For Germany, the ratio relative to the unemployment rate works out at $\sigma_u = 6.4$, whereas the indicator measured in terms of output yields the value $\sigma = 2.2$.[13] Ball (1994) uses a similar method but identifies specific disinflation periods for each country. For Germany he obtains a ratio of $\sigma = 3.6$ on the basis of quarterly figures for the period 1980:1–86:3.[14] In a similar way to Ball, but with a different approach to estimating production potential, Herrmann (1996) computes a value of roughly $\sigma = 2.6$ on the basis of quarterly data for the period 1981:4–86:4, whereas

11. In simulations with small empirical models for the United States, Croushore comes to the conclusion: "In a comparison of disinflation costs across the different models, the Monetarist-type model shows the lowest cost (actually a negative cost), the New-Classical-type model shows zero cost, the Keynesian-type model shows a high cost, and the PSTAR+ model shows a cost in between the high and low costs of the other models" (1992, 13).

12. Goodhart (1992, 332). Taylor argues along similar lines: "But if there is any change in the paradigm of macro-economics that most economists would agree with, it is that the trade-off view was mistaken" (1992, 13). On the other hand, Akerlof et al. argue that lasting real costs of disinflation exist on account of a "deeply rooted downward nominal wage rigidity" in the economy: "The unemployment costs are not one-time but, rather, permanent and substantial" (1996, 52).

13. For the longer periods from 1979 to 1985 or 1988, the values for σ were actually lower, 1.2 and 1.6, respectively. This suggests that the costs of disinflation are temporary and decrease over time.

14. With annual data for the period 1980–86 he arrived at the value 2.1.

the ratio for the most recent period of disinflation 1992:1–95:4 works out at $\sigma = 2.2$.

More analytically oriented approaches to the estimation of the costs of disinflation are mostly based on Phillips-type relations for wage or price inflation. In the context of the P^* model (eqs. [7] and [8]) the output sacrifice ratio can be measured as the relation between the coefficients of nominal and real rigidity (see Schelde-Andersen 1992, 112):

$$(10) \qquad \sigma = \gamma/\lambda\beta.$$

In this model, a decline in monetary growth by 1 percentage point leads directly to an equally large decrease in the growth rate of equilibrium prices and ultimately also of the actual inflation rate. The expected inflation rate, however, initially declines by only $1 - \gamma$, in line with equation (8). Hence, a gap of γ percent between the actual decrease in the inflation rate and the expected decrease comes into being on account of nominal rigidities. In order to close this gap, the degree of capacity utilization must drop by $\gamma/\lambda\beta$ percentage points. In the long run, that is, after expectations have come into line with the reduced monetary growth, output and the unemployment rate revert to their equilibrium values.

On the basis of price equations similar to equation (7), Schelde-Andersen (1992) estimates the value of $\sigma = 3.3$ for the output sacrifice ratio for Germany. A Phillips relationship for the wage inflation rate yields $\sigma_u = 4.4$ for the unemployment sacrifice ratio. These estimates also take account of the possibility of permanent disinflation costs, which might derive from the presence of hysteresis effects on the labor market.[15]

It is conspicuous that in these studies the costs of disinflation as estimated for Germany lie distinctly above the OECD average (see table 2.2). In a comparison by Schelde-Andersen (1992) on the basis of the sacrifice ratios he estimated for 16 OECD countries, Germany comes last, as the country with the highest disinflation costs. One possible "explanation" might be that disinflation costs appear to be higher, the lower the initial inflation rate: "A high initial rate of inflation seems to reduce the sacrifice ratio, thus suggesting that inflation is more costly to reduce when it is already very low."[16]

As the above remarks have illustrated, empirical estimates of sacrifice ratios involve a high degree of uncertainty. The results depend crucially on the method, the frequency of the data used, and a number of other factors. This is why simulations with a macroeconometric structural model form an alternative

15. Schelde-Andersen (1992, 159) rejects the hypothesis of extreme hysteresis on the basis of estimates of the Phillips relationship for all countries except the United Kingdom. On the other hand, the null hypothesis that the unemployment rate follows a random walk process cannot be rejected for any of the 16 countries under review.

16. Schelde-Andersen (1992, 129). Other reasons for high disinflation costs relevant for Germany may have been a high real exchange rate (i.e., an unfavorable international competitive position) and low flexibility of the wage-bargaining process.

Table 2.2 **Estimates of the Sacrifice Ratio for Germany**

Method and Author	Period or Data	Sacrifice Ratio: Unemployment (σ_u)	Sacrifice Ratio: Output (σ)
Period analysis			
Schelde-Andersen 1992	1979–82	6.4	2.2
Ball 1994	1980:1–86:3	–	3.6
Herrmann 1996	1981:4–86:4	–	2.6
Herrmann 1996	1992:1–95:4	–	2.2
Unweighted OECD average			
Schelde-Andersen 1992	Annual data	2.5	1.6
Ball 1994	Quarterly data	–	1.5
Ball 1994	Annual data	–	0.8
Phillips approach			
Schelde-Andersen 1992	1960–90	4.4	3.3
Model simulation			
Jahnke 1996	1997:1–2004:4	–	4.0

to such partial analytical estimates.[17] Using the Bundesbank's multicountry econometric model Jahnke (1998) simulated a permanent increase in short-term interest rates that leads to a permanent decline in the inflation rate.[18] The estimation period for the forecasts of behavioral equations in the model extends from 1975:1 to 1995:4, and the simulation period covers the time span from 1997:1 to 2004:4. Over that span of eight years the sacrifice ratio, measured in terms of output, works out at about $\sigma = 4$; this value is above the estimates obtained by partial analytical approaches (see table 2.2).

Altogether, the available empirical evidence suggests that in the past the output sacrifice ratio for Germany can hardly have been above $\sigma = 4$.[19] At that level it would have been about two to three times as high as the average of the other OECD countries. The empirical estimates suggest that the costs of disinflation (C) do not simply depend linearly on the disinflation rate but rather rise disproportionally fast:

$$C = \sigma\pi^{1+\varphi}, \qquad \varphi > 0. \tag{11}$$

According to this equation, a reduction of the inflation rate by 1 percentage point—regardless of φ—would imply an output loss amounting to 4 percent

17. Schelde-Andersen argues in favor of the model simulation approach: "Analytically, this is by far the most satisfactory method as it is comprehensive and exogenous factors are isolated. The sensitivity of costs to changes in the lag structure of the price and wage formation process can be estimated and it is also possible to illustrate the effect of changes in credibility" (1992, 122).

18. Documentation for the Bundesbank model is included in Deutsche Bundesbank (1994a, 1996c).

19. Feldstein uses an output sacrifice ratio for the United States of 2 to 3 in his calculations.

of GDP. Assuming $\varphi = 0.5$, a reduction of the inflation rate by 2 percentage points, by contrast, would be associated with an output loss of 11.3 percent.[20]

The available evidence suggests that the costs of disinflation are temporary and are incurred over a comparatively short period.[21] By contrast, the benefits of price stability (G), expressed as a percentage of GDP, are permanent. To compare costs and benefits, we consider the present value of the benefits in all future periods. Given a discount rate of ρ, the present value of the benefits works out at G/ρ. The reduction of inflation is beneficial if the permanent benefits of price stability exceed the annualized costs of disinflation:[22]

$$G > \rho\sigma\pi^{1+\varphi}. \tag{12}$$

Given a discount rate of $\rho = 2.5$ percent per annum[23] and the above-mentioned values for the other parameters ($\sigma = 4$, $\pi = 2$, $\varphi = 0.5$), the breakeven point works out at $G = 0.28$. Hence, to summarize the result of this section, the lasting benefits of price stability would have to be greater than 0.28 percent of GDP to warrant the costs of disinflation by 2 percentage points. In section 2.3 we shall turn to the calculation of the benefits of price stability.

> This is real money.
> —Lucas (1994)

2.3 Benefits of Price Stability

The interaction between the tax system and inflation has repercussions on many areas of economic activity. In this section, we are concerned with estimating the welfare-theoretical benefits of price stability. In this context, we consider the steady state effects on the following economic activities: (1) the intertemporal allocation of consumption and saving, (2) the demand for owner-occupied housing, (3) money demand and seigniorage, and (4) government debt service.

We base our quantification of the benefits of price stability on a steady state with a stable and fully anticipated inflation rate of 2 percent per annum[24] and

20. The reduction of inflation by 3 percentage points (from 4.5 to 1.5 percent per annum) between 1992 and 1995 was accompanied by an output loss of 6 to 7 percent. However, starting from this lower level, any further reduction in inflation is likely to involve higher costs.

21. Ball (1994) finds evidence suggesting that rapid disinflation is more favorable, whereas King (1996a) argues in favor of a gradual disinflation process.

22. We are well aware in this context that this criterion derived from a present value concept treats the future worse than the present. Hence, there is a risk that too little importance is attached to future benefits and hence to future generations. This is why the discount rate, in cases of doubt, should tend to be set low, even though this remains ethically questionable from the point of view of intergenerational equity; see Issing (1996b).

23. This rate is roughly in line with the difference between the real rate of interest under conditions of price stability and the growth rate of real potential production (see section 2.3).

24. What is meant is an effective inflation rate of 2 percent, i.e., an inflation rate after adjustment for statistical measuring errors.

examine the comparative static effects of lowering that rate to zero. We take into account both the direct benefits of reducing inflation-induced distortions and the indirect welfare effects emanating from the change in tax revenue owing to the lowering of the inflation rate given the prevailing expenditure stance of the public authorities.

Other advantages of price stability are not included in our computations, although we certainly do not deem them to be insignificant (see the survey in Edey 1994; Fischer 1994b; King 1996b). The avoidance of distortions due to inflation is accompanied by enhancement of performance incentives and more efficient operation of economic processes. This includes the greater informative value of relative prices, a better balanced financing structure, improved economic efficiency, and higher productivity. Furthermore, redistribution processes and redistribution conflicts due to inflation would be avoided, and the wastage of scarce resources in order to sidestep the adverse effects of inflation would cease. In addition, under conditions of price stability the uncertainty engendered by inflation would diminish.[25] The extent to which such improved underlying conditions influence the long-term *growth* path is outside the scope of our investigation. But as is shown in models of the new growth theory, price stability can also contribute to lastingly stronger economic growth (Black, Macklem, and Poloz 1994).[26]

In computing the welfare effects, we are largely following the approach adopted by Feldstein, although we have made a number of modifications to take account of the special features of the German tax system. Moreover, in calculating the indirect revenue effects, we do not set the parameter that measures the deadweight loss of the tax system exogenously but derive it from the model.

2.3.1 Intertemporal Allocation of Consumption and Saving

The taxation of capital and of the earnings accruing from it involves welfare losses. The existing tax system admittedly gives rise to such distortions even if price stability obtains. However, the interaction of inflation and distortionary taxation results in an additional welfare loss, a "deadweight loss," that derives from the fact that inflationary processes drive a "tax-inflation wedge" between the gross yield and the net return on capital. This—as we shall show—reduces the real return on investment, impairs saving, and distorts the intertemporal allocation of consumption. Similarly, the elimination of a positive inflation rate is associated with deadweight gains.

25. This uncertainty depends, as mentioned above, in part on whether the central bank is aiming at the target of an inflation *rate* of zero or at price *level* stability; see subsection 2.2.2.

26. Even a small increase in the pace of growth would generate a huge effect over time. If, in the event of a decline in the inflation rate of 2 percentage points, the real growth rate rose by 0.2 percentage points (this is the magnitude that Grimes [1991] ascertained empirically in a cross-sectional analysis for 27 countries), given a difference of 2.5 percentage points between the real rate of interest and the real growth rate in the starting period, the present value of the increase in real output amounts to three times current GDP.

Welfare-Theoretical Approach

The starting point of the analysis is a two-period overlapping generations model. In this model the following fundamental relationship exists between the savings of the young generation (S) and their later consumption in old age (C):

$$(13) \qquad S = pC.$$

In this intertemporal budget equation, p denotes the price of future consumption. Given a real net payment of interest on savings at a rate r over a period of T years (i.e., over one generation), the price of future consumption, expressed in terms of units of present consumption, is

$$(14) \qquad p = (1 + r)^{-T}, \qquad \text{with } \varepsilon_{pr} = -T\frac{r}{1 + r}.$$

As the elasticity ε_{pr} indicates, an increase in the real net yield on savings leads to a decline in the price of retirement consumption. The price-quantity combinations in the three scenarios under investigation are designated as follows:

No tax, no inflation	(p_0, C_0)
Tax, no inflation	(p_1, C_1)
Tax and (2%) inflation	(p_2, C_2)

As is explained in more detail in appendix A and illustrated by figure 2A.1, under the welfare-theoretical approach to the quantification of the benefits of price stability, the following quantities (areas) are relevant:

$$(15) \qquad \mathrm{A} = \tfrac{1}{2}(p_1 - p_0)(C_0 - C_1),$$

$$(16) \qquad \mathrm{B} = (p_1 - p_0)(C_1 - C_2),$$

$$(17) \qquad \mathrm{C} = \tfrac{1}{2}(p_2 - p_1)(C_1 - C_2),$$

$$(18) \qquad \mathrm{D} = (p_1 - p_0)C_2,$$

$$(19) \qquad \mathrm{E} = (p_2 - p_1)C_2.$$

In the absence of taxes and inflation, an economic agent may save the amount S_0 at the price p_0 in order to achieve the consumption level C_0 in old age. By the introduction of a tax on investment income, the real yield declines and the price of consumption rises to p_1, while the consumption level falls to C_1. As a result the consumers' surplus decreases to the extent of the area A + B + D, and a tax yield amounting to the area B + D comes into being. The difference between the two areas, viz., the (Harberger) *triangle* A is, in terms of welfare economics, a deadweight loss of taxation.

If, under the existing tax system, inflation is added (i.e., if the inflation rate rises from zero to, say, $\pi = 2$ percent), then the *interaction of distortionary taxes and inflation* leads, as will be demonstrated below, to a decline in the real net yield and a further rise in the price of future consumption to p_2, whereas the level of consumption falls to C_2. Hence the consumers' surplus drops by the area C + E, whereas the tax yield changes by B − E. The difference is again a deadweight loss, but its magnitude is no longer in line only with the "small triangle" of traditional welfare theory, which arises through the "disruption" of a "first best" equilibrium. The deadweight loss of inflation is rather the *trapezoid* B + C, which may be much bigger and which comes into being through the extension, due to inflation, of the already existing tax-induced distortion. On the return to price stability, there arises a correspondingly large deadweight gain.

As will be demonstrated below, the change in the tax yield at zero inflation as measured by the area B − E is negative; that is, a shortfall in tax revenue occurs owing to the disappearance of inflation. Generally, it is assumed that the changed tax revenue is offset by a lump-sum tax, with a neutral effect in terms of welfare accounting. This, however, is an unrealistic assumption. In actual fact, it is to be expected that the shortfall in tax revenue is offset by the introduction, or raising, of other taxes (at a given level of expenditure), which in their turn are associated with welfare-theoretical deadweight losses. If these offsetting taxes involve a deadweight loss per deutsche mark of tax revenue amounting to λ, the welfare gain of price stability will decrease to the extent of $\lambda(B - E)$.[27] The overall benefit of a reduction in inflation then constitutes the sum of the direct deadweight gain and the indirect income effect:

(20) $$G_C = (B + C) + \lambda(B - E).$$

However, the form in which the tax losses due to the reduction in inflation would be offset, and the associated welfare effects, remain an open question. Feldstein assumes that $\lambda = 0.4$ would be a reasonable "benchmark" value for the shadow price of taxation. By contrast, we calculate the parameter λ directly from our model. More precisely, we approximate the deadweight loss of the German tax system by the ratio

(21) $$\lambda_C = A/(B + D),$$

which is the deadweight loss of capital income taxation per deutsche mark tax revenue in the regime of price stability. The overall inefficiency of the regime with tax and inflation is also of interest. It can be expressed by

(22) $$\lambda_{C+\pi} = (A + B + C)/(D + E),$$

while the marginal inefficiency of inflation-induced taxes is defined by

(23) $$\lambda_\pi = (B + C)/(E - B)$$

(see fig. 2A.1 in appendix A).

27. The parameter λ can therefore be regarded as a measure of inefficiency of taxation; in the best case, i.e., in one with offsetting neutral taxes (lump-sum taxes), λ would equal zero.

The above-mentioned areas are, in each case, the product of a price component and a quantity component, which will have to be measured in the next subsections.

Interest Rate and Price Effects

Given a real yield before tax of r_0 and a tax rate on investment income of Θ, in the event of an inflation rate of zero the real net yield amounts to

$$r_1 = r_0(1 - \Theta). \tag{24}$$

Given a positive inflation rate ($\pi = 2$ percent), investment income is composed of a nominal and a real component. If the simple Fisher theorem applies, and if both components of investment income are taxed at the same rate, then the real net yield, in the case of inflation, is approximately[28]

$$r_2 = (r_0 + \pi)(1 - \Theta) - \pi = r_1 - \pi\Theta. \tag{25}$$

That is to say, the real rate of interest is reduced owing to inflation by the amount $\pi\Theta$.[29] In principle, this adverse effect of inflation on real net interest rates could be prevented or lessened by indexing the tax system. But it is also conceivable that market adjustment reactions might ensure that the nominal interest rate (R) not only increases to the extent of the inflation rate, as in the simple Fisher theorem, but also responds disproportionately fast: $dR/d\pi > 1$.[30] To take this into account, we write the real net interest rate in the case of inflation as

$$r_2 = \left(r_0 + \frac{1 - \omega}{1 - \Theta}\pi\right)(1 - \Theta) - \pi = r_1 - \pi\omega. \tag{26}$$

The parameter ω, which will be very important hereafter, reflects the decline in the real yield after tax that would result if the inflation rate were increased by 1 percentage point; it can be interpreted as the effective marginal tax rate on the inflation-induced component of investment income. If $\omega = \Theta$, the real and the inflation-induced components of investment income are treated alike in tax terms, and inflation exerts an unabated impact on the real net yield. If $\omega = 0$, inflation has no effect on the real net yield. After the insertion of equation (24), equation (26) can also be expressed as

28. Furthermore, it is assumed that the gross real interest rate does not include any inflation-induced risk premium and that a Tobin effect (asset substitution between fixed capital and money on account of inflation), if any, can be disregarded.

29. E.g., given a gross yield of 10 percent and a tax rate of 50 percent, the net yield under conditions of price stability would be 5 percent. With 2 percent inflation, the nominal gross yield would rise to 12 percent, but the real net yield would fall to 4 percent. It should be borne in mind in this connection that the coupon is subject to tax, with the result that if the buying rate is above par, the net real interest rate on final maturity decreases even further (and vice versa).

30. See Darby (1975) and Feldstein (1976). Given $dR/dp = 1/(1 - \Theta)$, the effect of inflation on the real net yield would be eliminated entirely.

$$(27) \qquad r_2 = r_0(1 - t),$$

where t is the effective average tax rate under conditions of inflation:

$$(28) \qquad t = \Theta + \frac{\omega}{r_0}\pi.$$

For Germany, the average real gross yield on fixed capital between 1991 and 1995 works out at $r_0 = 10.8$ percent, according to internal computations by the Bundesbank.[31]

The profits of German corporations distributed to domestic individuals are subject to a variety of taxes: trade tax (on returns and capital), corporation tax, investment income tax, property tax, income tax, and the solidarity surcharge (to finance German unification).[32] But in contrast to the situation in the United States, corporation tax and investment income tax (as well as the applicable solidarity surcharge) are set off against income tax, in the form of a *tax credit*. As can be seen from appendix table 2D.1, the average tax burden in this model calculation amounts to $t = 60.7$ percent.[33] Thus it follows from equation (27) that the real net yield is $r_2 = 10.8(1 - 0.607) = 4.24$ percent.

This yield was achieved with an average inflation rate of 3.3 percent between 1991 and 1995. If it is assumed that the inflation rates recorded in the statistics overstate the actual increases in prices,[34] then it is possible to calculate for the period in question, as Feldstein did for the United States, an average effective inflation rate of $\pi = 2$ percent. The real net yield that would result in the absence of inflation can now be computed from equation (26):

$$(26') \qquad r_1 = r_2 + \pi\omega.$$

In order to determine the effective tax rate on nominal investment income (ω), we take account of the *depreciation* and the *interest paid* in the corporate sector and the *interest received* in the private sector.[35]

$$(29) \qquad \omega = \tau z - \tau b + \tau' b'.$$

31. The gross income of nonfinancial enterprises (excluding also the housing sector, agriculture, and fishery, as well as imputed entrepreneurs' earnings) in relation to net fixed capital at replacement costs is used as an indicator of the fixed capital yield. In order to prevent distortions on account of German unification, we will henceforth use western German data (old Länder) for the period 1991–95 where necessary.

32. The following calculations refer to the stylized tax regulations prevailing in 1995 and 1996. Starting in 1997 the investment income tax was cancelled; furthermore, the abolition of the trade tax on capital is envisaged.

33. The average tax burden on the retained profits of a domestic corporation works out at 64.3 percent, and that on the earnings of a partnership at a calculated rate of 55.3 percent.

34. The consumer price index is likely to be upwardly distorted on account of a product substitution bias, a quality bias, a new goods bias, and an outlet substitution bias (see Edey 1994).

35. In the private sector Feldstein also takes account of the effect of taxing capital gains, but this plays only a subordinate role under German tax legislation (in income taxation there are so-called speculation periods of six months and two years, respectively, for securities transactions and real property transactions).

In this equation, τ is the marginal tax rate for distributed corporate profits and τ' is the (weighted) marginal income tax rate, including the solidarity surcharge. Moreover, z denotes the present value of tax depreciation, b the debt ratio of enterprises (the ratio of borrowed capital bearing interest at market rates to total capital), and b' the ratio of shares and debt securities in households' portfolios.

Since the depreciation is effected in order to calculate the taxable earnings on the basis of historical purchase prices (and not of replacement costs), inflation reduces the present value of depreciation (z) and thus increases the effective tax rate. Auerbach (1978) showed that capital costs increase by the amount τz if the inflation rate rises by 1 percentage point. The present value depends on the write-off period for tax purposes of the asset in question (T_S), as well as on the depreciation method used and the discounting factor (nominal market interest rate after tax). As an approximation to the customary depreciation allowances, we use the formula

$$(30) \qquad z = \frac{2/T_S}{r_2 + \pi + 2/T_S}.$$

As appendix table 2D.1 shows, with the assumptions underlying our considerations the marginal tax burden on the distributed profits of a domestic corporation amounts to $\tau = 48$ percent.[36] If, moreover, one assumes an average write-off period of $T_S = 10$ years, given a real net yield of $r_2 = 4.24$ percent, as calculated above, and an inflation rate of 2 percent, the present value of tax depreciation works out at $z = 0.76$; that is to say, the reduction of the inflation rate by 1 percentage point would increase the real yield by $\tau z = 0.37$ percentage points.

This positive effect on the real yield is counteracted by the tax deductibility of nominal interest costs. If every percentage point of inflation increases the nominal cost of corporate indebtedness by 1 percent (see Feldstein 1997, 133–34; Mishkin 1992), then the real interest costs remain unchanged whereas the enterprise obtains an additional deduction option when calculating its taxable profits. In the case of an inflation rate of zero, this relief of earnings would disappear. Given a corporate debt ratio of $b = 45$ percent,[37] the reduction of the inflation rate by 1 percentage point leads to a decline in the real yield of $\tau b = 0.22$ percentage points.

In the private sector, income taxes are likewise related to nominal interest income, which gives rise to taxation of fictitious profits. Hence, a reduction in the inflation rate lowers the effective tax rate and raises the real net yield. If the real gross yield is independent of the level of the inflation rate, then the

36. The distributed profits of a partnership are subject to a marginal tax burden of identical size. On the other hand, the marginal tax burden on the retained profits of a corporation, at 57 percent, is actually even higher (see appendix table 2D.1).

37. This figure refers to the average corporation's liabilities other than its provisions (see Deutsche Bundesbank 1994b, 16).

real net yield falls to the extent of the marginal tax rate. On the basis of a ratio of shares and debt securities to households' net financial assets of $b' = 43$ percent,[38] and on the assumption of a weighted marginal income tax rate (including the solidarity surcharge) of $\tau' = 37.6$ percent,[39] in the event of a decline in the inflation rate of 1 percentage point, a rise in real net interest rates of $\tau' b' = 0.16$ percentage points occurs.

If one combines these three components, the outcome is an effective marginal tax rate on inflation-induced capital income of $\omega = 0.31$. The upshot of this, in accordance with equation (26′), for the real net yield with an inflation rate of zero is $r_1 = 4.24 + 2{*}0.31 = 4.87$ percent. According to this estimate, the real net yield would rise by 0.63 percentage points on account of the disappearance of an inflation rate of 2 percent.[40]

If one assumes a time span of $T = 27$ years for the average period elapsing between the saving of the young generation and their consumption in old age,[41] the following prices result from equation (14) for retirement consumption in the three aforementioned scenarios:

Scenario	Interest Rate (%)	Price
No tax, no inflation	$r_0 = 10.80$	$p_0 = 0.0627$
Tax, no inflation	$r_1 = 4.87$	$p_1 = 0.2771$
Tax and (2%) inflation	$r_2 = 4.24$	$p_2 = 0.3255$

A First Approximation

Given the interest rates and price changes between the two regimes derived above, we are now able to give a first and rough estimate of the benefits of price stability. For this purpose we need an approximation of the change in retirement consumption $(C_1 - C_2)$. From equation (13) the following expression for the consumption reaction can be derived:

$$(31) \qquad dC = \frac{S}{p}\frac{dp}{p}\varepsilon_{Cp}, \qquad \text{or } C_1 - C_2 = \frac{p_1 - p_2}{p_2} C_2 \varepsilon_{Cp},$$

where ε_{Cp} denotes the compensated elasticity of retirement consumption with respect to its price.[42]

Using the Slutsky decomposition and equations (13) and (14), the unobservable compensated price elasticity of retirement consumption (ε_{Cp}) and the un-

38. The net financial assets are calculated without mortgage debts (see Deutsche Bundesbank 1996a; 1996b, 25–47).

39. This rate results from a (weighted) income tax rate of 35 percent and a solidarity surcharge of 7.5 percent (see appendix table 2D.1).

40. For the United States, Feldstein ascertains a rise of 0.49 percentage points in the real net yield.

41. For the United States, Feldstein assumes a period of 30 years.

42. Regarding the compensated demand function, see Silberberg (1978) and Varian (1984).

compensated interest rate elasticity of the saving of the young generation (η_{Sr}) are related through

$$(32) \qquad \varepsilon_{Cp} = -(1 - \sigma_y - \eta_{Sp}), \qquad \text{with } \eta_{Sp} = -\eta_{Sr}\frac{1 + r}{rT},$$

where σ_y is the income effect caused by a change in the interest rate; it is measured by the ratio of the saving of the young generation to their (exogenous) wage and salary income. In this subsection, we assume that saving is completely interest inelastic and we ignore the income effect, resulting in $\varepsilon_{Cp} = -1$.

As equation (B9) of appendix B shows, in the overlapping generations model the following link exists between the saving of the young generation (S_2) and aggregate private saving (S):

$$(33) \qquad S = S_2(1 - q), \qquad \text{where } q = (1 + n + g)^{-T}.$$

In this equation, $n + g = 2.2$ percent is the longer term average growth rate of real wages and salaries (and at the same time of the real domestic product) between 1986 and 1994.[43] If one also bears in mind that private saving accounts for a share $S = 9.3$ percent in GDP, the saving of the young generation is estimated as $S_2 = 20.9$ percent of GDP, giving $C_2 = S_2/p_2 = 64.1$ percent of GDP.[44]

Plugging this value into equation (31) and recalling from the previous section that we estimated the relative change of the price for retirement consumption as $(p_1 - p_2)/p_2 = 14.9$ percent, we obtain the following increase in retirement consumption: $C_1 - C_2 = 9.55$ percent of GDP. In conjunction with equations (16) and (17) we obtain $2.05 + 0.23 = 2.28$ percent of GDP as a rule-of-thumb estimate of the trapezoid area B + C.

To make the factors behind this calculation more explicit, we may alternatively use the following simple but instructive formula:

$$(34) \qquad \begin{aligned} \mathrm{B} + \mathrm{C} &\approx S_2 \frac{p_1 - p_0}{p_1} \cdot \frac{p_2 - p_1}{p_2} \\ &= 0.209 * 0.774 * 0.149 = 2.4\% \text{ of GDP}, \end{aligned}$$

which largely confirms the result derived above. Equation (34) decomposes the welfare gains of price stability into three factors. The first, saving of the young, is the base for capital income taxation. The second factor is the change in the price of retirement consumption due to capital income taxation. The third fac-

43. In this case, the average rate of the last five years is distorted downward owing to German unification, which is why we use a 10-year average here.

44. Alternatively, the saving of the young generation can also be determined using eq. (B5) of appendix B. In this way, the estimated value of the share of saving of the young generation in the gross domestic product likewise works out at $S_2 = 20.9$ percent.

tor measures the price increase due to (2 percent) inflation. This factor itself can be decomposed approximately into the rate of (dis)inflation (π), the implicit inflation tax rate (ω) defined in equation (26), and the average number of years until retirement (T):

$$(34') \qquad \frac{p_2 - p_1}{p_2} \approx \pi\omega T.$$

Hence, the welfare costs of inflation tend to be high if the saving rate is high, if capital income is taxed heavily, or if the tax system is not indexed. All of these factors apply to the German economy and may explain—besides still deeply rooted historical experiences with hyperinflation and more recent inflation periods in the seventies and early eighties—the pronounced inflation aversion and stability culture of the German population.

Thus on the basis of this first approximation we may conclude that the elimination of a low inflation rate of 2 percent produces a direct welfare gain of more than 2 percent of GDP. This ready-reckoner admittedly neglects any substitution effects and income effects of the change in interest rates. Moreover, the welfare effects of compensatory tax revenue changes are not yet included. This is the subject of the next subsection.

Quantity Effects

For a more exact calculation of the quantity effects we need the uncompensated interest elasticity of saving (η_{S_r}) as well as the saving ratio of the young generation (σ_y). As outlined in more detail in appendix B, from the overlapping generations model we obtain $\eta_{S_r} = 0.25$ for the uncompensated saving elasticity, implying $\eta_{S_p} = -0.228$. Since on average gross wages account for 56 percent of GDP, we get $\sigma_y = S_2/\text{GDP} = 0.209/0.56 = 0.374$. Therefore, equation (32) yields the value $\varepsilon_{C_p} = -[1 - 0.374 - (-0.228)] = -0.854$ for the price elasticity of retirement consumption. This in turn yields $C_1 - C_2 = (-0.149)*0.642*(-0.854) = 8.16$ percent of GDP for the change in retirement consumption and, by the same procedure, $C_0 - C_1 = 49.9$ percent of GDP. Finally, equation (13) provides the value $C_2 = 64.3$ percent of GDP.[45] Combining the estimated price and quantity effects, areas A to E can now be quantified from equations (15) through (19):

A = 5.35 percent of GDP
B = 1.75 percent of GDP
C = 0.20 percent of GDP
D = 13.79 percent of GDP
E = 3.11 percent of GDP

45. This assumes that the share of saving of the young generation is roughly the same under both regimes, i.e., both with and without inflation.

Owing to the disappearance of the distortions in the intertemporal allocation of consumption and saving alone, the direct welfare gain of price stability amounts to B + C = 1.95 percent of GDP.

However, tax revenue would decrease by B − E = −1.36 percent of GDP. The deadweight loss per deutsche mark of tax revenue on the taxation of investment income is estimated at λ_C = A/(B + D) = 5.35/15.54 = 0.34. If one assumes that the above-computed tax loss in the case of price stability is offset by raising taxes with a similar shadow price, then the overall benefit of reducing inflation amounts on balance, pursuant to equation (20), to

$$G_C = 1.95 + 0.34 * (-1.36) = 1.48\% \text{ of GDP.}$$

The Problem of Indexation

The shadow price of capital income taxes under conditions of inflation $\lambda_{C+\pi}$ = (A + B + C)/(D + E) = 0.43, as calculated from equation (22), is distinctly higher than under price stability, which is λ_C = 0.34. The reason is the exceptionally high shadow price of the implicit inflation tax, defined in equation (23), which turns out to be λ_π = (B + C)/(E − B) = 1.43, demonstrating yet again that inflation is an extremely inefficient way of generating government revenue. Hence, the principle of causation as well as welfare analysis suggests that monetary policy and not tax policy should be primarily responsible for eliminating the highly inefficient inflation tax.

Nevertheless, it is sometimes argued that the welfare gain deriving from the reduction of inflation could be accomplished equally well by indexing the tax system. This argument is correct only in principle. To attain the same real yield under conditions of inflation as in a state of price stability—that is, r_1—the tax rate would have to be made dependent on the inflation rate. The taxation of capital income would have to be shaped in such a way that the effective average tax rate is a diminishing function of the (true, not necessarily the measured) inflation rate; that is, the following equation would have to apply:

$$(28') \qquad \Theta = t - \frac{\omega}{r_0}\pi = 0.607 - 2.87\pi.$$

Given an inflation rate of 2 percent, the average tax rate of t = 60.7 percent would have to fall by 5.7 percentage points to Θ = 55 percent in order to attain the same effective taxation as in the case of price stability. Since r_0 is not necessarily constant, and since ω likewise hinges on variables rather than constants, the indexation formula would have to be adjusted continually. That is only one of many reasons why indexation is not a practicable alternative to price stability.[46] In the absence of inflation, however, the lower effective tax rate would materialize "of its own accord."

46. A more detailed discussion of the problems posed by the indexation of the tax system can be found in Feldstein (1997, 150–53).

The Effect of Social Security Contributions

The analysis so far has implicitly assumed that a fully funded system is in place for providing old-age pensions. This assumption allows us to keep the model relatively simple. However, it would be interesting to check whether the results obtained above survive if we take into account that actually many retirees receive a significant amount of exogenous income through an unfunded ("pay as you go") system.

For this purpose we assume that the young pay a fraction of their gross wages as contributions to the social security system (γW), receiving $\gamma W/q$ when retired, where $q = (1 + n + g)^{-T}$ and $n + g$ is the implicit rate of return in a pay-as-you-go system. (In a fully funded system the rate of return would be r.) Moreover, we assume that the old generation leaves "indirect bequests" (R) to the government and the young generation receives transfers (Z) from the government that are not directly linked to R. As explained in appendix C, the budget constraint of the extended overlapping generations model linking savings (S) of the young to their retirement consumption (C) changes from equation (13) to

$$S = pC - \frac{p}{q}(\gamma W - R). \qquad (13')$$

From national accounts data for the period 1991–95 we get the value $\gamma = 0.15$. The parameter $R = 0.10\text{GDP}$ was calibrated such that the model approximately reproduces the income and expenditure account of the private sector for the stated period.

Perhaps surprisingly, these extensions leave the results practically unchanged. The reduced distortion of intertemporal allocation of consumption yields benefits amounting to

$$G_C = 1.87 + 0.40*(-0.91) = 1.50\% \text{ of GDP},$$

which is almost the same result as that obtained on the basis of the simpler model.

2.3.2 Demand for Owner-Occupied Housing

Owner-occupied dwellings are given preferential treatment in income taxation, although they are fundamentally regarded as a consumer good.[47] Nevertheless, some parts of the acquisition costs are allowed to be deducted from taxes, while the notional rental value (which represents implied investment income) is not subject to taxation. (In contrast to the situation in the United

47. The following comments are based on former tax legislation up to 1995, excluding the tax relief on loan interest (which was limited to three years) up to the end of 1994 as well as the special assistance measures in eastern Germany. The system of assistance for residential property that was reformed by the Owner-Occupied Housing Allowance Act of 1 January 1996 has not been taken into consideration.

States, however, debt interest cannot be deducted from taxes.) This results in a subsidy-induced distortion of the demand for residential property as well as in a major shortfall in tax revenue.[48]

For reasons similar to those in subsection 2.3.1 with regard to the deadweight loss of inflation, the following trapezoid measures the inflation-induced deadweight loss in the case of owner-occupied housing:

$$G_{H_1} = [(R_0 - R_1) + \tfrac{1}{2}(R_1 - R_2)](H_2 - H_1), \tag{35}$$

where H is the demand for owner-occupied housing and R represents the user costs per deutsche mark of invested capital.

The Price and Quantity Component

In the absence of taxes and inflation, the implicit rental costs of residential property would amount to

$$R_0 = r_0 + m + \delta, \tag{36}$$

where $m + \delta$ is the sum of maintenance costs and depreciation per deutsche mark of employed capital, which we put at 4 percent. Given a real gross rate of return in the enterprise sector of $r_0 = 10.8$ percent, the user costs amount to $R_0 = 14.8$ percent. By contrast, under present tax legislation the following calculation is relevant for a married couple given inflation:[49]

$$R_2 = \mu i_m + (1 - \mu)(r_2 + \pi) + (m + \delta) - \tau' h - \pi, \tag{36'}$$

where μ designates the share of the mortgage debt in the value of the house, i_m the nominal mortgage rate, and h the tax concession per deutsche mark of invested capital. Accordingly, the annual user costs of owner-occupied housing are the sum of the (non-tax-deductible) interest payments on the mortgage debt, the opportunity costs of the invested capital, and the maintenance and depreciation costs. The tax saving due to the possibilities of deduction for tax purposes and the inflation-induced increase in the value of the property are to be counted against this.

Under the previous form of Section 10 of the Income Tax Code, 6 percent of the (maximum DM 330,000) acquisition costs of owner-occupied dwellings (which were completed in 1992 or later) may be deducted for tax purpose for

48. A further benefit of price stability is the prevention of the "front loading" problem. This liquidity effect makes the acquisition of residential property more difficult since—given positive inflation—the real debt service is highest at the start of the period and later decreases; see the report of the Expert Commission on Housing Policy (Expertenkommission zur Wohnungspolitik 1994, 162 ff.). Given price stability, the real burden would, by contrast, be equally high throughout the period of the mortgage. Croushore (1992) estimates the benefit of this effect alone—assuming a reduction of inflation by 2 percentage points—to be between 0.06 and 0.12 percent of GDP.

49. Owner-occupied houses until 1996 were, in principle, also subject to general (net) wealth tax. Because of the low values to be assessed and the nominal value of the mortgage debts to be counted against them, however, very little wealth tax or none at all was due. Profits from sales are basically negligible in terms of income tax legislation.

an initial period of four years and 5 percent for a further four years.[50] Over eight years this assistance adds up DM 145,200. In addition, the home buyers' child benefit of DM 1,000 per child is deducted from liable tax. In the case of two children, this produces an amount of DM 16,000, which—given a tax rate of $\tau' = 37.6$ percent—corresponds to a gross deductible amount of around DM 42,600. In total, this produces a reduction in the tax base of DM 187,800 for the entire period in which assistance is granted. If average acquisition costs are assumed to be DM 373,000,[51] this corresponds to around 50 percent of the acquisition costs. Both marriage partners can make use of this assistance once. This is taken into account by halving the useful economic life of the property to 25 years. Spread over that period, the tax-deductible amount is $h = 50/25 =$ 2 percent per annum of the acquisition costs. Given a share of borrowing in capital spending on housing construction of $\mu = 60$ percent and a nominal annual mortgage rate of 8.5 percent (at 2 percent inflation), equation (36) results in $R_2 = 0.6*8.5 + (1 - 0.6)*(4.24 + 2) - 0.376*2 + 4 - 2 = 8.85$ percent.

Assuming that the simple Fisher relationship ($di_m/d\pi = 1$) applies to the mortgage rate, and also considering the fact that according to equation (26) $dr_2/d\pi = -\omega$, it follows from equation (36) that $dR_2/d\pi = -\omega(1 - \mu)$. This assumes that h is independent of the inflation rate. Given a lack of inflation, the user costs would hence rise to

$$R_1 = R_2 + \pi\omega(1 - \mu). \tag{37}$$

Since $\omega = 0.31$ was calculated above, it follows that $R_1 = 8.84 + 2*0.31*(1 - 0.6) = 9.09$ percent; that is, the elimination of an inflation rate of 2 percent would increase the user costs of owner-occupied housing by 0.24 percentage points. The welfare effect (34) becomes $G_{H_1} = 0.0583(H_2 - H_1)$. The increase in user costs that are distorted downward by inflation results in a decline in the demand for housing, which leads to a corresponding reduction of capital misallocation. We approximate this quantity effect by

$$H_2 - H_1 = \frac{R_1 - R_2}{R_2} H_2 \varepsilon_{HR}, \tag{38}$$

where ε_{HR} is the compensated interest rate elasticity of capital spending on housing construction. Döpke (1996) estimates a long-term value of 0.14 for the uncompensated interest rate elasticity. This corresponds to a compensated

50. Since 1991, an income limit for a single/couple of DM 120,000/240,000 has applied to basic assistance and home buyers' child benefit.

51. Between 1991 and 1995, pure construction costs amounted to an average of DM 2,500 per square meter. This gives construction costs of around DM 305,000, assuming an average floor area of 122m^2. Furthermore, DM 50,000 in real estate costs are added to this, assuming that a property has an area of 200m^2 and a real estate price of DM 250 per square meter. Finally, assuming ancillary costs of around 5 percent of the acquisition costs results in the above-mentioned value of DM 373,000.

elasticity of around $\varepsilon_{HR} = 0.25$.[52] A ratio of 1.7 between the value of the owner-occupied housing stock and GDP thus gives $H_2 - H_1 = 1.20$ percent of GDP. In conjunction with the price effect, the direct benefit of price stability with owner-occupied housing is $G_{H_1} = 0.07$ percent of GDP.

The Indirect Revenue Effect

The indirect revenue effect is defined as

$$G_{H_2} = (H_1 - H_2)r_0\Theta. \tag{39}$$

A fall in demand for owner-occupied housing of 1.20 percent of GDP was produced by equation (38). The capital stock in the enterprise sector increases by the same amount and generates a gross rate of return of $r_0 = 10.8$ percent and a net yield (without inflation) of $r_1 = 4.87$ percent. This corresponds to an effective average rate of taxation of $\Theta = 55$ percent; that is, $G_{H_2} = 1.20*0.108*0.55 = 0.07$ percent of GDP. If the deadweight loss per deutsche mark of tax revenue calculated above is likewise put at $\lambda_C = 0.34$ here, a net benefit is produced on balance (given price stability) of

$$G_H = G_{H_1} + \lambda_C G_{H_2} = 0.07 + 0.34*0.07 = 0.09\% \text{ of GDP.}$$

2.3.3 Money Demand and Seigniorage

The Direct Welfare Effect

Inflation increases the alternative costs of holding non-interest-bearing money balances and lowers the real demand for money below its optimal level. Since the real costs of an increase in the money stock are virtually nil, the optimal money stock, according to Friedman (1969), is that in which the opportunity costs of cash holdings are zero, that is, $r(\pi^*) + \pi^* = 0$.[53]

With the current system of taxation and given 2 percent inflation, the opportunity costs of cash holdings are $r_2 + \pi = 4.24 + 2.0 = 6.24$ percent. Given a zero inflation rate, these costs fall to $r_1 = 4.87$ percent. A Harberger analysis of the money demand produces the following trapezoid as the welfare gain due to a lowering of the inflation rate from effectively 2 percent to zero:

52. The relationship $\varepsilon = \eta + \Xi*(H/Y)$ applies between the compensated (ε) and uncompensated (η) elasticity, where Ξ is the income elasticity of the capital spending on housing construction and H/Y is the ratio of capital spending on housing construction to disposable income. With the income elasticity of 1.26 estimated by Döpke (1996) and a ratio of capital spending on housing construction to disposable income of 10 percent, this gives $\varepsilon = 0.14 + 1.26 * 0.10 \cong 0.25$ for the compensated elasticity.

53. The value $r_1 = 4.87$ percent has been determined for the real return given a zero inflation rate. Assuming for the sake of simplicity that the real yield is a linear function of the inflation rate, to which $dr/d\pi = -\omega$ applies, the optimal inflation rate according to Friedman is produced as the solution of $r_1 - 0.31\pi^* + \pi^* = 0$; i.e., $\pi^* = -7$ percent. If there are no lump-sum taxes, it is theoretically possible, however, that the inflation rate is positive as part of an optimal tax mix provided that money is regarded as an end good and not as an intermediate good. See also the papers by Phelps (1973) and Chari, Christiano, and Kehoe (1991).

(40) $$G_{M_1} = [(r_1 - 0) + \tfrac{1}{2}(r_2 + \pi - r_1)](M_1 - M_2);$$

that is, $G_{M_1} = 0.0556(M_1 - M_2)$. The change in the money demand can be approximated by

(41) $$M_1 - M_2 = \frac{r_2 + \pi - r_1}{r_2 + \pi}\varepsilon_{Mi}M_2.$$

According to our estimations, the interest rate elasticity of the demand for money (currency in circulation and required reserves) is $\varepsilon_{Mi} = 0.25$ in absolute value. Given a 9 percent share of these monetary components in GDP, it follows that $M_1 - M_2 = 0.50$ percent of GDP. The product of the price and the quantity effect gives the direct welfare gain of price stability in the money demand; it amounts to just $G_{M_1} = 0.03$ percent of GDP.

The Indirect Revenue Effect

The indirect revenue effect of reduced money demand is made up of three components. First, the reduction of the "inflation tax" to real money balances (M) leads to a loss of monetary seigniorage. This implies a welfare loss since other distorting taxes have to be increased. The (active) seigniorage to the amount of[54]

(42) $$S = \pi M$$

reacts to changes in the inflation rate in accordance with $dS/d\pi = M + \pi(dM/d\pi)$. After some transformations using $d(r_2 + \pi)/d\pi = 1 - \omega$, this may be written as

(43) $$dS = \left[1 - \varepsilon_{Mi}(1 - \omega)\frac{\pi}{r_2 + \pi}\right]M\pi.$$

Assuming a ratio of money balances (currency in circulation and minimum reserves) to GDP of 9 percent and an interest rate elasticity of money demand in absolute terms of $\varepsilon_{Mi} = 0.25$, the loss of seigniorage if there is price stability comes to $dS = 0.17$ percent of GDP.

Second, an income effect results from the fact that less capital and more real money balances are held if there is price stability. The value $M_1 - M_2 = 0.50$ percent of GDP has been determined above for the rise in the money demand. In the enterprise sector this capital earns a gross return of $r_0 = 10.8$ percent and is subject (given price stability) to taxation at $\Theta = 55$ percent. The loss of income is thus

(44) $$dK = (M_1 - M_2)r_0\Theta;$$

that is, $dK = 0.03$ percent of GDP.

54. Seigniorage also arises in a growing economy independent of the rate of inflation (passive seigniorage).

Third, the government is in a position to reduce interest-bearing debt instruments to the amount of the increased cash holdings. Although this is a one-off effect, it permanently reduces the government's debt service by

(45) $$dB = r_{ng}(M_1 - M_2),$$

where

(46) $$r_{ng} = (1 - \tau')\gamma - \pi$$

is the real rate of interest on the public debt. Assuming that the ratio of debt service to public debt is $\gamma = 7.8$ percent, and given a rate of taxation of $\tau' = 37.6$ percent, there is a real interest rate of $r_{ng} = 2.87$ percent. The income effect thus comes to $dB = 0.01$ percent of GDP. The total loss of government income if there is price stability is therefore

(47) $$G_{M_2} = -dS - dK + dB;$$

that is, $G_{M_2} = -0.19$ percent of GDP. Using the same shadow price of taxation as before yields a small negative benefit of money demand under price stability:

$$G_M = G_{M_1} + \lambda_C G_{M_2} = 0.03 + 0.34 * (-0.19) = -0.04\% \text{ of GDP.}$$

2.3.4 Government Debt Service

This subsection considers the welfare effect that results from the fact that higher real rates of interest also increase the real costs of the government's debt service. A fully anticipated inflation leaves the real gross interest rate on the public debt unchanged, whereas the inflation premium is subject to income tax. A lower inflation rate hence does not reduce the pretax cost of debt service—that is, it does not produce a direct advantage—but it does reduce the tax revenue accruing from the (eligible) interest rate payments on the public debt. This requires a compensatory increase of other taxes.

The starting point for quantifying this effect is the following budget equation for the change in the level of debt (D):

(48) $$\Delta D = G - T + (r_g + \pi)(1 - \tau')D,$$

where r_g is the real gross interest rate on the public debt and τ' is the marginal rate of taxation. In equilibrium the public debt grows at the same rate as nominal GDP; that is, $\Delta D = D(n + g + \pi)$. Combining this equilibrium condition with the above budget equation produces the following expression for the tax revenue:

(49) $$T = [(1 - \tau')(r_g + \pi) - (n + g + \pi)]D + G.$$

Differentiation of this budget constraint with respect to the inflation rate gives the reaction of tax revenue if there is a change in the inflation rate:

Table 2.3 **Benefits of Price Stability: Reducing Inflation from 2 Percent to Zero (change as percent of GDP)**

Item	Welfare Effect			Memo Item:
	Direct	Indirect	Overall	United States
Consumption timing	1.95	−0.47	1.48	0.95
Housing demand	0.07	0.02	0.09	0.22
Money demand	0.03	−0.06	−0.04	−0.03
Debt service	–	−0.12	−0.12	−0.10
Overall benefit	2.04	−0.63	1.41	1.04
Memo item: United States	1.14	−0.10		

(50) $$dT = -\tau' D\, d\pi.$$

Given government debt of $D = 48$ percent of GDP on average over the years 1991–95, $d\pi = 2$ percentage points produces a change of $dT = 0.36$ percent of GDP. This fall in tax revenue resulting from the elimination of inflation must be offset by compensatory tax increases, which gives rise to a (negative) benefit:

$$G_D = 0.34 * (-0.36) = -0.12\% \text{ of GDP}.$$

2.3.5 Overall Benefit of Price Stability

The benefits of a zero inflation rate from the intertemporal allocation of consumption (G_C), the demand for owner-occupied housing (G_H), the demand for money (G_M), and the government's debt service (G_D) are combined in table 2.3.

Accordingly, the reduction of an (anticipated, equilibrium, and effective) inflation rate from 2 percent to zero results in a benefit of 1.41 percent of GDP year by year. This benefit is primarily the outcome of preventing inflation-induced distortions in the intertemporal allocation of consumption and saving (1.48 percent of GDP). The correction of the distortions in the demand for owner-occupied housing makes a net contribution amounting to 0.09 percent of GDP. The slight benefit in the case of money demand is overcompensated by the associated shortfalls in government income, resulting on balance in costs amounting to 0.04 percent of GDP. The lack of the alleviating financing effect of inflation in the servicing of public debt leads by itself to further costs, which are estimated at 0.12 percent of GDP. Just under one-third of the direct welfare gains amounting to 2.04 percent of GDP is used up again by indirect revenue shortfalls.

During the years 1991–95 the statistically measured inflation rate in Germany came to an average of 3.3 percent. On account of the lack of precision in statistical measuring, it is not possible to state beyond doubt whether this corresponds to an effective inflation rate of 2 percent. There is hence some

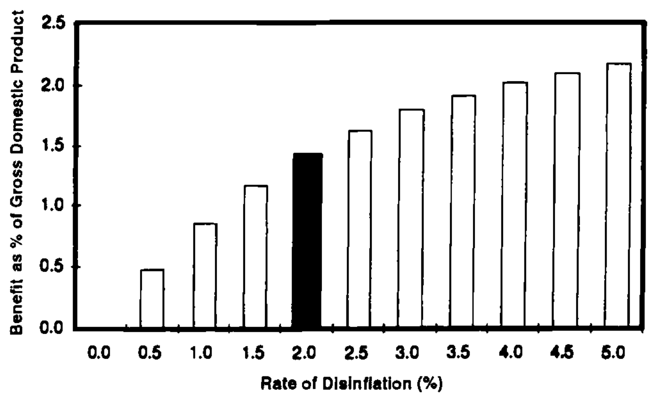

Fig. 2.1 Benefits of price stability

amount of uncertainty regarding the actual size of the "disinflation potential." As figure 2.1 shows, the benefit of price stability is a nonlinear function of the size of reduction in inflation. Assuming a reduction in inflation of 3 percentage points (which would then roughly correspond to a measured inflation rate of zero), rather than of 2 percentage points, the benefit increases from 1.41 to 1.78 percent of GDP. Conversely, a reduction in the inflation rate by only 1 percentage point would still produce a sizable benefit of 0.85 percent of GDP. By way of approximation, the relationship between the size of the reduction in inflation (π) and the benefit as a percentage of GDP (G) may be expressed by

$$(51) \qquad G = \pi^{\zeta}, \qquad \zeta > 0,$$

where $\zeta = 0.5$ describes this relationship quite well.

Comparing the results for Germany with Feldstein's for the United States reveals greater differences, above all, in terms of the intertemporal allocation of consumption. At 1.95 percent of GDP (according to our calculation), the direct welfare gain in this component is almost twice as large as Feldstein's, at 1.02 percent. In order to explain this difference, the direct benefit of price stability in consumption allocation has been broken down into the product of four factors in table 2.4: the relative price effect (RPE), the interest rate elasticity of consumption, the relative savings of the young generation, and the share of private saving in GDP. As this table shows, the differences in the first three of those effects are comparatively small and they mutually compensate each other. The greater benefit of price stability in our calculation hence ultimately rests on the fact that the saving ratio (as a percentage of GDP) is almost twice as high in Germany as it is in the United States.

The higher saving ratio in Germany also largely explains the greater (negative) indirect income effect in our calculation. Putting the saving ratio in our calculation at 5 percent for Germany, too, would produce a direct benefit in consumption allocation of 1.26 percent of GDP (compared with 1.02 percent for the United States) and an indirect income effect of −0.22 percent (−0.10

Table 2.4 **Comparison of Results with the United States**

Country	Relative Price Effect[a] (RPE)	Interest Rate Elasticity ($\|\varepsilon_{C_p}\|$)	Savings of Young Generation (S_y/S_N)	Saving Ratio (%) (S_N/GDP)	Direct Benefit (% of GDP) (G_{C_1})
Germany	0.109	0.854	2.251	9.30	1.95
United States	0.092	1.230	1.800	5.00	1.02
Ratio (Germany/U.S.)	1.19	0.69	1.25	1.86	1.91

[a]RPE = $[(p_1 - p_0)/p_2 + (p_2 - p_1)/(2p_2)]\,(p_2 - p_1)/p_2$.

percent). Despite all the other differences between the systems of taxation and the structural and behavioral parameters in the two economies, the overall benefit of a reduction of the inflation rate by 2 percentage points—given matching saving ratios—would be almost as large, at 0.94 percent of GDP, as for the United States (1.04 percent). Hence, it is the high saving rate in Germany, coupled with capital income taxes, that explains the large costs of even moderate rates of inflation.

2.3.6 The Risks: Some Sensitivity Calculations

Our calculations of the scale of the benefit due to price stability rely on a number of simplifying assumptions. Furthermore, some of the assumed quantitative values for the structural and behavioral parameters of the German economy are attended by considerable uncertainties. Appendix table 2D.2 contains an overview of all parametric assumptions (benchmark values) and a comparison with the coefficients assumed by Feldstein for the United States.

In order to obtain some initial points of reference for the sensitivity of the calculations to the assumptions that have been made, we have calculated each coefficient with alternative lower and upper values deviating from the benchmark. The range of these values was chosen to correspond to what we felt subjectively to be roughly two standard deviations.[55] As the results of these calculations show in appendix table 2D.3, varying the coefficients changes the overall benefit comparatively little; most results remain within the range of 1.41 ± 0.10 percent of GDP. The benefit of price stability that has been estimated thus appears to be quite robust in terms of the parametric assumptions that have been made.

An exception to this is the length of the *discounting period*. If the period is reduced (increased) from $T = 27$ to $T = 24$ (30) years, the benefit of price stability falls (rises) to 1.30 (1.51) percent of GDP. Another very important parameter is the *average rate of taxation* on distributed profits ($t = 60.7$ percent); a 3 percentage point reduction lowers the overall benefit to 1.31 percent of GDP, whereas an increase by the same amount raises the overall benefit of

55. For a normally distributed random variable, the stated interval includes the actual value with a probability of about .68.

Table 2.5 Benefits of Price Stability: Simulation (change as percent of GDP)

Item	Mean Value	Standard Deviation	Median	Skewness[a]
Consumption timing	1.44	0.490	1.39	0.30
Housing demand	0.10	0.065	0.09	0.62
Money demand	−0.03	0.023	−0.03	−0.22
Debt service	−0.12	0.044	−0.12	−0.28
Overall benefit	1.39	0.473	1.34	0.30

Note: Results are based on 10,000 stochastic simulations.

[a]Pearson's measure of skewness: 3*(arithmetic mean − median)/standard deviation.

disinflation to 1.52 percent. Besides this, the marginal rate of taxation ($\tau' =$ 37.6 percent) has an appreciable influence.

In addition, the calculations react quite sensitively to the assumption concerning the *interest rate elasticity of savings,* for which a benchmark value of $\eta_{s_r} = 0.25$ was determined (see appendix B). Lowering this elasticity to 0.10 reduces the benefit to 1.11 percent of GDP, whereas increasing it to 0.40 (i.e., the benchmark value used by Feldstein) increases the benefit to 1.74 percent.[56]

The shadow price of taxation for calculating the indirect revenue effects was set by Feldstein at the benchmark value $\lambda = 0.4$ and the alternative value 1. As explained above, this parameter is not set exogenously in our calculations but is instead determined model-endogenously as the shadow price of capital income taxation with the value $\lambda = 0.34$.

Deterministic parameter variations, in which all the other input values are kept constant, can give only an incomplete description of the uncertainties contained in a model calculation of this kind. For that reason, we have also used a Monte Carlo simulation to assess the variability of the benefit of price stability. In doing this, we regard all 23 parameters as independently normally distributed random variables.[57] The mean values of this distribution are the benchmark values used in our calculation. The difference between the lower (or upper) parameter value shown in appendix table 2D.3 and the benchmark value was set as the (subjective) standard deviation in all cases. As mentioned above, we assume that there is a roughly .68 probability of the actual parameter value being within the stated interval. We have taken a random sample from each of the 23 distributions and recalculated the benefit of price stability. This operation was repeated 10,000 times.

Table 2.5 shows the results of these simulation exercises. At 1.39 percent of GDP, the arithmetic mean of the benefit of price stability is very close to the

56. This sensitivity to the interest rate elasticity of savings is likewise revealed in the calculations made by Feldstein, which show the overall benefit (0.65, 1.04, and 1.62) for alternative values of the interest rate elasticity (0, 0.4, and 1).

57. The assumption of independence is undoubtedly a great simplification. An empirically grounded estimation of the correlation structures between the structural parameters and the behavioral coefficients would go beyond the scope of this study, however.

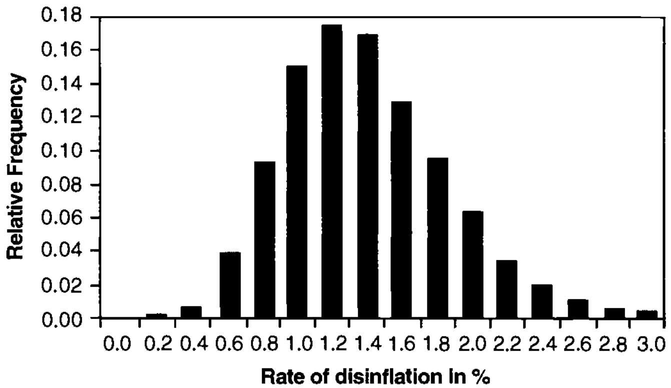

Fig. 2.2 Frequency distribution of benefits

deterministic value 1.41. The simulated standard deviation amounts to 0.47 percent of GDP. The median of the distribution of the overall benefit is 1.34 percent of GDP. This means (see also fig. 2.2) that the distribution of the benefit is positively skewed, which is likewise expressed in the positive Pearson measure of skewness of 0.30.

According to the simulation calculations, the probability of an overall benefit of less than 1 percent of GDP is 0.21. By contrast, the probability of the benefit being greater than the breakeven point of $G = 0.28$ percent of GDP (which was established in section 2.3) is 0.998.

2.3.7 On the Optimal Rate of Disinflation

We have assumed hitherto that the rate of inflation is reduced by 2 percentage points. In view of the determined costs and benefits, it remains questionable whether this is the optimal strategy, however. This requires an additional test criterion. Howitt, from a welfare-economic point of view, postulates the following rule in order to assess which (dis)inflation rate a central bank should aim for (Howitt's rule): "In order to estimate the optimal target rate of inflation, one must somehow balance the gains from reducing inflation against the costs of doing so. The reduction in inflation should continue as long as the present discounted value of the benefits to society from a further small reduction exceeds the present discounted value of the cost. The optimal target rate is the rate at which the benefit of further reduction just equals the cost of raising unemployment by the required amount above the natural rate."[58] As the preceding comments have shown, both the benefits (G) and the costs (C) are regarded as (nonlinear) functions of the rate of disinflation (π); see equations (11) and (51) and figure 2.3.

As a function of the constant discounting factor ρ (see subsection 2.2.3), the net benefit (g) of disinflation may be expressed as

58. Howitt (1990, 104). Howitt's rule is discussed in detail by Thornton (1996).

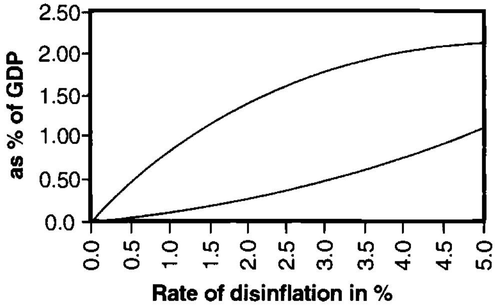

Fig. 2.3 Benefits and costs of price stability
Note: Upper curve shows benefits; lower curve, costs.

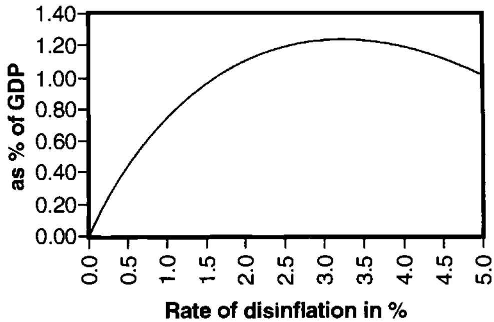

Fig. 2.4 "Optimal" rate of disinflation

(52) $$g(\pi) = G(\pi) - \rho C(\pi) = \pi^{\zeta} - \rho\sigma\pi^{1+\varphi}.$$

In accordance with Howitt's rule, the optimal disinflation rate (π^*) must fulfil the necessary condition $\partial g/\partial\pi = 0$, resulting in

(53) $$\pi^* = \left(\frac{1}{\rho\sigma}\cdot\frac{\zeta}{1+\varphi}\right)^{1/(1+\varphi-\zeta)}.$$

The higher the discounting rate and the higher the sacrifice ratio, the lower the optimal disinflation rate. Assuming as before $\zeta = \varphi = 0.5$, $\rho = 2.5$ percent, and $\sigma = 4$, the *optimal disinflation rate is* $\pi^* = 3.3$ *percent* (see fig. 2.4). The empirical data used in the estimate reflect the average conditions in the period 1991–95 when the statistically measured average inflation rate was 3.3 percent. Bearing this in mind, the result achieved suggests the conclusion that it would be optimal to aim at a zero inflation rate or stability of the measured price level.[59] The result obtained for the optimal inflation rate in accordance with equation (53) depends to a considerable extent, however, on the choice of pa-

59. As Scarth (1990) has shown, a goal of this kind would be both transparent and credible.

rameters included in it and, for that reason, should not be overvalued. Additionally, there are uncertainties and risks both in quantifying the disinflation costs and (as the sensitivity analyses have shown) in quantifying the benefits, which suggest a cautious interpretation of the results.

> If there is anything in the world which ought to be stable it is money, the measure of everything which enters the channels of trade.
> —François Le Blanc, *Traité historique des monnayes de France* (1690; quoted in Einaudi 1953)

2.4 Summary and Conclusions

In the run-up to European monetary union and the discussion to be held on the monetary policy strategy of a future European Central Bank, Issing writes, "The current large measure of consensus is not a guarantee, however, that the pendulum will not swing back at some point in the future. . . . The risk of inflation is not dead simply because the statistics show price stability at present. It will have been really conquered only when it has disappeared once and for all from the range of attractive available policy options" (1996a, 309).

In that respect, this study has confirmed for Germany what Feldstein discovered for the United States: inflation is anything but an attractive option. The interaction of even moderate rates of inflation with the existing system of taxation results in a significant loss of welfare. The change from an equilibrium "true" inflation rate of 2 percent (which may correspond to a measured rate of 3 percent) to a rate of zero brings permanent welfare gains, equivalent to 1.4 percent of GDP year for year. The deadweight loss of 2 percent inflation is so great because Germany has a high saving rate, capital income is taxed heavily, and the tax system is not indexed. Inflation intensifies the distortions of taxation on capital income. For that reason the welfare gains of price stability should be measured not by a "Harberger triangle" but by a "Feldstein trapezoid." Even if we regard the output losses (in the form of a temporary Okun gap) during disinflation as far from negligible, there are, in our opinion, no convincing arguments that moderate inflation is superior to price stability.

In the years 1991–95, the base period of our calculations, the average measured rate of inflation turned out to be 3.3 percent per annum. In 1996 the rate of inflation was 1.5 percent. Considering the sustained economic problems of the new Länder in eastern Germany and the difficult labor market situation, one may ask whether this policy of disinflation by about 2 percentage points was justified or whether the Bundesbank should have executed a more expansionary monetary policy in order to stabilize the inflation rate at 3.3 percent.

According to our calculations, the disinflation by almost 2 percentage points was well justified, provided one is prepared to look not only at the short-lived costs of disinflation but also at the longer term gains of price stability. This is a powerful argument for putting monetary policy into the hands of an indepen-

Table 2.6 Menu of Choices (costs and benefits as percent of GDP)

Initial Measured Rate of Inflation[a]	3.3	3.3	3.3	3.3	3.3	3.3
Rate of Disinflation	0.0	1.0	2.0	3.3	4.0	5.0
Final Measured Rate of Inflation	3.3	2.3	1.3	0.0	−0.7	−1.7
Permanent benefits	0.00	0.85	1.41	1.86	2.01	2.24
Annualized costs	0.00	0.10	0.28	0.60	0.80	1.12
Benefits minus costs	0.00	0.75	1.13	1.26	1.21	1.12
Annual loss in welfare	−1.26	−0.51	−0.13	0.00	−0.05	−0.14

[a]Average rate of inflation between 1991 and 1995.

dent and forward-looking institution with a long time horizon. An independent central bank with the primary goal of price stability is able to invest in the public good called "price stability" even if the starting costs exceed the first-round benefits, as is usually the case for long-lived investments. Besides this, it should not be forgotten that the sacrifice ratio hinges on the degree of nominal rigidity, which can be influenced to some extent by carefully choosing the timing, speed, and policy mix of disinflation. The menu of choices in table 2.6 summarizes the main results of our study.

Stabilizing the rate of inflation at 3.3 percent would have avoided any costs of disinflation, but there would have been no gains either. Compared to the optimal strategy, the policy of preserving the status quo achieved at that time would have incurred a permanent annual welfare loss of roughly 1.3 percent of GDP. A modest disinflation by 1 percentage point already would have reduced the unexploited gains to 0.5 percent of GDP. The actual amount of disinflation by almost 2 percentage points exploits almost all potential gains, provided the present rate of inflation will be sustained. More disinflation (to bring the measured rate down to zero) would produce only small additional gains. On the other hand, as table 2.6 shows, overshooting the optimal rate of disinflation is associated with relatively small welfare losses. However, one should keep in mind that there are other costs and benefits of disinflation, not investigated in this paper. A too low (i.e., negative) inflation rate may, for example, destabilize international financial markets and cause a range of other adjustment problems.

Having made these caveats, we conclude our study as follows:

Importance: Inflation, even at moderate rates of 2 or 3 percent per annum, is a very costly economic policy option.

Asymmetry: The welfare loss of a too high inflation rate is large; the welfare loss of a too small inflation rate appears to be small.

Robustness: It does not matter much whether monetary policy aims at price stability in terms of the measured or the "true" rate of inflation. This decision should be based on such criteria as transparency, clarity, and—above all—credibility.

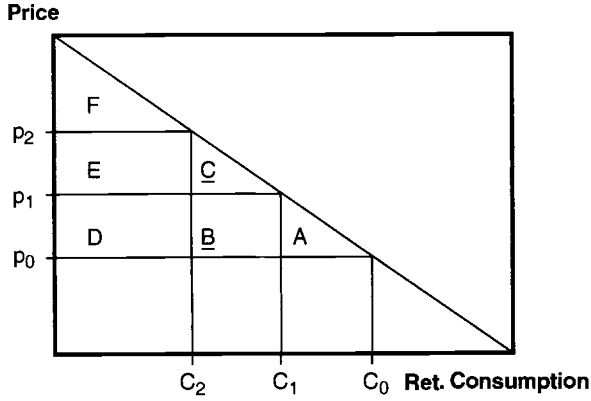

Fig. 2A.1 Demand for retirement consumption

At the outset we asked whether the benefits of price stability justify the costs of disinflation. To this we can now give a short, unequivocal answer: No inflation is better than low inflation! In fact, our results clearly indicate that the aim of price stability should receive priority. Tobin's often-quoted comment that "it takes a heap of Harberger Triangles to fill an Okun Gap" (1977, 467) therefore needs to be amended. In brief—and to extend the metaphor—it should continue "but it only takes one single Feldstein Trapezoid to do it."

Appendix A
The Welfare-Theoretical Approach

Consider the following three points (p_i, C_i) on the compensated demand function for retirement consumption, each corresponding to a specific type of regime (see fig. 2A.1):

No tax, no inflation	(p_0, C_0)
Tax, no inflation	(p_1, C_1)
Tax and inflation	(p_2, C_2)

Without taxes and inflation consumer surplus is the sum of areas A through F.[60] Introducing capital income taxes in an environment of price stability moves the equilibrium point from (p_0, C_0) to (p_1, C_1) with less retirement consump-

60. Problems with the concept of consumer surplus as a measure of welfare effects are discussed in detail by Silberberg (1978).

tion at a higher price. Consumer surplus is reduced to the area C + E + F and tax revenues corresponding to the area B + D are created. The difference, the triangle A, is a deadweight loss; it is the reduction of consumer surplus that is not compensated by higher tax revenues. The deadweight loss per deutsche mark of taxes raised is

$$\lambda_C = A/(B + D). \tag{A1}$$

Introducing both taxes and inflation moves the equilibrium point to (p_2, C_2), with a reduced consumption level at a higher price. The remaining consumer surplus is the area F, whereas tax revenues correspond to the rectangle D + E. The deadweight loss increases to the triangle A + B + C. The following table summarizes the welfare accounting for the three regimes:

Regime	Consumer Surplus	Tax Revenues	Deadweight Loss
No tax, no inflation	A + B + C + D + E + F	–	–
Tax, no inflation	C + E + F	B + D	A
Tax and inflation	F	D + E	A + B + C

Hence, moving from the equilibrium with taxes and inflation to price stability increases consumer surplus by the area C + E and changes tax revenues by the amount (B + D) − (D + E) = B − E. The welfare difference between the two regimes is a reduction of deadweight loss, that is, a deadweight gain, measured by the *trapezoid* B + C.

Assuming that the government faces a strict budget constraint at the margin, the change in tax revenues needs to be compensated by increasing (if negative) or decreasing (if positive) other taxes. If the deadweight loss per deutsche mark of some compensating tax is denoted by λ, then

$$G_C = (B + C) + \lambda(B - E) \tag{A2}$$

is the net deadweight gain of price stability.

Appendix B

An Overlapping Generations Model

Consider the following simple overlapping generations model with a constant relative risk aversion utility function:

$$\max \frac{C_{yt}^{1-\Psi}}{1-\Psi} + s\frac{C_{ot+1}^{1-\Psi}}{1-\Psi}; \qquad s = (1 + \rho)^{-T}, \quad \rho > -1, \quad \Psi > 0, \tag{B1}$$

subject to

(B2) $$C_{yt} + S_{yt} = W_t,$$

(B3) $$C_{ot+1} = \frac{1}{p}S_{yt}, \qquad p = (1 + r)^{-T}.$$

C_y denotes consumption of the young generation and C_o is their retirement consumption; S_y represents savings of the young and W is their (exogenous) wage income. The parameter ρ represents the rate of time preference, and $1/\Psi$ measures the intertemporal elasticity of substitution.[61] Equation (B3) corresponds to equation (13) in the main text. The solution of this model is

(B4) $$C^*_{yt} = W_t\Omega \qquad \text{with } \Omega = (1 + p^{1-1/\Psi}s^{1/\Psi})^{-1},$$

(B5) $$S^*_{yt} = W_t(1 - \Omega),$$

(B6) $$C^*_{ot+1} = \frac{1}{p}W_t(1 - \Omega).$$

The variable Ω is the young generation's propensity to consume out of wage income. Assuming that real wages grow with the rate $n + g$, from equation (B3) we can write consumption of the *presently old* as the sum of their previous period's savings and the accumulated interest income of these savings as

(B7) $$C_{ot} = \frac{1}{p}S_{yt-1} = \frac{q}{p}S_{yt}, \qquad \text{where } q = (1 + n + g)^{-T}.$$

(Dis)saving of the presently old equals interest income minus consumption:

(B8) $$S_{ot} = \frac{q}{p}(1 - p)S_{yt} - C_{ot} = -qS_{yt}.$$

Total savings (in period t) are equal to savings of the young plus savings of the *presently* old:

(B9) $$S_{Nt} = S_{yt} + S_{ot} = (1 - q)S_{yt}.$$

In the period 1985–94 the average annual growth rate of real wages was $n + g = 2.2$ percent,[62] which discounted over a generation of $T = 27$ years yields $q = 0.556$, implying $S_N = 0.444S_y$. Private saving accounted for 9.3 percent of GDP on average between 1991 and 1995. Hence, from equation (B9) we get $S_y = 0.209$GDP.

61. See Blanchard and Fischer (1989) and Romer (1996). In the special case $\Psi \rightarrow 1$, the instantaneous utility function simplifies to the logarithmic utility function.

62. Due to German unification and other factors, the growth rate of real wages in West Germany in the period 1990–94 (1.4 percent) was exceptionally low and understates the long-term equilibrium growth rate. For this reason we use the average growth rate of the past 10 years.

Alternatively, equation (B5) can be used to calculate savings of the young. This requires estimating the intertemporal elasticity of substitution ($1/\Psi$). Applying the Euler equation approach, Flaig (1990, 1994) obtains an intertemporal elasticity of substitution (IES) in the range 0.24–0.43 from aggregate consumption data for Germany. These low values imply a negative interest rate elasticity of saving. However, estimates of the IES by the Euler equation approach from aggregate data are likely to be biased downward. Attanasio and Weber show "that the bias introduced by using aggregate consumption data to estimate the elasticity of intertemporal substitution can be substantial" (1995, 569). In particular, aggregate data may imply an elasticity of substitution close to zero, even if it is one at the microlevel. This is confirmed in an empirical study by Beaudry and Wincoop (1996) for the United States based on a panel of state data. They find "that the IES for nondurables consumption is significantly different from 0, and probably close to 1." Hence, Flaig's results would seem to be consistent with $1/\Psi = 4/3$. Using the real interest rate calculated in the main text, that is, $r = r_2 = 4.24$ percent ($p = 0.326$) and assuming a rate of time preference of $\rho = 2.5$ percent ($s = 0.513$), yields $\Omega = 0.626$. Wages in West Germany accounted for $\alpha = 56$ percent of GDP on average over the period 1990–94. Hence, from equation (B5) we obtain $S_y = 0.209GDP$, which matches the result obtained via equation (B9).

Differentiating equation (B5) with respect to the interest rate yields the interest rate elasticity of the saving of the young:

$$\text{(B10)} \qquad \eta_{S_r} = \left(\frac{1}{\Psi} - 1\right)\Omega\frac{rT}{1 + r}.$$

This elasticity is positive if the elasticity of substitution ($1/\Psi$) is greater than one. Using the same parameter values as before, we obtain an estimate of the interest rate elasticity of saving of the young of $\eta_{S_r} = 0.23$.

Appendix C

An Overlapping Generations Model with Transfers

The analysis so far has implicitly assumed that a fully funded system is in place for providing old-age pensions. The purpose of this appendix is to take into account the fact that many retirees actually receive a significant amount of exogenous income through an unfunded (pay as you go) system.

We retain the utility function (B1) of appendix B, that is,

$$\text{(C1)} \quad \max \frac{C_{yt}^{1-\Psi}}{1 - \Psi} + s\frac{C_{ot+1}^{1-\Psi}}{1 - \Psi}; \qquad s = (1 + \rho)^{-T}, \quad \rho > -1, \quad \Psi > 0,$$

but change the budget constraints for the young (B2) and the old (B3) generation to

(C2) $$C_{yt} + S_{yt} = W_t(1 - \tau - \gamma) + Z_t,$$

(C3) $$C_{ot+1} = \frac{S_{yt}}{p} + \frac{\gamma W_t}{q} - \frac{R_t}{q}.$$

We assume that the total wage income accrues to the young generation, as well as all government transfers, except pension payments. On the other hand, the old (retired) generation receives all nonwage income plus the pension payments. Hence, in equation (C2), W represents the (exogenous) gross wage income, including employers' contributions to social security (i.e., to the pension fund and to health and unemployment insurance); τ is an average "tax" rate that comprises employees' and employers' contributions to the social security system except for contributions to the pension fund; γ is the rate paid (by both employers and employees) to the pension fund; and Z is the amount of net government transfers received by the young generation. In equation (C3), $\gamma W/q$ is the amount of pensions received by the old generation; and R is the net amount of transfers left by the old generation. We assume that this amount is channeled through the government sector such that there is no direct link between the amount bequeathed by the old (R) and the amount of transfers received by the young (Z). Note that in contrast to the rate of return (r) of savings of the young, the implicit rate of return of contributions to the pay-as-you-go pension fund is the real growth rate $n + g$.[63]

Solving equation (C1) subject to the restrictions (C2) and (C3) yields the following optimal consumption and saving schedules:

(C4) $$C^*_{yt} = [W_t(1 - \tau - \gamma) + Z_t]\Omega + \frac{p}{q}[\gamma W_t - R_t]\Omega,$$

(C5) $$S^*_{yt} = [W_t(1 - \tau - \gamma) + Z_t](1 - \Omega) - \frac{p}{q}[\gamma W_t - R_t]\Omega,$$

(C6) $$C^*_{ot+1} = \frac{1}{p}[W_t(1 - \tau - \gamma) + Z_t](1 - \Omega) - \frac{1}{q}[\gamma W_t - R_t](1 - \Omega).$$

The parameter Ω is defined in equation (B4) of appendix B. Assuming, that the growth rate of real wages (W) and transfers (Z, R) is $n + g$, consumption of the presently old (eq. [B7]) becomes

(C7) $$C_{ot} = \frac{q}{p}S_{yt} + \gamma W_t - R_t.$$

63. In a fully funded system we have $p = q$ and $\gamma W/p$ drops out of eq. (C3) when eq. (C2) is inserted. Hence, the optimal saving and consumption plan is independent of contributions to the pension fund (γ) in a fully funded system.

Table 2C.1 **Income and Expenditure of Private Sector**

Item	Young	Presently Old	Total
Saving	S_y	S_o	S_N
Consumption	C_y	C_o	C_N
Total	W_n	Q_n	Y_D

Table 2C.2 **Income and Expenditure of Private Sector under 2 Percent Inflation (percent of GDP)**

Item	Young	Presently Old	Total	Total (1991–95)
Saving	18.1	−10.1	8.1	9.3
Consumption	28.8	29.3	58.1	56.4
Total	46.9	19.2	66.2	
Total (1991–95)	46.2	19.5	65.7	

The equations for savings of the presently old (B8) and total private savings (B9) remain valid, however:

(C8) $$S_{ot} = -qS_{yt},$$

(C9) $$S_{Nt} = (1 - q)S_{yt}.$$

These relationships imply accounting table 2C.1 for period t.

In table 2C.1, $W_n = W(1 - \tau - \gamma) + Z$ denotes net wage income plus transfer payments (but excluding pensions), which is attributed to the young generation; Q_n is the sum of net income from capital ownership (profit plus interests) and pension payments, both attributed to the old generation; Y_D is disposable income of the private sector, which is broken down into private savings (S_N) and private consumption (C_N).

We use the same parameter values as in appendix B, that is, $\rho = 2.5$ percent, $r_2 = 4.24$ percent, $n + g = 2.2$ percent ($\rightarrow \Omega = 0.626$), and $W = 0.56$GDP, and additionally set

$$\gamma = 0.15, \quad \tau = 0.28, \quad Z = 0.15\text{GDP}, \quad R = 0.10\text{GDP}.$$

The parameter R was calibrated such that the model approximately reproduces the income and expenditure account of the private sector in Germany for the period 1991–95 (see the last row and last column of table 2C.2). Under conditions of price stability the net real interest rate rises from $r_2 = 4.24$ percent to $r_1 = 4.87$ percent (see subsection 2.3.1). A new equilibrium can be calculated, which is reported in table 2C.3.

The higher real interest rate increases saving of the young only by 0.5 percent of GDP and reduces consumption of the young accordingly (note that the

Table 2C.3 **Income and Expenditure of Private Sector under Price Stability (percent of GDP)**

Item	Young	Presently Old	Total
Saving	18.6	−10.4	8.3
Consumption	28.3	35.8	64.1
Total	46.9	25.4	72.4

net income of the young is given exogenously).[64] Because dissaving of the old rises by 0.3 percent of GDP, total private saving increases only by 0.2 percent of GDP. The biggest change occurs for *consumption of the old:* this aggregate increases from 29.3 to 35.8 percent of GDP.

What are the welfare consequences of this move from 2 percent inflation to price stability? To recalculate the benefits of price stability along the lines of section 2.3, we have to recognize that equation (13) ($S = pC$) changes to equation (C3), which is reproduced here for convenience, dropping subscripts, as

(C3′/13′)
$$S = pC - \frac{p}{q}(\gamma W - R).$$

From this equation we derive the following expression for the price elasticity of saving:

(C10)
$$\eta_{S_p} = -\left[\frac{W(1 - \tau - \gamma) + Z}{S}\eta_{\Omega p} + \frac{p}{q}\frac{\gamma W - R}{S}(1 + \eta_{\Omega p})\right]\Omega,$$

where

$$\eta_{\Omega_p} = (1/\Psi - 1)(1 - \Omega).$$

The compensated price elasticity of retirement consumption becomes

(32′)
$$\varepsilon_{Cp} = -\left[\left(1 - \frac{\gamma W - R}{qC}\right)(1 - \eta_{Sp}) - \sigma_y\right],$$

with

$$\sigma_y = \frac{d(pC)}{dW} = (1 - \Omega)\left[1 - \tau - \gamma\left(1 - \frac{p}{q}\right)\right].$$

Introducing the parameter values used above produces $\eta_{\Omega p} = 0.125$, $\eta_{Sp} = -0.170$ ($\eta_{Sr} = 0.186$), $\sigma_y = 0.246$, and $\varepsilon_{Cp} = -0.987$. This, in turn, yields $C_1 - C_2 = 7.82$ percent of GDP as the induced change of old-age consumption.

64. This suggests that the change of the marginal product of capital would be small, justifying our assumption of a constant pretax rate of return (r_0).

Using equations (15) through (19) we obtain the following areas under the compensated demand function:

A = 5.21 percent of GDP
B = 1.68 percent of GDP
C = 0.19 percent of GDP
D = 11.30 percent of GDP
E = 2.58 percent of GDP

The net benefit of price stability in this extended model incorporating intergenerational transfers turns out to be

$$G_C = 1.87 + 0.40 * (-0.91) = 1.50\% \text{ of GDP.}$$

Hence, the gain from improved intertemporal allocation of consumption and saving is almost the same as that obtained on the basis of the simpler model in the body of the paper.

Appendix D

Table 2D.1 **Taxation of Corporate Profit**

	Rate[a] (%)	Distributed Profits of Domestically Incorporated Enterprise		Rate[a] (%)	Income of Partnership		Rate[a] (%)	Retained Profits of Domestically Incorporated Enterprise	
a. Gross rate of return (%)		10.80			10.80			10.80	
b. Trading capital (DM)		925.93			925.93			925.93	
c. Gross profit (DM)		**100.00**	**101.00**		**100.00**	**101.00**		**100.00**	**101.00**
d. Tax on trading capital (of b)	0.80	−7.41	−7.41		−7.41	−7.41		−7.41	−7.41
e. Trade earnings tax (of c + d)	16.67	−15.43	−15.60		−15.43	−15.60		−15.43	−15.60
f. Gross dividend/taxable income		77.16	77.99		77.16	77.99		77.16	77.99
g. Corporation tax (of f)	30.00	−23.15	−23.40				45.00	−34.72	−35.10
i. Trade earnings tax (of f + g)	25.00	−13.50	−13.65						
j. Solidarity surcharge (of g + i)	7.50	−2.75	−2.78					−2.60	−2.63
k. Corporation property tax (of b)	0.45	−4.17	−4.17					−4.17	−4.17
l. Income tax (of f)	35.00	−27.01	−27.30		−27.01	−27.30			
m. Solidarity surcharge (of l)	7.50	−2.03	−2.05		−2.03	−2.05			
n. Property tax (of b)	0.50	−4.63	−4.63	0.38	−3.47	−3.47			
o. Tax credit (g + i + j)		39.40	39.83						
p. Net profit (DM)		39.33	39.85		44.66	45.18		35.67	36.10
q. Net rate of return (%)		4.25							
r. Tax burden (DM)		60.67	61.15		55.34	55.82		64.33	64.90
s. Marginal tax burden (%)			48.02			48.02			56.98

[a]Effective calculated rates, relative to the respective basis for assessment.

Table 2D.2 Assumptions for Calculating the Benefits

Parameter	Germany	United States[a]
Effective inflation rate (%)	2.00	2.00
Fiscal policy parameters		
Average tax rate on distributed profits (%)	60.70	41.00
Marginal tax rate on distributed profits (%)	48.00	35.00
Marginal income tax rate (including solidarity surcharge; %)	37.60	25.00
Property tax rate (%)	–	2.50
Effective tax rate on capital gains (%)	–	10.00
Auerbach elasticity	–	0.57
Useful fiscal economic life of fixed assets (years)	10.00	–
Tax concession as percentage of acqusition costs of owner-occupied housing	2.00	–
Marginal excess burden of taxation	–	0.4, 1.5
Financial parameters		
Real gross rate of return (%)	10.80	9.20
Discounting period (years)	27.00	30.00
Ratio of corporate debt to capital (%)	45.00	40.00
Ratio of equity and bonds to net wealth of private households (%)	43.00	60.00
Depreciation and maintenance costs of housing (%)	4.00	4.00
Nominal mortgage rate (%)	8.50	7.20
Ratio of mortgage to value of owner-occupied houses (%)	60.00	20/50
Value of owner-occupied housing (% of GDP)	170.00	105.00
Debt service (% of public debt)	7.80	8.50
Public debt (% of GDP)	48.00	50.00
Macroeconomic relations		
Growth rate of real wages and of GDP (%)	2.20	2.60
Ratio of wages to GDP (%)	56.00	75.00
Ratio of saving to GDP (%)	9.30	5.00
Ratio of money stock (currency in circulation and minimum reserves; % of GDP)	9.00	17.00
Behavioral coefficients		
Interest rate elasticity of saving	0.25	0, 0.4, 1.0
Compensated interest elasticity of investment in housing capital	0.25	0.80
Interest rate elasticity of money demand	0.25	0.20

[a]From Feldstein (1997).

Table 2D.3 Sensitivity Calculations

Parameter	Benchmark	Assumptions A	Assumptions B	Results[a] A	Results[a] B
Effective inflation rate (%)	2.00	1.50	2.50	1.16	1.61
Fiscal policy parameters					
Average tax rate on distributed profits (%)	60.70	57.70	63.70	1.31	1.52
Marginal tax rate on distributed profits (%)	48.00	45.00	51.00	1.38	1.45
Marginal income tax rate (including solidarity surcharge; %)	37.60	32.60	42.60	1.35	1.47
Useful fiscal economic life of fixed assets (years)	10.00	13.00	7.00	1.32	1.51
Tax concession as percentage of acquisition costs of owner-occupied housing	2.00	1.00	3.00	1.40	1.42
Financial parameters					
Real gross rate of return (%)	10.80	9.80	11.80	1.40	1.42
Discounting period (years)	27.00	24.00	30.00	1.30	1.51
Ratio of corporate debt to capital (%)	45.00	50.00	40.00	1.32	1.50
Ratio of equity and bonds to net wealth of private households (%)	43.00	38.00	48.00	1.34	1.48
Depreciation and maintenance costs of housing (%)	4.00	5.00	3.00	1.40	1.42
Nominal mortgage rate (%)	8.50	9.50	7.50	1.40	1.43
Ratio of mortgage to value of owner-occupied houses (%)	60.00	65.00	55.00	1.40	1.43
Value of owner-occupied housing (% of GDP)	170.00	150.00	190.00	1.40	1.42
Debt service (% of public debt)	7.80	6.80	8.80	1.41	1.41
Public debt (% of GDP)	48.00	51.00	45.00	1.40	1.42
Macroeconomic relations					
Growth rate of real wages and of GDP (%)	2.20	2.70	1.70	1.32	1.51
Ratio of wages to GDP (%)	56.00	53.00	59.00	1.36	1.46
Ratio of savings to GDP (%)	9.30	8.30	10.30	1.34	1.47
Ratio of money stock (currency in circulation and minimum reserves; % of GDP)	9.00	10.00	8.00	1.41	1.42
Behavioral coefficients					
Interest rate elasticity of saving	0.25	0.10	0.40	1.11	1.74
Compensated interest rate elasticity of investment in housing capital	0.25	0.15	0.35	1.37	1.45
Interest rate elasticity of money demand	0.25	0.10	0.40	1.40	1.43

[a]Figures show the net benefit in comparison to the net benefit of 1.41 percent of GDP assuming the benchmark values.

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