What Are the Costs of Disinflation?

*Dean Croushore**

The Federal Reserve can use monetary policy to reduce the inflation rate, a process known as *disinflation*. Are the benefits of disinflation worth the costs? Proponents of disinflation argue that the long-run benefits of price stability, including lower interest rates, increased economic efficiency, and perhaps faster economic growth, greatly exceed the short-run costs. Opponents, of course, claim the opposite, usually arguing that the short-run costs in terms of higher unemployment and lost output would be immense.

Recent legislation introduced into Congress would force the Fed to disinflate. The Neal Resolution, introduced in 1989, would require the Fed to reduce inflation to zero within five years. It would also make fighting inflation the Fed's only goal.

How can we evaluate the costs and benefits of disinflation? Only by writing down explicit models of the economy and seeing how the economy is likely to behave when the inflation rate is reduced. The costs of reducing inflation can then be compared with estimates of the benefits of disinflation.

Economists do not have very precise estimates of the benefits of disinflation. In addition, estimates of the costs of disinflation differ depending upon the type of economic model used.

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BENEFITS OF DISINFLATION

To examine the benefits of disinflation, let's compare an economy with an inflation rate of 0 percent to an identical economy with an inflation rate of 5 percent.[1] There are two benefits to disinflation that may be large even when the economy moves from an inflation rate of 5 percent to zero. One benefit comes from reducing the distortion to savings and investment that is caused by the interaction of the tax system with inflation. Another benefit comes from increasing the availability of mortgage loans; they are more affordable when inflation is lower, because the initial mortgage payments are lower.

Reducing the Distortion Due to the Tax System. Our tax system is not fully indexed to inflation. As a result, the effective tax rate on interest income is much higher when there is inflation than when there is none. For example, suppose that when inflation is 5 percent you put $100 in the bank at an interest rate of 7 percent. Your nominal return is $7, but $5 of that return just compensates you for inflation, so your real return is only $2. You must pay taxes, however, on your nominal, not your real, return. If your total tax rate is 30 percent, then you owe the government $2.10 in taxes, which leaves you with an after-tax return of just $4.90. But if we adjust for the 5 percent inflation, your after-tax *real* return is -$0.10. In other words, your $104.90 today buys fewer goods than your $100 did one year ago. Because the government is actually taxing away more than you've earned in real terms, your effective real (inflation-adjusted) tax rate is over 100%.

Throughout much of the 1970s, the effective real tax rate on interest income exceeded 100 percent. Inflation was very high, and the fact that taxes were based on nominal interest income rather than on real interest income meant that real after-tax returns were negative. Even in recent times, with inflation in the range of 3 to 5 percent, the effective real tax rate remains fairly high. Eytan Sheshinski of Hebrew University and Columbia University calculates the effective real tax rate on interest income in the U.S. at 86 percent in 1985 and 58 percent in 1989.

In addition to these effects on the rate of return to saving, the tax system contains numerous other distortions that affect the way firms behave, especially with regard to investment spending. For example, nominal (not real) interest payments are deductible, and depreciation costs are in nominal (not real) terms. So even a low inflation rate like 5 percent can reduce investment spending in the economy, both by reducing saving through a high effective real tax rate and by discouraging firms from investment spending. Reducing inflation would increase investment and lead to a rise in the nation's capital stock and its future output.

How much better off would the economy be if it could eliminate the tax system/inflation distortion? Estimates range from 0.06 percent of output to 0.62 percent of output per year.[2] Unfortunately, there has been no definitive study that pins down a figure within this range. As a preliminary estimate, let's assume a per-

[1]Our focus here is on the costs of a constant, known level of inflation. When the inflation rate isn't constant, there are additional costs because the inflation rate is uncertain. Some research even suggests that the higher the level of the inflation rate, the greater will be its variability (see the 1990 study by Laurence Ball of Princeton University and Stephen Cecchetti of Ohio State University). But to keep things simple for this article, let's suppose that inflation can be maintained at any constant rate.

[2]Rao Aiyagari in a 1990 Minneapolis Fed study argues that the distortion from the interaction of the tax system with inflation is small, as low as 0.06 to 0.12 percent of GNP per year. But David Altig and Charles Carlstrom of the Cleveland Fed, building further on work in their 1991 article, suggest that the distortion may be as high as 0.62 percent of GNP per year, over 10 times as large as Aiyagari's lowest estimate.

manent gain of between 0.25 and 0.50 percent of gross national product (GNP) per year if the tax system/inflation distortion is eliminated by reducing inflation from 5 percent to 0 percent.[3] This is roughly the central tendency of many different estimates of the benefit of eliminating the distortion; however, more research on measuring the size of the distortion is clearly needed.

How can this distortion be eliminated? Reducing inflation to zero is one approach. Another is to change the tax laws so that only real, not nominal, returns are taxed. But this second approach is complex, so much so that the major tax reform efforts in the 1980s were unable to address the issue. Perhaps the costs of changing the tax system exceed the benefits of doing so. Since further tax reform toward taxing real rather than nominal returns seems unlikely, the tax system/inflation distortion can most effectively be reduced by lowering inflation.

Making Mortgages More Affordable. The other major benefit to disinflation is that it would increase home ownership. When inflation occurs, there is a tilt to mortgage payments that makes it more difficult for people to buy homes. This results from the front-loading of real payments on loans when inflation is positive. For example, suppose the interest rate on a mortgage is 10 percent when inflation is 5 percent. Assuming that the nominal interest rate moves directly with inflation, suppose inflation is reduced to 0 percent and the mortgage interest rate falls to 5 percent.[4] Consider the effect of this change on the monthly payment on a $100,000 30-year mortgage. At a 10 percent mortgage interest rate, the monthly payment is $880; at a 5 percent interest rate, the payment is $540. With a 5 percent inflation rate, the real value of the $880 monthly payment falls over time.[5] But at 0 percent inflation, the $540 monthly payment remains constant in real terms. So the higher inflation rate causes repayment of the mortgage to be front-loaded earlier in the life of the loan. Inflation causes people to make higher real payments early in the life of the loan, rather than making constant real payments through time.

This effect is compounded by the fact that lower nominal interest rates make it easier for people to qualify to take out mortgage loans. Many lenders require that a mortgage payment not exceed 28 percent of a borrower's income when the loan is made. Using this guideline, at a 10 percent mortgage interest rate, a borrower's annual income would have to be more than $37,000 to take out this loan; at a 5 percent interest rate, the lower monthly payment means that income would have to be only $23,000. People could qualify for mortgage loans more easily if inflation were lower.

There is a way to solve this tilt problem without reducing inflation. The solution is to allow price-level-adjusted mortgages (PLAMs). PLAMs allow the principal value and monthly payment on a mortgage to move directly with the price level. They mimic the effects of having zero inflation. But people may have some trouble accepting this new type of loan because it requires negative nominal amortization—the dollar value of the mortgage rises with inflation. So after 15 years of paying off her mortgage, a homeowner might owe more (in dollar

[3]This doesn't mean that GNP would be 0.25 to 0.50 percent higher, but rather that the allocation of resources in the economy would be improved; the value of improving that allocation of resources is 0.25 to 0.50 percent of GNP.

[4]In this example, the real interest rate remains at 5 percent whether inflation is 5 percent or zero. Also, the example ignores the tax benefits that arise because mortgage interest is deductible on the federal income tax. Tax deductibility mitigates the tilt problem but does not eliminate it.

[5]For example, after 15 years at a 5 percent inflation rate, the $880 nominal payment is worth only $423 in real (inflation-adjusted) terms; but at 0 percent inflation, the $540 nominal payment is still worth $540 in real terms.

terms) than she did initially, although the real value of the mortgage (adjusted for inflation) would be less. Again, in considering the benefits of disinflation, we can't assume that these loans will be available and that people will use them if inflation remains high. So that leaves disinflation as the only method of reducing the tilt problem.

How big are the benefits of reducing the mortgage-tilt problem? While economists have recognized the problem's importance, there has been no concrete estimate of its cost to the economy. Since housing is such an important sector of the U.S. economy, and because the effect of the mortgage-tilt problem over a person's life cycle is so severe, a reasonable guess (assuming that the benefits here are somewhat lower than the benefits of eliminating the tax system/inflation distortion) is that eliminating it by reducing inflation from 5 percent to 0 percent would be valued at 0.15 to 0.30 percent of GNP per year. As with the tax system/inflation distortion, however, this is a very rough estimate; more research is needed to nail it down more precisely.

Other benefits of disinflation are likely to be quite small in reducing inflation from a moderate level like 5 percent to zero. These benefits include avoiding real losses by people who have fixed nominal incomes, reducing the implicit tax on moneyholding, reducing the "shoe-leather" costs that arise from running to the bank more often to try to avoid the implicit tax on moneyholding, and reducing menu costs (the costs of changing prices).[6]

The interaction of the tax system with inflation and the mortgage-tilt problem both reflect the inability of institutions to adjust to permanent inflation, and their effects may be substantial.[7] Reducing inflation from 5 percent to 0 percent by eliminating the interaction of the tax system with inflation would be worth an additional 0.25 to 0.50 percent of GNP, and eliminating the tilt problem may be valued at another 0.15 to 0.30 percent. And there are other, but smaller, benefits. So, in total, a rough estimate of the benefits of disinflation (that we can use as a benchmark for comparison with the costs of disinflation) is that the benefits to reducing inflation from 5 percent to zero are worth 0.4 to 0.8 percent of GNP per year. The present value of 0.4 to 0.8 percent of GNP per year forever is roughly 24 to 48 percent of 1990 GNP, when discounted at 4 percent and when GNP grows at 2.5 percent per year.[8] It is this benefit measure that we must compare (in present-value terms) with the costs of disinflation. Notice that the benefits are *permanent*, while the costs of disinflation are *temporary*, so a relatively small benefit per year may justify fairly large one-time costs.

THE COSTS OF DISINFLATION

Measuring the costs of disinflation depends a great deal on the economic model used. Classical models show low costs, while Keynesian models show high costs. Debate over which

[6]For a full discussion of these benefits of disinflation, see the 1978 study by Stanley Fischer and Franco Modigliani of MIT.

[7]If inflation were large enough so that these effects were severely damaging to the economy, then these institutions would probably adjust in some way. But at only 5 percent inflation, the costs of changing the institutions probably exceed the benefits of doing so, and these institutional structures persist.

[8]Mathematically, if the benefits of disinflation are β percent of GNP per year forever, if GNP grows at 2.5 percent per year, and the real interest rate is constant at 4 percent, then the present value of the benefits of disinflation as a percent of current GNP is given by the formula:

$$\sum_{i=1}^{\infty}(1.04)^{-i}\beta\,(1.025)^{i}.$$

This sum is 68.333 times β. Accounting for the fact that disinflation is not achieved for 10 years reduces this to about 60 times β.

theoretical model best explains macroeconomic events has raged for many years, with no consensus.

Further complicating matters is the issue of credibility. Suppose the Federal Reserve tightens monetary policy to reduce inflation. The resulting reduction in aggregate demand in the economy causes unemployment to rise. The Classical model of the economy suggests that the economy returns to full employment fairly quickly, while the Keynesian model argues that sluggish adjustment of wages and prices will cause a long period of higher unemployment. But both models show that the speed at which the economy adjusts depends on how credible the commitment to disinflation is. If people believe that the Fed means business and that it is committed to reducing the inflation rate, they are likely to take actions that adjust wages and prices more quickly in response to Fed policy. But if people doubt that the Fed will really go through with its disinflation plan (that is, to keep monetary policy tight despite the short-run repercussions) and that it might in fact give up the battle before inflation is defeated, they will be less willing to adjust in response to the announced policy change. When policy is credible, the costs of disinflation will be lower, as the whole economy moves together to a lower rate of inflation. But if policy is not credible, people will wait to see if inflation really declines before changing their wage demands or interest-rate demands, and the economy will adjust more slowly.

If the Federal Reserve embarked on a policy of disinflation, would such a policy be very credible? Credibility might be enhanced if something like the Neal Resolution to reduce inflation to zero in five years became law. The Fed might also increase its credibility if it were to announce a planned, multiyear path for key monetary variables (the money supply and interest rates) that it was targeting and to project the macroeconomic consequences (for output and unemployment) thereof. The plan would probably have to specify details, including how long it should take to reduce inflation, so that people could observe its progress and see how well the Fed was adhering to the plan. This would make the plan verifiable and thus more credible.

To develop such a plan, the Fed needs to know much about the economy's response to a tightening of monetary policy. If the goal is to reduce the inflation rate while minimizing the short-run costs to the economy, the Fed needs a model of the economy to measure such costs and evaluate alternative policies. It can use such a model to evaluate the optimal monetary policy over time—to find the path of interest rates and money growth that gives the smallest costs relative to the benefits of disinflation, and to find the best time period (5 years? 10 years?) over which the disinflation should occur.

MODEL-BASED MEASURES OF THE COSTS OF DISINFLATION

Some previous studies have provided estimates of the costs of disinflation.[9] In 1980, Laurence Meyer of Washington University and Robert Rasche of Michigan State University ran simulations to determine the cost of reducing the inflation rate from 10 percent to 2.5 percent based on four simple models. They showed that a Keynesian model had costs of disinflation that were three to six times as large as those of a Classical model. They found much uncer-

[9]Some evidence on the costs of disinflation might come from looking at past data (rather than using models) to see how much output growth has changed in the past when inflation was reduced. Previous studies (see the papers by Gordon and King, Fischer, Howitt, Okun, and Scarth) find that GNP must fall 5 percent or more to reduce inflation by 1 percentage point. However, this evidence isn't necessarily relevant to evaluating the response of the economy to a gradual disinflation, since previous reductions in inflation have generally come only during recessions. It is possible theoretically to disinflate without causing a recession, at least in most models.

tainty in the estimates of both benefits and costs and suggested that additional research was needed to provide more precise estimates. In a 1982 study, Robert Gordon and Stephen King of Northwestern University found that, in a Keynesian model, reducing the inflation rate by 5 percentage points had a total cost of 29 percent of one year's GNP. However, a nonstructural (neither Keynesian nor Classical) model studied in 1985 by Craig Hakkio and Bryon Higgins of the Federal Reserve Bank of Kansas City showed that the long-run benefits of reducing inflation greatly exceeded the short-run costs. Their results suggested that the growth rate of potential GNP is significantly higher at lower levels of inflation.

Because these studies were all done some time ago, we need to update them to see if recent history might have changed their results. We attempt to do this by empirically estimating the costs of disinflation in four small macroeconomic forecasting models:[10] (1) a New Classical model, in which rational expectations play a dominant role in determining the costs of disinflation; (2) a Monetarist model, in which money growth is the key determinant of inflation; (3) a Keynesian model, in which slack in the economy is needed to reduce inflation; and (4) a hybrid model called PSTAR+ that combines the Monetarist notion that money growth determines inflation with the Keynesian idea that changes in interest rates may affect real output. All of the models are small, consisting of just three or four equations to determine output growth, inflation, and one or two other variables (such as monetary velocity, interest rates, energy prices, or money growth).

This study uses forecasting models because this is a policy-evaluation exercise, one in which the Fed must plan a path for monetary policy that will bring about disinflation and make forecasts of major macroeconomic variables along the path.[11] First, we estimate each of the models over the period 1959 to 1990.[12] Second, we form two forecasts for the next 10 years for each model.[13] One forecast is based on policy designed to maintain inflation at about its current level; the other is designed to reduce inflation significantly, but without reducing real GNP growth below 1 percent at any time. To calculate the costs of disinflation, we add up the (discounted) differences over time between the two forecasts in terms of real GNP.[14]

The PSTAR+ Model. The PSTAR+ (pro-

[10]The exact specifications of the models can be found in my working paper, "The Short-Run Costs of Disinflation." Citations for all the research referred to in this article can be found in the "References" section at the end of this article.

[11]One caveat is in order in performing such an exercise—it is subject to the critique of econometric policy evaluation made by Robert E. Lucas, Jr., of the University of Chicago. The Lucas critique suggests that studies like this may not be fruitful because the type of disinflation we are going to simulate has not occurred before, yet the models are estimated with past data. As a result, estimating the models on past data may yield an overestimate of the costs of a slow, gradual disinflation.

[12]The models are estimated on data ending in the second quarter of 1990. This is done, rather than using more recent data, to keep the recent recession from affecting the results.

[13]The 10-year horizon stretches out the time period somewhat, compared with the 5-year horizon of the Neal Resolution. But spreading disinflation out over a longer time span allows inflation to fall with less risk of a recession.

[14]Note that these costs are just the costs to the economy in terms of lost output for changing from steady, positive inflation to zero inflation. An additional cost of disinflation that we haven't discussed is that the government loses seignorage revenue (which is the profit from printing new money) when inflation is reduced; this revenue must be made up by raising taxes, which distort the economy in different ways. But the amount of lost revenue is small when inflation is as low as 5 percent, so the size of this cost is negligible.

In addition, the models used to determine the costs of disinflation are not complete enough to capture the benefits of disinflation through the channels described earlier in the paper. The benefits of disinflation come from reducing

nounced P-Star-plus) model is a small macro model developed by Herb Taylor at the Federal Reserve Bank of Philadelphia. It is based on the P* model developed in 1989 by Jeffrey Hallman, Richard Porter, and David Small, all then of the staff of the Board of Governors of the Federal Reserve System, and it incorporates the interest-rate spread approach of Bob Laurent of the Federal Reserve Bank of Chicago. The P* analysis predicts future inflation using the Monetarist theory that the price level is proportional to the money supply in the long run. Laurent finds that the spread between the federal funds rate and a long-bond rate is closely related to subsequent GNP growth. This is a Keynesian idea because interest rates affect the economy's output in the short run.

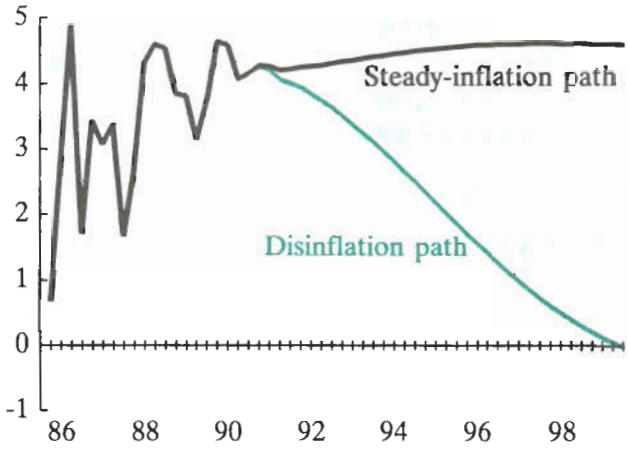
To develop a complete macroeconomic model that combines these two approaches, Taylor adds some equations that specify other features of the economy—money growth depends on changes in short-term interest rates, and the nominal long-run interest rate moves toward the value of a fixed real rate plus an inflation premium. The model uses the federal funds rate as the tool of monetary policy; to disinflate, the Fed needs to find the optimal path over time for the federal funds rate.

In the PSTAR+ model, the disinflation path is obtained by increasing the federal funds rate, thus reducing money growth and putting downward pressure on the inflation rate. This pressure is maintained until inflation is eliminated. As inflation declines, the federal funds rate declines as well, so the rise in nominal interest rates is only temporary. The results of simulating the model are shown in Figure 1. On the

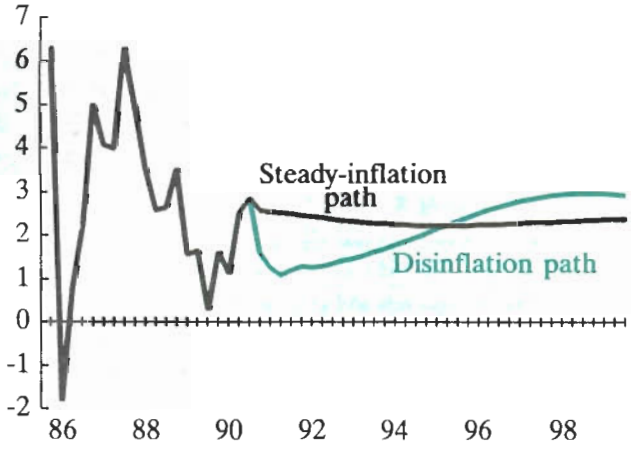
FIGURE 1

PSTAR+ Model Results

Inflation Rate



Real GNP Growth Rate



distortions to the economy, which improves people's well being, but doesn't necessarily raise output in the economy. Consequently, we have dealt with the benefits separately from the costs.

steady-inflation path, inflation is maintained at about 4.5 percent. Along the disinflation path, however, inflation is gradually reduced to zero over the 10-year horizon. The disinflation process drives the real GNP growth rate down below 2 percent per year for several years. The GNP gap between the two paths looks substantial, but it is never more than 4 percent of GNP and it is eventually closed. Disinflation has no permanent effect on real GNP.

To measure the total cost of disinflation, we add up the quarterly differences between real GNP on the steady-inflation path and real GNP on the disinflation path, discounted at the long-term real interest rate, which is estimated to be 4 percent. From 1990 to 1999, these differences amount to about 22 percent of 1990 GNP. According to the PSTAR+ model, the benefits of lowering the inflation rate permanently from 4.5 percent to 0 percent must be valued at 22 percent of 1990 GNP or more for disinflation to be worthwhile.

The Monetarist Model. For a prototype Monetarist model, we use a variant of the model developed by John Tatom of the Federal Reserve Bank of St. Louis. His model is based on the well-known St. Louis model of Leonall Andersen and Jerry Jordan but differs by taking account of energy price shocks. While the shifts in M1 velocity of the early 1980s sharply reduced the predictive power of the St. Louis model, Tatom's model has performed somewhat better. In fact, it was found to be superior to many other small macro models (including the St. Louis model, some rational-expectations models, and some Phillips-curve-based Keynesian models) at a forecasting conference in 1982.[15]

The core of the model consists of two equations that determine nominal GNP growth and inflation. Nominal GNP growth is determined by money growth, government expenditure growth, and changes in the relative price of energy. The inflation rate depends on money growth and on changes in the relative price of energy. In this model, the measure of the money supply M1 is the tool of monetary policy, so the Fed disinflates by slowing down the growth of M1.

The results of slowing down money growth in this model are shown in Figure 2. Along the steady-inflation path, inflation is constant at just over 3 percent,[16] while real GNP settles down to a long-run growth rate of about 3.75 percent. But on the disinflation path, inflation gradually decelerates to near zero, while the benefits of disinflation show up as a higher growth rate of real GNP, which rises to nearly 5 percent. In this model, lower inflation actually raises real GNP growth.

The costs of disinflation here are very low: real GNP on the disinflation path is never less than 1 percent lower than real GNP on the steady-inflation path. Since disinflation does affect the long-run growth rate of real GNP in this model, there are benefits to disinflation that are quite high: a permanent rise of 1.25 percent in the GNP growth rate. So this model is quite favorable to disinflation. Discounted real GNP is higher on the disinflation path than on the steady-inflation path, so disinflation pays for itself.[17] In addition, since the growth

[15]See the results in the 1983 paper edited by Laurence Meyer.

[16]On the steady-inflation path, inflation in the Monetarist model is 3 percent, and in the PSTAR+ model it's 4.5 percent because the Monetarist model implies that the Fed's actions to reduce money-supply growth over the past few years have already put into place some future disinflation.

[17]Technically, this is because real GNP growth is not explicitly modeled. There are separate equations determining nominal GNP growth and inflation; real GNP growth is computed by subtracting the inflation rate from the nominal GNP growth rate. Estimation of the model yields the result that inflation is affected more than nominal GNP growth by changes in money growth. Thus, a reduction in money growth leads to an increase in real GNP growth.

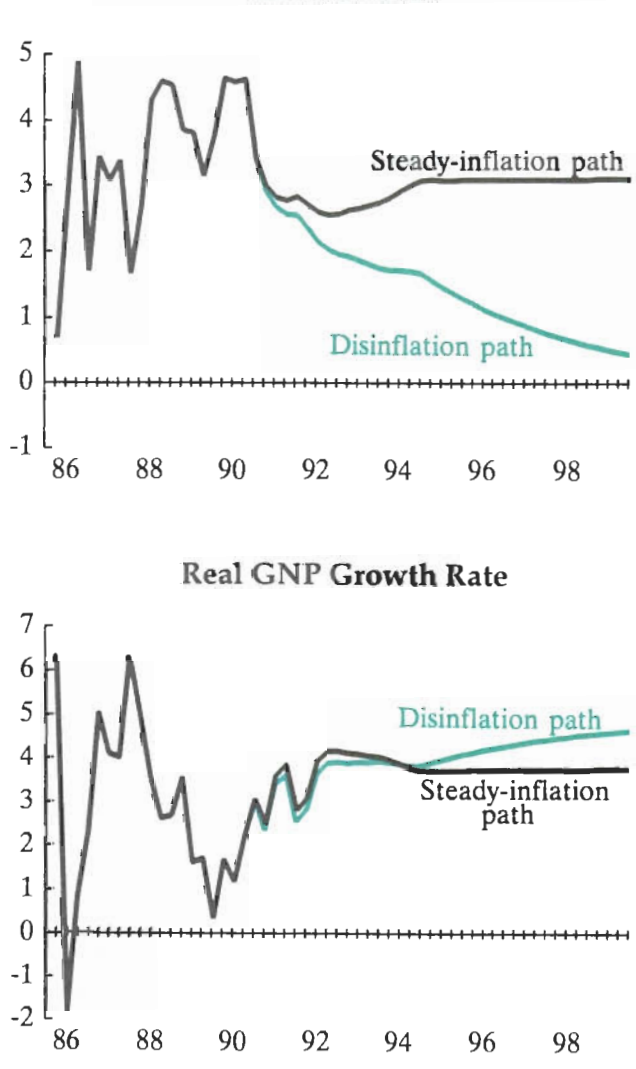
rate of real GNP is permanently higher on the disinflation path, and since it is greater than the long-term real interest rate of 4 percent, it is worth bearing any finite cost to achieve this permanently higher GNP growth rate.

The New Classical Model. Robert Barro, now at Harvard University, developed a model for testing rational-expectations hypotheses in the 1970s. He hypothesized that only unexpected changes in money growth would have an effect on real variables. Expected money growth would affect nominal variables only; inflation simply rises by the same amount as expected money growth. Barro tested and could not reject the hypothesis using both annual and quarterly data.

We base our prototype New Classical model on the 1980 version of the model used by Barro and Mark Rush, who were then at the University of Rochester. The model's main equation forecasts money growth. The unexpected money growth variable is calculated from that equation as the difference between predicted and actual money growth. Real GNP growth depends on unexpected money growth; if money growth is unexpectedly high, then real GNP growth increases. Inflation depends partly on unexpected money growth, but it rises one-for-one with expected money growth in the absence of unexpected changes in money growth. The policy tool used in this model is the M1 growth rate. The model simulations are shown in Figure 3. Along the steady-inflation path, inflation remains at just above 3 percent.[18] But the disinflation path takes advantage of the fact that an-

FIGURE 2

Monetarist Model Results



[18]Again, as in the Monetarist model, the slowdown in money growth over the past few years is reflected in a decline in inflation from 4.5 percent to 3 percent, even with steady monetary policy in the future.

ticipated money shocks don't affect real variables. Money growth is reduced immediately and kept constant thereafter. As a result, inflation drops immediately to zero and stays there. There is no cost in terms of lost GNP of pursuing this policy, as long as the change in monetary policy is credible and expected.

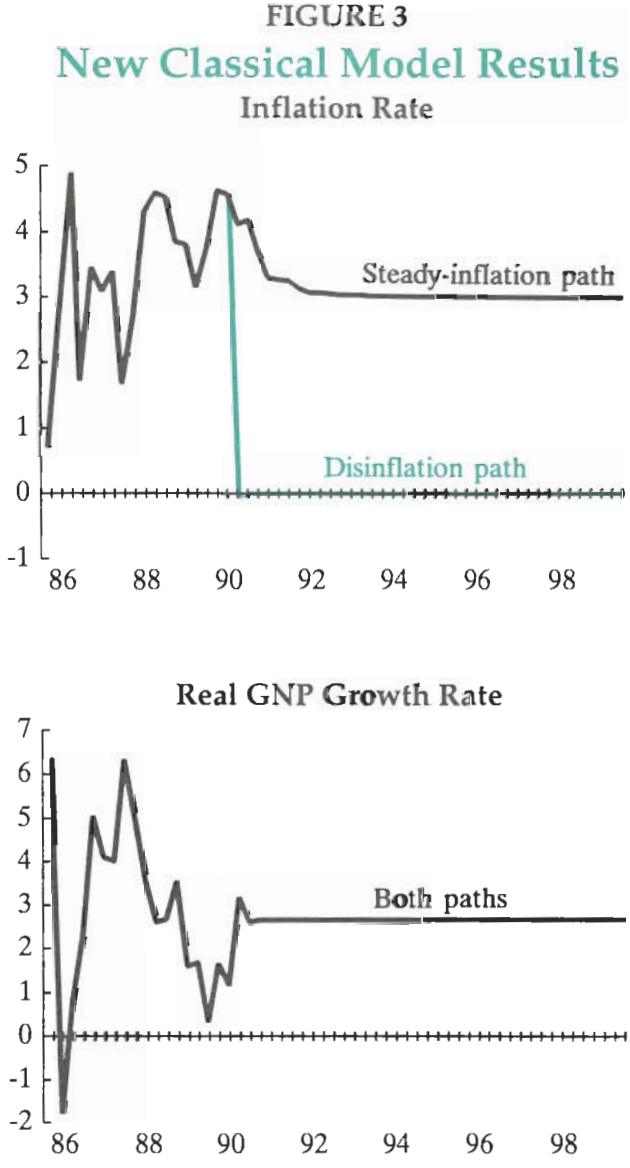
The Keynesian Model. For a prototype Keynesian model, we use a version of the model developed by Ben Friedman of Harvard University. He used the model to examine money's role as an intermediate target of the Fed and to discuss the reasons for interest rates being so high in the early 1980s. In the model, real GNP growth depends on government expenditure growth and on changes in the long-term interest rate and in import prices. Inflation is affected by real GNP growth and by import price changes. Money demand growth is determined by real GNP growth and by the change in the short-term interest rate. And there is a term structure equation relating the long-term interest rate to the short-term interest rate.

The short-term interest rate is the instrument of monetary policy. To cause disinflation, the short-term interest rate must be increased, causing long-term rates to rise and reducing real GNP growth. In this model, the decline in real GNP growth then reduces inflation.

The steady-inflation path has a long-run inflation rate of 4.5 percent, and real GNP grows at just over 3 percent (Figure 4). However, reducing inflation in this model is very difficult because it takes rising interest rates, not just high interest rates, to reduce GNP growth and inflation. On the disinflation path, raising short-term interest rates by 25 basis points each quarter (so that by 1999 the short-term interest rate is over 25 percent) reduces inflation to about 3.6 percent. Real GNP growth must be held below 2 percent

FIGURE 3

New Classical Model Results



permanently to achieve disinflation.[19] The discounted value of the difference in real GNP from 1990 to 1999 is about 43 percent of 1990 GNP. Reducing inflation to zero would cost about five times as much, more than 200 percent of 1990 GNP.

[19]Technically, this results because the only controllable variable that enters the inflation equation is lagged real GNP growth. In this model, even in the long run, there is a direct relationship between inflation and real GNP growth. So a permanent reduction in real GNP growth is required to reduce inflation permanently.

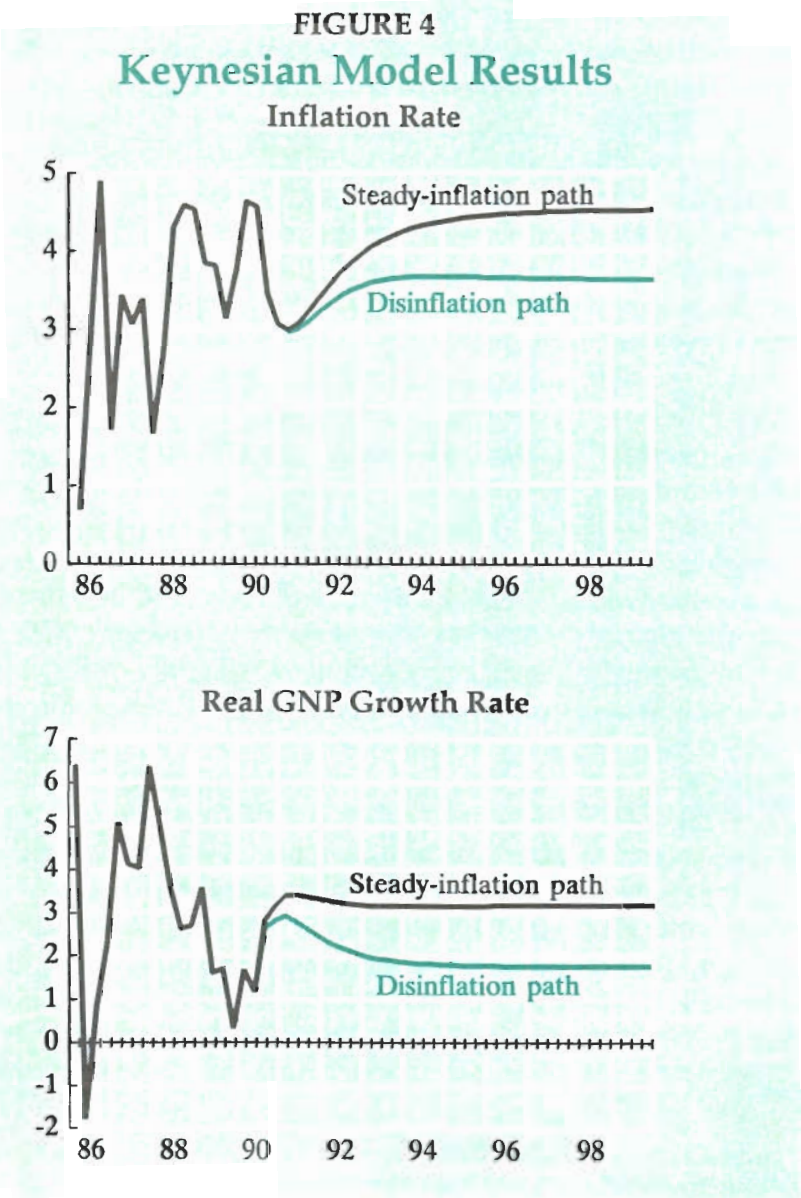
COMPARING COSTS AND BENEFITS

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.

A major difference among the models, which has much to do with why they give very different costs of disinflation, is the theoretical basis for how inflation changes. The Monetarist-type and New-Classical-type models contain inflation equations that allow the inflation rate to be changed immediately with a change in money growth. There is very little inertia to inflation, so the policy prescription is simple: reduce the growth rate of the money supply promptly to reduce inflation. Furthermore, money supply growth can be reduced without major declines in real GNP. In the New-Classical-type model, there's no decline in real GNP at all, as long as the reduction in money supply growth is expected. And in the Monetarist-type model, a gradual reduction in money supply growth has only minor effects on real GNP growth.

FIGURE 4

Keynesian Model Results



At the other extreme is the Keynesian-type model. Its inflation equation contains a lot of inertia, so it takes sustained downward pressure on inflation to move it to a lower level. What's more, money growth can't directly affect inflation in the model; instead, inflation can be reduced only by reducing the growth rate of real GNP permanently. In this model, then, inflation reduction is extremely costly in terms of lost output. However, more recent Keynesian models that incorporate rational expectations and allow for credibility effects would likely show lower costs because such modifications permit faster, smoother adjustments of the economy to a change in monetary policy.

In the middle is the PSTAR+ model. There is a fair amount of inertia in its inflation equation. But inflation can be reduced in the long run by slowing money growth. Reducing money growth raises the federal funds rate, which reduces real GNP growth. The effect on real GNP is larger than in the Monetarist-type and New-Classical-type models but much smaller than in the Keynesian-type model.

How do the costs compare with the benefits? We guessed earlier that the benefits of reducing inflation from 5 percent to 0 percent were about 24 to 48 percent of 1990 GNP, although this is an imprecise estimate. This range of estimated benefits is obviously larger than the cost of disinflation in the Monetarist-type model (a negative cost) and the New-Classical-type model (zero cost). For the PSTAR+ model we found the costs of reducing inflation from 4.5 percent to 0 percent were 22 percent of 1990 GNP, so the costs of reducing inflation from 5 percent to 0 percent are likely to be about 25 percent of 1990 GNP. This is at the lower end of the range of benefits, so the benefits and costs of disinflation are close, but the benefits probably exceed the costs. In contrast, the benefits of disinflation are far lower than the costs in the Keynesian-type model (200 percent of 1990 GNP).

Is there any way for policymakers to decide which model is best? The stagflation of the 1970s showed that many of the Keynesian models used at that time were inadequate, so Monetarist and New Classical models gained more acceptance. These more recent models of the economy have lower or no costs of disinflation. But the changing relationship between money and GNP in the 1980s has led economists to question the usefulness of these models as well. Perhaps hybrid models like the PSTAR+ model, which capture some elements of the competing theories, are more likely to be accepted. Since these models are fairly new, we need to see how they perform over time before we can confidently use them in evaluating monetary policy. Nevertheless, the thrust of economic research after the early 1970s has been on models that have lower costs of disinflation.

One critical issue that remains unresolved and that would help us assess the costs and benefits of disinflation is whether inflation affects the growth rate of the economy. If it does, then the Monetarist-type model is the most relevant because only in that model does lower inflation lead to greater economic growth. Furthermore, if lower inflation raises economic growth, the benefits of disinflation are very large and can justify any temporary cost.

Is there any convincing evidence that lower inflation raises the growth rate of GNP? A few studies, including a 1982 study by Peter Jarrett and Jack Selody of the Bank of Canada, as well as the one by Hakkio and Higgins discussed earlier, find that reducing inflation raises real GNP growth. But this result may arise not because inflation and GNP growth are directly related, but because the models were estimated using historical data that included the 1970s, when inflation was high and large oil price shocks reduced productivity and growth. The empirical literature surveyed in a recent article by Robert F. Lucas of the University of Saskatchewan suggests that inflation has *not* substantially affected real GNP growth in many countries over many time periods.

CONCLUSION

Is disinflation worth the price? Determining the costs of disinflation depends on the specific model of the economy one uses. The early econometric models of the economy were of the Keynesian type, in which the costs of disinflation are very large. Those economists who continue to use Keynesian models similar to the one discussed here are unlikely to be convinced that disinflation is worth the price. But more recent models of the economy, along with theoretical developments that suggest the economy can adjust more quickly and smoothly to changes in monetary policy, indicate the costs of disinflation are much lower.

Determining which particular model of the economy is best for both explaining past events and forecasting the future is not easily resolved. Over time, as economists learn more about how the economy works, choosing among the alternative models and their estimated costs of disinflation should become easier. Because more recent models suggest that the costs of disinflation are not nearly as large as previously believed, support for disinflation has been growing.

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