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In This Issue . . .

In the first article of this *Review*, "The Dairy Price Support Program: A Study of Misdirected Economic Incentives," Michael T. Belongia finds that the large and rapidly expanding surplus of dairy products in the United States can be traced directly to the production incentives offered by the dairy price support program. He shows, by applying elementary economic principles, why effective price supports will create surplus production and, moreover, why the surplus will grow over time if limits are not placed on production.

Belongia then applies the same economic principles to recent milk price and production data to evaluate the likely impact of changes in the dairy price support program approved by Congress in 1983. He finds that these changes are likely to have little, if any, effect on current surpluses and will offer no solution to the problem of larger surpluses in the future.

In the second article in this issue, "Does Higher Inflation Lead to More Uncertain Inflation?" A. Steven Holland investigates the relationship between the rate of inflation and the level of inflation uncertainty. He cites evidence from previous studies of this relationship and discusses the theoretical arguments concerning the likely consequences of greater inflation uncertainty on the economy.

Holland demonstrates that the results from empirical tests of the hypothesis that higher inflation leads to more uncertainty about future inflation are sensitive both to the measure of inflation uncertainty used and to the inclusion of energy shocks into the analysis. He finds that, if individuals incorporate the impact of energy shocks in their predictions of future inflation, there is no significant link between inflation and inflation uncertainty. On the other hand, using measures of inflation uncertainty derived from the Livingston survey of inflation expectations, he finds a positive relationship between the rate of inflation and inflation uncertainty even if the positive impact of energy shocks on inflation uncertainty are included in the analysis.

Holland argues that the latter result is more likely to reflect the actual relationship between the rate of inflation and inflation uncertainty. Thus, he concludes, the reduction of inflation uncertainty is an important, albeit often overlooked, benefit of anti-inflation policies.

In the third article, "Calculating the Adjusted Monetary Base under Contemporaneous Reserve Requirements," R. Alton Gilbert describes how the method of calculating this Bank's adjusted monetary base is modified to reflect the timing of reserve accounting under contemporaneous reserve requirements. One important result of the change is that the reserve adjustment magnitude (RAM), the component of the adjusted monetary base that measures the effects of changes in reserve requirements, must be estimated for the most recent weekly observations. The adjusted monetary base for the most recent one or two weeks, therefore, will be preliminary. Past data indicate that errors in estimating RAM will be small.

The adjusted reserves series will no longer be published on a weekly basis, because of a change in the timing of data on currency in the hands of the public. This Bank, however, will continue to publish adjusted reserves on a monthly average basis.

The Dairy Price Support Program: A Study of Misdirected Economic Incentives

Michael T. Belongia

THE dairy price support program is likely to be the focal point of agricultural policy in 1984. Dramatic increases in the program's cost have made it a visible target for politicians concerned about federal budget deficits. Consumer groups, who favor lower dairy prices, also are opposed to the current program. Livestock producers, however, opposed recent changes in the dairy program, fearing that such efforts to reduce surplus dairy production will promote a significant slaughter of dairy cows that will keep beef prices at low levels. These groups and their opposition to the dairy program were confronted, as usual, by a politically powerful dairy lobby.[1]

This article first reviews the history and mechanics of the dairy price support program. Elementary economic principles show why the dairy program has generated an increasing volume of dairy surplus by effectively maintaining milk prices above the competitive market level. The program's guarantee to purchase all surplus product at the support price is shown to produce an inefficient allocation of resources and a transfer of wealth to dairy producers and suppliers of production inputs. The analysis also demonstrates why a lower support price would reduce both surplus production and the prices of dairy products without large increases in the program's cost. The article's final section evaluates the likely effects of the compromise dairy legislation, passed by Congress and signed by the President last November, that provides for direct payments to farmers for reducing output.[2]

THE DAIRY PROGRAM: A BRIEF HISTORY

For many years, milk prices have been supported, both directly and indirectly, by a variety of government initiatives.[3] In 1922, the Capper-Volstead Act effectively exempted dairy cooperatives from antitrust actions, thereby allowing producer organizations to restrict output, charge higher prices for milk and earn monopoly profits. Later, in 1935, amendments to the Agricultural Adjustment Act established marketing orders that set minimum prices for milk; the USDA was charged with enforcing the payment of established minimum prices to farmers.

Since 1949, the federal government has supported the price of milk directly by guaranteeing to purchase all milk that cannot be sold in the market at the federally established support price ($12.60 per hundredweight (cwt.) currently; $13.10 prior to last November). The price of milk is maintained by Commodity Credit Corporation (CCC) purchases of manufactured dairy products from dairy processors. The CCC actually

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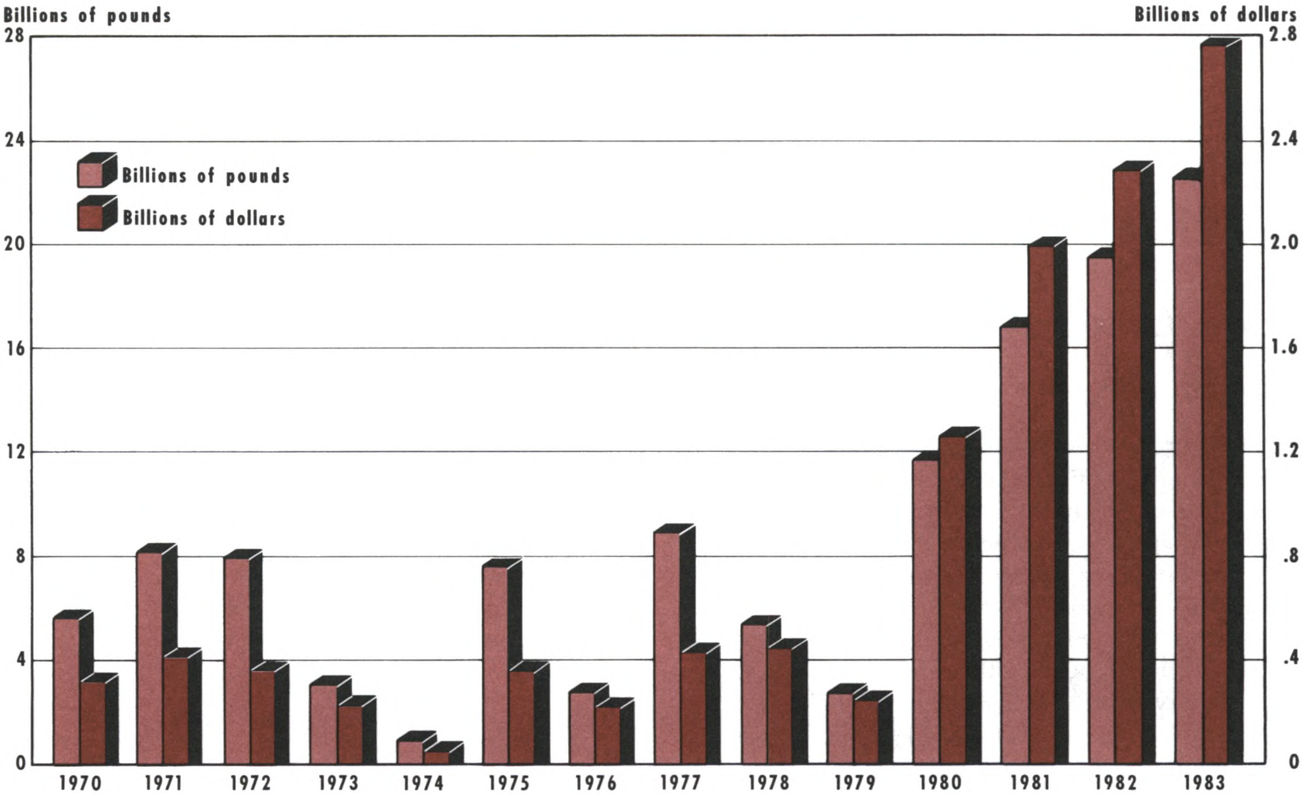
[1]Since January 1, 1981, the dairy lobby has contributed over $1.3 million to 293 members of the House of Representatives. Two-thirds of these officials voted against reductions in dairy price supports. Moreover, much of legislative support for the dairy program — which raises the cost of dairy products to consumers — comes from congressmen who, for all practical purposes, have no dairy farmers in their districts. For example, in the 1982 election, the dairy lobby contributed to 117 congressmen from districts with less than 1 percent of their populations engaged in farming. Seventy-two of these congressmen voted against reductions in price supports. See Jackson and Birnbaum (1983).

[2]For general details on provisions of the legislation, see King (1983a).

[3]The dairy program is discussed in detail in Manchester (1983). Donahue (1983) and Malcolm (1983) provide brief surveys of the dairy program and its history.

Chart 1

CCC Purchase of Dairy Products: Butter, Cheese and Dry Milk [1]



[1] Data for fiscal year 1983 are preliminary.

processed milk products: butter, cheese and nonfat dry milk. Prices also are supported indirectly by food stamps, import restrictions on foreign dairy products, and government purchases of milk for use in the National School Lunch Program. To support milk prices at the pre-November level, the CCC has purchased more than 10 percent of all milk marketed by farmers in recent years.

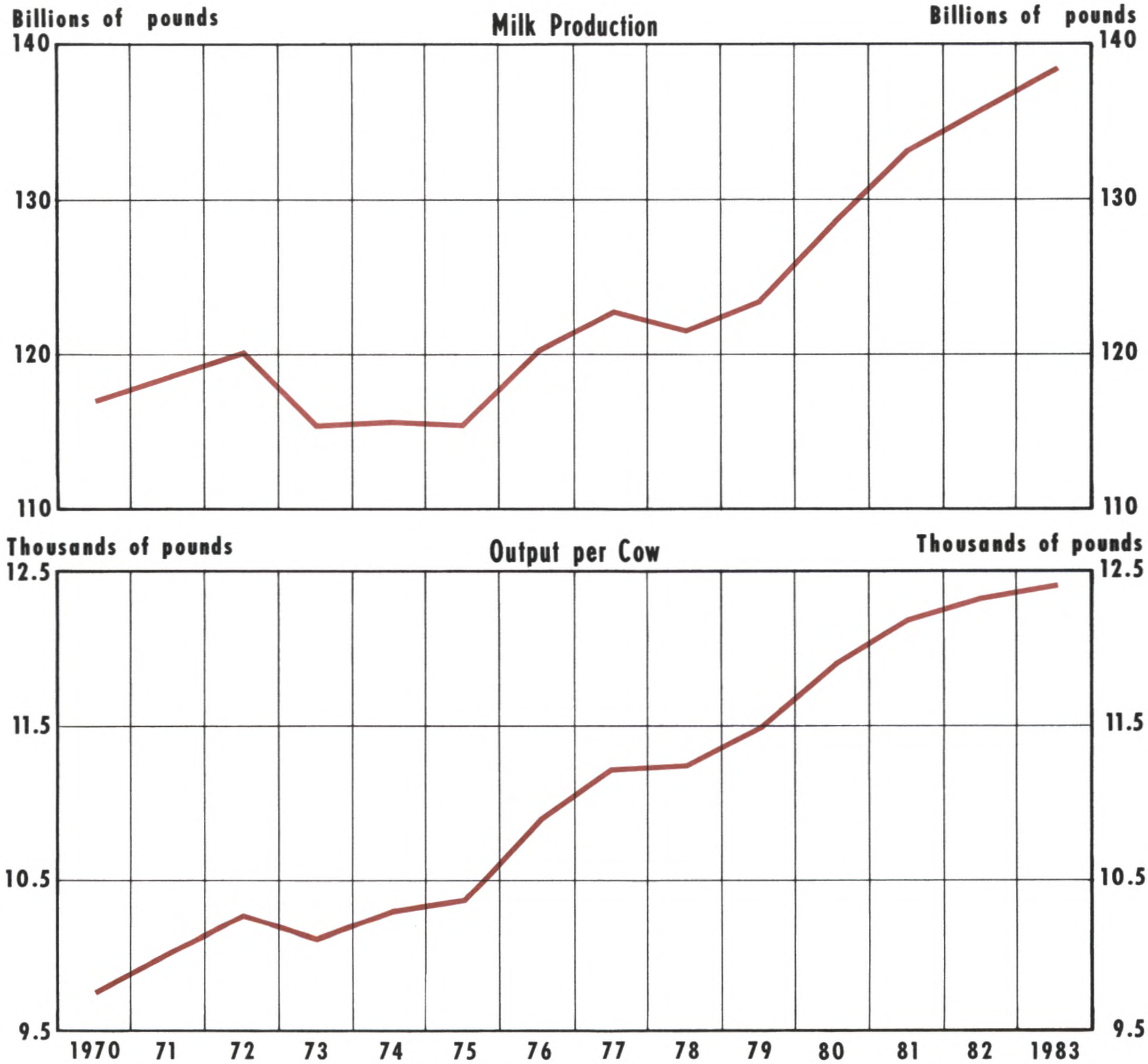
At the previous support price of $13.10 per cwt., the volume of CCC purchases of surplus dairy product grew rapidly since 1979.[4] In the fiscal years 1977–79, net CCC expenditures on the dairy program averaged less than $500 million annually.[5] As the data in chart 1 indicate, this expenditure more than tripled to an average cost of more than $1.8 billion for fiscal years 1980–82. In the fiscal year ending September 30, 1983, CCC outlays for the purchase and storage of surplus dairy product exceeded $2.7 billion.[6] These rapid increases

[4]Previous legislation had mandated an adjustment in the support level each April and October such that the new support price represented 80 percent of parity. The last such increase, which raised the support level to $13.10/cwt., occurred in April 1981.

[5]This average expenditure, however, includes only *direct* government outlays for the purchase and storage of surplus product. Several studies have attempted to measure the additional social loss associated with the higher prices paid by consumers for the smaller volume of dairy products they consume. Although these studies are somewhat dated, the indirect social cost of the dairy price support program in the early 1970s was estimated to average nearly an additional $100 million per year. In other words, the direct cost of the dairy program represented, on average, about half of its full social cost. Since large increases in the volume of surplus product purchased in recent years implies that the gap between the support price and competitive market price has widened substantially, the indirect social cost of the program may now be considerably larger. See Heien (1977), Ippolito and Masson (1978), and Dahlgran (1980) for details on the derivation of the social cost estimates.

[6]The United States is not alone in trying to curb large increases in the costs of price support programs. See Tangermann (1983), for example, on the structure and cost of the European Economic Community's dairy price support program.

Chart 2
Trends in Milk Production



occurred, in part, because the dairy program — unlike the price support programs of other commodities — places virtually no restrictions on the volume of milk that a dairy farmer can market at the support price.

The cost of the program increased, of course, because the program's incentives caused output to grow at a faster rate than the demand for dairy products. As the data plotted in chart 2 indicate, milk production increased at a 1.3 percent annual rate since 1970. Aside from the incentive effects of the dairy program, this steady increase in output also is partially attributable to the 1.9 annual increase in average output per dairy cow. Most important to the present analysis, however, is the much larger 2.7 percent average rate of increase in milk production since 1978.

Figure 1
How Price Supports Produce Surpluses That Grow Larger Over Time

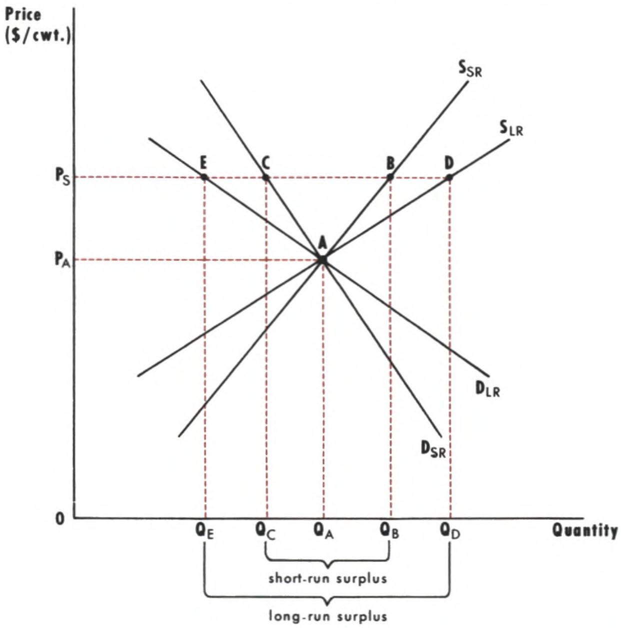
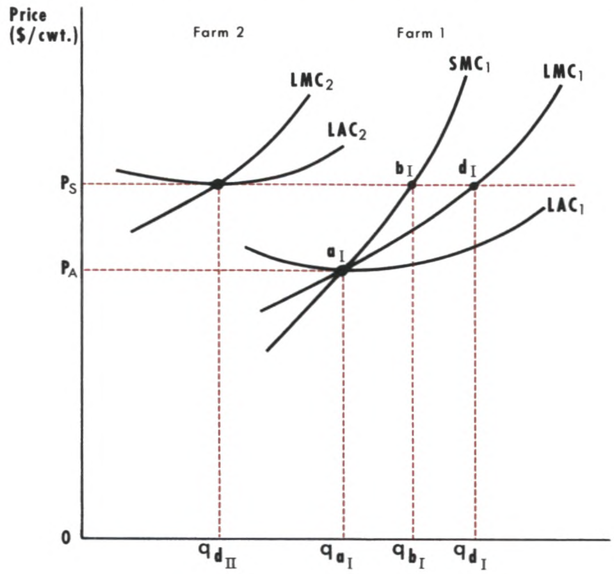


Figure 2
How Price Supports Encourage More Production and More Producers



The most recent version of the dairy program — prior to the adoption of the paid diversion plan last November — supported the price of milk at $13.10 per cwt., but imposed two 50-cent-per-cwt. fees. The first 50-cent fee was collected on all milk marketed, effectively lowering the 1983 support price to about $12.60 per cwt. The second 50-cent fee was to be collected only if CCC purchases of surplus product were expected to exceed 7.5 billion pounds (milk equivalent); this second fee was to be refunded, however, to producers who reduced their production to specified levels. Since this program was not in effect long enough for the second assessment to be binding, the analyses that follow deal in terms of only one 50-cent deduction.

THE SIMPLE ECONOMICS OF DAIRY PRICE SUPPORTS

To illustrate how the existence of a price support program affects the dairy market, consider the model of the dairy market shown in figure 1. Without a support price, the long-run market equilibrium for milk would be at point A where, at the competitive price P_A, the quantity of milk supplied to the market by milk producers (Q_A) is equal to the quantity demanded by consumers (Q_A). At P_A, where the market supply and demand schedules intersect, there is neither a surplus nor a shortage of milk. Since the quantity of milk brought to the market by producers at that price exactly satisfies consumer demand, there are no incentives for either producers or consumers to change their rates of production or consumption.

If the support price is above P_A, both consumers and producers will modify their behavior in predictable fashion. A price support like that represented by P_S guarantees producers a higher return for their output than they would otherwise have obtained. In the short run, this higher return will provide an incentive for dairy farmers to increase output to point B. At the higher market prices, however, consumers will reduce their milk consumption until they reach point C. The net result of the increased production and reduced consumption produces a short-run milk surplus, in this instance equal to the difference between the quantities supplied and demanded at P_S ($Q_B - Q_C$).

SHORT-RUN AND LONG-RUN CONSEQUENCES OF MILK PRICE SUPPORTS

Figure 2 shows why these changes in the dairy market occur by focusing on the revenue and cost curves of a representative dairy farmer. In the absence of a support price for milk, the representative producer (Farm I) would produce q_{aI} units of milk at the competitive price of P_A. At this level of output, both his short-run and long-run marginal costs (SMC and LMC) of increasing output by one unit are exactly equal to the price he would receive from selling one more unit. He has no incentive to increase milk production beyond q_{aI}, however, because the marginal cost of doing so exceeds P_A, the price he would receive for the milk. Increasing output beyond q_{aI}, then, would produce a loss equal to the vertical distance between average cost (SAC) and price times the total amount produced.

The stability of the representative producer's equilibrium at a_I is reflected in the market equilibrium at point A in figure 1, where Q_A units would be produced and consumed at the price P_A. Output levels Q_A (for the industry) and q_{aI} for dairy Farm I depict a long-run equilibrium for several reasons. First, because the price received by each producer for his milk is equal to both his marginal and average costs of production, the representative producer is earning only a normal rate of return on his production.[7] The absence of short-run losses or rents indicates that there are no incentives to attract new producers to the industry (e.g., Farm II) or induce existing producers to change their rates of output.

The figure also indicates that the total output produced by all dairy farmers is sold in the market for the price at which the market supply and demand schedules intersect. Until some exogenous factor changes either the price or the position of the curves depicted in figure 1, the representative producer's output and the market price and quantity will remain at their respective long-run equilibrium points.

The introduction of a price support increases the price received by producers and upsets the long-run equilibrium at point A in figure 1. In the short run, farmers engaged in milk production respond by increasing their rates of output until their SMC is equal to the new higher marginal revenue (which is equal to the support price, P_S). Thus, Farm I increases its rate of output to b_I units, which, when added to the increased production of all other current dairy farmers, increases the quantity supplied in the market to Q_B (figure 1). At the higher support price, however, consumers purchase only Q_C units of milk. In the short run, the price support generates a market surplus equal to the difference between quantities supplied and demanded at the support price ($Q_B - Q_C$).

This initial surplus, however, understates the long-run impact of the price support program. The surplus will continue to increase because the maintenance of a support price above average cost introduces *short-run* economic rent equal to the difference between the support price and average cost times the higher level of output produced. This rent gives an incentive to new producers to enter the industry (e.g., Farm II) and to existing producers to increase permanently the size of their capital stock (larger herds, larger barns, etc.).

As new farms begin and existing farms expand production, there will be increased demand for the scarce resources needed to produce milk: dairy cows, feed, equipment, land and the specific skills necessary to be a successful dairy farmer. Increased demand for these inputs eventually will raise the marginal and average costs of producing milk to LMC_I and LAC'_I in figure 2 where, at the new long-run equilibrium position (q_{dI} and q_{dII}), economic profits for each producer in the industry equal zero, just as they did originally. Notice in figure 1, however, that the higher support price at P_S eventually produces a *long-run* surplus of dairy products equal to the difference $Q_D - Q_E$. The surplus is larger in the long-run because supply and demand schedules become more elastic over time.[8]

BENEFICIARIES OF THE DAIRY PROGRAM

Who, then, benefits from the dairy program and who lobbies for its continuation? First, farmers who own dairy operations have benefited from price supports because the values of the specific inputs (including their own specific knowledge) used to produce milk have increased. Without a support program, dairy farming would be less profitable and, consequently, the land, equipment and dairy cows used in milk production would be less valuable.

The suppliers of inputs used in the dairy industry also have benefited from the price support program. The increased demand for their inputs by both old and new dairy farmers tends to raise input prices and permits suppliers of these inputs to earn greater profits

[7]Included in these costs is the capitalized value of the net earnings of the dairy farm; this represents the sale value of the farm and, hence, is a "cost" of staying in the dairy business to the current farmer. See, for example, Stigler (1966).

[8]The absolute value of the slope of a supply or demand schedule is smaller as it becomes more elastic. Demand is more elastic in the long run because substitutes can be found for higher priced dairy products. The long-run supply curve is more elastic than the short-run supply schedule because of the entry of new producers to the industry. It is easy to see, for any level of price supports, that flatter supply and demand curves will increase quantity supplied, reduce quantity demanded and increase the size of the market surplus.

than they would in the absence of a price support program. Thus, not surprisingly, both input suppliers and dairy farmers oppose large reductions in the program's benefits because such reductions would reduce their wealth.

IMPACT OF THE 50-CENT DEDUCTIONS IMPOSED IN 1983

An attempt was made in 1983 to reduce the growing volume of surplus production — caused by behavioral relationships like those in figures 1 and 2 — with the imposition of a 50-cent fee on all milk produced. Although adopted early in 1983, court rulings delayed the actual collection of fees until late in the year. Essentially, the fee amounted to a reduction in the support price.

In terms of figure 3, the 50-cent deduction can be treated as a parallel downward shift in the support price line from \$13.10 to \$12.60 per cwt. From basic economics, we know that a decrease in output price will, ceteris paribus, lead to a decrease in output; producers move down and to the left along their upward-sloping marginal cost curves. Starting from an assumed long-run equilibrium at point A_p, the 50-cent deduction would be expected to move producers toward point B_p as they attempt to equate marginal cost with the new, lower level of marginal revenue (price). The net effect of all producers decreasing output in this manner would be a reduction in quantity supplied to the market, similar to the movement from point B to point A in figure 1. In short, an effective decrease in prices will cause individual producers and, hence, the industry to scale back production to the point where the new support price is equal to marginal cost.

A second effect of a lower support price — through its negative effect on production — would be a reduction in the demand for inputs used in the dairy industry. The reduced input demand would tend to reduce input prices and exert pressure on some inputs to leave dairy production. This market reaction would lower costs and ultimately shift LAC to LAC′ as figure 3 shows. In fact, producers would continue to exit from the dairy industry until LAC′ = SMC′ = \$12.60 for all existing farmers and a new long-run equilibrium exists at point B_p.

Thus, the 50-cent deduction should have promoted a decrease in milk production. The absence of production controls, however, led to the speculation among some analysts that farmers would compensate for the 50-cent deductions by producing more milk even if it meant producing at a loss.[9] The argument supporting this conclusion is that farmers need to generate a minimum level of revenue — or cash-flow — to meet operating expenses. Therefore, if prices are reduced, sufficient cash-flow can be generated only by increasing output. Thus, the argument goes, the deduction plan would cause an *increase* in the dairy surplus rather than a curtailment in its growth.

This reasoning is specious, however, as can be seen from figure 3. If the representative producer's SMC curve is upward sloping, a lower price will be associated with a reduced volume of output as producers move down and to the left along the SMC curve. Therefore, unless the costs facing dairy producers behave contrary to usual relationships, a lower support price should cause reductions in output.[10] The gaps between the predictions of economic theory and producers' actual response to the 50-cent deductions suggest an alternative explanation for the increase in milk production in 1983.

An Alternative Explanation for Increased Output Under Fee Assessment

A more conventional explanation of the increased dairy production in 1983 can be based on a different view of the cost structure facing milk producers. Instead of showing farmers producing at a short-run loss after the 50-cent deduction as in figure 3, available data indicate that the effective support price, even with the deduction, still was greater than LAC. Under these conditions, new and existing producers could continue to earn short-run economic rents by increasing output as they did last year.

The best evidence that a \$12.60/cwt. support level remained above average cost can be found in data on the size of dairy herds. Despite the 50-cent deduction

[9]In recent congressional debate over changes in dairy legislation, comments like the following were common: "Instead of helping to lower the milk supply, the \$1 assessment program . . . has forced too many dairy farmers to increase production in order to keep their cash flow from declining to stay in business." See Albosta (1983).

[10]Aside from the downward-sloping marginal cost argument, one other explanation could explain increased production in response to a lower support price. If the labor of the farm owner is treated explicitly as an input and the owner faces a tradeoff between extra revenue and leisure in his use of free time, it is possible to construct a theoretical preference mapping that would allocate marginal time to the production of extra revenue from increased milk output.

Figure 3
Effects of the Fifty-Cent Deduction Plan

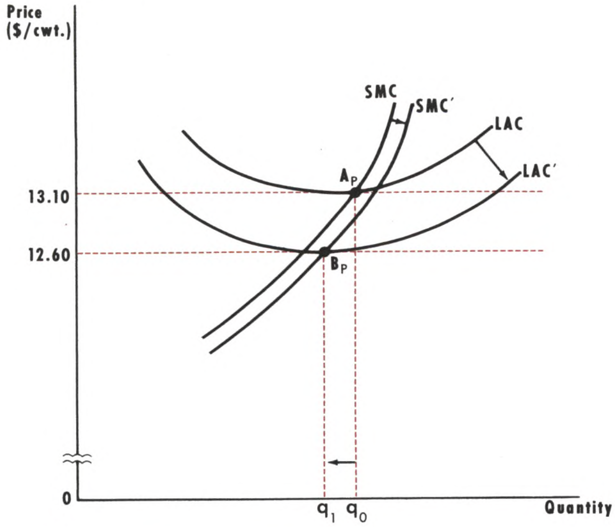
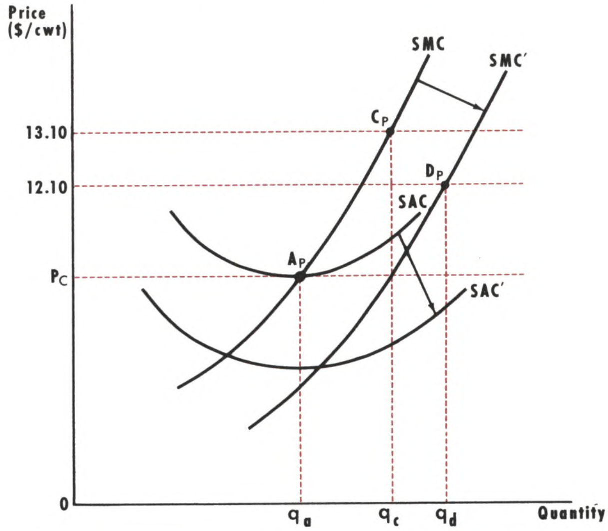


Figure 4
Cost and Production Relationships Suggested by Market Data



and higher feed costs, farmers increased the size of their herds during 1983. Moreover, with a record proportion of replacement heifers, farmers are likely to expand herds even further in 1984. These data suggest that the LAC facing the typical producer still was less than the support price of $12.60; consequently, farmers were finding it profitable to expand production. The data also imply that short-run rents could be earned by dairy producers until the entry of new firms and increased input demand increased the LAC to $12.60.

The production decisions of dairy farmers in recent years appear to be consistent with the relationships shown in figure 4. Historical data suggest that producers responded to higher support prices in 1980 by increasing production from, for example, q_a to q_c in figure 4. Furthermore, good weather and the incentives of the grain price support programs produced large stocks of relatively cheap feed grain. Lower feed prices would shift SMC and SAC downward to positions like SMC′ and SAC′ in figure 4. If these cost shifts have, in fact, occurred, a lower support price of $12.60 still produces short-run economic rents for all dairy farmers operating at point D_P. This explanation suggests that reductions in the support price beyond those achieved by the 50-cent fee are necessary to reduce surplus production. The relationships in figure 4 also suggest that if the support price is not reduced further, surplus production will continue to grow until competition for inputs increases SAC′ to a level that passes through point D_P.

POSSIBLE EFFECTS OF THE PAID DIVERSION PLAN

Efforts to reduce the support price further to $11.60 per cwt. have been defeated in Congress. Instead, compromise legislation that combines the 50-cent fee collection and a lower $12.60 per cwt. support price ($12.10 effective support level) with a plan to pay farmers directly for reducing output has been passed; the payment is $10 per cwt. to farmers who reduce output by up to 30 percent of historical levels. The program is scheduled to be in effect for 15 months beginning January 1, 1984. The bill also contains provisions for further adjustments in the support level — either up or down — in 1985 if the Secretary of Agriculture expects CCC purchases to be less or greater than 5 billion pounds milk equivalent. The analysis that follows considers whether this combination of a lower support price and paid diversion is likely to achieve the desired reductions in surplus dairy production and program costs.[11]

The key elements in plans to pay farmers directly to reduce output are the 1981–82 base used in determining their historical production levels and the net benefits to reducing output. Several existing pieces of data are especially pertinent to this analysis. First, a USDA study has determined that, since this 1981–82 base period, 58 percent of dairy farmers have increased

[11]Much of this analysis is based on Tipton (1983).

output, while 36 percent decreased output.[12] These data imply that individual dairy farms have very different cost structures and that their responses to a diversion payment will vary substantially.

The main consideration is the calculation of net benefits to reducing output. A first approximation of this value is simplified below (all entries are in $/cwt.):

+ $10.00	diversion payment
+ $ 7.00	variable cost saved by reducing output
− $12.60	income lost from milk not sold
≃ 4.40	net benefit of reducing output.

This calculation actually is made more complicated, however, by the unknown costs and benefits of taking resources out of production, then, in 15 months when the diversion program expires, adding them back into production. In other words, a correct assessment of net benefits must be based on a present value calculation that includes the full costs and benefits of participating in the diversion program. These other costs and benefits include — among many others — net revenues from cows slaughtered now, future replacement costs of new cows and the increased long-run efficiency of the herd if older cows are replaced by younger animals. It is not clear, a priori, that the net benefits of the diversion program — crudely estimated above at $4.40/cwt. — still are positive when the present values of expected costs and benefits are taken into account.[13]

Likely Response to Current Diversion Incentives

The response of farmers to the paid diversion might be best analyzed by considering how different groups of dairy farmers have altered their rates of output in recent years. Consider first dairy farmers who have decreased production since the 1982 base year. These farmers voluntarily have reduced output in response to their relatively higher operating costs. By participating in the diversion plan, they will receive payments for output reductions already achieved in 1983 or planned for 1984. Therefore, while these producers have a strong incentive to participate in the diversion plan, it is not clear whether these payments will reduce their production beyond the levels already achieved voluntarily in response to higher operating costs.

In contrast, consider those dairy producers with relatively lower operating costs who have increased output since 1982. To qualify for the diversion payments, these producers would have to reduce output not only below the level planned in 1984, but also below the increased level of 1983. Moreover, because these producers can produce at lower cost, the diversion payments may not be sufficient to offset the lost revenues from output reductions. Therefore, the extent to which dairy farmers who increased production since 1982 will participate in the diversion plan is unknown. Chart 3 shows the break-even points for participating in the diversion plan for farmers who have expanded by different amounts since 1981–82. These data indicate that participation will be less profitable if output has been increased substantially in recent years.

The diversion plan, then, appears to focus on the following issues: relatively efficient producers — nearly 60 percent of the total — are less likely to participate in efforts to reduce output; 6 percent more are not eligible to participate in the program. Less efficient producers — about 35 percent of the total — already have reduced output below the 1982 levels to be used as the historical basis for payments. Therefore, these producers will be paid for output reductions already achieved. Finally, it is unclear that the program's benefits will offset the full costs of adjusting production for a plan scheduled to last only 15 months. The question remaining is whether the incentives to reduce output are sufficient to generate further reductions beyond those realized since 1982.

One Study's Results

One analyst has investigated and produced estimates of the diversion program's likely effects in 1984.[14] Under certain assumptions about participation in the program by different classes of producer, the plan would show an intended reduction of 15 billion pounds of milk at a taxpayer cost of $1.5 billion (15 billion pounds × $10 per cwt.). Because 5.5 billion pounds of this reduction are likely to have already occurred, however, the diversion plan will pay $1.5 billion for the 9.5 (15.0 − 5.5) billion pound reduction in output attributable to the program itself.

This reduction in output would be offset somewhat, however, by the continuing increase in production by the more efficient producers. After estimating further

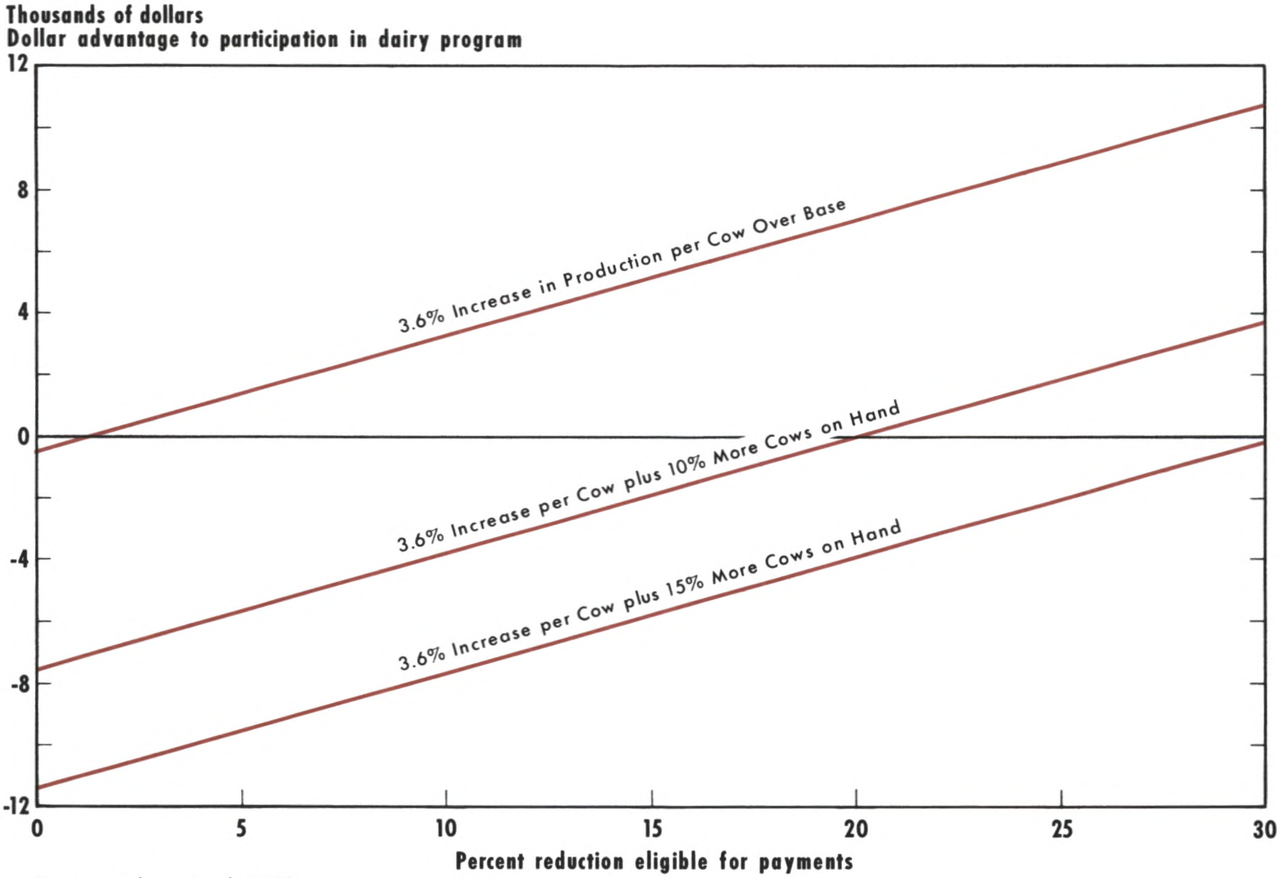
[12] The remaining 6 percent of farms were formed after 1982 and would not qualify for the diversion program.

[13] Just prior to publication of this article, the USDA announced that only 12 percent of U.S. dairy farmers agreed to participate in the diversion program. This low rate of participation is expected to reduce dairy production by no more than 6 percent, about one-half the production cutback sought by the legislation. A significant cost factor cited by farmers who elected not to participate in the program was the deterioration of their breeding stock's genetic pool that would result from selling some cows to reduce production for just 15 months. See King (1984) and Shipp (1984).

[14] Tipton.

Chart 3

Returns from Participating at Different Levels in the Dairy Diversion Program [1]



Source: Feltes, et al. (1983)

[1] Returns are calculated for a 50-cow herd with a 14,000-pound production average.

effects from projected increases in dairy product demand and revenues collected from the 50-cent fee assessment, the diversion plan was projected to have the following impacts next year:

- Seven billion pounds of surplus dairy products would be produced;
- The surplus product would cost $1.2 billion to purchase and store;
- The diversion payments would cost $1.5 billion; and
- $650 million would be collected from the 50-cent fee assessments.[15]

Under these assumptions, the net cost of the dairy program in 1984 (in billions of dollars) is estimated to be:

$$\$1.20 + \$1.50 - \$.65 \simeq \$2.00$$

[15]The proposed legislation also intends to reduce the surplus by increasing domestic demand for dairy products. This is to be achieved through increased advertising expenditures paid for with fees assessed on dairy producers. Planned expenditures of $200 million per year for dairy advertising would be a 250 percent increase over 1982's advertising expenditures.

This figure is about double the Office of Management and Budget estimates of the cost of a dairy program based solely on a reduction in the support price to $11.60.[16] The OMB also estimates that the program will increase the cost of dairy products to consumers by $1.8 billion.[17] Furthermore, the diversion payments are expected to have little effect on the long-run surplus problem because the oldest and least productive cows will be slaughtered.[18] This will leave the dairy herd younger and more productive when the program and its payments end early in 1985.

CONCLUSIONS

The foregoing analysis suggests several important conclusions about the dairy price support program. First, a price support program without production controls will generate increasing surpluses and program costs. Second, the dairy price support — at least since 1980 — has been kept substantially above what would have otherwise been a competitive market price. This has caused an inefficient allocation of resources (too many resources allocated to dairy production) and transferred wealth from consumers and taxpayers, in general, to dairy producers and suppliers of inputs to the dairy industry. Third, efforts to reduce surplus production by paying farmers not to produce are likely to have little impact on surplus production, particularly in the long run, but will keep program costs near their current levels. Finally, the only effective way to reduce surplus dairy production is to reduce the support price further. Congress already has defeated a proposal to reduce the dairy price support level and has passed instead a plan to pay farmers directly for reducing output. Under these conditions, consumers can expect to pay higher prices for dairy products, while taxpayers can expect further increases in the costs of this program.

[16]Jackson and Birnbaum.

[17]King (1983b).

[18]More to the point, any reduction in output achieved through smaller numbers of dairy cows will be short-lived because output increases have come primarily from greater productivity per animal. This point is highlighted by comparing the 1.6 percent increase in the number of dairy cows between 1980 and 1983 to the 5.1 percent increase in average output per cow (from 11,889 lbs. to about 12,400 lbs. per year) over the same period.

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Does Higher Inflation Lead to More Uncertain Inflation?

A. Steven Holland

IN recent years, many countries have experienced "stagflation," a period of high and rising inflation and unemployment. Over this time, higher inflation increasingly has come to be blamed for higher unemployment and reduced growth of real output. This contrasts sharply with previously held notions that there was either a long-run tradeoff between inflation and unemployment or a "natural rate of unemployment" regardless of the inflation rate.

One reason why many people have changed their minds about inflation's impact on the economy is the presumed impact of "inflation uncertainty." Many now argue that there is greater uncertainty about future prices during periods of higher inflation.[1] This increased uncertainty leads to a less efficient allocation of resources.

The best-known statement of this view came from Milton Friedman in his Nobel Lecture. Briefly stated, Friedman argued that greater inflation uncertainty shortens the average duration of contracts and reduces the efficiency of the price system. These two forces combine to lower the growth rate of real output and potentially increase the rate of unemployment.[2] Thus, if reducing inflation produces sufficiently larger output growth and lower unemployment in the long run, it is a worthwhile venture, even if doing so would produce a large short-term loss of output and rise in unemployment.[3] While Friedman's discussion primarily concerns the variability of inflation — not necessarily identical to the notion of inflation uncertainty — it is clear that he considers them to be closely related.

This argument can be split into three separate hypotheses: (1) higher inflation leads to greater variability of inflation; (2) greater inflation variability implies greater uncertainty about future inflation; and (3) greater inflation uncertainty has a detrimental effect on economic activity. For policymakers to be concerned about the relevance of hypothesis 3, they must believe that they can influence the level of inflation uncertainty. Hypotheses 1 and 2 state that they can do this by controlling the rate of inflation. If exogenous factors, such as energy shocks, are primarily responsible for greater inflation uncertainty, then policymakers can do little to affect it.

This article focuses on the validity of the first two hypotheses, which together imply that higher inflation leads to greater inflation uncertainty. Besides analyzing the causes of inflation uncertainty, an assessment of its potential effects is presented as well.

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[1]Some have suggested that uncertainty begins to increase once the rate of inflation rises above some threshold. For example, see Logue and Willett (1976) and Hafer and Heyne-Hafer (1981).

[2]Friedman (1977). He suggests that the natural rate hypothesis holds for the very long run (a period of decades), because the economy's institutional structure for dealing with inflation eventually will adjust to eliminate the real effects of inflation.

[3]To determine whether the long-term benefits of anti-inflation policies would offset the short-term costs, one must consider the timing of the output effects and the rate at which future output gains are discounted. See Meyer and Rasche (1980).

Since energy shocks have been the single most important factor accounting for temporary price level changes, this article also investigates the impact of changes in the relative price of energy on both the rate of inflation and the level of inflation uncertainty.[4] Energy shocks and inflation uncertainty should be positively associated, because the magnitude and timing of the effects of an energy shock on the rate of inflation are bound to be viewed with uncertainty.

WHAT IS INFLATION UNCERTAINTY?

Inflation uncertainty arises from a lack of complete knowledge about how future price levels are determined. Of course, an individual typically will have enough information to make some forecast of future inflation rates. A given estimate of next period's inflation can be thought of as the mean of some underlying probability distribution.

The forecaster's inflation uncertainty may be estimated by looking at the size of some specified confidence interval for his forecast. For example, a person may have predicted at the end of 1982 that 1983 inflation had a 90 percent probability of being between 3 percent and 5 percent. If the same individual's 90 percent confidence interval for 1984 inflation (forecast at the end of 1983) is wider, say 4 percent to 7 percent, then his uncertainty about 1984 inflation is greater than it was for 1983 inflation.

The analysis presented here deals with inflation uncertainty for a representative individual. Though the level of an individual's uncertainty about inflation is not directly observable, ways of estimating it have been suggested in the literature. One of these is to use the variance or standard deviation of the errors made in forecasting inflation. A forecaster is trying to predict the outcome of a process that has both systematic and random components. With an unbiased forecast of the inflation rate, the variance of the forecast errors indicates the importance of the random component and can be considered an estimate of the level of inflation uncertainty.[5] An implicit assumption in this type of analysis is that the variance need not be constant but may vary over time.

[4]See Tatom (1981).

[5]It is the *ex ante*, not the *ex post*, variance of forecast errors that is relevant. Estimates of the latter, however, are commonly used as proxies for inflation uncertainty. See, for example, Klein (1978), Engle (1983), and Pagan, Hall and Trivedi (1983).

WHY DOES INFLATION UNCERTAINTY MATTER?

The real effects of inflation uncertainty arise in part because inflation expectations enter into the contracting process. Any contract that provides for payment in nominal rather than real terms incorporates an expectation of future inflation. If actual inflation ends up higher than was expected when the contract was made, a redistribution of wealth occurs: those making the contracted nominal payments gain and those receiving them lose. If actual inflation is lower than was expected, the opposite wealth redistribution occurs.

When there is greater inflation uncertainty, risk-averse individuals will attempt to shorten the duration of contracts to reduce the risk of loss caused by deviations of actual from expected inflation. More frequent negotiation of contracts will divert economic resources to the contracting process from other, previously more efficient uses.[6]

As the accompanying insert demonstrates, greater inflation uncertainty increases the risk associated with both saving and investing, since both require a contract of some kind. Individuals faced with greater inflation uncertainty may choose to reduce both their planned savings and investment. The result is likely to be lower long-term real economic growth.

Another potential real effect of inflation uncertainty is reduced efficiency of the price system in allocating resources. The basic idea is this: the more uncertain is inflation, "the harder it becomes to extract the signal about relative prices from the absolute prices."[7] Because individual prices adjust to unexpected inflation at different rates due to the presence of long-term contracts and the costs of adjusting prices, relative prices may be temporarily distorted.[8] They also may be incorrectly perceived, because information does not flow smoothly across markets. As a result, economic efficiency is reduced, producing lower output growth

[6]Indexation of contracts can reduce (though not totally eliminate) the risk associated with contracting, and one would expect indexation to increase as inflation uncertainty increases. For a theoretical analysis of indexation in this context, see Gray (1978). Klein finds evidence that an increase in "long-term price uncertainty" leads to a reduction in the average term to maturity of outstanding corporate debt.

[7]Friedman, p. 467. Again, Friedman's discussion is in terms of inflation variability; if this variability were anticipated, however, adjustments could be made that reduce or eliminate this effect. His discussion of this effect is based on the work of Hayek (1945) and Lucas (1973) among others.

[8]See Bordo (1980) and Sheshinski and Weiss (1977).

How Inflation Uncertainty Creates Greater Risk for Savers and Investors

To see how greater inflation uncertainty affects savings and investment, consider the consequences of an unexpected price level increase for a saver. The expected real rate of return (r^*) on savings can be written:

$$(1) \quad r^* = i - \dot{p}^*,$$

where i is the nominal rate of return (assumed to be constant) and $\dot{p}^*$ is the expected rate of inflation. There is risk to the saver, because the realized real rate of return (r) will only equal the expected real rate if the actual inflation rate ($\dot{p}$) equals the expected inflation rate. The difference between the realized and expected real rates can be written as:

$$(2) \quad r - r^* = -(\dot{p} - \dot{p}^*).$$

Using the variance of the difference between the actual and expected real return as a measure of risk and the variance of inflation forecast errors as an estimate of inflation uncertainty, inflation uncertainty and risk are equated:[1]

$$(3) \quad \text{var}(r - r^*) = \text{var}(\dot{p} - \dot{p}^*).$$

The effect of greater risk on the flow of savings is not clear a priori. The greater risk could reduce the savings of risk-averse individuals and, as a consequence, reduce the actual amount of investment as well. If a person's goal in saving is to assure a given level of real wealth in the future, however, greater risk could actually lead to increased savings.

For investment in physical capital, the analysis is not as straightforward, because the nominal rate of return (i) varies to some degree with the rate of inflation. A deviation of actual from expected inflation does not necessarily indicate that the realized real rate is different from the expected real rate of return. Therefore, the effect of inflation uncertainty on investment risk depends on how the nominal rate of return is expected to respond to a change in the rate of inflation. This response may also be viewed with uncertainty. If investors are risk averse, then risk-increasing inflation uncertainty will reduce investment and lower output growth in the long term.

[1]A similar analysis can be carried out for other types of contracts. For example, if one considers wage contracts, the risk measure is the variance of the actual less the expected real wage.

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and possibly higher unemployment than if all relative prices were correctly perceived.[9]

The notion that greater inflation uncertainty leads to reduced economic growth and higher unemployment has been supported by empirical research. Mullineaux finds some measures of inflation uncertainty to have a negative effect on the growth of industrial production and a positive effect on unemployment; Levi and Makin get similar results for employment growth. Furthermore, Blejer and Liederman find that increased dispersion of relative price changes leads to a significant reduction in real GNP and increased unemployment.[10]

WHY SHOULD HIGHER INFLATION LEAD TO GREATER INFLATION UNCERTAINTY?

The relationship between higher rates of inflation and inflation uncertainty is based more on empirical regularities than on theoretical rationale. Beginning with Okun in 1971, several researchers have found that there are significant positive correlations between rates of inflation and the variability of inflation across countries and across time for a given country. Others

[9]Carlton (1981) discusses in detail the impact of inflation uncertainty on the organization of markets. He concludes that (p. 19):

> . . . in response to inflationary uncertainty, we expect to see fewer contracts with fixed prices for long time-periods, fewer customized goods, greater use of standardized goods sold in a liquid market, a move from outside contracting of customized goods to internal production through vertical integration, and a move from vertical integration to reliance on standard quality goods sold in a liquid market where "the market" price is easy to observe. All of these changes are undesirable from an efficiency standpoint.

[10]See Mullineaux (1980), Levi and Makin (1980), and Blejer and Leiderman (1980). Evans (1983) finds an unstable price level to have a negative effect on real GNP growth, and Able (1980) finds a negative impact of inflation variability on the rate of investment.

have found a positive relationship between inflation variability (or inflation itself) and proxies for inflation uncertainty, the latter including the dispersion of inflation expectations across survey respondents and the variance of estimated inflation forecast errors. The insert on pages 20 and 21 provides a summary of findings from previous studies.

The theoretical rationale centers on the hypothesis that a more inflationary economy produces greater uncertainty about the future direction of government policy, causing greater uncertainty about future inflation. Okun states that the application of fiscal and monetary policies is apt to be less consistent (i.e., predictable) during inflationary times because of the difficulty in reducing inflation without causing unacceptably high rates of unemployment and interest.[11] In a similar vein, Friedman states that:

> A burst of inflation produces strong pressure to counter it. Policy goes from one direction to the other, encouraging wide variation in the actual and anticipated rate of inflation. And, of course, in such an environment, no one has single-valued anticipations. Everyone recognizes that there is great uncertainty about what actual inflation will turn out to be over any specific future interval.[12]

One can argue that an inflationary economy creates an environment in which major policy changes become more likely and the effects of such policy changes become more uncertain. To support this argument, one need only look at some of the policy measures taken or proposed in recent years at least partially in response to an inflationary economy: deregulation of financial institutions, wage and price controls, indexation of income taxes and changes in methods for implementing monetary policy.

INFLATION FORECASTS AND THE VARIANCE OF ERRORS

The discussion above suggests that the variance of errors in forecasting inflation could be used as one measure of inflation uncertainty. If the variance of the forecast errors remains constant over time, so does the level of inflation uncertainty. One way to determine whether inflation uncertainty has changed over time is to test for non-constant variance (i.e., heteroscedasticity) in the residuals from a model of inflation expectations.[13]

Table 1

Two Models of Inflation Expectations: II/1954–III/1983

	(1)	(2)
Intercept	0.108	0.376
	(0.40)	(1.46)
$\dot{p}_{t-1}$	0.285	0.210
	(3.35*)	(2.59*)
$\dot{p}_{t-2}$	0.099	0.100
	(1.17)	(1.26)
$\dot{p}_{t-3}$	0.309	0.261
	(3.92*)	(3.56*)
$\dot{M}_{t-1}$	0.109	0.125
	(2.47*)	(3.05*)
$\dot{M}_{t-2}$	0.023	0.037
	(0.48)	(0.84)
$\dot{M}_{t-3}$	0.022	0.026
	(0.44)	(0.56)
$\dot{M}_{t-4}$	0.102	0.107
	(2.08*)	(2.31*)
$\dot{p}^e_{t-1}$	—	0.017
		(1.43)
$\dot{p}^e_{t-2}$	—	0.039
		(3.10*)
$D1_t$	−1.017	−0.936
	(−1.85*)	(−1.85*)
$D2_t$	2.022	1.189
	(3.98*)	(2.35*)
$\bar{R}^2$	0.770	0.804
SE	1.33	1.23
h	1.46	0.50

t-statistics in parentheses.
*Significant at the 5 percent level (one-tailed test).

First, we need an inflation expectations model that provides unbiased forecasts over both lower and higher inflation periods; we can then test whether the error variance is larger for the higher inflation period. A model obtained by regressing the quarterly growth rate of the GNP deflator ($\dot{p}$) on its own lagged values, lagged values of the growth rate of M1 ($\dot{M}$), and dummy variables for periods of wage-price controls and their aftermath (D1 and D2) is given by equation 1 in table 1.[14] The equation was estimated using data from II/1954–III/

[11] See Okun (1971).

[12] Friedman, p. 466.

[13] This is the approach suggested by Engle (1982) and Pagan, Hall and Trivedi.

[14] All growth rates are expressed in annualized log differences. D1 has a unity value during the control period of III/1971–I/1973 and zero otherwise. D2 represents the period during which controls were being phased out, taking a unity value for the period I/1973–I/1975 and zero otherwise.

Table 2

Tests for Inflation Uncertainty Using Regression Models of Inflation Expectations

(1) $e_t^2 = \underset{(1.80^*)}{0.732} - \underset{(-0.259)}{0.035}\ \dot{p}_{t-1} + \underset{(1.17)}{0.163}\ \dot{p}_{t-2} - \underset{(-1.03)}{0.144}\ \dot{p}_{t-3} + \underset{(1.67^*)}{0.225}\ \dot{p}_{t-4}$

$R^2 = 0.082$ SE = 2.24 DW = 2.13

(2) $e_t^2 = \underset{(2.25^*)}{0.881} - \underset{(-0.42)}{0.055}\ \dot{p}_{t-1} + \underset{(0.942)}{0.127}\ \dot{p}_{t-2} - \underset{(-1.04)}{0.140}\ \dot{p}_{t-3} + \underset{(1.39)}{0.180}\ \dot{p}_{t-4}$

$R^2 = 0.040$ SE = 2.17 DW = 2.00

t-statistics in parentheses.
*Significant at the 5 percent level (one-tailed test).

1983, and the number of lags was chosen using standard t and F tests. When we divide the sample into a lower inflation period, II/1954–IV/1967, and a higher inflation period, I/1968–III/1983, we can reject the hypothesis that the error variance is the same in both periods.[15] As expected, the variance is higher in the period of higher inflation.[16]

Another test of the constancy of the variance of the forecast errors over time is obtained by regressing the squared value of the inflation forecast error for period t (e_t^2) estimated from equation 1 on the variables thought to cause changes in the variance. When four lagged values of the inflation rate are used, the estimated equation yields the results shown in equation 1 in table 2. The results indicate, once again, that inflation affects the variance of forecast errors using this model of expected inflation.[17] The effect over four quarters is both positive (as indicated by the sum of the coefficients of the lagged values of the inflation rate [0.209]) and statistically significant at the 5 percent level.[18]

Relative Energy Price Changes and Expected Inflation

The above result seems to suggest rather strongly that a higher inflation rate is associated with more inflation uncertainty. This conclusion must be carefully viewed, however; the results are quite sensitive to the way in which the model of inflation expectations is specified. In particular, if one considers the possibility that individuals anticipate some impact of a higher relative price of energy on the rate of inflation, then inflation does not affect the variance of the errors. An estimated inflation expectations model that incorporates two lagged values of the change in the relative price of energy is presented in equation 2 of table 1.[19] When the sample was divided into the same lower and higher inflation periods as before (and the impact of energy prices is taken into account), the hypothesis that the error variance is the same in both periods cannot be rejected at the 5 percent level of significance.[20]

Furthermore, as equation 2 in table 2 shows, lagged values of the inflation rate do not affect the squared inflation forecast error estimated from equation 2 in table 1.[21] Therefore, when this inflation expectations model is used, there is no indication that higher inflation is associated with greater inflation uncertainty.

[15]The average quarterly rate of growth of the GNP deflator between II/1954 and IV/1967 was 2.18 with a maximum of 4.57 and a minimum of −0.87; for I/1968–III/1983, the average growth rate of the GNP deflator was 6.31 with a maximum of 11.41 and a minimum of 2.83. The value of the calculated F-statistic ($F_{53,47} = 1.77$) from the Goldfeld-Quandt test is statistically significant at the 5 percent level. For an explanation of this test for heteroscedasticity, see Goldfeld and Quandt (1965).

[16]A Chow test does not indicate that the structure of the model is different for the two periods. The Chow test statistic is $F_{10,98} = 0.705$, far below the level required for statistical significance at the 5 percent level.

[17]The test statistic TR^2 (where T is the number of observations) has a χ^2 distribution with degrees of freedom equal to T minus the number of regressors. This statistic is used to test for heteroscedasticity. In equation 1 in table 2, $TR^2 = 9.62$, which is statistically significant at the 5 percent level. This test is suggested by Engle (1982).

[18]The t-statistic for the sum of the coefficients is 2.59. Additional lagged values of $\dot{p}$ up to a total of 12 had no effect. Lagged values of the rate of inflation are used instead of the current rate, because the rate for period t is not known at the time the forecast is made. This procedure of regressing squared residuals on a set of variables as a test for heteroscedasticity is suggested by Breusch and Pagan (1979).

[19]The relative price of energy is defined as the ratio of the "fuels and related products and power" component of the producer price index (PPI) to the business sector deflator. See Tatom for a slightly different model of the inflation rate itself (rather than expected inflation).

[20]The Goldfeld-Quandt F-statistic is $F_{51,45} = 1.47$.

[21]Neither the value of TR^2 (4.72) nor the sum of the coefficients of lagged inflation (0.112, t = 1.44) are statistically significant at the 5 percent level.

Previous Research on the Relationships among Inflation Rates, Inflation Variability and "Inflation Uncertainty"

Article	Countries Studied	Time Periods	Major Findings
Okun (1971)	17 industrialized OECD countries	1951–1968	High correlation between the average annual percentage increase in the GNP deflator and the standard deviation of annual inflation rates.
Gordon (1971)	same as Okun	1960–1968	Smaller correlation than in Okun. Also, if five relatively small countries are omitted, correlation disappears.
Logue and Willett (1976)	41 industrialized and nonindustrialized countries	1949–1970	Inflation rates of no more than 2–4 percent cause no problem of increased variability of inflation.
Jaffee and Kleiman (1977)	same as Okun United States (survey)	1951–1971 1955–1971 (survey)	(a) Positive correlation across countries between inflation and its variance, though correlation is weak during 1960s. (b) Positive relationship between mean and standard deviation of inflation rates expected in the SRC survey.
Foster (1978)	40 countries	1954–1975	Large correlations between inflation and the average absolute change in inflation.
Cukierman and Wachtel (1979)	United States	1948–1975 1955–1976	Variance of expected inflation across individuals is positively related to variance of actual inflation using both the Livingston and SRC surveys.
Taylor (1981)	7 large industrialized countries	1954–1979	Strong correlation (except during 1960s) between average inflation and its standard deviation, which is at least partially due to association between average inflation and inflationary shocks.
Fischer (1981)	United States	1806–1979 1954–1976 (survey) 1950–1980 (survey) 1948–1980	(a) Positive relationship between inflation and its variability. (b) Variance of expected inflation across individuals is positively associated with actual, expected and unanticipated inflation using the Livingston and SRC surveys. (c) No significant association between the rate of inflation and the variance of residuals from a forecasting equation of the inflation rate.

Frohman, Laney and Willett (1981)	United States	1954–1976	Positive relationship between both actual and expected inflation and the variance of expected inflation across individuals using the Livingston survey.
Hafer and Heyne-Hafer (1981)	same as Logue and Willett, excluding Chile	1970–1979	Inflation and its variability are positively related; may require rates as high as 9 percent.
Pagan, Hall and Trivedi (1983)	Australia	1973–1981 1968–1982	Inflation affects variance of errors in forecasting, as measured by squared estimated forecast errors.
Engle (1983)	United States	1947–1979	Inflation does not affect squared value of estimated forecast errors. Past values of squared forecast errors do.

INDIVIDUAL INFLATION UNCERTAINTY AND THE VARIABILITY OF INFLATION EXPECTATIONS AMONG INDIVIDUALS

The preceding tests illustrate one of the major problems involved in trying to estimate an individual's uncertainty about future inflation: estimates can be sensitive to one's assumptions about the nature of the information used to forecast inflation. In this section, we use a different approach to estimating inflation uncertainty based on very different assumptions about the way individuals form inflation expectations.

In contrast to the models of inflation expectations estimated previously, individuals may use considerably more information to forecast inflation rates than the past growth rates of such aggregates as the price level and money supply. For example, each forecaster may have personal information regarding the historical relationship between the price of a specific product and the general price level. This specialized information is likely to be too costly for all individuals to obtain. If there is greater heterogeneity in the inflation signals that forecasters receive from this type of market-specific information, then greater dispersion of individual inflation forecasts can result. An individual who observes a wider variety of predictions of next period's inflation rate (through published sources, for example) may become more uncertain about the accuracy of his own forecast, especially if he believes that different forecasts are based on information he does not have.[22]

In the analysis to follow, it is assumed that greater dispersion of inflation forecasts among individuals leads to increased inflation uncertainty. Therefore, we use measures based on the variability of responses to the Livingston survey of inflation expectations to further investigate the relationship between inflation and inflation uncertainty.[23]

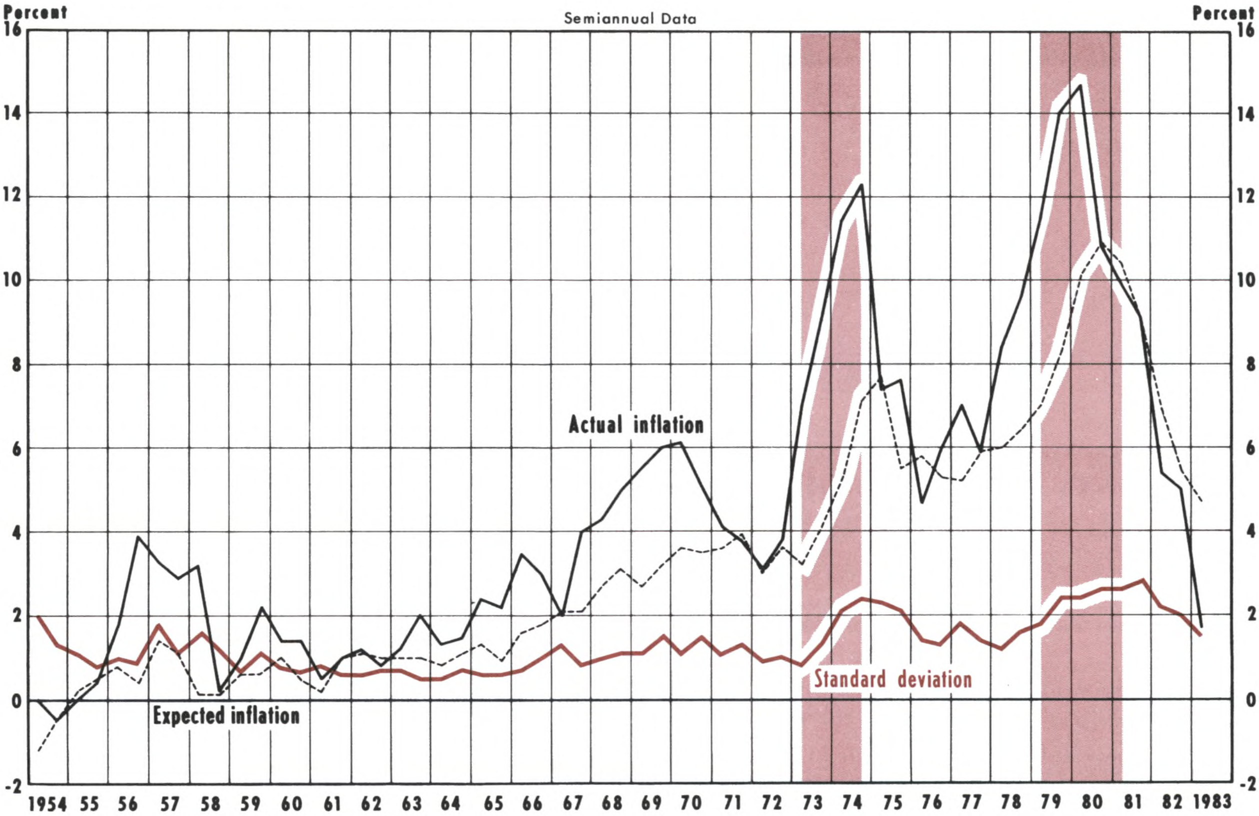
The standard deviation of the individual inflation forecasts from the Livingston survey is the first proxy for inflation uncertainty. Chart 1 shows the actual inflation rate over the forecast period and the mean and standard deviation of six-month inflation forecasts from the first half of 1954 to the first half of 1983. The shaded areas of the chart represent periods of energy shocks.[24] The chart indicates that both energy shocks

[22]This kind of partial information framework is used by Cukierman and Wachtel (1982). There is, however, an alternative explanation for increased variability of individual inflation forecasts: forecasters may all use the same information but in different ways. This would not necessarily imply greater inflation uncertainty for a particular individual since each forecaster could be just as certain as he ever was about the accuracy of his forecast.

[23]Joseph Livingston of *The Philadelphia Inquirer* conducts a survey each spring and fall, requesting respondents to indicate their predictions about a number of economic indicators including the consumer price index (CPI). Because the survey results published, for example, in June contain predictions for the following December, Livingston refers to them as six-month-ahead forecasts as does this article. (The survey also includes 12-month forecasts, which are not used here.) Because the respondents to the June survey are thought to know only the April CPI, however, they are actually predicting an eight-month rate of change. For a detailed discussion of the Livingston expectations data, see Carlson (1977). This article uses the data in Carlson's revised form updated to the present.

[24]The periods of energy shocks are the first half of 1973 to the second half of 1974, and the first half of 1979 to the first half of 1981. The quarterly deflator for fuels and related products and power divided by the business sector deflator grew at an annual rate of 22.9 percent from IV/1972 to IV/1974 and 23.4 percent from I/1979 to II/1981.

Chart 1
Actual Inflation, Expected Inflation and Standard Deviation of Six-Month Inflation Forecasts



Shaded areas represent periods of energy price shocks.
Latest data plotted: First half 1983

and inflation may have a positive impact on inflation uncertainty. All three series rose substantially during periods of energy shocks, and there are significant positive correlations between the uncertainty measure and the other two series in other periods.[25]

The root-mean-squared error (RMSE) of the individual forecasts of inflation from the survey serves as the second proxy for inflation uncertainty. An examination of chart 1 indicates that the survey mean inflation expectation is biased; it consistently underpredicts the inflation rate over most of the sample period. The RMSE of the inflation forecasts incorporates these errors. The squared value of this variable is the sum of the variance of inflation expectations across survey respondents (the standard deviation squared) and the squared forecast error using the survey mean as the expected inflation rate.[26] The use of this variable

[25]The correlation coefficient between the standard deviation and the expected inflation rate is 0.787 for the entire period and 0.667 for the period omitting the two energy shock periods. Between the standard deviation and the actual inflation rate, the correlations are 0.724 and 0.597, respectively. These figures are all statistically significant at the 5 percent level.

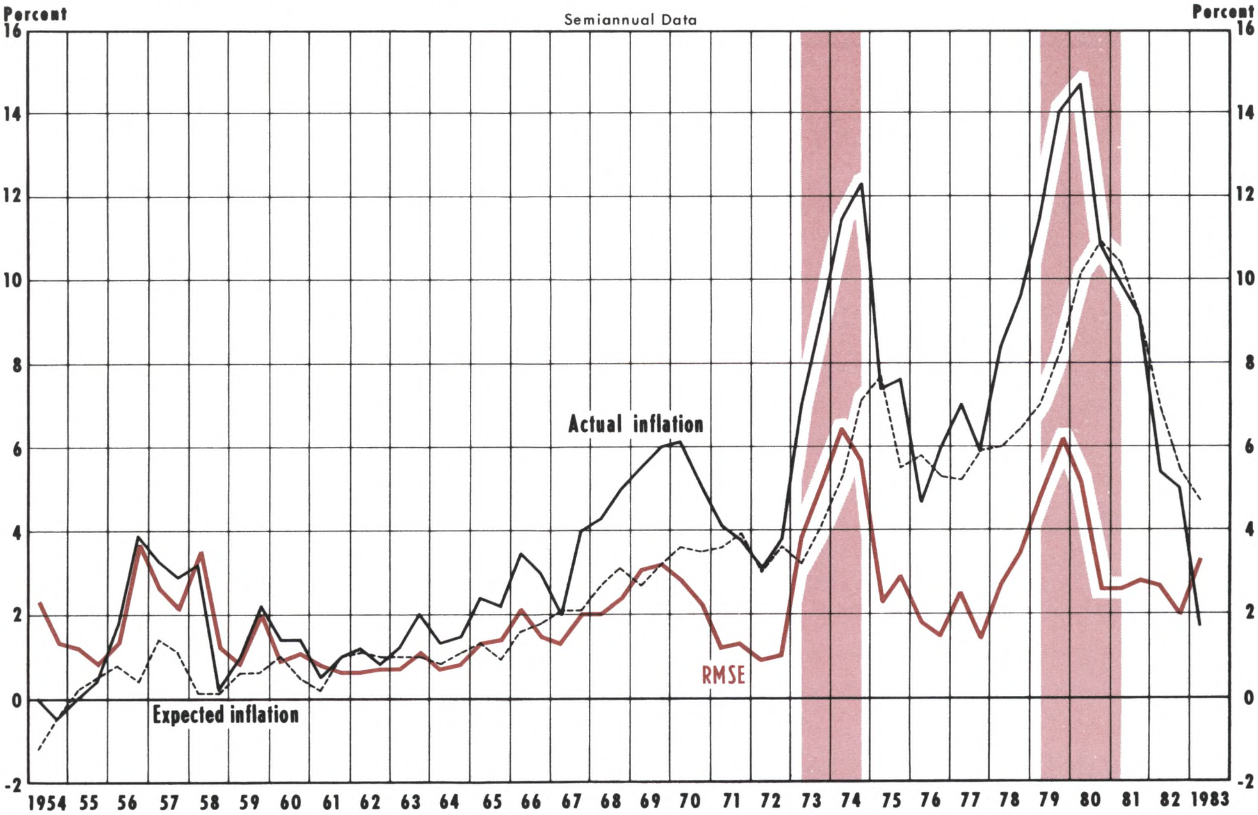
[26]The mean-squared error of the forecasts can be written:

$$MSE_t = \frac{1}{n}\sum_{i=1}^{n}(\dot{p}^*_{it} - \dot{p}_t)^2 = (\dot{\bar{p}}^*_t - \dot{p}_t)^2 + \frac{1}{n}\sum_{i=1}^{n}(\dot{p}^*_{it} - \dot{\bar{p}}^*_t)^2,$$

where n is the number of forecasters, $\dot{p}^*_i$ is the expected rate of inflation for the ith forecaster, and $\dot{\bar{p}}^*$ is the mean expected inflation rate among the forecasters. The first term on the right-hand side of the equation is the squared forecast error, and the second is the variance of individual inflation expectations. We use the square root of this variable and the standard deviation of expectations because regressions using the mean-squared error and the variance exhibited heteroscedasticity.

Chart 2

Actual Inflation, Expected Inflation and Root-Mean-Squared Error of Six-Month Inflation Forecasts



Shaded areas represent periods of energy price shocks.
Latest data plotted: First half 1983

as a measure of inflation uncertainty assumes that there is greater inflation uncertainty, holding constant the variance of inflation expectations, when a large mean forecast error occurs than when a small mean forecast error is observed.[27]

Chart 2 plots the RMSE along with the actual inflation rate and the mean expected inflation rate from the survey. Again there is a positive association between the uncertainty measure and the other two series, with the largest increases in RMSE occurring during periods of energy shocks.[28] As chart 2 shows, the RMSE is considerably more variable than the standard deviation over the sample period. The most interesting difference in the two series, however, is their behavior during the energy shock periods: the standard deviation remains higher than normal throughout each of the energy shock periods and does not decline until the period is over; the RMSE peaks, then declines substantially while relative energy prices are still rising. Therefore, these two measures imply different responses of inflation uncertainty to energy shocks.

INFLATION AND THE VARIABILITY OF INFLATION FORECASTS

This section provides more detailed evidence on the effects of inflation and energy shocks on the two measures of inflation uncertainty discussed above. Table 3 presents results from regressions based on six-month inflation forecasts. The data used are from the same sample period shown in the charts.

[27]The standard deviation of the forecasts has one advantage over RMSE as a proxy for inflation uncertainty: it does not contain any *ex post* information. $RMSE_{t+1}$ includes the actual inflation rate from period t+1, $\dot{p}_{t+1}$.

[28]The correlation coefficient between RMSE and the expected inflation rate is 0.559 for the entire sample period and 0.433 for the period exclusive of the periods of energy shocks. Between RMSE and the actual rate of inflation, the correlations are 0.826 and 0.658, respectively.

Table 3
Tests for Inflation Uncertainty Using Livingston Survey Data

	(1) $SD_{t+1}\|I_t$	(2) $RMSE_{t+1}$
Intercept	0.802 (8.32*)	1.407 (4.32*)
$\dot{p}_t$	0.103 (5.40*)	0.267 (3.66*)
$\dot{p}_{t-1}$	—	−0.038 (−0.57)
$\dot{p}_{t-2}$	—	0.180 (2.64*)
$\dot{p}_{t-3}$	—	−0.223 (−3.06*)
Sum	—	0.186 (2.69*)
$\dot{p}^e_{t+1}$	—	0.023 (1.84*)
$\dot{p}^e_t$	0.006 (1.42)	0.000 (0.02)
$\dot{p}^e_{t-1}$	0.003 (0.73)	−0.024 (−1.75*)
$\dot{p}^e_{t-2}$	0.014 (3.54*)	—
Sum	0.023 (2.55*)	−0.001 (−0.01)
$\hat{\rho}$	0.389 (3.25*)	0.448 (3.85*)
$\bar{R}^2$	0.769	0.663
SE	0.30	0.84
DW	2.05	1.91

t-statistics in parentheses.
*Significant at the 5 percent level (one-tailed test).

Inflation's Effect on the Standard Deviation of Forecasts

In equation 1, the dependent variable is $SD_{t+1}|I_t$, which is the standard deviation of inflation expectations for period t+1 as calculated from responses to the Livingston survey at period t.[29] The most recent six-month rate of inflation known to the forecasters, $\dot{p}_t$, has a positive and strongly significant effect on the standard deviation of the forecasts. Lagged values of this variable had no significant effect. The value of the intercept implies that, in the absence of inflation or changes in the relative price of energy, the standard deviation of inflation forecasts would be about a 0.8 annualized percentage rate. The coefficient for $\dot{p}_t$ indicates that for every 1 percentage-point increase in the annual rate of inflation, the standard deviation increases by about 0.1 percentage point. Therefore, with 8 percent inflation, the standard deviation would be twice as high as with zero inflation.

The three most recent values of the annualized six-month change in the relative price of energy ($\dot{p}^e$) also have a significant positive impact on this measure of inflation uncertainty.[30] A 1 percent increase in this variable leads to an increase in the standard deviation of 0.023 percentage points over three six-month periods. In other words, an energy shock affects this measure of inflation uncertainty for up to 18 months. A 20 percentage-point increase in the relative price of energy — not uncommon in the last decade — causes the standard deviation of inflation expectations to increase by about 0.45 percentage points.[31]

Inflation's Effect on the Root-Mean-Squared Error of Forecasts

Equation 2 presents results using the RMSE of inflation forecasts for period t+1 ($RMSE_{t+1}$) as the dependent variable.[32] The conclusion that inflation exerts a positive influence on inflation uncertainty is the same as in equation 1, although the impact occurs over four six-month periods. The sum of the coefficients of current and lagged inflation is positive and significant. Over 24 months, a 1 percentage-point increase in inflation leads to an increase in RMSE of about 0.19 percentage points. Although this is about twice the impact that

[29]The variable is written $SD_{t+1}|I_t$ to indicate that it is based on forecasts of period t+1 inflation given an information set from period t, I_t.

[30]The series for the inflation rate and changes in the relative price of energy are constructed to include the most recent numbers known by the forecaster, so monthly data are used. The spring forecaster is assumed to know the April levels of the CPI and the relative price of energy, so the six-month rate of change is calculated between October and April. For the fall forecast, the rate is calculated between April and October. The denominator in the relative energy price variable for monthly data is the finished goods component of the PPI.

[31]The regressions also were run with a somewhat different dependent variable, the standard deviation across individuals of the expected *level* of the CPI divided by the mean expected level. This is the coefficient of variation of the CPI level forecasts. The results were similar to those for the standard deviation of the inflation *rate* forecasts. The coefficient of variation of the inflation rate forecasts is clearly an inappropriate variable to use, since, as the expected inflation rate approaches zero, the coefficient of variation approaches infinity.

[32]$RMSE_{t+1} = \sqrt{(SD_{t+1}|I_t)^2 + (\bar{\dot{p}}^*_{t+1}|I_t - \dot{p}_{t+1})^2}$.

inflation had on the standard deviation, the constant term is nearly twice as high in this equation; thus, the impacts actually are quite similar. The initial impact of inflation on RMSE is much greater than it is on the standard deviation, but this effect is partially offset after 24 months have passed.

The impact of relative energy price changes is quite different in this regression than it was in equation 1. The initial impact on the uncertainty measure is positive, but the effect is totally offset 12 months later.[33] Consequently, if the relative price of energy were to increase by the same amount each period, it would cease to have any effect on the RMSE after 12 months. In contrast, for the standard deviation of expectations to stabilize, the level rather than the growth rate of the relative price of energy must stabilize.[34]

In both equations, the effect of higher inflation on the measure of inflation uncertainty is positive and permanent. There is no indication that, over time, forecasters come to be just as certain about higher rates of inflation as they were about lower rates. This evidence supports the hypothesis that higher inflation leads to more uncertain inflation.

CONCLUSION

Researchers have compiled considerable evidence suggesting that the rate and variability of inflation are positively related and a lesser amount of evidence linking these variables to inflation uncertainty. This article has explored the relationship between the rate of inflation and the level of inflation uncertainty in greater detail, looking also at the impact of energy shocks on inflation uncertainty.

The empirical results presented here are somewhat mixed and are sensitive to the method chosen for measuring inflation uncertainty. On the one hand, a model of inflation expectations was introduced and estimated for which the variance of the estimated inflation forecast errors is related to the rate of inflation. A different inflation expectations model — one incorporating the effects of changes in the relative price of energy on expected inflation — led to the opposite conclusion. On the other hand, there are positive relationships between the rate of inflation and the standard deviation and root-mean-squared error of inflation forecasts taken from the Livingston survey. Energy shocks also affect these two measures of inflation uncertainty, but in quite different ways.

Because the results of empirical tests based on inflation forecasting models are sensitive to the specification of the model, the usefulness of these results is questionable. Therefore, uncertainty measures based on the variability of "observed" inflation forecasts or forecast errors should be given more attention. In this article, these measures indicate that inflation uncertainty can be reduced if the rate of inflation is reduced.

In light of recent evidence that greater inflation uncertainty has a detrimental effect on the levels of economic activity and unemployment, the reduction of inflation uncertainty is an important potential benefit of anti-inflation policies.

[33]The inclusion of the variable $\dot{p}^e_{t+1}$ in the regression is not meant to imply that forecasters know the value of this variable, only that it affects $RMSE_{t+1}$.

[34]The regressions in table 3 also were run with several other independent variables, none of which was statistically significant at the 5 percent level. These included current and lagged values of the absolute value of unanticipated inflation (based on the survey mean expectation), a dummy variable for the period of wage and price controls, and a time trend. In regressions excluding the relative price of energy, the estimated effects of inflation on the uncertainty measures were somewhat larger.

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Calculating the Adjusted Monetary Base under Contemporaneous Reserve Requirements

R. Alton Gilbert

THE adjusted monetary base is designed to be a single measure of all Federal Reserve actions, including changes in reserve requirements, that influence the money stock. It is equal to the source base plus a reserve adjustment magnitude (RAM) that accounts for changes in reserve requirements by the Federal Reserve.[1]

The adoption of contemporaneous reserve requirements (CRR), which became effective in February of this year, did not affect the reserve requirement ratios applicable to any group of deposit liabilities. It did, however, alter the relationships between deposit liabilities and the periods over which depository institutions are required to hold reserves against them.[2] This article describes how the adoption of CRR has modified the calculation of RAM and, hence, the adjusted monetary base.

THE CALCULATION OF RAM AND THE ADJUSTED MONETARY BASE

RAM is calculated as the difference between the reserves that would have been required (given current deposit liabilities) if the base period's reserve requirements were in effect and the reserves that are actually required (given current requirements). Adding RAM to the source base produces an adjusted monetary base series that shows what the source base would have had to be, given the deposit liabilities for each period, if the reserve requirement ratios had always been those of the base period.[3] Thus, this procedure converts reserve requirement changes into equivalent changes in the source base, holding the reserve requirements constant.

The base period for calculating RAM is January 1976 through August 1980. Base period reserve requirements are the average reserve requirements over that period for two categories of deposit liabilities: check-

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[1]The following articles describe and explain the adjusted monetary base in greater detail: Gilbert (1980), Tatom (1980) and Gilbert (1983).

[2]For a general description of the new system of contemporaneous reserve requirements, see Gilbert and Trebing (1982).

[3]The source base equals the reserve balances of depository institutions with Federal Reserve Banks, which excludes their required clearing balances, plus total currency in circulation, whether held by depository institutions or the public. It is derived from the combined balance sheets of the Federal Reserve Banks and the U.S. Treasury.

able deposits and total time and savings deposits. For member banks, the average reserve requirement was 12.664 percent on checkable deposits and 3.1964 percent on total time and savings deposits.[4] For nonmember institutions, base period reserve requirements were zero, since they were not subject to reserve requirements of the Federal Reserve in the base period. Thus, RAM is calculated as the current checkable deposits of member banks multiplied by 0.12664, plus the current total time and savings deposits of member banks multiplied by 0.031964, minus the current required reserves of all depository institutions.

CALCULATION OF RAM UNDER THE PRIOR SYSTEM OF LAGGED RESERVE REQUIREMENTS

The specific data on deposit liabilities and required reserves used to calculate RAM necessarily reflect the system of reserve accounting in effect. Under lagged reserve requirements (LRR), the average reserves of a depository institution over the seven-day reserve maintenance period ending each Wednesday must equal or exceed its required reserves. The required reserves for a depository institution in each maintenance week were based on its average deposit liabilities over the seven-day period ending 14 days before the end of the current maintenance week. Thus, in calculating RAM under LRR, data on the required reserves of depository institutions for each maintenance week were matched with the deposit liabilities of member banks of two weeks earlier.

THE CALCULATION OF RAM UNDER CRR

Under CRR, the reserve maintenance periods, during which average reserves must equal or exceed required reserves, have been lengthened to two-week periods that end every other Wednesday. Required reserves on checkable deposits for the current two-week maintenance period are based on daily average checkable deposits for the 14-day period ending two days before the end of the current maintenance period. Required reserves on time and savings deposits are based on daily average deposits over a 14-day period ending 30 days before the end of the current maintenance period.[5] Table 1 presents the timing of reserve accounting for maintenance periods in 1984.

Calculating RAM: An Example

The calculation of RAM must be adjusted to the new timing of reserve accounting under CRR. The new procedure for calculating RAM is illustrated for the first maintenance period under CRR: February 2 through February 15, 1984. Required reserves for that period are based on daily average checkable deposits over the period January 31 through February 13, and daily average time and savings deposits from January 3 through January 16. For this maintenance period, RAM is calculated as the average of total time and savings deposits of member banks over January 3–16 multiplied by 0.031964, plus average checkable deposits of member banks over January 31–February 13 multiplied by 0.12664, minus the required reserves of all depository institutions for the period February 2–15. In calculating RAM for the next maintenance period, February 16 through February 29, observations for each category of deposit liabilities and required reserves apply to periods brought forward 14 days.

Calculating a Weekly Adjusted Monetary Base with a Biweekly RAM

Given the timing of reserve accounting under CRR, RAM is calculated for *two-week periods* ending every other Wednesday. This Bank's adjusted monetary base will still be published on a weekly basis for seven days ending each Wednesday. The measurement of the source base is not affected by the change to CRR, since it is derived from the balance sheets of Federal Reserve Banks and the U.S. Treasury. The adjusted monetary base is calculated for each week by adding the value of RAM that covers that week to the value of the source base. Because of the timing of reserve accounting under CRR, each value for RAM is used in calculating two weekly observations for the adjusted monetary base.

THE MOST RECENT VALUES OF RAM MUST BE ESTIMATED

The change from LRR to CRR changes the availability of data necessary to calculate RAM. Previously, under LRR, data on required reserves and the lagged values of

[4]Gilbert (1980).

[5]The timing of reserve accounting for vault cash is also altered under CRR. Under the previous LRR system, the average vault cash held by a depository institution over the seven-day period ending 14 days before the end of the current maintenance period counted as part of reserves in the current maintenance period. Under CRR, the average vault cash held over a 14-day period ending 30 days before the end of the current maintenance period counts as reserves in the current maintenance period. The timing of reserve accounting for vault cash is not discussed in the text because it does not influence calculation of the adjusted monetary base.

Table 1

1984 Reserve Periods
Computation and Maintenance Dates Under Contemporaneous Reserve Requirements (weekly reporters)

Reserve period number	Maintenance period	Computation period: Non transaction accounts and vault cash	Computation period: Transaction accounts
1	2/ 2/84 – 2/15/84	1/ 3/84 – 1/ 9/84 1/10/84 – 1/16/84	1/31/84 – 2/ 6/84 2/ 7/84 – 2/13/84
2	2/16/84 – 2/29/84	1/17/84 – 1/23/84 1/24/84 – 1/30/84	2/14/84 – 2/20/84 2/21/84 – 2/27/84
3	3/ 1/84 – 3/14/84	1/31/84 – 2/ 6/84 2/ 7/84 – 2/13/84	2/28/84 – 3/ 5/84 3/ 6/84 – 3/12/84
4	3/15/84 – 3/28/84	2/14/84 – 2/20/84 2/21/84 – 2/27/84	3/13/84 – 3/19/84 3/20/84 – 3/26/84
5	3/29/84 – 4/11/84	2/28/84 – 3/ 5/84 3/ 6/84 – 3/12/84	3/27/84 – 4/ 2/84 4/ 3/84 – 4/ 9/84
6	4/12/84 – 4/25/84	3/13/84 – 3/19/84 3/20/84 – 3/26/84	4/10/84 – 4/16/84 4/17/84 – 4/23/84
7	4/26/84 – 5/ 9/84	3/27/84 – 4/ 2/84 4/ 3/84 – 4/ 9/84	4/24/84 – 4/30/84 5/ 1/84 – 5/ 7/84
8	5/10/84 – 5/23/84	4/10/84 – 4/16/84 4/17/84 – 4/23/84	5/ 8/84 – 5/14/84 5/15/84 – 5/21/84
9	5/24/84 – 6/ 6/84	4/24/84 – 4/30/84 5/ 1/84 – 5/ 7/84	5/22/84 – 5/28/84 5/29/84 – 6/ 4/84
10	6/ 7/84 – 6/20/84	5/ 8/84 – 5/14/84 5/15/84 – 5/21/84	6/ 5/84 – 6/11/84 6/12/84 – 6/18/84
11	6/21/84 – 7/ 4/84	5/22/84 – 5/28/84 5/29/84 – 6/ 4/84	6/19/84 – 6/25/84 6/26/84 – 7/ 2/84
12	7/ 5/84 – 7/18/84	6/ 5/84 – 6/11/84 6/12/84 – 6/18/84	7/ 3/84 – 7/ 9/84 7/10/84 – 7/16/84
13	7/19/84 – 8/ 1/84	6/19/84 – 6/25/84 6/26/84 – 7/ 2/84	7/17/84 – 7/23/84 7/24/84 – 7/30/84
14	8/ 2/84 – 8/15/84	7/ 3/84 – 7/ 9/84 7/10/84 – 7/16/84	7/31/84 – 8/ 6/84 8/ 7/84 – 8/13/84
15	8/16/84 – 8/29/84	7/17/84 – 7/23/84 7/24/84 – 7/30/84	8/14/84 – 8/20/84 8/21/84 – 8/27/84
16	8/30/84 – 9/12/84	7/31/84 – 8/ 6/84 8/ 7/84 – 8/13/84	8/28/84 – 9/ 3/84 9/ 4/84 – 9/10/84
17	9/13/84 – 9/26/84	8/14/84 – 8/20/84 8/21/84 – 8/27/84	9/11/84 – 9/17/84 9/18/84 – 9/24/84
18	9/27/84 – 10/10/84	8/28/84 – 9/ 3/84 9/ 4/84 – 9/10/84	9/25/84 – 10/ 1/84 10/ 2/84 – 10/ 8/84
19	10/11/84 – 10/24/84	9/11/84 – 9/17/84 9/18/84 – 9/24/84	10/ 9/84 – 10/15/84 10/16/84 – 10/22/84
20	10/25/84 – 11/ 7/84	9/25/84 – 10/ 1/84 10/ 2/84 – 10/ 8/84	10/23/84 – 10/29/84 10/30/84 – 11/ 5/84
21	11/ 8/84 – 11/21/84	10/ 9/84 – 10/15/84 10/16/84 – 10/22/84	11/ 6/84 – 11/12/84 11/13/84 – 11/19/84
22	11/22/84 – 12/ 5/84	10/23/84 – 10/29/84 10/30/84 – 11/ 5/84	11/20/84 – 11/26/84 11/27/84 – 12/ 3/84
23	12/ 6/84 – 12/19/84	11/ 6/84 – 11/12/84 11/13/84 – 11/19/84	12/ 4/84 – 12/10/84 12/11/84 – 12/17/84
24	12/20/84 – 1/ 2/85	11/20/84 – 11/26/84 11/27/84 – 12/ 3/84	12/18/84 – 12/24/84 12/25/84 – 12/31/84

deposit liabilities used in calculating RAM were available before the end of a maintenance period. Thus, RAM could be calculated before data were available on the source base. Under CRR, however, it will not be possible to calculate RAM until more than a week after the end of each maintenance period.

The difference in the timing of the data necessary to calculate RAM under LRR and CRR, and the problem CRR creates for calculating a weekly adjusted monetary base, are illustrated for the last maintenance period under LRR and the first two maintenance periods under CRR. Required reserves for the week ending February 1 were based on average deposit liabilities for the week ending January 18. The data on deposit liabilities and required reserves necessary for calculating RAM for the week ending February 1 were available by February 1. Because the source base for the seven days ending February 1 was available by February 3, the exact adjusted monetary base for the week ending February 1 was published in this Bank's *U.S. Financial Data* on February 3, 1984.

The data necessary for calculating the value of RAM for the next maintenance period, the 14 days ending February 15, were available on February 23. If publication of the adjusted monetary base was delayed until all data necessary for calculating RAM were available, the adjusted monetary base for the weeks ending February 8 and 15 would not be published until February 23. Such delays can be avoided only by estimating RAM for the most recent maintenance period. This is done for the adjusted monetary base series published in this Bank's *U.S. Financial Data* release, with preliminary data published for the most recent one or two weeks (see table 2).

If there is no change in reserve requirements, the estimate of RAM used to obtain the preliminary weekly adjusted monetary base is the value of RAM for the most recent maintenance period. If a change in reserve requirements becomes effective during the current maintenance period, however, the estimated RAM for this period equals its lagged value plus an estimate of the effect of the change in reserve requirements on required reserves.

A change in reserve requirements became effective in the maintenance period covering the two weeks ending February 15, the last phased reduction in reserve requirements of member banks specified in the Monetary Control Act of 1980. The prior phased reductions in member bank reserve requirements reduced total required reserves by about $2 billion (see figure 1).

Table 2

Weekly Schedule for Publishing Preliminary Data on the Adjusted Monetary Base in *U.S. Financial Data*

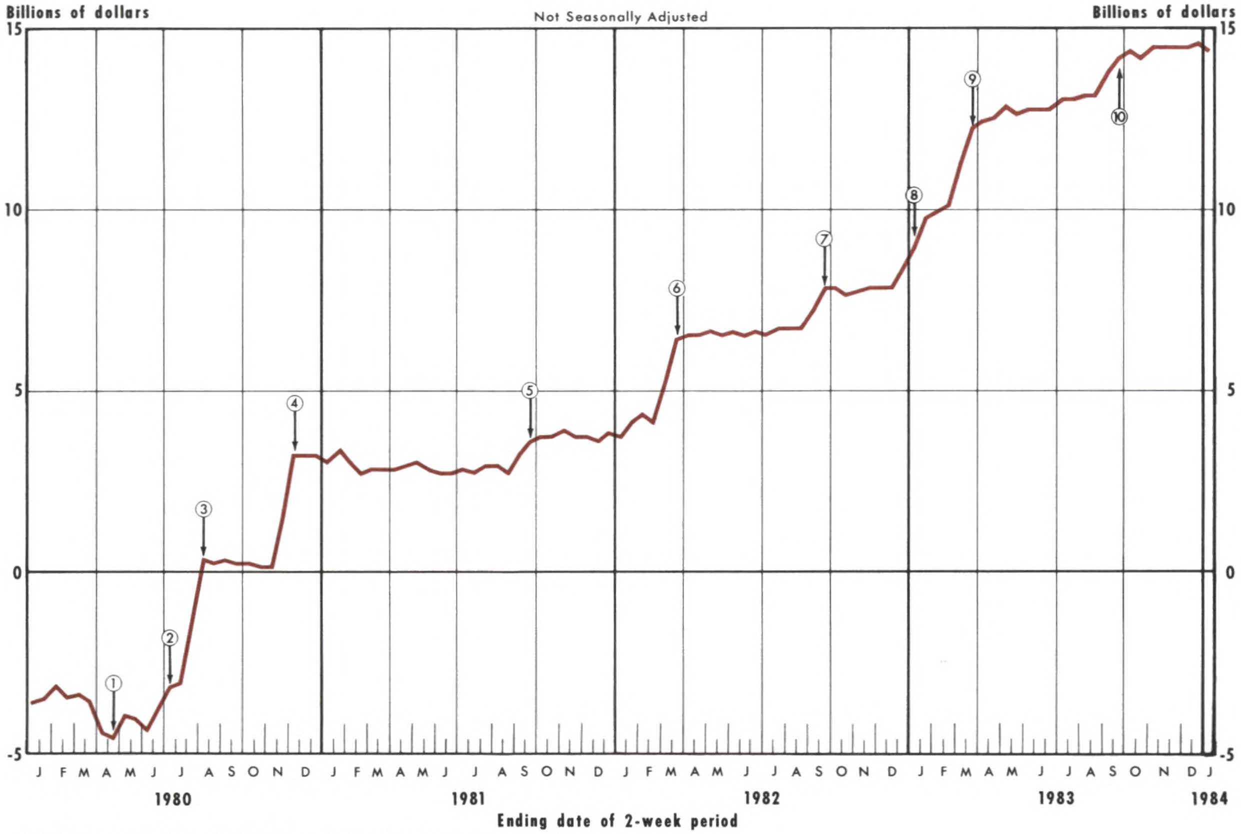
Publication date	Preliminary data for week(s) ending
February 10, 1984	February 8
February 16	February 8, 15
February 23	February 22
March 1	February 22, 29
March 8	March 7
March 15	March 7, 14
March 22	March 21
March 29	March 21, 28
April 5	April 4

Thus, the estimated value of RAM used in calculating preliminary values of the adjusted monetary base for the weeks ending February 8 and February 15 was the value of RAM calculated for the week ending February 1 *plus* $2 billion. A preliminary value of the adjusted monetary base for the week ending February 8, published on February 10, was calculated as the source base for the week ending February 8 plus that estimated value of RAM.

Note that the deposit data for the week ending January 18 were used to derive this value of RAM. This value is subject to further revisions due to revisions of both the deposit data for the week ending January 18 and the required reserves for the week ending February 1. The preliminary number for the adjusted monetary base for the following week, the seven days ending February 15, which was published on February 16, equals the source base for the week ending February 15 plus the estimated value of RAM.

By February 23, the data on checkable deposits and required reserves were available to calculate RAM for the two weeks ending February 15. At that time, the preliminary adjusted monetary base data for the weeks ending February 8 and 15 were revised to incorporate the new value for RAM. Moreover, this latest value for RAM was used in calculating the preliminary value of the adjusted monetary base for the week ending February 22 (published on February 23), and the preliminary value for the week ending February 29 (published on March 1). When using this approach to calculate the weekly adjusted monetary base series, either one or two of the most recent weekly observations are preliminary. RAM for the current and prior weeks remains

Chart 1
Two-Week Averages of RAM



NOTE: Numbers indicate effective dates of major changes in reserve requirements.

1. The 8 percentage point marginal reserve requirement was raised to 10 percent. In addition, the base upon which the marginal reserve requirement is calculated was reduced. This action increased required reserves about $1.7 billion.
2. The marginal reserve requirement was reduced from 10 to 5 percentage points and the base upon which the marginal reserve requirement is calculated was raised. This action reduced required reserves about $980 million.
3. The 5 percent marginal reserve requirement on managed liabilities and the 2 percent supplementary reserve requirement against large time deposits were removed. These actions reduced required reserves about $3.2 billion.
4. Required reserves of member banks and Edge Act corporations were reduced about $4.3 billion and required reserves of other depository institutions were increased about $1.4 billion due to the implementation of the Monetary Control Act of 1980.
5. In conjunction with the transitional phase-in program under the Monetary Control Act, required reserves of member banks were reduced $2.0 billion, and required reserves of other depository institutions were increased $0.9 billion.
6. In conjunction with the transitional phase-in program under the Monetary Control Act, required reserves of member banks decreased by $2.0 billion.
7. In conjunction with the transitional phase-in program under the Monetary Control Act, required reserves of member banks were reduced $2.1 billion, and required reserves of other depository institutions were increased $0.9 billion.
8. In accordance with provisions of the Depository Institutions Act of 1982 that exempted the first $2.1 million of reservable liabilities at all depository institutions from reserve requirements, required reserves were reduced by an estimated $800 million.
9. In conjunction with the transitional phase-in program under the Monetary Control Act, required reserves of member banks were reduced by approximately $1.9 billion. Also, the reserves released by the growth of money market deposit accounts (available after mid-December 1982) produced an upward drift in RAM during 1983, especially during the first half of the year.
10. In conjunction with the transitional phase-in program under the Monetary Control Act, required reserves of member banks were reduced $2.0 billion, and required reserves of other depository institutions were increased $0.9 billion.

subject to revisions due to revisions in the data on deposit liabilities and required reserves.

ERRORS IN ESTIMATING RAM ARE LIKELY TO BE SMALL

Errors in estimating RAM with its lagged value generally will be small relative to the size of the adjusted monetary base. The size of the errors using this approach are simulated for the period from 1980 through early 1984, using the average RAM calculated for each two-week period over these four years. For periods when no changes in reserve requirements occurred, the error in using the value for the prior two-week period to estimate RAM for the current period was less than $100 million in half of the periods, and less than or equal to $200 million in about 84 percent of the periods.

As chart 1 indicates, large changes in RAM typically have occurred only when there have been major changes in reserve requirements. Changes in RAM, other than those resulting from the 10 major changes in reserve requirements identified in chart 1, have been relatively small.

Errors in estimating the effects of changes in reserve requirements should not generally be large. The Federal Reserve is generally able to estimate the effects of a change in reserve requirements on required reserves very accurately. Furthermore, most changes in reserve requirements have applied to time and savings deposits.[6] Since under CRR, the time and savings deposits subject to reserve requirements in a reserve maintenance period are lagged four weeks, data should be available to indicate the effects of those changes on required reserves when the preliminary data on the adjusted monetary base are published.

To illustrate the timing, suppose that reserve requirement ratios on time and savings deposits were raised, effective in the maintenance period covering the two weeks ending February 29. Required reserves for that maintenance period are based on average time and savings deposits over the two weeks ending January 30. The first weekly observation of the adjusted monetary base affected by that change in reserve requirements, covering the week ending February 22, would be published on February 23.

[6]Changes in reserve requirements since November 1980 are dictated by the Monetary Control Act of 1980 and the Depository Institutions Act of 1982; they apply to both checkable deposits and to time and savings deposits. From 1960 until November 1980, the Board of Governors changed reserve requirements 35 times. Only 11 of those changes involved demand deposits.

THE PUBLICATION OF ADJUSTED RESERVES UNDER CRR

Adjusted reserves will not be published weekly under CRR. Adjusted reserves are calculated by subtracting seasonally adjusted currency in the hands of the public from the adjusted monetary base, seasonally adjusted. Until February 1984, weekly observations for currency in the hands of the public covered seven-day periods ending each Wednesday, the same periods that applied to weekly observations of the adjusted monetary base. Weekly currency data now cover the seven days ending each Monday, matching the timing of weekly average checkable deposits under CRR. With this change in timing, it would be inappropriate to subtract weekly average currency from weekly average adjusted monetary base to obtain a weekly adjusted reserves series; the periods for currency and the adjusted monetary base do not match up. The change described above in the timing of data on currency in the hands of the public probably has little effect on data for monthly average currency. This Bank, therefore, will continue to publish adjusted reserves on a monthly average basis.

CONCLUSIONS

The timing of data used in calculating the adjusted monetary base has been changed to reflect the timing of reserve accounting under the new system of contemporaneous reserve requirements. Observations for the adjusted monetary base for the most recent one or two weeks will be preliminary, because the most recent values of the reserve adjustment magnitude will be estimated. The adjusted reserves series will no longer be published on a weekly basis, due to a change in the days covered by weekly average data on currency in the hands of the public. This Bank will continue to publish the adjusted reserves series on a monthly average basis.

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