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CONTRACTS, CREDIBILITY, AND DISINFLATION

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ABSTRACT

Estimates of the cost of disinflation made before the recent reduction in the inflation rate varied widely. Estimates were made in terms of the sacrifice ratio--the percentage points of GNP at an annual rate lost per percentage point reduction in the inflation rate. At one extreme it was argued that a resolute and credible monetary policy could reduce inflation virtually costlessly. At the other extreme were estimates that the sacrifice ratio exceeded 10.

Costless immediate disinflation is not possible in an economy with long-term labor contracts. This paper sets out a simple contracting model of wage and output determination and uses it to calculate sacrifice ratios for a disinflation program, under the assumption that announced policy changes are immediately believed. Under this assumption disinflation with a structure of labor contracts like those of the United States would be less costly than typically estimated. The model is then modified to allow for the slow adjustment of expectations of policy to actual policy; sacrifice ratios then approach the ranges typically estimated.

The sacrifice ratio for the current disinflation is calculated in the last section: the current disinflation was somewhat more rapid and less costly than previous estimates suggested. The calculated sacrifice ratio is consistent with the predictions of the simple contracting model.

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CONTRACTS, CREDIBILITY, AND DISINFLATION

Stanley Fischer*

Predictions of the costs of disinflation made in the few years preceding the recent recession and disinflation ranged from the pessimism of Arthur Okun's (1978) summary of six Brookings papers relating to the United States that "the cost of a 1 point reduction in the basic inflation rate is 10 percent of a year's GNP, with a range of 6 percent to 18 percent" (p.348) to the carefully hedged optimism of Thomas Sargent (1981) that "under the proper hypothetical conditions, a government could eliminate inflation very rapidly and with virtually no 'Phillips curve' costs in terms of foregone real output or increased unemployment" (p.4).

The difference between the two forecasts reflects Sargent's emphasis on the credibility of policy as the key determinant of the flexibility of wages and prices, and the lesser emphasis placed on expectations by the researchers quoted by Okun.[1] Once long-term nominal contracts are taken into account, however, credibility of policy is not enough for rapid disinflation. John Taylor (1983) concludes that, given the structure of labor contracts in the United States, it would take four years to disinflate from a rate of wage increase of 10% per year to 3% without creating unemployment, even if there were no doubts about the continuance of disinflationary policy.

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[1]The quotation from Sargent continues "The 'measure' that would accomplish this would be a once-for-all, widely understood, and widely agreed upon change in the monetary or fiscal policy regime. Here a regime is taken to be a function or rule for repeatedly selecting the economic policy variable in question as a function of the state of the economy."

In this paper I first describe the contracting approach to the problem of disinflation and discuss criticisms of the approach and characteristics of contracts that affect the possible speed of disinflation. In Section II I calculate the sacrifice ratio--the percentage points of GNP lost per one percent reduction in the inflation rate--for alternative policies and parameter values. Section III examines the problem of the credibility of policy intentions, and the effects of a lack of belief that a policy will be maintained; Section IV briefly describes alternate policies to disinflate. In Section V, I compare the costs of disinflation in the United States from 1979 to 1986 with predictions of those costs.

I. A Contracting Model.

In this section I set out a simple model, which combines elements of the Taylor (1980) and Fischer (1977a) approaches to the modelling of labor contracts in macroeconomic models. The model attributes the existence of wage and price stickiness, and thus the difficulties of disinflation, to the existence of long-term contracts. Labor contracts, agreed upon at different dates in the past, specify the nominal wage to be paid in period t to workers under each contract. The price level increases with the average nominal wage. The level of output is determined by aggregate demand.

The aggregate demand function is:

$$(1) \quad y_t = m_t - p_t + v_t$$

Here y is the level of output, m the nominal money stock, p the price level, and v a disturbance term, for instance a shift of the demand for money function. Lower case letters denote logarithms. From the viewpoint of the analysis of disinflation, the major simplifications in this equation are first, the omission

of interest rates, and thus expectations of inflation, as determinants of aggregate demand, and second the omission of fiscal variables and the exchange rate.[2] The price level is related to the average wage:

$$(2) \quad p_t = \bar{w}_t + u_t$$

Here $\bar{w}_t$ is the average wage, and u is the percentage excess of the price level over the wage. The formulation is sufficiently general that u can be thought of as a supply shock, or could be systematically related to the behavior of any of the other variables in the model, such as the level of output. The price equation is that used by Taylor (1980).[3]

In any period, the proportion θ_j, (j=1,...,J) of the work-force is being paid a wage that was agreed upon j periods back. Thus the average wage is

$$(3) \quad \bar{w}_t = \sum_{1}^{J} \theta_j \, {}_{t-j}w_t$$

where ${}_{t-j}w_t$ is the wage that was agreed to for period t in period (t-j). It is assumed that the wage specified for period t in period (t-j) is the same for all

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[2]The aggregate demand function derived from an IS-LM model includes the expected rate of inflation as a determinant of aggregate demand. The inclusion of the expected rate of inflation would complicate the solution of the model, because it makes the current price level a function of all future money stocks. A solution for a related model, which explicitly uses the IS-LM framework, is presented in Fischer (1977b).

[3]Fischer (1977a) includes an aggregate supply function that makes the level of output an increasing function of the real wage. This formulation is frequently critized on the empirical grounds that it implies the real wage is countercyclical. However, the behavior of the real wage resulting from such a (Keynesian) supply function differs depending on whether output is changing because of a supply or a demand shock. In response to a supply shock, the real wage in such models moves procyclically; in response to demand shocks, the real wage moves countercyclically. Although (2) above can be made consistent with the earlier supply function by allowing u to be correlated with y, I use the present formulation to avoid taking a stand on the inessential (from the viewpoint of this paper) issue of the response of the real wage to demand shocks. Factors omitted from this model, such as capacity utilization, certainly affect the response of the real wage to disturbances.

contracts, of whatever duration.[4]

The relationship between the proportion of contracts of length k, defined as η_k, and the weights θ_j in the expression for the average wage is:

$$(4) \quad \theta_j = \sum_{k=j}^{J} \frac{\eta_k}{k}$$

where it is assumed that the distribution of signing dates of contracts of a given length is uniform.

The wage set in period (t-j) for period t is assumed to be:

$$(5) \quad {}_{t-j}w_t = (1-\mu)\left[\lambda {}_{t-j}p_t + (1-\lambda) {}_{t-1}p_t + h {}_{t-j}y_t + q {}_{t-j}u_t\right] + \mu {}_{t-j}\bar{w}_t$$

The notation ${}_{t-j}p_t$ means the expectation formed at time (t-j) of p_t, and similarly for other variables except w_t. The wage setting equation assumes that the real wage responds to the expected level of output, with coefficient h representing the sensitivity of the real wage to output; the real wage is also permitted to respond to expectations of the variable u_t, thereby providing an interpretation of equation (5) as asserting that the (logarithm of the) expected real wage is set equal to its expected equilibrium value.

The coefficient μ represents the extent to which contracts are based on the relative wage, rather than the real wage. The larger is μ, the less the weight of the fundamental factors--the price level, the level of output, and u--in determining the nominal wage, and the greater the weight of the average wage. The notion that workers are concerned with the relative wage does not necessarily reflect irrationality or envy, but may result rather from a sophisticated understanding of a labor market in which there are costs to mobility: if the wage

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[4]This too is a substantial simplification. In particular, it will be assumed below that the extent of indexing in contracts is independent of the length of the contract. In practice, longer term contracts are more likely to be indexed.

diverges far from the average, there are incentives for one side or the other in the labor contract to initiate a separation.

The coefficient λ is a measure of the extent of price indexation of contracts. When λ is equal to unity, there is no price indexation, and contracts are fully nominal. When λ is equal to zero, the nominal wage to be paid in period t is determined at the end of period (t-1), on all contracts of whatever length. It is important to note that wage indexation here adjusts the nominal wage to the expected price level rather than for past changes in prices. Indexation in practice tends rather to adjust nominal wages for past inflation. The nominal wage is indexed only for changes in the expected price level that have occurred since the signing of the contract--there is no adjustment for other unforeseen contingencies that have taken place since period (t-j).

Criticisms of the Contracting Approach: Before using this model to examine disinflation, I briefly discuss criticisms of the labor contracting model (e.g. Barro, 1977). The basic criticism is that labor contracts that specify a wage rate without also specifying a rule for the efficient determination of output are incomplete. In this context, an efficient level of output is one at which the marginal value product of labor is equal to the shadow marginal value of leisure. (Hall and Lilien, 1979). Taking this argument further, it is sometimes asserted that the wage need play no allocative role in contracting models, serving merely to determine the transfer payments made by firms to their workers (Hall, 1980).

There is no question that the type of labor contract assumed in this paper leads to inefficient allocations of resources in the face of disturbances not taken into account when the contracts were entered into. Such inefficient allocations are precisely the central problem of macroeconomics; they have alternatively been explained as resulting from incomplete information. I have little to add to my (1977c) response to Barro on the issue. The essential point

is that a careful examination of actual labor contracts in the United States suggests that they are of the form assumed in this paper: the contracts specify the wage and leave output to be determined by the firm. The omission of explicit conditions for output determination is not a casual matter that can be glossed over by reference to implicit contracts, for a remarkable feature of labor contracts is their very detailed specifications about many aspects of the job, including for instance the order of layoffs by seniority. It is reasonable to embody relevant characteristics of the wage setting process of the economy in models used to study price and output determination--and indeed it seems to be essential to understanding the process of disinflation.

At the same time, the Barro critique does point to the need for a theory to explain the existing form of labor contracts. There has been significant microeconomic research in this area (for summaries of the literature, see Azariadis and Stiglitz (1983) and Hart (1983)) examining the effects of differential risk aversion and differential information between firms and workers on the optimal form of contract. In some of these contracts, it is optimal for the firm to determine the level of output. The research to date has not examined reasons for specification of wages in nominal rather than real terms, and thus omits the most important link between contracting and price behavior. It is likely that the costs of complexity in contracts, and differences in price indexes relevant to different economic agents, will play a key role in the explanation of nominal contracting.

A second criticism of the contracting approach as applied to the United States is that it exaggerates the role of unions and formal contracts in the labor market.[5] It is argued that it is misleading to base a theory on long term labor contracts when less than 25% of the labor force is unionized, and when some of the

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[5]I have benefitted from discussions on this point with James Medoff.

unionized labor force works on one year contracts.[6]

Including professional associations, or white collar unions, about 28%, rather than less than 25%, of the labor force is unionized. More significantly, about 50% of the labor force works in establishments in which some workers belong to unions.[7] Presumably the wages received by the unionized workers in such establishments influence the wages received by the remaining workers. Further, there are large firms that are entirely non-unionized and whose devotion to remaining that way leads them to provide wage and benefit packages that on balance match those obtained by unionized workers. The a priori case for building a theory on the characteristics of observed labor contracts is stronger if we assume that more than 50% of the labor force, rather than less than 25%, is closely affected by the terms of union contracts.

Empirical research on the relationship between union and non-union wages in the United States, much of it surveyed by Mitchell (1982), has been inconclusive. Early findings by Flanagan (1976) and Johnson (1977) that nonunion wages cause (in the Granger sense) union wages have been shown by Mitchell (1980a) and Vroman (1980) to be sensitive to the data samples used.

A third criticism of the labor contracting model notes that labor contracts typically include reopening clauses, and therefore argues that changes in policy can potentially operate much more rapidly than the contracting model implies. It is indeed correct that contracts can be, and sometimes are, reopened. Mitchell

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[6]Most union contracts involving more than 1000 workers are for three years: over the period 1978-1980, 88% of workers whose contracts were recorded in Current Wage Developments were on three year contracts, 9% on two year contracts, and less than 3% on one year contracts. The total number of workers recorded as being involved in a three year settlement involving at least 1000 workers during that three year period was 7.5 million, less than 10% of the labor force. (Calculations are based on data presented in Taylor, 1983.)

[7]This statistic is developed in Freeman and Medoff (1984).

(1982) examines concessions in union contracts during the recent recession, including twenty-six renegotiations of existing contracts (mostly in industries affected by international competition or deregulation). Less than two million workers were covered by the contracts on which there were concessions, as defined by Mitchell, and most contracts were not reopened. The infrequency of renegotiation confirms the suggestion from the existing form of United States labor contracts that there are major costs to the negotiating process.

A related criticism of the contracting approach notes that the form of contracts responds to changes in economic policy regimes.[8] This is undoubtedly true and probably provides a good test for detecting a change in policy regime. There is no general way of handling the problem of the potential endogeneity of elements that are taken as structural, beyond examining the reasons for, and the likely effects on the conclusions reached, of induced changes in the model.

There is no denying the logic of the criticisms of the labor contracting model discussed above. They point to potential theoretical and empirical problems with using the model. The significance of those problems for the particular conclusions reached using the contracting model has to be evaluated in each case, and, at the extremes, could produce results that are equivalent to those that would obtain if wages were continually readjusted as in a spot market. But there is no reason to think that the extreme versions apply in fact, and therefore the criticisms do not imply that the contracting approach should be abandoned.

Solving the Model: We return now to the model. Expectations are assumed to be rational, in the sense that expectations of prices and output are based on the

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[8]It is surprising that Stigler's (1977) "Conference Handbook" does not include among its list of comments "Of course, it is not appropriate to treat that feature of the model as exogenous."

structure of the model.[9] A solution for the price level and output are obtained for arbitrary paths of the money stock and disturbances.[10]

Substituting (5) into (3) and (2), and using (1) to substitute for y_t, we obtain the price level equation:

$$(6)\quad p_t = \sum_{j=1}^{J} \theta_j \{ [(1-\mu)(\lambda-h) + \mu]_{t-j} p_t + (1-\mu)(1-\lambda)_{t-1} p_t + (1-\mu)h_{t-j}[m_t+v_t] + [(1-\mu)q - \mu]_{t-j} u_t \} + u_t$$

Since the velocity shock, v_t, always enters additively with m_t, it will be dropped and m_t should henceforth be understood to represent the sum (m_t+v_t).

The rational expectations solution for the price level is:

$$(7)\quad p_t = {}_{t-J}m_t + (1+q-h)\frac{{}_{t-J}u_t}{h} + \sum_{i=1}^{J-1} c_i x_i + \sum_{i=1}^{J-1} \gamma_i z_i + u_t$$

$$= {}_{t-J}m_t + (1+q)\frac{{}_{t-J}u_t}{h} + \sum_{1}^{J-1} c_i x_i + \sum_{1}^{J-1} \gamma_i z_i + ({u_t - {}_{t-J}u_t})$$

where

$$x_i = {}_{t-J+i}m_t - {}_{t-J+i-1}m_t$$

$$z_i = {}_{t-J+i}u_t - {}_{t-J+i-1}u_t$$

$$c_i = \frac{h(1-\mu)b_{J-i}}{D_i}$$

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[9]The rational expectations assumption is not an innocent one, for adjustment in the model to preannounced policy changes will be much slower if expectations are formed adaptively than if they are formed rationally. In Section III below we examine a situation in which expectations about future policy adjust adaptively; this produces reaction patterns that are similar to those obtained when expectations of inflation are adaptive.

[10]It is more usual in rational expectations models to specify a feedback rule for monetary policy. The form of the solution presented below is more convenient for discussing the implications of private sector beliefs about future policy.

$$\gamma_i = \frac{[q(1-\mu)-\mu]b_{J-i}}{D_i}$$

$$b_{J-i} = \sum_{j=1}^{J-i} \theta_j$$

$$D_i = b_{J-i}(1-\mu)h + (1-b_{J-i})[(1-\mu)\lambda+\mu]$$

The level of output can be deduced from the aggregate demand equation (1).

The solution for the price level is based on expectations of the money stock and of u formed at time (t-J), and updated by innovations in expectations of m_t and u_t occurring in subsequent periods.[11]

To understand the solution for the price level, we first consider the equilibrium levels of output and prices when there are no surprises. In that case, the innovations, x_i and z_i in (7) are zero, and

$$(8) \quad p_t = m_t + (1+q)\frac{u_t}{h}$$

From (5), noting that $\sum_1^J \theta_j = 1$, we have

$$(9) \quad \bar{w}_t - p_t = hy_t + qu_t$$

so that the real wage is determined solely by the level of output and the supply shock (q may be negative). Substituting (9) into (2), we obtain

$$(10) \quad y_t = \frac{-(1+q)u_t}{h}$$

The (logarithm of the) level of output is zero when the supply shock is zero. The

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[11]The variable u will henceforth be referred to as a supply shock, though it should be understood from the earlier discussion that it has other potential interpretations.

supply shock reduces the level of output, to an extent that depends on q, the sensitivity of the real wage to the shock and h, the sensitivity of the wage to output. Returning to equation (8), we see that the price level is proportional to the money stock, with a factor of proportionality $u_t \frac{(1+q)}{h}$ that depends on the supply shock.[12]

Any fully believed change in the money stock, expected at least J periods before it occurs, has no effect on output and has its full effects on the price level. Thus an implication of the structure of contracts in this model is that a monetary change announced and believed far enough in advance will be fully neutral.[13]

The coefficients c_i in (7) determine the dynamics of prices and output during a disinflation. Before examining the properties of the c_i, we indicate the way the c_i should behave. First, the longer the time a change in the money stock has been expected, the larger the effect of that change on the price level and the smaller the effect on output. Accordingly we should have

$$c_i > c_{i+1}$$

We also expect that price indexation should increase the responsiveness of the price level to monetary changes, that a concern over relative wages will lessen that responsiveness, and that the response of prices to monetary shocks will be larger the steeper the Phillips curve (the larger h). Thus we should find

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[12]Note, incidentally, that if (1) were generalized slightly to

(1)' $y_t = \alpha(m_t - p_t) + v_t$

the coefficient h would be replaced everywhere by αh. Thus the dynamics of the price level are affected by the product of the strength of the effects of changes in the money stock on aggregate demand and the effect of aggregate demand on the real wage.

[13]Alternative contract structures, to be discussed below, do not have this implication.

$$\frac{\partial c_i}{\partial \lambda} > 0, \qquad \frac{\partial c_i}{\partial \mu} < 0, \qquad \frac{\partial c_i}{\partial h} > 0$$

Since b_{J-i} is decreasing in i, we can discover whether $c_i > c_{i+1}$ by checking whether $\frac{\partial c_i}{\partial b}$ is positive. Writing

$$(11) \quad c_i = \frac{1}{1+\frac{(1-b_{J-i})[(1-\mu)\lambda+\mu]}{h(1-\mu)b_{J-i}}}$$

it is clear that $c_i > c_{i+1}$. It is similarly clear from inspection of (11) that increases in both λ and h increase the sensitivity of the price level to monetary innovations and therefore reduce the sensitivity of output to innovations. Rewriting $[(1-\mu)\lambda+\mu]$ as $[\mu(1-\lambda)+\lambda]$ it can also be confirmed that $\frac{\partial c_i}{\partial \mu} < 0$. Thus a concern over relative, rather than real, wages reduces the responsiveness of the price level to monetary shocks.

In the extreme case in which indexation is complete ($\lambda=0$) and there is no concern over relative wages ($\mu=0$), we find

$$(12) \quad c_i \equiv 1$$

In this case monetary innovations are completely reflected in prices and not at all in output. This is obviously because the contract terms are able to adjust fully to purely nominal disturbances so long as they occur in any period before t. From the viewpoint of the response to nominal disturbances, indexation is completely equivalent to the use of one period contracts. However, this result disappears if $\mu \neq 0$, that is, if wages are based in part on the average wage. In this case it is assumed in (5) that the nominal wage is partly predetermined, based on the expectation $_{t-j}\bar{w}_t$.

Figure 1 presents a smoothed version of the typical responses of output and prices to changes in the money stock. The right hand side of the diagram shows

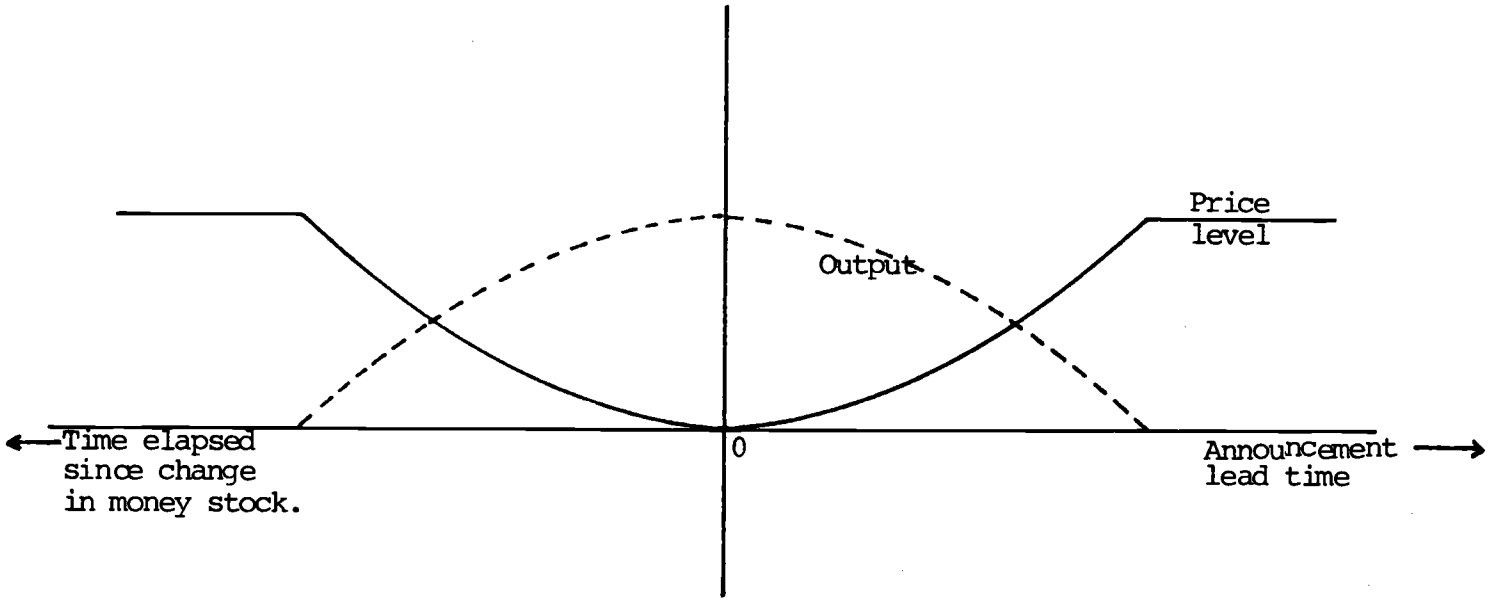

Figure 1: Price Level and Output Responses to a Permanent Change in the Money Stock.

the responses of prices and output in the period the money stock changes to a pre-announced change in the money stock as a function of the announcement lead time. The left hand side shows the responses of prices and output to an unanticipated change in the money stock, as a function of the length of time since the change occurred.

Examples: To provide some intuition for the implied price and output level responses, I present several examples.

(a) Assume that all contracts last three periods (years). In this case $\theta_1 = \theta_2 = \theta_3 = 1/3$. Assume further that $\mu = 0$, $\lambda = 1$ (no indexing), and $h = .2$. Then

$$c_1 = 2/7 = .29$$

$$c_2 = 1/11 = .09$$

With this set of parameters, changes in the money supply have very little effect on prices until all contracts have been renegotiated. The main reason is that only one third of the contracts come up for renewal each year. In addition, until all the contracts have been renegotiated, it is the coefficient h that primarily determines the response of prices to the monetary shock.

(b) Suppose that we have the same parameters except that $h = .5$. This means that a 1% shortfall in real output reduces the real wage by 1/2%. Then:

$$c_1 = .5$$

$$c_2 = .2$$

Thus within the period during which existing contracts remain outstanding, the slope of the Phillips curve (h) has a substantial impact on price and output responses to monetary disturbances.

(c) We now allow for the role of relative wages in contracts, by setting $\mu = 1/2$. We maintain $h = .5$.

$c_1 = .33$

$c_2 = .11$

Relative wage concerns in contracts thus slow down the response of prices to monetary policy.

(d) Indexation speeds up responses. Setting μ back to zero and with $h = .5$ (so that (b) is the baseline case); and assuming $\lambda = .5$ (instead of 1)

$c_1 = .67$

$c_2 = .33$

(e) Next consider the effects of assuming that one third of all contracts are for one year, one third for two years, and one third for three years. Thus

$\theta_1 = 11/18 \quad \theta_2 = 5/18 \quad \theta_3 = 1/9$

With such a structure of contracts, the economy should react much faster to monetary changes. Assuming $\lambda = 1$, $h = .5$, $\mu = 0$, we obtain

$c_1 = .80$

$c_2 = .44$

The responses are much more rapid in this case. Nearly half the response is completed in the first period (since 61% of the labor force signs new contracts each year, this is not surprising) and 80% within two years.

II. Disinflation.

Suppose now that the government wishes to disinflate. The money stock and thus the price level have been growing at the rate g, implying that m and p have

each been increasing by amount g from period to period. The new target rate of inflation is (g - .01). The government will announce and implement a growth rate of the money stock equal to (g - .01). In this section we assume that the announcement is completely and immediately believed by private agents.

As noted earlier, if the change in monetary policy is announced at least J periods (for example, three years) ahead, it will have no real effects. But by the same token, it will also have no nominal effects until it goes into operation.[14] Thus in this model, adjustment to a disinflation program that is announced sufficiently far ahead is abrupt. There is no effect on inflation until the date monetary policy actually changes; on that date the rate of inflation adjusts completely to the change in policy, and there is no effect on output.

It might thus seem that a disinflation program would have no real costs if only it were announced long enough in advance. However, the delay in implementation means that the existing inflation rate is maintained until policy is changed. If there were no costs to the high rate of inflation, there would be no call for the disinflation program. Accordingly, the strategy of delaying a change in monetary policy should be recognized as involving the trade-off of continued inflation at the original rate for J periods for the avoidance of unemployment. Alternative strategies that incur the costs of unemployment can result in more rapid disinflation.

At the opposite pole from the policy announced J periods in advance is a monetary policy change implemented without warning. Assume that the growth rate of money is reduced in the current period by 1%, and that the lower growth rate is maintained in perpetuity. Assume also that expectations of policy adjust

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[14]The sensitivity of this result to model structure is examined below.

simultaneously with the policy change. With policy changing in period t, the effects on the inflation rate and output in subsequent periods are given by:

$$(12)\quad \Delta(p_{t+i}-p_{t+i-1}) = c_{J-i} + i(c_{J-i}-c_{J-i-1}) \qquad \begin{matrix} i=1,\ldots,J \\ c_J \equiv 0 \end{matrix}$$

$$(13)\quad \Delta y_{t+i} = \Delta m_{t+i} - \Delta p_{t+i}$$

The adjustment is complete after J periods.

Examples: Suppose that all contracts last for three years, but wages are re-adjusted every six months. Then $\theta_i = 1/6$, $i=1,\ldots,6$. Table 1 shows, in examples A through C, the effects on inflation (at an annual rate, period over period) and output of a reduction in the growth rate of money by 1% per year (1/2% per period), under alternate assumptions about indexation and the role of the relative wage in wage determination.

The basic pattern is the same in cases (A-C). There is very little effect on the inflation rate to begin with, and there is at the end of the adjustment period a very low rate of inflation. The rate of inflation falls throughout the adjustment period. This characteristic is however a result of the assumption that all contracts are for three years. Example D in Table 1 shows the disinflation path when one third of the contracts are for one, two, and three years, respectively with the wage being adjusted every six months. In this case the disinflation is much more rapid, and the inflation rate does not behave monotonically. It remains true in example D that the largest reduction in the inflation rate occurs in period J, but that too is a result of the structure of contracts.

The last column of Table 1 shows the sacrifice ratio implied by this model to reduce the inflation rate by 1%, through the policy of reducing the growth rate of

Table 1: Disinflationary Effects of a Reduction in the Growth Rate of Money

$\theta_i = 1/6$, $i = 1,\ldots,6$; $h = .5$		Period								Sacrifice ratio
A		0	1	2	3	4	5	6	7	
μ=0	Inflation rate (%p.a.)	0	-.18	-.42	-.73	-1.17	-1.78	-2.72	-1	-
λ=1	Output	-.5	-.91	-1.2	-1.33	-1.25	-.86	0	0	3.03
B										
μ=.5	Inflation rate	0	-.10	-.24	-.47	-.86	-1.67	-3.67	-1	-
λ=1	Output	-.5	-.95	-1.33	-1.60	-1.67	-1.33	0	0	3.65
C										
μ=0	Inflation rate	0	-.33	-.67	-1.00	-1.33	-1.67	-2.0	-1	-
λ=.5	Output	-.5	-.83	-1.0	-1.0	-.83	-.5	0	0	2.32
$\theta_1 = \frac{11}{36}$ $\theta_2 = \frac{11}{36}$ $\theta_3 = \frac{5}{36}$ $\theta_4 = \frac{5}{36}$ $\theta_5 = \frac{1}{18}$ $\theta_6 = \frac{1}{18}$										
D										
μ=0	Inflation rate	0	-.36	-.97	-1.07	-1.6	-1.37	-1.69	-1	-
λ=1	Output	-.5	-.82	-.83	-.80	-.5	-.32	0	0	1.89

the money stock immediately to its new steady state level. The sacrifice ratio is the ratio of the cumulated percentage loss of output (at an annual rate) to the reduction in the inflation rate. These sacrifice ratios are substantially below the range of 6 to 18 quoted by Okun.[15] Thus the model implies faster disinflation than the standard econometric estimates. The model also implies that the sacrifice ratio could be reduced to zero by announcing a policy change sufficiently far in advance.[16]

Alternate Monetary Policies: Alternative paths of the money stock imply different paths of inflation and output. I examine here the path of the money stock that is needed to reduce the inflation rate immediately to its new steady state level, assuming for simplicity that the change in monetary policy is announced one period ahead. With $\Delta\pi$ as the desired change in the inflation rate, equation (7) implies that the change in the money stock needed to achieve the new price path is given by:

$$(14) \quad \Delta m_{t+i} = \frac{i\Delta\pi}{c_{J-i}}$$

It is understood that the reduction in the money stock in (14) is relative to the path that was previously expected.

When all contracts are of the same duration, the monetary policy implied by (14) consists of a sharp first period reduction in the money stock, followed later by a higher rate of increase than the new steady state inflation rate. After J periods the money stock is back at the level it would have reached had the money

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[15]The Okun sacrifice ratios, calculated in 1978, assumed a 3 to 1 Okun coefficient translating unemployment into GNP; with a 2.5 to 1 ratio, the sacrifice ratios would range from 5 to 15 rather than 6 to 18. (I am indebted to Ben Friedman for this point.

[16]Recent estimates by Gordon (1982) imply a sacrifice ratio of less than 5, well below his earlier estimates. The change reflects the inclusion of an exchange rate channel in the inflation process: tight money causes an appreciation that reduces the prices of imports.

growth rate been reduced immediately in period 1 to its new steady state level. This path of the money stock of course induces a large recession in the first period, and produces a much larger sacrifice ratio than the examples in Table 1.

The general point to be made about the sacrifice ratio for alternate policies is clear from the fact that a policy change delayed J periods has no output cost: policies that attempt to reduce the inflation rate rapidly have high output costs. This is because in the short run policy can drive the inflation rate down only by forcing reductions in the wage rates negotiated in contracts that come up for renewal in those periods.[17]

Model Specification and the Speed of Response: The dynamic patterns shown in Table 1, particularly in Example D, appear to suggest that the inflation rate would respond very quickly to changes in monetary policy, with small output costs. For instance, in Example D,[18] the inflation rate is down by nearly 1% (per annum) within 18 months of a reduction of 1% in the growth rate of money. In this section, I briefly examine characteristics of the model that produce this rapid response of inflation to monetary policy.[19]

A major factor responsible for the rapid response in this model is the synchronization of adjustments to wages. Every contract specifies a potentially

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[17]The contracting model used in this paper implies that workers with different contract renewal dates work at different wage rates. Accordingly, further development of the model would imply that relative price dispersion increases when there are unanticipated changes in the inflation rate.

[18]Although the maturity structure of contracts in D is much shorter than that discussed above for United States union contracts, it is an open question how non-union workers should be treated in the contract model--and thus example D may be relevant to United States behavior.

[19]Despite the emphasis on factors that might make the response of prices and output less rather than more rapid than implied in the model described above, it should also be recalled that the reopening of contracts would make for more rapid responses. Further, if the existence of long term contracts is a result of large negotiating costs, a very large change in monetary policy would be more likely than a more gradual change in policy to lead to reopening of contracts and thus to a rapid response of the inflation rate to policy.

different wage rate for each period. Examining equation (5), we see that all the expectations that affect the wage set for period t relate to variables in period t. Thus the contracts aim to obtain the "correct" wage in every period. It is well known that non-synchronized adjustments create the possibility of slower adjustment. For example, Taylor (1980) produces long adjustment lags in a model with two-period labor contracts in which the same wage applies in both periods of the contract.[20] When wage adjustments are not synchronized, wages for any given future period are based not only on expectations of conditions in that period, but also on expectations of conditions in other periods. Adjustment lags may be very long even with short contracts, in particular when wage determination reflects concern about relative wages.

Non-synchronization of wage adjustments in the United States takes the form of wages being held constant within each year of a contract, though not for its entire life. Results by Taylor (1983) suggest that non-synchronization in this context does not substantially change the speed of disinflation. But it is clear that non-synchronization is potentially important in explaining, for instance, the difficulties of disinflating in Britain as compared with the relative ease of doing so in Japan.[21]

The adjustment patterns in this model are simplified too by basing all the dynamics on wage contracting. Independent lags in price adjustment, for instance by including a lagged price term in equation (2) that results from modelling a cost of price change, (Rotemberg (1982)) would slow the response. It would also

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[20]Blanchard (1983) shows how non-synchronization of price changes can lead to long lags in the adjustment of prices to monetary policy changes.

[21]I plan to extend the model of this section in a subsequent paper to include non-synchronization.

result in the adjustment to a change in the growth rate of money being spread over the entire future, rather than being complete within J periods. Backward-looking elements in wage-setting, for instance attempts by labor to catch up for the effects of past inflation, would also slow and smooth the responses of wages and prices to monetary policy changes.

Similarly, the inclusion of the expected rate of inflation in the aggregate demand equation would affect the time profile of adjustment to monetary policy changes. A major change in the conclusions of the analysis of disinflation in that case would be that even long pre-announced changes in monetary policy would have real effects. Any announcement of a future change in monetary policy would trigger a rise in wages, and thus in prices, and result in the short run in changes in output. These changes would be smaller the longer in advance the change in policy is announced, and would be completed by the time the change in policy took place.

A third reason that adjustment of inflation to policy changes is relatively rapid in the examples studied earlier is that all policy announcements are immediately believed and incorporated in wages being negotiated for the future. Adjustment is much less rapid when policy intentions are not believed.

III. Credibility.

In the present model the credibility of policy affects prices and output entirely by its effects on expectations of future money stocks. We can thus use the model to examine output and price effects of monetary policy changes under alternative assumptions about expectations of policy.

I consider two examples in this section. In the first, the growth rate of money is reduced by 1% per annum, starting in period t. The reduction may be announced in advance, but is simply not believed by private agents, who continue

to expect that money growth will proceed at its former rate. The policy change thus has no effects on wages before it goes into effect. After the policy change, economic agents do not believe there has been a change in the growth rate of money. Each reduction in the money stock relative to expectations is treated as a permanent, but one-time, shock. Wages do adjust to the unanticipated changes in the money stock, because such changes are believed to be permanent and reduce estimates of the level but not the growth rate of future money stocks.

The price and output effects that follow from this set of assumptions are shown in Example A in Table 2. The inflation rate does fall by 1% as a result of the new policy and a new steady state is reached--but the expected inflation rate is by assumption not equal to the actual inflation rate. Correspondingly, the level of output is permanently below the full employment level. This extreme example indicates the effects of a lack of credibility of monetary policy in this model in which wages are set entirely on the basis of expectations of future events.

Table 2: Disinflation Under Alternate Expectations of Policy.

$\theta_i = 1/6$, $i = 1,\ldots,6$ $h = .5$, $\mu=0$, $\lambda=1$		Period 0	1	2	3	4	5	6	Sacrifice Ratio
A. Policy change not believed	Inflation rate	0	-.09	-.20	-.33	-.5	-.71	-1.0	--
	Output	-.5	-.95	-1.35	-1.69	-1.94	-2.08	-2.08	--
B. Adaptive expectations about money growth	Inflation rate	0	-.12	-.26	-.50	-.78	-1.18	-1.80	--
	Output	-.5	-.94	-1.31	-1.56	-1.67	-1.58	-1.18	6.0

Example B in Table 2 allows expectations of policy to adjust to experience.

All observed changes in the level of the money stock, resulting from unanticipated policy actions, are believed to be permanent. But now there are adaptive expectations about the growth rate of the money stock. In each period (half year), the expected rate of increase of the money stock is increased by one quarter of the excess of the actual growth rate of money over the expected rate. Eventually the economy will converge to full employment with a 1% reduction in the inflation rate. But Table 2 shows that the adjustment is lengthy. After six periods output remains more than 1% below the full employment level. At that stage the expected growth rate of money is over 80% of the way to converging to the new rate. The sacrifice ratio in this latter case--summed over the entire adjustment period--is 6.

It is clear from these examples that a lack of credibility of policy can substantially prolong the adjustment of output and the inflation rate to disinflationary policy.[22] But credibility is unfortunately very difficult to obtain. This is partly because the private sector knows that the government (usually) is not prepared to go to any lengths to reduce inflation. In the model of this paper, the monetary authority can monitor the effects of its announcements on wages by examining contract terms in newly negotiated contracts. A long preannounced policy will have small output effects when implemented only if contract terms have adjusted appropriately. But what is the monetary authority to do with its preannounced policy if it observes that contract terms have not changed? It is then precisely in the position it was in when it announced its future policy change some periods back. Namely, it knows that putting the policy change into effect immediately will cause unemployment. That is why it chose in the first place to announce a future policy change, rather than to implement it

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[22]See DiTata (1983) for an interesting analysis of credibility in a related context.

immediately.

Proposals for enhancing the credibility of policy changes typically rely on some form of precommitment of policy. But there are two difficulties with precommitment. First, intelligent policy-makers cannot be sufficiently certain of their understanding of the dynamics of the response to disinflationary policy to be sure that precommitment to a rigorous policy will succeed in bringing the inflation rate down at low cost. It may at some point be necessary to change policy. Second, in democracies it is difficult to devise methods of committing future governments to policies--particularly potentially costly and controversial policies--being undertaken at present. The credibility of policy, while obviously important, may be one of the stickiest of the elements that determines the response of the economy to attempts to change the inflation rate.

IV. Alternate Policies.

I will not discuss other policies to speed disinflation in any detail. The variable u_t in equation (2) above can be taken to represent supply side factors that can affect the price level. Changes in u, for instance in payroll taxation, could be a useful adjunct to the start of a disinflation program. One difficulty of using such supply side policy instruments is that it is rarely obvious when payroll taxes should be increased for stabilization reasons. A one time reduction may be desirable if a major effort is being made to institute a change in policy, and if quick success is needed to persuade economic agents that the policy will be successful.

Ingenious tax incentive plans (TIP's) to reduce the inflation rate have received considerable attention. Such plans are discussed in detail in Okun and Perry (1978); at least in the United States, their implementation looks administratively too complicated for success. Layard (1982) suggests a tax on wage increases above a certain norm and begins to discuss the "nuts-and-bolts issues of tax design" (p.229) in the English context.

Any approach to the problem of disinflation that emphasizes the role of expectations is bound to consider the possibility of using incomes policies, or wage and price controls. The argument for wage and price controls at the macro level is that they can be used to force prices and wages to follow the paths they would follow if all contracts were immediately renegotiable. Controls have the further advantage that they enhance the credibility of any restricitive policy measures undertaken at the same time. Wage and price controls not accompanied by restrictive policies are a waste of time. Unfortunately, it appears that controls are frequently used instead of, rather than along with, restrictive monetary and fiscal policies.

Because the distortions produced by controls increase the longer the controls are in place, they cannot be used for long. But there is no reason to shrink totally from the use of controls because some distortions are bound to be created: the unemployment that results from the implementation of disinflationary policies is also a distortion.

V. United States Disinflation, 1979-1986.

In October of 1979, with the inflation rate for the previous twelve months at over 12%, the Fed announced a new monetary policy designed to reduce the inflation rate. Four years and two recessions later the twelve month inflation rate (CPI, October over October) was down to 2.9%. What lessons about disinflation can be learned from this episode?[22] The main lesson is that there is no cheap way out of an entrenched inflation. The cure for inflation during this period used the old-time medicine of recession.

Figure 2 shows the unemployment rate and the GNP deflator inflation rate (quarter over the same quarter a year earlier) for the United States over the period since 1950. Vertical lines mark off recessions. The rate of increase of the deflator is now somewhat below the lowest level it reached in the seventies, but it has taken a prolonged period of high unemployment to achieve that low inflation. Further, the inflation rate is now cyclically low.

The general outlines of the disinflation were as expected. Quantitatively, though, the disinflation may have been slightly faster than predicted. I have calculated the sacrifice ratio for this disinflation making the following assumptions: the Okun's law coefficient is 2.5; the stabilization period begins in early 1980; unemployment will move smoothly from the current (last quarter of

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[22]Eckstein (1983) and Friedman (1983) examine this episode, concluding that the disinflation is consistent with earlier estimates of the Phillips relationship.

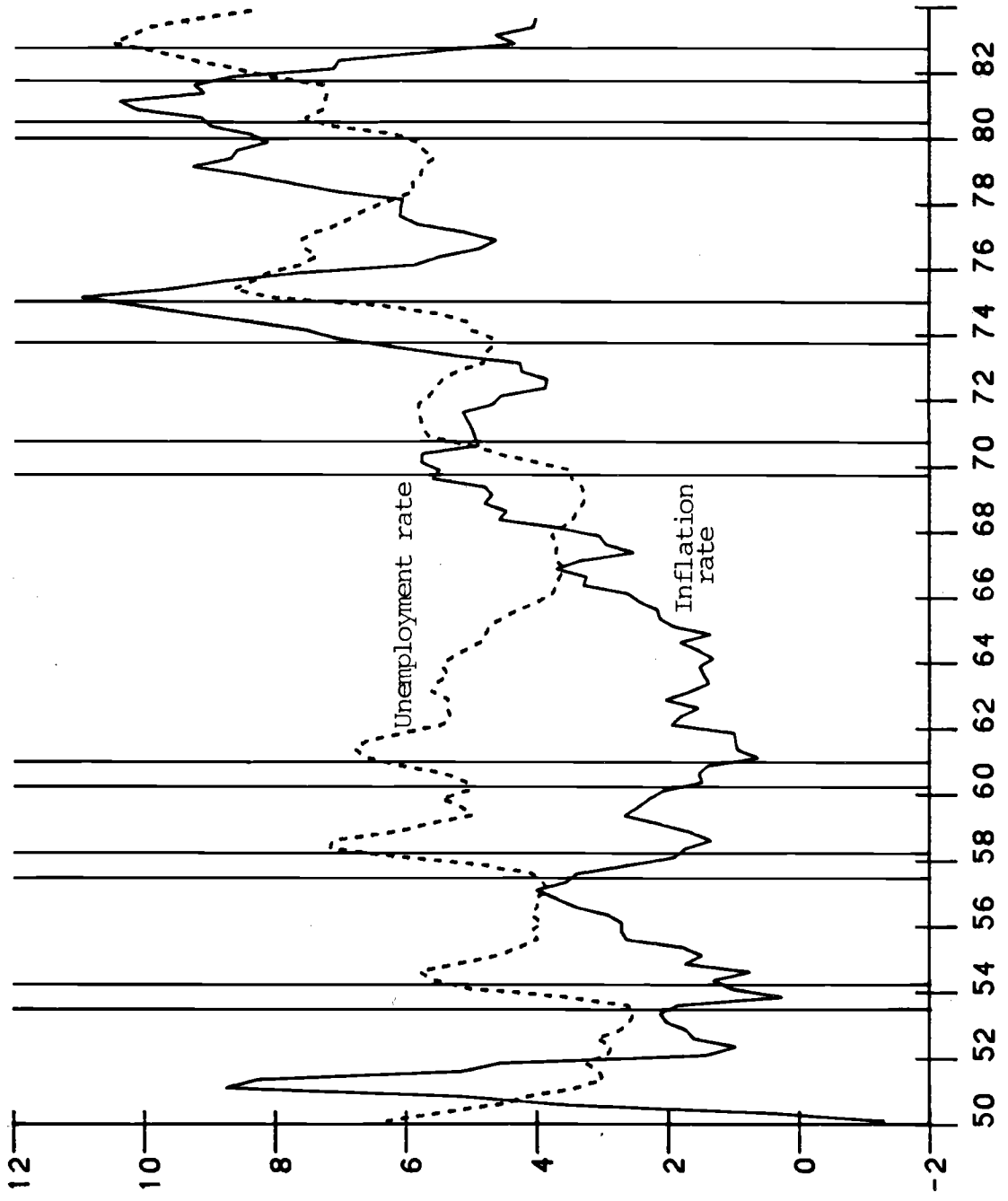

Figure 2: Unemployment and Inflation (GNP deflator) in the United States, 1950-1983:III

1983) 8.4% to 6.5% at the end of 1985; and the inflation rate will by 1985 have fallen from 10% to 5%.

Assuming the natural rate of unemployment is 6.5%, the cumulative output loss is 23.6%; with a 6% natural rate, the output loss would be 29.8%. These estimates give a sacrifice ratio around 5 or 6, at the lower end of the range quoted by Okun. This estimate is however very sensitive to the assumption that the fall in the inflation rate is 5%: with a 4% decline, the sacrifice ratio would be 6 to 7.5, closer to the mean Okun estimate; with a 6% drop in the inflation rate the ratio would be 4 or 5, below the Okun range. All these estimates are below the median sacrifice ratio suggested by Okun.

The calculated value of the sacrifice ratio of 5 to 6 thus suggests that disinflation this time was somewhat less costly than in past episodes.[24] Examination of some earlier estimates of the output costs of reducing inflation gives the same impression. Perhaps the most famous of these is by Tobin (1980), who examines in a model that is a "stylized version of the consensus view" (p.67), the effects of a policy that reduces the rate of increase of nominal GNP with the aim of reducing the inflation rate to zero. The path he illustrates, described as a cautionary tale, starts in 1980 and shows the unemployment rate hitting 10% and an inflation rate of 2.5% in 1987. We succeeded in reaching this point in less than half the predicted time. However, Tobin notes that the inflation rate might well come down more rapidly than his diagram suggests.

Among the reasons he offers is the possibility that actual and prospective bankruptcies and plant closings could lead to more rapid changes in wage and price

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[24]The favorable oil price shock has received some of the credit for the relatively rapid disinflation. However, low demand during the recession contributed substantially to creating this "shock". The exchange rate channel--attributable to the fiscal-monetary policy mix--is appropriately credited with speeding the disinflation.

patterns than had been experienced in the post-World War II period. There were such concessions in the recent recessions, in industries and plants that were threatened with bankruptcy or closing. Similar concessions have taken place in earlier recessions (Mitchell, 1982) but were later taken back. The depth of the recession, and the high real interest rates that made bankruptcies more likely, both probably contributed then to greater flexibility of wages than would be predicted by a simple contract model.[25] But the general outlines of the disinflation path taken in the United States since 1979 are consistent with the contracting model, with appropriate allowance being made for the slowness with which expectations of future policy adjust to actual policy.

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[25]This suggests that the monetary-fiscal mix, which produced high real interest rates and thus a greater risk of bankruptcy, was partially responsible for the speed of the disinflation.

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