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Wage Indexation and the Cost of Disinflation

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Abstract

While a standard academic presumption has been that wage indexation reduces the cost of disinflation, policymakers generally contend that wage indexing makes disinflation more difficult. To shed light on these views, this paper reexamines the effects of wage indexing on the output loss caused by money-based stabilization. It finds that the cost of disinflation with indexed wage contracts tends to be smaller than that with contracts that specify preset time-varying wages, but larger than that with contracts that specify fixed wages. Thus the academic and policymakers views can be both appropriate depending on the standard of reference.

JEL Classification Numbers:
E24, E31

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Summary

Ever since Friedman recommended the widespread use of indexation to help fight inflation in the early 1970s, the standard academic presumption has been that wage indexation reduces the cost of disinflation. The academic view notwithstanding, policymakers generally contend that wage indexing makes disinflation more difficult.

To shed light on these views, this paper re-examines the effects of wage indexation on the output loss caused by money-based disinflation. The analysis reveals that wage indexing, when the lags observed in actual indexation rules are taken into account, can either raise or reduce the cost of disinflation depending on the standard of reference being used. Indeed, indexed wage contracts can be compared with contracts that specify preset time-varying wages, typically observed in the unionized sector of the U.S. labor market, or with contracts that specify fixed wages, common in the rest of the world. The analysis shows that the disinflation costs in an economy with indexed wage contracts tend to be smaller than those in an economy with preset time-varying wage contracts, but larger than those in an economy with fixed wage contracts.

This result dispels the notion that wage indexation necessarily raises the cost of disinflation because of the lags in actual indexation rules and provides a suitable explanation for the difference between the views of academics and policymakers on the effects of wage indexing on disinflation, namely, that both views can be valid depending on whether indexed wage contracts are compared with preset time-varying wage contracts or with fixed wage contracts. This explanation accords with the fact that much of the academic literature refers to the U.S. labor market, where preset time-varying wage contracts seem a relevant yardstick, while the policymakers' view alludes essentially to other labor markets, where fixed wage contracts often provide a more appropriate standard of reference.

I. Introduction

In the early seventies, Friedman (1974) proposed the widespread use of indexation clauses in wage contracts and other covenants. He visualized price escalator clauses as a device that would not only reduce the harm done by inflation, but also facilitate the end of inflation. In the presence of indexation, he argued, any effects on prices caused by a deceleration in demand would be transmitted promptly to wage and other contracts; this would speed up the impact of stabilization policy on inflation and moderate its adverse repercussions on unemployment. 1/ By reducing the side effects of disinflation, he added, indexation would help to make the combat of inflation politically feasible and enhance credibility on the authorities willingness to persist in the fight against inflation.

Friedman's recommendation was soon countered on the grounds that wage indexation would make the adjustment of the economy to real shocks more difficult. However, his view that wage indexation would reduce the cost of disinflation has prevailed in the academic literature. In the standard model, his argument that indexation speeds up the adjustment of wages to changes in inflation is captured by the assumption that indexed wages adjust contemporaneously to the price level, as in the seminal paper by Gray (1976). Under this assumption, indexed wages in any period are tantamount to flexible nominal wages, and thereby help straightforwardly to stabilize output during disinflation in comparison to preset nominal wages. 2/

1/ Friedman (1974, page 43) wrote "most important, indexation will shorten the time it takes for a reduction in the rate of growth of total spending to have its full effect in reducing the rate of inflation. As the deceleration of demand pinches at various points in the economy, any effects on prices will be transmitted promptly to wage contracts, contracts for future delivery, and interest rates on outstanding long term loans. Accordingly, producers' wage costs and other costs will go up less rapidly than they would without indexation... With widespread indexation, in sum, firm monetary restraint by the Federal Reserve System (the "Fed") would be reflected in a much more even reduction in the pace of inflation and a much smaller transitory rise in unemployment."

2/ The view that wage indexation reduces the cost of disinflation can be found for instance in Taylor (1983), Fischer (1986, 1988), Devereux (1989), Fischer and Summers (1989), Ball and Cechetti (1991), VanHoose and Waller (1991), Waller and VanHoose (1992), Milesi-Ferreti (1994), and Crosby (1995). Two well known references on wage indexation excluded from this list are Gray (1976) and Fischer (1977); although they argue that wage indexation helps to stabilize output in the face of nominal shocks, strictly they refer to shocks in the level of money demand or supply rather than on shocks on the rate of growth of those variables. Surveys on the literature on wage indexation can be found in Aizenman (1987), Carmichael, Fahrer, and Hawkins (1985), Devereux (1994), and Van Gompel (1994).

The academic view notwithstanding, policymakers generally contend that wage indexation makes disinflation more difficult. This fact was first highlighted by Simonsen (1983), and is revealed for instance in the papers contained in a volume edited by Williamson (1985). In recent experience, the economic authorities in Chile have pointed to wage indexation to explain why faster disinflation has not been possible in the country, and during recent stabilization programs in Argentina and Brazil wage indexing has been prohibited. Moreover, in several Eastern European countries were wage indexation has been introduced or proposed, the main arguments in favor of this policy highlight the effects it has on mitigating the costs of inflation and attaining social order rather than on making disinflation easier.

A partial reconciliation of these views might be that wage indexation reduces the cost of disinflation and it nevertheless makes disinflation harder because it palliates the costs of average inflation and thus weakens the will to fight it. The importance of this effect was stressed by Fischer and Summers (1989) for the case of fiscal and financial indexation, and was examined for the case of wage indexation by Ball and Cechetti (1991); using the assumption of contemporaneous indexation within an extended Barro-Gordon (1983) model of inflation, Ball and Cechetti showed that wage indexing can indeed increase inflation even if it reduces the cost of disinflation. However, this rejoinder is not fully satisfactory because on close examination the policymakers' main allegation on this issue is not that wage indexation weakens the will to fight inflation, but simply that it makes disinflation more costly. 1/

In order to explain the difference between the policymakers and academic views, Simonsen (1983) preferred to conjecture that the lags that exist in actual indexation practices imply that wage indexing in real life raises rather than reduces the cost of disinflation. While the analysis he offered was merely suggestive, his conjecture has seemed to be supported recently by the results of Bonomo and Garcia (1994). 2/ These authors replicated Ball's (1990) analysis of credible disinflation policies in an economy with staggered fixed prices, but in the presence of an indexation

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1/ For example, the Central Bank of Chile (1994, pages 19-20) explained recently that "the slow adjustment of nominal wages shows the relevance of inertial aspects in Chilean inflation. The institutions and usual practices in our economy are marked by the memory of high inflation episodes, which has lead to widespread indexation as a form of insurance against inflationary surprises. The inflationary inertia associated with this widespread indexation puts a limit on the speed of the disinflation, as to avoid the important costs in economic activity that would arise in the case of a rapid disinflation." (translation by the author). Also see Williamson et al. (1985).

2/ Simonsen explored the issue by adding a lagged inflation term to an expectations augmented Phillips curve. Several authors have followed his approach to model the consequences of wage indexation; recent examples are De Gregorio (1995) and Milesi-Ferreti (1995).

rule whereby individual prices are adjusted by the inflation accumulated since the last adjustment. As Ball, they found that certain disinflation policies could cause a boom in the economy if they were credible; however, Bonomo and Garcia discovered that under indexation the boom caused by those policies would be followed by a recession, so that the net output gain during the disinflation would be smaller in the indexed economy than in Ball's economy. They also estimated that the time necessary to reduce inflation without affecting output would be longer in the indexed economy.

Yet the notion that lagged wage indexation raises the costs of disinflation is somewhat contradicted by the results obtained earlier by Fischer (1986, 1988) and Taylor (1983). In his examinations of the effects of a cut in money growth, Fischer found that the cost of disinflation in an economy with "ex ante" or "lagged ex post" wage indexation would be smaller than in an economy with predetermined wages. Similarly, in simulations based on the actual structure of union wage contracts, Taylor found that lagged wage indexation as observed in practice increased the speed at which disinflation could be achieved in the Unites States without an increase in unemployment. However, the indexation rules examined by Fischer do not correspond to the usual formula that links current wage adjustments to past inflation, 1/ and Taylor's analysis did not refer strictly to costs of disinflation.

In order to shed light on whether wage indexation raises or reduces the cost of disinflation, this paper reexamines the effects of wage indexing on the output loss caused by money-based disinflation. The analysis reveals that wage indexation, when the lags observed in actual indexation rules are taken into account, can either raise or reduce the cost of disinflation depending on the standard of reference being used. Indeed, indexed wage contracts can be compared with contracts that specify preset time-varying wages, typically observed in unionized sector of the U.S. labor market, or with contracts that specify fixed wages, common in the rest of the world. The analysis shows that the cost of disinflation in an economy with indexed wage contracts tends to be smaller than that in an economy with preset time-varying wage contracts, but larger than that in an economy with fixed wage contracts.

1/ Under Fischer's "ex ante" indexation rule, indexed nominal wages are set according to the expectation held at t-1 about the price level at t; the implied cost of living adjustment is the difference between the one-period-ahead expectations on the current and past price levels. Under his "lagged ex post" indexation rule, in turn, indexed nominal wages are set equal to the price level observed at time t-1 when there is a cost of living adjustment, and are equal to the expectation held at t-1 about the price level at t when there is a contract revision. As in this case Fischer focuses on two-period contracts, the implied cost of living adjustment (granted at the contract mid-life) is the difference between the actual price in the previous period and the one-period-ahead-expectation about the same price.

This result dispels the notion that wage indexation necessarily raises the cost of disinflation because of the lags in actual indexation rules and provides a suitable explanation for the difference between the views of academics and policymakers on the effects of wage indexation on disinflation, namely, that the academic view is valid if indexed wages are compared with preset time-varying wages, while the policymakers view is valid if indexed wages are compared with wages that are fixed during the life of each contract. This explanation accords with the fact that much of the academic literature refers to the U.S. labor market, where contracts with preset time-varying wages seem a relevant yardstick, while the policymaker's view alludes essentially to other labor markets, where fixed wage contracts often provide a more appropriate standard of reference. 1/

According to the analysis, although indexed wage contracts tend to reduce the total cost of disinflation in comparison with preset time-varying wage contracts, they imply similar effects in the initial stages of disinflation. With both type of contracts the adjustment of wages to a reduction in expected inflation tends to be postponed until the changes actually occur, or are expected to take place. Once initial reductions in the inflation rate have been achieved, however, wage indexation tends to make disinflation easier. The reason is that indexation clauses automatically transmit any initial reductions in the inflation rate to wages and inflation in the following periods. After the initial fall in output induced by an unanticipated cut in money growth, and depending on the structure of the economy and the nature of monetary policy, this feedback effect can prevent a larger decline on output, permit a faster recovery, or create a boom following the recession. As a result, the total output cost of the disinflation tends to be smaller with indexed wage contracts than with preset time-varying wage contracts.

Indexed wage contracts tend to raise the cost of disinflation in comparison with fixed wage contracts because indexation dampens the responsiveness of wages at the beginning of disinflation relative to this alternative standard of reference. While fixed wage contracts are front loaded and thereby maximize current wage adjustment when a persistent reduction in inflation is expected, indexed contracts tend to postpone that adjustment until inflation has fallen, making it less necessary for current wages to adjust. This effect is reinforced at the aggregate level if the indexed contracts are longer in duration than the fixed wage contracts--which seems the relevant case in practice--since contracts with a longer life reduce the number of wage bargainings held in any period and thus make the current aggregate wage less sensitive to the new macroeconomic conditions. The consequence is that wage indexation magnifies the drop in

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1/ Indeed, Friedman (1974), Taylor (1983), and Fischer (1986, 1988) referred mostly or solely to the U.S. economy and used preset time-varying wages as their standard of reference. Bonomo and Garcia (1994), in turn, referred explicitly to high inflation economies, and used fixed prices as the standard of reference (however, they argued that disinflation with indexation is also more difficult than with preset time-varying prices).

output that occurs in the initial stages of the disinflation. While the automatic cost of living adjustments in subsequent periods can speed up the recovery and create a boom after the recession is over, the magnitude of this effect tends to be smaller. As a result, the total cost of disinflation tends to be smaller with indexed wage contracts than with fixed wage contracts.

The remainder of this paper is organized as follows. Section II presents a model of indexed wage contracts and compares the aggregate wage equations implied by these and alternative nonindexed contracts. Section III studies the effects of wage indexation on the output cost of an unanticipated but credible disinflation using a simple model of the economy. Section IV checks the robustness of the results to alternative assumptions, and the last section provides concluding remarks.

II. Wage Indexation and Aggregate Wage Dynamics

This section examines the aggregate wage behavior implied by indexed and nonindexed wage contracts. The analysis takes the structure of the contracts as given, and assumes uniform staggering. Wage indexation is modeled explicitly as a contract clause that grants periodic adjustments in the contract wage according to a lagged value of the inflation accumulated since the last wage revision.

1. Indexed wage contracts 1/

Indexed wage contracts in real life generally do not provide full protection against fluctuations in the price level. Although they stipulate mperiodic wage revisions which depend on actual inflation, normally these revisions are not granted in every period and are based on a lagged value of the inflation accumulated since the previous wage adjustment. For instance, in Chile where most wage contracts are indexed, cost of living adjustments are typically granted every six months, according to 100 percent of the inflation accumulated since the last wage revision (Jadresic (1992)). In the United States, indexed wage contracts observed in the unionized sector typically specify a cost of living adjustment once a year, according to a fraction of the inflation measured during the previous year. In both countries, due to the delays in the availability of consumer price indexes, the cost of living adjustments are usually based on a one-month lagged value of accumulated inflation. 2/

1/ This section is based in Jadresic (1991).

2/ Contracts with trigger-point indexation can offer better protection against price fluctuations, but are less common in practice. The implications of this alternative kind of contracts are not studied here.

To study the consequences of wage indexation in a simple framework, assume that cost of living adjustments are granted in every period according to 100 percent of the previous period's rate of inflation. 1/ If the length of the contracts is denoted by the integer n>1, then uniform staggering implies that in every period 1/n of the wages is negotiated, while the remainder are adjusted according to past inflation. It follows that the variation of the aggregate wage in a given period when contracts are indexed is

$$w_t^I = (1-\frac{1}{n})\,\pi_{t-1} + \frac{1}{n}\,x_t = \pi_{t-1} + \frac{1}{n}\,(x_t-\pi_{t-1}), \qquad (1)$$

where π_{t-1} is the past period's inflation rate, and x_t is the initial increase in the nominal wage agreed in the recently revised contracts. Unless explicitly pointed out, variables in this paper are measured in log terms, with lower case letters representing their first differences, and capital letters their levels.

Applied discussions of indexed economies often assume that $x_t-\pi_{t-1}$ is a negative function of the current unemployment rate or simply a constant. If contracts are revised, however, x_t must be agreed upon in the wage negotiations between firms and workers. To determine its value, it is postulated here that the outcome of the negotiations maximizes the expected value of a quadratic function of the average real wage implied by each contract. 2/

This setup implies that the initial wage increase is set so as to make the expected average real wage of the corresponding contracts equal to a target real wage, where the latter depends on the expectations that the wage setters have on the exogenous variables that enter into their objective function. If contracts that begin at time t are negotiated with information on the events that occurred up to time t-1, this relation can be written as

$$x_t \textit{ is such that } E_{t-1}[\textit{Contract's average real wage}] = E_{t-1}\,[\frac{1}{n}\sum_{s=0}^{n-1}\Omega_{t+s}], \qquad (2)$$

1/ The cases in which the cost of living adjustments are not granted every period, and the degree of indexation is less than 100 percent, are analyzed in Jadresic (1992).

2/ The goal of maximizing a non linear function of the real wage is implied by different microeconomic models of wage determination. This includes the case in which unions set wages so as to maximize the wage bill--if firms keep their right to manage so that employment is defined by labor demand--and the case in which firms set wages according to efficiency wage considerations. The specification of the maximand as a quadratic function of the real wage is used to introduce expected variables in a log linear manner, and can be interpreted as a second order approximation to the actual objective function. The assumption that it is the average real wage rather than its present value that matters simplifies the algebra.

where the right-hand side represents the target real wage for the contracts signed for period t to t+n-1 according to information available in t-1. To simplify comparisons made below, this target real wage is represented as an average of period-specific target real wages $E_{t-1}\Omega_{t+s}$ between s=0 and s=n-1. Defining precisely what determines the latter is not important in this section.

To derive the initial wage increase implied by this condition, suppose that wage negotiators agree on a nominal wage X_t for the first period of a contract's life. Taking into account the indexation rule, it follows that the sequential evolution of the real wage during the contract's lifetime is

$$\begin{aligned} & X_t - P_t \\ & X_t + (P_t - P_{t-1}) - P_{t+1} \\ & \quad \cdots \\ & X_t + (P_{t+n-2} - P_{t-1}) - P_{t+n-1}, \end{aligned} \tag{3}$$

where P_t denotes the price level during period t, P_{t-1} the price level during period t-1, and so forth.

Computing the average of this sequence, taking expectations conditional on information available at time t-1, and using the resulting expression in equation (2), provides an expression for the initial wage expressed in levels. The initial wage increase can then be obtained as the difference between X_t and the value achieved in period t-1 by the wage negotiated in period t-n. This gives

$$\begin{aligned} x_t &= X_t - (X_{t-n} + P_{t-2} - P_{t-n-1}) \\ &= \pi_{t-1} + (1 - L^n)\, E_{t-1}\left[\frac{1}{n}\sum_{s=0}^{n-1} (\Omega_{t+s} + \pi_{t+s})\right], \end{aligned} \tag{4}$$

where L is the standard lag operator.

Replacing equation (4) in equation (1) implies that with indexed wage contracts aggregate wage behavior is

$$w_t^I = \pi_{t-1} + \frac{1}{n}(1 - L^n)\, E_{t-1}\left[\frac{1}{n}\sum_{s=0}^{n-1} (\Omega_{t+s} + \pi_{t+s})\right]. \tag{5}$$

The first term on the right-hand side of this equation captures the familiar link between current wage adjustments and past inflation that is associated with wage indexation. In proportion 1/n-1 this term stems from the indexation clauses contained in the contracts not revised during the

reference period. In proportion 1/n it also corresponds to a bench-mark adjustment in the revised wage contracts, with respect to which a "plus" or "minus" initial adjustment is granted. In the aggregate, this term implies that an (unexpected) shock in last period's inflation rate has a proportional impact on current wage adjustments--a direct consequence of the assumption of a one-period and 100 percent indexation rule.

The second term captures the effect of the initial wage revisions. These revisions can break the mechanical link between aggregate wage changes and past inflation. Whether this happens or not depends on the wage setters' expectations about the appropriate real wage and the likely inflation during the life of the new contracts, compared to the expectations they held when the contracts just ended were signed. For example, if the inflation rate expected (at t-1) for the n periods to come rises relative to the inflation rate that was expected (at t-n-1) for the last n periods, then the aggregate wage will grow faster than past prices.

Note that the second term at the right hand side of equation (5) implies that the elasticity of the current aggregate wage with respect to a change in expected inflation is equal to 1/n (assuming that current and future inflation rates are all expected to change in the same amount). This elasticity would be zero if the indexation of wages to the price level were contemporaneous: in that case all wage adjustments would be postponed until the changes in inflation actually occur. This is not the case here, however, because due to the lags in the indexation mechanism a permanent increase in inflation reduces the real wage proportionally. Thus, unless the target real wage is modified, each contract signed with the new inflation expectations includes an equivalent initial wage increase, to compensate for the expected increase in the inflation rate. The impact of these adjustments at the aggregate level is 1/n, as this effect is filtered by the fraction of contracts negotiated in each period.

2. Alternative wage contracts

One possible standard for evaluating the implications of indexed contracts is provided by the case the wage in each contract remains fixed during the term of the agreement (as in Taylor (1980)). In this case, if wage settlements attempt to achieve an average target real wage--as in the previous section--it can be shown that uniform staggering implies

$$w_t^F = \frac{1}{n}\sum_{s=1}^{n} \pi_{t-s} + \frac{1}{n}(1-L^n)\, E_{t-1}\left[\frac{1}{n}\sum_{s=0}^{n-1}(\Omega_{t+s} + (n-s)\,\pi_{t+s})\right]. \qquad (6)$$

The first term on the right-hand side of this equation indicates that there is a component of inflationary inertia in the determination of wages even though contracts are not indexed. This inertia comes from a catch-up wage increase granted in the revised contracts, which compensates for the depreciation--due to inflation--of the real value of the wages agreed in the negotiations held n periods earlier. As only a fraction of the

contracts are renegotiated in every period, the impact of these catch-up adjustments at the aggregate level is equivalent to 1/n times the inflation accumulated in the last n periods. Note that this implies that the impact of last period's inflation rate on current wages is 1/n, significantly smaller than the unit elasticity found for indexed contracts (for n>1).

The second term corresponds to the wage increase above or below the catch-up term granted in the revised contracts. Its interpretation is similar to the indexed contracts case, except that the impact of a change in expected inflation on the current aggregate wage is larger. Computing the sum of the weights attached to the current and future inflation variable in equation (6) implies that the expectation of a permanent increase in inflation raises the current aggregate wage by a proportion of (n+1)/2n. This expression is always larger than 1/n for n>1, so that it is larger than the elasticity of indexed wages with respect to expected inflation. The intuition is that, as fixed-wage contracts are front loaded and do not offer any cost of living adjustments, these contracts tend to be much more sensitive to changes in inflation expectations when they are renegotiated.

Another alternative is to have contracts that specify preset time-varying wages, in which the sequence of each contract's nominal wage can vary according to the expectations that were held when the agreement was signed (as in Fischer (1977, 1986, 1988)). In this case, wage setters can go beyond the attempt to achieve an average expected real wage, and rather target a specific real wage for each period. With uniform staggering, it can be shown that such behavior leads to

$$w_t^P = \frac{1}{n}\sum_{s=1}^{n} E_{t-s}\,[\pi_t+\omega_t] + \frac{1}{n}\,(1-E_{t-n-1})\sum_{s=1}^{n}[\pi_{t-s}+\omega_{t-s}], \qquad (7)$$

where $E_{t-s}\omega_t$ is the expected change in the target real wage between t-1 and t according to information at t-s, and so forth.

The first term on the right hand side of equation (7) contains the adjustment of wages stemming from the changes in expected prices and the targeted real wage, according to the information that was available at the time the contracts were signed. The second term captures the effect of the updating of wages in the recently negotiated contracts, which depends on the discrepancy between the inflation rates and target real wages forecasted in the previous negotiation with respect to their actual values.

Note that equation (7) shows a different form of inflationary inertia: if the target real wage is constant, the current aggregate wage is determined by past expectations about current inflation and observed forecasting errors. The consequence is that the elasticity of the current aggregate wage with respect to a shock in the previous period's inflation rate is the same as the fixed-wage contracts case: 1/n. On the other hand, the elasticity of the current aggregate wage with respect to a shock in expected inflation is the same as the indexed contracts case: 1/n. The

intuition for the latter is that when both type of contracts are negotiated, the adjustment of wages tend to be postponed, either until the changes in inflation actually occur or until they are expected to occur.

Table 1 summarizes the elasticities of the current aggregate wage in response of a shock in the previous period inflation rate and of a change in expected inflation for the alternative wage contracts being considered. 1/

III. Wage Indexation and the Cost of Disinflation: Basic Results

In order to gauge the effects of wage indexation on the cost of disinflation, this and the following section examine the behavior of inflation and output during money-based stabilization given the different wage equations previously derived. This analysis is carried out using a simple model for the remainder of the economy, under the assumption that the reduction in money growth is unexpected but is permanent and credible.

1. A simple model of the remainder of the economy

In the base model to be studied, output (Y_t) is driven by real money balances:

$$y_t = m_t - \pi_t. \tag{8}$$

where the variable m_t represents the rate of growth of money, assumed to be the monetary authority's policy instrument. It is also possible to interpret this variable as the rate of change in nominal aggregate demand, and to suppose that the monetary authority regulates it through changes in the interest rates.

As in Fischer (1986), Taylor (1980), Ball (1990), and others, inflation is assumed to be given by the rate of change of wages:

$$\pi_t = w_t. \tag{9}$$

Finally, the target real wage for a given period is supposed to be determined by the expected level of average output for the same period:

1/ In terms of a distinction proposed by Chadha, Masson, and Meredith (1992), these elasticities provide analytical measures of the backward-looking and forward-looking components of current wage adjustments associated to each type of contracts. Note, however, that while they assume that the sum of the elasticities corresponding to these two components adds up to one, here this sum is always different from unity for viable contract lengths.

Table 1. Elasticity of the Current Aggregate Wage

	In Response of a Shock In Previous Period Inflation	In Response of a Shock In Expected Inflation
Indexed wage contracts	1	1/n
Preset time-varying wage contracts	1/n	1/n
Fixed wage contracts	1/n	$(n+1)/2n > 1/n$

$$E_{t-s}\Omega_t = E_{t-s}Y_t. \qquad (10)$$

2. Costs of disinflation

Consider a set of economies similarly characterized by equations (8), (9), and (10), but differing in that their wages are set according to indexed contracts, preset time-varying wage contracts, and fixed wage contracts. The latter could either be of the same duration as the indexed and preset time-varying wage contracts, case in which they will be identified below as long-term fixed wage contracts, or be half as long, case in which they will be identified as short-term fixed wage contracts. This is a useful distinction because, in practice, relevant fixed wage contracts are likely to be shorter in duration than indexed or preset time-varying wage contracts, as argued further below.

Suppose that money growth, inflation, and output have been stable for a long time in these economies, but then there is a permanent reduction in the rate of money growth, unanticipated but credible since its announcement and implementation at period t-1. What is the path for inflation and output in each economy? What is the total cost of the disinflation in each case?

Figure 1 shows the behavior of inflation and output implied by such a shock in the four economies under consideration. The paths for these variables were obtained by solving equations (8), (9) and (10) together with either equations (5), (6), (6) with n replaced by n/2, or (7), depending on the case at hand. Since it proved difficult to find analytical solutions for inflation and output as a function of the length of the contracts in all the relevant experiments, it was necessary to choose a specific contract length to solve the implied dynamic equations numerically. For practical reasons, n was set equal to four. In simulations using other values for this parameter, the results did not change in their essentials. In particular, the ranking of costs of disinflation, measured as the net output sacrifice during the stabilization, was not modified. 1/

It is not surprising that, as observed in Figure 1, the cut in money growth leads to a recession in all the economies being examined: when the new monetary policy is announced and implemented, the short-run dynamics of wages in all cases is mostly determined by past events and decisions consistent with higher money growth. The interesting exercise is to compare the behavior of output throughout the different economies.

Compare first the disinflation in the indexed economy with the one in the preset time-varying wages economy. In the initial stages of the disinflation, the path of output in both economies is quite similar. This is because, in the short run, the evolution of wages depends crucially on the elasticity of the aggregate wage with respect to the expected disinflation, which is the same in both economies (1/n). As time goes by,

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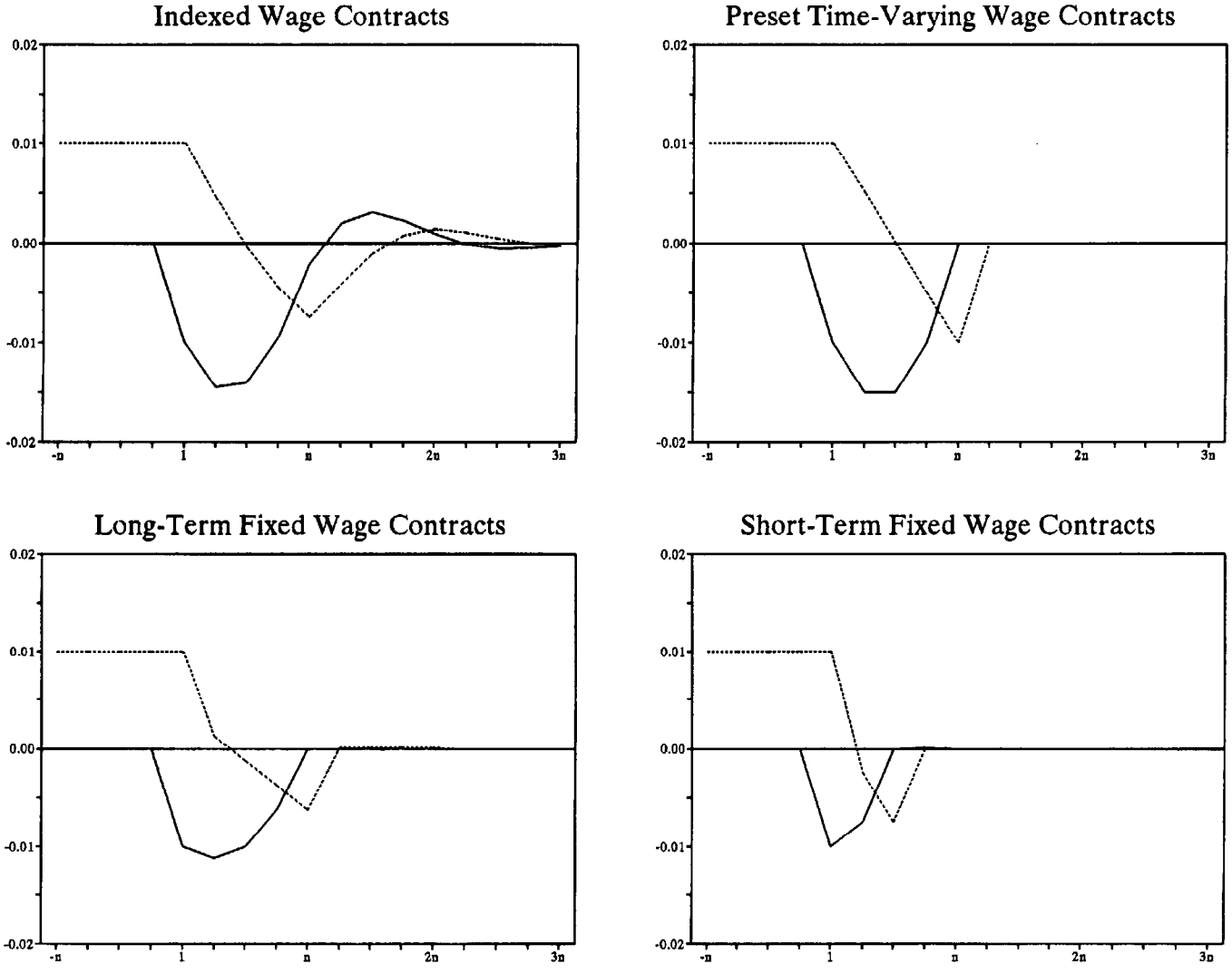
1/ The cut in money growth was normalized to 0.01 in log terms.

Figure 1. Money Growth Stabilization: Base Model

(log deviation from the final steady state)



however, the automatic adjustment of wages to past inflation implied by indexation makes an increasing difference to the relative behavior of output. In the policy experiment studied here, the main difference is that the indexed economy experiences a boom following the recovery. This boom arises because, to return to full employment, the economy must experience a period with inflation below the new rate of money growth. When the indexed economy reaches full employment, the indexation clauses feedback the low inflation observed during the recovery into low current inflation; as the new rate of money growth is constant, the consequence is a boom. In the predetermined-wages economy, this does not happen due to the absence of automatic cost of living adjustments. As a result, the net output loss during the adjustment to the new steady state is smaller in the indexed economy than in the preset time-varying wages economy (Table 2, row one). 1/

Disinflation policies with a more complex path for the rate of growth of money can eliminate the boom experienced by the indexed economy following recovery. However, the absence of a boom under some alternative disinflation policy does not mean that the output sacrifice would be larger in the indexed economy than in the economy with preset time-varying wages. For instance, it can be shown that if monetary policy is designed to obtain a linear disinflation in the indexed economy, the indexed economy displays no boom following the recovery, but enjoys a faster disinflation and thus a faster recovery to full employment than the economy with preset time-varying wages. As a result, the cost of disinflation still turns out to be smaller in the indexed economy. 2/

Compare now the behavior of the indexed economy with the behavior of the economies with fixed wage contracts. During the initial stages of the disinflation, the indexed economy suffers a larger drop in output. The reason is that the response of the aggregate wage to the expected disinflation is smaller in the indexed economy, so that its inflation rate falls comparatively little when the new monetary policy is announced. Afterwards, both economies recover and, as already noted, the indexed economy experiences a boom after the recession. This boom, however, does not compensate for the deeper recession experienced by the indexed economy in the initial stages of disinflation, so that the net output sacrifice is greater in the economy with indexed contracts. This is true in comparison with the output sacrifice in the economies with either long- or short-term fixed wage contracts, although, not surprisingly, the differences are maximized when the standard of reference is the economy with short-term

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1/ The boom in the indexed economy is followed by a sequence of recession-and-boom cycles of decreasing amplitude. These cycles are due to reasons analogous to the ones that generate the first boom and fade way relatively fast. Their (marginal) effect is taken into account in Table 2.

2/ Below it is found that, in comparison to preset time-varying wages, indexed wages may also prevent a larger deterioration of output after the initial impact of the cut of money growth. This is another effect that can help to make disinflation relatively easier in the indexed economy.

Table 2. Net Output Loss During Money Growth Stabilization 1/

Simulation	Indexed Wage Contracts	Preset Time-Varying Wage Contracts	Fixed Wage Contracts	
			Long-Term	Short-Term
1. Base model	.0433	.0500	.0375	.0175
2. Partial credibility	.0662	.0750	.0623	.0323
3. Anticipated disinflation	.0000	.0000	-.0125	-.0025
4. Procyclical price to wage ratio	.0240	.0333	.0250	.0117
5. Less sensitive target real wage	.0555	.0632	.0477	.0206
6. Interest elastic money demand	.0344	.0399	.0329	.0171
7. Open economy	.0196	.0283	.0217	.0111

1/ Sum of log deviations of output from its steady state level in response to a cut in money growth by .01 in log terms.

fixed wage contracts. As shorter contracts are negotiated more often, they make the aggregate wage more sensitive to the stabilization policy during the initial stages of disinflation (Table 2, row one).

IV. Robustness

This section examines how the basic results are modified if the disinflation is partially credible and anticipated. It also examines the effects of relaxing some of the structural assumptions about the economy.

1. Partial credibility

In reality, even successful stabilization programs are not fully credible when they are implemented; they gain credibility as time goes by. What are the consequences of partial credibility on disinflation in the different economies? Does it modify the ranking of costs of disinflation obtained in the previous section?

Figure 2 considers the case in which wage setters believe, once the disinflation has been announced and implemented, that money growth will revert permanently to its prestabilization level with probability q_t (starting next period), and that it will remain for always unchanged at the stabilized level with probability $1-q_t$. For the sake of concreteness, the figure focuses in the case in which the perceived likelihood of a policy reversal declines exponentially according to the formula $q_t=(1/2)^t$.

Not surprisingly, in all the economies the recession induced by the disinflation turns out to be deeper and longer than in the base case: the fall in output is large and the recovery of output to full employment levels takes more time. The important observation, however, is that the relative pattern of evolution of inflation and output changes similarly across the different economies. As a result, partial credibility does not alter the ranking of costs of disinflation (Table 2, row two).

2. Anticipated disinflation

What is the effect on the different economies of an anticipated cut in money growth? This is an interesting case to look at from a theoretical point of view: Ball (1990) found that in an economy with fixed-wage contracts, a credible and gradual reduction in money growth can generate a boom rather than a recession. This can happen if the reduction in money growth during the initial stages of disinflation is less than the reduction in wage increases due to the expected disinflation.

In order to look at the most extreme case, Figure 3 examines the effects of a fully anticipated cut in money growth in the base model. Since the expected disinflation reduces wage increases in anticipation of the actual cut in money growth, the economies with fixed wage contracts now experience a boom, as in Ball's case. The indexed economy, in turn, also experiences a boom, but this is followed by a recession (for reasons

analogous to the ones that explain the boom after the recovery in the base case). Finally, output in the economy with preset time-varying wages is not affected by the disinflation, since all the necessary wage adjustments are included in the contracts sufficiently in advance.

How do the output effects of the disinflation compare across the alternative economies? Consider first the indexed economy as compared to the economy with preset time-varying wages. Although the paths of output in both economies are quite different, the net output loss is zero in both cases (Table 1, row three). In this sense, it can be said that the "cost" of a fully anticipated disinflation in these economies is similar. This qualifies the result obtained previously that indexed wages make disinflation easier than preset time-varying wages, but only slightly, since a fully anticipated disinflation is an unlikely event in practice. In comparison with the economies with fixed wage contracts, in turn, the economy with indexed contracts dampens the magnitude of the boom caused by the anticipated disinflation, and, in addition, creates a recession. Under the standard interpretation that output gains are welfare improving, this implies that indexation makes the disinflation relatively harder, as in the previous experiments (Table 2, row three).

3. Procyclical ratio between prices and wages

The assumption that price inflation equals wage inflation presumes that the changes in output occurring during the disinflation do not have an impact on prices directly. An alternative assumption is that, given wages, prices are procyclical. For instance, this could happen if increases in the level of output raise the firms' marginal costs and the price elasticities of the individual demands they face.

If the price-wage ratio is procyclical, the fall in output associated with an unanticipated cut in money growth moderates price increases independently of its impact on wages. As shown in Figure 4, this effect reduces the cost of disinflation in all the economies under study (the figure assumes that a 1 percent fall in output reduces the price to wage ratio by 0.5 percent). The relative impact on the costs of disinflation, however, is different across the various economies. In the economy with indexed contracts, the initial reduction in the inflation rate feedback automatically into smaller wage adjustments in following periods, so that the costs of disinflation diminish more than in the other economies (Table 2, row four).

This effect strengthens the result that the cost of disinflation in the indexed economy is smaller than in the economy with preset time-varying wages, but it weakens the result that the cost of disinflation in the indexed economy is larger than in the economies with fixed wage contracts. Indeed, for the assumed elasticity of the price-wage ratio, the cost of disinflation in the indexed economy is similar--and actually slightly smaller--than in the economy with fixed wage contracts of the same duration.

Figure 2. Money Growth Stabilization: Partial Credibility

(log deviation from the final steady state)

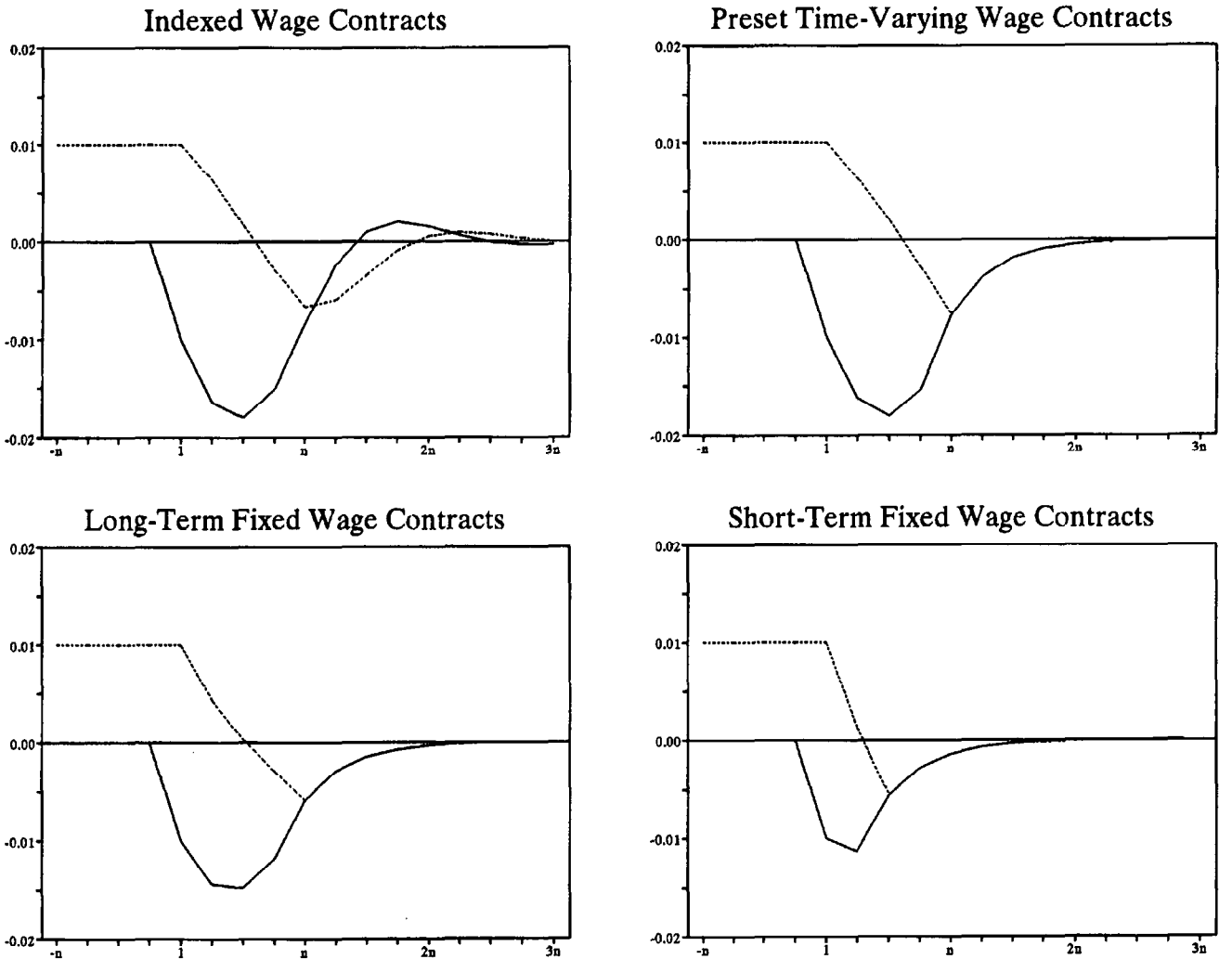


Figure 3. Money Growth Stabilization: Fully Anticipated

(log deviation from the final steady state)

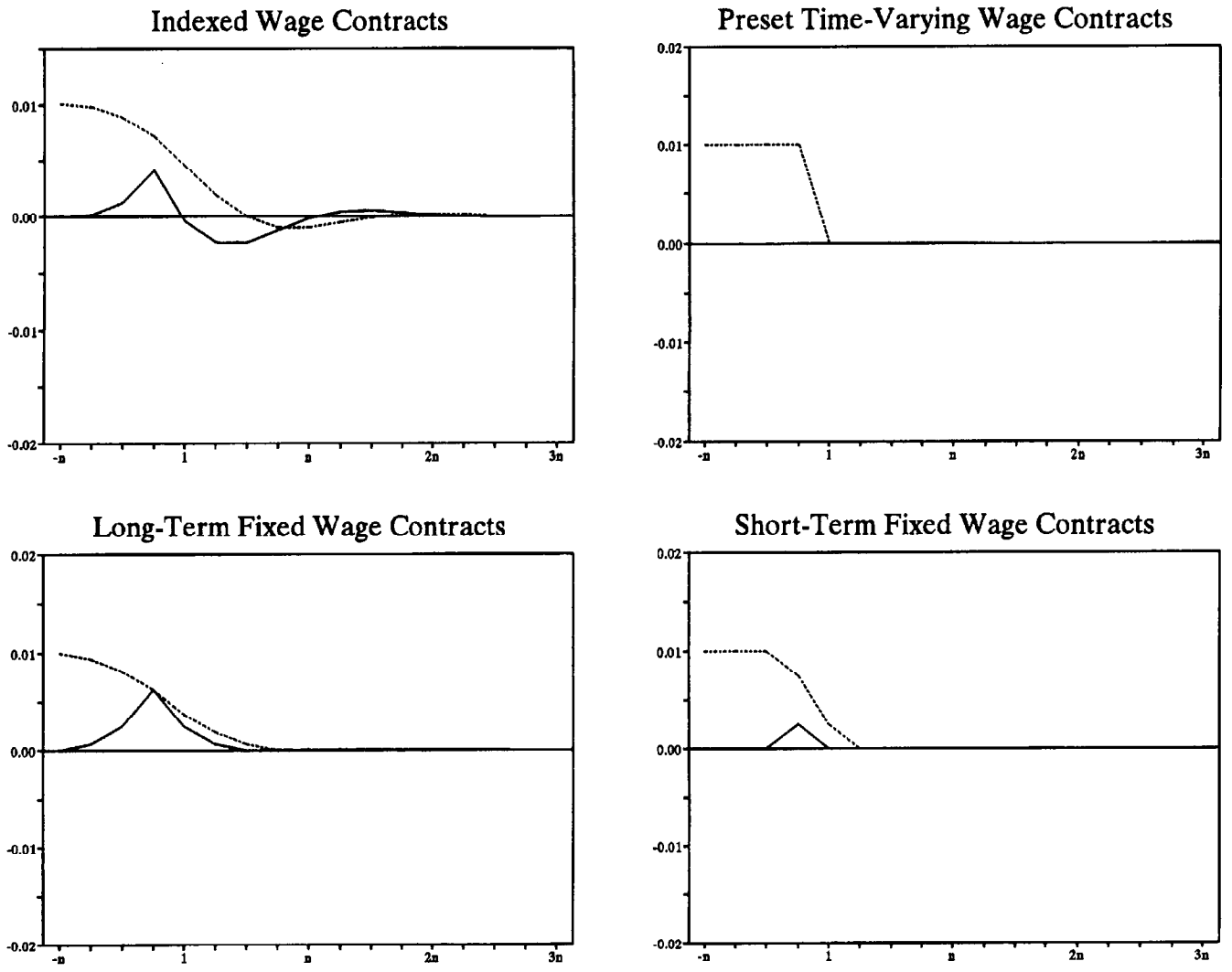
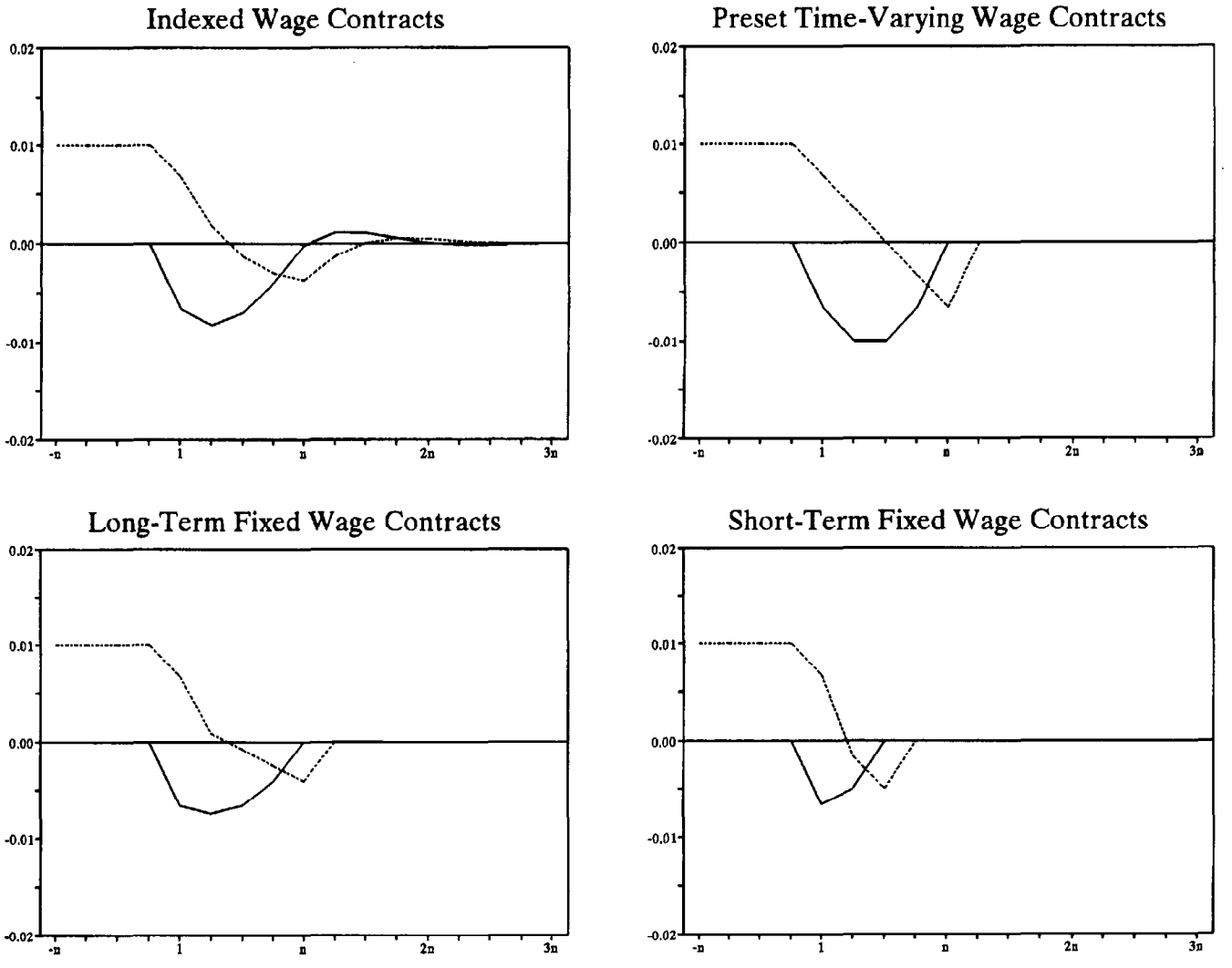


Figure 4. Money Growth Stabilization: Procyclical Price-Wage Ratio

(log deviation from the final steady state)



Nevertheless, the possibility that a procyclical price-wage ratio can make disinflation harder with indexed than with fixed wages is more theoretical than practical. First, there is no reason to presume in practice a significant positive effect of output on prices, given wages. As summarized by Blanchard and Fischer (1989), most empirical studies are consistent with the notion that marginal costs are roughly constant or perhaps even declining; moreover, there are several theoretical reasons why imperfectly competitive firms may choose countercyclical markups. Second, since the main microeconomic function of wage indexation is to prevent the frequent negotiations associated with fixed wage contracts, it seems to clear that in practice the relevant comparison is between indexed contracts and short-term rather than long-term fixed wage contracts. Indeed, in reality, while indexed contracts normally last two years in Chile, and three years or longer in the U.S. unionized sector, most fixed wage contracts around the world seem to last for only one year.

4. Sensitivity of the target real wage

Assuming that the target real wage is proportional to the expected level of output is consistent with the empirical evidence on the relationships between wages and unemployment, and between unemployment and output. Indeed, Blanchflower and Oswald (1995) have summarized their extensive research on the "wage-curve" by stating that a 1 percent increase in the unemployment rate typically reduces the real wage by 0.1 percent, and the typical estimates for Okun's Law coefficient range between 2 and 3 (for example, see Adams and Coe (1990)). For an unemployment rate near 5 percent, these estimates imply that a 1 percent increase in GDP would raise the real wage on the order of 1 percent, as assumed in the base model.

Nevertheless, there is still the question of what would happen if the elasticity of the target real wage with respect to the level of output takes values different than one. To consider one specific case, Figure 5 depicts the behavior of output and inflation in the base case experiment, but under an elasticity equal to 0.5. Not surprisingly, the depth of the recessions in this case becomes larger. In addition, the economies with indexed and fixed wage contracts now take more time to return to their state of full employment. The ranking of costs of disinflation, however, is not modified (Table 2, row five).

5. Interest-elastic money demand

The base model implicitly assumes a cash-in-advance constraint in which interest rates play no role. In practice, however, money demand is interest-elastic, so that a cut in money growth is likely to modify the velocity of money and thus break the strict link between money and output, given prices. What would be the resulting impact on the costs of disinflation in the different economies?

To provide an answer, Figure 6 examines the effects of considering an interest elastic money demand. The behavior of output and inflation in this case were obtained by replacing aggregate demand equation (8) with a

standard IS-LM specification:

$$Y_t = M_t - P_t + \alpha i_t, \tag{11}$$

$$Y_t = -\beta (i_t - E_t\pi_{t+1}), \tag{12}$$

where i_t is the nominal interest rate in period t, and α and β are positive parameters. The simulations on which the figure is based assume $\alpha=\beta=0.5$.

Figure 6 shows that the recession caused by the disinflation policy under this specification for aggregate demand is less severe than in the base model in the four economies under consideration. Indeed, as inflation is expected to fall slowly during the initial stages of the disinflation--due to the inertia stemming from the contracts--the initial drop in output is attained by way of a rise in the nominal interest rate; the concurrent increase in the velocity of money attenuates the fall in output, moderating the severity of the recession. Since this effect shows up in the four economies, however, the ranking of the costs of disinflation previously obtained is not modified (Table 2, row six). 1/

6. Open economy

Following the previous related literature, the preceding analysis focuses on the effects of indexation on the costs of disinflation in a closed economy setting. This is a relevant framework for studying the effects of wage indexation on the costs of disinflation; in practice countries with significant wage indexing have often also been countries with closed capital accounts or poor access to the international capital

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1/ An alternative approach to study the effects of an interest-elastic money demand is to replace aggregate-demand equation (8) by equation (11) and a modified IS-equation linking the expected real interest rates to the expected change in output, as suggested by the standard consumers' Euler equation. Simulations performed under that alternative specification, using a range of intertemporal rates of substitution, produced the curious result of a decline in the nominal interest rate at the beginning of the disinflation (under that specification the real interest rate has to be relatively low at the time of the shock so that output can be expected to continue falling for some time, in accordance to the temporary persistence of inflation after the cut in money growth). The concurrent reduction in the velocity of money aggravated the initial drop in output and the severity of the recession caused by the cut in money growth in all the economies under consideration. The ranking for the costs of disinflation, however, remained unchanged.

Figure 5. Money Growth Stabilization: Less Sensitive Target Real Wage

(log deviation from the final steady state)

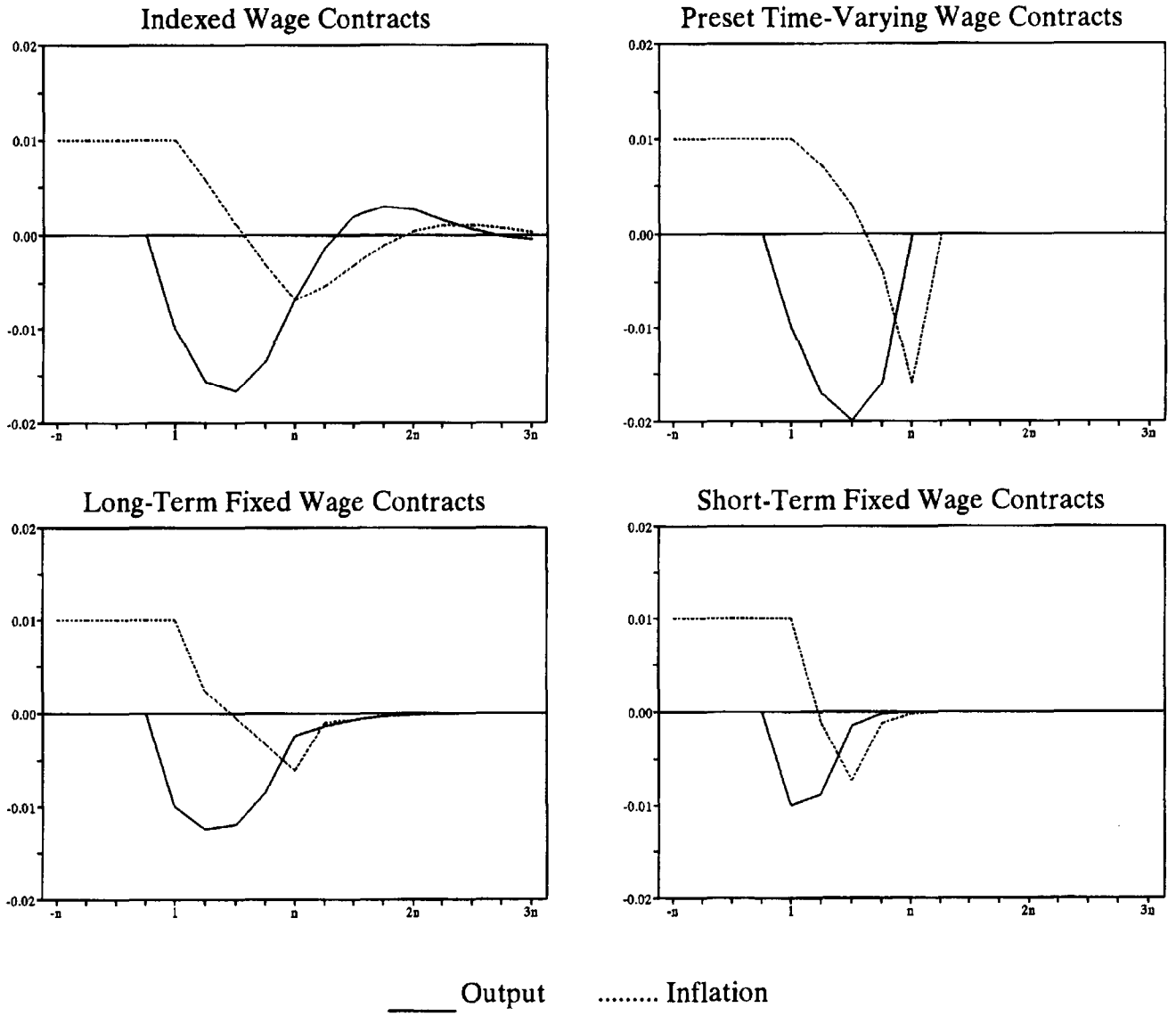
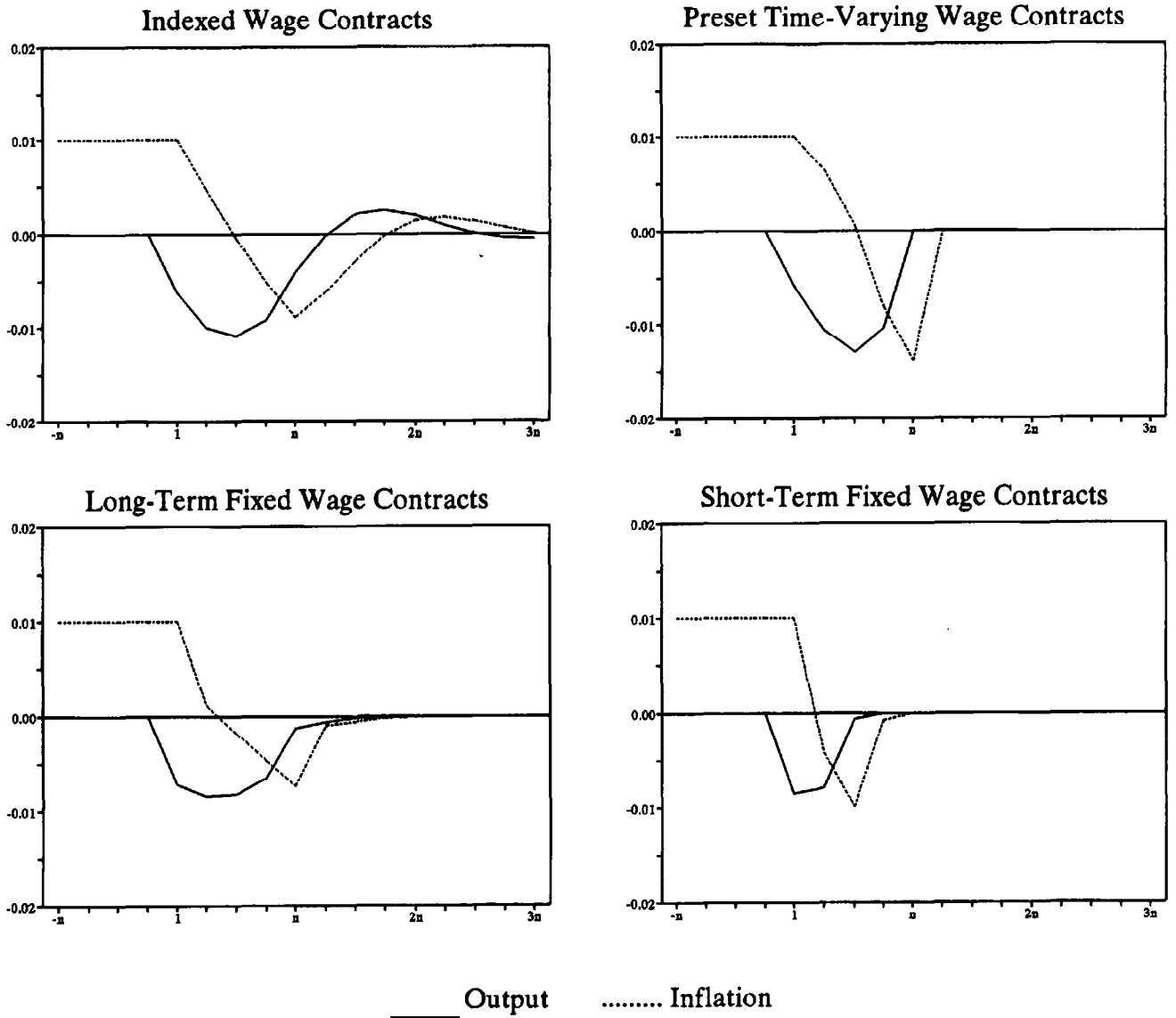


Figure 6. Money Growth Stabilization: Interest Elastic Money Demand

(log deviation from the final steady state)



markets. The results obtained up to this point are directly applicable to an open economy with limited capital mobility if the nominal exchange rate is adjusted to keep the real exchange rate constant. 1/

In an economy integrated with the international capital markets, however, an unanticipated money-based stabilization is likely to strengthen the domestic currency at the time of its announcement. This effect could rapidly reduce or curb the price of tradable goods and inputs, helping to break the inflationary inertia at the beginning of the disinflation. A priori, it seems likely that this mechanism would reduce the costs of the disinflation in general, but especially so in the indexed economy, as the cost of living adjustment clauses contained in the indexed contracts would automatically feedback the low inflation rate observed at the beginning of the disinflation into reduced wage increases in the following periods.

The simplest way to examine the effects of indexation on disinflation in an open economy setting is to modify the base model to distinguish between a domestic and a foreign good in a Mundell-Fleming setting. For this purpose, redefine y_t as domestic output, and replace aggregate demand and price equations (8) and (9) by the relationships

$$Y_t = -\beta E_t[s_{t+1} - \pi_{t+1}] + \gamma (S_t - W_t), \tag{13}$$

$$y_t = m_t - \pi_t, \tag{14}$$

$$\pi_t = \delta w_t + (1-\delta) s_t. \tag{15}$$

where S_t is the nominal exchange rate in period t, defined as the price of foreign currency in terms of domestic currency; the parameters β, γ and δ are positive, with the latter smaller than one.

Equation (13) is an IS curve, linking the level of domestic output to the expected real interest rate under the assumption of perfect capital mobility, and to the real exchange rate, defined as the ratio between the nominal exchange rate and domestic wages (the international interest rate and the price of the foreign good are omitted for convenience). Equation (14), in turn, is an LM curve derived from a money demand function with zero interest elasticity, as to separate the effect of opening the economy from the effect of considering an interest-elastic money demand, examined above. Finally, equation (15) provides the definition of the aggregate price level, expressed in rate of change form.

1/ More generally, they are also applicable to an open economy in which fiscal policy or capital controls are adjusted to keep the real exchange rate constant.

Figure 7 shows the behavior of inflation and output during the base experiment using this modifications to the model (for β=0.5, γ=0.3, and δ=0.7). Due to the jump in the exchange rate at the time of the cut in money growth, inflation now abates rapidly in all the economies. Since wages continue growing fast for some time, however, this does not prevent output from falling significantly during the initial stages of the disinflation. Thereafter, owing to the automatic feedback of the rapid initial disinflation on the subsequent cost of living adjustments, the recovery is faster in the indexed economy than in the preset time-varying and fixed wages economies with contracts of the same duration. The faster recovery implies that the output cost of the disinflation in the indexed economy is not only smaller than in the economy with preset time-varying wages, but also somewhat smaller than in the economy with fixed wage contracts of the same duration. Nonetheless, the indexed economy still displays a higher disinflation cost than the economy with fixed wage contracts whose life is half as long (Table 2, row seven).

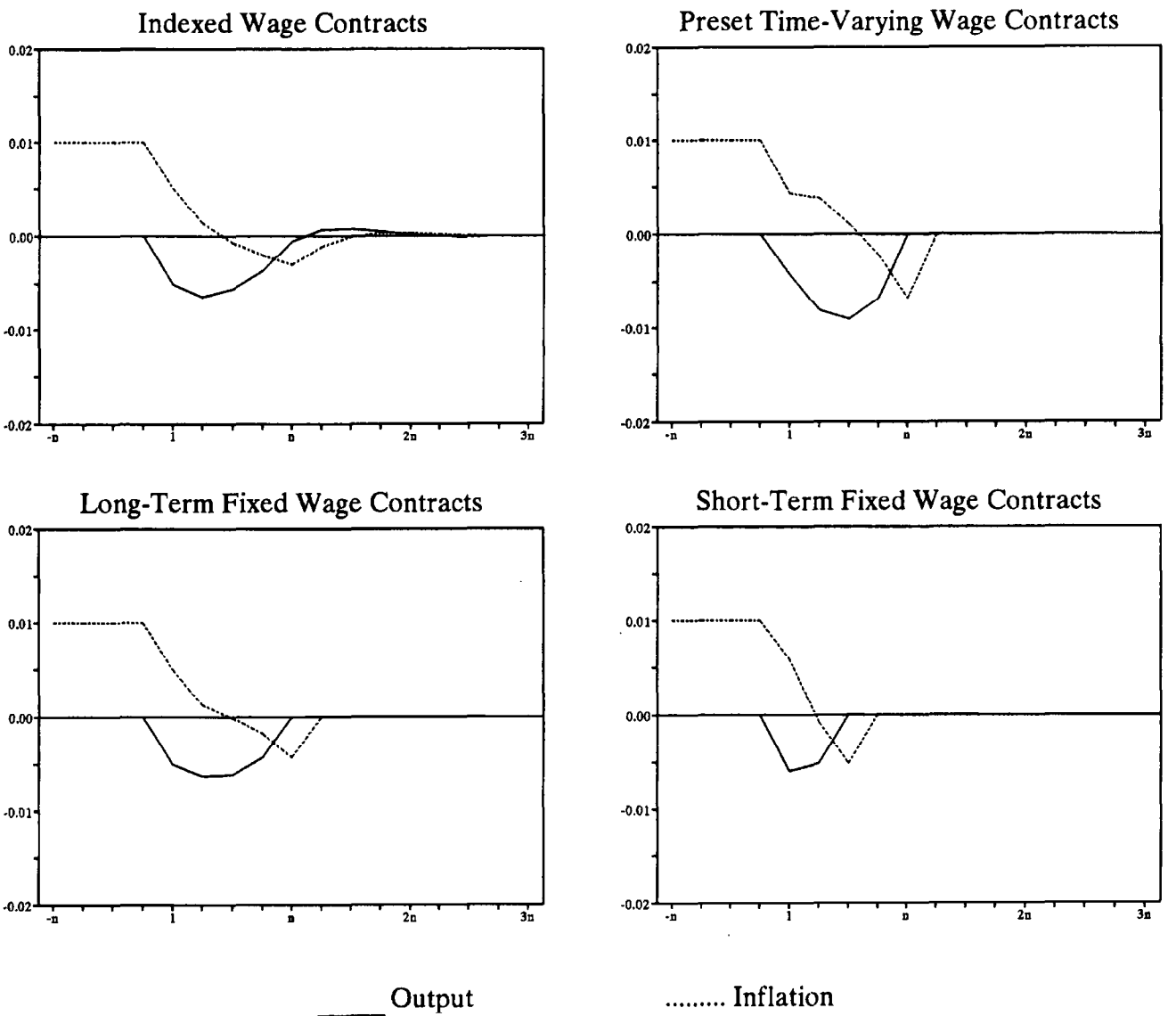
V. Concluding Remarks

This paper has shown that the effects of wage indexing on the output loss caused by money-based stabilization depend on the yardstick being used. On the one hand, the indexed economy tends to display smaller disinflation costs than an economy with contracts that specify preset time-varying wages. This is because, once initial reductions in the inflation rate have been achieved, indexation automatically feedback those reductions into wages and inflation in following periods. This effect can prevent a larger deterioration of output, permit a faster recovery, or create a boom following the recession caused by disinflation. On the other hand, the indexed economy tends to exhibit larger disinflation costs than an economy with fixed wage contracts. While in this comparison wage indexation still has the advantage that it automatically feedback previous reductions in the inflation rate, it also has the larger disadvantage that it reduces the responsiveness of wages during the early stages of a disinflation. The latter makes it harder to break any initial inflationary inertia in the indexed economy, increasing the depth of the recession caused by a sudden reduction of money growth.

The simulations performed in this paper indicate that these results are robust to a set of alternative circumstances. The main qualification that emerges from the analysis relates to the finding that indexed contracts make disinflation harder than fixed wage contracts: that result can be reversed when comparing contracts of the same duration, if early during the disinflation there is a sizable fall in prices independently of wages--due for instance to a significant appreciation of the domestic currency or a sharp drop in marginal costs. Nonetheless, this qualification seems more theoretical than practical, as relevant fixed wage contracts appear to be shorter than indexed wage contracts. In the simulations, when indexed contracts were compared with fixed wage contracts with a life half as long as the indexed contracts, the standard result emerged unchanged.

Figure 7. Money Growth Stabilization: Open Economy

(log deviation from the final steady state)



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