IMF Working Paper

WP/98/15

INTERNATIONAL MONETARY FUND

Research Department

The Macroeconomic Consequences of Wage Indexation Revisited

Prepared by Esteban Jadresic[1]

Authorized for distribution by Peter Wickham

February 1998

Abstract

Since the mid-1970s, there has been considerable research on the macroeconomic consequences of wage indexation. Nonetheless, until recently, this research had not explicitly explored the implications of contracts that index wages to lagged inflation, the usual type of wage indexation observed in practice. Drawing mainly on recent research by the author, this paper examines the consequences of wage indexation to lagged inflation on aggregate wage formation, the cost of disinflation under money- and exchange-rate-based stabilization, the variability of output under alternative shocks and policy regimes, the choice of exchange rate regime, and the level and variability of inflation.

JEL Classification Numbers: E24, E31, E32, E52

Keywords: Wages, indexation, macroeconomics

Author's E-Mail Address: ejadresic@imf.org

---

[1]This paper was prepared for the conference "Indexation, Inflation and Monetary Policy" organized by the Central Bank of Chile and held in Santiago, August 11-12, 1997, and will be published as part of the conference volume. The author is grateful to Patricio Arrau, Eliana Cardoso, Miguel Kiguel, Fernando Lefort, Klaus Schmidt-Hebbel, Peter Wickham, and participants at the above conference, at a seminar at the International Monetary Fund, and at the 1998 American Economic Association Meetings for helpful comments.

Contents **Page**

Figures

SUMMARY

Since the mid-1970s, there has been considerable research on the macroeconomic consequences of wage indexation. Most of the academic literature on this subject has studied the effects of wage indexation under the key assumption that indexing is with respect to current inflation. However, indexed wage contracts generally adjust wages to the evolution of prices infrequently and with a lag, so that typical cost of living adjustments are determined according to lagged inflation rather than current inflation.

Drawing on recent research by the author, this paper reviews the macroeconomic consequences of wage indexation, treating wage indexation explicitly as a clause in long-term contracts that grants periodic wage adjustments according to lagged inflation. Specifically, the paper reviews the consequences of wage indexation to lagged inflation on the aggregate wage, the cost of disinflation under money- and exchange-rate-based stabilization, the variability of output under alternative types of shocks and policy regimes, the choice of exchange rate regime, and the level and variability of inflation.

Two main lessons emerge from this review. The first one is that the standard analysis of wage indexation in the academic literature can provide a very misleading picture of the consequences of the typical type of wage indexation observed in real life. In particular, the assumption that wages are indexed to current inflation can be of little use even as a gross approximation to the issue. The second lesson is that taking into account the lags in actual wage indexation validates the views that most policymakers and applied observers seem to hold on the consequences of wage indexation, although with some qualifications.

I. INTRODUCTION

Since the mid 1970s, there has been considerable research on the macroeconomic consequences of wage indexation. Starting with an enthusiastic proposal of indexation by Friedman (1974) and two influential papers by Gray (1976) and Fischer (1977), the academic literature has examined the effects of wage indexation on the costs of disinflation and the level of inflation, the effects of wage indexation on the behavior of an economy hit by alternative types of shocks, the relationship between wage indexation and exchange rate and monetary policy, the type of indexation indicators that are best suited for macroeconomic stability, and so on. The sizable literature that has emerged on the subject has been reviewed by Carmichael, Fahrer and Hawkins (1985), Aizenman (1987), Devereux (1994), Van Gompel (1994) Riveros (1996), and Landarretche, Lefort and Valdés (1997).

Following Gray's (1976) analysis, most of the academic literature on this subject has studied the effects of wage indexation under the key assumption that indexing is with respect to current inflation. This assumption implies that wage indexation helps to stabilize the real wage, which in standard models has strong implications on the behavior of the economy; for instance, it directly implies the well known proposition that wage indexation would help to maintain full employment when shocks are nominal and exacerbate employment and output fluctuations when shocks are real. However, as emphasized among others by Fischer (1977, 1985 and 1988); and Simonsen (1983), standard wage indexation is not based on current inflation. Indexed wage contracts typically adjust wages to the evolution of prices infrequently and with a lag, so that cost of living adjustments are determined according to lagged inflation rather than current inflation.

The fact that typical cost of living adjustments are based on lagged inflation is central because it implies that standard wage indexation defines a nominal rather than a real type of rigidity. As shown below, the basic implication of wage indexation to lagged inflation is a distinct and non trivial dynamic behavior of nominal wages, stemming from both the direct effect of the indexation clauses and the indirect effect of those clauses on the outcome of wage negotiations. Because these mechanisms for wage adjustments can only respond to inflation with a lag, wage indexation need not stabilize or even affect the real wage, as the real wage can vary with changes in current inflation.[1] Similarly, the aggregate consequences of wage indexation generally depend, among other factors, on the nature of monetary policy. An obvious corollary is that there is no a priori reason why the effects of actual wage indexation should necessarily resemble those implied by the assumption that wages are indexed to current inflation.

---

[1]For instance, in an economy where labor productivity is constant and firm's individual demand curves are isoelastic, optimal price setting can imply a constant price-wage ratio regardless of whether wages are indexed or nonindexed.

Until recently, the formal academic literature had not explored explicitly the consequences of contracts that index wages to lagged inflation. As mentioned above, most of this literature has assumed that wage indexation is based on current inflation. Moreover, while Fischer (1977, 1985 and 1988) examined in detail the effects of wage contracts with certain lagged indexation rules, the formulas he considered do not correspond to the typical indexation rule by which current wages are adjusted according to past inflation. Similarly, while Simonsen (1983) was persuasive in arguing that disinflation under lagged wage indexation is costly—unlike disinflation under perfect wage indexation—his formal model was not based on an explicit consideration of wage contracts indexed to lagged inflation. In consequence, his model could not be used to compare the effects of indexed wage contracts with those of nonindexed wage contracts, the most relevant comparison in practice.

I have attempted to fill part of the above gap in the literature on wage indexation in three recent papers (Jadresic, 1996a, 1996b and 1997). These papers have in common the explicit modeling of wage indexation as a clause in long-term contracts that grants periodical cost of living adjustments according to the inflation rate cumulated since the last wage revision. In addition, they evaluate the consequences of wage indexation by comparing the behavior of the economy in the presence of contracts with indexation clauses against two main alternative standards of reference. One of these is defined by the behavior of the economy under long-term contracts that specify preset time-varying wages during the life of each contract. The other yardstick is defined by the behavior of the economy under short-term contracts that specify fixed wages during the life of each contract.

This paper reviews the main lessons emerging from the above papers and explores a further implication of indexing wage contracts to lagged inflation—namely, the consequences of wage indexation during exchange-rate-based stabilization. While the paper provides some background to the issues being examined, it is not the intent to provide a general review of the literature on wage indexation, which has been surveyed elsewhere. Rather, the focus of the paper is on the macroeconomic consequences of wage indexation to lagged inflation. Specifically, the paper reviews the consequences of wage indexation to lagged inflation on the aggregate wage, the cost of disinflation under money and exchange rate based stabilization, the variability of output under alternative types of shocks and policy regimes, the choice of exchange rate regime, and the level and variability of inflation.

Two main lessons emerge from this review. The first one is that the standard analysis of wage indexation in the academic literature can provide a very misleading picture of the consequences of the typical type of wage indexation observed in real life. In particular, the assumption that wages are indexed to current inflation can be of little usefulness even as a gross approximation to the issue. The second lesson is that taking into account the lags in actual wage indexation validates the views that most policymakers and applied observers seem to have on the consequences of wage indexation, although with some qualifications.

The paper is organized as follows. Following this introduction, Section II briefly reviews previous approaches to model wage indexation. Section III presents the model of wage contracts indexed to lagged inflation in the papers mentioned above and two models of nonindexed wage contracts that can be used as benchmarks for comparison purposes. Sections IV to VI examine the implications of using these models on the macroeconomic issues listed above. Section VII summarizes these implications and extracts the main lessons that emerge from the analysis.

II. Models of Wage Indexation in the Previous Literature

To avoid confusion, it is useful to pinpoint the meaning of wage indexation. We adopt here the definition provided by Aizenman (1987) in his survey article for the New Palgrave Dictionary of Economics. He wrote there: "Wage indexation is a mechanism designed to adjust wages to information that cannot be foreseen when the wage contract is negotiated. A wage contract with indexation clauses will specify the wage base (i.e. the money wage applicable in the absence of new information), the indexation formula that will be used to update wages, and how often updating will occur. Most traditional discussion has focused on wage indexation to the price level..."

Note that, according to this definition, the mere adjustment of wages in line with inflation does not qualify as wage indexation. What is special about indexation is that it is a mechanism that enables wages to adjust to new information without the need to renegotiate the contract. If the adjustment of wages in line with inflation is due to the outcome of wage renegotiations, or to a preset path of wage adjustments agreed at the time the contracts were signed, such adjustment in general cannot be attributed to wage indexation. In general, to discern the effects of wage indexation, one should compare the effects of wage contracts that include indexation clauses against the effects of wage contracts without those clauses.

A. Wage Indexation to Current Inflation

Following Gray's (1976) original analysis, the standard model in the academic literature assumes that wage indexation adjusts wages according to the changes in the current price level. The model considers only one period, say period t. Right before the beginning of this period, wage contracts are negotiated. During the period, macroeconomic shocks are realized. Given a degree of indexation λ, the change in wages (w_t) is assumed to be:

$$w_t = \lambda \pi_t, \tag{1}$$

where π_t is the inflation rate in period t. (Unless otherwise indicated, hereafter variables are measured in log terms, with lowercase letters representing their first differences and capital letters their levels).

Given this specification, the effects of wage indexation are studied by varying the degree of indexation. Under full wage indexation λ is taken to be unit and the real wage is thus assumed to be fixed. The absence of indexation corresponds to $\lambda=0$, which assumes that without indexation the contract's nominal wage is fixed. Intermediate degrees of indexation correspond to partial wage indexation.

The direct implication of this approach is that wage indexation helps to stabilize the real wage. While this effect might be irrelevant if the contracts negotiated between firms and workers are fully efficient, in standard macroeconomic models in which these contracts establish wage conditions, while employment is determined by labor demand, this increased real wage rigidity due to wage indexation has strong implications for the behavior of the economy. The best known is that wage indexation would stabilize output when shocks are nominal but destabilize output when shocks are real. Others implications are mentioned below.

B. Lagged Wage Indexation

The above approach is simple and has strong implications, but it has long been recognized that standard wage indexation is based on lagged rather than current inflation. Because of the lags in the availability of information about aggregate price indexes, actual cost of living adjustments due to indexation tend to be based on past inflation. Possibly more important, wage revisions due to indexation in practice are not done in every possible period. With infrequent indexation, even if current CPIs were available in every period, wage adjustments are not proportional to current inflation but to inflation cumulated since the last wage revision.

Note that despite the information lags and the infrequency of the cost of living adjustments, indexed contracts could approximately fix the real wage by establishing trigger-point indexation, a type of indexation according to which wages are revised whenever accumulated inflation is larger than a given threshold. Similarly, indexed contracts could effectively fix the real wage by specifying ex post lump-sum payments between the parties so as to compensate them for the differences between past and actual inflation. In practice, however, trigger-point wage indexation seems to have been the exception, and indexed contracts with ex post compensations for changes in inflation rates have not been reported. The fact that actual indexed contracts do not attempt to really fix the real wage might well be a consequence of the problems highlighted by the literature on wage indexation to current prices.

Aware of the lags in actual indexation rules, Fischer (1977) was the first to attempt to model formally the consequences of lagged wage indexation. However, the indexing formula he examined in the main model of his paper is not the usual indexation rule by which current wages are adjusted according to past inflation. Rather, Fischer assumed that indexed wages are set equal to the one-period-ahead expectation of the price level. In consequence, current wages in his model are adjusted according to the difference between the one-period-ahead

expectations on the current and past price level. In the case of a two-period model, this wage adjustment rule can be written as

$$w_t = E_{t-1}P_t - E_{t-2}P_{t-1}, \quad \textbf{(2)}$$

where P_{t-i} is the price level in period t-i (i=0,1) and E_{t-j} is the expected value operator on the basis of information available at the end of period t-j (j=1,2).

Fischer (1977) admitted that the indexing formula he considered in that paper (and in Fischer (1985)) might be a far cry from the indexing formula used in practice Thus it is not surprising that in a later paper, Fischer (1988) introduced an alternative indexation formula. However, his alternative formula also differs from the usual rule by which wages are adjusted according to lagged inflation. Specifically, he considered contracts that last for two periods and assumed that indexed wages during the second period of the contract are set on the basis of the actual price level in the first period of the contract. Also, he assumed that wages during the first period of the contracts are set on the basis of the one-period-ahead expectations of the price level during that period. This specification implies that the wage adjustment due to indexation in period t is equal to the one-period-ahead prediction error of the first period of the contract:

$$w_t = P_{t-1} - E_{t-2}P_{t-1}. \quad \textbf{(3)}$$

Thus the cost of living adjustment formula implied by this specification also differs from the usual rule by which wages are adjusted according to lagged inflation.

Despite Fischer's formal attempts to model lagged wage indexation, probably the best known reference on wage indexation to lagged inflation is Simonsen (1983). Simonsen's approach was to postulate a nominal wage adjustment rule of the form

$$w_t = \lambda \pi_{t-1} + (1-\lambda)E_{t-1}\pi_t + \mu Gap_t, \quad \textbf{(4)}$$

where Gap_t is the gap between actual and full employment output and μ a positive parameter (for simplicity, I have dropped a term measuring the change in labor productivity included in Simonsen's original specification). Simonsen interpreted the first term of the right hand side of equation (4) as the contribution of indexation to lagged inflation to the adjustment of wages, with λ measuring the degree of wage indexation.

Simonsen's approach to wage indexation has been used extensively in the applied literature on wage indexation, frequently under the assumption that $\mu=0$. However, as his equation (4) is not derived from an explicit analysis of the implications of alternative wage contracts, it is not clear how to interpret it. For instance, there is sizable empirical and analytical research based on the assumption that aggregate inflation is determined by an expression similar to the right hand side of equation (4), in which the first and second terms are denominated the backward-looking and forward-looking component of inflation

respectively. In these models, the backward-looking component of inflation is often interpreted as stemming from adaptive expectations rather than indexation. Alternatively, this component also could stem from other characteristics of the contracts and of the working of the economy. In general, in Simonsen's model there is no specific reason why the comparison of cases in which $\lambda=1$ or $\lambda>0$ with cases in which $\lambda=0$ would necessarily indicate anything about the consequences of having full or partial wage indexation versus no wage indexation.[2]

There are other models of lagged wage indexation that have been developed to analyze the consequences of centralized wage policies, but they have typically referred to case-specific rules. For instance, Morandé (1985) formally examined the consequences of a mandatory rule that imposes a floor on the base wage negotiated in collective agreements. Such a wage rule was applied in Chile at the beginning of the 1980s, but was abolished in 1983.

C. Standards of Reference

Note that to evaluate the consequences of wage indexation, as important as specifying the nature of the adjustment of wages under indexation, it is central to define the standard of reference against which those consequences are measured. In Gray's (1976) popular model nonindexed wages are wages that remain fixed in nominal terms during the (only) period of reference. In Fischer's (1977, 1985 and 1988) analyses, instead, nonindexed wages correspond to wages that were preset in nominal terms when the contracts were signed, but that might be time-varying. An example of this type of wage setting can be found in the unionized sector of the U.S. labor market, where three or four year contracts often specify a fixed wage increase every year. The differences in the standards of reference that can be used to evaluate the effects of wage indexation should be kept in mind in considering the analysis of the following sections.

---

[2]Below it will become clear that the wage adjustment rule implied by the explicit consideration of contracts with indexation clauses differs from equation (4). Indeed, while the first term of its right hand side could be interpreted under certain assumptions as coming mainly from clauses of indexation to lagged inflation, the remainder of equation (4) does not capture appropriately the effects on wages of the periodic renegotiation of the contracts. One unappealing consequence of this specification problem is that, according to equation (4), the policymaker could maintain output permanently above full employment by engineering a continuously rising inflation rate.

III. A Model of Wage Indexation to Lagged Inflation

While the models of wage indexation presented in the previous section might be useful for some purposes, they do not model the consequences of wage contracts indexed to lagged inflation. This section presents a model that considers explicitly the consequences of these type of contracts, as well as two models of nonindexed wage contracts that define alternative standards of reference to evaluate the effects of the indexed contracts. The analysis is based on the models developed in Jadresic (1991). A model of wage indexation that is similar in spirit, but with continuous time and with contracts that grant only one cost of living adjustment during the life of each contract, was developed by Bonomo and Garcia (1994). They used their model to examine the effects of wage indexation during disinflation; I will refer to their results below.

A. A Model of Wage Contracts Indexed to Lagged Inflation

Our focus is on the behavior of the aggregate wage. 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 cumulated since the last wage revision.

As mentioned above, indexed wage contracts generally do not provide full protection against fluctuations in the price level. Although they stipulate periodic 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 cumulated 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 cumulated since the last wage revision (Jadresic (1992, 1995); Maturana (1992); Garcia (1995)). In the United States, indexed wage contracts observed in the unionized sector typically specify a cost of living adjustment quarterly or once a year, according to a fraction of the inflation measured during the previous period (Hendricks and Kahn (1985); Kaufman and Woglom (1986)). In these countries, due to the delays in the availability of consumer price indexes, the cost of living adjustments are typically based on a n-month lagged value of cumulated inflation, with n equal to 1 in the case of Chile and n equal to 2 or 3 in the case of the United States.

To model the consequences of wage indexation to lagged inflation, consider a group of wage contracts that last for N periods and that contemplate cost of living adjustments according to 100 percent of past inflation every n periods. Suppose that these contracts are renegotiated in a uniformly staggered fashion, and that N/n is an integer larger than one, in accordance to what is seen in actual indexed contracts. Then, brief reasoning implies that in every period 1/N of the wages are renegotiated, 1/n-1/N are adjusted according to the

indexation clause, and 1-1/n are kept unchanged. If the cost of living adjustments are defined in terms of inflation cumulated between the last wage increase and the last period before the adjustments, then the average wage increase in period t is

$$w_t^I = \left(\frac{1}{n} - \frac{1}{N}\right)\sum_{s=1}^{n} \pi_{t-s} + \frac{1}{N}x_t = \frac{1}{n}\sum_{s=1}^{n} \pi_{t-s} + \frac{1}{N}\left(x_t - \sum_{s=1}^{n} \pi_{t-s}\right), \qquad (5)$$

where x_t is the initial nominal increase of the wages renegotiated at time t. The superscript I over w_t denotes that this variable measures the change in the aggregate wage when contracts are indexed.

In order to complete the model of aggregate wage adjustment, one needs to specify what determines x_t. Extrapolating from simple studies of lagged wage indexation, one could be tempted to simply assume that the second term of the right hand side of equation (5) is a positive function of the output gap, or merely a constant. If contracts are revised, however, x_t must be agreed upon in the wage negotiations between firms and workers.

To model x_t, we postulate that the outcome of the wage negotiations maximize the expected value of a quadratic function of the average real wage implied by each contract.[3] This specification implies that the initial nominal wage of each contract is set so as to make the expected value of the average real wage of the contract equal to a target real wage, with the latter depending on the wage setter's expectations on the exogenous variables that enter their objective function. If contracts that begin at time t are negotiated with information on events that occurred up to time t-1, this can be written as

$$x_t \text{ is such that } E_{t-1}(\text{Contract's average real wage}) = E_{t-1}\left(\frac{1}{N}\sum_{s=0}^{N-1} \Omega_{t+s}\right), \qquad (6)$$

where the right hand side expression represents the target real wage for the contracts signed for period t to t+N-1 according to information available at the end of t-1. To simplify comparisons made below, this target real wage is specified 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 target real wage is not important here; this issue will be addressed below.

---

[3]The goal of maximizing a nonlinear function of the real wage is implied by different microeconomic models of wage determination, including the union wage model and the efficiency wage model. 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 the average real wage rather than its present value matters simplifies the algebra.

Given the structure of the contracts, this specification for the behavior of wage setters can be used to obtain expressions for x_t, as functions of past and current expectations about the target real wage and inflation in different dates, as well as of past inflation. The resulting expression can then be replaced in equation (5) to obtain an equation for aggregate wage adjustment. For space reasons, the derivation is not presented here (see Jadresic (1996b), for the derivation in the case n=1). The general solution is

$$w_t^I = \frac{1}{n}\sum_{s=1}^{n}\pi_{t-s} + \frac{1}{N}(1-L^N)\,E_{t-1}\left[\frac{1}{N}\sum_{s=0}^{N-1}(\Omega_{t+s} + \Phi_n(s)\pi_{t+s})\right], \qquad (7)$$

where $\{\Phi_n(s)\}_{s=0}^{\infty} = \{n\ n-1 \ldots 1\ n\ n-1 \ldots 1\ \ldots\}$, and L is the standard lag operator.

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 to lagged inflation. In proportion 1/n-1/N 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. Note, that in the aggregate, this term implies that the elasticity of current wage adjustment with respect to an unexpected shock in the last period's inflation rate is equal to 1/n.

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' target real wage and expected inflation during the life of the new contracts, as compared to the target real wage and inflation 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.

It is easy to show that the second term at the right hand side of equation (7) implies that the elasticity of the current aggregate wage with respect to a change in expected inflation is equal to (n+1)/2N (this assumes that current and future inflation rates are all expected to change by the same amount). This elasticity would be zero if wage indexation were relative to the current price level: in that case all the wage adjustments would be postponed until the changes in inflation actually occur. This is not the case here, however, because with indexation to lagged inflation the anticipation of a permanent increase in inflation reduces the expected real wage and leads wage setters to grant larger initial wage increases; the size of this effect is proportional to (n+1)/2. The impact of this effect at the aggregate level is multiplied by 1/N, as this effect is filtered by the fraction of contracts negotiated in each period.

B. Alternative Standards of Reference

As wage indexing helps to prevent the cost of too frequent negotiations, in practice indexed wage contracts are long-term contracts; for instance, the duration of typical indexed contracts in the unionized sector of the U.S. labor market is three years or more, and in Chile two years. Different standards of reference can be used to evaluate the effects of these contracts. One possibility is to compare the indexed wage contracts against similarly long-term contracts that specify preset time-varying wages during the life of each contract, like the nonindexed contracts observed in the unionized sector of the U.S. labor market. Another possibility is to compare these indexed wage contracts against shorter-term contracts that specify a fixed wage during the life of each contract, like the one-year contracts that seem more common in the rest of the world.

Contracts with preset time-varying wages

Consider first the case in which the nonindexed contracts specify preset time-varying wages (such as Fischer's (1977) nonindexed contracts). 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 this leads to

$$w_t^P = \frac{1}{N}\sum_{s=1}^{N} E_{t-s}\,[\pi_t + \omega_t] + \frac{1}{N}\,(1 - E_{t-N-1})\sum_{s=1}^{N}[\pi_{t-s} + \omega_{t-s}], \qquad \textbf{(8)}$$

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 superscript P over w_t is used to denote that the change in the aggregate wage refers to contracts with preset time-varying wages. Here we have assumed that the length of these contracts is the same as the length of the indexed contracts.

The first term on the right hand side of equation (8) contains the adjustment of wages stemming from the changes in expected prices and the target 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 forecast in the previous negotiation with respect to their actual values.

Note that in equation (8), the elasticity of the current aggregate wage with respect to a shock in the previous period's inflation rate is smaller than before: 1/N rather than 1/n. Also, if n is larger than one, the elasticity of the current aggregate wage with respect to a shock in expected inflation is smaller: 1/N rather than (n+1)/2N.

Contracts with fixed wages

Consider now the case of contracts in which wages remain fixed during the term of the agreement (such as Taylor's (1980) contracts). Denote the length of these contracts by M. With uniform staggering, and if wage setters target an average real wage during the life of each contract, it can be shown that where the subscript F over w_t denotes that the change in the aggregate wage refers to contracts with fixed wages.

Equation (9) can be seen as a special case of the equation (7) for indexed contracts, one in which the indexation period and the length of the contracts are identical and set equal to M. Accordingly, the first term on the right-hand side of this equation comes from a catch-up wage increase granted in the revised contracts, which compensates for the effect of inflation on of the real value of the wages agreed in the negotiations held M periods earlier. The second term corresponds to the wage increase above or below the catch-up term granted in the revised contracts.

$$w_t^F = \frac{1}{M}\sum_{s=1}^{M} \pi_{t-s} + \frac{1}{M}(1-L^M)E_{t-1}\left[\frac{1}{M}\sum_{s=0}^{M-1}(\Omega_{t+s} + (M-s)\pi_{t+s})\right], \qquad (9)$$

There is the issue of defining how long should be the duration of the fixed wage contracts used for comparison purposes. In practice, as the duration of fixed wage contracts is usually shorter than the duration of indexed wage contracts, it is most relevant to consider cases where M<N. Also, as actual indexed contracts typically specify indexation periods equal or shorter than one year, while the most common fixed wage contracts seem to have a duration of one year, it seems more relevant to consider cases where $M \geq n$. The research reviewed below focuses primarily on such cases, often assuming M=N/2, and then exploring the consequences of alternative assumptions when relevant for the purposes at stake.

With this range for M, the elasticities of the current aggregate wage with respect to expected and past inflation under fixed wage contracts can be compared unambiguously with those under indexed contracts. First, equation (9) implies that the response of the current aggregate wage to the expectation of a permanent increase in inflation is proportional to (M+1)/2M, which for $M \leq N$ is always larger than the corresponding response in the case of indexed wage contracts. The intuition is that, as fixed wage contracts are front loaded and do not offer any cost of living adjustments during their term, these contracts tend to be much more sensitive to changes in inflation expectations when they are renegotiated. Second, equation (9) implies that the response of the current aggregate wage to a shock in last period's inflation rate is proportional to 1/M, which for $M \geq n$ is always smaller or equal to the corresponding response in the case of indexed contracts.

For the reader's convenience and use below, Table 1 summarizes the elasticities of the current aggregate wage in response of a shock in the previous period inflation rate and of a shock in expected inflation implied by the alternative wage contracts being considered.

The target real wage

To model the determination of the target real wage, I generally have assumed that wage-setters target a real wage that is equiproportional to the expected level of aggregate output (which under the implicit assumption that the labor force is constant, is the same as the expected level of aggregate output per person in the labor force). Formally, this can be written as

$$E_{t-1}\,\Omega_{t+s} = E_{t-1}\,Y_{t+s}, \qquad \textbf{(10)}$$

where Y_{t+s} is the level of aggregate output in period t+s.

This specification for the target real wage captures the intuition that the real wage tends to increase when the labor market becomes tighter and when the economy becomes richer. In addition, this specification is consistent with the theory and the empirical evidence. From a theoretical point of view, for a given size of the labor force, the assumption that the target real wage is proportional to the level of output is consistent with a *supply wage relation* linking the real wage negatively with the rate of unemployment. As emphasized by Blanchard and Katz (1997), such a relationship is implied by all the main modern approaches to wage determination based on explicit maximization models, including the *matching approach*, the *efficiency wage approach*, and the *competitive approach*. From an empirical point of view, in turn, the assumption that the target real wage is equiproportional to the expected level of output ensures that the rate of unemployment and the functional distribution of income in the models considered below are constant in the steady state, features that conform with the long-term evidence on these variables. Furthermore, the assumption of equiproportionality between output and the target real wage is consistent with the extensive empirical evidence on the *wage-curve* compiled by Blanchflower and Oswald (1995).[4]

While this is a plausible specification for the target real wage, it is worth noting that the driving force for the results presented below is the differences in the elasticities of the aggregate wage with respect to past and expected inflation implied by the different type of contracts. Therefore, it seems unlikely that the essence of those results would be altered

---

[4]Their central finding from data for a number of regions and periods is that a 1 percent increase in the unemployment rate typically reduces the real wage by about 0.1 percent (Blanchflower and Oswald (1995)). It is easy to check that with standard estimates for the Okun's Law coefficient (between 2 and 3; for instance, see Adams and Coe (1990)), and around an unemployment rate of the order of 5 percent, their finding implies that a 1 percent increase in aggregate output would raise the real wage by the order of 1 percent.

Table 1. Elasticity of the Current Aggregate Wage 1/

	In response of a shock in previous period's inflation	In response of a shock in expected inflation
Contracts with indexed wages	1/n	(n+1)/2N
Contracts with preset time-varying wages	1/N (-)	1/N (- or =)
Contracts with fixed wages	1/M (- or =)	(M+1)/2M (+)

1/ The signs is parenthesis indicate whether the elasticity is smaller than (-), larger than (+) or equal to (=) the corresponding elasticity for contracts with indexed wages. It is assumed that n, N, and M are positive integers, and that $n \leq M < N$.

significantly by considering other plausible specifications for the target real wage. For instance, as noted below, assuming that the elasticity of the target real wage with respect to output is different from one tends to make no difference on the basic results discussed below.

IV. Wage Indexation and the Cost of Disinflation

It is apparent that the consequences of the wage equations derived in the previous section can be very different from those implied by the assumption that indexation is with respect to current inflation. But what precisely are those consequences? We start by examining the effects of wage indexation on the cost of disinflation.

A. Money-Based Stabilization

There is a remarkable contrast between the views that academic researchers and policymakers have had on the effects of wage indexation on the cost of disinflation. On the one hand, the standard academic presumption since Friedman (1974) has been that price escalator clauses facilitate the end of inflation. This presumption is based on the notion that indexation speeds up the adjustment of wages to changes in inflation, and is implied by the standard model of indexation to current inflation, as well as by the lagged wage indexation models due to Fischer (1985, 1988). On the other hand, as highlighted by Simonsen (1983) and Williamson (1985), policymakers have generally contended that wage indexation causes inflation inertia and thus makes disinflation more difficult. In recent experience, for instance, the economic authorities in Chile pointed to wage indexation to explain why faster disinflation was not possible in the country, and wage indexing was prohibited during recent stabilization programs in Argentina and Brazil.[5]

Until recently, the only published paper that had evaluated explicitly the consequences of indexation to lagged inflation during disinflation was Bonomo and Garcia (1994).[6] These authors replicated Ball's (1990) analysis of credible disinflation policies in a closed economy with staggered fixed prices, but they added to the model an indexation rule by which individual prices are adjusted, at the midpoint of the period between successive price revisions, by the inflation cumulated since the last price revision. Like Ball found earlier, Bonomo and Garcia (1994) found that certain gradual disinflation policies could cause a boom in the economy if they were credible; however, they found 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 the economy modeled by

---

[5]For a brief review of the literature on the effects of wage indexation on the cost of disinflation, see the Introduction in Jadresic (1996b).

[6]Formally, they referred to price indexation rather than wage indexation, but this difference is insubstantial.

Ball. They also estimated that the time necessary to reduce inflation without affecting output would be longer in the indexed economy.

Bonomo and Garcia's (1994) findings suggests that wage indexation could make disinflation harder. However, as their analysis focuses on gradual and credible policies that cause net booms rather than net recessions, it really does not evaluate whether indexation makes disinflation more costly. Perhaps most important, Bonomo and Garcia (1994) provided no obvious explanation for the contrasting academic and policymakers' views on the effects of indexation on the cost of disinflation.

To shed light on these issues, Jadresic (1996b) examined the costs of disinflation implied by wage equations similar to those presented in the previous section. As in most of the prior literature, the paper focused on the output loss caused by money-based stabilization. Its results fully dispel the notion that wage indexation necessarily raises or reduces the cost of disinflation, and provides a suitable explanation for the difference between the views of academics and policymakers on the effects of wage indexation on disinflation. Namely, the analysis showed 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 in an economy with short-term fixed wage contracts. Thus, it turns out that the academic and policymakers' views can both be appropriate depending on the standard of reference used to evaluate the effects of wage indexation.[7]

To illustrate this result, Figure 1a shows the behavior of output and inflation implied by the wage equations (7) to (9) after a sudden reduction of money growth, under the simple assumptions that price inflation is equal to wage inflation ($\pi_t=w_t$), and that aggregate output growth is determined by

$$y_t = m_t - \pi_t, \tag{11}$$

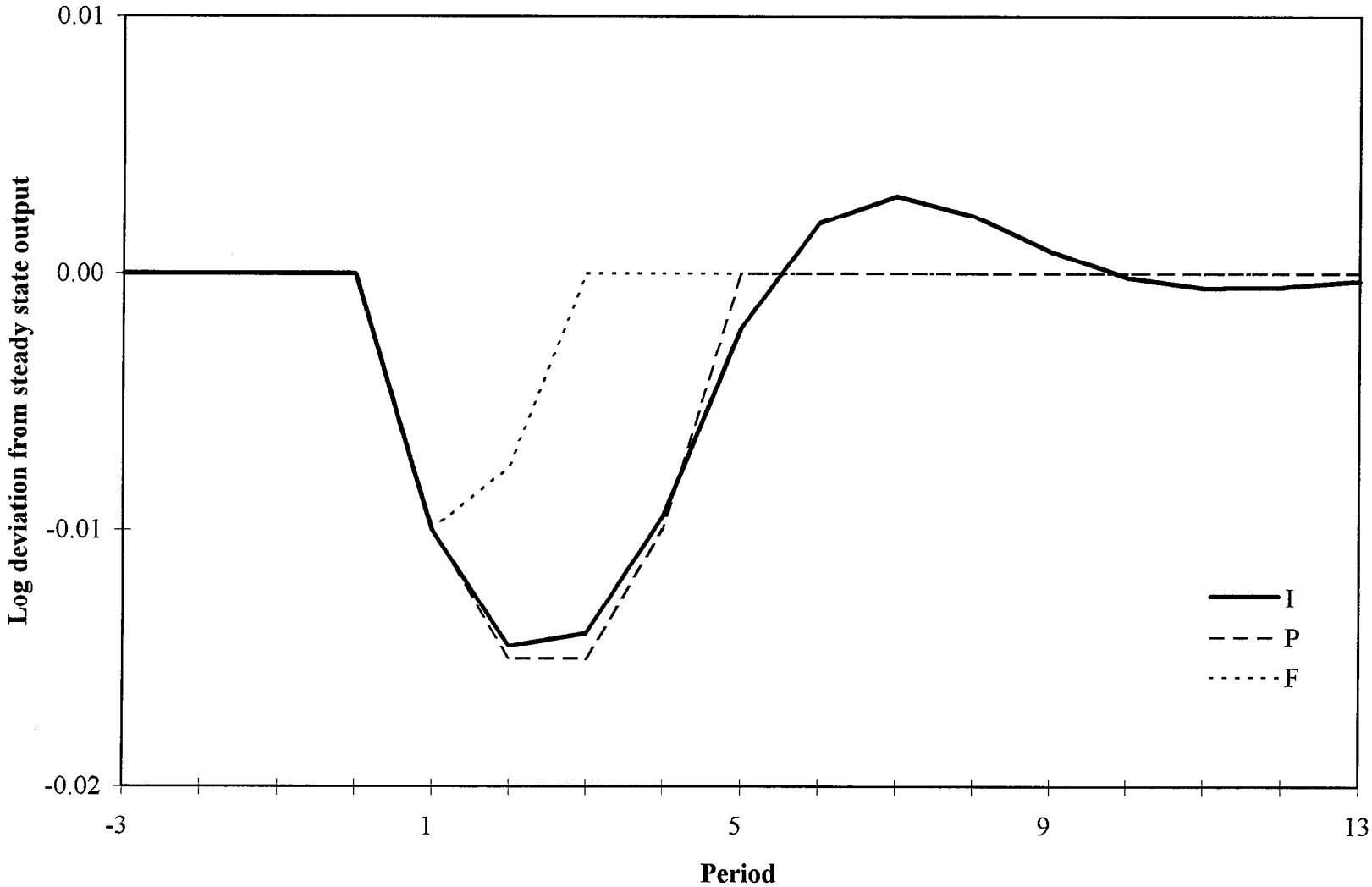
where m_t is the rate of growth of money. The figure assumes that the cut in money growth is unanticipated but permanent (equal to 0.01 in log terms) and that N=4, n=1. The short-term fixed wage contracts assume M=N/2=2 (the less relevant case M=N is discussed extensively in Jadresic (1996a) and is omitted here for space reasons).

Figure 1a illustrates that the net output loss during the disinflation is larger when contracts specify preset time-varying wages, smaller when contracts are short-term and specify fixed wages, and intermediate when contracts contain indexation clauses. Note that the cost of disinflation with indexed wage contracts appear to be smaller than with preset

---

[7]This explanation accords with the fact that much of the academic literature refers to the United States—where contracts with preset time-varying wages abound in the unionized sector of the labor market and thus seem a relevant yardstick to evaluate the effects of wage indexation—while the policymakers' view alludes essentially to other countries, where fixed-wage contracts often provide a more appropriate standard of reference.

Figure 1a
Output During Money-Based Stabilization: Closed Economy



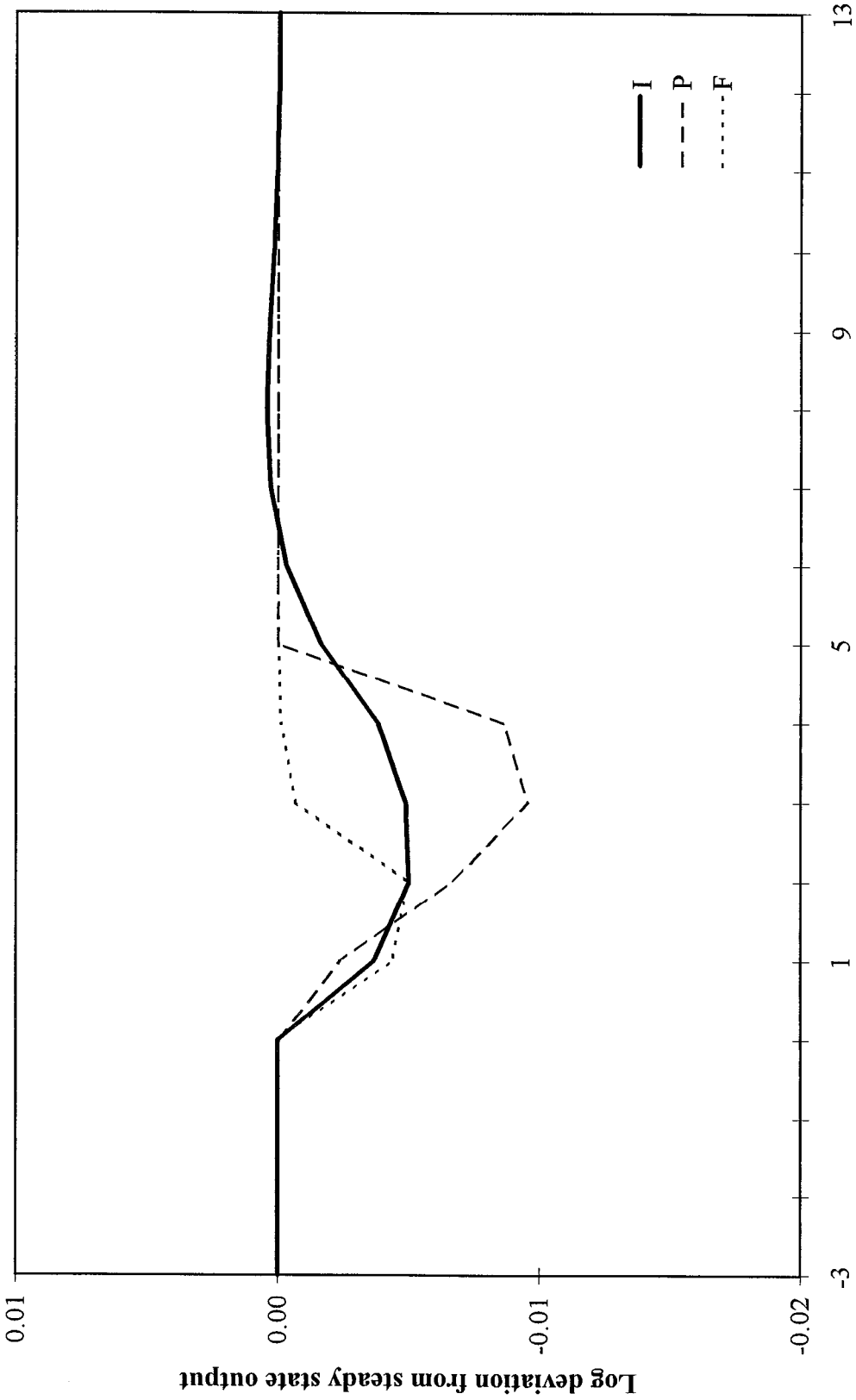
time-varying wage contracts because, in the indexed economy, an initial recession that is more or less comparable in order of magnitude is followed by a boom. To understand the origin of this boom, note first that, during the recovery, the economy under consideration must undergo a period in which inflation is below the new rate of money growth. The boom depicted in Figure 1a occurs because, once the indexed economy reaches full employment, the indexation clauses feed back the low previous inflation into low current inflation. Given that the new rate of money growth is constant, the consequence is a boom.

Disinflation policies with more complex paths for the rate of growth of money can eliminate the boom shown above by the indexed economy. For instance, it can be shown that, with a monetary policy designed to obtain a linear disinflation in the indexed economy, this economy displays no boom following the recovery but enjoys a faster disinflation and thus a faster recovery to full employment. Similarly, the path of output and inflation during disinflation can differ from the one depicted in Figure 1a for several other reasons; for instance, if there is only partial credibility, if the disinflation is anticipated, if there is a procyclical ratio between prices and wages, if the real wage targeted by wage setters depends on output with an elasticity different from unity, if money demand is interest-elastic, or if the economy is open (for use below, the latter case is shown in Figure 1b, using the model and base case parameters presented below). However, the analysis in Jadresic (1996b) indicates that the ranking of costs of disinflation mentioned above is quite robust under these alternative circumstances. As mentioned above, the net output loss during the disinflation tends to be smaller in the indexed economy than in the economy with preset time-varying wage contracts, while larger than in the economy with short-term fixed wage contracts.

What is the source of the discrepancies in the behavior of the economies with and without indexation? The answer to this question lies on the different elasticities for the current aggregate wage implied by the contracts under consideration.

Compare first the elasticities of the aggregate wage under indexed wage contracts with the elasticities of the aggregate wage under contracts that specify preset time-varying wages. As noted above and shown in Table 1, the elasticity of the aggregate wage in response to changes in the past-period's inflation rate in this comparison is always larger when wages are indexed. During disinflation, this feature implies that, once initial reductions in the inflation rate have been achieved, the existence of indexation feeds a larger part of those reductions back into wages and inflation in following periods. In comparison to an economy with contracts that specify preset time-varying wages, this enhanced feedback from recent inflation to current inflation can permit a faster recovery, create a boom following the recession, or prevent a larger drop of output during the recession caused by the cut in money growth. As a result, the output cost of disinflation in the indexed economy tends to be smaller.

Figure 1b
Output During Money-Based Stabilization: Open Economy



The favorable consequence of indexation on the cost of disinflation due to the effect just described can be reinforced if the indexation period is longer than the basic period in which the preset time-varying wages are kept fixed (in the model, if $n>1$). If this is the case, the aggregate wage under indexation is not only more responsive to past inflation but also more responsive to changes in expected inflation. In comparison to an economy with preset time-varying wages, this effect directly helps to break the inflationary inertia in the indexed economy at the beginning of the disinflation and, as a result, also helps to reduce the output cost of disinflation.[8]

Compare now the elasticities of the aggregate wage under indexed wage contracts with the elasticities of the aggregate wage under fixed wage contracts. As noted above and shown in Table 1, the elasticity of the aggregate wage in response of a shock in expected inflation in this comparison is always smaller when wages are indexed. This implies that wage indexation makes it harder to break the initial inflationary inertia of the economy and thus it tends to deepen the recession associated with a sudden reduction in money growth. Unless some other force dominates, it follows that wage indexation raises the cost of disinflation when indexed wage contracts are compared to fixed wage contracts.

Note, however, that the elasticity of the aggregate wage in response of the past-period's inflation rate is larger when wages are indexed if the length of the fixed wage contracts used as standard of reference is longer than the length of the indexation period, for instance, if the fixed wage contracts have the same duration as the indexed contracts. This observation raises the question whether, in this case, the enhanced feedback from past to current inflation due to wage indexation can more than compensate the adverse effect of indexation on the cost of disinflation due to the smaller responsiveness of wages to the expected disinflation. On this issue, in Jadresic (1996b) I found that this can be the case if the fixed wage contracts used as standard of comparison have the same duration as the indexed wage contracts and if the economy is such that early during the disinflation there is a sizable fall in prices independent of wages—due, for instance, to a large appreciation of the domestic currency or a sharp drop in marginal costs. However, when I used as standard of reference fixed wage contract half as long as the indexed contract, and twice as long of the indexation period, the result that wage indexation raises the cost of disinflation emerged unchanged in the simulations, even in the case of disinflation with sizable initial falls in prices independent of wages. More generally, of course, the basic result can always be preserved by using as

---

[8]This effect is not considered in Jadresic (1996b), paper which assumes $n=1$.

standard of reference short-term fixed wage contracts with length equal or shorter than the indexation period of the indexed contracts.[9]

To summarize, wage indexation can raise or reduce the net output loss caused by money-based stabilization depending on the standard of reference. In comparison with contracts with preset time-varying wages, indexed wage contracts reduce the cost of disinflation; this is mainly because the automatic feedback from past to current inflation due to indexation facilitates the disinflation once initial reductions in inflation have been achieved. In comparison with short-term contracts with fixed wages, in turn, indexed wage contracts tend to raise the cost of disinflation; the basic reason is that indexation reduces the responsiveness of wages during the early stages of the disinflation.

B. Exchange-Rate Based Stabilization

The theoretical literature on wage indexation has dedicated little specific attention to the effects of wage indexation during exchange rate-based inflation stabilization.[10] However, it is easy to see that in this case the Gray (1976) model also implies that wage indexation would make disinflation easier (for instance, with full wage indexation to current inflation, pegging the exchange rate should stop inflation abruptly and without costs). As in the case of money-based disinflation, this prediction again stands in sharp contrast with the view of policymakers and applied observers, who tend to believe that wage indexation makes disinflation harder during exchange rate based stabilization. For instance, the ban of wage indexation in Brazil

---

[9]To provide an example of the relative elasticities of indexed and fixed wage contracts, consider the case of Chile. Typical indexed wage contracts last there for 24 months and have an indexation period of 6 months (with 100 indexation to lagged inflation); the implied elasticities of the current aggregate wage with respect to the inflation rate in the past period and expected inflation are 0.167 and 0.146 respectively. Suppose that the alternative to these contracts are fixed wage contracts that last for 12 months. In this case, the elasticities of the current aggregate wage with respect to inflation in the past period and to expected inflation are 0.083 and 0.542 respectively. Thus the elasticity of the aggregate wage with respect to past inflation for the indexed contracts is twice as large as the same elasticity for the fixed wage contracts, and the elasticity of the aggregate wage with respect to expected inflation for the indexed contracts is close to 1/4 of the same elasticity for the fixed wage contracts.

[10]There is a sizable theoretical literature on the relationship between wage indexation and monetary and exchange rate policies in open economies, but this literature has focused on other issues (see next section and the surveys listed in the opening paragraph). This gap contrasts with the significant attention that exchange rate based stabilization has received elsewhere in the academic literature since the early eighties. For a review and attempt to assess the different approaches that have been used in the latter literature, see Rebelo and Végh (1995).

and Argentina mentioned above was implemented in a context of exchange rate based stabilization plans.[11]

This section explores whether the consequences of wage indexation during a money-based stabilization described above also apply in the context of an exchange rate-based stabilization. For this purpose, we consider now a Mundell-Fleming economy characterized by a domestic and a foreign good that are imperfect substitutes, and by a domestic and a foreign bond that are perfect substitutes. The notation for the variables in this economy is as follows: y_t measures the rate of growth of aggregate domestic output; p_t is the rate of change of the price of the domestic good in terms of domestic currency; π_t denotes the inflation rate; i_t represents the nominal interest rate of the domestic bond; m_t is the rate of growth of domestic money supply; and s_t indicates the rate of devaluation of the domestic currency. We assume that foreign variables are constant in levels. The following relationships hold in this economy:

$$y_t = -\beta(1-L)(i_t - E_t\pi_{t+1}) + \gamma(s_t - p_t), \tag{12}$$

$$m_t - \pi_t = y_t - \delta(1-L)i_t, \tag{13}$$

$$p_t = w_t + \alpha y_t, \tag{14}$$

$$\pi_t \equiv \epsilon p_t + (1-\epsilon)s_t, \tag{15}$$

$$i_t = E_t s_{t+1}, \tag{16}$$

where α, β, γ, δ, and ϵ are nonnegative parameters.

---

[11]The policymaker's view is often illustrated with the aid of Simonsen's (1983) wage equation described in Section II, under the assumption that $\mu=0$, and an additional inflation equation of the type $\pi_t = \eta w_t + (1-\eta)s_t$, where s_t is the rate of devaluation of the domestic currency and η is a parameter between zero and one (for instance, a recent example can be found in Edwards (1996). This framework directly implies that pegging the exchange rate when wages are indexed reduces inflation slowly and at the cost of a real appreciation (because it implies $\pi_t = \lambda\eta\pi_{t-1}$ and $s_t - \pi_t = -\lambda\eta\pi_{t-1}$). As noted in Section II, however, this approach does not permit an explicit comparation of the effects of indexed and nonindexed wage contracts, and thus should only be considered as illustrative of the policymaker's concern.

Equations (12) to (16) represent respectively the principle of effective demand in the market for the domestic good, the money market equilibrium condition, the pricing equation for the domestic good, the definition of inflation as a weighted average of the rate of change of the price of domestic and foreign goods in domestic currency, and the uncovered interest parity condition for the domestic and the foreign bond. Equations (12) and (15) implicitly assume the law of one price for the foreign good.

Figure 2a combines equations (12) to (16) with the wage equations presented above in order to show the effects of an unanticipated, credible reduction of the rate of devaluation. The economy is assumed to have been in a steady state with persistent inflation before the new policy is implemented, at time t=1. The path of output depicted for each type of contracts corresponds to a base case in which $\alpha=0$, which captures the stylized fact that output does not have strong effects on prices, given wages (Blanchard and Fischer (1989), pp. 464-7). This base case also assumes $\beta=0.5$, $\gamma=0.2$, $\delta=0.5$, and $\epsilon=.7$, which are comparable in order of magnitude with those considered by Fischer (1988) and Henderson and McKibbin (1993). Also, the base simulations assume N=4 and n=1, with the short-term fixed wage contracts half as long as the indexed contracts. The experiment considers a reduction in the rate of devaluation equal to 0.01 in log terms.

Figure 2a shows that, with the base-case parameters, the basic outcome of a sudden reduction of the rate of devaluation is a recession. This result is just as in the case of a money-based stabilization, although it can be noted that now the overall output loss is smaller (compare Figure 2a with Figure 1b and the first and last row of Table 2) and that in the case of contracts with preset time-varying wages there is a short-lived initial boom in the economy. Most important for our purposes, Figure 2a suggests that ranking of the costs of disinflation is the same as in the case of money-based stabilization; i.e., the largest net output loss occurs when contracts specify preset time-varying wages, the smallest one occurs when contracts are short-term and specify fixed wages, and the net output loss when contracts are intermediate. This perception is confirmed when comparing the numerical net output loss reported in the first row of Table 2.

To help understand this result, Figure 2b and Figure 2c consider two special cases that permit the separation of the two channels through which the exchange rate-based stabilization affects aggregate demand. First, Figure 2b shows that when demand responds only to the real exchange rate ($\beta=0$), the exchange rate based stabilization causes a recession. This is because, due to the gradual adjustment of wages and inflation, the reduction of the rate of devaluation leads to a temporary real appreciation of the domestic currency; this appreciation reduces demand for the domestic output during the adjustment process. Second, Figure 2c shows that when demand responds only to the real interest rate ($\gamma=0$), the exchange rate-based stabilization can cause a boom-recession cycle, as the one noted by Rodriguez (1982) and Dornbusch (1982). This is because the fixing of the exchange rate can reduce the real interest rate during the early stages of the disinflation—as it fixes the nominal interest rate in an inflationary contex—must fall below its steady state level in order to reestablish the equilibrium real exchange rate.

Table 2. Net Output Loss During Exchange Rate-Based Stabilization1/

	Indexed wages	Preset time-varying wages	Fixed wages
Base model 2/	1.32	1.69	0.76
$\beta=0$	1.26	1.58	0.54
$\gamma=0$	0.35	0.35	0.35
$\beta=1$	1.50	1.89	1.61
$\gamma=0$, $\beta=1$	0.70	0.70	0.70
$\gamma=1$	3.75	5.03	1.99
$\alpha=0.5$	1.08	1.47	0.64
$\epsilon=0.5$	1.16	1.64	0.69
N=2	0.77	0.81	0.55
N=2, $\gamma=0$	0.35	0.35	0.35
N=8	2.63	4.91	1.45
N=8, $\gamma=0$	0.35	0.35	0.35
Net output loss during money-based stabilization 3/			
Base model 2/	1.80	2.72	1.01

1/ Sum of log deviations of output from its steady state level in response to a reduction in the rate of devaluation of 0.01 in log terms (×100).

2/ Assumes $\alpha=0$, $\beta=0.5$, $\gamma=0.3$, $\delta=0.5$, $\epsilon=0.7$, N=4, and n=1.

3/ Sum of log deviations of output from its steady state level in response to a reduction in money growth of 0.01 in log terms (×100).

Figure 2a
Output During Exchange Rate-Based Stabilization: Base Case

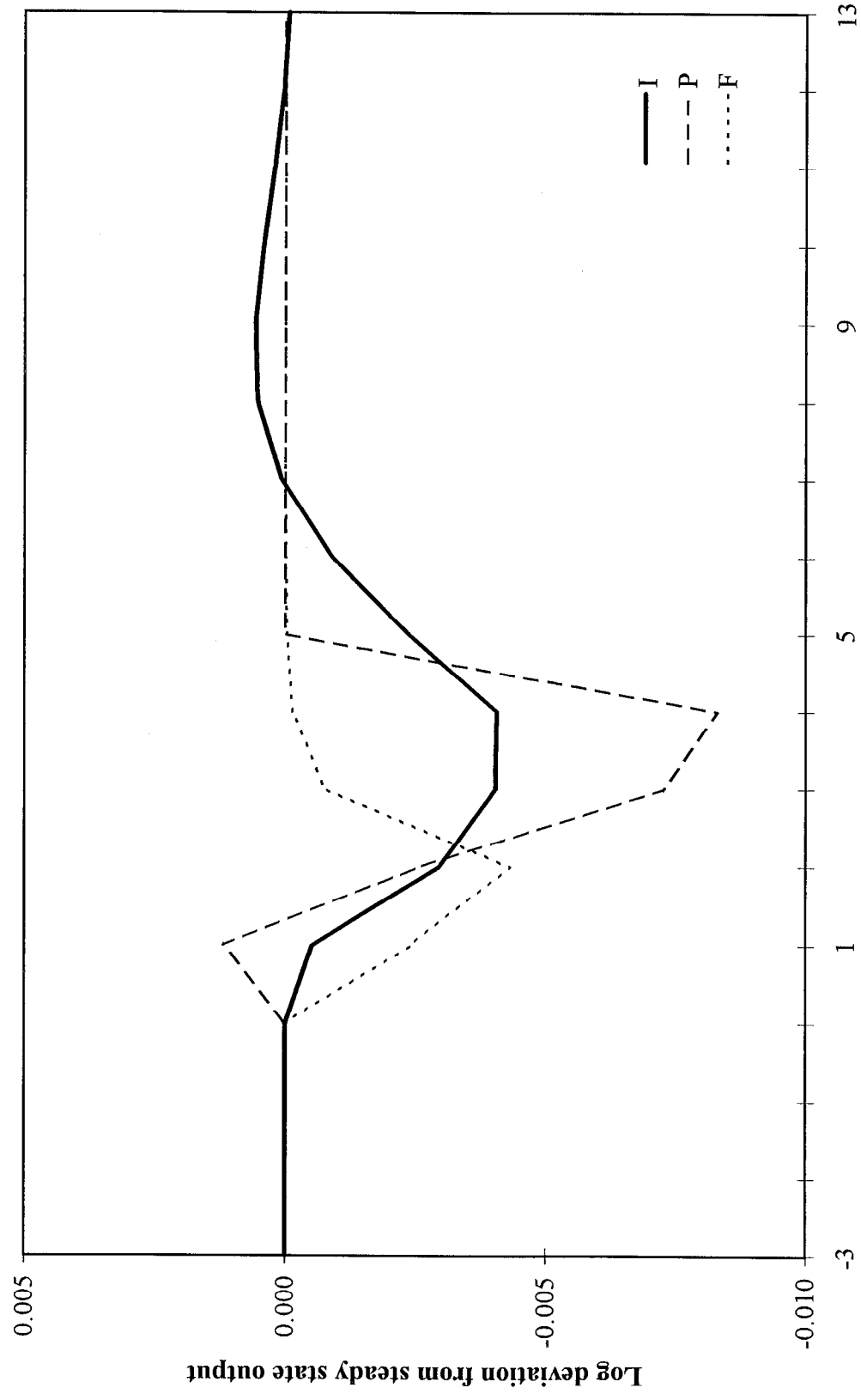


Figure 2b. Output During Exchange Rate-Based Stabilization: Demand Elastic to Real Exchange Rate Only

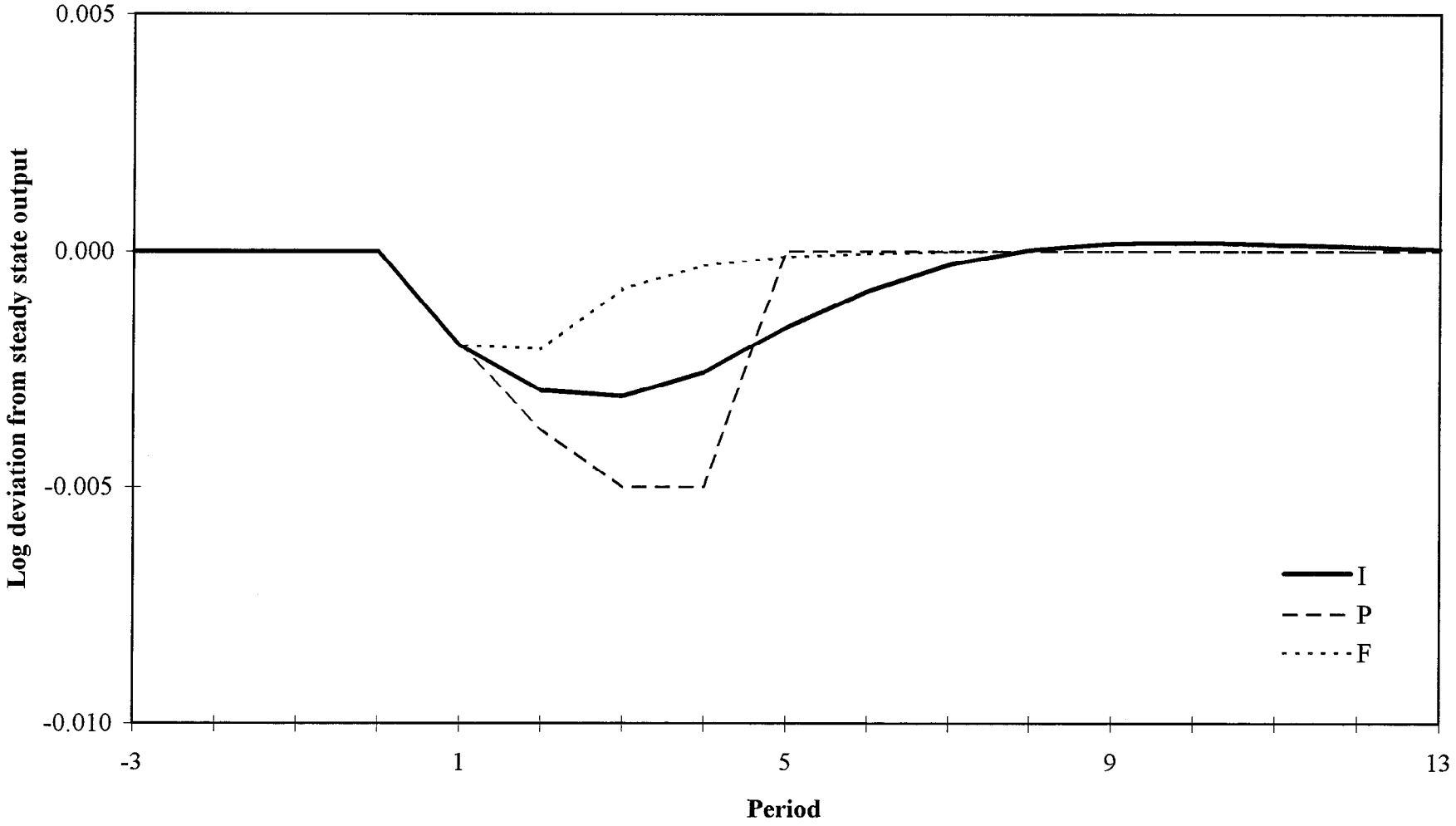
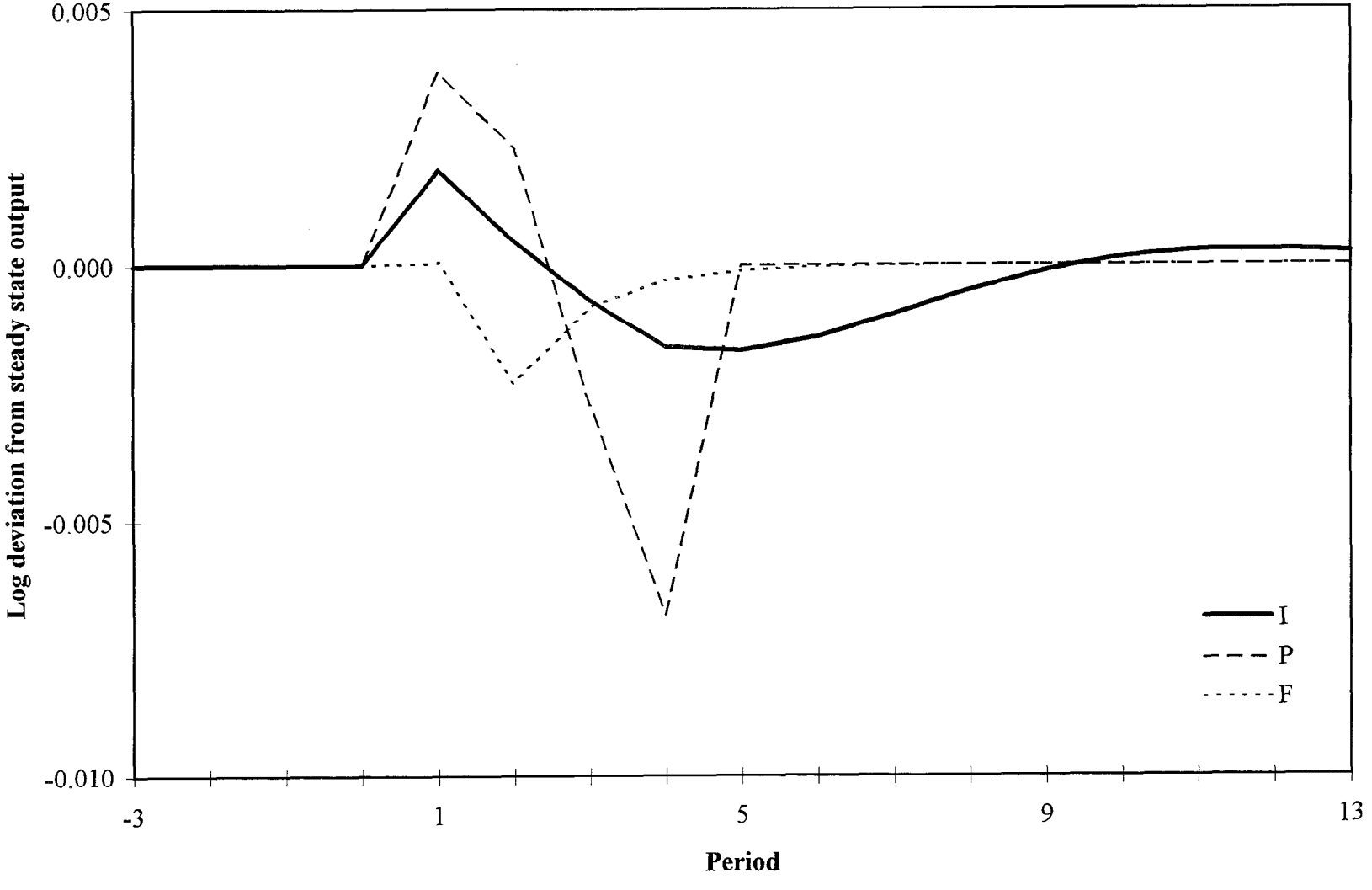


Figure 2c. Output During Exchange Rate-Based Stabilization: Demand Elastic to Real Interest Rate Only



The evaluation of the net output losses with and without wage indexation in these two special cases is revealing. When aggregate demand depends only on the real exchange rate, the ranking of these losses is as above; i.e., indexed wage contracts reduce the cost of disinflation relative to preset time-varying wage contracts and raise it relative to short-term fixed wage contracts (second row of Table 2). When aggregate demand depends only on the real interest rate, in turn, the net output losses are identical regardless of the type of wage contracts prevailing in the economy (third row of Table 2). This implies that wage indexation influences the cost of disinflation only through its effect on the size of the real appreciation of the domestic currency. Inasmuch as the elasticity of the aggregate wage to the expected disinflation when contracts are indexed is larger than the same elasticity when contracts specify preset time-varying wages, it is not surprising that indexed wage contracts reduce the cost of disinflation relative to those contracts. By a similar reasoning, it is not surprising that indexed contracts increase the cost of disinflation relative to short-term fixed wage contracts.

I offer no general proof in this paper to show that the above finding should always obtain, but the simulations results reported in Table 2 suggest that this finding is robust to alternative parameter specifications. More generally, it seems clear that to the extent that output is affected adversely by a real appreciation of the domestic currency, the basic effect of wage indexation described in the previous paragraph will be preserved. Thus I conclude that the qualitative effects of wage indexation on the cost of disinflation under an exchange rate-based stabilization are likely to be similar to those under a money-based stabilization; i.e, indexed wage contracts tend to reduce the cost of disinflation relative to preset time-varying wage contracts, and raise it relative to short-term fixed wage contracts.

V. Wage Indexation and Output Stability

The previous section examined the consequences of wage indexation in the context of a change in policy regime, characterized by a change in the rate of growth of money or in the rate of devaluation. Most of the academic literature on wage indexation, however, has focused on the consequences of wage indexation when the economy is hit by exogenous shocks, for a given policy regime. This section reviews the effects of wage indexation to lagged inflation in such a context, focusing on its impact on output stability.

A. The Gray-Fischer Proposition Revisited

There is no doubt that, despite the sizable literature that has accumulated on the topic, the major academic proposition on wage indexation has continued to be that originally stated by Gray (1976) and Fischer (1977): that indexing wages stabilizes output when shocks are nominal and destabilizes output when shocks are real. Following Gray, the standard argument in support of this proposition hinges on the assumption that wage indexation is with respect to current inflation. However, Fischer's analysis of the lagged indexation rule described by equation (2) also has supported this proposition. Moreover, while Fischer admitted that such an indexing formula may be a far cry from the indexing formula used in practice, and

mentioned that indexing to lagged inflation could modify his conclusion that wage indexation stabilizes output in the face of nominal shocks if shocks were transitory, he conjectured that if the nominal shocks were permanent, his basic conclusion would be preserved. He did not address this issue formally.

In Jadresic (1996a), I reexamined the effects of wage indexation on output stability in an economy similar to that considered by Gray and Fischer, but using wage equations like the ones derived above. Following their analysis, I considered a closed economy in where the exchange rate plays no important role and focused mainly on the case in which the policy regime is one of fixed money supply, which was the one they considered. In order to solve the problem analytically, I also assumed that indexed and preset time-varying wage contracts have a duration of two periods, while fixed-wage contracts have a duration of one period, equal to the indexation period. To compare, Gray's contracts are one-period contracts, while Fischer's contracts are two-period contracts in the case of nonindexed contracts and an undetermined number of periods in the case of indexed contracts.

The main result stemming from Jadresic (1996a) is that, in Gray and Fischer's economy, wage indexation to lagged inflation tends to destabilize output regardless of whether shocks are nominal or real. This appears to be true both when indexed wage contracts are compared with short-term fixed wage contracts, and under plausible parameter values, when they are compared with preset time-varying wage contracts.

To illustrate this result, consider an economy in which the rate of change of aggregate output is determined by the rate of change of real money supply and a nominal shock v_t that is independent and serially uncorrelated with mean zero and variance σ_v^2. This shock can be interpreted as a permanent and unanticipated shock reduction in money demand. With the assumption that the monetary authority follows a fixed money supply rule, this specification implies that

$$y_t = -\pi_t + v_t . \qquad \textbf{(17)}$$

Also, assume that inflation is determined by the simple relationship

$$\pi_t = w_t - u_t, \qquad \textbf{(18)}$$

where u_t is a real shock at period t, assumed to be independent and serially uncorrelated with mean zero and variance σ_u^2. This shock can be interpreted as an unexpected and permanent increase in the level of productivity.[12]

---

[12]This is a simplified version of the inflation equation considered in Jadresic (1996a), which in addition includes the term α $(y_t - u_t)$ in its right hand side, where α is the elasticity of prices, given wages. This term is omitted here for simplicity, as the stylized fact seems to be $\alpha \approx 0$ (Blanchard and Fischer (1989), pp. 464-7). See the discussion below.

Equations (17) and (18) can be solved for each type of contracts by combining them with the corresponding wage equation with N=2 and n=M=1, and making the rational expectations assumption that the policy regime of fixed money supply is well known and that agents know the structure of the economy. Our main focus of interest is the behavior of the output gap (Gap_t), defined as the difference between the actual and the frictionless level of output, with the latter being the level of output that would be observed if wages were fully flexible and the current shocks were fully observable.[13] Solving for this variable leads to the following stochastic difference equations:

$$Gap_t^I = \frac{2}{5} Gap_{t-1}^I - \frac{1}{5} Gap_{t-2}^I + v_t + \frac{1}{5} v_{t-1} + \frac{2}{5} u_{t-1}, \quad \textbf{(19)}$$

$$Gap_t^P = v_t + \frac{1}{2} v_{t-1}, \quad \textbf{(20)}$$

$$Gap_t^F = v_t, \quad \textbf{(21)}$$

where the meaning of the superscripts is obvious.

The behavior of the output gap in response of real and a nominal shocks implied by these equations is depicted in Figure 3a and Figure 3b. Consider first the case of a nominal shock. The initial impact of such a shock is identical regardless of the type of wage contracts. This result arises because, independently of the type of contracts considered, wages in any given period are predetermined; in consequence, a positive shock v_t tends to increase real money balances and output identically. Note also that, because of the assumption that prices do not respond directly to output, inflation is not modified at the time of the impact and output increases precisely by the amount of the shock.

In subsequent periods, the effects of a nominal shock does depend on the nature of the contracts in the economy. The quickest adjustment of output to equilibrium occurs when short-term fixed wage contracts prevail; in this case the initial expansion of output lasts only during the period of the impact. When instead preset time-varying wage contracts prevail, 1/2 of the initial expansion of output persists one period following the impact; thereafter the economy rests in equilibrium. Finally, in the case of indexed contracts, 3/5 of the initial

---

[13] In the model presented here, the frictionless level of output is proportional to the level of productivity. Indeed, with fully adjusting wages and perfect information, wage setters would set $w_t = \pi_t + y_t$; this equation and equation (18) imply that the rate of change of the frictionless level of output is u_t.

Figure 3a
Output Effects of a Nominal Shock in a Closed Economy
(Fixed Money Supply)

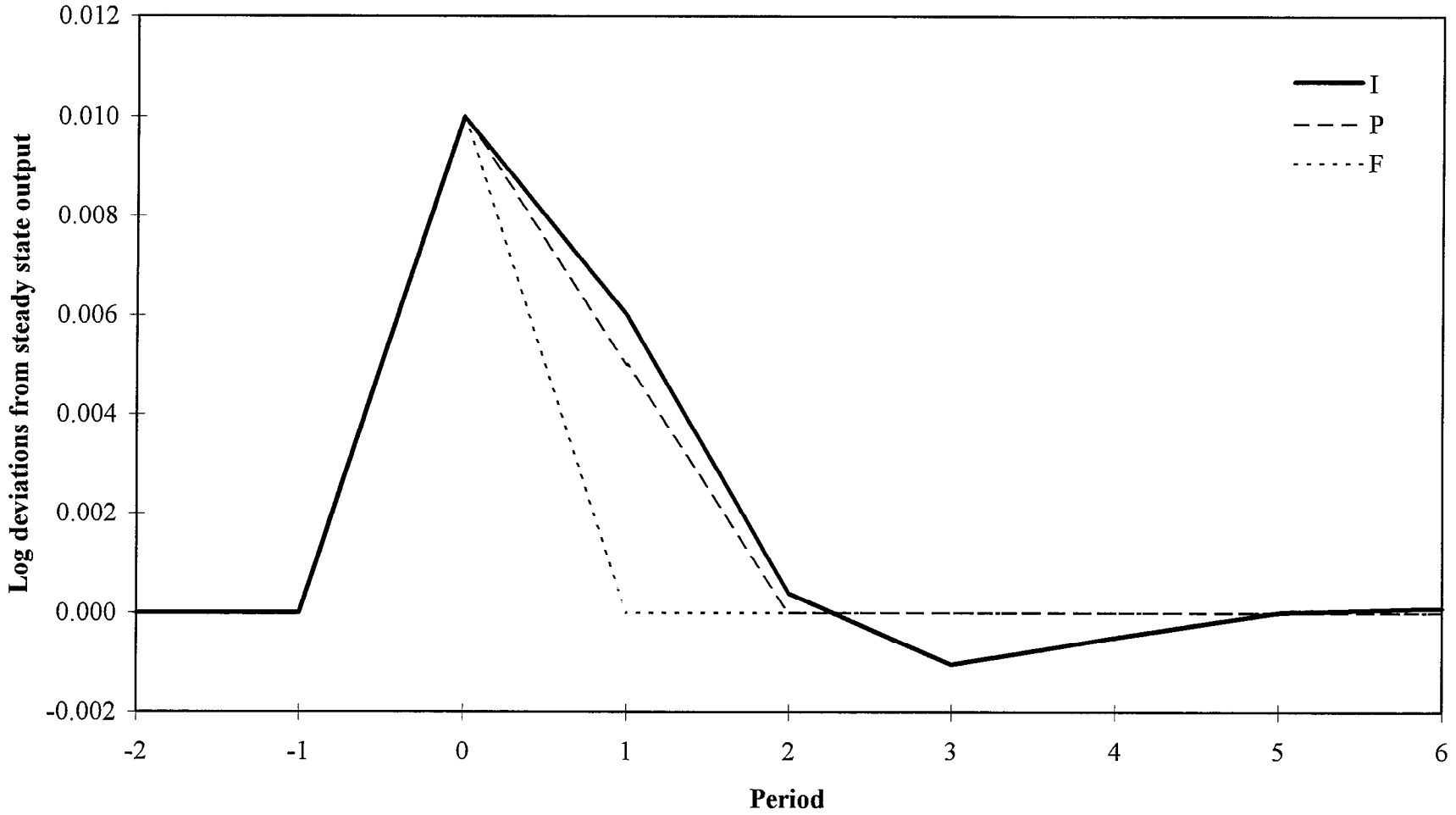
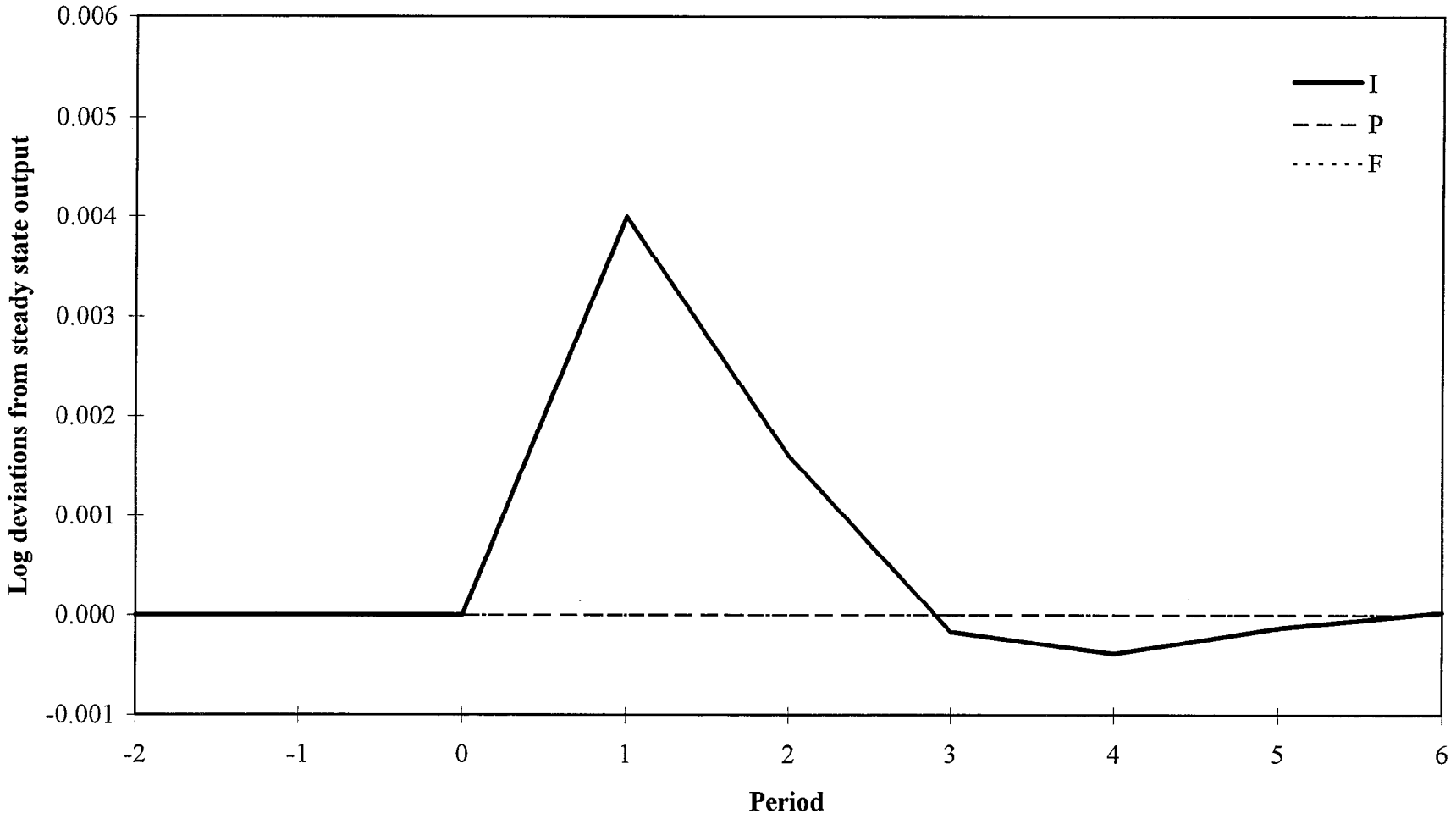


Figure 3b
Output Effects of a Real Shock in a Closed Economy
(Fixed Money Supply)



expansion of output persists one period after the shock; thereafter output converges to its equilibrium through an oscillatory process that rapidly fades away.[14]

Using any reasonable way to measure instability, the overall effect of wage indexation on the response of output to the nominal shock implied by these results is unambiguous: wage indexation destabilizes output. What is the intuition? In comparison to short-term fixed wage contracts, this occurs simply because indexed wage contracts imply a slower return of output to its equilibrium level; i.e. the indexation clauses do not provide a mechanism to compensate the fact that with contracts of longer duration a smaller fraction of wages are revised in every period. In comparison to preset time-varying wage contracts, the reason is more subtle: as the indexation clauses transmit automatically part of the increase in wages and inflation from one period to the other, after a positive nominal shocks hits the economy, wage setters anticipate that in subsequent periods inflation will stay temporarily above the trend and that real money balances and output will continue falling; the anticipation of falling output moderates the adjustment of wages and inflation during the first period after the impact, slowing down the adjustment of the economy and causing the initial expansion of output to persist.

Consider now the case of a real shock. As shown in Figure 3b, such a shock has no effect on the output gap in the period it impacts on the economy. Indeed, given that in any single period wages are predetermined, a positive real shock u_t reduces prices proportionally and increases real money balances and output exactly by the same magnitude as the size of the shock. As output and the frictionless level of output increase by the same amount, the output gap thus remains unaltered. Note that while this result differs from the expansive effect implied by the positive nominal shock considered above, once again, this outcome does not depend on the type of contracts considered.

In subsequent periods, output with short-term fixed and preset time varying wage contracts remains in equilibrium, but output with indexed wage contracts is destabilized: in the first period after the shock there is a boom and thereafter output converges gradually to its equilibrium level. The boom occurs because the reduction in the inflation rate in the period of the shock is transmitted automatically into an inflation rate lower than the trend in the next period; this effect raises real money balances and expands output despite the fact that no additional shocks have occurred (in the simple model considered here, the size of the output gap in the period following the shock is 2/5 of the magnitude of the shock). In the next period, upward pressure on wages increases inflation and moves real money balances and output

---

[14]The oscillatory and convergent nature of the evolution of output can be verified by computing the roots of the characteristic equation implied by equation (19), which are both imaginary and have the property that the multiplication of their inverses is smaller than one.

towards their equilibrium levels. Thereafter, output converges to its equilibrium after a sequence of oscillations that gradually fade away.[15]

In the context of Gray and Fischer's specific closed-economy model, Jadresic (1996a) shows that the findings that wage indexation to lagged inflation generally destabilizes output tend to be robust to considering a more general inflation equation, which allows for a direct effect of output on prices, given wages. For nominal shocks, the caveat is that if this effect is positive and strong enough, wage contracts indexed to lagged inflation can stabilize output relative to preset time-varying wage contracts—although they would continue to destabilize output relative to short-term fixed wage contracts. In the case of real shocks, wage indexation would always be destabilizing.

It must be warned, however, that these findings are not robust to alternative assumptions about the nature of the economy. As discussed in the following section, considering an open economy can fully reverse these findings. Similarly, allowing for alternative monetary policies can also have significant effects. For instance, the analysis in Jadresic (1996a) shows that if money supply is indexed to lagged inflation rather than fixed, the variability of output with indexed wage contracts is reduced to the same level as the variability of output with contracts that specify preset time-varying wages under a fixed money supply. One implication of this result is that, even if the economy is hit only by real shocks, wage indexation does not necessarily destabilize output. Of course, the drawback of indexing money supply is that such a policy destabilizes inflation dramatically.

B. Output Stability in the Open Economy

Analyzing the effects of wage indexation on output stability in a closed economy can be useful for academic purposes, and can be appropriate for understanding the behavior of economies with a small external sector or whose financial sectors are poorly integrated to the international financial markets and that apply a crawling peg. However, for most countries today, it would be more relevant to discuss the effects of wage indexation in an open economy context. I have done so in Jadresic (1997), with the help of the simple model presented above for analyzing exchange rate-based stabilization. This section reviews some of the implications of such analysis. As the focus now will not only be on evaluating the overall effects of wage indexation on output stability, but also on exploring more generally the effects of wage indexation on output behavior, we provide first some background.

In the literature on international macroeconomics, there is substantial agreement on the behavior of an open economy hit by aggregate shocks under perfect capital mobility and simple nominal price or wage rigidities. The basic common principles are contained in the Mundell-Fleming results, according to which a monetary shock destabilizes output when the

---

[15]As in the case of a nominal shock, this process of adjustment can be verified by computing the roots of the characteristic equation associated with equation (19).

exchange rate floats but does not affect it when the exchange rate is fixed, while a shock on the demand for goods destabilizes output more when the exchange rate is fixed than when it floats. More generally, there is a consensus that in a conventional open economy the response of output and other macroeconomic variables to aggregate shocks depends crucially on the exchange rate regime in place.[16]

According to the literature on wage indexation, however, the behavior of an open economy can be very different from the one just described when wages are indexed.[17] The sharpest contrast arises under the assumption of *full wage indexation*, in which case nominal wages are assumed to move proportionally with the current price level and the real wage is thus deemed fixed. As in conventional models a fixed real wage makes the level of output independent from nominal variables, it follows that in this case the Mundell-Fleming results cease to hold: monetary shocks do not affect output even if the exchange rate is flexible, while shocks on the demand for goods affect output identically with a fixed and a floating exchange rate. More generally, full wage indexation would make the exchange rate regime totally irrelevant for output behavior.[18]

Once the lags in actual indexation rules are taken into account, however, it is apparent that wage indexation will not have the effects mentioned in the previous paragraph. The analysis in Jadresic (1997) confirms this presumption. By running simulations based on the open economy model and wage equations presented in the previous sections, it is found there that, once the lags in actual indexation are taken into account, wage indexation to lagged inflation affects output behavior substantially less than posited by the previous academic literature. In particular, wage indexation does not appear to invalidate or modify the Mundell-

---

[16]The seminal references on the behavior of an open economy with nominal rigidities are Fleming (1962), Mundell (1963), and Dornbusch (1976). A useful survey of the related literature can be found in Marston (1985). For an analysis using a representative agent framework, see Obstfeld and Rogoff (1996).

[17]On the effects of wage indexation in open economies, in addition to the general surveys on wage indexation mentioned in the introduction, see Genberg (1989), Argy (1990), and Turnovsky (1995).

[18]When the academic literature refers to *partial wage indexation*, the contrast with the conventional predictions are less acute, but qualitatively the differences remain. In this case, nominal wages are taken to move less than proportionally with the current price level, but the real wage is still assumed to be more rigid than without wage indexation. In standard models, this increased real wage rigidity lessens the effects of monetary shocks on output when the exchange rate is flexible, and dampens the effect of shocks in the demand for goods on output when the exchange rate is fixed. The general proposition is that the larger the degree of wage indexation, the smaller the differences on output behavior across exchange rate regimes (Marston (1982), and Turnovsky (1983)).

Fleming results nor to blur the behavior of output across exchange rate regimes. Rather, the response of output to a variety of shocks appears to be qualitatively similar and of the same order of magnitude regardless of the type of contracts prevailing in the economy.

These result are illustrated in Figure 4a and Figure 4b. These figures show the response of output to a monetary and a demand shock implied by the open economy model of the previous section and the wage equations presented above. The shocks correspond to a permanent, unexpected reduction in the demand for money, and a permanent, unexpected increase in aggregate demand for the domestic output respectively. As before, the simulations assume that the respective policy regime and the structure of the economy is well known by the agents of the economy. The floating exchange rate regime corresponds to the assumption $m_t=0$, and the fixed exchange rate regime to $s_t=0$. The shocks are equivalent to 0.01 in log terms and the parameter values are those of the base case already defined.

Consider first the case of a monetary shock. The top box of Figure 4a shows the response of output when the exchange rate floats. Output tends to expand temporarily whatever the type of contracts prevailing in the economy. The basic reasons are familiar. First, the monetary shock reduces nominal interest rates and raises expected inflation, cutting down expected real interest rates. Second, the shock depreciates the domestic currency, which with predetermined wages and prices, increases the competitiveness of the economy. Both effects tend to boost demand and output.

The top box of Figure 4a clearly shows that wage indexation to lagged inflation does not insulate output from the monetary shock. This result is partly explained by the fact that, with wage indexation to lagged inflation, the depreciation of the domestic currency caused by the monetary shock affects future wages but does not affect current wages. Because of this initial predetermination of wages, the temporary rise in the competitiveness of the economy, as well as the temporary reduction in expected real interest rates, occur despite the existence of wage indexation. In principle, however, the evolution of indexed and nonindexed wages following the period of the shock could be sufficiently different as to alter substantially the behavior of output, both after and at the time of the shock. In this regard, the top box of Figure 4a shows that, perhaps not surprisingly, the adjustment of output to its steady state level takes longer with indexed contracts than with short-term fixed wage contracts. Also, output with indexed contracts does not stabilize completely once all contracts have been revised—it rather converges cyclically to the steady state level. But it is clear from the figure that in all cases the overall response of output to the monetary shock is qualitatively similar, and that the order of magnitude of the effects are comparable.

Nonetheless, does wage indexation to lagged inflation at least help to reduce somewhat its variability? The simulations for alternative parameter values in Jadresic (1997) indicate that the answer is ambiguous and depends crucially on the specific characteristics of the economy. The ambiguity is closely related to the size of the depreciation of the domestic currency due to the monetary shock and of its initial impact on prices and inflation. If these effects are large enough, the indexation clauses imply a relatively large adjustment of wages

Figure 4a
Output Effects of a Monetary Shock in an Open Economy
(Log deviations from steady state output)

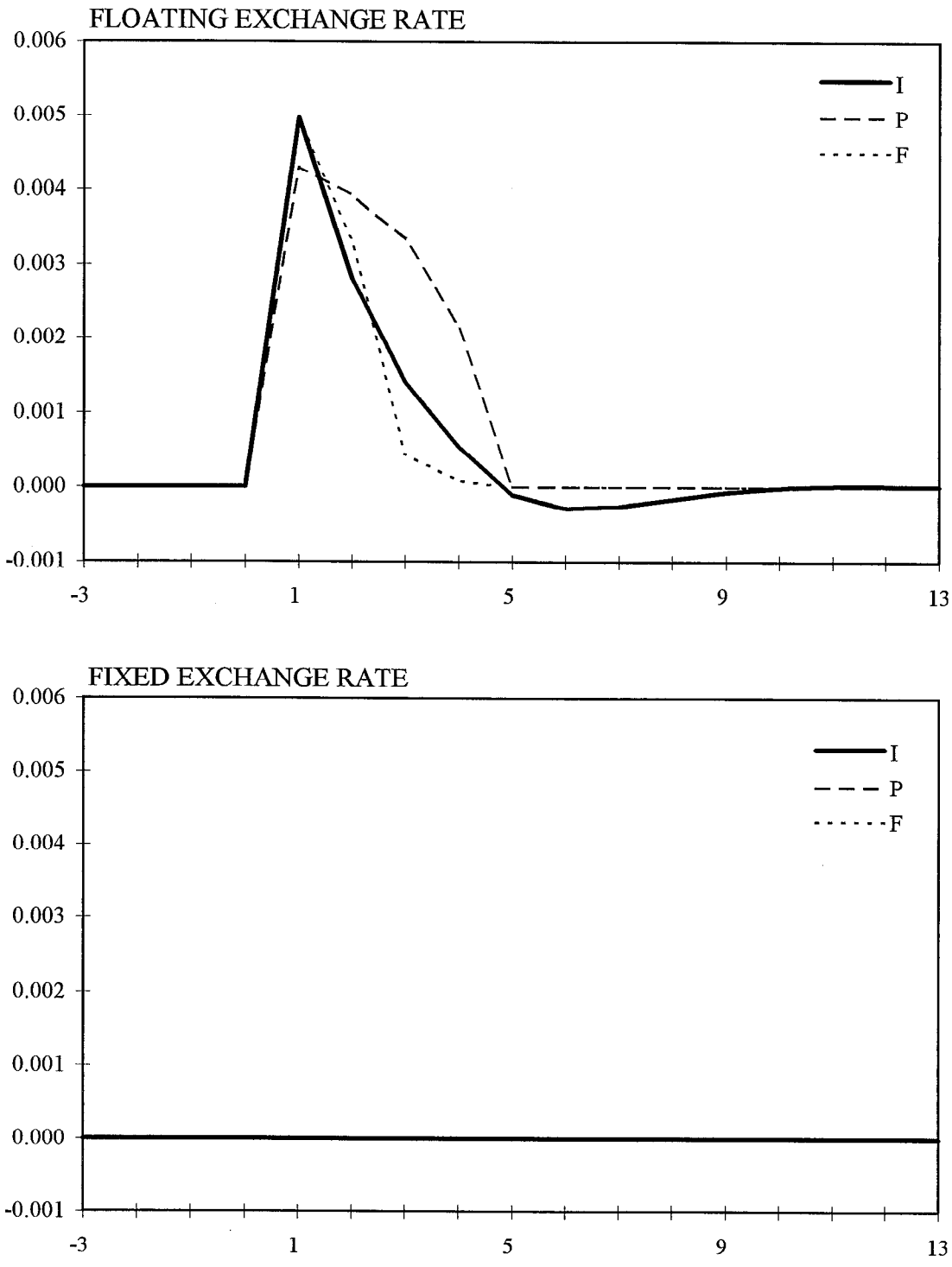
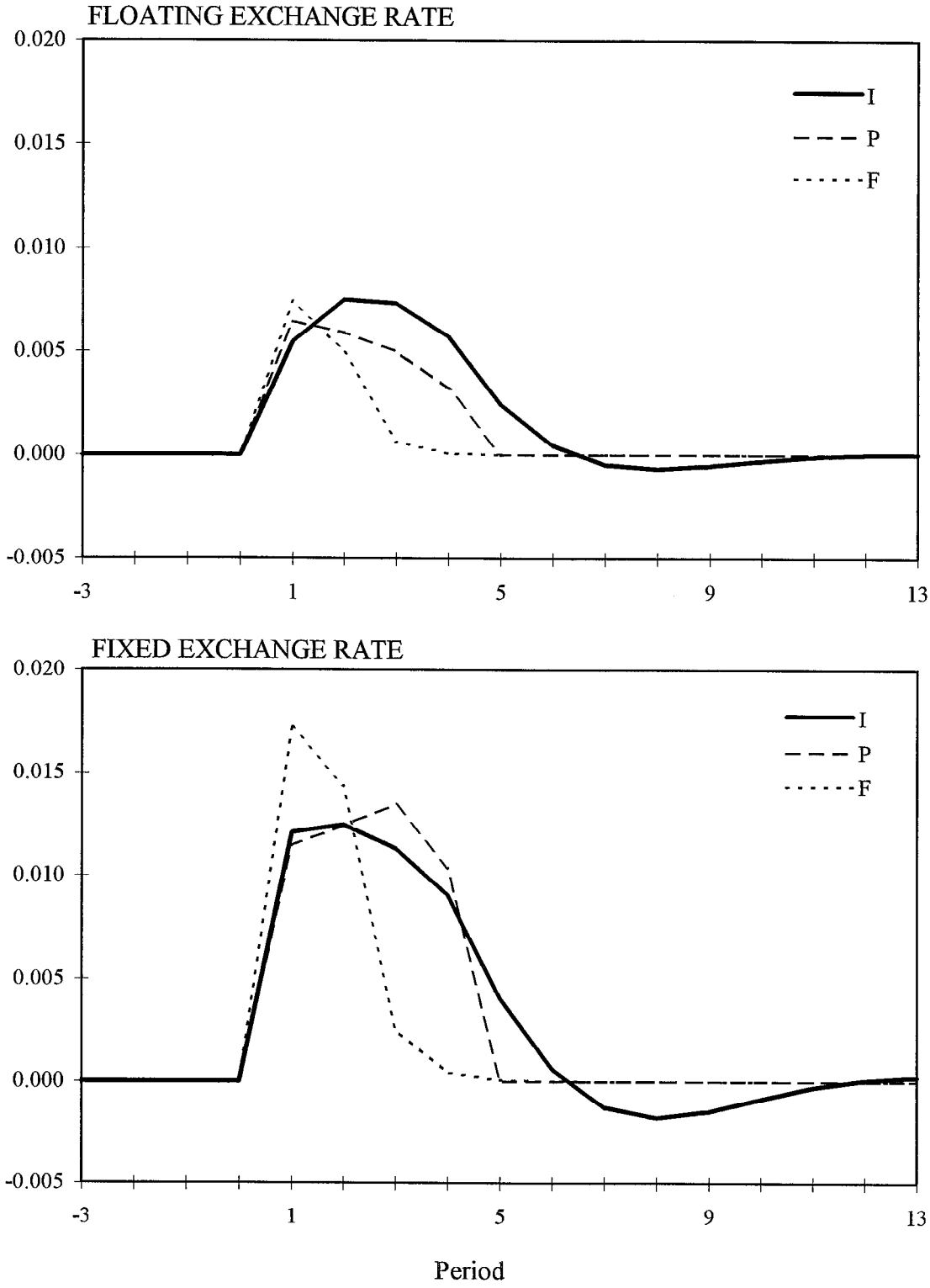


Figure 4b
Output Effects of a Demand Shock in an Open Economy
(Log deviations from steady state output)



in the period after the shock occurs, and indexed wage contracts can contribute to accelerate the process of adjustment of wages, prices, and output. However, if these effects are small—for instance, because the weight of foreign goods in the CPI is low, or because aggregate demand is very sensitive to the real interest rate or the real exchange rate—then indexed contracts can destabilize output. This is because, as indexed wage contracts automatically feedback part the initial increase in wages and inflation to subsequent periods, they tend to reduce expected real interest rates and thus make the initial expansion of output more persistent. In addition, in later periods indexed contracts tend to generate excessive cumulated inflation, which elevates nominal and real interest rates, reduces competitiveness, and can drive output below its steady state level. Both effects work to increase the variability of output.

Figure 4b shows the case of a shock in the demand for the domestic good. Given the nominal rigidity introduced by the wage contracts, the increase in demand causes a temporary boom in output. Moreover, in line with the Mundell-Fleming results, the magnitude of this boom is significantly smaller when the exchange rate floats than when the exchange rate is fixed. The reason is that the long-term real appreciation required by the economy in order to accommodate the demand shock is attained differently depending on the exchange rate regime. With a fixed exchange rate, the real appreciation is achieved through an increase in wages and inflation in the periods following the shock. This process reduces temporarily expected real interest rates and achieves the real appreciation only gradually, effects which work to destabilize output during the period of adjustment. With a floating exchange rate, in turn, most of the required real appreciation is attained through a nominal appreciation at the time of the shock. This nominal appreciation helps to stabilize output, both by shifting demand out of the domestic good more quickly, and by putting less pressure on wages and inflation as vehicle for adjustment, which helps to stabilize expected real interest rates.

For this paper, most important is the result is that the order of magnitude of the output boom caused by the demand shock does not depend on the whether wages are indexed or not. While the alternative type of wage contracts under consideration do imply some differences in the behavior of output during the adjustment process, those differences are relatively minor, and do not change the fact that a floating exchange rate moderates substantially the response of output to the shock. The relatively small effect of wage indexation on output behavior is again partly due to the fact that, regardless of the type of wage contracts prevailing in the economy, wages are predetermined at the time the shock occurs. In addition, the top box of Figure 4b shows that, even when fully considering the different dynamics associated to the alternative type of contracts, the differences in the behavior of output are minor.

Nonetheless, does wage indexation have any tendency to destabilize the behavior of output in response of a demand shock when the exchange rate floats and to stabilize it when the exchange rate is fixed? In the case of a floating exchange rate, the top box of Figure 4a and the simulations for alternative parameter values in Jadresic (1997) indicate that wage indexation does tend to destabilize output. In this case, and for almost all parameter values considered, the variance of output with indexed wage contracts is larger than with preset

time-varying wage contracts and with short-term fixed wage contracts. The reason is that, in the periods immediately after the shock occurs, the indexation clauses quickly feedback into wages the lower inflation due to the initial appreciation, tending to curb or even reduce them. This effect works first to moderate the magnitude of the real appreciation and then to reduce the expected real interest rate, as demanders anticipate that wages and inflation will have to accelerate in the future in order to compensate the unnecessary cutback of current wages. Consequently, with a floating exchange rate, the output boom caused by the shock in demand tends to persist for longer when contracts are indexed, which destabilizes output.

In the case of a fixed exchange rate, instead, the analysis in Jadresic (1997) indicates that wage indexation has no clear cut effect on the output response to a demand shock. Two parameters that are especially important in determining whether wage indexation raises or reduce this response are the elasticities of the demand for the domestic good with respect to the expected real interest rate and with respect to the real exchange rate. This is because wage indexation slows down the adjustment of wages and inflation, which tends to moderate the initial fall in expected real interest rates but to reduce the speed of the real appreciation required to reestablish equilibrium. While the former effect is stabilizing, the latter is destabilizing. Depending on the specific elasticities of the demand for the domestic good, wage indexation can either stabilize or destabilize output.

Jadresic (1997) also considers the effects of price shocks and productivity shocks. The analysis confirms that the effects of wage indexation to lagged inflation on output behavior are relatively small. Also, the results indicate that wage indexation is likely to destabilize output when shocks are in prices and that it has an ambiguous effect when shocks are in productivity.

To summarize, once the lags in actual indexation are taken into account, wage indexation in the open economy affects the behavior of output substantially less than posited in the previous literature. Also, the net effects of wage indexation on output stability in this context are ambiguous. For instance, if the economy is hit mainly by price shocks, wage indexation is likely to destabilize output. The same is bound to happen if the economy is hit mostly by shocks in the demand for goods and there is a floating exchange rate. However, if the economy is hit mainly by monetary or productivity shocks, or if it is hit mainly by demand shocks and there is a fixed exchange rate, the net effects of wage indexation are ambiguous and depend on the economy's parameter values. The overall implication is that a definite evaluation of the net effects of wage indexation on output stability in the open economy requires a precise specification of the economy under consideration, an issue which requires further research.

VI. Further Macroeconomic Consequences of Wage Indexation

The previous sections have focused on the consequences of wage indexation on the behavior of output. The above analysis, however, also has implications on other variables and issues. This section explores some of those implications, comparing them with the implications of the standard approach in the academic literature..

A. The Choice of Exchange Rate Regime

Building on models where wage indexation is with respect to current inflation, the indexation literature has inferred that wage indexation would be a powerful reason to prefer a flexible exchange rate regime over a fixed exchange rate regime. This result has come out under the traditional approach in which the policymaker is assumed to be concerned only with output stabilization, as well as under the more modern approach in which the policymaker is assumed to be concerned with keeping low inflation along with output stability, but in which his preferences are time-inconsistent and exhibit an inflation bias. The crux of the argument is that wage indexation helps to protect output from monetary shocks regardless of the exchange rate regime in place. If this effect is true, wage indexation makes a fixed exchange rate unnecessary to deal with monetary shocks and reduces the incentives to create inflationary surprises.

To explain this in more detail, consider first the traditional approach that evaluates exchange rate regimes according to the extent that they help to stabilize output. While it is obviously recognized that in the more general case of an arbitrary degree of indexation anything can happen, the literature has shown and highlighted that with *optimal wage indexation*, case in which the degree of indexation is optimally chosen to minimize the deviations between the actual and the frictionless level of output, a floating exchange rate regime is always better or at least as good as a fixed exchange rate regime.[19] This result hinges on the prediction that wage indexation helps to protect output from monetary shocks regardless of the exchange rate regime in place. If this effect is true, it is clear that wage indexation weakens the key merit of a fixed exchange rate regime under the criterion of output stabilization.

Wage indexation would also be a strong reason for preferring a flexible exchange rate regime if the policymaker is concerned with keeping low inflation along with output stability.

---

[19]This proposition was shown by Flood and Marion (1982), and Aizenman and Frenkel (1985a, 1985b and 1986). The latter also showed that, around the optimal degree of wage indexation, a higher degree of indexation raises the optimal degree of exchange rate flexibility. Besides, they showed that the concept of optimal wage indexation based on the minimization of the expected squared discrepancy of actual output from its frictionless level is equivalent to a concept of optimal wage indexation based on the minimization of the welfare cost of the distortions existing in the labor market.

This issue has been examined using a Barro and Gordon (1983) framework in where the policymaker's preferences are time-inconsistent and exhibit an inflation bias. In such a context, and in the absence of wage indexation, it is generally accepted that a fixed exchange rate can dominate a flexible exchange rate; such a result requires that the fixed exchange rate makes low inflation more credible and that the benefits due to this improved credibility outweigh the costs of losing flexibility to adjust to aggregate shocks.[20] In contrast, the indexation literature has shown that if the degree of wage indexation is optimal in the sense explained above, a flexible exchange rate regime generally dominates a fixed exchange rate regime.[21] As in the previous paragraph, this result also hinges on the prediction that wage indexation helps to protect output from monetary shocks. To the extent that this effect is true, wage indexation obviously reduces the incentives to create inflationary surprises, and thus weakens the usefulness of the credibility effect associated with a fixed exchange rate regime.

Despite the faultless logic of the above arguments, the conclusion that wage indexation makes a flexible exchange rate generally preferable over a fixed exchange rate is unwarranted once the lags in actual indexation rules are taken into account. As it is clear from the argument, that proposition depends crucially on the premise that wage indexation protects output from monetary shocks even when the exchange rate is flexible. As it is also clear from the analysis in the previous sections, such a premise does not conform with the result obtained above, at least as a general or significant proposition.

What are then the general implications of the analysis already presented on the choice of exchange rate regime? From a constructive perspective, the broad similarity of the behavior of output with and without wage indexation found in that analysis suggests that the choice of exchange rate regime in economies with wage indexation depends on the same type of factors that affect the choice of exchange rate regime in economies without wage indexation. For instance, wage indexation seems unlikely to alter significantly the possible tradeoff between credibility in low inflation and flexibility in dealing with aggregate shocks that part of the literature attributes to the choice between a fixed and a flexible exchange rate. Therefore, while considering the existence of wage indexation does not seem to help to solve the long standing problem of which is the optimal exchange rate regime, it also does not appear to be a crucial factor on deciding which is that regime. This suggested implication contrasts sharply with the suggestion of the academic literature that wage indexation generally makes a flexible exchange rate preferable.

---

[20]This result can be formally derived by applying Barro and Gordon's (1983) analysis of inflationary bias with discretionary policy in an open economy context. See for instance Alogouskofis (1994) and Obstfeld and Rogoff (1996).

[21]This result is due to Rasmussen (1993). It requires the condition that wage setters care about inflation at least as much as the policymaker does.

A corollary of the above is that the existence of wage indexation is unlikely to be a good reason for implementing an indexed exchange rate regime. This is confirmed in Jadresic (1997), where it is found that, regardless of the type of contracts in the economy, the effects of such a regime on output and real exchange rate stability are broadly similar to those of presetting the path for the exchange rate. In the end, with or without wage indexation, the main distinctive effect of an indexed exchange rate regime seems to be its well known adverse effect on inflation stability.

B. The Level and Variability of Inflation

The fact that actual indexation is with respect to lagged rather than current inflation also has implications on the determination of the level and variability of inflation. We now explore these implications.

Whether and how wage indexation affects the level of inflation depends on the factors that determine monetary policymaking. In the previous literature, this issue has been typically analyzed in the context of Barro and Gordon's (1983) model, under the assumption that the monetary authority has time-inconsistent preferences and cannot commit credibly to maintain low inflation. Within this framework, the academic research has been ambiguous regarding the effects of wage indexation on the level of inflation. On the one hand, because of the standard assumption that wage indexation is with respect to current wages and thus stabilizes output when shocks are nominal, most authors have assumed that introducing wage indexation reduces the incentives to create nominal surprises and thus reduces the level of inflation (for instance, see Fischer and Summers (1989); Milesi-Ferreti (1994); and Crosby (1995)). On the other hand, while not questioning that wage indexation has this anti-inflationary effect, Ball and Cecchetti (1991) have argued that this effect is more than compensated by the fact that wage indexation mitigates the cost of inflation, which is inflationary.

Once the lags in actual wage indexation are considered, wage indexation seems relatively more likely to increase the level of inflation. Indeed, the findings discussed above indicate that when the cost of living adjustments are based on lagged inflation, the standard assumption that wage indexation protects output from nominal shocks is unwarranted: wage indexation to lagged inflation can increase the response of output to a nominal shock, and, more generally, it modifies the effect of the shock on output substantially less than assumed in the literature mentioned above. In consequence, wage indexation to lagged inflation is not necessarily a deterrent to the creation of nominal surprises, and when it is, it certainly is not as strong as wage indexation to current inflation. If it is also considered that wage indexation diminishes the cost of inflation and reduce the will to fight inflation, then wage indexation seems relatively more likely to raise the level of inflation. Of course, this presumption is conditional on the postulate that the monetary authority cannot commit credibly to maintain low inflation, which is controversial (for instance, see McCallum (1997)).

Regarding the variability of inflation, Gray (1976) and Fischer (1977) had argued that wage indexation increases price variability, result which at least in their basic models also implied larger inflation variability. In contrast, the general result in Jadresic (1996a and 1997) is that the effects of wage indexation is ambiguous. For instance, in the closed-economy and fixed money supply setting studied above, wage indexation raises inflation variability when indexed wage contracts are compared to preset time-varying wage contracts, but it can either raise or reduce inflation variability when indexed wage contracts are compared to short-term fixed wage contracts. In simulation with the open-economy setting, in turn, it appears that wage indexation also can reduce inflation variability, but there is no guarantee that this is always the case.

VII. Summary and Concluding Remarks

This paper has reviewed the macroeconomic consequences of wage indexation drawing on recent research by the author. In line with standard indexation rules, and in contrast with the previous academic literature, this research treats wage indexation explicitly as a clause in long-term contracts that grants periodic wage adjustments according to lagged inflation. Also, to evaluate the consequences of contracts with this type of clauses, it models the behavior of the economy in the absence of indexation using two alternative standards of reference. These are defined by the behavior of the economy with contracts that specify preset time-varying wages, and with short-term contracts that specify fixed wages.

Table 3 summarizes some of the main consequences of wage indexation to lagged inflation implied by this analysis, contrasting them with the predictions of the standard approach that assumes that wage indexation is with respect to current inflation. The details that underlie the construction of this table have already been discussed throughout the paper and in the references there provided. For the record, the result that the effects of wage indexation on the cost of disinflation under exchange rate-based stabilization are likely to be qualitatively similar to those under money-based stabilization is new.

An important lesson that emerges from this summary and comparison is that the standard analysis of wage indexation in the academic literature can provide a very misleading picture of the consequences of the typical type of wage indexation observed in real life. To some extent, this finding should not be very surprising, because as soon as one recognizes that standard wage indexation rules define a nominal rather than a real rigidity, it becomes apparent that the effects of wage indexation can be very different from those predicted by the assumption that wage indexation is with respect to current inflation. However, the research reviewed in this paper goes beyond this general statement by showing that the assumption that wages are indexed to current inflation can be of little usefulness even as a gross approximation

Table 3. Summary of Some Macroeconomic Consequences of Wage Indexation

	Type of Wage Indexation	
	to Current Inflation	to Lagged Inflation
Cost of disinflation		
Money-based	reduces	reduces if nonindexed contracts specify preset time-varying wages, raises if nonindexed contracts specify fixed wages
Exchange-rate-based	reduces	idem as in money-based stabilization
Output stability		
Closed economy 1/	depends on the variance of real and nominal shocks	reduces
Open economy	ambiguous	ambiguous
Choice of exchange rate regime	prefer flexible exchange rate	choice with and without indexation similar
Level of inflation 2/	ambiguous	ambiguous, but relatively more likely to increase inflation
Variability of Inflation	increases	ambiguous

1/ With fixed money supply.

2/ If the monetary authority cannot credibly commit to maintain low inflation.

to the issue. Indeed, Table 3 indicates that in most of the issues examined, the macroeconomic consequences of wage indexation to lagged inflation are substantially different from the consequences of wage indexation to current inflation, even at a qualitative level.

The broad picture that emerges from taking into account the lags in actual wage indexation validates the views that most policymakers and applied observers seem to have on the consequences of wage indexation. The analysis indicates that wage indexation to lagged inflation can increase the cost of disinflation, destabilize output regardless of the type of shocks in the economy, and matter relatively little for the choice of exchange rate regime. In addition, the analysis suggests that, unless the policymaker is firmly committed to maintain low inflation, wage indexation to lagged inflation is relatively more likely to increase average inflation. However, the analysis also indicates that there are important qualifications to be made with respect to these propositions. In particular, wage indexation to lagged inflation can reduce the cost of disinflation if the alternative to indexed wage contracts are contracts that specify preset time-varying wages. Also, in an open economy and for a given policy regime, wage indexation to lagged inflation can increase or reduce output stability depending on the specific characteristics of the economy under consideration. A definite evaluation of what is the more relevant case in practice requires further research.

REFERENCES

Adams, Charles, and David T. Coe, 1990, "A Systems Approach to Estimating the Natural Rate of Unemployment and Potential Output for the United States," *Staff Papers*, International Monetary Fund, No. 2, Vol. 37 (June), pp. 232-93.

Aizenman, Joshua, 1987, "Wage Indexation," in J. Eatwell, M. Milgate, and P. Newman (eds.), *The New Palgrave: A Dictionary of Economics*, (London: Mac Millan), pp. 838-40.

———, and Jacob A. Frenkel, 1985a, "Optimal Wage Indexation, Foreign Exchange Intervention, and Monetary Policy," *American Economic Review*, No. 3, Vol. 75 (June), pp. 401-23.

———, 1985b, "On the Tradeoff between Wage Indexation and Foreign Exchange Intervention," *Weltwirtschaftliches Archiv*, Vol. 121 pp. 1-17.

———, 1986, "Wage Indexation, Supply Shocks, and Monetary Policy in a Small, Open Economy," in S. Edwards and L. Ahamed (eds.), *Economic Adjustment and Exchange Rates in Developing Countries*, NBER Conference Report, (Chicago:University of Chicago Press), pp. 89-129.

Alogouskofis, George, 1994, "On Inflation, Unemployment, and the Optimal Exchange Rate Regime," in F. Van Der Ploeg (ed.), *The Handbook of International Macroeconomics*, Basil Blackwell (Cambridge, Massachusetts), pp. 192-223.

Argy, Victor, 1990, "Choice of Exchange Rate Regime for a Smaller Economy: A Survey of Some Key Issues," in Victor Argy and Paul De Grauwe (eds.), *Choosing an Exchange Rate Regime: The Challenge for Smaller Industrial Countries*, (Washington: International Monetary Fund), pp. 6-81.

Ball, Lawrence, 1990, "Credible Disinflation with Staggered Price Setting," *NBER Working Paper*, No. 3555, (Cambridge, Massachusetts: National Bureau of Economic Research), December.

———, and Stephen Cechetti, 1991, "Wage Indexation and Discretionary Monetary Policy," *American Economic Review*, No. 5, Vol. 81 (December), pp. 1310-9.

Barro, Robert J., and David B. Gordon, 1983, "A Positive Theory of Monetary Policy in a Natural Rate Model," *Journal of Political Economy*, Vol. 91 (April), pp. 589-610.

Blanchard, Oliver J., and Lawrence F. Katz, 1997, "What We Know and Do Not Know About the Natural Rate of Unemployment," *Journal of Economic Perspectives*, No. 1, Vol. 11 (Winter), pp. 51-72.

Blanchflower, David G., and Andrew J. Oswald, 1995, "An Introduction to the Wage Curve," *Journal of Economic Perspectives*, No. 3, Vol. 9 (Summer), pp. 153-67.

Bonomo, Marco, and Rene Garcia, 1994, "Indexation, Staggering and Disinflation," *Journal of Development Economics*, Vol. 43, pp. 39-58.

Carmichael, Jeffrey, Jerome Fahrer, and John Hawkins, 1986, "Some Macroeconomic Implications of Wage Indexation: A Survey," in V. E. Argy and J. W. Nevile (eds.), *Inflation and Unemployment: Theory, Experience, and Policy-Making*, George Allen and Unwin (London), pp. 78-102.

Crosby, Mark, 1995, "Wage Indexation and the Time Consistency of Government Policy," *Scandinavian Journal of Economics*, No. 1, Vol. 97 pp. 105-21.

Devereux, Michael, 1994, "Wage Indexation, Adjustment, and Inflation," in S. Horton, R.S.M. Ravi, and D. Mazumdar (eds.) *Labor Market in an Era of Adjustment*, Vol. 1 (Washington: World Bank), pp. 195-236.

Dornbusch, Rudiger, 1976, "Expectations and Exchange Rate Dynamics," *Journal of Political Economy*, Vol. 84 (December), pp. 1161-76.

———, "Stabilization Policy in Developing Countries: What Lessons Have We Learnt? *World Development*, No. 10, pp. 701-8.

Edwards, Sebastian, 1996, "A Tale of Two Crisis: Chile and Mexico," NBER Working Paper No. 5794, (Cambridge, Massachusetts: National Bureau of Economic Research), October.

Fischer, Stanley, 1977, "Wage Indexation and Macroeconomic Stability," in *Stabilization of the Domestic and International Economy*, Carnegie-Rochester Conference Series on Public Policy, Vol. 5, (Amsterdam; New York: North-Holland), pp. 107-48.

———, 1985, "Contracts, Credibility, and Disinflation," in J. W. Neville and V. Argy (eds.), *Inflation and Unemployment*, George Allen and Unwin (London).

———, 1988, "Real Balances, the Exchange Rate and Indexation: Real Variables in a Disinflation," *Quarterly Journal of Economics*, No. 1, Vol. 103 (February), pp. 27-49.

———, and Lawrence Summers, 1989, "Should Governments Learn to Live with Inflation?," *American Economic Review*, Vol. 79 (May), pp. 382-87.

Fleming, J. Marcus, 1962, "Domestic Financial Policies Under Fixed and Under Floating Exchange Rates," *Staff Papers*, International Monetary Fund, Vol. 9 (November), pp. 369-79.

Flood, Robert P. and Nancy P. Marion, 1982, "The Transmission of Disturbances under Alternative Exchange Rate Regimes with Optimal Indexing," *Quarterly Journal of Economics*, No. 1, Vol. 97 (February), pp. 43-66.

Friedman, Milton, 1974, "Monetary Correction: A Proposal for Escalator Clauses to Reduce the Costs of Ending Inflation," in Griesch et al. *Essays on Inflation and Indexation*, (Washington: American Enterprise Institute,).

García, Pablo S., 1995, "Mercado Laboral y Crecimiento: Chile 1980-1994 y Proyecciones de Mediano Plazo," *Colección Estudios CIEPLAN*, Vol. 40 (Santiago, Chile), pp. 39-70.

Genberg, Hans, 1989, "Exchange Rate Management and Macroeconomic Policy: A National Perspective," *Scandinavian Journal of Economics*, No. 2, Vol. 91 pp. 439-69.

Gray, Jo Anna, 1976, "Wage Indexation - A Macroeconomic Approach," *Journal of Monetary Economics*, No. 2, Vol. 2 (April), pp. 221-35.

Henderson, Dale W. and Warwick J. McKibbin, 1993, "A Comparison of Some Basic Monetary Policy Regimes for Open Economies: Implications of Different Degrees of Instrument Adjustment and Wage Persistence," *Carnegie Rochester Conference Series on Public Policy*, Vol. 39 (December), pp. 221-317.

Hendricks, Wallace E. and Lawrence M. Kahn, 1985, *Wage Indexation in the United States: Cola or Uncola*, Ballinger (Cambridge, Massachusetts).

Kaufman, Roger T. and Geoffrey Woglom, 1986, "The Degree of Indexation in Major U.S. Union Contracts," *Industrial and Labor Relations Review*, No. 3, Vol. 39 (April), pp. 439-48.

Jadresic, Esteban, 1991, *Wages, Indexation, and Aggregate Supply*, (Ph. D. thesis; Cambridge, Massachusetts: Harvard University).

———, 1997, "Dinámica de Salarios y Contratos en Chile," *Colección Estudios CIEPLAN*, Vol. 34 (Santiago: June 1992), pp. 5-30, version in English in "What Type of Contracts Underlie Aggregate Wage Dynamics?" *IMF Working Paper*, 97/67, International Monetary Fund, (May).

———, 1996a, "Wage Indexation and Macroeconomic Stability: The Gray-Fischer Theorem Revisited," *IMF Working Paper*, 96/121, (Washington:International Monetary Fund), November.

———, 1996b, "Wage Indexation and the Cost of Disinflation," *Staff Papers*, No. 4, Vol. 43, (Washington: International Monetary Fund), December, pp. 796-825.

Jadresic, Esteban, 1997, "Macroeconomic Performance Under Alternative Exchange Rate Regimes: Does Wage Indexation Matter?," (unpublished draft; Washington: International Monetary Fund), May.

Landerretche, Oscar, Fernando Lefort and Rodrigo Valdés, 1997, "Causes and Consequences of Indexation: A Survey," *unpublished*, paper presented at the International Conference of the Central Bank of Chile: "Indexation, Inflation and Monetary Policy" (Santiago, Chile: August 11-12).

Marston, Richard C., 1982, "Wages, Relative Prices and the Choice between Fixed and Flexible Exchange Rates," *Canadian Journal of Economics*, No. 1, Vol. 15 (February), pp. 87-103.

———, 1985, "Stabilization Policies in Open Economies," in Ronald W. Jones and Peter B. Kenen (eds.) *Handbook of International Economics*, Vol. 2, (Amsterdam; New York: North-Holland), pp. 859-916.

Maturana, Victor, 1992, "Los Acuerdos Salariales bajo Negociaciones Colectivas y la Situación Macroeconómica," *unpublished thesis*, (Santiago, Chile: Catholic University of Chile).

McCallum, Bennett T., 1997, "Issues in the Design of Monetary Policy Rules," *unpublished paper*, prepared for the conference "Recent Developments in Macroeconomics," held March 7-8, 1997, at the Federal Reserve Bank of San Francisco, and forthcoming in the *Handbook of Macroeconomics*, edited by John B. Taylor and Michael Woodford (Amsterdam; New York: North-Holland).

Milesi-Ferretti, Gian Maria, 1994, "Wage Indexation and Time Consistency," *Journal of Money, Credit and Banking*, No. 4, Vol. 26,(November), pp. 941-50.

Mundell, Robert A., 1963, "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates," *Canadian Journal of Economics and Political Science*, Vol. 29 (November), pp. 475-85.

Morandé, Felipe G., "A Note on Wage Indexation in a Model with Staggered Wage Setting," *Economic Letters*, Vol. 17 (1985), pp. 19-22.

Obstfeld, Maurice and Kenneth Rogoff, 1996, *Foundations of International Macroeconomics*, (Cambridge, Massachusetts: MIT Press).

Rasmussen, Bo S., 1993, "Exchange Rate Policy, Union Wage Indexation, and Credibility," *Journal of International Economics*, Vol. 35, pp. 151-67.

Rebelo, Sergio and Carlos A. Végh, 1995, "Real Effects of Exchange Rate-Based Stabilization: An Analysis of Competing Theories," NBER Working Paper, 5197 (Cambridge, Massachusetts: National Bureau of Economic Research), July.

Riveros, Luis A., 1996, "Adjustment, Inflation and Equity Effect: A Literature Survey on Wage Indexation," (unpublished draft; Chile: University of Chile), October.

Rodriguez, Carlos A., "The Argentine Stabilization Plan of December 20th," *World Development*, No. 10, pp. 801-11.

Simonsen, Mario H., 1983, "Indexation: Current Theory and the Brazilian Experience," in Dornbusch, Rudiger, and Mario H. Simonsen (eds.), *Inflation, Debt, and Indexation*, (Cambridge, Massachusetts: MIT Press), pp. 99-132.

Taylor, John B., 1980, "Aggregate Dynamics and Staggered Contracts," *Journal of Political Economy*, No. 1, Vol. 88 (February), pp. 1-23.

Turnovsky, Stephen J., 1983, "Wage Indexation and Exchange Market Intervention in a Small Open Economy," *Canadian Journal of Economics*, No. 4, Vol.16 (November), pp. 574-92.

———, 1995, "Macroeconomic Stabilization Policy under Rational Expectations," in *Methods of Macroeconomic Dynamics*, (Cambridge, Massachusetts: MIT Press), pp. 201-30.

Van Gompel, Johan, 1994, "Stabilization with Wage Indexation and Exchange Rate Flexibility," *Journal of Economic Surveys*, No. 3, Vol. 8 pp. 251-81.

Williamson, John, 1985, "Concluding Appraisal," in Williamson, John (ed.) *Inflation and Indexation. Argentina, Brazil and Israel*, (Washington: Institute for International Economics), March, pp. 167-78.