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Staggered Wage Setting in a Macro Model

By JOHN B. TAYLOR*

Few economists now question the validity of the Friedman-Phelps accelerationist hypothesis that the Phillips curve is vertical in the long run—at least as a first-order approximation. Indeed, the once controversial hypothesis is now embodied in basic textbook macro models (see Rudiger Dornbusch and Stanley Fischer, and Robert J. Gordon, for example). This new accelerationist consensus, however, has done little to settle the ongoing debate over aggregate demand policy, where the crucial issues appear to depend on the *short-run* Phillips curve and its dynamic properties. The accelerationist theory provided an elegant and concise representation of the inflationary process for the long run. However, it has proved distressingly unspecific as a framework for the development of short-run dynamics.

Two sources of this incomplete specification have stimulated extensive research in recent years. The first—about which little will be said here—is that the accelerationist theory was not specific about the process of expectation formation. According to the theory, the expected inflation rate π^* should be added to the right-hand side of the Phillips equation. Hence the expectation process determining π^* matters greatly for short-run dynamics. For example, if expectations are formed rationally, then as Thomas Sargent and Neil Wallace have shown (using the Robert Lucas supply model), the Phillips curve will be vertical in the short run as well as the long run from the point of view of aggregate demand policy. On the other hand, if expectations are adaptive—either by assumption or by derivation from a learning model—then the short-run slope might be

very flat. But, if this were the only source of ambiguity in the accelerationist model, then it is likely that the controversy over the short-run properties would have been settled quickly: the attractiveness of rational expectations—again as a first-order approximation—has become increasingly evident in theoretical and empirical work.

The second source of imprecision is more troublesome and is unlikely to be resolved quickly. It involves the micro-economic details of wage and price adjustment which are just as much a part of the famous macro “expectations” adjustment, as the expectation formation mechanism itself. While an extremely literal reading of the accelerationist theories would interpret π^* as a pure forecast of inflation independent of the dynamics of wage and price contracts, a more practical reading would suggest that π^* represents the persistence of inflation due to the gradual adjustments of outstanding wage and price contracts to new economic information. Some modelling of this phenomenon can be found in Edmund Phelps (1970), especially his Appendix 1, and in Arthur Okun’s contract-based inflation model with accelerationist implications. Empirical work on price and wage equations by Philip Cagan and Michael Wachter has emphasized the dynamic implications of both contracts and expectations. Policy-oriented studies by William Fellner (1978) and George Perry have also taken this view of the accelerationist theory, though with widely differing policy suggestions.

The impact of aggregate demand on inflation and employment is crucially dependent on whether the contract mechanism or the expectation mechanism dominates the persistence effects commonly represented by π^* . Hence, a resolution of the current macro-economic controversy requires some explicit models to disentangle the two mechanisms theoretically, if not empirically, and to determine how contract length and adjustment

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speeds affect aggregate demand.

The purpose of this paper is to discuss one such model which focuses on contracts and staggered wage setting with rational expectations. The model is based on some of my recent research (see my 1978, 1979 papers) but is generalized here to permit alternative mixes of expectation and contract effects in the wage equations.

I. Staggered Wage Setting

A property of wage and price contracts which has not typically been emphasized in micro-economic analyses, but which is important from the viewpoint of macroeconomics is that contract decisions are staggered: all contract decisions in the economy are not made at the same point in time. While some months are more popular than others for adjusting wage contracts, these adjustment decisions are generally staggered throughout the year. This property of contract formation is the central feature in the model discussed below.

To make things simple suppose that *wage* contracts last one year and that decision dates are evenly staggered: half the contracts are set in January and half in July. If we let six-month (semiannual) intervals be the period of measurement, and x_t be the *log* of the contract wage for periods t and $t + 1$, set at the start of period t , then a simple model of contract wage determination is given by

$$(1) \quad x_t = bx_{t-1} + d\hat{x}_{t+1} + \gamma(b\hat{y}_t + d\hat{y}_{t+1}) + \epsilon_t$$

where y_t is a measure of excess demand in period t , ϵ_t is a random shock, and b , d , and γ are positive parameters. The "hat" over a variable represents its conditional expectation based on period $t - 1$ information. Equation (1) states the assumption that the contract wage set at the start of each semiannual period depends on three factors: the contract wage set in the previous period, the contract wage expected to be set in the next period, and a weighted average of excess demand expected during the next two periods. Since, by assumption, x_t will prevail for two periods,

firms and/or unions contemplating a wage adjustment in period t will be concerned with wage rates which will be in effect during periods t and $t + 1$. Hence both x_{t-1} and \hat{x}_{t+1} are included in the equation. Note that contracts set before period $t - 1$ and after period $t + 1$ are not included in the equation. Such contracts do not overlap with the current contract and are therefore not part of the relative wage structure.

The b and d coefficients in equation (1) represent the elasticity of the current contract wage with respect to the previous contract wage and the next contract wage, respectively. Let us assume that $b + d = 1$ so that the current contract decision is homogeneous of degree 1 in these lag and lead contracts. If $b = d = 1/2$ then the lag and lead distribution is symmetric. This has been the parametric assumption used in my previous work and reflects the plausible assumption that current negotiations weight other contracts according to the number of periods that they overlap with the current contract. In this sense, when b and d are equal to $1/2$, contract decisions are unbiased. Wage setters look forward to the same degree they look backward. However, I will allow for the possibility of biased weights in this paper by permitting b and d to differ from $1/2$. This permits a spectrum of contract determination hypotheses between the extremes of pure backward looking ($b = 1$), and pure forward looking ($d = 1$). As will be demonstrated below the size of b vs. d is important for the dynamic behavior of contracts, and for the sensitivity of wage behavior to excess demand. This importance of forward looking vs. backward looking has been emphasized in a recent paper by Perry in analyzing an hypothesis set forth by Fellner (1976).

In order to derive a dynamic representation for the behavior of the contract wage from equation (1), it is necessary to solve for \hat{y}_t , \hat{y}_{t+1} , and \hat{x}_{t+1} . This involves specifying an aggregate demand relationship and a policy rule. Assume that the excess demand variable y_t is the percentage output gap (that is, the deviation of the *log* of real output from trend), and that the demand for money is given by $m_t = y_t + w_t - v_t$ where the

variables m_t , w_t , and v_t are the *logs* of the aggregate wage level, the money supply and a shock, all measured as deviations from trend. Note that this money demand equation is simply the quantity equation with the wage substituted for the price level. This approximation saves one equation and can easily be modified. If the policy rule for the money supply is the *log-linear* form $m_t = gw_t$, then we can derive the simple aggregate demand relation

$$(2) \quad y_t = -\beta w_t + v_t$$

where $\beta = 1 - g$. Note that β is a policy parameter indicating the degree of accommodation of aggregate demand to wage changes. The model is closed by noting that w_t is an aggregate of the contract wages x_t and x_{t-1} outstanding at time t . If we use the geometric average, then

$$(3) \quad w_t = .5(x_t + x_{t-1})$$

By substituting equations (3) and (2) into (1) and taking expectations conditional on $t - 1$ information we have that

$$(4) \quad b\hat{x}_{t-1} - c\hat{x}_t + d\hat{x}_{t+1} = 0$$

where $c = (1 + .5\gamma\beta)/(1 - .5\gamma\beta)$. Assuming that x_t is stable yields a solution for x_t of the form

$$(5) \quad x_t = \alpha x_{t-1} + \epsilon_t$$

where $\alpha = \frac{c - [c^2 - 4d(1 - d)]^{1/2}}{2d}$

An equation for the average wage w_t can readily be derived from (5) using (3) and is given by

$$(6) \quad w_t = \alpha w_{t-1} + .5(\epsilon_t + \epsilon_{t-1})$$

Equations (6) and (2) can be used to address a number of the issues raised above. From the parameter α we can determine how the wage dynamics depends on aggregate demand policy (β), on the sensitivity of wage change to excess demand (γ), and on the degree of forward looking (d).

Note, however, that in this model we cannot identify the two parameters γ and d from a time-series on w_t and y_t without further assumptions. Given such time-series

we could easily estimate β and α from equations (2) and (6). However, from the definition of α , these estimates would not determine d and γ uniquely. Of course this identification problem could be surmounted by making additional assumptions or by looking for shifts in policy. For example, additional identifying constraints arise when contracts last for more than two periods. Nevertheless, this potential identification problem should be kept in mind when attempting to estimate the degree of forward looking using aggregate time-series data.

II. Forward Looking Contracts and Aggregate Wage Dynamics

The parameter α in equation (5) characterizes the degree of persistence in aggregate wage behavior. Clearly the persistence will depend on how accommodative aggregate demand policy is to wage contract adjustments which are "too inflationary." This dependence is captured in the model by the relationship between α and β . The higher is β (i.e., the less accommodative is policy) the lower is α (i.e., the less persistent are wage fluctuations). Hence by choosing β large enough, policy can achieve high degrees of stability in the path of aggregate wages. However, since higher values of β result in larger fluctuations in the output gap (see equation (2)), this wage stability must be traded off against real output and employment stability. This stability tradeoff defines the inflation unemployment dilemma in this model.

In order to distinguish between the impact of contract effects and expectations effects on this tradeoff, the parameter d can be varied over its range between 0 and 1. Recall that the lower is d the more backward looking is contract determination and the less important are expectations. For certain values of β and γ , Figure 1 illustrates how the wage dynamics depend on d . As one would expect, smaller values of d are associated with larger values of α . That is, more backward-looking wage determination increases the persistence or the inertia of aggregate wages. The shape of this negative relationship shows that increasing

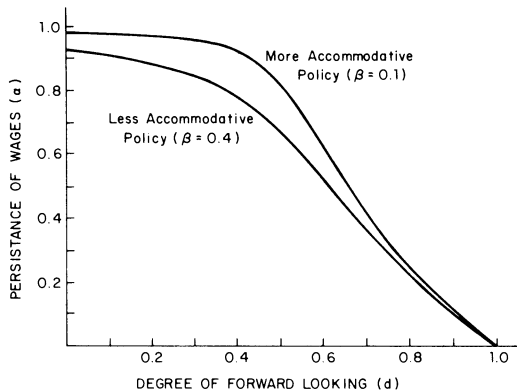


FIGURE 1. THE EFFECT OF FORWARD LOOKING CONTRACTS ON THE PERSISTENCE OF WAGES ($\gamma = .2$)

forward looking (d) from 40–50 percent would reduce persistence substantially. Increasing d from 10–20 percent would only reduce persistence slightly, however.

It can also be shown that the wage-output stability tradeoff depends on d . Because forward looking increases the demand effects on wages, higher values of d improve the tradeoff. This corresponds to the intuitive notion that more forward-looking contract determination increases the impact of aggregate demand policy on wages. Hence, inflation-stabilizing fluctuations in aggregate demand can be smaller and need not last as long.

III. Contract Length, Empirical Regularities, and Micro Foundations

The wage and output dynamics generated by this model share a number of features with the actual behavior of these series and this lends some support to the idea that contract formation as well as expectations is an important part of wage and price dynamics. Two features are worth mentioning here. (For further details see the author, 1978.)

First the serial correlation structure for the output gap (or unemployment) in this model is hump shaped: the impact of shocks on output rises before diminishing toward zero. This hump shaped property is also present in the actual process for output or unemploy-

ment in the United States and a number of other countries. Hence, the model is capable of explaining not only the serial persistence of unemployment but also the shape of the persistence.

Second, a striking aspect of the *U.S.* quarterly data is that the humped shape reaches a peak at about one year; this corresponds to contract lengths in the model of about the same length. Hence, relatively short contracts (much shorter than the frequently cited three-year union contracts) are capable of displaying empirically observed serial persistence. Although other models might explain these correlations just as well, this type of model with relatively short contracts appears to be consistent with the data.

Whether the model is consistent with a rigorous micro theory is more difficult to determine. Unfortunately, the assumed contract formation behavior is not explicitly derived from a utility maximization model (see Robert Barro). While significant gains have been made in our understanding of contracts through the work by Costas Azariadis, Martin Baily (1974), and D. F. Gordon, the micro foundations of the staggered contract model presented here are far from complete. I think there are important information reasons for contracts to be staggered (without an auctioneer some staggering is necessary for firms to obtain information about the relative wage structure), but these are yet to be laid out rigorously. For this reason such models should be used cautiously since contract length is not a datum, and the optimal length of contracts may change with changes of policy. By way of comparison the information-based theories of aggregate dynamics which have been developed by Lucas also have problems with micro foundations. For example, disparate information is imposed on such models with little discussion of how stabilization policy might affect mobility or communication between markets which would alter this information structure.

The theoretical approach to micro foundations has proved difficult and is likely to remain so. But there is also an empirical approach which has received little attention. An early example of this approach is the

study of compensation policy made by Richard Lester in the late 1940's. His aim was to investigate (through a survey of firms) a number of alternative wage setting procedures: whether firms use wage surveys in determining their wage scales, whether firms try to anticipate future wage developments, and whether tight labor markets influence wage policy. While far from conclusive the study is suggestive of what might be done using modern techniques. For example, although wage surveys are now used almost universally by firms in determining wage scales, there is very little information available concerning how firms use these surveys. Such information would appear to be invaluable in modelling the macroeconomics of wage behavior.

IV. Concluding Remarks

The theme of this paper has been that the inflation dynamics typically associated with the "expectations-augmented" Phillips curve are significantly influenced by the interaction of staggered contracts as well as by expectations effects. While these ideas are implicit in much accelerationist research, the aim here has been to make them explicit in order that alternative hypotheses concerning the inflation process can be stated more clearly. The overlapping contract model described in the paper is closely related to a number of other models. (See George Akerlof, Baily, 1976, Fischer, Phelps, 1978, forthcoming, Stephen Ross and Wachter, and J. C. R. Rowley and D. A. Wilton, for example.) While the micro foundations of such models need to be developed more rigorously, they seem capable of improving our understanding of the dynamics of the inflationary process within a reasonable well-specified rational setting.

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