of six equations which constitute the basic system of the model. These equations are:

\[ \frac{\partial y}{\partial z} = p_1 - \lambda_1 \frac{\partial y}{\partial z} = 0 \]

(6a) \[ \frac{\partial y}{\partial z} = m_1 - m_2 \frac{\partial y}{\partial z} = 0 \]

(6b) \[ \frac{\partial y}{\partial z} = (m_1 - m_2) - (s_1 - s_2) - (c_1 - c_2) \]

(6c) \[ \frac{\partial y}{\partial z} = -r_1 \frac{\partial y}{\partial z} = 0 \]

(6d) \[ \frac{\partial y}{\partial z} = T(M_1, S_1, C_1) - f(a_1, h_1) \frac{\partial y}{\partial z} = 0 \]

(8a) \[ \frac{\partial y}{\partial z} = 1 - \lambda_1 = 0 \]

The value of \( \lambda_1 \) in (8a) can be substituted into the rest of the system. In addition, since \( R_1 \) appears in only one equation, its value is obtained by substituting the optimal values of \( M_1, S_1, C_1 \) into (6a). Thus, the system of eight equations can be reduced to a system of six equations which constitute the basic system of the model. These equations are:

(1) \[ \frac{\partial y}{\partial z} = r_1 - r_2 \frac{\partial y}{\partial z} = 0 \]

(2) \[ \frac{\partial y}{\partial z} = r_1 + r_2 \frac{\partial y}{\partial z} = 0 \]

(3) \[ \frac{\partial y}{\partial z} = r_1 + r_2 \frac{\partial y}{\partial z} = 0 \]

(4) \[ \frac{\partial y}{\partial z} = -r_1 \frac{\partial y}{\partial z} = 0 \]

(5) \[ \frac{\partial y}{\partial z} = -r_1 \frac{\partial y}{\partial z} = 0 \]

(6) \[ \frac{\partial y}{\partial z} = T(M_1, S_1, C_1) - f(a_1, h_1) \frac{\partial y}{\partial z} = 0 \]

The purpose of this paper is to describe a source of systematic bias in conventional statistical tests of the natural rate of employment hypothesis. The basic problem involves the customary implicit assumption that no significant difference exists between inflation expectations of wage earners and those of employers over time. Econometric models which incorporate this restriction will be shown to be inconsistent with the fundamental principles of the natural rate hypothesis and to provide misleading evidence on its validity.

The study is composed of three sections. First, a distinction is drawn between the short run and long run implications of the natural rate hypothesis, emphasizing the importance of allowing for differences between employer and employee expectations in the short run. Second, evidence is presented indicating that a significant, systematic difference has existed between the average rate of inflation expected by business leaders and the average rate anticipated by American households over the past 10 years. Finally, implications of this difference in expectations for statistical tests of the natural rate hypothesis are discussed and empirical evidence is presented which supports the arguments raised.

1. The Natural Rate Hypothesis

For modeling purposes, the labor market will be viewed as essentially competitive or "atomistic" in nature with market participants having limited access to information on current economic conditions. The nominal wage rate is competitively set at the beginning of each time period, over which it remains fixed. Earnings are paid in lump sum amounts at the end of each period.

The long run implications of the natural rate hypothesis can be viewed within this framework with the aid of a simple supply and demand illustration. Briefly stated, the hypothesis proposes that a natural or normal rate of employment exists for the economy at any point in time, dependent in part on factors affecting job search and placement, and independent of fully or unanimously anticipated price inflation. The effective supply of and

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*See Friedman (1968) and Phelps (1970) for development of the natural rate hypothesis. Conventional statistical tests referred to in this paper are of the type performed by Solow (1968, 1969), Fertig and Wachter (1972), and Ekelund and Brinner (1972).*
demand for labor schedules, $S'$ and $D'$, in Figure 1 below, are drawn on the presumption that no increase in the price level is anticipated by any individual in the economy. Alternative schedules $S'$ and $D'$ reflect adjustments made when all labor market participants expect (with certainty) a proportionate increase in prices of $p'$ over the forthcoming period. Both the supply and demand schedules are displaced upward by an amount proportional to the expected increase in prices so that the quantity of labor $L'$ would continue to be supplied and demanded only at the higher nominal wage $w'$. Since the proportional change in the market wage is equivalent to the anticipated proportionate change in the price level, the real wage expected to be paid (or received) at the end of the period is perceived as unchanged from the initial situation by both purchasers and providers of labor services.

The conventional statistical test of the natural rate hypothesis appears to be based on such a conceptual model. Solow [1968, 1969], Turnovsky [1972], and others have estimated various forms of the general equation

$$\Delta w = \alpha + \beta \Delta w + \gamma p' + \epsilon,$$  
where $\Delta w$ is the rate of change of the market wage, $w$ is the unemployment rate (indicating the degree of excess demand for labor), $p'$ is an index of (or proxy for) expected inflation, and $\epsilon$ is a stochastic disturbance term. Customary interpretation of the regression results is that the natural rate hypothesis is supported if the estimated value of $\gamma$ is not significantly different from unity (based on the standard $t$ test). Since both Solow and Turnovsky obtained estimates of $\gamma$ in the neighborhood of $0$, their results are regarded as contradictory to the natural rate hypothesis.

A number of arguments have been advanced to explain the low estimated values of $\gamma$ on the basis of statistical problems. Turnovsky [1977, Chapter 6] and Sargent [1973] suggest that $\gamma$ may be downward biased due to the use of poor proxy variables for expectations (errors in variables) or to simultaneity in the determination of wages and unemployment (the unemployment variable may be contemporaneously correlated with the disturbance term). Accordingly it is argued that estimated values of $\gamma$ less than unity do not necessarily refute the natural rate hypothesis. When the natural rate hypothesis is viewed from the short run perspective, however, a potentially more significant problem appears in relation to equation (1) in the form of a basic conceptual inconsistency. A fundamental element of the natural rate hypothesis is that inflation, unanticipated by the labor force, may result in a short term increase in employment. This result is predicated on the assumption that businessmen are in the short-run more accurate in predicting future price increases than are ordinary wage earners or job seekers. The supply and demand schedules $S'$ and $D'$ in Figure 2 are, as in Figure 1, drawn on the assumption that no general increase in prices is anticipated by labor market participants. Due to past experience and analysis of current data, however, assume that employers (or businessmen) anticipate a price level increase of $p_1$ during the next period, whereas wage earners, lacking adequate information or not capable of analyzing that which is available, anticipate a smaller price increase of $p_2$. The supply schedule is displaced upward by a smaller increment than the demand schedule so that the "equilibrium" wage rises less in proportion to the rate of inflation anticipated by employers but more than in proportion to the rate expected by the labor force in this period. The quantity of labor demanded is increased due to employer perceptions of a lower than normal real wage, and the quantity supplied is increased due to worker perceptions of a higher than normal real wage offered.

In the long run, workers and job seekers would allegedly come to recognize and forecast continuation of any constant rate of price inflation with the same relative accuracy as businessmen, so that in some future period the disparity between employer and employee perceptions of the negotiated real wage disappears and employment returns to its natural level, as depicted in Figure 1. This distinction between short-run and long-run implications of the natural rate hypothesis is critical to any attempt to test the theory empirically.

II. Systematic Differences in Expected Inflation

Two well-established and widely referenced continuing surveys lend support to the hypothesis that a systematic difference may exist between inflation expectations of the business community and those of the general labor force over the course of the business cycle. Joseph A. Livington's [1973] survey of businessmen and economists has contained questions relating to the extent of expected inflation since the mid-1940's. The Survey Research Center at the University of Michigan has been soliciting estimates of future price inflation on a regular basis as part of its general household survey since mid-1968.

Using the data obtained from these two sources, semiannual index numbers of expected inflation were constructed for the period from mid-1968 to mid-1977. The average expected yearly inflation rate as determined from each survey is plotted along with the realized rate of inflation for the forecast period in Figure 3 below. It is apparent from the graph that a systematic difference existed between the average rates of inflation expected by the two groups surveyed over the period analyzed.

1. Results of Mr. Livington's survey are currently published twice each year (in late June or early July, and in late December or early January) in the business section of the Sunday Philadelphia Inquirer.

2. Results of the Michigan survey are published regularly in the Institute for Social Research publication, Surveys of Consumers. Because of the form of the questions regarding expected inflation were changed in mid-1977, this study utilizes data only from mid-1968 through mid-1977, over which a set of consistent responses are available.

3. Construction of a quarterly index of expected inflation from the Michigan data was done in a manner equivalent to that suggested by de Moul and Balla [1975]. The semiannual index was obtained by averaging the first and second quarter and the third and fourth quarter respectively. Based on personal correspondence with Mr. Livington and to retain consistency with previous work by Turnovsky [1970, 1972], the expected inflation index based on the Livington survey was constructed from the published data which contains adjustments to account for fluctuations in prices between the date on which the survey questionnaire is mailed and the date on which the results are published.
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FIGURE 3 Expected and Realized Inflation Rates

actual rates of price inflation and lagged expected inflation rates in several commonly used functional forms. Selected least squares results are presented in Table 1 below in which the following notation applies:

- $\beta_u$ – Rate of inflation expected by households over the next 12 months (Source: Livingston Survey).
- $\beta$ – Realized inflation rate over the next year.
- $\beta_{12}$ – Index of inflation expected over the next year calculated from the Livingston Survey.
- $\beta_{MN}$ – Index of inflation expected over the next year calculated from the Michigan Survey.
- $\beta_{12M}$ – Annual rate of inflation expected by businessmen and economists over the next 6 months (Source: Livingston Survey).

$\beta_u$ – Rate of inflation expected by businessmen and economists over the next 12 months (Source: Livingston Survey).

$\beta$ – Actual annual rate of inflation of Consumer Price Index for the period (6 months).

$\beta_{12}$ – Adjusted $\beta$ (reduced for degrees of freedom).

DW – Durbin-Watson statistic.

Standard errors of the coefficients appear in parentheses, and a $-1$ subscript indicates a one period (6 month) lag.

The regression results appear to support the contention that a significant difference exists between the expectations of the two groups surveyed. The average expected rate of inflation calculated from the Livingston data is more responsive to the current inflation rate in the static expectations equations, and more responsive to errors made in the previous forecast in the adaptive equations than is the expected inflation index calculated from the Michigan data. Note also that the coefficient of the lagged expectations term in the adaptive equation estimated for the Michigan data is not significantly different from zero, which raises a question concerning the appropriateness of using an adaptive mechanism as a proxy for consumer expectations.

III. Implications for Tests of the Natural Rate Hypothesis

Once the existence of systematic differences in expectations is recognized, it becomes apparent that conventional statistical tests of the natural rate hypothesis may be misleading when interpreted in the usual manner. Algebric functions, such as Solow's distributed lag are inappropriate as proxies for expected inflation if there is no single expected rate of inflation which can serve as an acceptable indicator for both sides of the labor market. The geometric lag, which is algebraically identical to the adaptive expectations mechanism, cannot even be regarded a good indicator of the "average" of the expectations of the two groups, since the adaptive mechanism does not seem to be an appropriate proxy for household expectations as shown in Table 1. If the Livingston or Michigan Survey data is used in estimating the impact of price expectations wages, the composition of the sampled population must be recognized. Since each survey appears more representative of the attitudes of one side of the labor market than the other, in actuality, one of two different equations is estimated:

$\hat{w} = \alpha_1 + \beta_1 w + \gamma_1 \beta_{u} + \epsilon$ (2)

$\hat{w} = \alpha_1 + \beta_1 w + \gamma_2 \beta_{u} + \epsilon$ (3)

where $\beta_{u}$ and $\beta_{12}$ represent indexes of expected inflation for businessmen and for wage earners, calculated from the Livingston and Michigan Surveys respectively. When expectations of businessmen are significantly higher than those of the labor force, positive disturbances would be anticipated in equation (2) and negative disturbance, in equation (3). That is, the wage would appear overly responsive to the rate of inflation anticipated by wage earners but less than fully responsive to the rate of inflation expected by businessmen, as depicted in Figure 2 above.
In addition, the sign of the coefficient of the unemployment rate in equation (2) or (3) becomes theoretically indeterminate in this case. When a large (positive) gap exists between inflation expectations of businessmen and those of wage earners, both employment and wage would be expected to be rising. When the disparity between inflation expectations closes, however, as wage earners more fully recognize inflation or become more capable of predicting it, employment falls (returning to its natural level), but wages continue to rise adjusting to the higher expected inflation rate on the supply side of the market. It would not be surprising, therefore, to find that the unemployment variable is statistically insignificant in the wage change equations or to enter with a negative sign when quarterly or semiannual data is analyzed.

Regression results presented in Table 2 are in general consistent with these arguments. The same notion as previously used applies with the following additions:

\[ w_u = \text{Annual rate of change of average hourly gross earnings per production worker in manufacturing, excluding overtime.} \]

TABLE 2  Effect of Expected Inflation on Wages

<table>
<thead>
<tr>
<th>Manufacturing Sector</th>
<th>[ w_w = -4.50 - 10.45 / w_u + 1.22 \hat{p}_w ]</th>
<th>[ R^2 = .26 ]</th>
<th>DW = 2.57</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[ (2.45) (1.75) (1.03) ]</td>
<td>[ (1.65) (1.94) (1.50) ] [ (1.71) (1.86) ] [ (1.28) (1.47) ]</td>
<td></td>
</tr>
</tbody>
</table>

uniformly high in Table 2, above 2.5 in every case and beyond the lower significance point for all but the first three equations indicating the presence of negative first order autocorrelation. This is not surprising and in fact might have been anticipated on the basis of the expected correlation between the expectations term and the disturbance term in each equation and the period-to-period oscillations displayed in the movement of the expectations variables in Figure 3. The unemployment variable is statistically insignificant in all cases, as anticipated, and more often than not enters with the reverse sign.

Caution must be exercised in interpreting the results due to the problems such as biases arising out of the treatment of expectations as point predictions held with complete certainty. Although increases in the expected rate of inflation on the part of businessmen theoretically lead to increases in demand for labor, high expected rates of inflation may be highly correlated with high degrees of uncertainty regarding future price changes. While the expectation of higher prices in the future would normally result in increased wages, the increased uncertainty would be expected to reduce the demand for labor to some degree, since manufacturers may be somewhat cautious in production decisions if they are not fully confident in future markets for their products.

Increases in uncertainty on the part of households (or wage earners) might also be expected to reduce the upward pressure on the wage level, other factors being equal. While higher expected rates of inflation would supposedly lead to demands for higher wages, an unemployed individual, highly uncertain of future changes in the price level or of future labor market conditions, may become more inclined to accept a wage offer during the current period to increase his assets as a hedge against the uncertain future. This line of logic is consistent with research done by F. T. Juster [1975] of the University of Michigan's Survey Research Center which indicates that individuals tend to make "conservative" decisions when faced with uncertainty regarding the real value of future income. Juster suggests using the variance of the distribution of expected inflation rates obtained through the household survey as an indicator of the degree of uncertainty of future price movements and finds that the variance is positively correlated with the mean of the distribution, i.e., with the average expected rate of inflation. Unfortunately, the variance of the Livingston Survey responses is not reported in Livingston's semiannual analysis; however, data supplied by Livingston for the period 1967-1973 showed the same high degree of correlation between the mean and variance of the distributions of expected inflation rates as reported in the Michigan data.

Although there are obvious theoretical problems involved in interpreting the variance of individual forecasts as an index of the typical employer or employee's certainty in his prediction, there is a certain amount of intuitive appeal to the logic that distributions of expected inflation rates tend to have more spread when individuals are less certain of their predictions. According to these arguments, when the uncertainty of future price movements is omitted from the wage change equation, either for businessmen or for households, the coefficient of the expectations term with which it is presumably positively correlated may be downward biased. Even expectations coefficients as low as 0.4, estimated by Solow and Turnovsky, therefore, cannot necessarily be interpreted as evidence contrary to the natural rate hypothesis.

IV. Summary and Conclusions

The purpose of this study was not to provide evidence for or against the natural rate of employment hypothesis, per se, but rather to demonstrate that the conventional statistical test of the hypothesis is inappro...
private if significant systematic differences exist between price expectations of businessmen and wage earners. Existence of differences in expectations in the short-run is a fundamental assumption of the natural rate hypothesis, which seeks to explain how employment may rise above its long-run normal level for brief periods. Analysis of survey data does appear to support the thesis that employers may at times interpret the real wage to be paid as unusually low while workers simultaneously interpret it as unusually high, stimulating employment in the economy. If these systematic differences in expectations exist for long periods of time (as for example over the period from 1968 through 1977) the market wage may appear less than fully responsive to "expected inflation" when adaptive expectation mechanisms or surveys of business attitudes are used as the appropriate indicator of the (unanimously anticipated) expected rate of inflation.

An appropriate method of settling the controversy relating to the natural rate hypothesis might be to estimate the supply and demand for labor functions individually in a system of simultaneous equations. Unfortunately degrees of freedom limitations owing to a shortage of available observations in the two sets of survey data on expectations rule out this procedure at the present time. Such a study would also seem to require utilization of a theoretically sound estimate of the certainty with which expectations are held.

References


I. Introduction

In Arrow (1963) attention was directed to two related issues: (1) the efficient amount of compensation under medical care insurance and (2) the welfare implications of the effects of existing insurance policies on the level of medical care expenditure. Since that time there seems to have been a tendency to deal with the latter issue separately and to subsume the former issue in more general discussions of optimal insurance. This dichotomy appears to be, at least in part, responsible for the prevalence of extreme views concerning the welfare effects of existing insurance policies. Specifically, it is widely recognized that the cost-sharing formulas characterizing most policies encourage additional medical care expenditure. The price distortion inherent in this method of providing insurance has led some to attribute a welfare loss to all medical care expenditure in excess of the no-insurance level (See, for example, Phlps, 1968, 1969, Feldstein, 1973, and Rosett and Hung, 1973).

The above interpretation of welfare loss may have been encouraged by the initial belief held by Arrow, Inc. in 1970, 1-23. This conception of the risk is no longer held to be appropriate. General models that can more accurately represent the risks associated with medical care expenditure have been developed by Arrow (1974) and Cook and Graham (1977). An important emphasis of these models is that certain insurable events can affect individual utility in ways other than that represented by a simple loss in wealth. It is essential only that these events raise the marginal utility of wealth to a higher level than would exist under more normal conditions. Insurance, in general, improves welfare by transferring wealth from states of nature characterized by relatively low marginal utilities of wealth to those characterized by relatively high ones. As a first approximation of optimality, welfare is maximized under insurance when the marginal utilities of wealth in all states of nature are equated.

The above principle was earlier recognized by Zeckhauser (1973) who applied it less formally, though specifically, to the uncer-