THE EFFECTS OF THE CARTER PAY AND PRICE STANDARDS: A RATIONAL EXPECTATIONS APPROACH

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INTRODUCTION

With inflation increasing to about 9 percent in the second half of 1978, the Carter administration announced on October 24, 1978,[1] the beginning of what was to become a two-year program of "voluntary" pay-price guidelines aimed at lowering the inflation rate. Despite the guidelines, the inflation rate accelerated to 11.3 percent in 1979, up from 7.7 percent for 1978.

Inflation worsened further in 1980, averaging 13.5 percent. Thus, during the two years of the program the inflation rate actually increased. However, the program cannot necessarily be called ineffective simply because the inflation rate increased. The possibility exists that the inflation rate, in the absence of the program, could have been even higher.

Purpose of the Study

The purpose of this study is to determine if the Carter program was effective in combating wage and price inflation. Traditionally, the effectiveness of incomes policies has been estimated by a test of the statistical significance of an intercept dummy variable. This method suffers from the requirement that the policy only shifts the intercept, and ignores other ways in which the policy might affect the structure of a wage or price inflation model. Some of these other possibilities, which policymakers often proclaim in support of incomes policies, include (but are not limited to) bringing wage inflation into line with trend productivity growth, changing the short-run inflation-unemployment tradeoff, reducing inflationary expectations, and insulating the economy from price shocks.

In this study, each of the above justifications will be converted into testable hypotheses. The model estimated here differs from the models that have typically been used to test for the effects of incomes policies. Previous studies have generally incorporated price inflation expectations into their wage equations by assuming that the expected price level is a weighted average of past price levels. This formulation, known as adaptive expectations, has been criticized for ignoring information that may be relevant. The model used here overcomes this criticism by relying on the theory of rational expectations; i.e., expectations based on the efficient use of all available, relevant information. Thus, in this study, price inflation expectations will be estimated, and these expectations will then be incorporated into the wage inflation equation. Dummy variables representing the incomes policies (or their phases) will be interacted with the relevant explanatory variable which depends upon the hypothesis being tested. The estimated coefficients of these interacted variables in the wage inflation equation will provide evidence relating to the effectiveness of the various incomes policies.

Plan of the Study

Chapter II will have three main sections, beginning with a discussion of the details of the Carter pay and price guidelines, including some of the loopholes. This section will be followed by a section on the approaches that have previously been used to measure the effects of the program. A summary of the results of these previous empirical studies will also be included in this section. The final section will be a discussion of the shortcomings of the previous empirical studies. The third chapter will include a discussion of the models to be used in examining the effects of the Carter program, including a discussion of the incorporation of the theory of rational expectations (as opposed to the use of adaptive expectations) into models designed to measure the effectiveness of incomes policies, and the results derived from these models. The fourth chapter will examine the effects of the Carter program on wage inflation in fifteen SIC 2-digit manufacturing industries. The fifth and final chapter will be the conclusions and recommendations.

ENDNOTES

[1] The guidelines were announced in preliminary form at this time; final standards were published in the *Federal Register* on December 28, 1978. These standards were not truly final, however, as the program was amended several times during its two-year existence.

CHAPTER II

THE CARTER PAY AND PRICE STANDARDS

Introduction

During the last twenty-five years, the United States has experimented with incomes policies during three separate periods. The first of these three policies began in 1962 during the Kennedy Administration and lasted almost six years. The second of these three policies was the Nixon Administration's Economic Stabilization Program. It was the only postwar period of mandatory wage and price controls in the United States, and lasted from August 15, 1971 through April 30, 1974, although the second half (starting January 11, 1973) was a period of decontrol. The third of these policies was the Carter Administration's Pay and Price Standards Program, which lasted approximately two years, although the second year's standards were more relaxed than the first.

The dramatic increase in the inflation rate early in 1978 initially caused the Carter administration to increase efforts to persuade business and labor to moderate price and wage increases. As the public urgently demanded that the government "do something" to check inflation, the Carter administration asked companies to slow their 1978 price increases relative to the prior year, and major unions were asked to bring their settlements in line with the economy-wide average rate of wage increase. These efforts at "jawboning" were barely under way before it was decided that these measures were not strong enough. With the 1978 Congressional elections just several weeks away, President Carter announced on October 24, 1978, economy-wide standards for wage and price increases.

The Carter Program

The primary authority for the design and implementation of the standards was delegated to the Council on Wage and Price Stability (COWPS). COWPS was created by Congress[1] in 1974 as an agency within the Executive Office of the President. The President was given the authority to appoint the eight members and four adviser-members to the Council, and to designate the Chairman of the Council. At the time of its creation, COWPS was charged with the monitoring of wage and price changes throughout the economy and with determining the extent to which the activities of the federal government were contributing to inflation. COWPS' function was greatly expanded in 1978 when the agency became responsible for administering the Carter pay and price standards.[2] COWPS apparently believed that the success of the program hinged on the pay side, as it was thought that competitive market conditions would assure that any labor-cost savings would result in smaller price increases.

The Pay Standard

During the first year of the program, the pay standard provided that average increases in hourly compensation (wage rates plus hourly private fringe-benefit costs) not exceed 7 percent for each employer group. The groups were defined as (1) employees covered by collective bargaining agreements, (2) other nonmanagerial personnel, and (3) managerial personnel.[3] There were various exceptions to this rule. For example, workers earning less than $4.00 per hour on October 1, 1978, were exempted from the pay standard, as were labor compensation increases mandated by federal statutes. In addition, an exception was created so that employers could raise wages above the standard if such wage increases were necessary to overcome an "acute labor shortage." The pay standard did not apply to contractual agreements which were in existence before the announcement of the program.

The pay program contained several loopholes, one of the most important of which turned out to favor union workers who had a cost-of-living adjustment (COLA) in their contract. Under COWPS' rules, the monetary equivalent of an expected COLA payment was computed for purposes of determining compliance on the assumption that the annual rate of inflation during the life of the contract would be 6 percent. Thus, COWPS considered a contract with a 7 percent pay increase and no COLA to be the equivalent of a contract with a 3.4 percent pay increase plus a COLA adjusting for 60 percent of inflation. If the rate of inflation turned out to be 12 percent (which it approximately was), however, the contract with a COLA would result in a 10.6 percent pay increase, and would be in compliance. At the same time, a contract without a COLA would be stuck at a 7 percent pay increase. During the second year of the program, the inflation assumption for evaluating COLA clauses was increased to 7.5 percent. Over roughly the same time period, however, the CPI increased 12.9 percent. With this loophole, COLA workers had an average pay increase of 10.3 percent during the first year and 11.1 percent during the second year, while non-COLA workers averaged 6.5 percent and 8.8 percent for the same time periods.[4] In an attempt to alleviate the problem, COWPS announced on October 2, 1979, that employee units that had complied with the first-year pay standard and had not received cost-of-living adjustments were eligible for an additional 1 percent increase in pay. In addition, COWPS encouraged companies to use a gross-inequity exception clause to request larger pay increases if required to remedy interfirm or intra-firm inequities caused by the guidelines regarding COLA payments.

On March 31, 1980, a new pay standard range of 7.5 percent to 9.5 percent was announced and was made retroactive to October 1, 1979.[5] In effect, 9.5 percent became the second-year pay limitation because there was no criteria announced for limiting pay increases below 9.5 percent.

The Price Standard

The price standard was designed to be consistent with the pay standard. The initial price standard was derived by adding to the 7 percent pay standard one-half of a percentage point because of relatively large increases in employment taxes and subtracting one and three-quarters percentage points for trend productivity growth. Assuming that prices are a constant percentage mark-up over unit labor costs, COWPS set the aggregate price standard at 5.75 percent. This aggregate price standard was 0.5 percentage points less than the estimated inflation rate (during the 1975:4 to 1977:4 base period) in the sector of the economy which was covered by the price standard (which did not cover food prices at the farm, mortgage interest rates, crude oil prices, and exports among other things). COWPS set a company-specific price deceleration standard which required firms to limit price increases to 0.5 percentage points less than the base-period rate of change. Any increase below 1.5 percent was automatically considered to be in compliance and any increase exceeding 9.5 percent was considered not to be in compliance. In addition, for any company which experienced a pay deceleration greater than 0.5 percentage points, full pass-through of the additional pay deceleration was required for compliance. In such cases, the total price deceleration percentage was 0.5 percentage points plus the product of the rate of pay deceleration that was in excess of 0.5 percentage points multiplied by the ratio of employment costs in the base quarter to total revenue in the base quarter. An alternative profit-margin standard was designed for firms who either had uncontrollable increases in costs or who could not compute a meaningful average price change. This alternative standard consisted of two parts. First, a company's profit margin[6] for the program year was limited to no more than the average profit margin in the best two of the company's previous three fiscal years. Second, the company's increase in its dollar profit was limited to 6.5 percent plus the percentage increase in unit sales volume.

Alternative standards and rules were created for industries where there were highly volatile raw materials prices (such as in petroleum refining or food processing), where institutional characteristics made application of the price standard inappropriate (such as in insurance or banking), or where there were difficulties in carrying out the required computations (such as in wholesale or retail trade). In these cases, standards were developed that generally limited the percentage or dollar gross margin (roughly defined as revenues minus the cost of intermediate products) that a company could earn.

On October 2, 1979, COWPS published its proposed second-year price standards. The price limitation was increased by one percentage point to 6.75 percent to reflect the one percentage point non-COLA catch-up allowance on the pay side. The profit limitation was retained, but was made more restrictive (by 50 percent) to reduce the amount of catch-up that had been possible where a company's profit margin in the base-year was not as great as in the best two out of three previous fiscal years. No significant changes were made in the special-sector standards.

While the government called the guidelines voluntary, it also announced its intention to punish those who failed to comply. Specifically, the government threatened to punish violators by withholding federal contracts, exerting federal regulatory powers more strenuously, and publishing an "enemies list" of noncompliers. The government never used the sanction of barring noncomplying firms from government contracts, however, and by the fall of 1979, COWPS had only two firms on its public list of definite noncompliers with the price guidelines. While a number of firms did comply with the price guidelines, many did not. For those who did not comply, the general sequence of events went like this: COWPS would publicly accuse a company of noncompliance, then the company would deny noncompliance and seek reconsideration and permission to switch to the more lenient profit-margin standard, and after several weeks of inquiries and negotiations, COWPS would grant an exception. By COWPS' own estimate, only one-third of the firms monitored were under the basic price limitations; the rest were "complying" with the alternative profit limitation or the gross-margin standards.

Given the standards' loopholes, the lack of enforcement of the guidelines, the "guidelines math" which resulted in almost every major labor contract being in compliance regardless of the size of the wage increase granted, and COWPS' granting of exceptions to the price guidelines to almost every company that applied for one, is it possible that this "voluntary" program filled with loopholes and exceptions and little if any enforcement was responsible for reducing the rate of inflation?

Previous Assessments of the Carter Standards

Several empirical studies have been performed to determine the effects of the Carter program on wage and price inflation. Generally, these studies have been based on the notion that expectations of inflation are formed adaptively; that is, people base their expectations for next period's inflation rate on an average of actual inflation rates during previous periods, with the most recent periods weighted the most heavily. The empirical evidence on the effects of the Carter standards is mixed.

A Simplified Wage Price Model

Most of the empirical studies have relied upon a two-equation model to measure the effects of an incomes policy on wage and price inflation[7]. A simplified model of the wage-price process is as follows:

$$\dot{W} = a_0 + a_1 L(\dot{P}) + a_2(U - \bar{U}); \quad (2.1)$$

$$\dot{P} = b_0 + b_1(\dot{W} - R) + b_2\dot{E}. \quad (2.2)$$

Equation (2.1) says that the percentage rate of change in hourly labor compensation, $\dot{W}$, is a linear function of a distributed lag on past percentage rates of change of consumer prices, $L(\dot{P})$, and the difference between the actual, U, and natural rates of unemployment, $\overline{U}$.

The distributed lag on past inflation rates is usually interpreted as a reflection of adaptive expectations of future inflation rates. In the absence of money illusion, the coefficient a_1 would be equal to 1.0 since $L(\dot{P})$ is defined as being equal to

$\sum_{j=1}^{n} a_j \dot{P}_{t-j}$, where $\sum a_j = 1$.

The difference between the actual and natural unemployment rates is a measure of labor-market disequilibrium. This measure incorporates into the model the intertemporal shift of the short-run Phillips curve which is primarily attributable to demographic changes in the labor force, which until recently have raised the natural unemployment rate. The coefficient, a_2, is interpreted as the slope of the short-run Phillips curve.

If $a_1 = 1$, and $U = \overline{U}$, then a_0, the constant term, can be interpreted as equilibrium real wage growth. If factor shares are constant, the equilibrium wage growth is equal to the trend growth of labor productivity.

The above wage equation is less than fully specified; a fully specified equation would include a number of other variables, including such things as changes in employment taxes and in the minimum wage.

Equation (2.2) states that the percentage rate of increase of prices is a function of the growth of unit labor costs at trend productivity growth, R, and the percentage rate of change of exogenous materials prices, $\dot{E}$. In recent years, changes in oil prices, crude materials prices, and farm prices have been potential candidates for the variable E.

In equation (2.2), capital costs are omitted; capital costs have rarely had much explanatory power, presumably because of difficulty in measuring them. In this formulation, the estimated values of b_1 and b_2 should approximately equal the shares of labor and materials in total cost divided by the complement of capital's share. If factor shares are constant, b_0 should be approximately zero.

To test for the effectiveness of an incomes policy in slowing inflation, researchers have used two methods. The first one involves the use of dummy variables. Equations (2.1) and (2.2) would be rewritten as:

$$\dot{W} = a_0 + a_1 L(\dot{P}) + a_2(U - \bar{U}) + a_3 Z; \qquad (2.3)$$

$$\dot{P} = b_0 + b_1(\dot{W} - R) + b_2\dot{E} + b_3 Z. \qquad (2.4)$$

In equations (2.3) and (2.4), the new variable Z represents the dummy variable and may take on a value of 1 for each period the incomes policy is in effect, and a value of 0 for each period the incomes policy is not in effect. At times, it may be appropriate to assign Z a value between 0 and 1 to reflect the anticipation of an incomes policy beginning or ending or to reflect the "enforcement" of the policy. The estimated value of a_3 and b_3 can be interpreted as the direct effects of an incomes policy on the rates of wage and price inflation, respectively. If either a_3 or b_3 were positive, or if a_3 or b_3 were not statistically different from 0, this would be evidence that the policy was ineffective. On the other hand, a negative value for either a_3 or b_3 would be evidence that the policy was effective.

The second method involves the use of a simulation. This method of testing the effectiveness of an incomes policy requires an estimation of the coefficients in equations (2.1) and (2.2) using data from the period prior to the announcement of the policy. The estimated equations are then used to project or simulate the behavior of wages and prices during the period following the implementation of the incomes policy. If this forecast predicts wage and price increases which were greater than the actual increases, this would be evidence that the incomes policy had an effect in holding down wage and price inflation. On the other hand, if the predicted values are close to or less than the actual values, this would provide evidence that the policy was ineffective in slowing wage and price inflation.

The major shortcoming of both methods is that neither one can discriminate between the effects of an incomes policy and any other shocks that are not fully represented by the explanatory variables that appear in equations (2.1) and (2.2). Thus, the evidence that is provided by these methods for or against the effectiveness of an incomes policy cannot be viewed as conclusive. It is always possible that something other than the incomes policy itself caused wages and prices to diverge from their long-term trend. Thus, the debate over the effectiveness of an incomes policy should hinge on the evidence derived from a wide variety of reasonable, theoretical specifications of the wage and price equations.

Previous Empirical Studies

The empirical studies dealing with the effects of the Carter program can be divided into two groups, the early studies that did not include the poststandards period and the later studies that did include this period.

One important problem exists in the early studies; none of them consider the problem of postprogram catch-up effects. For example, Alan Blinder has shown that after the period of Nixon controls, the price level returned to the level it would have achieved without controls approximately four months after the controls were removed. Blinder estimated that ten months after the program had ended, the price level was 0.9 percentage points higher than it would have been had the program never existed.[8]

A study by Lloyd Ulman and Robert Flanagan of the effectiveness of incomes policies in Europe lends additional support to the idea that the postcontrols period should be taken into account. These authors document a number of cases where postcontrols catch-up has overwhelmed the favorable effects generated during the controls period.[9]

This postprogram catch-up phenomenon has important implications for an evaluation of the Carter program, and the early studies must be examined with the view that they may be incomplete. With this in mind, we can now look at how COWPS, in an early study, evaluated the effectiveness of its own program.

The COWPS Study. One of the first studies on the effectiveness of the program was done by COWPS.[10] For the period from 1978:4 through 1980:3, COWPS estimated both the direct effects and the full effects (allowing for the interaction between wage and price increases) of the standards, using both the simulation approach and the dummy variable approach. For the period under study, COWPS, using their preferred equations, found about a 1 percentage point reduction in pay inflation using the dummy variable and simulation approaches for the direct effects. Using the dummy variable approach to measure the direct effects, COWPS found that the standards did not affect price inflation. When the simulation approach was used to determine the direct effects of the standards on price inflation, COWPS found that the standards caused a 0.8 percentage point reduction in the CPI.

In order to assess the robustness of the estimated effects of the standards, COWPS re-estimated the direct effects, using the dummy variable approach, for alternative specifications of the pay and price equations. Several variations in the initial specification of the independent variables in the pay equation caused a substantial range to develop in the estimates of the reduction in wage inflation attributable to the standards. The range was from a 1.664 percentage point reduction to a 0.319 percentage point reduction in wage inflation, with some estimates not statistically significant at the 5 percent level.

Variations in the initial specification of the price equation supported the conclusion that the price standard had little or no direct effect on price inflation. The only effect of the program was indirect, through the lowering of wage inflation.

Using the simulation approach to measure the full effects of the standards, COWPS found a 1.2 percentage point reduction in wage inflation and a 1.5 percentage point reduction in price inflation over this period. COWPS concluded that this result was due to two factors:

first, the price simulation equation generated an average direct effect of a 0.8 percentage point reduction in price inflation, and secondly, the larger effect of the pay standard is reflected in lower rates of price inflation (through reduced labor-cost inflation) more quickly than the effect of the price standard is reflected in lower rates of wage inflation (through reduced inflationary expectations of workers).

The GAO Study. The COWPS study demonstrated that the findings on program effectiveness are highly sensitive to the specification of the equations. A separate early study (1980) by the General Accounting Office (GAO) further demonstrated the importance of accounting for the sensitivity of econometric results to variations in the specifications of the equations.[11] GAO used a preliminary COWPS estimate of a 1.58 percentage point reduction in wage inflation[12] due to the standards (using the dummy variable approach) as their benchmark, and substituted several alternative variables into the COWPS pay equation in place of some of the explanatory variables COWPS was using. When GAO substituted the personal consumption expenditure deflator (PCE) for the CPI, the standards coefficient was nearly cut in half, from -1.58 to -0.92. Further substitution of the nonfarm business deflator for the PCE reduced the standards coefficient by another two-thirds, from -0.92 to -0.31 and caused the standards variable to lose its statistical significance.[13] GAO also claimed that similar results were obtained when they used a simulation to estimate the effect of the pay standard.

Using the dummy variable approach for the 1967:2 to 1980:1 time period, GAO estimated that the guidelines increased the CPI rate of price inflation by an average of 2.07 percentage points from 1978:4 to

1980:1. This unexplained acceleration also occurred when GAO estimated the price equation for the period prior to the standards and forecast inflation for the period from 1978:4 to 1980:1. In this case, the predicted rate of increase in the CPI fell short of the actual rate of increase in each quarter by an average of 1.8 percentage points.

The Frye and Gordon Study. Further support for the proposition that the Carter price standards had no effect on price inflation was found by Jon Frye and Robert J. Gordon.[14] Using a reduced-form price equation, Frye and Gordon introduced dummy variables for the periods 1978:4 to 1979:4 and 1980:1 to 1980:2 and concluded that both variables were insignificantly different from zero. Frye and Gordon did not estimate a wage equation in their study.

The Meyer Study. There have been two important studies of the Carter pay and price guidelines which have included an analysis of the postcontrols period; one study was done by Jack Meyer,[15] the other was by John B. Hagens and R. Robert Russell.[16] Meyer begins his analysis by estimating wage equations similar to those used by both COWPS and GAO through the time period covered by their analysis.[17] Next, Meyer uses the same equations with the time period extended through 1981:3. This added one year to the COWPS sample period and one and a half years to the GAO sample period. Meyer's results show that the standards variable in the equation corresponding closely to COWPS' preferred wage equation drops to half its former size (from -0.29 to -0.14) and loses its statistical significance when the 1980:3 through 1981:3 time period is included.

Meyer then re-estimates the GAO preferred equation, which used the PCE instead of the CPI as a measure of price changes. In this equation, the standards impact was not significant initially. When the longer time frame is used, the coefficient goes from negative and significantly statistically insignificant to positive and statistically insignificant.

Finally, Meyer tests the sensitivity of the results for the longer time period by using the hourly earnings index in place of a pay measure including fringe benefits as the dependent variable in COWPS' pay equation. The results were substantially the same as in the regular equation, with only a slight variation in the size of the standards variable, which remained statistically insignificant.[18]

<u>The Hagens and Russell Study</u>. The most sophisticated previous study of the Carter program was done by Hagens and Russell. With regard to wage inflation, Hagens and Russell tested four separate hypotheses: (1) Did the standards bring wage demands into line with productivity growth? (2) Did the standards change the inflation-unemployment tradeoff? (3) Did the standards deflate inflationary expectations? (4) Did the standards insulate the economy from the oil-price shocks of 1979 and 1980? We will now examine these four questions in turn.

In their study of the Carter program, Hagens and Russell argue that the standard wage equations generally used in incomes policy research are misspecified. Specifically, they argue that in the wage equation in a wage-price model with no money illusion, the constant term should be equal to the trend rate of growth of labor productivity.

Trend productivity growth, however, has not been constant in the United States, leading Hagens and Russell to replace the constant with a trend-productivity variable. They then test for the effect of the Carter standards in bringing wage demands into line with trend-productivity growth by including in the wage equation two dummy variables that interact with the trend-productivity variable, with each dummy variable representing a distinctive phase of the program.[19] Hagens and Russell estimated that the Carter standards reduced wage inflation by 1.2 percentage points in the first year and by 1 percentage point in the second year of the program.[20]

When Hagens and Russell tested the hypothesis that the Carter program changed the slope of the short-run Phillips curve, they interacted the standards dummy variables (one for each of the two years of the Carter program) with the difference between the unemployment rate and the natural unemployment rate. Hagens and Russell concluded the standards did not affect the short-run inflation unemployment trade-off.

For the hypothesis that the standards program retarded inflationary expectations, Hagens and Russell interacted the standards dummy variables with a 12 quarter polynomial distributed lag on past percentage rates of change of consumer prices. They found that inflationary expectations were lowered by 17 percent in the first year and 11 percent in the second year. Hagens and Russell argued that $L(\dot{P})$ over the relevant periods averaged 7.4 percent and 9.7 percent, respectively. This estimate translated to direct effects on wage inflation of 1.3 percentage points (-.17 x 7.4) and 1.1 percentage points (-.11 x 9.7) during the two phases.[21]

Hagens and Russell also examined the hypothesis that the standards program was successful in preventing the energy price explosion of 1979-80 from getting built into wage demands. Specifically, they tested whether or not workers took into account price increases directly attributable to the energy price explosion in formulating their wage demands. Their findings indicate that most of the effects of the energy price explosion were not passed through in the form of higher wage demands.

Hagens and Russell also tested the direct effects of the Carter program on price inflation. Unfortunately, they did not report their results; however, they did report that their tests decisively rejected the hypothesis that the standards had any direct effects on price inflation. They argued, however, that if the standards affected wages directly, then the standards could have lowered price inflation indirectly through the pass-through of lower labor-cost inflation to prices.

In addition, Hagens and Russell estimated both the direct effect of the Carter program on wage inflation through simulation of the wage equation and the full effect of the program by taking into account the interaction between prices and wages through joint simulation of the wage and price equations. The simulations were done for both the standards period (1978:4 to 1980:4) and the standards and poststandards periods (1978:4 to 1983:2). In the simulations, it was assumed that the absorption of the energy price increases was attributable to the program rather than to some other structural change; this assumption is reflected in the wage equation through the inclusion of an energy price explosion variable. Hagens and Russell found that during the standards period, wage inflation was directly reduced by an average of 1.35 percentage points; for the standards and poststandards period, the reduction averaged 1.21 percentage points. This persistence of the reduction in wage inflation after the standards ended was attributed to the maintained hypothesis that workers were persuaded to absorb the energy price increases for all time, and to the fact that one of the explanatory variables in the wage equation is a twelve quarter lag on prices, with coefficients remaining significant all the way to the end of the lag.

The joint simulation of the wage and price equations shows that wage inflation was reduced by an average of 1.54 percentage points during the standards period, and by an average of 1.93 percentage points during the standards and poststandards period. Price inflation was reduced by an average of 0.79 percentage points during the standards period, and by an average of 1.27 percentage points during the standards and poststandards period. From early 1980 until early 1983, however, price inflation was reduced by an amount substantially greater than 1 percentage point, sometimes approaching 2 percentage points.

In summation, Hagens and Russell argued that the Carter standards (1) brought wage demands into line with trend productivity growth, (2) did not change the slope of the short-run Phillips curve, (3) retarded inflation expectations and thus directly lowered wage inflation, (4) prevented the energy price explosion of 1979-80 from getting built into wage demands, and (5) did not have any direct effects on price inflation. Hagens and Russell argued, however, that when the interaction between prices and wages was accounted for by a joint simulation of the price and wage equations, the results indicated that the standards reduced price inflation, apparently due to the pass-through of lower labor-cost inflation to prices.

Reassessing the Effectiveness of the Carter Standards

The Hagens and Russell study is the most recent and sophisticated of the various studies of the effects of the Carter program on pay and prices. This study, however, has three major shortcomings. The first shortcoming revolves around Hagens and Russell's assumption that expectations are adaptive. They may, however, be rational which implies that the relevant equations should be estimated using a rational expectations approach. The second shortcoming is a failure to interact dummy variables representing the Kennedy-Johnson guidelines and Nixon controls periods with variables that were interacted with the Carter standards dummy variables. In their test of whether the Carter standards brought wage demands into line with productivity growth, Hagens and Russell criticized earlier studies dealing with the Kennedy-Johnson guidelines and the Nixon controls periods for failing to use a trend-productivity variable in place of the constant term in the wage equation. As noted earlier, they argued that the appropriate way to test for the effect of an incomes policy in bringing wage demands into line with productivity growth is by including a dummy variable that represents the incomes policy, and interacting that dummy variable with the trend-productivity variable. In their wage equation Hagens and Russell include a dummy variable representing the Carter standards, and interact that dummy variable with the trend-productivity variable. Since they have included dummy variables representing both the Kennedy-Johnson guidelines and the Nixon controls in their wage equation, however, a more appropriate specification of the wage equation would be one where these dummy variables are allowed to interact with the trend-productivity variable. Similarly, when Hagens and Russell tested the hypotheses that the Carter program changed the slope of the short-run Phillips curve and that the standards program retarded inflationary expectations, they again incorporated interactive dummy variables only for the period of the Carter program. For the hypothesis concerning the slope of the short-run Phillips curve, Hagens and Russell interacted the standards dummy variables (one for each of the two years of the Carter program) with the difference between the unemployment rate and the natural unemployment rate. For the hypothesis concerning the retardation of inflationary expectations, the standards dummy variables are interacted with a 12 quarter polynomial distributed lag on past percentage rates of change of consumer prices. A more appropriate specification in each case would seem to be one that applied the interaction terms to the earlier periods as well. The third shortcoming is an apparent specification error of the equation used to test for the effectiveness of the Carter standards in preventing the energy price shock of 1979-80 from being passed through to wage inflation. We will deal with the first two shortcomings in the next chapter, and the last shortcoming (using the Hagens and Russell framework) directly below.

<u>Hagens and Russell's Test for Insulation from Shocks</u>

Hagens and Russell's basic wage equation[22] is

$$\dot{W}_t = A_0 R_t + A_1 L(\dot{P}_{t-1}) + A_2 (U_t - \bar{U}_t). \qquad (2.5)$$

In equation (2.5), $\dot{W}$ is the percentage change in labor compensation, R the trend labor productivity growth rate, $\dot{P}$ the percentage change in consumer prices, L a 12 quarter polynomial distributed lag function, U the actual unemployment rate, and $\overline{U}$ the natural unemployment rate. The 12 quarter lag on inflation starts with the variable lagged 1 quarter, and has its far endpoint constrained to zero; i.e., $L(\dot{P}_{t-1}) = \sum_{i=1}^{12} a_i \dot{P}_{t-i}$.

This equation is estimated without a constant term, because Hagens and Russell argued that in wage equations with no inflationary bias, the constant term should be equal to the trend rate of growth of labor productivity. Since trend productivity growth has not been constant in the United States, the constant term has been replaced with a trend productivity variable. Other variables, such as changes in employment taxes and minimum wage rates, are also incorporated into equation (2.5), but they are not important for the argument developed here.

When Hagens and Russell tested the hypothesis that the Carter standards prevented the energy price explosion of 1979-80 from being incorporated into wage demands, the equation they estimated was of the general form

$$\dot{W}_t = A_0R_t + A_1L(\dot{P}_{t-1}) + A_2(U_t-\overline{U}_t) \qquad (2.6)$$

$$+ A_3L(\dot{E}_{t-1}-\dot{P}_{t-1}) + A_4L[(\dot{E}_{t-1}-\dot{P}_{t-1})D_{t-1}],$$

where $\dot{E}$ is the percentage change in energy prices and D_t is equal to 1 for 1979:1 through 1980:2, and 0 otherwise. The purpose of the term $A_3L(\dot{E}_{t-1}-\dot{P}_{t-1})$ in equation (2.6) is to determine whether expectations about energy price inflation ($\dot{E}_{t-1}$) and non-energy price inflation

($\dot{N}_{t-1}$) are generated by the same mechanism that produces expectations about overall inflation ($\dot{P}_{t-1}$). According to Hagens and Russell, if the same mechanism holds, A_3 will equal zero, which is what they found. The term $A_4L[(\dot{E}_{t-1}-\dot{P}_{t-1})D_{t-1}]$ is used to determine whether the energy price increases were passed on in the form of higher wages during the Carter standards. If COWPS did not allow energy price increases to increase wages, A_4 would be negative. Otherwise, A_4 would equal zero since the effect of energy price increases would be seen in $L(\dot{P}_{t-1})$. The fact that energy price increases would show up in overall inflation would be guaranteed by A_3 being equal to zero.

This does not mean, however, that Hagens and Russell's framework is void of errors. One problem is that equation (2.6) is not consistent with equation (2.5), which underlies their analysis. Using the identity $\dot{P}_t = b_0\dot{E}_t + (1-b_0)\dot{N}_t$, where b_0 is the relative importance of energy prices in the Consumer Price Index,[23] it follows that $L(\dot{P}_{t-1}) = b_0L(\dot{E}_{t-1}) + (1-b_0)L(\dot{N}_{t-1})$. Equation (2.5) cannot be manipulated to yield equation (2.6). Ignoring the term $A_4L(\dot{E}_{t-1}-\dot{P}_{t-1})D_{t-1}$, and substituting for $L(\dot{P}_{t-i})$ in equation (2.5) yields

$$\dot{W}_t = A_0R_t + A_1L[(b_0)\dot{E}_{t-1}] + A_3L[(1-b_0)\dot{N}_{t-1}] + A_2(U_t-\overline{U}_t) \qquad (2.7)$$

Trying to rearrange equation (2.7) to conform to equation (2.5) yields

$$\dot{W}_t = A_0R_t + A_1L[(b_0)(\dot{E}_{t-1}-\dot{P}_{t-1})] + A_3L(\dot{P}_{t-1}) + A_4L[(1-b_0)(\dot{N}_{t-1}-\dot{P}_{t-1})] + A_2(U_t-\overline{U}_t) \qquad (2.8)$$

This equation could not be estimated since

$$L[(b_0)(\dot{E}_{t-1}-\dot{P}_{t-1})] = -L[(1-b_0)\dot{N}_{t-1}-\dot{P}_{t-1})].$$

In addition, the term $L[(\dot{E}_{t-1}-\dot{P}_{t-1})D_{t-1}]$ in equation (2.6) is puzzling. It is non-zero from 1979:2 through 1983:2, due to the fact that D is lagged 12 quarters and has a non-zero value (unlagged) from 1979:1 through 1980:2. In 1983:2 for example, this term would be equal to $a_{12}[\dot{E}_{t-12}-\dot{P}_{t-12})D_{t-12}]$, implying that the standards were operational for 10 quarters after the standards period ended. It seems unrealistic that in 1983:2, workers would still be reducing pay demands in response to 1980:2 relative price movements. A more realistic assumption is that the former patterns would re-emerge once the standards were lifted. Thus the term $L(D_{t-1})$ should be D_t, and using equation (2.7) to underlie their energy price-shock equation, Hagens and Russell should have estimated the energy price-shock equation as

$$\dot{W}_t = A_0R_t + A_1L[(b_0)\dot{E}_{t-1}] + A_3L[(1-b_0)\dot{N}_{t-1}] \qquad (2.9)$$
$$+ A_2(U_t-\overline{U}_t) + A_4L(\dot{E}_{t-1})D_t.$$

If the Carter standards had dampened the effects of energy prices, A_4 would be negative; otherwise, A_4 would equal zero.

Using the Hagens and Russell quarterly data, a more complete version of equation (2.9) that included additional explanatory variables was estimated from the second quarter of 1954 to the second quarter of 1983 in an attempt to determine if the Carter standards had prevented the energy price-shocks from causing higher pay inflation.[24] This new equation is

$$\dot{W}_t = A_0R_t + A_2(U_t-\overline{U}_t) + A_5\ DATADUM_t + A_6HRCHSSTAX_t \qquad (2.10)$$
$$+ A_7CHMINWA_t + A_8GUIDPS_t + A_9ESP1_t + A_{10}ESP2_t$$
$$+ K_0L(\dot{E}_{t-1}) + K_1L(\dot{N}_{t-1}) + K_2L(\dot{E}_{t-1})D_t + e_t,$$

where DATADUM is a dummy variable that corrects for the effects of linking two different wage series, HRCHSSTAX is the annualized percentage change in employment taxes, CHMINWA is the percentage change in the minimum wage, GUIDPS is a dummy variable representing the Kennedy-Johnson guidepost program, and ESP1 and ESP2 are dummy variables representing Phases I and II and Phases III and IV, respectively, of the Nixon Economic Stabilization Program.[25] The coefficient K_0 equals A_1b_0, K_1 equals $A_3(1-b_0)$, and K_2 has replaced A_4. Table I contains the parameter estimates of equation (2.10), and the variables are listed and defined in Table II.

The estimated coefficient of R, the trend productivity variable which replaced the constant term in equation (2.10), is positive (as expected) and statistically significant. It indicates that a one percentage point increase in trend productivity results in a 1.161 percent increase in wage inflation; this coefficient is significantly greater than its theoretically expected value of 1.

The estimated coefficient of the difference between the actual and natural unemployment rates, $U - \overline{U}$, is statistically significant, and it implies that a one percentage point increase in the unemployment rate lowers the wage inflation rate by 0.592 percentage points.

The third variable, DATADUM, is a dummy variable that corrects for the effects of linking two different data series. Starting in 1964:1,

TABLE I

MODIFIED WAGE EQUATION

Variable	Eqn 2.10
R	1.161* (16.231)
$U - \bar{U}$	-0.592* (-7.046)
DATADUM	-1.381 (-1.502)
HRCHSSTAX	1.038* (8.239)
CHMINWA	0.021* (4.24)
GUIDPS	-0.625* (-2.482)
ESP1	0.45 (0.976)
ESP2	-0.616 (-1.27)
$L(\dot{E}_{t-1})$	0.007 (1.069)
$L(\dot{N}_{t-1})$	0.88* (24.954)
$L(\dot{E}_{t-1})D_t$	-0.121* (-7.213)
Adjusted R_2	0.982
Standard Error	0.889
Durbin-Watson	1.698

TABLE I (Continued)

The sample period is 1954:2 through 1983:2; t-statistics are shown in parentheses.
The dependent variable is $\dot{W}$.
L( ) connotes a third-degree polynomial distributed lag, with the far endpoint constrained to zero. The lag length is 12 quarters, starting with the variable lagged 1 quarter.
*Significant at the 5 percent level.

TABLE II

HAGENS AND RUSSELL'S VARIABLES

Variable	Definition	Hagens and Russell's Sources
$\dot{W}$	Annualized percentage change in HRPAY	
HRPAY	HRJ x HRWSS/HRWS	
HRJ	Hourly earnings index of production workers in the private nonfarm sector. This series is adjusted for overtime (in manufacturing) and for interindustry shifts in employment	1954-63: Gordon (1971); 1964-83: Bureau of Labor Statistics (BLS)
HRWSS	Compensation of employees	National Income Accounts (NIA)
HRWS	Wages and salaries	NIA
R	Estimated trend rate of productivity growth, obtained by regressing HRCHPROD on HRCHGAP, $HRCHGAP_{-1}$, TIME, and HRDEOE, the period of estimation being 1953:1 to 1980:3, and using the fitted values setting HRCHGAP, $HRCHGAP_{-1}$, and HRDEOE equal to zero	
HRCHPROD	Annualized percentage change in output per man-hour in the nonfarm business sector	BLS
HRCHGAP	Annualized percentage change in GNPGAP	
GNPGAP	((POTGNP-GNP)/POTGNP) x 100	
GNP	Gross National Product-1972 dollars	NIA

TABLE II (Continued)

POTGNP	Potential GNP-1972 dollars	Council of Economic Advisors
TIME	1 for 1953:1, 2 for 1953:2, and so on	
HRDEOE	End of expansion dummy	Gordon (1979)
U	Unemployment rate for civilian workers	BLS
$\bar{U}$	Natural unemployment rate	Gordon (1978)
DATADUM	1 for 1964:1, 0 otherwise, corrects for the effects of linking two different wage series	
HRCHSSTAX	Annualized percentage change in 1/(1-HRTWER/HRWS)	
HRTWER	Employer contributions for social insurance	NIA
CHMINWA	Annualized percentage change in the minimum hourly wage for all covered and nonexempt workers	Office of Fair Labor Statistics, Department of Labor
GUIDPS	Kennedy-Johnson Guideposts, .25 for 1962:1, .5 for 1962:2, .75 for 1962:3, 1 for 1962:4 to 1966:4, .75 for 1967:1, .5 for 1967:2, .25 for 1967:3, 0 otherwise	
ESP1	Nixon Controls-Phases I and II, .5 for 1971:3, 1 for 1971:4 to 1972:4, .167 for 1973:1, 0 otherwise	
ESP2	Nixon Controls-Phases III and IV, .833 for 1973:1, 1 for 1973:2 to 1974:1, .333 for 1974:2, 0 otherwise	

TABLE II (Continued)

$\dot{E}$	Annualized percentage change in the energy component of the consumer price index	Constructed using BLS data
$\dot{N}$	Annualized percentage change in the non-energy component of the consumer price index (Note: This variable was not used in Hagens and Russell's work; therefore, any errors in the construction of this variable were committed by the author, and not by Hagens and Russell)	1951-1957: Constructed using data from Hagens and Russell and the Bureau of Labor Statistics; 1958-1983; Bureau of Labor Statistics
D	Dummy variable representing the energy price shock of 1979:1 through 1980:2, equal to 1 for this period, 0 otherwise	

a new wage series is used (see Table II). Consequently, an error is introduced into the calculation of the percentage change in pay for that quarter. To compensate, dummy variable DATADUM is introduced; it has a value of 1 for 1964:1 and zero elsewhere. It is not statistically significant.

The fourth variable, HRCHSSTAX, reflects the effects of changes in employment taxes on the wage inflation rate. The estimated coefficient is not statistically different from 1, which implies that all of an increase in employment taxes is passed forward in the form of higher prices, and none is passed backward in the form of lower wages.

The fifth variable, CHMINWA, reflects the effects of changes in the minimum wage on the wage inflation rate. While the coefficient is significantly different from zero, it is also very small, indicating that a ten percentage point increase in the minimum wage would only increase employee compensation by approximately two-tenths of one percentage point.

The sixth variable, GUIDPS is an intercept-shift dummy that takes into account the effects of the Kennedy-Johnson guideposts. Perry's[26] approach of phasing the guideposts in during 1962 and phasing them out during 1967 is used. The coefficient implies that the guideposts lowered wage inflation by 0.625 percentage points.

Similarly, the next two variables, ESP1 and ESP2, represent the two phases of the Nixon Administration's Economic Stabilization Program. Phases I and II (August 1971 - January 1973) of the Nixon Program, designated as ESP1 were periods of mandatory controls, while Phases III and IV (January 1973 - April 1974), designated as ESP2, were periods of decontrol. These two variables are phased in and out in a fashion similar to that of the GUIDPS variable. The estimated coefficients of both ESP1 and ESP2 are not significantly different from zero, indicating that the Nixon program had no effect on wage inflation.

The ninth coefficient is the sum of the coefficients of the distributed lag on energy prices. This coefficient is not statistically significant, indicating that over the 30 year sample period changes in energy prices did not have an impact on the rate of wage inflation.

The tenth coefficient is the sum of the coefficients of the distributed lag on non-energy prices. This coefficient is highly significant, and indicates that a one percentage point increase in non-energy prices results in a 0.88 percentage point increase in labor compensation.

The final coefficient, the one that tests whether the Carter standards prevented the pass through of energy price increases to labor compensation, is the sum of the coefficients of the distributed lag on energy prices incorporated with a dummy variable for the period of the energy price shock. The coefficient is negative and statistically significant, and implies that the Carter standards prevented the energy price explosion from getting built into wage demands. This conclusion, derived from a wage equation based on adaptive expectations, is consistent with the principal conclusion of the Hagens and Russell study.

As noted earlier, however, expectations may be rational, and the relevant wage equations should be estimated in a rational expectations framework. This problem, as well as the problem of interacting the dummy variables representing both the Kennedy-Johnson and Nixon incomes policies with the appropriate explanatory variables, will be addressed in the empirical work in the next chapter.

ENDNOTES

[1]Public Law 93-387 (August 24, 1974).

[2]Executive Order No. 12092 (November 1, 1978).

[3]Any one individual could receive more than 7 percent, so long as another individual received less than 7 percent. The average could not exceed 7 percent.

[4]Council on Wage and Price Stability, Evaluation of the Pay and Price Standards Program (Washington, D.C., January, 1981), p. 30.

[5]Lucretia Tanner and Mary Converse, "The 1978-80 Pay Guidelines: Meeting the Need for Flexibility," Monthly Labor Review, CIV/VII (July 1981), p. 17.

[6]The profit margin was defined as:

$$\text{Profit margin} = \frac{\text{profit}}{\text{net sales}} \text{ or profit margin} = \frac{\text{profit}}{\text{revenues}}.$$

[7]For example, see Council on Wage and Price Stability, Evaluation of the Pay and Price Standards Program (Washington, D.C., January, 1981); General Accounting Office, The Voluntary Pay and Price Standards Have Had No Discernible Effect on Inflation, PAD-81-02 Washington, D.C., December 10, 1980; and John B. Hagens and R. Robert Russell, "Testing for the Effectiveness of Wage-Price Controls: An Application to the Carter Program," American Economic Review, LXXV (March 1985), pp. 191-207.

[8]Alan S. Blinder, Economic Policy and the Great Stagflation (New York: Academic Press, 1979), p. 128.

[9]Lloyd Ulman and Robert Flanagan, Wage Restraint: A Study of Policies in Western Europe (Berkeley: University of California Press, 1971).

[10]Council on Wage and Price Stability, Evaluation of the Pay and Price Standards Program (Washington, D.C., January, 1981), pp. 98-104.

[11]General Accounting Office, The Voluntary Pay and Price Standards Have Had No Discernible Effect on Inflation, PAD-81-02 (Washington, D.C., December 10, 1980).

[12]This estimate appeared in the Council on Wage and Price Stability's Interim Report of the Effectiveness of the Pay and Price Standards (Washington, D.C., 1980). This report was prepared prior to the final COWPS report cited earlier, and the estimate of the effect of the standard was larger in the earlier report than it was in COWPS' preferred equation in their final report.

[13]GAO, pp. 53-58.

[14]Jon Frye and Robert J. Gordon, "Government Intervention in the Inflation Process: The Econometrics of 'Self-Inflicted Wounds,'" American Economic Review, LXXI (May 1981), pp. 288-294.

[15]Jack Meyer, Wage-Price Standards and Economic Policy (Washington, D.C.: American Enterprise Institute for Public Policy Research, 1982).

[16]John B. Hagens and R. Robert Russell, "Testing for the Effectiveness of Wage-Price Controls: An Application to The Carter Program," American Economic Review, LXXV (March 1985), pp. 191-207.

[17]Meyer claims that his attempts to replicate the COWPS preferred pay equation yielded an equation very close but not identical to the COWPS equation. In particular, he claims to have obtained a smaller, but still statistically significant coefficient, for the Carter standards dummy variable than did COWPS. Meyer, pp. 60-61.

[18]Meyer, pp. 60-63.

[19]For some reason, Hagens and Russell do not include interactive dummies for either the Kennedy-Johnson guidelines or the Nixon controls periods, even though the sample period began in 1954:2.

[20]Hagens and Russell, p. 198.

[21]Hagens and Russell commit the same error when testing the hypotheses concerning the slope of the short-run Phillips curve and the deflation of inflationary expectations as they did when they tested the hypothesis that the standards brought wage inflation into line with trend-productivity growth. Specifically, the interaction terms were not applied to the Kennedy-Johnson guidelines or the Nixon controls periods.

[22]As noted earlier, previous empirical studies by COWPS, GAO, Frye and Gordon, and Hagens and Russell concluded that the Carter pay and price standards had no direct effect on price inflation. Thus, we will concentrate on the standards' effects on wage inflation.

[23]Since $\dot{P}_t = b_0\dot{E}_t + (1-b_0)\dot{N}_t$, it follows that

$$\dot{P}_t = b_0\dot{E}_t + \dot{N}_t - b_0\dot{N}_t,$$

$$b_0\dot{N}_t - b_0\dot{E}_t = \dot{N}_t - \dot{P}_t,$$

$$b_0(\dot{N}_t - \dot{E}_t) = \dot{N}_t - \dot{P}_t, \text{ and}$$

$$b_0 = (\dot{N}_t - \dot{P}_t)/(\dot{N}_t - \dot{E}_t).$$

[24]Attempts to replicate the various equations in the Hagens and Russell work were generally successful, although on occasion the coefficients and t-ratios were slightly different. Most of the Hagens and Russell data only went to 1983:2. In their footnote to Table 1 (page 196), however, they claim that their estimation period is 1954:2-1983:3, while in several other places (pp. 195, 200) they claim this period is 1954:2-1983:2. Given the data base, the 1983:3 would seem to be a typographical error.

[25]The data used by Hagens and Russell and the data collected for use in this study are not always the same. In particular, the data for the following variables were different: the percentage change in pay $\dot{W}$ (different after 1963); the unemployment rate less the natural unemployment rate, $U - \overline{U}$; the percentage change in employment taxes, HRCHSSTAX; and the estimated trend rate of productivity growth, R. With the exception of trend productivity, which was calculated in a slightly different manner in this study (this will be discussed in more detail later), I could not authenticate all of the Hagens and Russell data. There are a variety of reasons why the data could be different, ranging from rounding differences to the fact that the data for this study was collected after the Hagens and Russell study was published and, therefore, may have been revised after Hagens and Russell collected their data.

It should also be noted that Hagens and Russell did not have a non-energy price inflation variable in their study. All other data used in the adaptive expectations part of this study were supplied by Hagens and Russell. The data collected for use in this study will be used in the section where rational expectations is used to test the four hypotheses in the Hagens and Russell study.

The definitions and the sources of the data collected for use in this study are shown in Table IV. Different variable names are used when the data are different from that used by Hagens and Russell.

[26]George L. Perry, "Changing Labor Markets and Inflation," Brookings Papers on Economic Activity, 3 (1970), pp. 411-48. Also "Inflation in Theory and Practice," Brookings Papers on Economic Activity, 1 (1980), pp. 207-41.

CHAPTER III

RATIONAL EXPECTATIONS AND THE EFFECTIVENESS OF THE CARTER STANDARDS

Introduction

As noted earlier, all prior studies dealing with the effects of incomes policies on wage inflation have relied on the hypothesis that expectations of inflation are formed adaptively; i.e., the expected price level in time period t is a weighted average of past price levels, with the most recent periods weighted the most heavily. One problem with this approach is that it ignores information (such as a change in the growth rate of the money supply or a change in fiscal policy) that may be relevant in predicting changes in the price level.

In this chapter, we use an alternative theory of expectations. This alternative theory, known as rational expectations,[1] incorporates all relevant information into the formation of expectations. Errors may still be made in predicting changes in the price level, but these errors are not systematic.

In addition to dealing with the assumption that expectations are formulated adaptively, we will also deal with the problem found in the work of Hagens and Russell of interacting a particular independent variable with dummy variables representing only the phases of the Carter standards. The interacted independent variable should be interacted with dummy variables representing previous incomes policies, or their phases, as well.

We begin this chapter by discussing the econometric methodology to be used in conjunction with rational expectations. We then apply this methodology to the four hypotheses Hagens and Russell tested. The hypotheses are that the Carter standards (1) brought wage demands into line with trend-productivity growth, (2) changed the inflation-unemployment trade-off, (3) deflated inflationary expectations, and (4) insulated the economy from energy-price shocks. In addition, we will also correct the variable interaction problem found in Hagens and Russell's tests of the first three hypotheses.

The Econometric Methodology of Rational Expectations

Rational expectations implies that the anticipations of X_t, where X_t represents some variable such as inflation, money growth, or nominal GNP growth will be formed optimally, using all available information and linear forecasting models.[2] A forecasting equation that can be used to generate these anticipations is

$$X_t = Z_{t-1}g + U_t \qquad (3.1)$$

where Z_{t-1} = a row vector of variables used to forecast X_t which are available at time t-1 (this includes variables known at t-1, t-2, t-3, etc.),

g = a vector of coefficients,

U_t = an error term which is assumed to be uncorrelated with any information available at t-1 (which includes Z_{t-1}

or U_{t-1} for all $i \geq 1$, implying that U_t is serially uncorrelated).

Due to the market's subjective probability distribution of outcomes being distributed about the objective probability distribution of outcomes, an optimal forecast for X_t conditional on information available at t-1 would be

$$X_t^e = Z_{t-1}g, \tag{3.2}$$

where X_t^e = anticipated X_t conditional on information available at t-1.

Specification of the Forecasting Equation

Rational expectations theory implies that X_t^e is an optimal, one-period forecast, conditional on available information. Therefore, an appropriate forecasting equation for X_t should rely only on lagged explanatory variables. Theoretically, any piece of information available at time t-1 may be a useful predictor of X_t even if there is no strong reason to include it in the Z_{t-1} vector, simply because the personalities involved in policy making may be such that they react to this variable nonetheless. For example, if the Federal Reserve linked the growth rate of M1 to the unemployment rate, even though there is no reason to do so in a world where the policy ineffectiveness proposition holds, the unemployment rate would be a useful predictor of the M1 growth rate. As a result, an atheoretical statistical procedure may be superior to economic theory in generating an accurate model of expectations formation.

The Granger "causality" concept is a natural way to approach the specification of the forecasting model.[3] A variable Z is said to

Granger-cause another variable X, if the prediction of X can be significantly improved by using past values of Z and X as opposed to using past values of X alone. Lagged values of X should be included in the forecasting equation of X to eliminate any serial correlation in the residuals. Should Z Granger-cause X, then it should also be included in the optimal forecast of X.

The procedure used for specifying the forecasting equation in this study is as follows. The X variable is regressed on its own lagged values as well as on the lagged values of a wide ranging set of variables. The number of lagged values of the X variable initially retained is determined by the last lagged value of X that is significant at the five percent level in the initial uninterrupted string of significant lagged X's. For example, if X is lagged 4 quarters and only quarters 1, 2, and 4 are significant, then X_{t-1} and X_{t-2} are included in the forecasting equation. The Z variables included in the forecasting equation are limited to those variables that are jointly significant at the five percent level. The number of lagged values of the Z variables included in the forecasting equation is determined in the same manner as the number of lagged values of the X variable. This procedure has the advantage of imposing a discipline on the researcher that prevents his/her searching for a forecasting equation that yields results confirming his/her "desired" results. In addition, a stepwise regression procedure may miss significant explanatory variables because of the order in which the regressors enter the regressions.

Testing for Rational Expectations

Once the forecasting equation is specified, it can be "substituted" into the general model

$$y_t = dM_t + \sum_{i=0}^{N} b_i X^e_{t-i} + e_t, \tag{3.3}$$

giving us

$$y_t = dM_t + \sum_{i=0}^{N} b_i (Z_{t-1-i} g) + e_t, \tag{3.4}$$

where y_t = dependent variable at time t;

d = a vector of coefficients;

M_t = a vector of explanatory variables which are available at time t and do not enter (3.4) through the Z_{t-1} vector;

b_i = a vector of coefficients;

e_t = an error term which may be serially correlated but is assumed to be uncorrelated with the right-hand-side variables.

The assumption that all the right-hand-side variables are exogenous and are uncorrelated with the error term implies that the least-squares estimation methods will yield consistent estimates of the b's.

The method for estimating this rational expectations model involves joint, nonlinear estimation of the equations (3.1) and (3.4) system, which is reproduced as

$$X_t = Z_{t-1} g + U_t \tag{3.5}$$

$$y_t = dM_t + \sum_{i=0}^{N} b_i (Z_{t-1-i} g) + e_t.$$

System (3.5) imposes rationality of expectations since the coefficient g which appears in the equation for X_t also appears in the equation for y_t. Relaxing the rationality constraint, system (3.5) becomes

$$X_t = Z_{t-1}g + U_t \tag{3.6}$$

$$y_t = dM_t + \sum_{i=0}^{N} b_i(Z_{t-1-i}g^*) + e_t,$$

where g^* = vector of (unconstrained) coefficients.

A comparison of the estimated systems (3.5) and (3.6) provides a test of the null hypothesis of rationality, that is, $g = g^*$.

The following procedure[4] is used to estimate the chi-square (χ^2) statistic necessary for testing the null hypothesis of rationality. Estimation of system (3.5) proceeds under the identifying assumption that the y equation is a true reduced form. This assumption implies that the covariance of the error terms in the X and y equations of system (3.5) is zero. Consequently, an initial estimate for the variance-covariance matrix of the residuals, $\hat{\Sigma}$, is made assuming that

$$\hat{\Sigma} = \begin{vmatrix} SSR_X/n & 0 \\ 0 & SSR_y/n \end{vmatrix}, \tag{3.7}$$

where SSR_X = the sum of squared residuals of the X equation,

SSR_y = the sum of squared residuals of the y equation,

n = the number of observations.

The initial $\hat{\Sigma}$ is obtained from unconstrained ordinary least squares estimates of the X and y equations. Once $\hat{\Sigma}$ is estimated, the constrained system can be estimated with nonlinear generalized least squares (GLS). Given the particular diagonal form of the matrix, nonlinear GLS is equivalent to nonlinear weighted least squares (WLS) using the estimates from $\hat{\Sigma}$; i.e., the observations for the X forecasting equation are weighted by $\sqrt{SSR_X/SSR_y}$, so that $(\sqrt{SSR_X/SSR_y})^{-1} X_t$ equals $(\sqrt{SSR_X/SSR_y})^{-1} (Z_{t-1}g + U_t)$. After the system is estimated using this procedure, a new $\hat{\Sigma}$ matrix can be estimated and the iterative procedure that corrects for heteroscedasticity across the equations continues as follows. The variables in the X equation are weighted by the ratio from the previous iteration of the standard error of the X equation divided by the standard error of the y equation. This means that the weighting variable from the previous iteration (originally $\sqrt{SSR_X/SSR_y}$) must be multiplied by the standard error of the weighted X equation divided by the standard error of the y equation. The system is then re-estimated with nonlinear WLS. The newly estimated residuals are then used to re-weight the X equation in the manner described directly above. This iterative procedure is continued until the standard errors of the weighted X forecasting equation and the y equation differ by less than 2.5 percent. Because the system is triangular, this procedure will converge to maximum-likelihood estimates, since theorems showing that iterative three-stage-least squares is equivalent to full-information-maximum-likelihood then apply to this nonlinear case as well.

In unconstrained system (3.6) no constraints are imposed on the y_t equation (i.e., rationality is not imposed). Therefore, both the X_t and y_t equations can be estimated separately using ordinary least squares.

The likelihood ratio statistic, which is distributed asymptotically as $\chi^2(q)$ under the null hypothesis, is

$$-2 \log \left[\frac{L^c(\hat{\Sigma}^c)}{L^u(\hat{\Sigma}^c)} \right] = 2n \log \left[\frac{SSR^c}{SSR^u} \right] \quad (3.8)$$

with superscripts on the $\hat{\Sigma}$ indicating that the maximized likelihood of both the constrained and unconstrained systems are estimated with the same weighting matrix $\hat{\Sigma}^c$, where

q = the number of constraints,

L^c = maximized likelihood of the constrained system,

L^u = maximized likelihood of the unconstrained system,

$\hat{\Sigma}^c$ = the resulting estimated $\hat{\Sigma}$ for the constrained system,

SSR^c = the sum of squared residuals from the constrained weighted system,

SSR^u = the sum of squared residuals from the unconstrained system,

n = the number of observations.

Note that SSR^u equals $(SSR_X^u + SSR_y^u)/(HETA)^2$, where HETA is the weighting variable used in the constrained system's final iteration. Comparison of this statistic with the critical $X^2(q)$ then tests the null hypothesis of rationality.

One problem concerning estimation remains to be resolved. Since the test statistics assume serially uncorrelated error terms, serial correlation must be eliminated from the residuals. So long as lagged dependent variables are included in the forecasting equation there should be little serial correlation in the U_t residuals and no serial correlation correction will be needed. Since there is no theoretical argument guaranteeing that the error term in the y equation is serially uncorrelated, however, the error term in the y equations estimated later is assumed to be a fourth-order autoregressive process.[5] Fourth-order autoregressions usually eliminate most serial correlation in quarterly, macroeconomic time series.

Rational Expectations and Trend Productivity

The first hypothesis tested by Hagens and Russell is whether the Carter program brought wage inflation into line with trend productivity growth. The rational expectations system outlined above can now be used to test this hypothesis. We begin by estimating the expected price inflation equation.

The Consumer Price Index Inflation Forecasting Equation

In the adaptive expectations approach to testing the effectiveness of an incomes policy in slowing wage inflation, one of the explanatory variables included in the wage equation is a distributed lag on past inflation. The rational expectations approach uses the forecast of expected inflation, conditional on available information, in place of the distributed lag used in the adaptive expectations studies. An optimal forecast for inflation is developed by using the procedure outlined in the section on the specification of the forecasting equation.

Table III contains the parameter estimates of the expected price inflation equation. In equation (3.9), the dependent variable is the annualized percentage change in the consumer price index (CPI). The independent variables are listed and defined in Table IV.

Using the M1 definition of the money supply, the results indicate that, for the most part, increases in the growth rate of the money

TABLE III

EXPECTED PRICE INFLATION EQUATION

Variable	Eqn (3.9)
Constant	-.142 (.323)
M1L1	.294* (.054)
DUM1	1.719 (1.873)
CPIL1	.788* (.045)
BUDL1	.019* (.006)
Adjusted R^2	.784
Standard error	1.839
Durbin h	-1.069

The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.
The dependent variable is CPIL.
*Significant at the 5 percent level.

TABLE IV

VARIABLES

Variable	Definition	Source
M1L	Annualized percentage change in the money supply (M1); the number appended to the variable refers to the number of quarters the variable is lagged	Gordon (1984)
DUM1	1 for 1959:2, 0 otherwise, used with M1L1; corrects for linking old M1 and new M1 in 1959:1	
DUM2	1 for 1959:3, 0 otherwise, used with M1L2; corrects for linking old M1 and new M1 in 1959:1	
CPIL	Annualized percentage change in the consumer price index for urban consumers, the number appended to the variable refers to the number of quarters the variable is lagged	Survey of Current Business
BUDL	Government surplus or deficit (annual rate); the number appended to the variable refers to the number of quarters the variable is lagged	Business Conditions Digest
TR	Estimated trend rate of productivity growth, obtained by regressing CHPROD on CHQ, CHQ_{-1}, CHQ_{-2}, TIME, and DEOE, and using the fitted values setting CHQ, CHQ_{-1}, CHQ_{-2}, and DEOE equal to zero, the period of estimation being 1953:1 to 1983:4	Constructed in a manner similar to Gordon's (1979) specification
CHPROD	Annualized percentage change in output per man-hour in the nonfarm business sector	Business Conditions Digest
GNP	Real gross national product - 1972 dollars	Survey of Current Business
NATRGNP	Natural Real GNP - 1972 dollars	Gordon (1984)
Q	(GNP/NATRGNP)	

TABLE IV (Continued)

CHQ	Annualized percentage change in Q	
TIME	1 for 1953:1, 2 for 1953:2, and so on	
DEOE	.25 for the first four quarters following a peak of (GNP/NATRGNP); -.20 for the next five quarters	Constructed in a manner similar to Gordon's (1979) original specification
UNEMRDI	Unemployment rate (U) for civilian labor force less the natural unemployment rate ($\overline{U}$)	U from *Business Conditions Digest*; ($\overline{U}$) from Gordon (1984)
CHMINWA	Annualized percentage change in the minimum hourly wage for all covered and nonexempt workers	Hagens and Russell
DATADUM	1 for 1964:1, 0 otherwise, corrects for the effect of linking two different wage series	
GUIDPS	Kennedy-Johnson Guideposts, .25 for 1962:1, .5 for 1962:2, .75 for 1962:3, 1 for 1962:4 through 1966:4, .75 for 1967:1, .5 for 1967:2, .25 for 1967:3, 0 otherwise	Hagens and Russell
ESP1	Nixon Controls-Phases I and II, .5 for 1971:3, 1 for 1971:4 through 1972:4, .167 for 1973:1, 0 otherwise	Hagens and Russell
ESP2	Nixon Controls-Phases III and IV, .833 for 1973:1, 1 for 1973:2 through 1974:1, .333 for 1974:2, 0 otherwise	Hagens and Russell
STD1	Carter Standards-first year (approximately), .667 for 1978:4, 1 for 1979:1 through 1979:4, 0 otherwise	Hagens and Russell
STD2	Carter Standards-second year, 1 for 1980:1 through 1980:3, .75 for 1980:4, 0 otherwise	Hagens and Russell

TABLE IV (Continued)

TWER	Employer contributions for social insurance	*Survey of Current Business*
WS	Wage and salaries	*Survey of Current Business*
CHSSTAX	Annualized percentage change in 1/(1 - TWER/WS)	
J	Hourly earnings index of production workers in private nonfarm sector. This series is adjusted for overtime (in manufacturing) and for inter-industry shifts in employment	1954-63: Gordon (1971); 1964-83: *Business Conditions Digest*
WSS	Compensation of employees	*Survey of Current Business*
PAY	J x WSS/WS	
$\dot{C}$	Annualized percentage change in PAY	
$\dot{E}$	Annualized percentage change in the energy component of the consumer price index	Hagens and Russell
CHECPI	Lagged values of $\dot{E}$; the number appended to the variable refers to the number of quarters the variable is lagged	
$\dot{N}$	Annualized percentage change in the non-energy component of the consumer price index	1951-1957: Constructed using data from Hagens and Russell and the Bureau of Labor Statistics; 1958-1983: Bureau of Labor Statistics
CHNON	Lagged values of $\dot{N}$; the number appended to the variable refers to the number of quarters the variable is lagged	

TABLE IV (Continued)

D	Dummy variable representing the energy price shock of 1979:1 through 1980:2, equal to 1 for this period, 0 otherwise	Hagens and Russell
CHCRUDP	Annualized percentage change in U.S. domestic crude oil production; the number appended to the variable refers to the number of quarters the variable is lagged	Survey of Current Business
CHCRUDM	Annualized percentage change in U.S. crude oil imports; the number appended to the variable refers to the number of quarters the variable is lagged	Survey of Current Business
CHPROF	Annualized percentage change in U.S. private domestic petroleum refining; the number appended to the variable refers to the number of quarters the variable is lagged	Survey of Current Business
CHELSAL	Annualized percentage change in electricity sales to ultimate consumers in the U.S.; the number appended to the variable refers to the number of quarters the variable is lagged	Survey of Current Business

supply increase the expected inflation rate. Equation (3.9) shows that a one percent increase in M1 in period t-1 (M1L1) results in an increase in the expected inflation rate in period t of .294 percent.

The third variable, DUM1, is a dummy variable that corrects for the effects of linking different M1 data series. The change from old M1 to new M1 occurred in 1959:1. Consequently, an error is introduced into the calculation of M1L1 for 1959:2. To compensate, dummy variable DUM1 is introduced. This dummy variable is insignificant.

The fourth variable represents past inflation rates. A one percent increase in the CPI in period t-1 (CPIL1) results in an increase in the CPI in period t of .788 percent.

BUDL1 is the budget surplus for all levels of U.S. government in period t-1. Interpretation of the estimated coefficient implies that a $100 billion dollar budget surplus results in an increase in the expected inflation rate in period t of 1.94 percent. While this result seems counter-intuitive at first glance, closer examination reveals one possible explanation. The magnitude of the budget surplus is influenced by current economic conditions and when the economy experiences a recession, tax revenues decline and transfer payments increase, thereby decreasing the magnitude of the budget surplus. Assuming that prices do not rise as rapidly during periods of contraction as during periods of expansion, lower inflation rates in period t may be associated with smaller budget surpluses in time period t-1.[6]

The Wage Inflation Equations

The X_t, or expected price inflation equation (3.9) was estimated in system (3.6). The next step is to estimate the y_t, or wage inflation equation in system (3.6).

For each potential lag length to be used in estimating the wage inflation equation in constrained system (3.5), a separate wage inflation equation must be estimated for unconstrained system (3.6). Using forecasting equation (3.9) and assuming the inflationary expectations variable in system (3.5) is unlagged, the unconstrained equation estimated is

$$\begin{aligned}\dot{C} = {} & d_1 TR + d_2 UNEMRDI + d_3 CHSSTAX + d_4 CHMINWA + d_5 DATADUM \\ & + d_6 GUIDPSTR + d_7 ESP1TR + d_8 ESP2TR + d_9 STD1TR \\ & + d_{10} ESP2TR + g_1 Constant + g_2 M1L1 + g_3 DUM1 + g_4 CPIL1 \\ & + g_5 BUDL1 + e_t.\end{aligned} \quad (3.10)$$

If the inflationary expectations variable in system (3.5) is lagged one quarter, equation (3.10) would be modified to include the variables M1L2, DUM2, CPIL2, and BUDL2. Similarly, as the inflationary expectations variable is lagged N additional quarters, MIL, DUM, CPIL, and BUDL are all lagged N additional quarters.

Since equation (3.10) is estimated merely to obtain the SSR's used to compute the X^2 statistic for testing the rationality hypothesis, we do not present or discuss these results.

In order to estimate the constrained system, the data are stacked so that system (3.5), a system of two linear equations, can be estimated as one equation with the appropriate nonlinear constraints.

Using forecasting equation (3.9), the system is estimated

$$\dot{C} = d_1TR + d_2UNEMRDI + d_3CHSSTAX + d_4CHMINWA + d_5DATADUM \quad (3.11)$$
$$+ \sum_{i=0}^{N} b_i CPIL^{e}_{t-i} + d_6GUIDPSTR + d_7ESP1TR + d_8ESP2TR$$
$$+ d_9STD1TR + d_{10}STD2TR + e_t$$

where $e_t = p_1e_{t-1} + p_2e_{t-2} + p_3e_{t-3} + p_4e_{t-4}$, and

$$CPIL^{e}_t = g_1 + g_2M1L1 + g_3DUM1 + g_4CPIL1 + g_5BUDL1.$$

One of the most difficult issues in the wage inflation equation is the measurement of price inflation expectations. More specifically, why are both current and lagged values of inflationary expectations included in the wage inflation equation. There are two important factors to be considered. First, when wages are set, forward-looking forecasts of prices and other wages influence the wage that emerges from the bargaining process the worker and the employer use to determine wages. For example, when a 3-year contract is negotiated, the built-in wage increases in the second and third years are larger if price inflation is expected to persist during the contract. If workers are informed about the economy, then these forward-looking forecasts will match rational expectations theory. Second, this influence of current expectations on the expected inflation term is only part of the story. It does not take into account that staggered labor contracts mean that the expectations term involves momentum that cannot be changed immediately. Employees and employers must take account of the wages that will be paid to other workers in the economy. Given the existence of staggered wage setting over time, some wages must be set looking back at the previous wage decisions of other workers. For example, in the United States, about 80 percent of labor contracts are three years in length, and are overlapping and staggered.[7] This means that the rate of wage change in any year, such as 1980, would be partly determined by 1980 settlements, partly by 1979 settlements made the previous year, and partly by 1978 settlements made two years before. Thus, at any point in time, workers may be worried about the inflationary effects of preexisting contracts still in effect, and they will form their wage demands accordingly. Wage inflation, therefore, involves inertia due to staggered labor contracts and relative wage setting. The price inflation expectations term must take account of this inertia.[8]

Hagens and Russell used a polynomial distributed lag on the CPIL variable. This is not the only possible specification, however, and for comparison purposes several of the hypotheses were tested in two separate ways, with and without this polynomial distributed lag. The appropriate lag length for CPIL is not known a priori, but is determined by minimizing Amemiya's[9] prediction criteria (PC), where

$$PC = s^2 (1 + K/n).$$

In the equation, s^2 is the estimated error variance, K is the number of regressors, and n is the number of observations.

At the .05 level of significance, rationality cannot be rejected for constrained wage inflation equations (3.11.10) and (3.11.12), presented in Table V. Rationality is rejected for the other equations. Note that these equations were estimated without a polynomial distributed lag restriction, and the variable $CPIL^e$ is lagged from quarter t to t-13 in (3.11.10), and from t to t-15 in (3.11.12). Since

TABLE V

CONSTRAINED WAGE INFLATION EQUATIONS FOR TREND PRODUCTIVITY HYPOTHESIS TEST -- WITHOUT A POLYNOMIAL DISTRIBUTED LAG

Variable	3.11.1 (5 lags)	3.11.2 (6 lags)	3.11.3 (7 lags)	3.11.4 (8 lags)	3.11.5 (9 lags)	3.11.6 (10 lags)
TR	1.412* (.25)	1.42* (.25)	1.419* (.255)	1.243* (.19)	1.234* (.183)	1.212* (.179)
UNEMRDI	-.034 (.167)	-.042 (.166)	-.04 (.171)	-.25 (.142)	-.271 (.14)	-.295* (.136)
CHSSTAX	.842* (.202)	.844* (.205)	.844* (.207)	.865* (.205)	.86* (.209)	.821* (.213)
CHMINWA	.0055 (.0065)	.0055 (.0065)	.0054 (.0066)	.0092 (.0062)	.01 (.0062)	.011 (.0061)
DATADUM	-1.861 (1.145)	-1.844 (1.149)	-1.855 (1.154)	-1.793 (1.105)	-1.812 (1.116)	-1.895 (1.105)
$\sum b_i$	1.533	1.511	1.545	1.281	1.244	1.23
GUIDPSTR	-.6* (.285)	-.606* (.285)	-.604* (.29)	-.456* (.214)	-.441* (.208)	-.42* (.199)
ESP1TR	.186 (.46)	.181 (.467)	.182 (.472)	.402 (.368)	.407 (.36)	.378 (.348)
ESP2TR	-.843 (.512)	-.854 (.511)	-.844 (.515)	-.672 (.418)	-.696 (.411)	-.743 (.399)
STD1TR	-1.299* (.658)	-1.259 (.657)	-1.282 (.663)	-1.46* (.568)	-1.49* (.561)	-1.557* (.545)
STD2TR	1.024 (.741)	1.068 (.742)	1.036 (.747)	.988 (.644)	1.004 (.639)	1.022 (.623)
RHO1	.3* (.087)	.297* (.09)	.299* (.091)	.17 (.096)	.148 (.099)	.121 (.1)
RHO2	-.098 (.071)	-.098 (.071)	-.096 (.072)	-.083 (.071)	-.09 (.071)	-.093 (.072)
RHO3	.268* (.072)	.283* (.072)	.286* (.072)	.278* (.072)	.275* (.072)	.278* (.073)

TABLE V (Continued)

RHO4	.059 (.067)	.06 (.068)	.062 (.068)	.03 (.068)	.037 (.068)	.042 (.069)
Adjusted R^2	.7298	.7277	.7238	.7601	.7601	.7626
Standard Error	1.2574	1.2624	1.2714	1.1847	1.185	1.1787
q	21	25	29	33	37	41
X^2	67.596	57.022	62.114	72.1194	86.5814	76.342
Critical X^2	32.67	37.646	42.552	47.4	52.189	56.939
PC	---	---	---	---	---	---

TABLE V (Continued)

Variable	3.11.7 (11 lags)	3.11.8 (12 lags)	3.11.9 (13 lags)	3.11.10 (14 lags)	3.11.11 (15 lags)	3.11.12 (16 lags)
TR	1.221* (.18)	1.241* (.193)	1.243* (.197)	1.225* (.209)	1.253* (.205)	1.235* (.208)
UNEMRDI	-.304* (.135)	-.343* (.139)	-.349* (.143)	-.379* (.148)	-.378* (.145)	-.379* (.147)
CHSSTAX	.83* (.216)	.866* (.216)	.868* (.216)	.852* (.216)	.855* (.211)	.845* (.217)
CHMINWA	.0113 (.006)	.0104 (.006)	.0103 (.006)	.0082 (.0062)	.0075 (.0062)	.0075 (.0063)
DATADUM	-1.781 (1.108)	-1.56 (1.083)	-1.562 (1.088)	-1.555 (1.08)	-1.512 (1.076)	-1.401 (1.091)
Σb_i	1.245	1.34	1.36	1.459	1.41	1.435
GUIDPSTR	-.43* (.20)	-.46* (.209)	-.463* (.212)	-.463* (.221)	-.489* (.217)	-.479* (.221)
ESP1TR	.316 (.348)	.167 (.359)	.146 (.368)	.068 (.384)	.087 (.38)	.074 (.384)
ESP2TR	-.818* (.3970	-.882* (.402)	-.893* (.406)	-.921* (.418)	-.901* (.415)	-.911* (.419)
STD1TR	-1.453* (.439)	-1.116* (.549)	-1.079 (.555)	-1.001 (.571)	-1.049 (.566)	-1.048 (.571)
STD2TR	1.156 (.619)	1.223* (.618)	1.25* (.623)	1.333* (.639)	1.223* (.64)	1.298* (.65)
RHO1	.105 (.099)	.137 (.095)	.142 (.097)	.169 (.096)	.17 (.1)	.173 (.1)
RHO2	-.083 (.07)	-.102 (.069)	-.099 (.07)	-.09 (.071)	-.092 (.071)	-.101 (.071)
RHO3	.276* (.071)	.301* (.071)	.298* (.071)	.312* (.072)	.309* (.073)	.316* (.073)
RHO4	.056 (.068)	.064 (.068)	.068 (.069)	.049 (.069)	.038 (.07)	.042 (.071)

TABLE V (Continued)

Adjusted R^2	.7626	.7663	.7630	.7618	.7649	.7625
Standard Error	1.1788	1.1694	1.1776	1.1806	1.173	1.179
q	45	49	53	57	61	65
X^2	74.579	70.919	74.766	75.144	80.361	75.686
Critical X^2	61.653	66.336	70.991	75.622	80.23	84.819
PC	---	---	---	1.7274	---	1.7466

The dependent variable is $\dot{C}$. The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.
*Significant at the 5 percent level.

equation (3.11.10) has the lowest PC, the lag length (14 quarters) used in this equation is considered to be the most appropriate, and the discussion of the results (presented in Table V) will focus on this equation.

In a wage-price model with a constant expected inflation rate (with a coefficient equal to 1) and U equal to $\overline{U}$ (with CHSSTAX and CHMINWA omitted), the equilibrium wage growth rate is equal to the trend labor productivity growth rate. As a result, in the wage inflation equations, the constant term is replaced with a trend productivity variable, constructed in a manner similar to that of Gordon.[10] The coefficient of TR, the trend productivity variable, in equation (3.11.10) is positive (as expected) and statistically significant; it indicates that a one percentage point increase in trend productivity results in a 1.225 percentage point increase in wage inflation, which is not significantly different from its theoretically expected value of 1.

The estimated coefficient of the difference between the actual and natural unemployment rates, UNEMRDI, is statistically significant, and it implies that a one percentage point increase in the unemployment rate lowers the rate of wage inflation by .379 percentage points.

The third variable, CHSSTAX, reflects the effects of changes in employment taxes on the wage inflation rate. The estimated coefficient is not statistically different from 1, which implies that all of an increase in employment taxes is passed forward in the form of higher prices, and none is passed backward in the form of lower wages.

The fourth variable, CHMINWA, reflects the effects of changes in the minimum wage on the wage inflation rate. The coefficient is not significantly different from zero, indicating that changes in the minimum wage do not affect the wage inflation rate.

The fifth variable listed, DATADUM, is a dummy variable that corrects for the effects of linking two different wage series. It is not statistically significant.

The coefficient, $\sum b_i$, represents the effects of current and lagged expected price inflation rates on the rate of wage inflation. The sum of these coefficients is 1.459. Thus, a one percentage point increase in expected inflation results in an increase in wage inflation of about one-and-a-half percentage points.

To determine whether an incomes policy lowers the productivity factor in wage inflation equations, a dummy variable which interacts with the trend productivity variable is included. This variable, GUIDPSTR, takes into account the effects of the Kennedy-Johnson guideposts. Perry's approach of phasing the guideposts in during 1962 and phasing them out during 1967 is used; however, the misspecification found in previous studies is corrected by interacting the guideposts dummy with the trend productivity factor.[11] The estimated effect of the program on wage inflation is -1.0866 percentage points (the coefficient, -.489, multiplied by the average value of TR for the period, 2.222 percent), and the interaction variable, GUIDPSTR, is statistically significant.

Similarly, the two variables ESP1TR and ESP2TR represent the two stages of the Nixon Administration's Economic Stabilization Program. Phases I and II (August 1971 - January 1973) of the Nixon program, designated as ESP1TR, were periods of mandatory controls, while Phases III and IV (January 1973 - April 1974), designated as ESP2TR, were periods of decontrol. Hagens and Russell's approach of phasing in and out the two ESP variables is adopted; however, their misspecification is corrected by interacting both of the ESP dummy variables with the trend productivity variable. The estimated effect of the first part of the program on wage inflation is .121 percentage points (the coefficient, .068, multiplied by the average value of TR for the period, 1.79 percent). The estimated effect of the second part of the program is -1.563 percentage points (-.921 multiplied by 1.697). These estimates suggest that while Phases I and II did not affect wage inflation (the coefficient is not significant), Phases III and IV reduced it (the coefficient is significant). Hagens and Russell argued that this apparent anomaly is due to the fact that the lowered price inflation they documented in Phases I and II was not translated into an equally lower wage inflation rate, while the increased price inflation they documented in Phases III and IV was not passed through in the form of higher wage inflation.

The two variables STD1TR and STD2TR are constructed in a manner similar to that of the three preceding variables. STD1 represents the first part of the Carter program (from 1978:4 through 1979:4), and STD2 represents the second part (1980). These two dummy variables are interacted with the trend productivity variable, TR. The estimated effect on the wage inflation rate of the approximately first year of the program is -1.366 percentage points (the coefficient, -1.001, multiplied by the average value of TR for the year, 1.365). The estimated effect of the second year of the program is 1.73 percentage points (1.333 multiplied by 1.298).[12] The coefficient for STD1TR is not significant, however, indicating that the first period of the standards had no impact on the wage inflation rate.

The coefficient for STD2TR is significant, indicating the second year of the standards actually added to wage inflation. These results are in direct conflict with those of Hagens and Russell, who found that the Carter standards did bring wage inflation into line with trend productivity growth.

While the results of the effectiveness of the Carter standards presented here conflict with those of Hagens and Russell, it should be pointed out that Hagens and Russell used a 12 quarter distributed lag of past price inflation rates to measure inflationary expectations. The results presented above, while being based on the rational expectations approach instead of the adaptive expectations approach used in Hagens and Russell, also did not use the distributed lag restrictions Hagens and Russell used. To ascertain if this distributed lag restriction made any difference in the results obtained above, system (3.11) was re-estimated, with the inflationary expectations variable modeled as a third-degree polynomial distributed lag, with the far endpoint constrained to zero, the same approach that Hagens and Russell took. The lag length was allowed to vary from 11 to 15 quarters.

The results of this procedure are presented in Table VI. At the .05 significance level rationality cannot be rejected for equations (3.12.4) and (3.12.5). Rationality is rejected for the other equations in Table VI. Comparing (3.11.10) and (3.12.4), which have the same lag lengths (14 quarters) and the lowest PCs for their respective models, the polynomial distributed lag seems to have had some effect on the

TABLE VI

CONSTRAINED WAGE INFLATION EQUATIONS FOR TREND PRODUCTIVITY HYPOTHESIS TEST -- USING A POLYNOMIAL DISTRIBUTED LAG

Variable	3.12.1 (11 lags)	3.12.2 (12 lags)	3.12.3 (13 lags)	3.12.4 (14 lags)	3.12.5 (15 lags)
TR	1.269*	1.244*	1.264*	1.231*	1.23*
	(.183)	(.183)	(.357)	(.192)	(.178)
UNEMRDI	-.296*	-.336*	-.328*	-.363*	-.354*
	(.136)	(.139)	(.134)	(.143)	(.16)
CHSSTAX	.75*	.756*	.746*	.746*	.737*
	(.138)	(.136)	(.139)	(.134)	(.137)
CHMINWA	.0116	.0115	.0117	.0102	.0097
	(.006)	(.006)	(.006)	(.0058)	(.0059)
DATADUM	-1.732	-1.621	-1.649	-1.687	-1.722
	(1.075)	(1.068)	(1.076)	(1.059)	(1.08)
Σb_i	1.218	1.24	1.328	1.504	1.47
GUIDPSTR	-.437*	-.437*	-.463*	-.458*	-.464*
	(.21)	(.211)	(.194)	(.21)	(.202)
ESP1TR	.293	.215	.152	.039	.014
	(.354)	(.36)	(.353)	(.361)	(.364)
ESP2TR	-.719	-.81*	-.745	-.894*	-.847*
	(.396)	(.402)	(.394)	(.396)	(.398)
STD1TR	-1.279*	-1.194*	-1.155*	-1.086*	-.999
	(.537)	(.54)	(.507)	(.531)	(.529)
STD2TR	1.601*	1.573*	1.477*	1.536*	1.518*
	(.608)	(.615)	(.575)	(.597)	(.604)
RHO1	.098	.086	.105	.144	.148
	(.092)	(.091)	(.091)	(.088)	(.089)
RHO2	-.098	-.1	-.085	-.076	-.072
	(.066)	(.065)	(.064)	(.065)	(.065)
RHO3	.295*	.302*	.305*	.306*	.305*
	(.065)	(.064)	(.064)	(.064)	(.065)

TABLE VI (Continued)

RHO4	.066 (.063)	.067 (.063)	.087 (.063)	.081 (.063)	.086 (.065)
Adjusted R^2	.7468	.7542	.7497	.7536	.7478
Standard Error	1.2173	1.1993	1.2104	1.2007	1.2146
q	45	49	53	57	61
X^2	70.774	90.261	75.063	74.636	72.442
Critical X^2	61.653	66.336	70.991	75.622	80.23
PC	---	---	---	1.6512	1.6897

The dependent variable is $\dot{C}$. The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.
The variable $CPIL^e$ is lagged using a third-degree polynomial distributed lag, with the far endpoint constrained to zero.
*Significant at the 5 percent level.

estimated coefficients, but not on the statistical significance of TR, UNEMRDI, CHSSTAX, CHMINWA, DATADUM, GUIDPSTR, AND ESP2TR. There was considerable change in the coefficients of ESP1TR, STD1TR, and STD2TR, and the coefficient for STD1TR changes from statistically insignificant to significant. The coefficient of ESP1TR fell from .068 to .039, implying that the estimated effect of the program fell from .121 to .07 percentage points, while the coefficient of ESP2TR decreased in absolute terms from -.921 to -.894, indicating that the estimated effect decreased in absolute terms from -1.563 to -1.517 percentage points. The coefficients from (3.12.4) indicate that the first phase of the Nixon program led to higher wage inflation, while the second phase led to lower wage inflation. Note that the coefficient for the first phase did not differ significantly from zero while the coefficient for the second phase was statistically significant. For the Carter program, the coefficient for STD1TR decreased from -1.001 to -1.086; consequently, the estimated effect increased from -1.366 to -1.482 percentage points. The STD2TR coefficient increased from 1.333 to 1.536 with the estimated effect increasing from 1.73 to 1.994 percentage points. The coefficients from (3.12.4) indicate that the first phase of the Carter program led to lower wage inflation while the second phase led to higher wage inflation. Since both coefficients differ significantly from zero, the two effects must be summed to determine if the Carter program significantly reduced wage inflation. The positive value of the STD2TR coefficient is greater, in absolute size, than the negative value of the STD1TR coefficient, indicating that any slowdown in wage inflation attributable to the first part of the program was overwhelmed by the increase in wage inflation attributable to the second part.

There is also a change in the sum of the coefficients of $CPIL^e_t$. It increased from 1.459 to 1.504, indicating that a given change in inflationary expectations results in a slightly larger change in wage inflation than originally reported.

In conclusion, the use of the rational expectations approach in modeling inflationary expectations (both with and without a polynomial distributed lag restriction) has led to results that are in direct conflict with those of Hagens and Russell; specifically, the rational expectations approach indicates that the Carter standards did not bring wage inflation into line with trend productivity growth.

Rational Expectations and the Short-Run Phillips Curve

The second hypothesis tested by Hagens and Russell was whether the Carter standards changed the inflation-unemployment trade-off. Using the adaptive expectations approach, Hagens and Russell concluded that the standards had no effect on the slope of the short-run Phillips curve. This same hypothesis will now be tested using the rational expectations approach. Equation (3.9), the price inflation expectations equation estimated above, will be used in the following analysis. A different set of wage inflation equations, however, will be estimated.

The Wage Inflation Equations

In the section dealing with the Carter program bringing wage inflation into line with trend productivity growth, unconstrained wage equation (3.10) and constrained wage equation (3.11) were estimated.

In each equation, the trend productivity variable, TR, was interacted with the dummy variables representing the Kennedy-Johnson guideposts, GUIDPS, the two phases of the Nixon controls, ESP1 and ESP2, and the two phases of the Carter standards, STD1 and STD2.

To test the effects of incomes policies in changing the slope of the short-run Phillips curve, each of the five dummy variables included to represent incomes policies or their phases must be interacted with the variable UNEMRDI, which is the difference between the unemployment rate, U, and the natural unemployment rate, $\overline{U}$.

An incomes policy would ideally steepen the slope of the short-run Phillips curve for increases in the unemployment rate. Steepening the slope for decreases in the unemployment rate would be perverse. Similarly, creating a positively sloped short-run Phillips curve for increases in the unemployment rate would be perverse. Alternatively, it might be hypothesized that the incomes policy would shift the short-run Phillips curve toward the origin, improving the tradeoff in both directions.

Using forecasting equation (3.9), and assuming the inflationary expectations variable in system (3.5) is unlagged, the unconstrained system estimated is

$$\begin{aligned}\dot{C} = {} & d_1 TR + d_2 UNEMRDI + d_3 CHSSTAX + d_4 CHMINWA \\ & + d_5 DATADUM + d_6 GUIDPSUNEMRDI + d_7 ESP1UNEMRDI \\ & + d_8 ESP2UNEMRDI + d_9 STD1UNEMRDI + d_{10} STD2UNEMRDI \\ & + g_1 CONSTANT + g_2 M1L1 + g_3 DUM1 + g_4 CPIL1 \\ & + g_5 BUDL1 + e_t.\end{aligned} \qquad (3.13)$$

If the inflationary expectations variable in system (3.5) is lagged one quarter, system (3.13) would be modified to include the variables M1L2, DUM2, CPIL2, AND BUDL2. Similarly, as the inflationary expectations variable is lagged N additional quarters, M1L, DUM, CPIL, and BUDL are all lagged N additional quarters.

Since system (3.13) is estimated merely to obtain the SSR's used to compute the X^2 statistic for testing the rationality hypothesis, we do not present or discuss these results.

The constrained system estimated is

$$\dot{C} = d_1 TR + d_2 UNEMRDI + d_3 CHSSTAX \tag{3.14}$$

$$+ d_4 CHMINWA + d_5 DATADUM + \sum_{i=0}^{N} b_i CPIL^{e}_{t-1}$$

$$+ d_6 GUIDPSUNEMRDI + d_7 ESP1UNEMRDI + d_8 ESP2UNEMRDI$$

$$+ d_9 STD1UNEMRDI + d_{10} STD2UNEMRDI + e_t,$$

where $e_t = p_1 e_{t-1} + p_2 e_{t-2} + p_3 e_{t-3} + p_4 e_{t-4}$, and

$$CPIL^{e}_{t} = g_1 CONSTANT + g_2 M1L1 + g_3 DUM1 + g_4 CPIL1 + g_5 BUDL1.$$

At the .05 level of significance, rationality cannot be rejected for constrained wage inflation equations (3.14.5), (3.14.6), (3.14.7), (3.14.8), and (3.14.9) presented in Table VII. Note that these equations were estimated without a polynomial distributed lag restriction, and the variable $CPIL^e$ is lagged from quarter t to t-11 in (3.14.5), from t to t-12 in (3.14.6), and so on. Since equation (3.14.5) has the lowest PC, the lag length (12 quarters) used in this equation is most appropriate, and the discussion of the results (presented in Table VII) will focus on this equation.

TABLE VII

CONSTRAINED WAGE INFLATION EQUATIONS FOR INFLATION-UNEMPLOYMENT HYPOTHESIS TEST -- WITHOUT A POLYNOMIAL DISTRIBUTED LAG

Variable	3.14.1 (8 lags)	3.14.2 (9 lags)	3.14.3 (10 lags)	3.14.4 (11 lags)	3.14.5 (12 lags)
TR	1.223* (.204)	1.213* (.195)	1.201* (.193)	1.206* (.192)	1.201* (.2)
UNEMRDI	-.245 (.162)	-.277 (.157)	-.294 (.156)	-.309* (.153)	-.365* (.15)
CHSSTAX	.836* (.214)	.832* (.217)	.798* (.226)	.809* (.232)	.85* (.222)
CHMINWA	.01 (.006)	.011 (.006)	.0118 (.0065)	.0125 (.0064)	.0115 (.0061)
DATADUM	-2.045 (1.149)	-2.071 (1.151)	-2.165 (1.152)	-2.052 (1.153)	-1.804 (1.094)
Σb_i	1.383	1.333	1.328	1.335	1.428
GUIDPSUNEMRDI	.387 (.431)	.394 (.414)	.384 (.406)	.404 (.397)	.471 (.386)
ESP1UNEMRDI	-2.65 (2.099)	-2.625 (2.062)	-2.415 (2.031)	-2.287 (1.975)	-2.378 (1.892)
ESP2UNEMRDI	1.046 (.831)	1.103 (.811)	1.155 (.799)	1.339 (.783)	1.473 (.754)
STD1UNEMRDI	6.71 (5.528)	8.071 (5.617)	8.378 (5.605)	7.294 (5.572)	6.336 (5.324)
STD2UNEMRDI	1.34* (.614)	1.328* (.606)	1.402* (.606)	1.642* (.607)	1.555* (.579)
RHO1	.224* (.096)	.2* (.099)	.18 (.1)	.149 (.1)	.169 (.094)
RHO2	-.082 (.073)	-.091 (.074)	-.099 (.074)	-.081 (.072)	-.101 (.071)
RHO3	.293* (.074)	.29* (.074)	.301* (.075)	.299* (.073)	.315* (.072)

Table VII (Continued)

RHO4	.028 (.07)	.036 (.071)	.041 (.072)	.056 (.07)	.065 (.069)
Adjusted R^2	.7341	.734	.7327	.736	.7533
Standard Error	1.2475	1.2476	1.2506	1.2431	1.2015
q	33	37	41	45	49
X^2	73.466	59.105	77.437	74.416	57.95
Critical X^2	47.4	52.189	56.939	61.653	66.336
PC	---	---	---	---	1.7645

TABLE VII (Continued)

Variable	3.14.6 (13 lags)	3.14.7 (14 lags)	3.14.8 (15 lags)	3.14.9 (16 lags)
TR	1.196*	1.171*	1.193*	1.178*
	(.205)	(.214)	(.211)	(.215)
UNEMRDI	-.378*	-.408*	-.408*	-.408*
	(.155)	(.158)	(.158)	(.158)
CHSSTAX	.852*	.831*	.831*	.824*
	(.224)	(.22)	(.218)	(.221)
CHMINWA	.0116	.0095	.0089	.0088
	(.0062)	(.0063)	(.0064)	(.0064)
DATADUM	-1.813	-1.804	-1.783	-1.695
	(1.109)	(1.093)	(1.096)	(1.102)
Σb_i	1.461	1.537	1.5055	1.5314
GUIDPSUNEMRDI	.491	.498	.522	.51
	(.395)	(.401)	(.402)	(.404)
ESP1UNEMRDI	-2.382	-2.068	-2.288	-2.139
	(1.925)	(1.951)	(1.98)	(1.984)
ESP2UNEMRDI	1.504	1.557*	1.523	1.544*
	(.767)	(.773)	(.779)	(.779)
STD1UNEMRDI	6.07	5.468	5.013	4.877
	(5.394)	(5.331)	(5.369)	(5.386)
STD2UNEMRDI	1.534*	1.5478	1.487*	1.557*
	(.592)	(.593)	(.601)	(.609)
RHO1	.175	.191*	.196*	.199*
	(.096)	(.095)	(.096)	(.098)
RHO2	-.098	-.084	-.087	-.095
	(.071)	(.073)	(.073)	(.073)
RHO3	.309*	.316*	.316*	.322*
	(.072)	(.073)	(.074)	(.074)

TABLE VII (Continued)

RHO4	.071 (.07)	.05 (.07)	.041 (.071)	.045 (.072)
Adjusted R^2	.7499	.7503	.7513	.7486
Standard Error	1.2099	1.2088	1.2065	1.2128
q	53	57	61	65
X^2	58.445	66.535	70.394	73.215
Critical X^2	70.991	75.622	80.23	84.819
PC	1.8016	1.8107	1.8164	1.8481

The dependent variable is $\dot{C}$. The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.
*Significant at the 5 percent level.

The coefficient of TR, the trend productivity variable, is positive (as expected) and statistically significant; it indicates that a one percentage point increase in trend productivity results in a 1.201 percentage point increase in wage inflation, which is not significantly different from its theoretically expected value of one.

The estimated coefficient of UNEMRDI is statistically significant, and it implies that a one percentage point increase in the unemployment rate lowers the rate of wage inflation by .365 percentage points.

The estimated coefficient of CHSSTAX is not statistically different from one, which implies that all of an increase in employment taxes is passed forward in the form of higher prices, and none is passed backward in the form of lower wages.

The fourth variable is the percentage change in the minimum wage. The coefficient is not significantly different from zero, indicating that changes in the minimum wage do not affect the wage inflation rate. Similarly, the coefficient for the fifth variable, DATADUM, is not statistically significant.

The coefficient, $\sum b_i$, indicates that a one percentage point increase in expected inflation results in an increase in wage inflation of about one-and-a-third percentage points.

To determine whether an incomes policy affects the slope of the short-run Phillips curve, a dummy variable which interacts with the difference between the actual and natural unemployment rates (UNEMRDI) is included. The variable GUIDPSUNEMRDI takes into account the effects of the Kennedy-Johnson guideposts on the slope of the short-run Phillips curve. The coefficient for this variable is not significant, indicating that the guideposts did not affect the inflation-unemployment trade-off.

Similarly, the two variables ESP1UNEMRDI and ESP2UNEMRDI represent the two stages of the Nixon controls interacted with UNEMRDI. Neither one of these coefficients is statistically significant, indicating that the Nixon program did not affect the inflation-unemployment trade-off.

The two variables STD1UNEMRDI and STD2UNEMRDI are constructed in a manner similar to that of the three preceding variables. The coefficient for STD1UNEMRDI, representing the dummy variable for the first part of the Carter program interacted with UNEMRDI, is not statistically significant. The coefficient for STD2UNEMRDI, however, is statistically significant. The estimated effect of the program is 1.753 percentage points in the second year, which can be found by multiplying the coefficient (1.402) by the average value of UNEMRDI (1.25) during the second year of the program. Thus, a one percentage point increase in UNEMRDI would cause wage inflation to increase by 1.753 percentage points. As was discussed above, the coefficient for the variable UNEMRDI was negative and significant, and implied that the slope of the short-run Phillips curve was negative. The positive coefficient for the variable STD2UNEMRDI implies that the Phillips curve had a positive slope in the second year of the standards. Thus, the short-run trade-off between wage inflation and unemployment worsened; i.e., an increase in the unemployment rate resulted in higher, rather than lower, wage inflation.

These results conflict with those of Hagens and Russell, who found that the standards did not affect the slope of the short-run Phillips curve. To test the sensitivity of the results presented here, system

(3.14) was re-estimated, with the inflationary expectations variable modeled as a third-degree polynomial distributed lag, with the far endpoint constrained to zero, the same approach that Hagens and Russell used. The lag length was allowed to vary from 11 to 15 quarters.

The results of this procedure are presented in Table VIII. At the .05 significance level rationality cannot be rejected for equations (3.15.1) and (3.15.3). These two equations have, respectively, the same lag lengths as (3.14.4) and (3.14.6). A comparison of the results presented in Table VII and Table VIII suggests that the use of a polynomial distributed lag restriction affects, for a given lag length, whether the null hypothesis of rationality can be rejected. For example, when a lag length of 12 quarters (equation (3.14.5)) is used without the polynomial distributed lag restriction, the null hypothesis of rationality cannot be rejected; however, when this same lag length (equation (3.15.2)) is used with a polynomial distributed lag restriction, the null hypothesis of rationality can be rejected.

A comparison of equations (3.15.1) and (3.15.3) shows that PC is lowest for (3.15.3), which has a lag length of 13 quarters. Thus, our discussion will be centered around equation (3.15.3).

There is a great deal of similarity in the parameter estimates of equations (3.14.5) and (3.15.5), despite the fact that they have different lag lengths (12 and 13 quarters, respectively), and (3.14.5) does not use a polynomial distributed lag restriction while (3.15.3) does.

The only striking difference between these two equations is the greater size of the parameter estimate for STD2UNEMRDI in equation (3.15.3). Returning to equation (3.14.5), the estimated effect of the

TABLE VIII

CONSTRAINED WAGE INFLATION EQUATIONS FOR INFLATION-UNEMPLOYMENT HYPOTHESIS TEST -- WITH A POLYNOMIAL DISTRIBUTED LAG

Variable	3.15.1 (11 lags)	3.15.2 (12 lags)	3.15.3 (13 lags)	3.15.4 (14 lags)	3.15.5 (15 lags)
TR	1.233* (.179)	1.194* (.131)	1.242* (.196)	1.208* (.221)	1.17* (.202)
UNEMRDI	-.273 (.151)	-.326* (.154)	-.321* (.139)	-.409* (.166)	-.384* (.145)
CHSSTAX	.713* (.145)	.743* (.142)	.748* (.135)	.746* (.135)	.737* (.136)
CHMINWA	.0113 (.0063)	.014* (.006)	.0124* (.0057)	.0118 (.006)	.011 (.006)
DATADUM	-1.93 (1.136)	-1.926 (1.1)	-1.916 (1.041)	-1.874 (1.071)	-1.888 (1.077)
$\sum b_i$	1.679	1.282	1.41	1.534	1.561
GUIDPSUNEMRDI	.341 (.366)	.34 (.374)	.471 (.435)	.461 (.425)	.452 (.441)
ESP1UNEMRDI	-1.949 (1.925)	-2.199 (1.885)	-2.249 (1.901)	-2.29 (1.958)	-2.047 (1.989)
ESP2UNEMRDI	.849 (.743)	1.321 (.739)	1.61 (.843)	1.501 (.796)	1.603 (.828)
STD1UNEMRDI	7.304 (5.069)	5.566 (4.869)	3.889 (4.525)	4.99 (4.918)	4.53 (4.871)
STD2UNEMRDI	1.58* (.419)	1.9* (.563)	2.246* (.549)	1.988* (.561)	2.033* (.57)
RHO1	.241* (.079)	.115 (.091)	.15 (.083)	.165 (.086)	.169 (.09)
RHO2	-.055 (.079)	-.089 (.091)	-.08 (.083)	-.072 (.086)	-.063 (.09)
RHO3	.322* (.066)	.306* (.065)	.31* (.062)	.314* (.065)	.296* (.065)

TABLE VIII (Continued)

RHO4	.092 (.065)	.058 (.063)	.084 (.06)	.081 (.064)	.091 (.064)
Adjusted R^2	.6976	.7351	.7358	.738	.7363
Standard Error	1.3302	1.245	1.2435	1.2382	1.2424
q	45	49	53	57	61
X^2	36.201	71.021	62.66	80.585	81.722
Critical X^2	61.653	66.336	70.991	75.622	80.23
PC	2.0265	---	1.771	---	---

The dependent variable is $\dot{C}$. The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.
The variable $CPIL^e$ is lagged using a third-degree polynomial distributed lag, with the far endpoint constrained to zero.
*Significant at the 5 percent level.

second year of the Carter program was shown to be 1.753 percentage points, which was found by multiplying the coefficient (1.402) by the average value of UNEMRDI (1.25) during the second year of the program. In equation (3.15.3), the coefficient for the second year of the program is 2.246. When this is multiplied by the value of UNEMRDI, the estimated effect of the second year of the program is 2.808 percentage points, which implies that a one percentage point increase in UNEMRDI would cause wage inflation to increase by 2.808 percentage points. This result implies that the standards caused a perverse impact on the short-run inflation-unemployment trade-off.

The results presented above do not agree with those of Hagens and Russell, who found that the Carter standards did not affect the slope of the short-run Phillips curve. Thus, in both hypotheses tested so far, the results found here have conflicted with those of Hagens and Russell. With this in mind, we now turn to the third hypothesis tested by Hagens and Russell, the impact of the Carter standards on inflationary expectations.

Rational Expectations and the Deflation of Inflationary Expectations

Using the adaptive expectations approach, Hagens and Russell concluded that the standards lowered inflationary expectations, and thereby directly lowered wage inflation during each of the two phases of the Carter program. This same hypothesis will now be tested using the rational expectations approach. Equation (3.9), the price inflation expectations equation estimated above, will be used in the following analysis. However, a different set of wage equations will be estimated.

The Wage Inflation Equations

To test the effects of incomes policies on inflationary expectations, each of the five dummy variables included in the constrained wage equation to represent incomes policies or their phases must be interacted with the polynomial distributed lag on expected price inflation.[13]

The constrained system takes the form

$$\dot{C} = d_1 TR + d_2 UNEMRDI + d_3 CHSSTAX + d_4 CHMINWA + d_5 DATADUM + \sum_{i=0}^{N} b_{1i} CPIL^{e}_{t-i} + \sum_{i=0}^{N} b_{2i} (CPIL^{e}_{t-i} \cdot GUIDPS) + \sum_{i=0}^{N} b_{3i} (CPIL^{e}_{t-i} \cdot ESP1) + \sum_{i=0}^{N} b_{4i} (CPIL^{e}_{t-i} \cdot ESP2) + \sum_{i=0}^{N} b_{5i} (CPIL^{e}_{t-i} \cdot STD1) + \sum_{i=0}^{N} b_{6i} (CPIL^{e}_{t-i} \cdot STD2) + e_t, \quad (3.16)$$

where $e_t = p_1 e_{t-1} + p_2 e_{t-2} + p_3 e_{t-3} + p_4 e_{t-4}$,

and $CPIL^{e}_{t} = g_1 CONSTANT + g_2 M1L1 + g_3 DUM1 + g_4 CPIL1 + g_5 BUDL1.$

Unfortunately, in this case, the null hypothesis of rationality cannot be tested when the lag length exceeds 4 quarters since an unconstrained wage equation cannot be estimated for a longer lag length. As an example, suppose that $CPIL^e$ is lagged 5 quarters, from i=0 to i=4. Thus, in the unconstrained wage equation, the term

$$\sum_{i=0}^{N} b_{ji} CPIL^{e}_{t-i}$$

would be replaced by 20 variables (ignoring the constant); each of the four variables in $CPIL^e$ for the periods i=0, i=1, i=2, i=3, and i=4. Each of these 20 variables would then need to be interacted with the 5 incomes policies dummy variables included in the wage equation. This alone would account for 120 variables, and since there are only 117 observations, this equation could not be estimated.

The results of the constrained wage equation regressions are presented in Table IX. The variable $CPIL^e$ is lagged from quarter t to t-11 in equation (3.16.1), from quarter t to t-12 in equation (3.16.2), and so on. While the sum of the coefficients of $CPIL^e$ and the coefficients for TR, UNEMRDI, CHSSTAX, CHMINWA, and DATADUM are reasonably stable across these four equations, the coefficients for the dummy variables (representing the incomes policies) that are interacted with the distributed lag on expected price inflation are highly variable. For example, when the lag length being used increases from 12 to 13 quarters, the coefficient for the first part of the Nixon program interacted with the distributed lag becomes almost 4 times as large, and the coefficient for the first part of the Carter program interacted with the distributed lag becomes over 7 times as large.

TABLE IX

CONSTRAINED WAGE INFLATION EQUATIONS FOR INFLATIONARY EXPECTATIONS HYPOTHESIS

Variable	3.16.1 (12 lags)	3.16.2 (13 lags)	3.16.3 (14 lags)	3.16.4 (15 lags)
TR	1.264* (.184)	1.12* (.2)	1.231* (.2)	1.182* (.231)
UNEMRDI	-.28* (.135)	-.312* (.141)	-.354* (.156)	-.334 (.166)
CHSSTAX	.649* (.148)	.58* (.157)	.602* (.15)	.552* (.144)
CHMINWA	.0121* (.0059)	.0116* (.0058)	.0108 (.0056)	.008 (.006)
DATADUM	-1.753 (1.093)	-1.955 (1.09)	-1.668 (1.064)	-2.26* (1.088)
GUIDPS $\cdot$ Σ CPIL^e	-.597	-.785	.398	2.404
ESP1 $\cdot$ Σ CPIL^e	3.316	11.938	7.58	9.549
ESP2 $\cdot$ Σ CPIL^e	.176	-.13	-.551	-1.232
STD1 $\cdot$ Σ CPIL^e	-.25	-1.841	-2.952	-4.5
STD2 $\cdot$ Σ CPIL^e	-.534	-.893	-1.567	-1.044
Σb_i	1.412	1.525	1.514	1.778
RHO1	1.51 (.092)	.17* (.08)	.188 (.096)	.258* (.076)
RHO2	-.064 (.065)	-.07 (.064)	-.067 (.067)	-.054 (.066)
RHO3	.274* (.064)	.272* (.063)	.255* (.063)	.241* (.065)

TABLE IX (Continued)

RHO 4	.066 (.061)	.058 (.059)	.067 (.062)	.076 (.06)
Adjusted R^2	.7273	.7482	.7473	.757
Standard Error	1.2633	1.214	1.216	1.193
PC	1.9641	1.8133	1.8198	1.753

The dependent variable is $\dot{C}$. The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.
*Significant at the 5 percent level.

In equation (3.16.4) (which has the lowest PC), the estimated coefficient of the interacted Kennedy-Johnson guidepost variable implies that this program increased inflation expectations by 240 percent. Since inflation expectations over this period averaged 3.333 percent, this translates into a direct effect on wage inflation of 8.013 percent.

Turning to the Nixon program, the estimated coefficients imply that the first part of the program raised inflation expectations by 955 percent, while the second part of the program lowered inflation expectations by 123 percent. As inflation expectations averaged 7.926 and 7.705 percent, respectively, over these two periods, the direct effects on wage inflation averaged 75.685 percent and -9.493 percent during these periods.

The estimated coefficients of the interacted Carter standards variables imply that inflation expectations were lowered by 450 and 104 percent, respectively, during the two parts of this program. With inflation expectations averaging 12.43 and 15.631 percent, respectively, this translates into a direct effect on wage inflation of -55.935 percent in the first year and -16.319 percent in the second year of the program.

Admittedly, some of the estimates just presented seem much greater in magnitude than what would be theoretically expected and do not make sense. It must be reiterated, however, that the null hypothesis of rationality cannot be tested in the equations of Table IX; therefore it is possible that the null hypothesis could be rejected for equation (3.16.4), but could not be rejected for, say, equation (3.16.1), whose interacted income policies dummy variables coefficients would generally imply that the policies had smaller (in absolute terms) effects on inflation expectations, and smaller (in absolute terms) effects on the rate of wage inflation.

With regard to the Carter program, the qualitative estimates presented directly above are in agreement with those of Hagens and Russell, who found that the standards did reduce inflationary expectations, which caused a reduction in the rate of wage inflation.

Rational Expectations and the Insulation of the Economy from Price Shocks

Hagens and Russell claimed that the main effect of the Carter program was its prevention of the 1979-80 energy-price explosion from being fully passed through to wages. Whether the Carter program actually insulated the economy from the price shocks may now be tested under the assumption of rational expectations. Before any estimations of effectiveness can be undertaken, however, several adjustments must be made in the econometric methodology described earlier in this chapter.

We will begin by using equation (2.8) in conjunction with rational expectations and lagged expectational variables. This equation will be modified, however, to include the data collected for this study rather than the Hagens and Russell data whenever the two data sets differ.[14] Thus, equation (2.8), appropriately modified for the rational expectations framework, becomes

$$\dot{C} = d_1 TR + d_2 UNEMRDI + d_3 CHSSTAX + d_4 CHMINWA + d_5 DATADUM + d_6 GUIDPS + d_7 ESP1 + d_8 ESP2 \quad (3.17)$$

$$+ \sum_{i=0}^{n} s_{1i}\dot{E}^{e}_{t-i} + \sum_{i=0}^{n} s_{2i}\dot{N}^{e}_{t-i}$$

$$+ \sum_{i=0}^{n} s_{3i}\dot{E}^{e}_{t-i}(D_t) + e_t$$

where the terms with a Σ in them are estimated as variable length polynomial lag functions with their far endpoints constrained to zero, $\dot{E}^{e}_{t-i}$ is the expected energy price inflation rate in period_{t-i}, and $\dot{N}^{e}_{t-i}$ is the expected non-energy price inflation rate in period_{t-i}.

To use equation (3.17) in conjunction with rational expectations and lagged expectational variables, separate expectational equations must be estimated for energy price inflation and non-energy price inflation.

The basic expectations equation used so far has been based on equation (3.2)

$$X^{e}_{t} = Z_{t-1}g. \qquad (3.2)$$

Modifying this equation to represent the general form of price inflation expectations, we get

$$CPIL^{e}_{t} = CPIL_{t-1}d + F_{t-1}h, \qquad (3.18)$$

where Z_{t-1} has been separated into price (CPIL) and non-price (F) variables (both which include information known at t-1, t-2, t-3, etc.), and d and h are both vectors of coefficients.

Using the identity $CPIL_t = b_0\dot{E}_t + (1-b_0)\dot{N}_t$, where b_0 is the relative importance of energy prices in the Consumer Price Index, equation (3.18) becomes

$$CPI_t^e = b_0[\dot{E}_{t-1}j + F_{t-1}h_a] \tag{3.19}$$

$$+ (1-b_0)[\dot{N}_{t-1}q + F_{t-1}h_b],$$

where j, q, h_a, and h_b are vectors of coefficients.

Since there is no reason to assume that expectations about energy and non-energy price inflation are formed in the same way, separate equations would have to be estimated for $\dot{E}_t^e$ and $\dot{N}_t^e$. Thus, if

$\dot{E}_t^e = \sum_{i=0}^{m} \dot{E}_{t-i}j_i + \sum_{i=0}^{m} F_{t-i}h_{ai}$, and if $\dot{N}_t^e = \sum_{i=0}^{m} \dot{N}_{t-i}q_i + \sum_{i=0}^{m} F_{t-i}h_{bi}$,

the constrained system of 3 equations to be estimated becomes

$$\dot{E}_t^e = \sum_{i=0}^{m} \dot{E}_{t-i}j_i + \sum_{i=0}^{m} F_{t-i}h_{ai} + a_t \tag{3.20}$$

$$\dot{N}_t^e = \sum_{i=0}^{m} \dot{N}_{t-i}q_i + \sum_{i=0}^{m} F_{t-i}h_{bi} + u_t$$

$$\dot{C}_t = d_1TR + d_2UNEMRDI + d_3CHSSTAX + d_4CHMINWA$$

$$+ d_5DATADUM + d_6GUIDPS + d_7ESP1 + d_8ESP2$$

$$+ \sum_{i=0}^{n} d_{9i}[\dot{E}_{t-i}^e b_0 + (1-b_0)\dot{N}_{t-i}^e]$$

$$+ \sum_{i=0}^{n} d_{10i}\dot{E}_{t-i}^e(D_t) + e_t,$$

where a_t and u_t are error terms which separately may be serially correlated but are both assumed to be uncorrelated with their respective right-hand-side variables, and

$$e_t = p_1e_{t-1} + p_2e_{t-2} + p_3e_{t-3} + p_4e_{t-4}.$$

Since this is a three-equation system, Mishkin's procedure, which constrained the covariances between disturbances in a two-equation model to be zero, will not be used here. Rather, we will proceed under the alternative assumption that the covariances between disturbances are not constrained to be zero. We begin by estimating the energy and non-energy expected price inflation equations.

<u>The Energy and Non-energy Inflation Forecasting Equations</u>

The optimal forecasts for energy and non-energy price inflation are developed by using the procedure used earlier to forecast the overall price inflation rate. Tables X and XI contain the parameter estimates of the expected non-energy and energy price inflation equations, respectively.

The dependent variable in equation (3.21), the non-energy price inflation expectations equation, is the annualized percentage change in the non-energy price index ($\dot{N}$). The independent variables are listed and defined in Table IV.

Using the M1 definition of the money supply, the results indicate that increases in the growth rate of the money supply increase the expected non-energy price inflation rate. Equation (3.21) shows that a one percent increase in M1 in period t-1 (M1L1) results in an increase in the expected non-energy price inflation rate in period t of .295 percent. Looking back at equation (3.9), the expected price inflation equation, we see that a one percent change in M1 in period t-1 has an almost identical effect on price inflation in period t (.294 percent) as it does on non-energy price inflation in period t (.295 percent). Variable DUM1, which corrects for the effects of linking different M1 data series, is insignificant.

TABLE X

EXPECTED NON-ENERGY PRICE INFLATION EQUATION

Variable	3.21
Constant	-.077 (.323)
M1L1	.295* (.053)
DUM1	1.925 (1.849)
BUDL1	.018* (.006)
CHNON1	.762* (.048)
Adjusted R^2	.753
Standard Error	1.814
Durbin h	-1.4534

The dependent variable is $\dot{N}$.
The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.
*Significant at the 5 percent level.

TABLE XI

EXPECTED ENERGY PRICE INFLATION EQUATION

Variable	3.22
Constant	-2.64 (1.75)
CHCRUDP1	-.295* (.079)
CHCRUDM1	-.0266* (.013)
CHCRUDM2	-.041* (.014)
CHPROF1	.046* (.015)
M1L1	-.076 (.273)
M1L2	.939* (.285)
DUM1	-2.424 (8.971)
DUM2	3.221 (8.893)
CHELSAL1	.092 (.049)
CHELSAL2	.182* (.053)
CHECPI1	.476* (.079)
Adjusted R^2	.505
Standard Error	8.689
Durbin h	-.1573

TABLE XI (Continued)

The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.

The dependent variable is E.

*Significant at the 5 percent level.

BUDL1 is the budget surplus for all levels of U.S. government in period t-1. Interpretation of the estimated coefficient of this variable implies that a $100 billion dollar budget surplus results in an increase in the expected non-energy price inflation rate in period t of 1.8 percent.

The variable CHNON1 represents the non-energy price inflation rate in period t-1. The estimated coefficient implies that a one percent increase in non-energy price inflation in period t-1 results in a .762 percent increase in non-energy price inflation in period t.

Equation (3.22), shown in Table XI, was estimated to measure energy price inflation expectations. The dependent variable for this equation is the annualized percentage change in the energy price index ($\dot{E}$). The independent variables are listed and defined in Table IV.

The variable CHCRUDP1 represents the annualized percentage change in U.S. crude oil production in period t-1. The estimated coefficient indicates that a one percentage point increase in crude oil production results in a .295 percentage point decrease in the rate of energy price inflation.

The two variables CHCRUDM1 and CHCRUDM2 represent the annualized percentage change in U.S. crude oil imports in periods t-1 and t-2, respectively. The estimated coefficients indicate that a 10 percentage point increase in crude oil imports in period t-2 would cause a .41 percentage point decrease in the rate of energy price inflation in period t; whereas, a 10 percentage point increase in crude oil imports in period t-1 would cause a .266 percentage point decrease in the rate of energy price inflation in period t.

Increases in after-tax profits from petroleum refining tended to increase the rate of energy price inflation, as is shown by the estimated coefficient of the variable CHPROF1. This variable represents the annualized percentage change in after-tax profits from petroleum refining in period t-1, and the estimated coefficient implies that a 10 percentage point increase in petroleum refining profits in period t-1 resulted in a .46 percentage point increase in the rate of energy price inflation.

Using the M1 definition of the money supply, the results indicate that, for the most part, increases in the growth rate of the money supply take longer to affect the rate of energy price inflation than the rate of non-energy price inflation. Increases in M1 in period t-1 (M1L1) significantly affected the non-energy price inflation rate in period t; however, these same increases in M1 in period t-1 did not significantly affect the energy price inflation rate in period t. On the other hand, increases in M1 in period t-2 did significantly affect the rate of energy price inflation in period t, while increases in M1 in periods earlier than t-1 did not affect the rate of non-energy price inflation in period t (and consequently, were not included in equation (3.21)). The estimated coefficient of M1L2 in equation (3.22) indicates that a one percentage point increase in M1 in period t-2 results in a .939 percentage point increase in the rate of energy price inflation in period t.

The two variables DUM1 and DUM2 are dummy variables that correct for the effects of linking different M1 data series. The change from old M1 to new M1 occurred in 1959:1. Consequently, an error is introduced into the calculation of M1L1 for 1959:2, and an error is introduced into the calculation of M1L2 for 1959:3. To compensate, dummy variables DUM1 and DUM2 are introduced. These dummy variables are insignificant.

The two variables CHELSAL1 and CHELSAL2 represent the annualized percentage rate of change in electricity sales to ultimate consumers in periods t-1 and t-2, respectively. The coefficient for CHELSAL1 is not significant. The coefficient for CHELSAL2 is significant and implies that a ten percentage point increase in electricity sales results in a 1.82 percentage point increase in the rate of energy price inflation.

CHECPI1 represents the annualized percentage rate of increase in energy price inflation in period t-1. Interpretation of the estimated coefficient of this variable implies that a one percentage point increase in energy price inflation in period t-1 results in a .476 percentage point increase in energy price inflation in period t.

The Wage Inflation Equation

After estimation of the non-energy and energy price inflation expectations equations, system (3.20) (see above) can be estimated. The results of the estimated wage equation that tests the hypothesis that the Carter standards prevented the full pass-through of the energy price explosion to wage inflation are presented in Table XII.

The expected rates of non-energy and energy price inflation are lagged from period t to t-11 in equation (3.23.1), from t to t-12 in equation (3.23.2), and so on. Since these were the lag lengths for price inflation that seemed to generate the best results (i.e., the null hypothesis of rationality was not rejected as often for these lag lengths as for other lag lengths), they were used here under the

TABLE XII

CONSTRAINED WAGE INFLATION EQUATIONS FOR ENERGY PRICE SHOCK INSULATION HYPOTHESIS

Variable	3.23.1 (12 lags)	3.23.2 (13 lags)	3.23.3 (14 lags)	3.23.4 (15 lags)
TR	1.108 (.717)	1.076 (.751)	1.035 (.669)	1.029 (.614)
UNEMRDI	-.391 (.653)	-.432 (.347)	-.426 (.587)	-.418 (.571)
CHSSTAX	.725 (.532)	.731 (.528)	.746 (.548)	.742 (.551)
CHMINWA	.007 (.025)	.007 (.025)	.009 (.025)	.009 (.025)
DATADUM	-2.27 (4.477)	-2.246 (4.433)	-1.918 (4.576)	-1.962 (4.605)
GUIDPS	-1.208 (2.131)	-1.227 (2.254)	-.979 (1.928)	-.984 (1.738)
ESP1	.299 (3.01)	.247 (3.13)	.043 (2.828)	.046 (2.656)
ESP2	-1.34 (3.284)	-1.32 (3.375)	-1.515 (3.059)	-1.501 (2.89)
$\Sigma[\dot{E}^e_{t-i} b_0 + (1-b_0)\dot{N}^e_{t-i}]$	1.243	1.285	1.14	1.18
$\Sigma[\dot{E}^e_{t-i} \cdot (D_t)]$	-.194	-.189	-.173	-.17
RHO1	.173 (.397)	.185 (.4)	.056 (.39)	.079 (.37)
RHO2	-.156* (.055)	-.156* (.055)	-.157* (.055)	-.1569* (.0555)

TABLE XII (Continued)

RHO3	.313* (.06)	.313* (.06)	.313* (.06)	.313* (.06)
RHO4	-.049 (.051)	-.049 (.051)	-.051 (.052)	-.051 (.052)
Adjusted R^2	.7082	.7106	.7178	.7167
Standard Error	1.3067	1.3014	1.2852	1.2876
PC	1.9701	1.9542	1.9057	1.9129

The dependent variable is $\dot{C}$.
The sample period is 1954:2 through 1983:2; standard errors are shown in parentheses.
*Significant at the 5 percent level.

assumption of rationality, which could not be tested for system (3.20). Since equation (3.23.3) had the lowest PC, the following discussion will concentrate on the results from that equation. Note that this equation was estimated using a 14 quarter Almon distributed lag.

One apparent problem with the estimates of the coefficients of the variables in equation (3.23.3) (as well as with the other equations in Table XII) is that none of the coefficients, with the exception of some of the RHO coefficients, are significantly different from zero. However, the size of most of the coefficients seems somewhat reasonable, based on the theoretical and/or empirical evidence presented earlier in this paper. For example, the coefficient for TR, the trend productivity variable, is 1.035 in equation (3.23.3), which almost exactly equals its theoretically expected value of one.

Other comparisons can be made, but the main concern is over whether the Carter standards prevented the energy price shock from getting passed through to wage inflation. The coefficient of $\Sigma\, [\dot{E}^{e}_{t-i} \cdot (D_t)]$ (the rate of energy inflation interacted with a dummy variable representing the period of the energy price shock) is negative and is greater, in absolute terms, than the relative importance of energy prices in the CPI (approximately 9.6 percent) during this period. This indicates that the Carter standards did prevent the roughly concurrent 1979-80 energy price shock from getting passed through to wages. This conclusion is in agreement with that of Hagens and Russell, despite their adaptive approach to modeling expectations and their apparent specification errors.

The Effects of Different Data Sets

The final question to be addressed is to what extent the differences in data used in this study and the data used in the Hagens and Russell study affected the estimated coefficients. In response to this question, equation (2.8), which is Hagens and Russell's equation (1.7) with the specification errors corrected, was re-estimated using the author's data, and is presented as equation (3.24) in Table XIII. Equation (2.8) is reproduced for the reader's convenience in Table XIII.

There are three variables in these two equations for which the data differed. There is virtually no difference in the estimated coefficients of the trend productivity variable, and the coefficients of the variables representing the difference between the unemployment rate and natural unemployment rate differ by only 0.055. However, the coefficients of the annualized percentage rate of change in social security taxes differed by 0.317, or about 30 percent. It should be noted that the differences in data did not affect the significance of the coefficients for any of these three variables.

On the other hand, the data used for the annualized percentage rate of change in the minimum wage were the same in these two equations, but the coefficient is significantly different from zero when the other Hagens and Russell data are used and it is not significantly different from zero when the author's data are used.

Two other results deserve mentioning. First, when the author's data are used, the coefficients for DATADUM, GUIDPS, ESP1, and ESP2 are all larger (in absolute terms) than when Hagens and Russell's data are

TABLE XIII

ADAPTIVE EXPECTATIONS WAGE EQUATIONS ESTIMATED WITH DIFFERENT DATA SETS

Hagens and Russell's Variable	Equation (2.8) Coefficients	Author's Variable (where different)	Equation (3.24) Coefficients
R	1.161* (16.231)	TR	1.168* (13.457)
$U-\overline{U}$	-0.592* (-7.046)	UNEMRDI	-0.537* (-4.989)
DATADUM	-1.381 (-1.502)		-1.654 (-1.407)
HRCHSSTAX	1.038* (8.239)	CHSSTAX	0.721* (4.651)
CHMINWA	0.021* (4.24)		0.007 (1.157)
GUIDPS	-0.625* (-2.482)		-0.672* (-2.085)
ESP1	0.45 (0.976)		0.80 (1.35)
ESP2	-0.616 (-1.27)		-0.957 (-1.557)
$L(\dot{E}_{t-i})$	0.007 (1.069)		-0.002 (-0.206)
$^{a}L(\dot{N}_{t-i})$	0.88* (24.954)		0.902* (20.025)
$L(\dot{E}_{t-i})D_t$	-0.121* (-7.213)		-0.14* (-6.489)
Adjusted R^2	0.982		0.97

TABLE XIII (Continued)

Standard Error	0.889	1.136
Durbin-Watson	1.698	1.954

The sample period is 1954:2 through 1983:2; t-statistics are shown in parentheses. Hagens and Russell's dependent variable is $\dot{W}$, the dependent variable in the author's equation is $\dot{C}$.
L( ) connotes a third-degree polynomial distributed lag, with the far endpoint constrained to zero. The lag length is 12 quarters, starting with the variable lagged 1 quarter.
*Significant at the 5 percent level.

[a]Hagens and Russell did not include a non-energy price inflation variable in their misspecified equation (1.7), this variable is the author's and not Hagens and Russell's.

used. The statistical significance (or lack of) for these coefficients was not affected by the data differences. Second, when the author's data are used, there is very little effect on the size of the coefficients for the energy and non-energy price inflation variables, or their statistical significance (or lack of). However, the sign of the coefficient for the annualized rate of change of energy prices (which is very small) changes from positive to negative (but remains statistically insignificant) when the author's data are used in place of Hagens and Russell's.

Thus, the data differences had no effect on the hypothesis being tested; i.e., regardless of the data set being used in the adaptive expectations model, the Carter standards prevented the energy price shock from getting passed through to wages, as is shown by the negative coefficient for $L(\dot{E}_{t-i})D_t$.

Conclusion

While the econometric results presented here are only in partial agreement with those of Hagens and Russell, these results do tend to confirm what Hagens and Russell labeled as their principal conclusion; i.e., for one reason or another, the energy price shock of 1979-80 was not passed through to wages in the usual manner. There may have been factors other than the Carter standards, however, that caused this result. Casual observation suggests that there was a simultaneous reduction in the wage inflation rate in other countries during the 1979-80 period. Was this simply a common response to this international price shock, or was it due to some fundamental structural change that took place during this period? If this was a common response, to what extent was this the result of the Carter standards? Questions like this are beyond the scope of this paper. What we have shown here is that, using two alternative expectations hypotheses, the hypothesis that the Carter standards prevented the energy price shock from getting passed through to wage inflation could not be rejected. Will this conclusion receive the same level of support at the industry level as it has at the aggregate level? That is the topic of the next chapter.

ENDNOTES

[1]John F. Muth, "Rational Expectations and the Theory of Price Movements," Econometrica, 29 (July 1961), pp. 315-35.

[2]The methodology relies heavily on Mishkin's A Rational Expectations Approach to Macroeconometrics (Chicago: University of Chicago Press, 1983).

[3]C. W. J. Granger, "Investigating Causal Relationships by Econometric Models and Cross-Spectral Methods," Econometrica, 37 (1969), pp. 424-38.

[4]Mishkin, pp. 17-20.

[5]Mishkin, pp. 20-21.

[6]When the high employment budget surplus is used in place of the actual budget surplus, the variable proves to be insignificant.

[7]Robert J. Gordon, Macroeconomics (Boston: Little, Brown and Co., 1987), p. 216.

[8]For more detail on this point, see John B. Taylor, "Staggered Wage Setting in a Macro Model," American Economic Review, 69 (May 1979), pp. 108-113.

[9]Takeshi Amemiya, "Selection of Regressors," International Economic Review, 21 (June 1980), pp. 331-54.

[10]Robert J. Gordon, "The End-of-Expansion Phenomenon in Short-Run Productivity Behavior," Brookings Papers on Economic Activity, 2 (1979), pp. 447-461.

[11]As discussed in the section on the Hagens and Russell study, the earlier studies did not include interaction terms for the various programs. Despite their criticism of this approach, Hagens and Russell include an interaction variable for the Carter pay and price standards only.

[12]The estimates for the trend rate of productivity used here differ from those used by Hagens and Russell. They estimate that trend productivity during the first part of the Carter program was 1.32 percent, and 1.26 percent during the second part. These differences may be due to several factors. First, the data used here are more recent than Hagens and Russell's. Second, the period of estimation is different. Hagens and Russell estimate trend productivity from 1953:1 to 1980:3; whereas, the estimation period used here is 1953:1 to 1983:4. Third, Hagens and Russell estimated trend productivity by regressing the percentage change in productivity on CHGAP (defined as the annualized percentage change in ((Potential GNP - Actual GNP)/Potential GNP) x 100, $CHGAP_{-1}$, TIME, and DEOE, and using fitted

values setting CHGAP, $CHGAP_{-1}$, and DEOE equal to zero. Alternatively, in this study trend productivity is estimated based more on Gordon's (1979) original specification; i.e., the percentage change in productivity is regressed on CHQ (defined as the annualized percentage change in (Actual GNP/Natural GNP), CHQ_{-1}, CHQ_{-2}, TIME, and DEOE, and using the fitted values setting CHQ, CHQ_{-1}, CHQ_{-2}, and DEOE equal to zero. Their estimates of Potential GNP are supplied by the Council on Economic Advisors; the estimates of Natural GNP used here are supplied by Robert Gordon (1984). Finally, one of the explanatory variables used in the estimation of trend rate of productivity growth, the end-of-expansion dummy as originally described by Gordon (1979), was specified in a slightly different way here than it was in Hagens and Russell, although it is not clear exactly how they specified their dummy. According to Gordon, employers engage in overhiring beginning in the quarter after the quarter when the ratio of real GNP(Q) to natural real GNP(Q*) reaches its peak. Since managers eventually recognize that this overhiring has occurred and take corrective action, the dummy variable is constructed to take on positive values for M quarters following the quarter when Q/Q* reaches its peak, and to take on negative values for N quarters thereafter. The variable is constrained to sum to zero over any given business cycle. An additional constraint is imposed by setting the values of M and N equal to the same number for each cycle. Gordon identifies five Q/Q* peaks between 1954 and 1979, these occurred in 1955:4, 1959:2, 1968:3, 1973:1, and 1978:4. Gordon set M equal to 6 and N equal to 8 for the last 4 cycles identified, and set M equal to 4 quarters and N equal to 6 quarters for the period that began with the Q/Q* peak in 1955:4, thus violating his constraint of always having M and N equal to the same number for each cycle. The larger value of N reflects the tendency of firms to take their corrective action over a longer period than the time taken for their overstaffing to occur.

The period of estimation used in this study includes years before 1954 and after 1979, however. Thus, two additional peak quarters were identified, 1953:2 and 1981:1. Given Gordon's own use of a shorter lag after the 1955:4 peak, and the fact that M and N could not sum to 14 quarters after either the 1953:2, 1978:4, or 1981:1 peak (given that the estimation period ended in 1983:4), the exceptions to the 14 quarter lag would outnumber the rule. Thus, M and N were constrained here to be equal to the same number for each cycle by taking the shortest peak to peak period, 1978:4 to 1981:1, a total of nine quarters, and, in staying with Gordon's argument that M<N, assigning M a length of 4 quarters and N a length of 5 quarters. For example, the dummy variable is defined as one-fourth for the first four quarters following each peak and as minus one-fifth for the subsequent five quarters.

[13] Attempts to estimate constrained wage equations without using a polynomial distributed lag restriction caused the computer program (SAS) to set some of the parameters to constants. This appeared to be caused

by the large number of parameters that would have to be estimated, since changes in the lag length being used changed the parameters and the number of parameters that were being set to constants.

[14] All previous work done in this chapter used the data collected for this study rather than the Hagens and Russell data whenever the two data sets differed.

CHAPTER IV

ASSESSING THE EFFECTIVENESS OF THE CARTER STANDARDS AT THE INDUSTRY LEVEL

Introduction

All previous empirical studies of the effectiveness of the Carter standards have concentrated on the impact of the standards at the aggregate level. In the last chapter it was argued that the main effect of the standards at the aggregate level was their prevention of the 1979-80 energy price shock from getting passed through to wages in the usual manner. In this chapter we will empirically investigate whether the standards prevented the energy price shock from passing through to wages at the industry level. A conclusion that the standards were successful in preventing the price shock from getting passed through to wages would lend additional support to the notion that the Carter standards provided the economy with some real benefits, while a conclusion that the standards were not successful at the industry level would leave the question of the effectiveness of the standards in preventing the pass through of the energy price shock unanswered.

Data Availability and the Selection of Industries

The initial decision that had to be made was which 2-digit SIC industries would be used in investigating the extent to which the

Carter standards prevented the pass through of the 1979-80 energy price shock to wages at the industry level. The availability of data was the main factor in determining which of the major industry groups may be analyzed.

In the previous chapter, system (3.20) was estimated to determine if the Carter standards were successful in preventing the pass through of the 1979-80 energy price shock to wages in the usual manner. Ignoring the non-energy and energy inflation forecasting equations, as well as the error terms of system (3.20), we have the wage inflation equation

$$\begin{aligned} \dot{C}_t = {} & d_1 TR + d_2 UNEMRDI + d_3 CHSSTAX \\ & + d_4 CHMINWA + d_5 GUIDPS + d_6 ESP1 + d_7 ESP2 \\ & + \sum_{i=0}^{n} d_{8i} [\dot{E}^e_{t-i} b_0 + (1-b_0) \dot{N}^e_{t-i}] \\ & + \sum_{i=0}^{n} d_{9i} \dot{E}^e_{t-i} (D_t). \end{aligned} \tag{4.1}$$

The difference between the actual unemployment rate and Gordon's natural unemployment rate (UNEMRDI) is one of the explanatory variables included in the above wage inflation equation. In the wage equations that are estimated in this chapter, that particular variable is replaced by IUNEMRDI, which represents the difference between an industry's unemployment rate and Gordon's natural unemployment rate. This variable imposes a limit of fifteen industry wage inflation equations that can be estimated, since the government has consistently reported the unemployment rate by major industry group for only fifteen 2-digit manufacturing industries. Furthermore, the period of time over which these equations can be estimated is more limited at the industry level than it is at the aggregate level because all industry unemployment rates reported before 1966 were based on data for persons 14 years of age and older, whereas, the unemployment rates reported for 1966 and all following years were based on data for persons 16 years of age and older. The U.S. Department of Labor has not adjusted the industry unemployment rates for the earlier years so that these rates are consistent with the definition of unemployment for the later time period.

The variable TR in equation (4.1) represents the trend rate of productivity growth. In the empirical work in the previous chapter, the variable TR was obtained by regressing CHPROD on CHQ, CHQ_{-1}, CHQ_{-2}, TIME and DEOE (these variables were defined in Table IV), and using the fitted values setting CHQ, CHQ_{-1}, CHQ_{-2}, and DEOE equal to zero. One problem that must be dealt with at the industry level is that most of the variables needed for estimating trend productivity growth do not exist as such and must be generated from other variables. The government does not calculate output per man-hour for 2-digit manufacturing industries, although the government does calculate this for some 4-digit manufacturing industries. Therefore, this variable had to be created. This was done for each 2-digit industry by dividing each quarter's monthly average of the Federal Reserve Board's Industrial Production Index (IPI) for that industry by the product of that industry's number of employees (L) multiplied by that industry's average labor hours per week (AH) for the quarter. Thus, an industry's productivity, IP, is equal to IPI/(L*AH).

The variable CHQ must also be created at the industry level. At the aggregate level, CHQ is the annualized percentage change in (GNP/NATRGNP) where NATRGNP represents natural real GNP and GNP represents real GNP. Gordon's original construction of natural real GNP involved the use of an adjusted unemployment rate that was obtained by dividing the number of unemployed persons by the civilian labor force net of self-employed persons. A similarly adjusted unemployment rate for each industry cannot be computed since the number of self-employed persons in each 2-digit manufacturing industry cannot be ascertained. As a result, we chose to compute natural output for each industry in a manner similar to how potential GNP is computed. If full employment is defined as a 5 percent unemployment rate, for example, quarterly potential GNP can be estimated by multiplying 95 percent of the labor force times the average hours of work per quarter (AHQ) times the average output per man-hour for the quarter (PROD). Substituting Gordon's natural unemployment rate ($\overline{U}$) for the full employment unemployment rate with the relevant industry labor force, ILF, industry average hours of work for the quarter, QAH, and industry output per man-hour, IP, being substituted for their respective corresponding aggregate variables gives us what will be called industry natural output (INO).

Thus,

$$INO = (1-\overline{U}) * ILF * QAH * IP.$$

An industry's actual quarterly output (IAO) can be determined by multiplying that industry's employed labor force (which is the equivalent of (1-U) for the industry multiplied by the industry's total labor force (ILF)) times the industry's average hours of work for the quarter (QAH) times the industry's average output per man-hour (IP).

Thus,

$$IAO = (1-U) * ILF * QAH * IP.$$

Our objective was to find an industry level variable that could be substituted for the aggregate level variable Q, which equals (GNP/NATRGNP). What we have derived is IQ, which is defined as being equal to (IAO/INO). Substituting, we find that

$$IQ = \frac{(1-U) * ILF * QAH * IP}{(1-\bar{U}) * ILF * QAH * IP} = \frac{1-U}{1-\bar{U}}.$$

At the industry level, the variable IQ will be used in place of Q. As shown directly above, we can find IQ simply by dividing 1 minus the unemployment rate by 1 minus the natural unemployment rate.

DEOE is the other variable that must be constructed before the trend rate of productivity growth can be estimated. At the aggregate level, DEOE was defined as one-fourth for the first four quarters following each peak of (GNP/NATRGNP) and as minus one-fifth for the subsequent five quarters and as zero at all other times. Due to the substitution, at the industry level, of the variable IQ for the variable Q, DEOE will be replaced by IDEOE, which will be defined for each industry as one-third for the first three quarters following each peak in that industry's IQ and as minus one-fourth for the subsequent four quarters and as zero for all other times. For each industry, there tended to be more peaks in IQ than in the economy's Q, which resulted in IDEOE having a non-zero value for just the first seven quarters following a peak in IQ; whereas, DEOE had a non-zero value for the first nine quarters following a peak in Q.

Once an industry's IQ, IDEOE, and its output per man-hour (IP) have been calculated, trend productivity can be estimated for that industry by regressing the annualized percentage change in output per man-hour (CHIP) on the annualized percentage change in IQ (CHIQ), its values lagged one quarter ($CHIQ_{-1}$) and two quarters ($CHIQ_{-2}$), IDEOE, and TIME (where TIME equals 1 for the first quarter trend productivity is being estimated for, 2 for the second quarter, and so on), and using the fitted values setting CHIQ, $CHIQ_{-1}$, $CHIQ_{-2}$, and IDEOE equal to zero. The variable TR is then replaced in equation (4.1) by ITR, which represents an industry's trend rate of productivity growth.

The variable $\dot{C}$ in equation (4.1) represents the annualized percentage change in pay, where pay is defined as being the product of the hourly earnings index of production workers in the private nonfarm sector multiplied by the ratio of aggregate compensation of employees to aggregate wages and salaries. At the industry level, the data for average hourly earnings excluding overtime (IAHE) are readily available on a quarterly basis, as was the case at the aggregate level. Each industry's total compensation of employees (IWSS) and total wages and salaries (IWS), however, are not available on a quarterly basis, but are only available on an annual basis. As a result, the annual data were converted into quarterly data by assuming that each industry's total employee compensation and total wages and salaries have the same quarterly-to-annual ratio as is found in the aggregate data. For example, suppose that in the first quarter of some given year the aggregate amount of total employee compensation (measured at an annual rate) is 98 percent of the total annual employee compensation for that year. Thus, each industry's employee compensation for that same quarter (measured at annual rate) would be set at 98 percent of the annual amount. This same procedure was used for every quarter of every year that required this data. Every method used to convert annual data to quarterly data is necessarily ad hoc, and the procedure used above is no exception. Hopefully, the procedure used above does reflect, to a large degree, changes that were occurring in the national economy that may have been affecting these manufacturing industries. One drawback to this procedure, however, is that aggregate employee compensation and aggregate wages and salaries may be increasing or decreasing at a rate that is faster or slower than the respective industry measures. As a result, at the industry level there could be some exaggeration of the changes in these two variables, particularly between the fourth quarter of any given year and the subsequent first quarter. To counteract this problem, the data for these two variables were exponentially smoothed, using both light and moderate smoothing.[1] In the empirical results reported below, it will be indicated whether light or moderate smoothing was being used. The variable $\dot{C}$ is then replaced in equation (4.1) by $I\dot{C}$, which represents an industry's annualized percentage change in pay.

The final aggregate variable in equation (4.1) that has to be replaced by an industry variable is CHSSTAX, which is the annualized percentage change in (1/(1-TWER/WS)) where TWER represents aggregate employer contributions for social insurance, and WS represents aggregate wages and salaries. Quarterly data for industry employer contributions for social insurance are not available; therefore, this variable had to be created for each of the fifteen 2-digit industries.

This variable was created for each industry by assuming that the proportion of the difference between aggregate compensation of employees and aggregate wages and salaries that was accounted for by aggregate employer contributions for social insurance is the same for each industry as it is at the national level; that is, each industry's employer contributions for social insurance (ITWER) is computed from the equation (TWER/(WSS-WS)) = (ITWER/(IWSS-IWS)), where IWSS is an industry's exponentially smoothed compensation of employees and IWS is an industry's exponentially smoothed wages and salaries. The variables TWER, WSS, WS, IWSS, and IWS are known and the above equation can be solved for ITWER for each quarterly observation in each industry. CHSSTAX in equation (4.1) is then replaced by ICHSSTAX, where ICHSSTAX is the annualized percentage change in (1/(1-ITWER/IWS)). All variables used in the empirical analysis in this chapter that have not been previously defined are listed and defined in Table XIV.

$\dot{C}$, TR, UNEMRDI, and CHSSTAX were the variables in equation (4.1) that had to be replaced by industry level variables to test whether the Carter standards prevented the energy price shock of 1979-80 from getting passed through to wages in the usual manner at the industry level. System (3.20) (equation (4.1) is the wage equation from that 3 equation system) was estimated to test this energy price shock hypothesis at the aggregate level in the previous chapter. Replacing the aggregate level variables $\dot{C}$, TR, UNEMRDI, and CHSSTAX with their corresponding industry level variables $I\dot{C}$, ITR, IUNEMRDI, and ICHSSTAX in system (3.20) would result in system

TABLE XIV

VARIABLES

Variable	Definition	Source
APP	Apparel and other finished products made from fabrics and similar materials -- SIC 23	
CHEM	Chemicals and allied products -- SIC 28	
ELEC	Electrical and electronic machinery, equipment, and supplies -- SIC 36	
FAB	Fabricated metal products, except machinery and transportation equipment -- SIC 34	
FOOD	Food and kindred products -- SIC 20	
FURN	Furniture and fixtures -- SIC 25	
LUMBER	Lumber and wood products, except furniture -- SIC 24	
MACH	Machinery, except electrical -- SIC 35	
PAPER	Paper and allied products -- SIC 26	
PRIM	Primary metal industries -- SIC 33	
PRINT	Printing, publishing, and allied industries -- SIC 27	
RUBBER	Rubber and miscellaneous plastics products -- SIC 30	
STONE	Stone, clay, glass, and concrete products -- SIC 32	
TEXT	Textile mill products -- SIC 22	
TRAN	Transportation equipment -- SIC 37	
IUNEMRDI	The difference between the industry unemployment rate (U) and Gordon's natural unemployment rate ($\overline{U}$)	

TABLE XIV (Continued)

U	An industry's unemployment rate	1966:1 - 1983:2: Bureau of Labor Statistics; 1983:3 - 1985:3: Employment and Earnings
ITR	An industry's estimated trend rate of productivity growth, obtained by regressing CHIP on CHIQ, $CHIQ_{-1}$, $CHIQ_{-2}$, IDEOE, and TIME, and using the fitted values setting CHIQ, $CHIQ_{-1}$, $CHIQ_{-2}$, and IDEOE equal to zero, the period of estimation being 1966:4 - 1985:4	
CHIP	Annualized percentage change in IP	
IP	An industry's output per man-hour, equal to (IPI/(L*AH))	
IPI	Industrial Production Index for an Industry	Federal Reserve Board
L	Number of employees for an industry	1966:1 - 1984:2: Employment, Hours, and Earnings, U.S. 1909-84; 1984:3 - 1985:3: Survey of Current Business
AH	Average labor hours per week (during a quarter) for an industry	1966:1 - 1984:2: Employment, Hours, and Earnings, U.S. 1909-84; 1984:3 - 1985:3: Survey of Current Business
CHIQ	Annualized percentage change in an industry's IQ	
IQ	Equal to $\frac{1 - U}{1 - \overline{U}}$	

TABLE XIV (Continued)

IDEOE	End-of-expansion dummy, equal to one-third for the first three quarters following a peak in an industry's IQ; minus one-fourth for the subsequent four quarters	Constructed in a manner similar to Gordon's (1979) original specification
TIME	1 for 1966:4, 2 for 1967:1, and so on	
$\dot{IC}$	An industry's annualized percentage change in PAY	
PAY	Equal to IAHE * (IWSS/IWS)	
IAHE	An industry's average hourly earnings, excluding overtime	1966:1 - 1984:2: *Employment, Hours, and Earnings, U.S. 1909-84*; 1984:3 - 1985:3: *Survey of Current Business*
IWSS	An industry's compensation of employees; created by converting annual data to quarterly data by methods described in the text	*Survey of Current Business*
ICHSSTAX	An industry's annualized percentage change in (1/(1-ITWER/IWS))	
ITWER	An industry's employer contributions for social insurance, created by assuming ITWER = ((IWSS - IWS) * TWER)/(WSS-WS)	

$$\dot{E}^e_t = \sum_{i=0}^{m} \dot{E}_{t-i} j_i + \sum_{i=0}^{m} F_{t-i} h_{ai} + a_t \qquad (4.2)$$

$$\dot{N}^e_t = \sum_{i=0}^{m} \dot{N}_{t-i} q_i + \sum_{i=0}^{m} F_{t-i} h_{bi} + u_t$$

$$\dot{IC}_t = d_1 ITR + d_2 IUNEMRD1 + d_3 ICHSSTAX$$

$$+ d_4 CHMINWA + d_5 GUIDPS + d_6 ESP1 + d_7 ESP2$$

$$+ \sum_{i=0}^{n} d_{8i} [\dot{E}^e_{t-i} b_0 + (1-b_0) \dot{N}^e_{t-i}]$$

$$+ \sum_{i=0}^{n} d_{9i} \dot{E}^e_{t-i} (D_t) + e_t,$$

where a_t and U_t are error terms which separately may be serially correlated but are both assumed to be uncorrelated with their respective right-hand-side variables, and

$$e_t = P_1 e_{t-1} + P_2 e_{t-2} + P_3 e_{t-3} + P_4 e_{t-4}.$$

The first two equations in this system represent the energy and non- -ergy inflation forecasting equations, respectively, while the third equation represents the wage inflation equation. Note that the variable DATADUM, which was included in system (3.20) to correct for linking different data series in the aggregate part of this study, is no longer necessary and is not included in system (4.2). As noted above, a lack of data means the wage inflation equations estimated for 2-digit industries cannot be estimated over the same time period that was used for estimation of the aggregate wage inflation equation. Thus, both the non-energy and energy inflation forecasting equations originally estimated in system (3.20) have to be re-estimated over the time period for which the 2-digit industry wage inflation equations will be estimated.

Inflation Forecasting Equations

The optimal forecasts for energy and non-energy price inflation are developed by using the procedure used in the previous chapter to forecast these components of overall price inflation. Tables XV and XVI contain the parameter estimates of the expected non-energy and energy price inflation equations, respectively. All variables included in these two tables were originally defined in Table IV, and retain their original meaning in this chapter. Due to differences in data availability at the 2-digit industry level, the wage equations being estimated for the fifteen manufacturing industries will be estimated over one of two time periods, either 1967:1 through 1985:3, or 1968:4 through 1985:3, with the longer time period being used whenever the data allows. Due to the wage equations being estimated over two different time periods, the non-energy and energy price inflation forecasting equations must be estimated over the same two time periods.

Equation (4.3.1) is estimated over the 1967:1 through 1985:3 time period, while equation (4.3.2) is estimated over the 1968:4 through 1985:3 time period. The dependent variable in both equations is the annualized percentage change in the non-energy component of the consumer price index. The estimated coefficients are presented in Table XV.

Using the M1 definition of the money supply, the results indicate that a one percent increase in M1 in period t-1 (M1L1) results in an increase in the expected non-energy price inflation rate in period t of .295 and .292 for the longer and shorter time periods, respectively.

TABLE XV

EXPECTED NON-ENERGY PRICE INFLATION EQUATIONS

Variable	4.3.1	4.3.2
Constant	.303 (.822)	.553 (.99)
M1L1	.295* (.072)	.292* (.078)
BUDL1	.017* (.005)	.018* (.005)
CHNON1	.729* (.077)	.709* (.089)
Adjusted R^2	.636	.614
Standard Error	1.87	1.917
Durbin h	-.6637	-.4262

The dependent variable is $\dot{N}$.
The sample period is 1967:1 through 1985:3 for equation 4.3.1, and 1968:4 through 1985:3 for equation 4.3.2, standard errors are shown in parentheses.
*Significant at the 5 percent level.

BUDL1 is the budget surplus for all levels of U.S. government in period t-1. Interpretation of the estimated coefficients of this variable implies that a $100 billion dollar budget surplus results in an increase in the expected non-energy price inflation rate in period t of 1.7 and 1.8 percent for the longer and shorter time periods, respectively.

The variable CHNON1 represents past non-energy price inflation rates. A one percent increase in the non-energy component of the CPI in period t-1 results in an increase in the expected non-energy price inflation rate in period t of .729 percent and .709 percent for the longer and shorter time periods, respectively.

Equations (4.4.1) and (4.4.2), shown in Table XVI, were estimated to measure energy price inflation expectations for the 1967:1 through 1985:3 and 1968:4 through 1985:3 time periods, respectively. The dependent variable for both equations is the annualized percentage change in the energy price index ($\dot{E}$).

The variable CHCRUDP1 represents the annualized percentage change in U.S. crude oil production in period t-1. The estimated coefficient indicates that a one percentage point increase in crude oil production results in a .263 and .363 percentage point decrease in the rate of expected energy price inflation in period t for the longer and shorter time periods, respectively.

The two variables CHCRUDM1 and CHCRUDM2 represent the annualized percentage change in U.S. crude oil imports in periods t-1 and t-2, respectively. The estimated coefficients for CHCRUDM1 indicate that a 10 percentage point increase in crude oil imports in period t-1 results in a .33 percentage point decrease in the rate of expected energy price

TABLE XVI

EXPECTED ENERGY PRICE INFLATION EQUATIONS

Variable	4.4.1	4.4.2
Constant	6.095* (1.654)	6.785* (1.819)
CHCRUDP1	-.263* (.131)	-.363* (.182)
CHCRUDM1	-.033* (.016)	-.032 (.017)
CHCRUDM2	-.049* (.018)	-.056* (.019)
CHPROF1	.086* (.023)	.094* (.025)
CHECPI1	.332* (.105)	.296* (.111)
Adjusted R^2	.401	.405
Standard Error	11.427	11.81
Durbin h	-.6119	-.7216

The dependent variable is $\dot{E}$.
The sample period is 1967:1 through 1985:3 for equation 4.4.1 and 1968:4 through 1985:3 for equation 4.4.2, standard errors are shown in parentheses.
*Significant at the 5 percent level.

inflation in period t in the longer of the two estimation periods; however, changes in crude oil imports in period t-1 did not significantly affect the rate of expected energy price inflation in period t in the shorter of the two estimation periods. The estimated coefficients for CHCRUDM2 indicate that a 10 percentage point increase in crude oil imports in period t-2 results in a .49 and .56 percentage point decrease in the rate of expected energy price inflation in period t for the longer and shorter estimation periods, respectively.

Increases in after-tax profits from petroleum refining tended to increase the rate of expected energy price inflation, as is shown by the estimated coefficients of the variable CHPROF1. This variable represents the annualized percentage change in after-tax profits from petroleum refining in period t-1, and the estimated coefficients imply that a 10 percentage point increase in petroleum refining profits in period t-1 resulted in a .86 and .94 percentage point increase in period t in the rate of expected energy price inflation for the longer and shorter estimation periods, respectively.

CHECPI1 represents the annualized percentage rate of increase in energy price inflation in period t-1. Interpretation of the estimated coefficients of CHECPI1 implies that a one percentage point increase in energy price inflation in period t-1 results in a .332 and .296 percentage point increase in expected energy price inflation in period t for the longer and shorter estimation periods, respectively.

Wage Inflation Equations

Using non-energy price inflation forecasting equation (4.3) and energy price inflation forecasting equation (4.4), the constrained wage inflation system is estimated as

$$\dot{IC}_t = d_1 ITR + d_2 1UNEMRD1 + d_3 1CHSSTAX + d_4 CHM1NWA + d_5 GUIDPS + d_6 ESP1 + d_7 ESP2 + \sum_{i=0}^{n} d_{8i} [\dot{E}^e_{t-i} b_0 + (1-b_0) \dot{N}^e_{t-i}] + \sum_{i=0}^{n} d_{9i} [\dot{E}^e_{t-i} (D_t)] + e_t \qquad (4.5)$$

where $e_t = P_1 e_{t-1} + P_2 e_{t-2} + P_3 e_{t-3} + P_4 e_{t-4}$,

$$\dot{E}^e_t = g_1 + g_2 CHCRUDP1 + g_3 CHCRUDM1 + g_4 CHCRUDM2 + g_5 CHPROF1 + g_6 CHECPI1, \text{ and}$$

$$\dot{N}^e_t = h_1 + h_2 M1L1 + h_3 BUDL1 + h_4 CHNON1.$$

At the aggregate level, the wage equation that was used to test the hypothesis that the Carter standards prevented the full pass-through of the energy price explosion to wage inflation had its lowest PC when the expected rates of non-energy and energy price inflation were lagged from period t to t-13. Due to this result, the wage equations used to test the energy price shock hypothesis at the 2-digit industry level are estimated using the same lag length; i.e., from period t to t-13. The results of the estimated wage equations for the fifteen 2-digit industries being used are presented in Table XVII and Table XVIII. The results presented in Table XVII are for the industry wage inflation equations where the quarterly data for each industry's total compensation and total wages and salaries (necessary for computing pay and the annualized percentage change in pay, which is the dependent variable in the wage inflation equations) were created from annual data

TABLE XVII

CONSTRAINED INDUSTRY WAGE INFLATION EQUATIONS WHEN INDUSTRY COMPENSATION AND WAGES AND SALARIES ARE LIGHTLY SMOOTHED

Variable	APP[a]	CHEM[a]	ELEC[a]	FAB[a]	FOOD[a]
ITR	1.11 (2.824)	2.404 (1.753)	1.267 (1.295)	.146 (2.647)	3.58 (1.884)
IUNEMRDI	-.219 (.518)	1.338 (.809)	.493 (.497)	.156 (.954)	1.955* (.799)
ICHSSTAX	.104 (.246)	-.149 (.25)	.009 (.097)	-.041 (.219)	-.297* (.128)
CHMINWA	.154* (.052)	.098 (.05)	.02 (.048)	.023 (.118)	.034 (.05)
GUIDPS	3.044 (11.119)	283.616* (14.673)	2.787 (9.814)	.546 (5.479)	1.465 (10.39)
ESP1	.024 (3.794)	-.883 (3.076)	.053 (3.268)	36.297* (6.753)	-1.161 (3.703)
ESP2	2.926 (4.202)	-3.21 (2.85)	-1.633 (3.408)	-5.649 (8.512)	-.569 (3.659)
$\Sigma [\dot{E}^e_{t-i} b_0 + (1-b_0) \dot{N}^e_{t-i}]$	-.293	.535	.532	.704	.449
$\Sigma [\dot{E}^e_{t-i} \cdot (D_t)]$	.17	.093	.067	-.115	.161

TABLE XVll (Continued)

RHO1	-.052 (.184)	-.539* (.021)	-.105 (.267	-.5* (.071)	.108 (.176)
RHO2	-.039 (.069)	-.083* (.024)	-.087 (.068)	-.281* (.06)	-.136* (.067)
RHO3	.186* (.068)	.21* (.02)	.21* (.069)	-.039 (.059)	.213* (.07)
RHO4	.083 (.062)	.17* (.009)	.079 (.061)	.03 (.061)	.137* (.061)
Adjusted R^2	.051	.969	.236	.166	.552
Standard Error	5.45	6.809	3.229	27.229	4.078

TABLE XVII (Continued)

Variable	FURN[a]	TRAN[a]	LUMBER[a]	MACH[a]	PAPER[b]
ITR	1.124 (2.44)	3.462 (3.211)	1.636 (1.486)	-1.137 (2.43)	-.634 (1.658)
IUNEMRDI	.05 (.372)	.305 (.426)	-.337 (.334)	.156 (.61)	-.431 (.648)
ICHSSTAX	-.08 (.186)	-.203 (.20)	-.058 (.084)	.152 (.341)	-.082 (.092)
CHMINWA	.026 (.046)	-.016 (.05)	.032 (.052)	-.019 (.047)	-.06 (.05)
GUIDPS	3.025 (8.882)	-6.136 (13.986)	-3.457 (11.258)	-3.493 (10.94)	
ESP1	1.016 (2.974)	-1.663 (3.923)	-3.512 (3.668)	.329 (3.419)	1.497 (2.605)
ESP2	-.469 (3.772)	-1.588 (3.835)	.261 (4.077)	-1.727 (3.669)	-2.349 (2.851)
$\Sigma[\dot{E}^{e}_{t-i} b_0 + (1-b_0)\dot{N}^{e}_{t-i}]$	.682	1.521	1.252	1.216	1.594
$\Sigma[\dot{E}^{e}_{t-i} \cdot (D_t)]$	-.063	-.377	-.259	-.315	-.336

TABLE XVII (Continued)

RHO1	-.406*	-.194	-.013	-.045	-.56*
	(.191)	(.119)	(.161)	(.295)	(.189)
RHO2	-.073	-.077	-.111	-.095	-.071
	(.066)	(.065)	(.067)	(.068)	(.068)
RHO3	.216*	.189*	.162*	.235*	.206*
	(.067)	(.064)	(.068)	(.069)	(.068)
RHO4	.071	.122*	.153*	.063	.066
	(.06)	(.059)	(.061)	(.061)	(.061)
Adjusted R^2	.148	.104	.139	.364	.275
Standard Error	3.34	6.491	5.372	2.895	3.701

TABLE XVII (Continued)

Variable	PRIM[a]	PRINT[a]	RUBBER[b]	STONE[a]	TEXT[a]
ITR	-4.395 (3.852)	4.202 (5.312)	.289 (.376)	1.078 (2.829)	-1.536 (1.507)
IUNEMRDI	.215 (.336)	.076 (1.018)	.787 (.61)	-.147 (.384)	-.957* (.449)
ICHSSTAX	.148 (.158)	-.36 (.439)	-.013 (.124)	-.122 (.172)	.13 (.172)
CHMINWA	.021 (.047)	.018 (.046)	-.024 (.055)	-.006 (.046)	.001 (.055)
GUIDPS	-6.152 (10.503)	-2.059 (9.106)		-2.855 (8.319)	-2.547 (10.491)
ESP1	3.885 (3.835)	-.327 (3.223)	-1.715 (4.114)	.311 (3.072)	-1.134 (3.707)
ESP2	.398 (3.761)	-1.003 (3.062)	-.346 (4.082)	-1.313 (3.068)	1.233 (3.924)
$\Sigma[\dot{E}^{e}_{t-i} b_0 + (1-b_0)\dot{N}^{e}_{t-i}]$	2.269	.769	.6	1.484	1.676
$\Sigma[\dot{E}^{e}_{t-i} \cdot (D_t)]$	-.478	.037	-.023	-.17	-.302

TABLE XVII (Continued)

RHO1	.003 (.245)	-.188 (.365)	.046 (.176)	-.247 (.289)	-.209 (.138)
RHO2	-.079 (.068)	-.081 (.068)	-.105 (.07)	-.078 (.068)	-.065 (.065)
RHO3	.22* (.07)	.236* (.069)	.218* (.072)	.217* (.068)	.128* (.064)
RHO4	.065 (.061)	.06 (.06)	.062 (.064)	.073 (.061)	.175* (.06)
Adjusted R^2	.528	.392	-.052	.39	.175
Standard Error	3.479	1.926	5.7	2.914	6.633

The dependent variable is $\dot{IC}$. Standard errors are shown in parentheses.
*Significant at the 5 percent level.
The variables $[\dot{E}^e_{t-i} b_0 + (1-b_0)\dot{N}^e_{t-i}]$ and $[\dot{E}^e_{t-i}(D_t)]$ are lagged from t to t-13.

[a]The sample period is 1967:1 through 1985:3.
[b]The sample period is 1968:4 through 1985:3.

TABLE XVIII

CONSTRAINED INDUSTRY WAGE INFLATION EQUATIONS WHEN INDUSTRY COMPENSATION AND WAGES AND SALARIES ARE MODERATELY SMOOTHED

Variable	APP[a]	CHEM[a]	ELEC[a]	FAB[a]	FOOD[a]
ITR	2.009 (2.58)	2.118* (.981)	1.14 (1.314)	.073 (2.219)	3.482 (3.0)
IUNEMRDI	-.06 (.497)	1.113 (.828)	.388 (.504)	.426 (.461)	1.916* (.797)
ICHSSTAX	-.061 (.217)	-.153 (.243)	.007 (.144)	-.128 (.147)	-.287 (.202)
CHMINWA	.162* (.049)	.098* (.049)	.022 (.048)	.049 (.119)	.039 (.05)
GUIDPS	4.143 (11.052)	294.333* (12.492)	3.635 (10.495)	-1.384 (16.534)	1.692 (10.984)
ESP1	-.634 (3.704)	-.996 (3.108)	-.183 (3.399)	37.493* (7.038)	-1.329 (3.641)
ESP2	3.916 (3.959)	-2.997 (3.164)	-1.595 (3.531)	-6.938 (7.056)	-.494 (3.657)
$\Sigma[\dot{E}^{e}_{t-i} b_0 + (1-b_0)\dot{N}^{e}_{t-i}]$	.062	.757	.659	.996	.444
$\Sigma[\dot{E}^{e}_{t-i} \cdot (D_t)]$	.112	.05	.035	-.153	.16

TABLE XVIII (Continued)

RHO1	-.108 (.209)	-.529* (.012)	-.042 (.285)	-.549* (.071)	.091 (.714)
RHO2	-.072 (.068)	-.072* (.02)	-.085 (.068)	-.307* (.066)	-.133* (.067)
RHO3	.194* (.068)	.213* (.019)	.213* (.069)	-.074 (.066)	.21* (.069)
RHO4	.084 (.061)	.171* (.016)	.077 (.061)	.025 (.061)	.137* (.061)
Adjusted R^2	.175	.968	.242	.192	.552
Standard Error	4.548	6.915	3.033	26.872	4.014

TABLE XVIII (Continued)

Variable	FURN[a]	TRAN[a]	LUMBER[a]	MACH[a]	PAPER[b]
ITR	1.343 (1.175)	2.606 (3.042)	1.586 (1.787)	.324 (3.509)	-.496 (1.46)
IUNEMRDI	.047 (.33)	.328 (.405)	-.402 (.325)	-.181 (.562)	-.458 (.546)
ICHSSTAX	-.083 (.124)	-.182 (.172)	-.053 (.109)	-.048 (.431)	0.072 (.102)
CHMINWA	.031 (.045)	-.024 (.054)	.043 (.052)	-.016 (.047)	-.043 (.054)
GUIDPS	3.355 (8.865)	-2.205 (10.268)	-5.08 (10.107)	-3.667 (10.808)	
ESP1	.993 (3.045)	-1.37 (3.495)	-3.484 (3.47)	-.075 (3.607)	1.073 (3.102)
ESP2	-.397 (.745)	-2.786 (3.438)	.265 (3.64)	-1.541 (3.653)	-2.337 (3.128)
$\Sigma[\dot{E}^{e}_{t-i} b_0 + (1-b_0)\dot{N}^{e}_{t-i}]$	.571	1.68	1.247	1.686	1.561
$\Sigma[\dot{E}^{e}_{t-i} \cdot (D_t)]$	-.039	-.357	-.262	-.501	-.33

TABLE XVIII (Continued)

RHO1	-.419 (.237)	-.256 (.149)	-.02 (.173)	.059 (.294)	-.482* (.243)
RHO2	-.074 (.067)	-.093 (.065)	-.111 (.067)	-.092 (.068)	-.078 (.069)
RHO3	.216* (.067)	.183* (.065)	.168* (.068)	.238* (.069)	.209* (.069)
RHO4	.072 (.06)	.124* (.061)	.145* (.061)	.06 (.061)	.069 (.062)
Adjusted R^2	.156	.165	.168	.448	.248
Standard Error	3.221	5.9	5.093	2.479	3.707

TABLE XVIII (Continued)

Variable	PRIM[a]	PRINT[a]	RUBBER[b]	STONE[a]	TEXT[a]
ITR	-4.372 (6.012)	3.985 (4.697)	.193 (.442)	1.563 (2.399)	-.464 (1.48)
IUNEMRDI	.191 (.327)	-.045 (.953)	.698 (.612)	-.191 (.414)	-.713 (.497)
ICHSSTAX	.14 (.273)	-.331 (.375)	-.033 (.098)	-.153 (.146)	.032 (.145)
CHMINWA	.029 (.048)	.023 (.046)	-.019 (.054)	.0003 (.0445)	.024 (.054)
GUIDPS	-6.338 (9.835)	-2.795 (8.775)		-2.359 (8.533)	-2.818 (11.681)
ESP1	3.215 (3.685)	-.362 (3.19)	-1.839 (4.161)	.163 (3.114)	-1.621 (3.856)
ESP2	.198 (3.563)	-1.084 (3.05)	-.652 (4.086)	-1.764 (3.318)	2.005 (3.955)
$\Sigma[\dot{E}^{e}_{t-i} b_0 + (1-b_0)\dot{N}^{e}_{t-i}]$	2.542	.742	1.079	1.396	1.386
$\Sigma[\dot{E}^{e}_{t-i} \cdot (D_t)]$	-.558	.037	-.157	-.15	-.188

TABLE XVIII (Continued)

RHO1	.062	-.136	.084	-.298	-.207
	(.248)	(.452)	(.179)	(.306)	(.146)
RHO2	-.08	-.082	-.11	-.077	-.09
	(.068)	(.068)	(.071)	(.068)	(.066)
RHO3	.22*	.236*	.22*	.217*	.137*
	(.07)	(.07)	(.072)	(.069)	(.065)
RHO4	.063	.059	.061	.074	.17*
	(.062)	(.061)	(.064)	(.061)	(.06)
Adjusted R^2	.525	.447	-.035	.43	.199
Standard Error	3.422	1.747	5.539	2.719	5.958

The dependent variable is $\dot{IC}$. Standard errors are shown in parentheses.
*Significant at the 5 percent level.

The variables $[\dot{E}^e_{t-i} b_0 + (1-b_0)\dot{N}^e_{t-i}]$ and $[\dot{E}^e_{t-i}(D_t)]$ are lagged from t to t-13.

[a]The sample period is 1967:1 through 1985:3.
[b]The sample period is 1968:4 through 1985:3.

in the manner described earlier in this chapter, using a smoothing parameter of 0.8 (light smoothing). Using the same procedure for converting annual data to quarterly data, but with a smoothing parameter of 0.5 (moderate smoothing) generated the results presented in Table XVIII.

One apparent problem with the estimates of the coefficients of the variables in the wage equations presented in both Table XVII and Table XVIII is that the vast majority of the coefficients are not significantly different from zero. In light of the aggregate results for the same hypothesis (presented in Chapter III), where none of the coefficients, with the exception of some of the RHO coefficients, were significantly different from zero, and given the ad hoc nature in which some of the variables had to be created due to data problems at the industry level, the results presented in this chapter, with regard to the lack of statistical significance, are not surprising.

Turning first to the results presented in Table XVII, we see that each industry's trend rate of productivity, ITR, had no effect on that industry's rate of wage inflation.

The difference between an industry's unemployment rate and the economy's natural unemployment rate, IUNEMRDI, significantly affected the rate of wage inflation in just two industries: FOOD and TEXT (textiles), with the effects being in opposite directions! In the case of the FOOD industry, the coefficient implies that a one percentage point increase in the unemployment rate in this industry raises the wage inflation rate by 1.955 percentage points; whereas, in the case of the TEXT industry, the coefficient implies that a one percentage point increase in the unemployment rate in this industry lowers the wage inflation rate by .957 percentage points.

The third variable, 1CHSSTAX, reflects the effects of changes in employment taxes on the wage inflation rate. FOOD is the only industry where the estimated coefficient for this variable is significantly different from zero, and this estimated coefficient implies that a one percentage point increase in employment taxes reduces the wage inflation rate by .297 percent.

The fourth variable, CHMINWA, reflects the effects of changes in the minimum wage on each industry's wage inflation rate. The coefficient is significantly different from zero only for the APP (apparel) industry, with the coefficient indicating that a ten percentage point increase in the minimum wage increases the overall wage rate (including fringe benefits) by 1.54 percentage points.

The fifth variable, GUIDPS, represents the Kennedy-Johnson guideposts and is included in just thirteen of the fifteen industry wage inflation equations, being excluded from the equations for the PAPER and RUBBER industries. The estimation period for the wage inflation equations for these two industries began in 1968:4, which was after the guideposts had ended. This estimation period was shorter than the estimation period for the other thirteen 2-digit industries, the difference in estimation periods being the result of the different time periods over which industry unemployment rates have been reported. The estimation period for the thirteen 2-digit industries that include the GUIDPS variable began in 1967:1. As a result, GUIDPS had a non-zero value for just three quarters, the first three quarters of 1967. The coefficient for GUIDPS was significantly different from zero only for the CHEM (chemical) industry. This coefficient is extraordinarily large, and indicates that the latter stages of the guideposts caused a 284 percent increase in wage inflation in this industry.

The two variables ESP1 and ESP2 are dummy variables that divide the Nixon controls program approximately in half. The coefficients for ESP2, which represents the second half of the program (Phases III and IV) are not statistically significant for any of the fifteen industries, while one of the ESP1 coefficients is statistically significant. The coefficient for ESP1 in the FAB (fabricated metals) wage inflation equation indicates that the first half of the Nixon program (a period of mandatory controls) caused a 36 percent increase in wage inflation.

The next variable, $\sum [\dot{E}^{e}_{t-i} b_0 + (1-b_0)\dot{N}^{e}_{t-i}]$, represents the weighted sum of expected energy and non-energy price inflation. This variable is modeled as a fourteen quarter (from t to t-13) polynomial distributed lag function with the far endpoint constrained to zero. The coefficients for these variables would be expected to be positive, which they are in fourteen of the fifteen industries for which wage inflation equations were estimated.

The hypothesis being tested is whether the Carter standards prevented the energy price shock of 1979-80 from getting passed through to wage inflation. The coefficient of $\sum [\dot{E}^{e}_{t-i} \cdot (D_t)]$ (the rate of energy inflation interacted with a dummy variable representing the period of the energy price shock) is negative in ten of the fifteen 2-digit industries wage inflation equations were estimated for. The size of the negative coefficients, in absolute terms, for eight of the ten industries where the coefficient is negative, is greater than the relative importance of energy prices in the CPI (approximately 9.6 percent) for the same time period. Thus, it appears that workers entirely swallowed the energy price explosion in eight of the fifteen industries, and in two other industries part of the energy price shock was not passed through to higher wages. This conclusion supports the aggregate level finding that the Carter standards did prevent the roughly concurrent 1979-80 energy price shock from getting passed through to wages.

Turning to the results presented in Table XVIII, it can be seen that there are very few differences between these estimated coefficients and the estimated coefficients in Table XVII. One difference is that the coefficient for ITR is significantly different from zero for the CHEM (chemicals) industry when employee compensation and wages and salaries are moderately smoothed (Table XVIII); whereas, this coefficient was not significantly different from zero when light smoothing was used (Table XVII). On the other hand, the coefficient for IUNEMRDI for the TEXT industry went from statistically significant when light smoothing was used to statistically insignificant when moderate smoothing was used. Similarly, the coefficient for ICHSSTAX for the FOOD industry went from statistically significant when light smoothing was used to statistically insignificant when moderate smoothing was used. The coefficient for CHMINWA for the CHEM industry changes from statistically insignificant when light smoothing is used to statistically significant when moderate smoothing is used. There is no change in the statistical significance (or lack of) for the coefficients of GUIDPS, ESP1, or ESP2.

When light smoothing was used, the coefficient for $\sum [\dot{E}^e_{t-i} b_0 \cdot (D_t)]$ was negative in ten of the fifteen industry wage inflation equations when both light and moderate smoothing were used. The only apparent difference is that, when light smoothing was used, eight of the ten negative coefficients were greater, in absolute terms, than the relative importance of energy prices in the CPI while this was the case for nine of the ten negative coefficients when moderate smoothing was used. The important point is that when moderate smoothing was used in place of light smoothing, it did not affect the earlier finding that the Carter standards did help prevent, to some degree, the roughly concurrent 1979-80 energy price shock from getting passed through to wages.

Conclusion

In this chapter, we have explored the question of whether the Carter standards prevented the roughly concurrent 1979-80 energy price shock from getting passed through to wages at the SIC 2-digit industry level. A modified version of the constrained wage equation used to test the same hypothesis at the aggregate level was developed for use at the industry level. Data for industry level variables that are comparable counterparts to aggregate level variables did not exist in some instances. As a result, some ad hoc methods had to be used in these situations to create industry level variables that were similar to their aggregate level counterparts.

The main finding in this chapter is that the Carter standards helped prevent, to some degree, the energy price increases of 1979-80 from getting passed through to wages in ten of the fifteen industries being studied. This conclusion supports the main conclusion of the previous chapter; i.e., the Carter standards helped prevent the energy price shock of 1979-80 from getting passed through to wages at the aggregate level.

ENDNOTES

[1]The exponential smoothing method used is based on the recursive formula

$$\bar{y}_t = (w)\ y_t + (1-w)\ \bar{y}_{t-1}$$

where $\bar{y}_t$ = smoothed series at time period t,

y_t = the original series at time period t,

w = the smoothing constant.

Since the exponentially weighted moving average is not centered and the original series were growing over time, the smoothed series will underestimate the original series unless the original series is first detrended. The original series was detrended by assuming a linear trend and estimating the equation

$$y_t = a + (b)\ (TIME) + U_t$$

where a = the coefficient of the constant term

b = the coefficient of the variable TIME

TIME = 1 for the first quarter of the series, 2 for the second quarter, and so on

U_t = the residual at time period t.

The estimated residuals from this regression, that is,

$$U_t = y_t - a - (b)\ (TIME),$$

provide the detrended series.

Exponential smoothing is then applied to this detrended series. Two alternative values of the smoothing parameter, w = 0.8 (light smoothing) and w = 0.5 (moderate smoothing), were used to smooth these detrended series. Finally we take the smoothed detrended series

$\bar{U}_t$ and add the trend back in; i.e., we compute $\bar{y}_t = \bar{U}_t + a + (b)$ TIME.

For a discussion, see Robert S. Pindyck and Daniel L. Rubinfeld, Econometric Models and Economic Forecasts, 2nd Edition, (New York: McGraw-Hill, 1981), pp. 484-487.

CHAPTER V

SUMMARY AND CONCLUSIONS

Introduction

In this chapter we will review the empirical results of this study, focusing primarily on how the Carter standards affected wage inflation at both the aggregate and 2-digit SIC industry levels. Recommendations for future research complete the chapter.

The Effects of the Carter Standards at the Aggregate Level

The previous studies of the effects of the Carter standards on wage inflation were at the aggregate level. Of these, the Hagens and Russell study had been the most recent and sophisticated. Hagens and Russell tested four different hypotheses, which were that the Carter standards (1) brought wage demands into line with trend-productivity growth, (2) changed the inflation-unemployment trade-off, (3) deflated inflationary expectations, and (4) insulated the economy from energy-price shocks. The wage inflation equations used by Hagens and Russell to test these hypotheses had three major shortcomings. The first shortcoming, which occurred in all the hypotheses listed above, involved the assumption that expectations are Keynesian in nature. These hypotheses could have been tested using a rational expectations approach. The second shortcoming, common to the first three hypotheses, was a failure to interact dummy variables representing the Kennedy-Johnson guidelines and Nixon controls periods with variables that were interacted with the Carter standards dummy variables. The third shortcoming, relating to the final hypothesis, was an apparent misspecification of the wage equation.

These problems were corrected in this study, and several of the results are in direct conflict with those of Hagens and Russell. To illustrate, the results presented in Chapter III imply that the Carter standards did not bring wage inflation into line with trend productivity growth, contrary to the results of Hagens and Russell.

Similarly, the results presented in Chapter III regarding the Carter standards' changing the slope of the short-run Phillips curve are in direct conflict with those of Hagens and Russell, who concluded that the Carter standards had no effect on the inflation-unemployment trade-off. The results presented here, however, indicated that the standards caused a perverse impact on the short-run Phillips curve; i.e., because of the standards, an increase in the unemployment rate would cause an increase in the wage inflation rate instead of causing it to decrease.

Turning to the hypothesis that the Carter standards deflated inflationary expectations, it was shown that these standards did indeed deflate inflationary expectations, resulting in a reduction in wage inflation. This result was in agreement with the conclusion of Hagens and Russell.

Finally, the hypothesis that the Carter standards prevented the energy price explosion of 1979-80 from getting built into wage demands was tested. Hagens and Russell found, and had claimed as their principle conclusion, that the Carter program prevented the roughly concurrent 1979-80 energy price shock from getting passed through to wages. After correcting their apparent specification errors, and using a rational expectations approach in place of an adaptive expectations approach, it was concluded here that the Carter standards did prevent the energy price explosion from getting built into wage demands.

Whether the benefits of the Carter program outweighed the costs remains an open question. The first two results discussed above indicate the standards imposed costs on the economy, while the last two results indicate the standards generated benefits for the economy. Unfortunately, it cannot be determined which were greater. Even if these benefits exceeded these costs, this would not constitute an endorsement of the Carter program, since the costs of administrative burden and market distortion must also be considered.

The Effects of the Carter Standards at the Industry Level

As noted above, none of the earlier studies dealing with the effects of the Carter standards on wage inflation examined these effects at the industry level. In this study, wage behavior was examined in fifteen 2-digit SIC manufacturing industries amenable to econometric modeling similar to that performed at the aggregate level. The availability of data was the limiting factor in determining the number of industries for which wage inflation equations could be estimated.

Hagens and Russell's principal conclusion about the Carter standards was that they prevented the roughly concurrent 1979-80 energy price explosion from passing through to wages at the aggregate level.

The same methodology used at the aggregate level in this study was applied at the industry level to test the energy price shock hypothesis. Due to the methods used to convert some annual data to quarterly data, two different wage equations were estimated for each of the fifteen manufacturing industries under examination. Two wage equations were estimated for each industry because two different smoothing constants were used in converting the annual data to quarterly data. Two smoothing constants were used to ascertain whether the results were sensitive to the method used to convert the data. The results concerning the hypothesis that the Carter standards prevented the 1979-80 energy price shock from getting passed-through to wages at the industry level varied little when one smoothing constant was substituted for the other. Regardless of the smoothing constant used, it was found that the Carter standards did help prevent the energy price explosion from getting passed-through to wages in ten of the fifteen industries, thus supporting the conclusion reached at the aggregate level.

Recommendations

The following are this researcher's recommendations:

1. The hypotheses outlined in this paper were tested under the assumption that in recent years, the Carter standards were the only factor that changed the structure of the wage-price process. It is possible that other factors may have affected this structure. For example, casual observation indicates a worldwide reduction in the wage inflation rate during the 1979-80 energy price explosion period. Research needs to be conducted into the question of whether some

fundamental structural change took place worldwide during this period, or if there was simply a common response worldwide to this international price shock. If there was a common response to this shock, to what degree was it due to the incomes policies put in place in the U.S. during this period?

2. The accumulation of data at the industry level needs to be expanded and improved. The lack of appropriate data at the industry level proved to be the major obstacle in investigating the effects of the Carter standards at this level. For example, there are twenty 2-digit SIC manufacturing industries (although one of these is miscellaneous), but due to a lack of data, wage equations could be estimated for only fifteen of these industries. Similarly, wage equations could not be estimated for 2-digit industries in the agriculture, mining, construction, transportation, wholesale trade, retail trade, finance, or services industries because of a lack of data. This is particularly disheartening since manufacturing's share of total employment in the United States today is only 19 percent.

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