# A THEORETICAL AND EMPIRICAL ANALYSIS OF WAGES, PRICES, AND UNEMPLOYMENT FOR SELECTED OKLAHOMA INDUSTRY GROUPS

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# PREFACE

Recent empirical studies of aggregate wage behavior in the United States and Great Britain have been quite successful in their attempts to discover the main determinants of changes in the general wage level. Although there is considerable disagreement as to the relative importance of each variable, the determinants are generally believed to be the level of unemployment, the consumer price level, and (to a lesser extent) the general business rate of profits.

Encouraged by the successes of these studies conducted on the national level, I have endeavored to show what results a similar analysis of aggregate wage behavior would yield on the state level. It is toward this end that I use a macroeconomic model to explain the postulated relationship and use a regression analysis to formulate a one-equation model that best fits the data. Because profit rate statistics are unavailable, the analysis is restricted to a study of wages, prices, and unemployment for selected Oklahoma industry groups in the period 1950-1966.

Indebtedness is acknowledged to my thesis adviser, Dr. Joseph J. Klos, for his valuable criticism and encouragement; to Dr. Richard H. Leftwich, whose outstanding lectures on price theory aroused my interest in the subject matter of this thesis; to Dr. David E. Bee and Gary L. Lance for their assistance in statistical formulations and computer programming; to Russell H. Baugh and Michael R. Edgmand for their estimable suggestions; and to the following for their assistance in the amassing of statistical materials: W. J. Bowman, Research and Planning

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# CHAPTER I

## INTRODUCTION

It has been argued that those students of economics who lived through the Great Depression in the United States have written an economic theory which reflects their fear of the depression's return. This could well explain the rapid spread in popularity of J. M. Keynes's, The General Theory of Employment, Interest, and Money, and the subsequent emphasis upon fiscal policy which was placed there by many writers. If there is any counterpart to this hypothesized "depression trauma" for the economic students of this decade, it might well be defined as a fear of continuing inflation--not depression. And, although there is much disagreement as to the relative importance of the effects of demand-pull and cost-push inflation, economists now seem to generally agree that there must be some degree of trade-off among the goals of full employment, stable prices, and increased productivity. This is to say that the goals appear to be somewhat contradictory of each other, and the full attainment of one goal may require the sacrifice of full attainment in the other two. A sane monetary and fiscal policy no longer chooses between the alternatives of inflation or no inflation. The maintenance of low levels of unemployment and high rates of productivity increases requires that the policy makers choose, instead, between alternative low rates of inflation.

In the belief that a discoverable relationship exists between

prices, unemployment, and productivity, several empirical studies have been done for the United States and British economies. Although these studies shall shortly be discussed in greater detail, it should be advantageous to mention one at this point. The study referred to was completed by A. W. Phillips in 1958.[1] It is the first really serious attempt to empirically investigate the theoretical relationship between unemployment and what Phillips believes to be a cause of inflation--rising money wages. The curvilinear relationship which Phillips contends he has found between the two variables has since come to be known as the "Phillips Curve." The curve shows, essentially, that an inverse linear relationship exists between changes in the wage level and the rate of unemployment when at high levels of unemployment. At low levels of unemployment the relationship becomes strongly curvilinear so that wage rates become highly sensitive to changes in unemployment.

A graphic representation of the curve, drawn with the percentage rate of change of money wage rates on the vertical axis and the percentage level of unemployment on the horizontal axis, would picture a line sloping downwardly to the right and convex to the origin. While the curve would probably intersect the horizontal axis at some positive percentage level of unemployment, the curve would become asymptotic to the vertical axis at relatively high percentage rates of change in money wages. Phillips's basic assumption is that unemployment is a measure of the demand for labor and that a low level of unemployment is an indication of an excess labor demand, which would lead to higher money wages. In the several studies which followed the Phillips analy-

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[1] A. W. Phillips, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1961-1957," Economica, N. S. XXV (1958), pp. 283-299.

sis, other variables--including prices and profits--are interjected into the analysis in the form of multiple regression equations.

It is in the spirit with which the Phillips and subsequent studies were done on the national level that this study is undertaken at the state level. It should prove interesting to see if statistics aggregated on the state level will yield results similar to those found in aggregative studies conducted on the national level. Problems that may arise are the relative scarcity of manufacturing industries in Oklahoma and the fact that individual firms play a larger role in market behavior at the state level than they do at the national level (where entire industries can be considered). Because this study uses wage and unemployment data for nonagriculture industries, the limited size of industrialization in Oklahoma restricts the number of employees covered in the analysis. The greater importance that must be attached to firm behavior--rather than industry behavior--at the state level may make the macroeconomic approach less effective than it would be on the national level.

Although it is recognized that these and other problems may be better dealt with in a microeconomic analysis, it is the purpose of this study to see how well the aggregative approach of national studies can be used to analyze Oklahoma wage and unemployment data. For this reason Chapter II uses a macroeconomic rather than microeconomic model in a graphical demonstration of the purported relationship between prices, unemployment, and wages. The model shows the direction in which each of the three variables could be expected to move in response to a shift in, or along, the labor demand curve. This theory is intended to make an interpretation of the empirical results more meaningful.

Chapter III discusses the results of recent empirical studies concerning aggregate wage behavior in the United States and Great Britain. In addition to being divided geographically between these two nations, the authors of the empirical studies are divided into two general groups according to which variable they credit as being the main determinant of wage behavior. The Phillips-Lipsey hypothesis, that wage changes are a function of unemployment and (to a lesser extent) prices, is supported by at least seven researchers. The Kaldor hypothesis, that the wage-determinant is a profits factor, is supported by only one other author. The results of these studies provide a background against which the outcome of this analysis can be put into perspective.

A description and criticism of the data used in the regression analysis appear in Chapter IV. This discussion includes an exposition of the sources of data, the procedures for aggregating the monthly into quarterly figures, and the method used in weighting selected figures before they were aggregated. Because the wage, unemployment, and price statistics are not published with an estimate of error contained in the figures, several criticisms of the data are advanced in this chapter that are intended to present the potential inaccuracies of the data as realistically as possible. The regression analysis in Chapter V is an attempt to find the best one-equation aggregate model that explains the relationship described geometrically in Chapter II. Due to the successes of the study results reviewed in Chapter III, the regression analysis in Chapter V assumes (not intending to prove or disprove) that the dependent variable, the percentage rate of change in wages, is a function of the two independent variables, unemployment and the CPI. The purpose of the analysis is to see how well wage-rate behavior can be explained

by variations in Oklahoma's levels of unemployment and the national price index. The regression equation is fitted to wage and unemployment data from each of three Oklahoma industry groups--total manufacturing, construction, and trade--in the period 1950-1966. The results of the regression analysis are summarized in Chapter VI. This last chapter also presents a conclusion regarding interpretation of the results with respect to other studies and the theoretical model.

# CHAPTER II

## A MACROECONOMIC EXPLANATION

Before the empirical results are encountered, it should be instructive to take a brief look at a short-run macroeconomic model which attempts to explain the relationship between wages, prices, and unemployment. The intent of this theoretical approach is not to prejudice the interpretation of study results but, rather, to provide a logical framework in terms of which the statistics will become meaningful. If no relationship could be found to exist between the dependent and independent variables, then this theoretical diversion from the paper's generally pragmatic approach would certainly be pointless. Empirical successes in recent studies, however, are probably sufficient justification for this theoretical "aside."

The following geometric presentation is intended to show the direction in which each variable could be expected to move in response to a shift in, or along, the labor demand curve. To avoid using the disconcerting third dimension, the price and wage variables are combined and accommodated in a single variable, the real wage, which is generally assumed to be a function of the employment level. A movement along the labor demand curve is believed to cause, under the prescribed conditions, opposite movements in the real wage level and employment level. And, as shall be explained, a shift in the labor demand curve is believed to cause the real wage and employment levels to move in like directions.

The model used is a short-run, macroeconomic analysis based upon these simplifying assumptions:

(1) Pure competition exists. . . many, knowledgeable buyers and sellers, flexible prices for the firm's product X, mobile factors of production, and the freedom to enter or leave the market.

(2) Labor is the only variable resource, whose units are interchangeable and homogeneous.

(3) Employers are profit maximizing and employees wage maximizing.

(4) All firms are operating in stage II of production (i.e., on that part of their total product curve incurring diminishing returns).

(5) The real wage is a function of the level of employment from the firms' viewpoint, and the employment level is a function of the real wage from the workers' viewpoint.[1]

## The Macro-Model

If all firms are profit-maximizing (or loss-minimizing), they will hire labor up to the point at which the marginal revenue product of labor ($MRP_1$) equals the money wage rate ($\overline{W}$). This means, also, that the marginal physical product of labor ($MPP_1$) will be equated with the

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[1] The assumption that $W/P = f(N)$ is the subject of much debate. Keynes argues that the workers may be blinded by a "money illusion" and give little heed to the cost of living. Bodgin contends that $W/P \neq f(N)$, because the employment variable is not the only determinant. The escalator clauses in wage contracts, which testify to the awareness by unions of the real wage, and the empirical conclusions presented later, are strong indication that the assumption in question is not unrealistic. For those not so easily convinced, however, Bodgin suggests that $\overline{W}$ simply be assumed to be determined exogenously. See Ronald G. Bodkin, The Wage-Price Productivity Nexus (Philadelphis, 1966), p. 67. For policy implications of the real versus money wage problem, see Abba P. Lerner, Economics of Employment (New York, 1951), pp. 209-210.

real wage rate. The resulting production function states that output (Y) is a function of the level of employment (N). Similarly, the $MPP_1$ is

$$\frac{dY}{dN} = f'(N).$$

The condition of profit-maximization (or loss-minimization) in the macro-model is:

$$\frac{W}{P} = f'(N).$$

Figure 1 is the graphic representation of this analysis.[2] The purpose of the model is to show the effects of a shift in the labor demand curve (d) upon employment (N), output (Y), prices (P), real wages (W/P), and money wages ($\overline{W}$). The aggregate supply curve in the northeast quadrant is derived from the algebraic relationships described above. Given the supply and demand curves for labor in the SW quadrant (s and d, respectively), the money wage curve in the NW quadrant, the production function curve in the SE, and given that wages are flexible, a perfectly inelastic aggregate supply curve ($SS_1$) can be traced out. In making the analysis more realistic, however, it shall be assumed that wages are downwardly rigid. This causes the aggregate supply curve (SS) to remain perfectly inelastic only at prices greater than or equal to $P_m$. Below this price the aggregate supply curve swings back toward the origin, indicating that as price falls below $P_m$ a contraction in aggregate supply will pull down the level of national output.

The labor market is in equilibrium at point E in the SW quadrant. As was pointed out by Keynes, the aggregate market of supply and demand

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[2] For a more elementary and general analysis of the model, see the presentation given by Gardner Ackley, Macroeconomic Theory (New York, 1961), pp. 359-398.

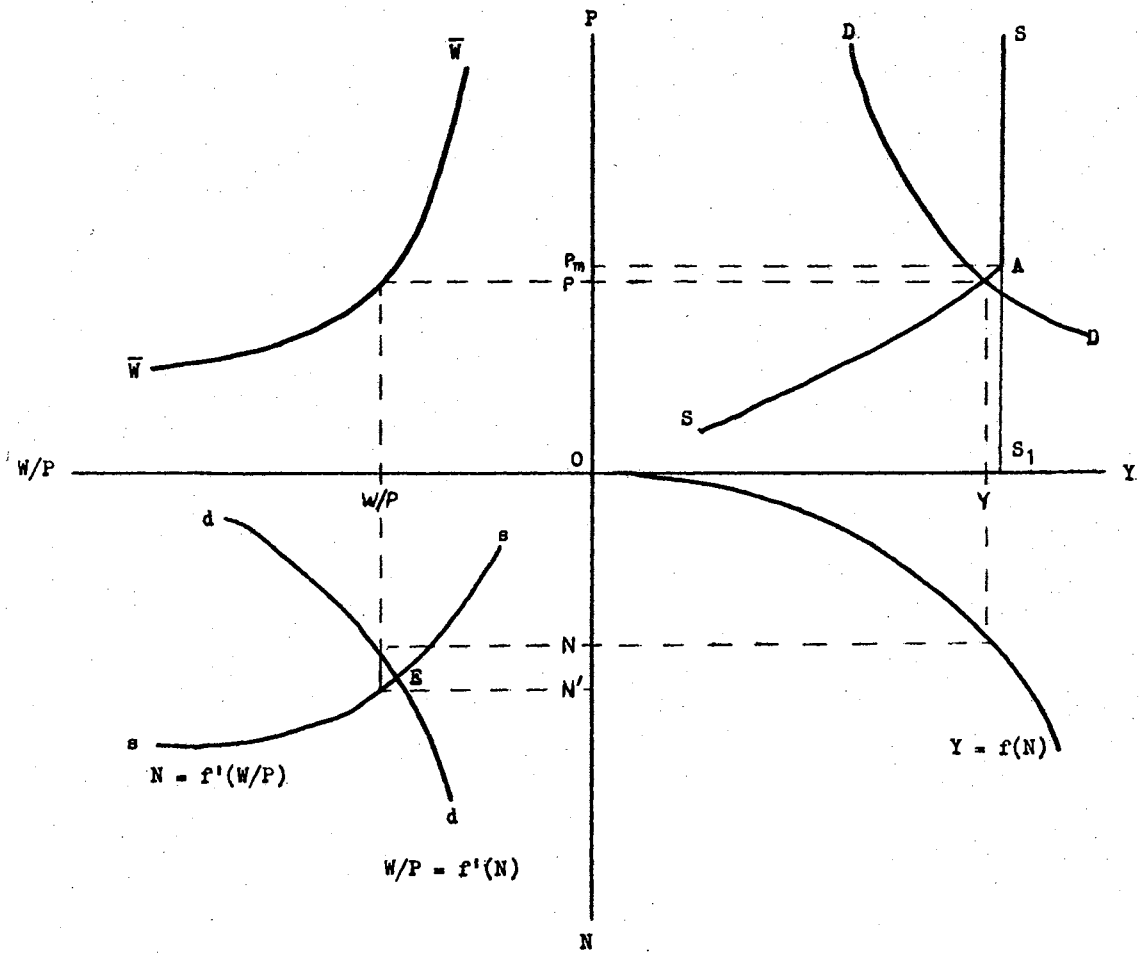


Figure 1. Macroeconomic Model Illustrating the Derivation of the Aggregate Supply Curve

may or may not be in short-run equilibrium at the same time as the market for labor.[3] Should both markets chance to be in equilibrium simultaneously, the aggregate demand curve (D)--the slope and position of which are determined exogenously--would intersect the aggregate supply curve at A, the point at which the curve swings back toward the vertical axis. The aggregate demand curve is shown, however, in a position which intersects the aggregate supply curve at B, a point slightly below A. When the aggregate market is in equilibrium at B, the labor market is in disequilibrium at a real wage level of W/P. At W/P the supply of labor is $N' - N$ greater than the demand for labor, so that the resulting level of unemployment is equal to $N - N'$. Because the Oklahoma labor market has generally incurred some positive level of unemployment, the position of D in the model is such that a slight amount of unemployment is indicated in the labor market of the model. This is done to make the figure as realistic as possible.

Figure 2 assumes prices to be flexible and demonstrates the effects of a series of outward shifts in the labor demand curve, an indication of increases in the demand for labor. When the labor demand curve is in the initial position as shown by d, the four variables take on the values of Y, N, W/P, and P. Unemployment, which in Figure 1 was measured on the vertical axis, is indicated here as the vertical difference between the labor supply and demand curves opposite W/P (line segment ab). The unemployment level ab is reduced measurably from ab to fg when the labor demand curve moves from d to $d_1$. At $d_1$ the aggregate supply curve has moved downward to the right from SS to $S_1S_1$, so that the real wage,

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[3] J. M. Keynes, The General Theory of Employment, Interest, and Money (New York, 1936), pp. 258-259.

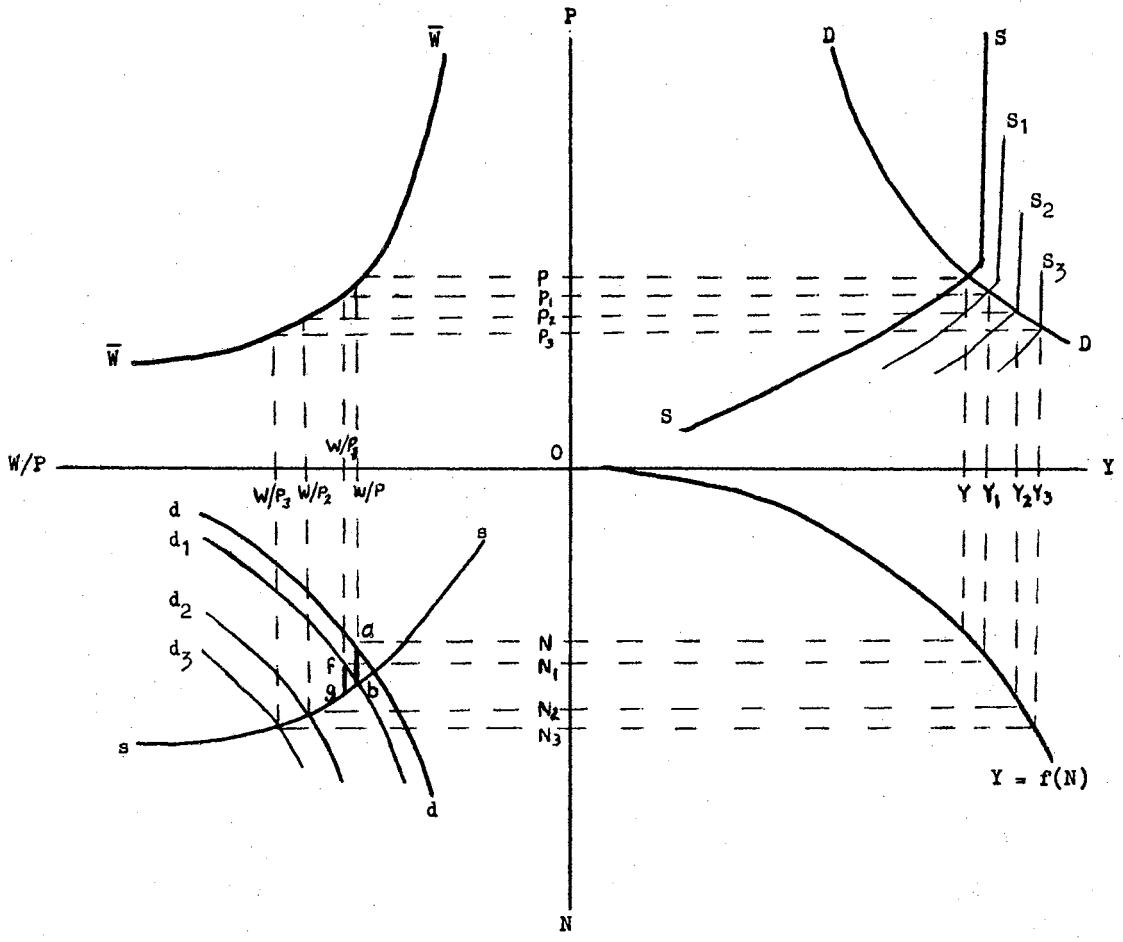


Figure 2. Macroeconomic Model Illustrating the Effects of Shifts in the Labor Demand Curve Upon Aggregate Supply

like the level of employment, experiences an increase (from W/P to $W/P_1$). As the demand curve moves to $d_2$, employment rises further, unemployment completely disappears, and the real wage increases again. As demand increases to $d_3$, however, the real wage increases while there is no unemployment left to diminish. Because unemployment is nonexistent, the increased demand for labor has a greater impact upon the real wage level than before, raising it at an accelerated rate. The higher wages attract persons into the workforce who formerly were not willing to work, which accounts for the increase in employment from $N_2$ to $N_3$. An increase in the labor demand beyond $d_3$ would have a full effect on real wages without any impact on the employment level, because the labor supply curve has become perfectly inelastic.

It is interesting to note that, as the labor demand curve shifts outward, the unemployment level diminishes at a diminishing rate and the real wage level increases at an increasing rate. This means that at low levels of unemployment it takes a much greater wage increase to reduce the unemployment level further (by a given percent) than is necessary at higher levels of unemployment. The unemployment level is more sensitive to the demand for labor at high levels of unemployment than at low levels. If the unemployment level were to be interpreted as a measure of the demand for labor, a given percentage increase in a low level of unemployment would correspond to a greater decline in the demand for labor than would the same percentage increase in a high level of unemployment. Because the empirical studies use the unemployment level as this type of indicator, the point being made here is very important. That is, the relationship between the level of unemployment and wage-rates is described by the model to be nonlinear.

It would be unrealistic, of course, to suppose that the demand for labor would continue to increase indefinitely without an increase in the aggregate demand. It may be that the labor demand might increase while the aggregate demand curve is still stationary. In this case the increased demand for labor would probably be the result of anticipations by employers of an increased aggregate demand for final goods. But if the anticipated, greater aggregate demand does not materialize, the demand for labor may well start decreasing. It might appear that, even if aggregate demand remained stationary, technological innovations could be sufficient cause for the demand for labor to rise. As the model makes clear, however, such an innovation would shift the production function, resulting in a movement along--not in--the labor demand curve. It should be noted, therefore, that in a growing economy the aggregate demand curve should be continually shifting upward to the right, which has the effect of offseting the real wage increases by exerting forces to reduce them--and of making employment increases more pronounced.

An increase in the aggregate demand, then, causes employment to increase and the real wage to decrease, until point of full employment is reached. It may seem contradictory, for this reason, that a similar increase in the demand for labor would cause the same two variables (i.e., employment and real wages) to increase together. Like the distinction made earlier, the explanation is that a shift in the aggregate demand curve has the effect of a movement along, not in, the labor demand curve.

Another very interesting observation can be made concerning the labor supply and demand schedules. The labor supply curve is said to indicate that the level of employment is a function of the real wage.

The labor demand curve, however, is based on an opposite relationship--that is, the real wage is a function of the level of employment. The question arises, then, as to which functional relationship is actually the determinant of the levels of employment and the real wage. The answer is actually quite simple. Neither relationship can be the sole determinant of the employment and real wage levels. The functional relationships simply describe those combinations of employment and real wages that are acceptable to workers and employers. The determinant of the actual levels of real wage and employment is the intersection point of the aggregate supply and demand curves. Because the aggregate supply curve is derived from the labor supply and demand schedules, the schedules can be given half the credit in the determining process, while the other half of the responsibility lies with the aggregate demand curve.

What sort of real wage-employment relationship, then, would one expect to find in the empirical studies? The answer might best be approached in this manner: Assume that in the period being studied a relatively high level of unemployment exists, an indication that the demand for labor is less than the labor supply at at a given real wage. In such a situation, the limits on the real wage and employment levels are placed there by what employers are willing to offer--not by what laborers are willing to accept. Assume, as a counterexample, that the converse situation exists. That is, labor supply is exceeded by demand and the unemployment level is zero or at some positive low level (allowing that frictional unemployment cannot be completely eliminated). Under these new circumstances, the willingness to work on the part of laborers is the restricting factor, and the employment level can be said to be a function of the real wage rate.

At high levels of unemployment, the reverse is true. Theoretically, there is a level of unemployment--comprised entirely of frictional unemployment--that indicates the existence of an equilibrium in the labor market. At such a level the wishes of employers and the work force are both being expressed and are in happy agreement. Hypothetically speaking, under these very exact conditions, the real wage level and employment level are a function of each other. It is good to remember, then, that once the frictional level of unemployment is reached, the rate of change in the real wage level--not in the unemployment level--becomes the new indicator of what sort of relationship exists in the labor supply and demand schedules.

Under the more realistic assumption of imperfect competition, workers are not homogeneous, job skills vary greatly, and neither workers nor employers are omniscient. An excess demand for chemists will not, therefore, have a significant effect upon a high unemployment level of sociologists. It is thus likely that a real national or state economy could be experiencing a general excess demand for labor and at the same time have a level of unemployment above the frictional minimum. It is quite logical, therefore, that a basic assumption in the empirical studies is that a positive, low level of unemployment may indicate a general excess demand for labor.

There is reason to believe, moreover, that the relationship $W/P = f'(N)$ may be far more often the case than the reverse situation. The reason is based on the observation that wages are more easily moved up than down, so that an excess demand for labor may more readily be eliminated by the market mechanism than might an excess supply of labor. If the more realistic assumption of downward price rigidities were added

to the model in Figure 2, the effect of an excess demand for labor could be easily imagined to be an upward shift in the money wage curve. If the price level were to remain the same, this would have the desired effect of raising the real wage level.

The following studies should become more meaningful in the light of the preceding theoretical relationships. If the real wage rate, for example, is observed to move in a direction opposite to the change in the unemployment level, the probable indication is that the labor demand curve is shifting. If the same two variables were to move in the same direction, the likely cause is a movement along the labor demand curve (i.e., a change in the quantity of labor demanded). If the curve elasticities drawn in Figure 2 are not too unrealistic, the studies should find that the relationship between unemployment and the percentage rate of change in wages is nonlinear. If straight lines would more accurately represent the labor supply and demand schedules, the hypothesized relationship should be found to be linear--if it can be found to exist. Of those studies using price as a partial determinant of wage-rate behavior, only one uses the price variable in a denominator capacity to convert money wages into real wages. The others, like the analysis in this paper, insert the price data into the regression equation as an independent variable. Price and wage-rate behavior are, nevertheless, expected to exhibit the relationship described in the macroeconomic model.

# CHAPTER III

## RECENT STUDIES OF AGGREGATE WAGE BEHAVIOR

The foregoing static analysis describes the determinants of the rate of change of money wages as being prices, the employment level, productivity, the aggregate supply and demand for products, and the supply and demand schedules for labor. The following review of recent empirical studies in this area will indicate the degree to which the theory has held up under pragmatic criticism. Although the same determinants listed above have been the subject of the empirical tests, various authors place emphasis upon different variables. The consideration of total product and aggregate supply and demand for final products, for example, may appear to be entirely left out of the analyses. These factors are included, however, in the earnings estimates made of business profits, a comprehensive variable. Similarly, no specific mention will be made of the employment level, although it will be used continually to reduce aggregate earnings to an hourly, per person wage rate. And the concept of supply and demand for labor becomes a measurable factor through the use of the inverse of unemployment indexes, which are assumed to be an indication of the degree of disparity between the two schedules of supply of and demand for labor, at particular money or real wages.

It is believed, therefore, that a low level of unemployment indicates that the demand for labor at a particular wage is high relative

to the supply for labor. Conversely, a high level of unemployment would suggest just the opposite--that the demand for labor is relatively low. Whether or not this relationship is strictly linear is the subject of much debate. Where relevant, the positions taken by the following authors on the subject of this linearity will be cited.

In regard to the determinants of the rate of change of money wages, A. W. Phillips argues in behalf of the supply and demand for labor, as this relationship is reflected in the unemployment level. Lending support to Phillips's hypothesis are Lipsey, Dow and Dicks-Mireaux in their studies of the British economy and Bowen, Bhatia and Perry in their independent research using United States data. Their support is by no means given without qualification; the introduction and consideration of price changes in the analysis, and the omission of the variable denoting the rate of change of the unemployment level, are commonly done in the way of experimentation with the models so as to obtain the best data-fitting equation.

Nicholas Kaldor, on the other hand, contends that the main determinant of the rate of change of money wages is the bargaining power of labor, as this factor is reflected in the profit rate for industry. The suggestion that wage behavior is a function of profits arises out of Kaldor's criticism of Phillips's research to be better support for the profits-theory than the unemployment theory of wage behavior.[1] Kaldor chooses to simply speculate and theorize, leaving the responsibility of empirically substantiating his hypothesis to others. And others do shortly appear. Although it is only supported in spirit by

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[1] Nicholas Kaldor, "Economic Growth and the Problem of Inflation," Economica, N. S. XXVI (1959), p. 292.

Roberts, Kaldor's hypothesis is tested with favorable results by Bhatia and with not-so-favorable results by Lipsey and Steuer.

It is interesting to observe that, given an increase in both profits and unemployment, Phillips would argue that the resulting effect would be a decrease in the level of wages because the increase in unemployment indicates a decline in the demand for labor and the profits increase is not relevant. Kaldor, on the other hand, argues that the increase in profits--not unemployment--is the significant factor. Higher profit rates would allow employers to bid up the wage rates. Should profits and unemployment be found to move in the same direction, as Lipsey and Steuer point out, the Phillips and Kaldor hypotheses would predict opposite changes in the rate of change of money wage rates. Unless unemployment never fails to exactly correlate with industrial profits, these two theories are obviously incompatible.[2]

It will now be of interest to look at the major findings of the studies completed by Phillips, the forerunner in recent investigations regarding the determinants of aggregate wage movements, and other authors.

## Research in the United Kingdom

A. W. Phillips.--Covering most of the years 1861-1957 in this study of the United Kingdom, the Phillips-hypothesis states that the percentage rate of change of money wage rates can be explained by the unemployment level and the percentage rate of change in the unemployment level.[3]

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[2]Richard G. Lipsey and M. D. Steuer, "The Relation Between Profits and Wage Rates," Economica, N. S. XXVIII (1961), p. 138.

[3]Phillips, pp. 283-299.

Although Phillips does not choose to introduce a prices-variable into the analysis, he does eliminate the observations for those years experiencing a fast enough rise in the import prices to nullify the tendency for increased productivity to lower the cost of living. It is his feeling that wage behavior will remain unaffected by cost of living adjustments except for those times when an extremely rapid increase in import prices forces up domestic retail prices. If the general level of retail prices were to rise at a rate of 1 percent annually, Phillips would argue that:

> . . . the introduction of cost of living adjustments in wage rates will have no effect, for employers will merely be giving under the name of cost of living adjustments part of the wage increases which they would in any case have given as a result of their competitive bidding for labor.[4]

It is on this basis that Phillips dismisses the years 1861 and 1862, for example, during which the wage rise is too large to be explained by the two unemployment variables alone. The 12.5 percent increase in import prices occurring between 1861 and 1862, which is probably due to the start of the American Civil War, is great enough to cause a significant increase in the costs of living. This brought about a greater increase in the wage level than would have been forthcoming as the result of employers' demand for labor alone.

However, the import price increases of 7.6 percent between 1899 and 1900 and between 1909 and 1910 are not held to have any significant effect on the wage level. Phillips considers the same to be true of the 7 percent wage rate increase between the years 1871 and 1872. But this is not the case for the periods of 1935-1937 and 1948-1957, years

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[4] Ibid., p. 284.

in which Phillips again has to put the blame on rapidly rising import prices. The entire period 1913-1948, moreover, is complicated by the price and unemployment effects of the two world wars. Of particular interest is the rapid rise in unemployment in 1920 from 2.6 percent to 17 percent. During this same period wage rates fell 22.2 percent, a fact which Phillips explains as being the result of a corresponding 12.8 percent drop in the cost of living and the result of the unusually quick change in the unemployment level. Through this fancy footwork of stepping over and around the obstinant data of those years which do not well fit into his regression curve, Phillips is able to support his hypothesis regarding price changes. That is, cost of living changes will not affect the outcome of wage-bargaining unless the changes are great enough to make a reduction in real wages.

When the years of rapid price increases are ignored, and an increase in productivity of 2 percent annually is assumed, Phillips finds that the level of unemployment would be just a little less than 2 ½ percent if the level of aggregate demand associated with it were stable.[5] The maintenance of aggregate demand at a value that would make wage rates stable would cause a 5 ½ percent level of unemployment. Phillips finds evidence that the wages-unemployment relationship is a nonlinear one, exhibiting a strong curvature of the fitted relation in the area of a low percentage unemployment. Although he tries many different curves, the one including a seven-month lag between unemployment changes and wage-rate changes yields the best fit (although the curve is remarkably

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[5] To make the British figures directly comparable with those computed for the United States, Perry gives evidence that the British figure should be multiplied by 3/2. See George L. Perry, Unemployment, Money Wage Rates, and Inflation (London, 1966), pp. 34-69.

similar without the time lag).

Unlike the procedures used in all of the later studies, Phillips groups his observations in accordance with unemployment levels, averaging each group's wage changes. Because he uses a logarithmic form to test the postulated relationship, he must group his data in this manner to avoid using negative logarithms to indicate the value of a falling wage. The logarithmic form[6] is $(1/W)(dW/dt) = a + bU^c$, which, for the years 1861-1913, becomes $\log (y + 0.900) = 0.984 - 1.394 \log x$, where y is the rate of change of wage rates and x is the percentage level of unemployment.[7]

Phillips's unemployment figures show the percent of the unionized labor force that is unemployed; wage rate figures are calculated from the Phelps Brown-Hopkins Index.[8] It is Guy Roth's contention that Phillips's data is not appropriate enough to lend support to his hypothesis. Roth believes that results significantly different can be obtained by using different wage and unemployment series. Even disregarding the data imperfections, Roth feels that Phillips is guilty of reading too much into his evidence. More specifically, Roth advances the following criticisms:

1. Phillips's wage data are derived from indexes constructed on standard rates, which are created by trade unions and employers' associations. It is noteworthy that these two organizations

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[6]This form is taken from Perry, who identifies it in his review of Phillips's article. See ibid., p. 6.

[7]Phillips, p. 290.

[8]E. H. Phelps, Brown and Sheila Hopkins, "The Course of Wage Rates in Five Countries, 1860-1939," Oxford Economic Papers, N. S. II (1950), pp. 226-296.

are excluded from his analysis. Standard rates, moreover, maintain no constant relation with the effective rates, and it is the effective rate which Phillips assumes to exist in the rationale surrounding his hypothesis.[9]

2. Bowley and Wood and the Department of Labor, who are Phillips's data source for wage rate figures, make allowance for some of the divergence of effective rates from standard rates. For the wage rate data following 1910, however, no such consideration is taken into account. The data for the years before and after 1910 are, thus, not readily comparable.

3. Standard rates are far more rigid than effective rates.

4. Phillips ignores the problem of weighting in both the wage-rate index and the unemployment series.

5. The wage series has a heavy representation during the period 1861-1913 of coal and agriculture, both of which are almost entirely excluded from the unemployment series.

6. For one period Phillips uses first central differences to obtain the wage series, but for the end period he lags unemployment by seven months, causing inconsistencies to appear in the time-relationship of different periods.

7. The simplifying process of averaging and the reduction of irregularities by curve fitting present an unreal picture of smoothness.[10]

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[9] Effective rates are those actually paid, as distinguished from standard rates, which are those set in collective agreements.

[10] Guy Routh, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates: A Comment," Economica, N. S. XXVI (1959), pp. 299-315.

Phillips's hypothesis is championed by Richard Lipsey, who dismisses Routh's criticisms lightly by recognizing that any set of statistics is imperfect. The question considered relevant by Lipsey is, ". . . whether or not the postulated relation is strong enough to show up in spite of imperfections in the data . . .," which can only be answered empirically.[11, 12]

Richard G. Lipsey.--While Lipsey believes that Phillips's hypothesis is well defended by the results of the Phillips study, Lipsey did a study of his own, which is a reconsideration of the Phillips hypothesis in which much more weight is given to the cost of living factor. Phillips believes that if, in the absence of a cost of living change, wage rates would have increased by 10 percent, then wages will not be affected by a cost of living increase which is less than 10 percent. It is Lipsey's conclusion that the statistical evidence fails to support Phillips's hypothesis that the cost of living has only a "threshold effect" on wage rates. Lipsey's hypothesis, then, is that wage behavior is determined by three factors--changes in the cost of living, the level of unemployment, and percentage rates of change in the level of unemployment (which are, respectively, dP, U, and dU). Lipsey reasons that an increase in the cost of living would make unions more insistent and make the employers less reluctant to yield to union demands.

Lipsey concludes that over 80 percent of the variance in money

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[11] Lipsey, p. 3.

[12] For an additional criticism of Phillips, see K. G. J. C. Knowles and C. B. Winsten, "Can the Level of Unemployment Explain Changes in Wages?" Bulletin of the Oxford Institute of Statistics, XXI (May, 1959), pp. 237-245. See also J. Downie, "The Present Position of Econometrics--Statistics and the Economist," Journal of the Royal Statistical Society, CXXIII (1960), pp. 278-282.

wages during the years 1862-1913 can be associated with the variables U and dU. By using all three determinants in the equation of the form

$$dW = a + bU^{-1} + cU^{-2} + dU + f(dP)$$

Lipsey is able to obtain an $R^2$ for the relation of 0.88 when covering the years 1920-1939 and 1947-1957. With these results he concludes that the relation is, ". . . very interesting . . . but a very low degree of confidence might be attached at this state to a particular estimate of the parameters."[13]

J. C. R. Dow and L. A. Dicks-Mireaux.--Unlike the above authors who use annual data, Dow and Dicks-Mireaux take advantage of available quarterly observations to avoid the inaccuracies of aggregation. This additional detail is due, perhaps, to the fact that the two authors concentrate on the post-World War II years, with special emphasis on the years 1946-1956. In analyzing wage behavior, they approach the problem through two separate studies.

The first study is an examination of the reliability of using unemployment and unfilled vacancies data as an indication of the demand for labor.[14] All results are based upon quarterly averages of the data, which is seasonally corrected and written as a percentage of the total number of employees. This is done for industry as a whole in Great Britain and for seven individual industry subgroups. Dow and Dicks-Mireaux consider the resulting indices as, ". . . rather good indicators," of the demand for labor.[15] Although unreliable as cardinal measures,

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[13] Lipsey, p. 30.

[14] J. C. R. Dow and L. A. Dicks-Mireaux, "Excess Demand for Labor," Oxford Economic Papers, N. S. X (1959), pp. 1-33.

[15] Ibid., p. 1.

the indices are considered quite reliable as ordinal measures of demand. An interesting finding of the study is that the aggregate excess demand for labor never appears to be of any considerable size. Even in boom years the excess demand for labor was only a few percent of the work force.

Satisfied that unemployment and unfilled vacancies data are rather reliable as an indication of the demand for labor, Dow and Dicks-Mireaux use this index as an integral part of their second study.[16] The hypothesis to be tested is that the rate of change of wage rates is a function of the pressure of labor demand and the rate of change in the retail price level. The wage rate and price data are quarterly averages calculated from the Ministry of Labor index.

Using multiple regression techniques to explain the variation in the rate of change of wages, the authors find a price coefficient of about 0.5. This they interpret to mean that:

> . . . workers obtain rather less than full compensation for price increases when prices rise more rapidly than usual, and rather more than full compensation when the price-rise is unusually small.[17]

An excess demand for labor appears to effect wage rate changes in a linear manner, but this conclusion is not valid in the region of less-than-full employment. The coefficient of the price variable indicates that a given percent change in the price level can be associated with a wage rate change (in the same direction) of about half that value. A given percentage change in the unemployment level, however, is associated

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[16] J. C. R. Dow and L. A. Dicks-Mireaux, "The Determinants of Wage Inflation: The United Kingdom, 1946-1956," The Journal of the Royal Statistical Society, CXXII (2) (1959), pp. 145-174.

[17] Ibid., p. 171.

with a 3 to 4 percent change in the wage rate. The unemployment effect is nonlinear. When unemployment is reduced to a bare minimum of frictional unemployment, an excess demand for labor will affect wage rate changes in a linear fashion.

Dow and Dicks-Mireaux do, therefore, find evidence to back their hunch that wages have become increasingly more determined by prices since World War II. The two factors of price changes and pressure of demand are used in a regression analysis of the rate of change of wage rates that yields an $R^2$ of 0.89. The authors conclude that if there are no price changes or excess demand, wage rates will increase at a rate of 2 to 2 ½ percent annually. So that this study may be more readily compared with the others, it is important to note that the demand for labor index developed by Dow and Dicks-Mireaux is very comparable to the inverse of percentage unemployment. The two authors obtained very nearly the same results when they actually used unemployment--instead of the unemployment-unfilled vacancies index--as a determining factor.

Although this study includes the analysis of several industry subgroups as well as the industry as a whole, the authors find that the aggregate unemployment data does almost as good a job of explaining wage behavior as does the unemployment data for separate groups of industries.

L. R. Klein and R. J. Ball.--This is the last study of the British economy to be reviewed here.[18] Klein and Ball's study is intended to assist in the understanding of post-World War II inflation. Their hypothesis is that wage rate changes are influenced by variations in the cost of living, the political stiuation, and the demand for labor. Esti-

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[18] L. R. Klein and R. J. Ball, "Some Econometrics of Determination of Absolute Prices and Wages," Economic Journal, LXIX (1959), pp. 465-482.

mates for the demand for labor are made from the annual average level of unemployment. For the wage and price variables simple first differences, rather than percentage rates of change, are used, a procedure which other authors think unwise.[19] Unemployment, moreover, is considered by Klein and Ball to be related to wage behavior in a linear fashion, a manner which contrasts sharply with the nonlinear relation ascribed to by Phillips, Lipsey, Dow and Dicks-Mireaux.

Ball and Klein believe that demand inflation exerts an influence on wage rates as indicated by the correlation coefficient of the unemployment variable, an index of quarterly averages.[20] The least squares estimate of this coefficient is -0.039, a value only a little greater than the sampling error. The coefficient value, found to be insignificant, is derived from a linear equation containing a six-month lag between the time prices change and the time wage rates are believed to respond to that change. No evidence is found to justify the use of a nonlinear instead of a linear function in the organization of sample data. By increasing the six-month time lag to nine months, the authors observe that the unemployment coefficient jumps from 0.039 to 0.06, an admittedly short jump indeed. It is their feelings, however, that the six-month time lag (and its poorer results) is more logically defensible than the latter.

Through additional experimentation with the correlation equation,

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[19] George L. Perry thinks this procedure to be questionable. He cautions that "the effect of this is to associate a given rate of unemployment with say a 10 percent increase in wages at one time, but only a 5 percent increase at some later time when wages have doubled." For a discussion of how this formulation may be prejudicing the outcome, see Perry, pp. 12-13.

[20] For the theoretical background to their arguments, see R. J. Ball, Inflation and the Theory of Money (Chicago, 1964).

Klein and Ball find that the association of average labor productivity with changes in the wage rates makes no significant improvement on the manner in which the equation correlates with wage rate behavior. Although profits-coefficient has a significant, positive value, the authors argue that the influence of profits is already greatly reflected in the other variables. For this reason they dismiss it from consideration in the final equation, which is arrived at using simple least squares. The coefficient of the prices variable is 0.812, an outcome which they interpret to mean that the wage rate adjusts to the price change to offset any effects it would have on unemployment. Perry is very critical of this near unity value of the price coefficient presented by Klein and Ball. Perry contrasts it to Lipsey's price coefficient of 0.69, which Lipsey later revises to approximately 0.5, and to the Dow and Dicks-Mireaux price coefficient of about 0.5.[21] The Klein and Ball price coefficient is supported by no other study made of the British or United States wage and price data.

Richard G. Lipsey and M. D. Steuer.--Interested in testing the Kaldor hypothesis that wage behavior is basically determined by industry profits, R. G. Lipsey and M. D. Steuer design a study that covers the years 1949-1958, the inter-war period, and the years 1870-1913.[22] The authors conclude that the annual U. K. data of the post-World War II years is inconsistent with the Kaldor hypothesis. The Phillips-Lipsey hypothesis is found to be far more consistent with the observations. The unemployment theory is favored by the evidence in the periods 1870-

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[21] Perry, p. 13.

[22] Lipsey and Steuer, pp. 137-155.

1912 and 1949-1958, while the profits theory is favored only in the period 1926-1938. And for this period it seems possible to explain away most of the profits wages relation by correlating profits and unemployment.

Rattan J. Bhatia, whose study is discussed below, is very doubtful of the validity of the results of the Lipsey-Steuer study. Bhatia criticizes the use of either no time lag or a time lag of one year between profits and wage rate changes. The time lag, he maintains, need not be a multiple of one year.[23] While this may well have affected the results, it is good to keep in mind that the purpose of the Lipsey-Steuer study is to test the Kaldor hypothesis. It is Kaldor's suggestion that the time lag is one year.[24] Bhatia's treatment of the time lag problem and the results of his study relate to data taken from the United States economy, the subject for the last half of this review.

## Research in the United States

William G. Bowen.--As the most comprehensive and exhaustive investigation of the wages unemployment relationship in the United States, William G. Bowen's study covers the twentieth century up to the end of the 1950's.[25] Particular emphasis is placed on the post-World War II years. The monthly observations supplied by his source material are aggregated into annual data, which are then grouped into numerous periods.

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[23] Rattan J. Bhatia, "Profits and the Rate of Change in Money Earnings in the United States, 1935-1959," Economica, N. S. XXIX (1962), 255-262.

[24] Kaldor, p. 292.

[25] William G. Bowen, Wage Behavior in the Postwar Period--An Empirical Analysis (Princeton, 1960).

By grouping the years in this manner, Bowen is able to explain the wage unemployment relation as it changes from one period to another. Unfortunately, this makes a comparison of the results of this study with those of others very difficult. Bowen does not regress one set of data against another over any lengthy period of years.

The central hypothesis tested is that wage rate behavior is affected by changes in the level of unemployment and by the level of unemployment. Bowen concludes that such a relation does exist, but that it is more loose than is generally assumed to be the case. The looseness may well be due to the averaging-out effect of using data aggregated into annual units. It could be due, also, to the existence of relatively brief time lags between unemployment and wage changes. Time lags of a short duration would not be reflected in the annual observations. After researching both of these possibilities, Bowen concludes, firstly, that no significant short-run relationship exists between unemployment and wage rates.[26] Secondly, there is a lack of evidence that a systematic and observable time lag exists between the unemployment and wage level changes.

The appearance of such a loose relationship is interpreted to mean that no predictions of reasonable accuracy can be made concerning the size of wage rate changes that should be associated with different unemployment rates of change. And the relationship holds true only for relatively permanent and significant variations in the level of unemployment. In addition, Bowen sees evidence that the responsiveness of wages to significant variations in the unemployment level is greater for wage

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[26] The short run encompasses anything less than a year.

increases than for wage decreases. This is not surprising, considering the popular view that wages are downwardly rigid. As Bowen had supposed, the results of his study show also that wage rates are influenced by the direction of unemployment rate changes as well as by the level of unemployment.

In support of Bowen's hypothesis, the results show that wages increase more rapidly when unemployment is low than when unemployment is high. This holds true for the period 1900-1958 and for the post-World War II years considered by themselves. Of more interest is the outcome that the rate of wage change in recessionary periods averages only 3.9 percent while in prosperity periods it averages 6.3 percent. Even the contractionary years demonstrate a lower average wage increase than do the years in the recovery phase. Industries with an above average increase in employment, moreover, show above average wage increases.

The large wage increases in the 1958 recession, Bowen explains, are accounted for in part by the effect of price increases on wage rates. Except for this short period, neither prices nor profits are believed to contribute significantly to the explanation of wage behavior. As to the role of wage rates as determinants themselves, Bowen believes that they help account for much of the rapid increase in the cost of living. To what extent this is so he makes no attempt to answer.[27]

Rattan J. Bhatia.--Determined to find out for himself which side is more correct in the Phillips-Lipsey and Kaldor debate, Rattan J. Bhatia completed two separate studies of the determinants for wage behavior.

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[27]The theoretical structure underlying the arguments advanced in Bowen's study are presented in his, The Wage-Price Issue--A Theoretical Analysis (Princeton, 1960).

In the first study, Bhatia puts the Phillips-Lipsey hypothesis to the test; in the second, he does the same for the Kaldor hypothesis.[28] It is in this way that Bhatia decides whether unemployment or profits is the better explanation of changes in wage rates.

The first study, using unemployment as the wage rate determinant, covers the twentieth century in the three periods 1900-1932, 1933-1948, and 1948-1958. Although a prices variable does not enter directly into any equation, like Phillips, Bhatia excludes from the study those years in which wage rates seem to be influenced by abnormally large changes in the retail price level. Dismissed on this basis are the years 1915-1920, 1933-1934, and 1942-1948.

In the first of the three periods, therefore, the years 1900-1914 and 1921-1932 remain after the purge of rapid price changing years. Bhatia finds the wages unemployment relation for this period to be linear (a result supported only by the Klein and Ball study of the British economy). He thus sticks to a straight line regression equation of the form

$$dE_t = a + bU_t$$

where $dE_t$ is the percentage rate of change of annual money wages, and $U_t$ is the corresponding percentage unemployment. When fitted to the data, the regression equation becomes

$$dE_t = 4.62 - 0.70U_t.$$

The relation has an $R^2$ of 0.80, indicating that 80 percent of the variation in money wage rates can be associated with variations in the unemployment level. When the excluded years 1915-1920 are brought back into

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[28] Rattan J. Bhatia, "Unemployment and the Rate of Change of Money Earnings in the United States, 1900-1958," Economica, N. S. XXVIII (1961), pp. 286-296. The second study, cited earlier, is Bhatia, "Profits."

the analysis, the resulting $R^2$ is only 0.37. Again eliminating the observations for these six years, Bhatia does further experimentation with the equation and includes the influence of percentage rates of change in the level of unemployment ($dU_t$). The basic equation takes the form

$$dE_t = a + bU_t + cdU_t,$$

which, when fitted to the data, becomes

$$dE_t = 4.56 - 0.69U_t - 0.004dU_t.$$

The relation's $R^2$ is 0.81, exhibiting only an insginificant enlargement upon the $R^2$ of 0.80 given by the initial equation. The new variable $dU_t$, therefore, is not considered to be of much use as an explanatory factor.

Bhatia continues to investigate the wages unemployment relation. Into the equation he introduces the rate of change in the cost of living ($dP_t$), imitating Lipsey's improvement upon the Phillips hypothesis. Fitted to the data, the new equation is

$$dE_t = 2.51 - 0.31U_t + 0.64dP_t.$$

The calculated $R^2$ is 0.96. From the size of the coefficient values, Bhatia concludes that the level of unemployment explains about 60 percent of the earnings variance not explained by cost of living changes. Similarly, cost of living changes explain 79 percent of the variations in earnings that are left unexplained by $U_t$. All of the above results are very closely repeated when the same equations are fitted to data from the second period 1935-1941.

The Phillips-Lipsey hypothesis does very poorly, however, in the third period (1948-1958). Bhatia uses the equation

$$dE_t = 5.46 - 0.37U_t - 0.02dU_t + 0.64dP_t$$

and obtains an $R^2$ of only 0.51. The standard errors of the $U_t$ and $dU_t$ coefficients, moreover, are as large as the coefficients themselves.

The results of the study in this period cast doubt over the validity of the postulated relationship. It is Bhatia's conclusion, as a result, that the changing rates of unemployment have no marked influence upon changes in wage rates. And, although there is an appearance of such a relation in the years 1900-1942, the relation is a variable one. A closer association is found to exist between wage rate changes and cost of living changes in each of the three periods studied. Even the wage price relation, however, weakens after 1948.

Bhatia's second study is a test of the Kaldor hypothesis that wage behavior is determined by industry profits. As mentioned earlier, it is Kaldor's suggestion that a study should be made in which wage behavior data is regressed on profits-rate data, because the bargaining strength of labor is effected by business profitability.[29] Kaldor speculates that a time lag of one year will occur between changes in profits and the corresponding adjustments in wages. It is Bhatia's feeling, on the other hand, that this time lag may well not be a multiple of one year. He thus experiments with many different intervals of time. The hypothesis tested is that the rate of change in money earnings might be affected, after some number of months, by the level of profits alone or in combination with the rate of change in that level. He gives separate examination to United States data in the two periods 1935-1948 and 1948-1959.

For the 1935-1948 analysis, Bhatia derives an equation of the form

$$dE = -10.21 + 0.04dP + 55.86P_{-6}.$$

The variable dP is the percentage annual change in profits, P is the level of profits, and--as in the earlier study--dE is the percentage

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[29] Kaldor, p. 292.

rate of change in the level of earnings. The equation relates changes in earnings to the level of profits six months earlier and to the rate of change in the current level of profits. The relation has an $R^2$ of 0.59. The same equation has a much better fit with observations taken from the 1948-1959 period, in which Bhatia obtains an $R^2$ of 0.80. This he interprets to mean that the two profits-variables together explain 80 percent of the variance in the rate of change of earnings.

In comparing the results of the two studies done by Bhatia, it might appear that unemployment and prices do just as well at explaining wage behavior before World War II as profits do after the war. And it may seem that the unemployment-prices variable is no worse a determinant of wage behavior after the war than is the profits variable before the war. These appearances do not coincide, however, with Bhatia's concluding remarks. He feels that his studies show that there is no marked influence of unemployment changes on wage rate changes. The profit factor is believed to be a most important explanatory variable, a conclusion which strongly contrasts with the findings of Bowen and Lipsey and Steuer.

It is Perry's contention that Bhatia's comparison of the Phillips-Lipsey and Kaldor hypotheses is not made fairly. The better results in the post-World War II period which back the Kaldor hypothesis may be due to the fact that the earlier study uses quarterly data and the second study (i.e., Kaldor's theory) uses monthly data. Perry's second criticism is that Bhatia's commitment to one central explanatory factor at a time is unsatisfactory. All of the variables, he feels, should be used together in one simultaneous equation.[30] As is evidenced below,

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[30]Perry, pp. 17-18.

Perry uses this approach with great success.

George L. Perry.--In his study, Perry corrects what he believes to be the shortcomings of the preceding studies by attempting to explain wage changes through the use of several variables--instead of just one or two--in a system of simultaneous equations.[31] He considers the significant determinants of wage behavior to be the levels of profit rates and unemployment and the rates of change in living costs and profits. Quarterly data are used. When using his regression equation to predict wage changes from 1948 through 1963, he finds that, "In no quarter is the error greater than 2 cents per hour, and at the end of the thirteenth quarter of prediction there is no error."[32] To obtain such outstanding results, Perry uses the following equation:

$$W_t = -4.313 + 0.367c_{t-1} + 14.711U_t^{-1} + 0.424R_{t-1} + 0.796dR_t + e_t$$

where $W_t$ is the predicted wage rate, c is the cost of living term, U is the level of unemployment, R is the profit rate, and dR is the percentage rate of change in profits, and e is error. The resulting $R^2$ is 0.870. The rate of change of the level of unemployment (dU) may be substituted for dR without significantly affecting the results.

Perry concludes that the unemployment variable is seen to have, ". . . an important independent effect in determining wage changes throughout the post-war period."[33] He rejects a linear relation between the unemployment level and wage rate changes in favor of a relation that

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[31] Perry, pp. 34-69.

[32] Mid-1960 through mid-1963 is the forecast period. See ibid., p. 85.

[33] Ibid., p. 110.

grows increasingly steeper as one reaches lower unemployment levels. As a result, a change in the rate of wage increases would be a little less than half as great for a change in the unemployment level from 6 percent down to 5 percent as it would be for an unemployment change from 4 percent to 3 percent.

For the living costs variable Perry observed a positive partial correlation with wage rate changes. The cost of living variable becomes increasingly more important in the post-1953 period than it is earlier. Estimating separate equations for various subgroups, the author sees evidence to suggest that costs of living are to some extent more important in the wage behavior of durable goods industries than they are in nondurable goods. The elasticity of wage rates to costs of living is estimated to be about one third for the entire post-World War II period and two thirds for the post-1953 period (up to mid-1963). With regard to a wage price spiral, Perry writes:

> The circular process whereby prices affect wages which in turn affect prices and profits (negatively) gives some appearance of a wage price spiral, but one that disappears rather than becoming explosive or indefinitely self-perpetuating. But although the interplay of wage and price changes does not yield the exaggerated spiral sometimes supposed, neither is it negligible.[34]

Through cost-of-living effects, wage changes thus have some feedback to promote subsequent wage changes in the same direction.

The relation between wage rate changes and profit rate changes seems to be linear, but Perry does not dismiss the possibility of non-linearity. Profits may contribute to inflation in two ways. First, prices may be increased to maximize or restore the profit level, and,

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[34] Ibid., p. 111.

second, profits are identified in the labor market as being a major determinant of wage rate changes.

More generally speaking, the results suggest that the United States economy is, ". . . . mildly inflation-prone. . . ."[35] Because low unemployment rates are generally associated with high profit rates, a certain amount of inflation is necessary if the present economy is to be operated at a low level of unemployment. The degree of inflation to be tolerated seems to be only moderate. A 4 percent unemployment level, for example, is compatible with a 2 percent rate of inflation and an 11.6 percent profit rate.

By way of summary, it can be noted in the foregoing studies that the authors have divided themselves into roughly two groups. The first group subscribes generally to the Phillips-Lipsey hypothesis that wage rate behavior is determined by unemployment variables and (to a lesser extent) by the price variable. In addition to the authors for whom the hypothesis is named, this group includes Dow, Dicks-Mireaux, Klein, Ball, Steuer, and Bowen. Although these men are in a general agreement that unemployment is an important variable, the importance of the price variable is more controversial. The latter is included in the analyses with successful results, but is is used sometimes directly in the regression equation and other times only as a means by which difficult years can be excluded from the study. The second group, far outnumbered by the first, consists of Kaldor and his follower, Bhatia. These two authors consider profits--not unemployment--to be the main determinant of wage behavior. Because a single person cannot very well be considered

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[35] Ibid., p. 108.

as making up a third group, the eclectic Dr. Perry can probably best be thought of as using the best of what each of the two groups has to offer. Perry, in short, considers prices, unemployment, and profits as all being determinants of wage behavior; wage rate changes are regressed on all three variables in a simultaneous equation. It is with Perry's study that the following analysis is most directly comparable.

# CHAPTER IV

## A DESCRIPTION AND CRITICISM OF THE DATA

A statistical analysis can only be as accurate as the quality of the data permits. It should be worthwhile, therefore, for this chapter to describe the original sources of data used in the regression analysis and shown in the appendix. Discussion will also be directed toward a presentation of the procedures used in aggregating monthly data into quarterly figures and a description of the necessary weighting of the trade-unemployment data. The chapter will be concluded with a general criticism of the data.

### Data Sources

The Consumer Price Index is taken from the Monthly Labor Review, a publication of the United States Department of Labor, Bureau of Labor Statistics.[1] The CPI is considered to be a measure of the average change in the retail price level of services and goods purchased by urban families of wage earners and clerical workers. About every ten years the index structure is revised to reflect the newer buying patterns of the group. The indexes are based on purchases made by all urban clerical worker and wage earner consumers. This includes families of two or more persons and single workers living alone. The base period used is 1947-

[1] Monthly Labor Review, Bureau of Labor Statistics, United States Department of Labor, LXX-XC (Washington, 1950-1967), Table D-1.

1949. This is the closest available base period preceding 1950, the first year from which observations are taken for the study. The wage earners and clerical workers represented in the CPI are moderate income workers living in large cities. For a detailed report of the methods used in constructing the CPI, see Changes in Cost of Living in Large Cities in the United States, 1913-1941, Bureau of Labor Statistics Bulletin 699.

The wage rate series was made available by the Oklahoma Employment Security Commission in its Oklahoma Labor Market.[2] The two series used are for hourly and weekly wages. Each series is broken down into wages for all manufacturing, construction, and trade industries. The averages cover both full and part-time employees in production or nonsupervisory positions. Included in the averages are overtime hours and pay, so that both the weekly and hourly wage rates may change to reflect changes in the amount of overtime.

The compensable unemployment series is a measure of the average number of persons actually receiving unemployment insurance benefits by industry as a percentage of the average number of persons covered in the employment series. The unemployment data used in the analysis is for those industry groups also used in the wage rate series (i.e., all manufacturing industries, the trade industry, and the construction industry). Here, again, the source is the Oklahoma Labor Market.[3] Because the trade series of unemployment must be aggregated from the retail and wholesale

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[2] Oklahoma Labor Market, Oklahoma Employment Security Commission, Oklahoma State Employment Service, Research and Planning Division (Oklahoma City, 1950-1967), Table II.

[3] Ibid., Chart VI.

unemployment series, the employment levels in retail and wholesale trade are taken from the Oklahoma Labor Market so that weights may be assigned to the respective unemployment levels in the computation of an unemployment level for trade as a whole.[4] The unemployment estimates are adjusted every two years to first quarter benchmark levels. The benchmark is an aggregation and summation of the most recent employment data for all firms in each industry group. The estimates cover all full and part-time employees working in nonagriculture establishments during any part of the pay period including the 12th of the month. During certain years, the 15th of the month is used as the break-off point.

It had been intended that the regression analysis include a profit rate variable, but the necessary profit data does not appear to be available for Oklahoma. An unsuccessful attempt was made to obtain the data from these sources: Oklahoma State University Library, Oklahoma State Capital Library, Oklahoma University Library, Chief of the Oklahoma Employment Security Commission,[5] Oklahoma State Tax Commission, and Oklahoma's Secretary of State John Rogers.[6] It was suggested by one source that a rough estimate of profits could be made from information supplied by the Census of Manufactures, Area Statistics.[7] Such an estimate would be derived by subtracting industrial expenditures on employees'

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[4] Ibid., Table I.

[5] Mr. W. J. Bowman, Chief of the Oklahoma Employment Security Commission's Research and Planning Division, was seen by appointment on February 26, 1967, in the Will Rogers Memorial Office Building, Oklahoma City.

[6] Secretary of State Rogers was seen by appointment at the capitol in Oklahoma City on February 26, 1967.

[7] The suggestion was made by Professor Francis Cella, Head of the Oklahoma University Business Research Department, in a brief discussion with the author on February 26, 1967, in Norman, Oklahoma.

payroll and new capital from the value added by manufacture. Such a procedure, however, would produce only incomplete results. Not only would the resulting estimate for all manufacturing industries be extremely inaccurate, but estimates for trade and construction profit rates would remain nonexistent.

## Data Aggregation and Weighting

All of the data used in the regression analysis is aggregated from monthly into quarterly observations. George L. Perry suggests that the best possible results of such a study would probably be arrived at when monthly observations are used. It is his feeling that the more detailed data would yield a sharper picture of any existing relationship.[8] There is reason, however, to question the efficacy of monthly observations. Mr. W. J. Bowman, Chief of the Research and Planning Division for the Oklahoma Employment Security Commission, has remarked that he would be very pleased if error in the data of the Oklahoma Labor Market could be kept as low as 1 percent of the stated values.[9] This means that monthly variations less than 1 percent of the observed value may be due entirely to error and do not necessarily indicate a real change in the value of the observed variable. As an example, consider the wage rate implications of this statement. In the 198 monthly observations of the hourly wage rate for all manufacturing industries, only 43 observations showed a wage change greater than 1 percent of the wage rate in the preceding month. This means that almost 88 percent of the observations have vari-

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[8] Perry, p. 17.

[9] Mr. Bowman's opinion was expressed in a discussion with the author on February 26, 1967, in Oklahoma City.

ances so small that the changes could be entirely attributed to error. Mr. Bowman admitted, moreover, that the 1 percent error figure is a conservative estimate. Quarterly data, which provide 66 observations for the years covered by the analysis, are therefore considered to be quite sufficient for the purposes of this study.

The consumer price index is converted into percentage rates of change by the formula:

$$\frac{dc_{t-1}}{c_{t-1}} = \frac{c_t - c_{t-1}}{c_{t-1}},$$

where $c_t$ is the consumer's cost of living in the current quarter. The price variable used in the analysis has a value as determined by this equation:

$$P_t = \frac{c_t - c_{t-1}}{c_{t-1}} + \frac{c_{t-1} - c_{t-2}}{c_{t-2}} + \frac{c_{t-2} - c_{t-3}}{c_{t-3}} + \frac{c_{t-3} - c_{t-4}}{c_{t-4}},$$

where $P_t$ is the value for the price variable in the current quarter.

Although wage rate data is readily available for both retail and wholesale trade workers, the corresponding rate of unemployment data is available only for trade workers as a whole. For this reason it was necessary to combine the wage rate data for retail trade and wholesale trade into an aggregated figure representing the trade industry. Because the wholesale trade workers are outnumbered three-to-one by those persons working in retail establishments, it was necessary to weight the wage rate data for each group before averaging them. The levels of employment for retail and wholesale trades were combined from monthly estimates into yearly figures, which were used to estimate the percent of total trade employment comprised of the workers of each sector. The percent of trade employment in retail and wholesale sectors was multiplied times

the corresponding wage rate figure to obtain the weighted wage rate series for the trade industry group.

## Criticisms of the Data

As pointed out by W. J. Bowman, the Oklahoma data may have an error component as high as 3 to 5 percent. The accuracy of the unemployment and wage series, he says, is to be found in a measurement of the changes in figures--not in the absolute size of figures.[10] The argument is that, if the errors in a previous time period are related to errors in the current period, the errors may be considered to be auto-correlated. To what extent the auto-correlation of errors may exist cannot be determined. Oskar Morgenstern cautions that, "It is unlikely that errors are so conveniently related and so stable in their relationship that they turn out not to matter in the end."[11] It could be, however, that the error is largely due to a bias in the statistics that has been persistent over the time period covered. Bias of this nature would lead to some measure of auto-correlation of errors.

The major limitations of the Consumer Price Index are quite well known. Despite the fact that the index is based on a new basket of goods about every ten years, consumer preferences may be expected to change more rapidly than index would allow. Quality changes in merchandise may not be fully indicated in the index. How well a national index can be applied to just the state of Oklahoma, moreover, cannot be easily determined. In the analysis the CPI is quoted to one-tenth of 1 percent.

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[10] Ibid.

[11] Oskar Morgenstern, On the Accuracy of Economic Observations (Princeton, 1965), p. 57.

This is done out of respect for the possibility that error auto-correlation may exist--not out of blind faith in the absolute level of CPI figures.

The only available source of employment and unemployment series is the Oklahoma Employment Security Commission, which develops its nonfarm wage and salary employment estimates in cooperation with the headquarters and regional offices of two national bureaus. They are the Bureau of Labor Statistics and the Bureau of Employment Security, both part of the United States Department of Labor. It is Morgenstern's opinion that the BLS and BES figures are generally lower and inferior to those cited by the Census Bureau.[12] Unlike the Census Bureau, the BLS and BES exclude domestic service workers, the agricultural laborers, and the self-employed. Another distinguishing factor is that the Census Bureau's estimates are based on a random sample that is geographically stratified. The approximately 35,000 households in the sample are chosen at random from sampling cells in over 300 geographical areas. The BLS series, on the other hand, are based on the reports of over 180,000 establishments rather than households. Where a person holds several jobs at once, the BLS data will duplicate its count. The BES bases its statistics on the unemployment and employment for persons covered by Railroad, State, and Federal Unemployment Insurance laws. Morgenstern concludes that the Census series is superior to the others, because, ". . . the random sampling procedure usually gives the truest picture of the population."[13] These criticisms will be referred to again when the results of the regression analysis are to be explained.

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[12] Ibid., pp. 221-222.

[13] Ibid.

# CHAPTER V

## AGGREGATE MODEL OF WAGE DETERMINATION

This chapter is intended to show whether aggregate wage behavior in Oklahoma can be explained to any extent by the Oklahoma rate of unemployment and the percentage rate of change in the national Cost of Living Index. The purpose of the analysis is to find the best one-equation aggregate model that explains the assumed relationship. Because it is a regression analysis, the model assumes at the outset (and does not pretend to prove or disprove) that the dependent variable, the percentage rate of change in wages, is a function of the two independent variables, unemployment and the CPI. This assumption of a causal relationship is made largely due to the success which G. L. Perry had in a similar study of national data. It should be interesting to see what results can be obtained from an equation formulated to fit statistics on the state level.

The discovery of such an equation has proven to be an exacting and time-consuming task. The simplifying assumptions made in the theoretical model are replaced by complicating factors in the real world. For this reason several attempts are made to fit the data with linear, quadratic, and exponential equations. Each of these three types of equations is used to regress the wage variable on the independent variables for three Oklahoma industry groups--total manufacturing, construction, and trade. In the event that the assumed causal relationship exists more strongly

in some industries than in others, it is hoped that the selected industry groups chosen for the analysis will make this fact evident. For the period 1950-1966 data is not sufficiently available to make possible a broader coverage of industry groups.

The analysis takes advantage of the fact that wage rate data in Oklahoma is readily available in both the hourly and weekly rate forms. The weekly wage rate has the advantage over the hourly rate of being able to indicate changes in the amount of overtime pay received by workers. This is believed to be an important consideration, because an increase in overtime work may have the effect of offsetting partially or wholly the need for an increase in the total number of employees. Were this to happen, the unemployment variable could not be expected to accurately indicate the level of demand for labor. The demand for labor, in effect, has increased without a corresponding decrease in the rate of unemployment, because the existing workers are simply worked for longer hours. To test whether the hourly or weekly wage rate is the better indicator, each is used in each of the regression equations.

### Graphic Representation of Wages and Unemployment

Figure 3 is a semi-logarithmic, three-cycle graph of the behavior of weekly wages (solid lines) and the unemployment inverses (dotted lines) for each of the three Oklahoma industry groups.[1] Because the points plotted represent percentage rates of change--not absolute levels--and because the graph has semi-logarithmic calibrations, a slope of a line shows the percentage rate of change in the percentage rates

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[1]The data used in the graph is taken from Table I-IV in the Appendix.

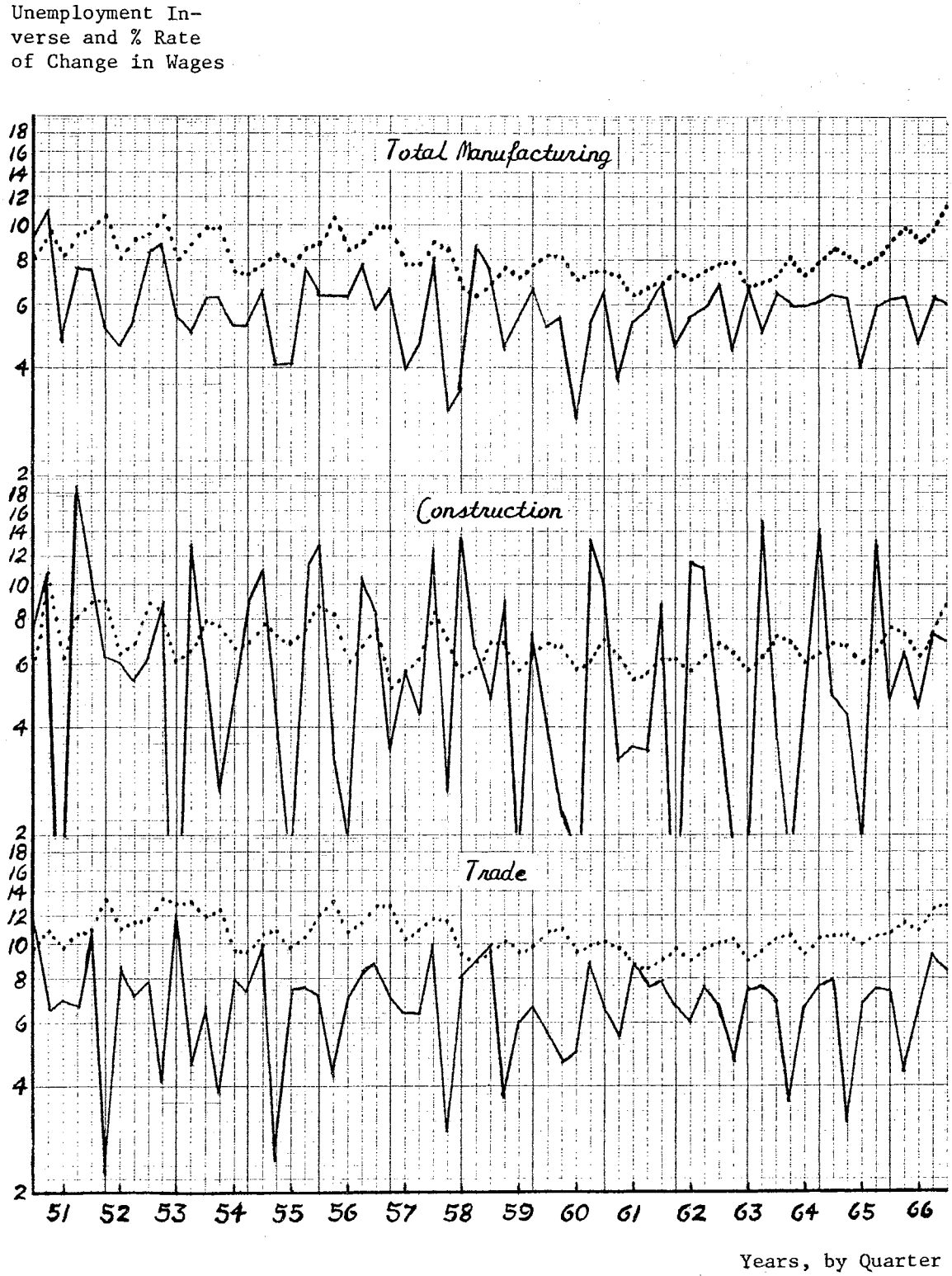


Figure 3. Graphic Representation of the Relationship Between the Unemployment Inverse and the Percentage Rate of Change in Weekly Wages, by Industry Groups--Quarterly Observations: 1950-1966

of unemployment and wage changes. This means that any two lines parallel to each other within the same cycle are an indication that the unemployment rate and wage rate in that interval are changing at the same rate and in the same direction. This permits an easy observation of the variable's rate of change on the vertical axis and an observation of the speed of that rate in the slopes.

The vertical axis is calibrated from 3 to 20 percent. To make the variables more directly comparable, the inverse figure of the unemployment rate is multiplied by ten. This simply narrows the distance between the two lines in each cycle without changing the slopes of the lines. A value of 5 percent is added to each variable value in the manufacturing and construction groups to eliminate negative signs and zero values. For the same reason 6 percent is added in the trade group.

Even a cursory glance at Figure 3 will make it quite evident that the best similarity of behavior between the two variables occurs in the total manufacturing group. The period of best fit in this group is probably 1951-1954, with the period 1958-1960 being the worst. Only on rare occasions do the lines have even similar slopes. Generally, the variations in the two lines show very little relation to one another. The construction industry is vulnerable to seasonal cycles of employment, so that the variations in the wage line for this industry may be a better indication of weather conditions than it is of the responsiveness of the variable to labor demand. In searching for evidence of a functional relationship here, one need not be dismayed by the radical changes in the wage rate line (which even runs down and off the cycle). This could simply mean that wage changes are highly sensitive to changes in the inverse of unemployment. It is also affected by the manner in which

the data is placed on the graph. What is discouraging, however, is the way in which the two lines crisscross and move so frequently in opposite directions. The relationship between the variables appears to be equally weak in the trade industry also. It seems unlikely, therefore, that the introduction of the price variable into the analysis will be a strong enough factor to offset what appears to be such random variation, but this remains to be seen. The quadratic and exponential equations may discover relationships too complicated to be observed casually from Figure 3. As far as the discovery of a functional relationship is concerned, however, the graph is not encouraging.

## Results of the Regression Analysis

The first regression equation used in fitting the data is a quadratic, which is capable of indicating the existence of either a linear or curvilinear relationship. Should the relation be simply a linear one, the squared terms in the equation would be given near-zero coefficients, which would leave the rest of the equation practically unchanged. The quadratic equation is of the form

$$Y = a + bX_1 + cX_1^2 + fX_2 + gX_2^2 + hX_1X_2.$$

These general symbols can be replaced by symbols more easily recognized as representing the real factors. The percentage rate of change in the wage rate from the last quarter to the current quarter is indicated by W. The subscripts w and h will be attached to this symbol to indicate weekly and hourly rates, respectively. The price variable (P) shows the percentage rate of change in the CPI from the quarter in time period t-4 to the current quarter in time period t. The symbol $U^{-1}$ is the inverse of the rate of unemployment in the current quarter. Attached

to W and $U^{-1}$ will be the subscripts m, c, and t, indicating the economic sectors, total manufacturing, construction, and trade, respectively. Thus, the equation formulated for the weekly wage rate in manufacturing becomes

$$W_{w,m} = a + bP + cP^2 + fU_m^{-1} + gU_m^{-2} + hPU_m^{-1} .$$

When fitted to the data, the equation has coefficient values of this form:

$$(1)\quad W_{w,m} = .1796 + .5986P - .04107P^2 + 1.7728U_m^{-1} + .7607U_m^{-2} - .4689PU_m^{-1} .$$

The $R^2$ for this equation is computed as follows:

$$R^2 = \frac{\text{regression sum of squares}}{\text{corrected total sum of squares}} = \frac{8.004}{87.274} = .0917 .$$

Similarly, equation (2) can be fitted to the data for a determination of the hourly wage rate in the manufacturing industry group. This becomes:

$$(2)\quad W_{h,m} = .9001 + .3434P + .007495P^2 + 8.9269U_m^{-1} - 10.0486U_m^{-2} - .4994PU_m^{-1} ,$$

where

$$R^2 = \frac{11.001}{55.875} = .1968 .$$

The other four equations can be written in a like manner with the following results:

$$(3)\quad W_{w,c} = 5.1989 - .9387P + .2300P^2 - 10.8677U_c^{-1} + 45.4459U_c^{-2} - 3.5049PU_c^{-1} ,$$

where

$$R^2 = \frac{69.844}{481.484} = .1450 .$$

(4) $$W_{h,c} = 2.5366 - .0183P + .0404P^2 - 3.3057U_c^{-1} + 1.4876U_c^{-2} - .6192U_c^{-1},$$

where

$$R^2 = \frac{14.814}{119.996} = .1234 .$$

(5) $$W_{w,t} = 1.6819 + .1456P - .03601P^2 - 1.3793U_t^{-1} + 1.7996U_t^{-2} + .4347PU_t^{-1},$$

where

$$R^2 = \frac{6.993}{106.538} = .0656 .$$

(6) $$W_{h,t} = 1.1864 - .2595P + .02044P^2 + 3.6631U_t^{-1} - 4.3577U_t^{-2} + .1575PU_t^{-1},$$

where

$$R^2 = \frac{1.406}{173.424} = .0081 .$$

It is apparent that the best quadratic regression is equation (2), which is formulated for the hourly wage rate for the manufacturing industry group. The $R^2$ for that equation, about 0.20, is far larger than the others. Even so, variation in the independent variables can only be shown to explain about 20 percent of the variation in the hourly wage rate. Judging from the relatively large coefficient for the squared unemployment variable, it appears that a curvilinear regression equation

better fits the data than a strictly linear one. Note also that the coefficients for both of the unemployment variables are far greater than the coefficient values for the price variables or the price-unemployment interaction variable. This would suggest that most of the variation in the dependent variable that is explained by the equation is mostly explained by variations in unemployment--not price. But even these conservative statements are not too meaningful, considering that the $R^2$ is only about 0.20.

The next highest $R^2$ is only 0.145. It is derived from equation (3), fitted to data in the construction industry for the determination of the weekly wage rate. Again, the relationship--small as it is--is nonlinear and the unemployment variables have far more explanatory power than the price variables. The same results are found in the third best equation (No. 4), which has an $R^2$ of 0.1234. One major distinction, however, can be noted between industries. The hourly wage is better explained than the weekly wage in manufacturing as a whole, but the reverse is true in both the construction and trade industries (where the $R^2$ is greater for the weekly wage determination). It is also interesting to note that the trade industry data has the weakest fit with the quadratic equation while the manufacturing industry data has the strongest fit. However, when the highest $R^2$ of about 0.20 in this analysis is compared with Perry's $R^2$ of 0.73 for a similar equation fitted to national data over very nearly the same time period,[1] none of the above equations can be said to have resulted in a significant $R^2$.

In an attempt to improve upon the hint of a relationship in the

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[1]Perry covers the period 1948-1960. See Perry, p. 43.

manufacturing industry, an exponential equation was fitted to the data in this group for the determination of both the weekly and hourly wage rates. The exponential equation is of the form

$$Y = a + be^{cX} ,$$

which, when formulated for the weekly wage rate and fitted to manufacturing wage and price data, becomes:

$$(7) \quad W_{w,m} = -11 + 12.061e^{.01062P} .$$

From this equation we obtain

$$R^2 = \frac{.0212}{.5056} = .0419 .$$

Formulated for the hourly wage rate, the equation is

$$(8) \quad W_{h,m} = -7 + 7.7679e^{.02343P} ,$$

where

$$R^2 = \frac{.1032}{.7447} = .1385 .$$

The $R^2$ for each exponential equation is insignificant, so that it can be concluded that wage rate behavior is not explained by any significant extent by variations in the price variable. It may be stated, therefore, that neither the hourly nor weekly wage variations in any industry group studied have been significantly explained by variations in the independent variables. This finding is true for each equation formulation in each of the three industry groups.

# CHAPTER VI

## SUMMARY AND CONCLUSIONS

In putting ivory tower theory to an empirical test, this study has been unable to find a regression equation that can significantly explain wage behavior in terms of price and unemployment variations. Both hourly and weekly wage rates have been regressed on price and unemployment variables for each of three industry groups--total manufacturing, construction, and trade. Out of the six quadratic and two exponential equations formulated, the highest $R^2$ value was found to be about 0.20 when an hourly wage rate was regressed on national price data and manufacturing unemployment statistics. Stating that any one of the equations resulted in a better fit with the data than the other equations would be almost as meaningless as saying that the equation was better than nothing.

It can be observed from the coefficient values that the unemployment variables appear consistently throughout the quadratic equations to have more explanatory power than the price variables. It is also evident that the indicated relationships--as small as they are--are strongly curvilinear. Considering the insignificance of the observed relation, however, it must be concluded that these two observations are void of implicative power. Even with the equation best fitting the data, 80 percent of variations in the dependent variable is left to be explained by factors other than the independent variables.

How can these results be compared to those of recent studies in

the same area? It is important to keep in mind that all of the other studies reviewed have been conducted on the national level. Among the results of those studies, Lipsey was able to obtain an $R^2$ of 0.88 covering the years 1920-1939 and 1947-1957. The high value of his $R^2$ may be due to many factors that are peculiar to national data that are not true for a smaller aggregation of statistics. Extraneous variation, for one thing, may be greater for statistics on the state level that it is on the national level. Note also that Lipsey eliminates from his analysis some periods of years in which the observations do not so neatly fit his equations. Several studies have found, moreover, that the post-World War II years are the most difficult ones in which to find a relationship between wages, prices, and unemployment. Lipsey's inclusion of the 1920-1939 period, therefore, may well have raised the resulting $R^2$ considerably higher than it would have been for the 1947-1957 period alone. Lipsey's study, because it is concerned with United Kingdom data, is really not directly comparable with this analysis.

The only study that can be very easily compared to this one is that analysis made by Perry, who studied the years 1948-1960. Perry obtains an $R^2$ of 0.73 when regressing wage variations on changes in the CPI and the unemployment rate for all manufacturing industries in the United States. Perry's relatively high $R^2$ may be due in part to a greater accuracy in available data on the national level. It may be that Oklahoma statistics are less reliable estimates. The elements of pure competition, moreover, may be stronger on the national level than they are on the state level. This is to say that the simplifying assumptions made for the theoretical model may be more realistic for the nation as a whole than they are for a small part of the nation. Labor may appear

to be more homogeneous and interchangeable in a large aggregative analysis than it is in a smaller one. Manufacturing may be more competitive in the United States as a whole than it is in Oklahoma. Prices, moreover, may well be more flexible when entire industries are taken into consideration than when just a few Oklahoma firms are included.

All of the above factors may be combining to make the results of this analysis so different from those obtained by Perry. It is possible that, using the same data which has been fitted to the foregoing equations, a much better regression equation could eventually be found that would explain a significant amount of the variation in wage rates for each of the industry groups. The results of this study show, however, that the proposed relationship between wages and prices and unemployment is strongest in the largest aggregative group (all manufacturing industries) and weakest in the smallest aggregative group (i.e., trade, where fewer persons are employed than in the other two groups). If the strength of such a functional relationship is, in fact, related to the number of employees encompassed by the study, then it cannot be expected that any regional or state analysis of aggregate wage behavior will meet with the success of a comparable analysis directed at the national level. This would be true unless another factor, like the increased availability of statistics, were to so strongly favor state level studies that the aggregative effect were negated and offset. As far as Oklahoma is concerned, however, it does not appear that this type of compensation exists. Profit data, for example, which is used successfully by Bhatia and Perry to help explain United States aggregate wage behavior, is unavailable for Oklahoma industry groups. If one hopes to meet with much success in explaining Oklahoma wage behavior in the period 1950-

1966, the results of this study indicate that he needs to incorporate variables into the analysis that have not been included in this one. The simple macroeconomic model, therefore, appears to be an insufficient explanation of wage behavior for the firms included in this study. It may well be that, in a state which is no more industrialized than Oklahoma, a microeconomic model (with a complex system of time lags and numerous variables) would be a better explanation of aggregate wage behavior.

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# APPENDIX

## TABLE I

## CONSUMER PRICE INDEX 1950-66

## BY QUARTERS

| | | CPI $c_t$ | $\frac{c_t - c_{t-1}}{c_{t-1}}$ | $P_t$ |
|---|---|---|---|---|
| 1950 | 3 | 103.7 | 1.382 | 2.678 |
| | 4 | 106.0 | 2.218 | 4.896 |
| 1951 | 1 | 109.6 | 3.396 | 7.692 |
| | 2 | 110.7 | 1.004 | 8.000 |
| | 3 | 111.1 | 0.361 | 6.979 |
| | 4 | 112.7 | 1.440 | 6.201 |
| 1952 | 1 | 112.6 | -0.089 | 2.716 |
| | 2 | 113.1 | 0.444 | 2.156 |
| | 3 | 114.2 | 0.973 | 2.768 |
| | 4 | 114.2 | 0.000 | 1.328 |
| 1953 | 1 | 113.8 | -0.350 | 1.067 |
| | 2 | 114.1 | 0.263 | 0.885 |
| | 3 | 115.0 | 0.783 | 0.695 |
| | 4 | 115.1 | 0.087 | 0.783 |
| 1954 | 1 | 115.0 | -0.087 | 1.046 |
| | 2 | 114.9 | -0.087 | 0.696 |
| | 3 | 115.0 | 0.087 | 0.000 |
| | 4 | 114.5 | -0.435 | -0.522 |
| 1955 | 1 | 114.3 | -0.175 | -0.610 |
| | 2 | 114.3 | 0.000 | -0.523 |
| | 3 | 114.7 | 0.350 | -0.260 |
| | 4 | 114.9 | 0.174 | 0.349 |
| 1956 | 1 | 114.6 | -0.261 | 0.263 |
| | 2 | 115.5 | 0.785 | 1.048 |
| | 3 | 117.0 | 1.299 | 1.997 |
| | 4 | 117.9 | 0.769 | 2.592 |
| 1957 | 1 | 118.6 | 0.594 | 3.447 |
| | 2 | 119.7 | 0.927 | 3.589 |
| | 3 | 121.0 | 1.086 | 3.376 |
| | 4 | 121.4 | 0.331 | 2.938 |
| 1958 | 1 | 122.7 | 1.071 | 3.415 |
| | 2 | 123.6 | 0.733 | 3.221 |
| | 3 | 123.8 | 0.162 | 2.297 |
| | 4 | 123.8 | 0.000 | 1.966 |
| 1959 | 1 | 123.8 | 0.000 | 0.895 |
| | 2 | 124.3 | 0.404 | 0.566 |
| | 3 | 125.0 | 0.563 | 0.967 |
| | 4 | 125.5 | 0.400 | 1.367 |
| 1960 | 1 | 125.6 | 0.080 | 1.447 |
| | 2 | 126.3 | 0.557 | 1.600 |
| | 3 | 126.7 | 0.317 | 1.354 |
| | 4 | 127.4 | 0.552 | 1.506 |
| 1961 | 1 | 127.5 | 0.078 | 1.504 |
| | 2 | 127.5 | 0.000 | 0.947 |
| | 3 | 128.1 | 0.470 | 1.100 |
| | 4 | 128.3 | 0.156 | 0.704 |
| 1962 | 1 | 128.6 | -0.078 | 0.548 |
| | 2 | 129.1 | 0.389 | 0.937 |
| | 3 | 129.7 | 0.465 | 0.932 |
| | 4 | 130.0 | 0.231 | 1.007 |
| 1963 | 1 | 130.2 | 0.154 | 1.239 |
| | 2 | 130.5 | 0.230 | 1.080 |
| | 3 | 131.4 | 0.690 | 1.305 |
| | 4 | 131.8 | 0.304 | 1.378 |
| 1964 | 1 | 132.1 | 0.228 | 1.452 |
| | 2 | 132.4 | 0.227 | 1.449 |
| | 3 | 132.9 | 0.377 | 1.136 |
| | 4 | 133.3 | 0.309 | 1.141 |
| 1965 | 1 | 133.6 | 0.225 | 1.138 |
| | 2 | 134.6 | 0.748 | 1.659 |
| | 3 | 135.1 | 0.371 | 1.653 |
| | 4 | 135.8 | 0.518 | 1.862 |
| 1966 | 1 | 136.8 | 0.736 | 2.373 |
| | 2 | 138.2 | 1.900 | 3.525 |
| | 3 | 139.6 | 1.013 | 4.167 |

TABLE II

WAGE AND UNEMPLOYMENT DATA FOR OKLAHOMA MANUFACTURING INDUSTRIES

1950-66 BY QUARTERS

| | | Wages | | | | Unemployment | |
|---|---|---|---|---|---|---|---|
| | | Absolute | | Rate of Change | | | |
| | | Weekly | Hourly | Weekly | Hourly | U | $U^{-1}$ |
| 1950 | 3 | 57.42 | 1.35 | 4.590 | 2.273 | 3.2 | .3125 |
| | 4 | 60.82 | 1.41 | 5.921 | 4.444 | 2.2 | .4545 |
| 1951 | 1 | 60.69 | 1.46 | - .214 | 3.546 | 3.4 | .2941 |
| | 2 | 62.29 | 1.48 | 2.636 | 2.055 | 2.3 | .4348 |
| | 3 | 63.84 | 1.50 | 2.488 | 1.351 | 2.1 | .4762 |
| | 4 | 63.99 | 1.48 | .235 | -1.333 | 1.9 | .5263 |
| 1952 | 1 | 63.71 | 1.51 | - .438 | 2.027 | 3.4 | .2941 |
| | 2 | 63.99 | 1.54 | .439 | 1.987 | 2.4 | .4167 |
| | 3 | 66.22 | 1.59 | 3.485 | 3.247 | 2.2 | .4545 |
| | 4 | 68.94 | 1.61 | 4.108 | 1.258 | 1.8 | .5556 |
| 1953 | 1 | 69.34 | 1.61 | .580 | 3.727 | 3.2 | .3125 |
| | 2 | 69.31 | 1.68 | - .043 | .599 | 2.7 | .3704 |
| | 3 | 70.23 | 1.70 | 1.327 | 1.190 | 2.0 | .5000 |
| | 4 | 71.14 | 1.70 | 1.296 | 0.000 | 2.0 | .5000 |
| 1954 | 1 | 71.37 | 1.73 | .323 | 1.765 | 4.0 | .2500 |
| | 2 | 71.53 | 1.73 | .224 | 0.000 | 4.3 | .2326 |
| | 3 | 72.71 | 1.75 | 1.650 | 1.156 | 3.7 | .2703 |
| | 4 | 72.09 | 1.74 | - .853 | - .571 | 3.0 | .3334 |
| 1955 | 1 | 71.47 | 1.73 | - .860 | - .575 | 3.7 | .2703 |
| | 2 | 73.51 | 1.77 | 2.854 | 2.312 | 2.7 | .3704 |
| | 3 | 74.58 | 1.80 | 1.456 | 1.695 | 2.3 | .4348 |
| | 4 | 75.58 | 1.81 | 1.341 | .556 | 1.9 | .5263 |
| 1956 | 1 | 76.47 | 1.85 | 1.178 | 2.210 | 3.0 | .3334 |
| | 2 | 78.55 | 1.90 | 2.720 | 2.703 | 2.6 | .3846 |
| | 3 | 79.16 | 1.92 | .777 | 1.053 | 2.0 | .5000 |
| | 4 | 80.56 | 1.94 | 1.769 | 1.042 | 2.0 | .5000 |
| 1957 | 1 | 79.68 | 1.94 | -1.092 | 0.000 | 3.7 | .2703 |
| | 2 | 79.52 | 1.96 | - .201 | 1.031 | 3.7 | .2703 |
| | 3 | 82.07 | 2.00 | 3.207 | 2.041 | 2.6 | .3846 |
| | 4 | 80.47 | 2.01 | -1.950 | .500 | 2.7 | .3704 |
| 1958 | 1 | 79.27 | 2.00 | -1.491 | - .498 | 6.0 | .1667 |
| | 2 | 82.23 | 2.04 | 3.734 | 2.000 | 7.3 | .1370 |
| | 3 | 84.19 | 2.06 | 2.384 | .980 | 4.8 | .2083 |
| | 4 | 83.83 | 2.03 | - .428 | -1.456 | 3.9 | .2564 |
| 1959 | 1 | 84.32 | 2.05 | .585 | .985 | 5.4 | .1852 |
| | 2 | 86.05 | 2.08 | 2.052 | 1.463 | 3.6 | .2778 |
| | 3 | 86.18 | 2.09 | .151 | .481 | 3.0 | .3334 |
| | 4 | 86.60 | 2.08 | .487 | - .478 | 3.2 | .3125 |
| 1960 | 1 | 84.64 | 2.09 | -2.263 | .481 | 4.9 | .2041 |
| | 2 | 84.98 | 2.10 | .402 | .478 | 4.4 | .2273 |
| | 3 | 86.66 | 2.10 | 1.977 | 0.000 | 4.3 | .2326 |
| | 4 | 85.41 | 2.09 | -1.442 | - .476 | 5.2 | .1923 |
| 1961 | 1 | 85.87 | 2.12 | .539 | 1.435 | 7.4 | .1351 |
| | 2 | 86.70 | 2.13 | .967 | .472 | 5.9 | .1695 |
| | 3 | 88.53 | 2.14 | 2.111 | .469 | 5.2 | .1923 |
| | 4 | 88.01 | 2.15 | - .587 | .467 | 3.8 | .2632 |
| 1962 | 1 | 88.52 | 2.17 | .579 | .930 | 4.9 | .2041 |
| | 2 | 89.48 | 2.17 | 1.085 | 0.000 | 4.1 | .2439 |
| | 3 | 91.29 | 2.20 | 2.023 | 1.382 | 3.6 | .2778 |
| | 4 | 91.12 | 2.21 | - .186 | .455 | 3.4 | .2941 |
| 1963 | 1 | 93.00 | 2.25 | 2.063 | 1.810 | 5.8 | .1724 |
| | 2 | 93.02 | 2.26 | .022 | .444 | 4.8 | .2083 |
| | 3 | 94.24 | 2.28 | 1.312 | .885 | 4.2 | .2381 |
| | 4 | 95.25 | 2.29 | 1.072 | .439 | 3.0 | .3334 |
| 1964 | 1 | 96.22 | 2.32 | 1.018 | 1.310 | 4.3 | .2326 |
| | 2 | 97.30 | 2.33 | 1.122 | .431 | 3.3 | .3030 |
| | 3 | 98.88 | 2.36 | 1.624 | 1.288 | 2.8 | .3571 |
| | 4 | 100.24 | 2.37 | 1.375 | .424 | 2.9 | .3448 |
| 1965 | 1 | 99.39 | 2.38 | - .848 | .422 | 3.7 | .2703 |
| | 2 | 100.38 | 2.40 | .996 | .840 | 3.1 | .3226 |
| | 3 | 101.64 | 2.42 | 1.255 | .833 | 2.4 | .4167 |
| | 4 | 103.01 | 2.43 | 1.348 | .413 | 2.0 | .5000 |
| 1966 | 1 | 102.75 | 2.46 | - .252 | 1.235 | 2.6 | .3846 |
| | 2 | 104.14 | 2.50 | 1.353 | 1.626 | 2.0 | .5000 |
| | 3 | 105.11 | 2.52 | .931 | .800 | 1.5 | .6667 |

TABLE III

WAGE AND UNEMPLOYMENT DATA FOR OKLAHOMA CONSTRUCTION INDUSTRIES

1950-66 BY QUARTERS

| | | Wages | | | | Unemployment | |
|---|---|---|---|---|---|---|---|
| | | Absolute | | Rate of Change | | U | $U^{-1}$ |
| | | Weekly | Hourly | Weekly | Hourly | | |
| 1950 | 3 | 62.31 | 1.69 | 2.433 | 3.049 | 7.0 | .1429 |
| | 4 | 66.09 | 1.69 | 6.066 | 0.000 | 4.4 | .6286 |
| 1951 | 1 | 59.60 | 1.79 | - 9.820 | 5.917 | 9.8 | .1020 |
| | 2 | 67.90 | 1.80 | 13.926 | .559 | 4.8 | .2083 |
| | 3 | 71.49 | 1.84 | 5.287 | 2.222 | 3.3 | .3030 |
| | 4 | 72.37 | 1.93 | 1.231 | 4.891 | 3.2 | .3125 |
| 1952 | 1 | 73.18 | 1.90 | .981 | -1.554 | 9.0 | .1111 |
| | 2 | 73.39 | 1.86 | .287 | -2.105 | 5.6 | .1786 |
| | 3 | 74.31 | 1.85 | 1.254 | - .538 | 3.4 | .2941 |
| | 4 | 77.49 | 1.91 | 4.279 | 3.243 | 4.0 | .2500 |
| 1953 | 1 | 69.69 | 1.94 | -10.066 | 1.571 | 9.2 | .1087 |
| | 2 | 75.53 | 2.02 | 8.380 | 4.124 | 6.5 | .1538 |
| | 3 | 75.93 | 1.96 | .530 | -2.970 | 5.0 | .2000 |
| | 4 | 74.10 | 1.94 | - 2.410 | -1.020 | 6.0 | .1667 |
| 1954 | 1 | 73.99 | 1.99 | - .148 | 2.577 | 14.2 | .0704 |
| | 2 | 76.71 | 2.07 | 3.676 | 4.020 | 10.4 | .0962 |
| | 3 | 81.01 | 2.07 | 5.606 | 0.000 | 5.8 | .1724 |
| | 4 | 78.12 | 2.02 | - 3.567 | -2.415 | 7.7 | .1299 |
| 1955 | 1 | 74.45 | 2.05 | - 4.698 | 1.485 | 13.8 | .0725 |
| | 2 | 78.80 | 2.14 | 5.843 | 4.390 | 6.3 | .1587 |
| | 3 | 85.50 | 2.12 | 8.503 | - .935 | 3.5 | .2857 |
| | 4 | 83.99 | 2.17 | - 1.766 | 2.358 | 4.1 | .2439 |
| 1956 | 1 | 80.26 | 2.16 | - 4.441 | - .461 | 10.9 | .0917 |
| | 2 | 84.74 | 2.19 | 5.582 | 1.389 | 5.7 | .1754 |
| | 3 | 86.99 | 2.23 | 2.655 | 1.826 | 3.6 | .2778 |
| | 4 | 85.62 | 2.31 | - 1.575 | 3.587 | 4.9 | .2041 |
| 1957 | 1 | 86.36 | 2.37 | .864 | 2.597 | 12.4 | .0806 |
| | 2 | 85.77 | 2.41 | - .683 | 1.688 | 7.7 | .1299 |
| | 3 | 92.21 | 2.41 | 7.508 | 0.000 | 3.0 | .3334 |
| | 4 | 89.88 | 2.48 | - 2.527 | 2.905 | 4.7 | .2128 |
| 1958 | 1 | 97.49 | 2.44 | 8.467 | -1.613 | 14.5 | .0690 |
| | 2 | 98.62 | 2.41 | 1.159 | -1.230 | 12.2 | .0820 |
| | 3 | 98.06 | 2.41 | - .568 | 0.000 | 5.4 | .1852 |
| | 4 | 101.84 | 2.42 | 3.855 | .415 | 5.1 | .1961 |
| 1959 | 1 | 98.24 | 2.56 | - 3.535 | 5.785 | 12.5 | .0800 |
| | 2 | 100.65 | 2.58 | 2.453 | .781 | 7.4 | .1351 |
| | 3 | 99.78 | 2.61 | - .864 | 1.163 | 4.8 | .2083 |
| | 4 | 97.20 | 2.65 | - 2.586 | 1.533 | 5.9 | .1695 |
| 1960 | 1 | 90.78 | 2.72 | - 6.605 | 2.642 | 14.3 | .0699 |
| | 2 | 99.36 | 2.63 | 9.451 | -3.309 | 8.3 | .1205 |
| | 3 | 104.18 | 2.67 | 4.851 | 1.521 | 4.3 | .2326 |
| | 4 | 102.44 | 2.71 | - 1.670 | 1.498 | 7.6 | .1316 |
| 1961 | 1 | 101.04 | 2.63 | - 1.367 | -2.952 | 16.1 | .0621 |
| | 2 | 99.52 | 2.62 | - 1.504 | - .380 | 12.2 | .0820 |
| | 3 | 103.56 | 2.71 | 4.059 | 3.435 | 7.2 | .1389 |
| | 4 | 97.52 | 2.77 | - 5.832 | 2.214 | 7.1 | .1408 |
| 1962 | 1 | 104.09 | 2.81 | 6.737 | 1.444 | 12.5 | .0800 |
| | 2 | 110.41 | 2.77 | 6.072 | -1.423 | 7.4 | .1351 |
| | 3 | 110.23 | 2.70 | - .163 | -2.527 | 5.0 | .2000 |
| | 4 | 105.99 | 2.71 | - 3.847 | .370 | 6.6 | .1515 |
| 1963 | 1 | 102.06 | 2.80 | - 3.708 | 3.321 | 13.0 | .0769 |
| | 2 | 112.93 | 2.75 | 10.650 | -1.786 | 7.5 | .1334 |
| | 3 | 111.73 | 2.82 | - 1.063 | 2.545 | 4.4 | .2273 |
| | 4 | 107.19 | 2.88 | - 4.063 | 2.128 | 4.8 | .2083 |
| 1964 | 1 | 106.93 | 2.91 | - .336 | 1.042 | 10.7 | .0935 |
| | 2 | 116.54 | 2.92 | 9.089 | .344 | 6.5 | .1538 |
| | 3 | 116.45 | 2.95 | - .077 | 1.027 | 4.6 | .2174 |
| | 4 | 115.59 | 3.04 | - .739 | 3.051 | 5.7 | .1754 |
| 1965 | 1 | 111.07 | 3.13 | - 3.910 | 2.961 | 9.6 | .1042 |
| | 2 | 120.38 | 3.10 | 8.382 | - .958 | 6.0 | .1667 |
| | 3 | 119.75 | 3.05 | - .523 | -1.613 | 3.8 | .2632 |
| | 4 | 121.82 | 3.14 | 1.729 | 2.951 | 4.1 | .2439 |
| 1966 | 1 | 121.49 | 3.23 | - .271 | 2.866 | 8.7 | .1149 |
| | 2 | 124.17 | 3.22 | 2.206 | - .310 | 4.0 | .2500 |
| | 3 | 126.73 | 3.24 | 2.062 | .621 | 2.4 | .4167 |

TABLE IV

WAGE AND UNEMPLOYMENT DATA FOR OKLAHOMA TRADE INDUSTRIES

1950-66 BY QUARTERS

| | | Wages | | | | Unemployment | |
|---|---|---|---|---|---|---|---|
| | | Absolute | | Rate of Change | | | |
| | | Weekly | Hourly | Weekly | Hourly | U | $U^{-1}$ |
| 1950 | 3 | 49.70 | 1.13 | 5.007 | 3.670 | 2.8 | .3571 |
| | 4 | 49.47 | 1.12 | .463 | - .885 | 1.9 | .5263 |
| 1951 | 1 | 49.99 | 1.15 | 1.051 | 2.679 | 2.7 | .3704 |
| | 2 | 50.37 | 1.15 | .760 | 0.000 | 2.1 | .4762 |
| | 3 | 52.86 | 1.18 | 4.943 | 2.609 | 2.0 | .5000 |
| | 4 | 50.83 | 1.19 | -3.840 | .847 | 1.3 | .7692 |
| 1952 | 1 | 52.22 | 1.22 | 2.735 | 2.521 | 2.1 | .4762 |
| | 2 | 52.72 | 1.23 | .957 | .820 | 1.8 | .5556 |
| | 3 | 53.82 | 1.25 | 2.086 | 1.626 | 1.7 | .5882 |
| | 4 | 52.76 | 1.25 | -1.970 | 0.000 | 1.3 | .7692 |
| 1963 | 1 | 56.21 | 1.30 | 6.539 | 4.000 | 2.0 | .5000 |
| | 2 | 55.24 | 1.29 | -1.726 | - .769 | 1.9 | .5263 |
| | 3 | 56.27 | 1.31 | 1.684 | 1.550 | 1.7 | .5882 |
| | 4 | 54.94 | 1.30 | -2.186 | - .763 | 1.6 | .6250 |
| 1954 | 1 | 56.04 | 1.30 | 2.002 | 0.000 | 2.7 | .3704 |
| | 2 | 56.75 | 1.32 | 1.267 | 1.538 | 2.9 | .3448 |
| | 3 | 59.05 | 1.36 | 4.053 | 3.030 | 2.3 | .4348 |
| | 4 | 56.91 | 1.34 | -3.624 | -1.471 | 2.2 | .4545 |
| 1955 | 1 | 57.82 | 1.45 | 1.599 | 8.209 | 2.8 | .3571 |
| | 2 | 58.73 | 1.35 | 1.574 | -6.897 | 2.2 | .4545 |
| | 3 | 59.40 | 1.41 | 1.141 | 4.444 | 1.7 | .5882 |
| | 4 | 58.33 | 1.39 | -1.801 | -1.418 | 1.3 | .7692 |
| 1956 | 1 | 58.88 | 1.40 | .943 | - .719 | 2.1 | .4762 |
| | 2 | 60.24 | 1.44 | 2.310 | 2.857 | 1.8 | .5556 |
| | 3 | 62.17 | 1.48 | 3.038 | 2.778 | 1.5 | .6667 |
| | 4 | 61.57 | 1.47 | .965 | - .676 | 1.4 | .7143 |
| 1957 | 1 | 61.80 | 1.47 | .374 | 0.000 | 2.3 | .4348 |
| | 2 | 62.04 | 1.49 | .388 | 1.361 | 2.1 | .4762 |
| | 3 | 64.61 | 1.53 | 4.142 | 2.685 | 1.7 | .5882 |
| | 4 | 62.68 | 1.51 | -2.987 | -1.307 | 1.7 | .5882 |
| 1958 | 1 | 63.96 | 1.50 | 2.042 | - .662 | 3.2 | .3125 |
| | 2 | 65.69 | 1.50 | 2.705 | 0.000 | 3.7 | .2703 |
| | 3 | 68.11 | 1.59 | 3.684 | 6.000 | 2.9 | .3448 |
| | 4 | 66.50 | 1.55 | -2.364 | -2.516 | 2.4 | .4167 |
| 1959 | 1 | 66.50 | 1.58 | 0.000 | 1.935 | 3.1 | .3226 |
| | 2 | 66.97 | 1.59 | .707 | .633 | 2.5 | .4000 |
| | 3 | 66.87 | 1.60 | - .149 | .629 | 2.0 | .5000 |
| | 4 | 65.98 | 1.59 | -1.331 | - .625 | 1.9 | .5263 |
| 1960 | 1 | 65.34 | 1.57 | - .970 | -1.258 | 2.8 | .3571 |
| | 2 | 67.38 | 1.63 | 3.122 | 3.822 | 2.6 | .3846 |
| | 3 | 67.86 | 1.62 | .712 | - .613 | 2.4 | .4167 |
| | 4 | 67.31 | 1.62 | - .810 | 0.000 | 2.5 | .4000 |
| 1961 | 1 | 69.41 | 1.67 | 3.120 | 3.086 | 3.7 | .2703 |
| | 2 | 70.58 | 1.69 | 1.686 | 1.198 | 3.8 | .2632 |
| | 3 | 71.92 | 1.71 | 1.899 | 1.183 | 3.2 | .3125 |
| | 4 | 72.36 | 1.73 | .612 | 1.170 | 2.6 | .3846 |
| 1962 | 1 | 72.37 | 1.74 | .014 | .578 | 3.3 | .3030 |
| | 2 | 73.88 | 1.78 | 2.086 | 2.299 | 2.7 | .3704 |
| | 3 | 74.45 | 1.78 | .772 | 0.000 | 2.4 | .4167 |
| | 4 | 73.47 | 1.77 | -1.316 | - .562 | 2.3 | .4348 |
| 1963 | 1 | 74.64 | 1.79 | 1.592 | 1.130 | 3.0 | .3334 |
| | 2 | 75.91 | 1.80 | 1.702 | .559 | 2.7 | .3704 |
| | 3 | 76.57 | 1.80 | .869 | 0.000 | 2.4 | .4167 |
| | 4 | 74.85 | 1.80 | -2.246 | 0.000 | 2.1 | .4762 |
| 1964 | 1 | 75.31 | 1.81 | .615 | .556 | 2.9 | .3448 |
| | 2 | 76.55 | 1.82 | 1.647 | .552 | 2.4 | .4167 |
| | 3 | 78.06 | 1.84 | 1.973 | 1.099 | 2.1 | .4762 |
| | 4 | 75.95 | 1.83 | -2.703 | - .543 | 2.1 | .4762 |
| 1965 | 1 | 76.52 | 1.85 | .750 | 1.093 | 2.5 | .4000 |
| | 2 | 77.79 | 1.86 | 1.660 | .541 | 2.2 | .4545 |
| | 3 | 79.06 | 1.90 | 1.633 | 2.151 | 2.0 | .5000 |
| | 4 | 77.76 | 1.88 | -1.644 | -1.053 | 1.7 | .5882 |
| 1966 | 1 | 78.83 | 1.92 | 1.376 | 2.128 | 2.0 | .5000 |
| | 2 | 81.47 | 1.96 | 3.349 | 2.083 | 1.6 | .6250 |
| | 3 | 83.37 | 2.03 | 2.332 | 3.571 | 1.5 | .6667 |

VITA

Charles William Needy, Jr.

Candidate for the Degree of

Master of Science

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Biographical:

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