AN EXAMINATION OF THE RATE OF WAGE CHANGE IN DURABLE AND NON-DURABLE GOODS INDUSTRIES FOR CANADA: A QUARTERLY ECONOMETRIC MODEL

By

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ABSTRACT

This thesis examines the rates of change of the average money wage rates for the Canadian durable and non-durable goods industries. The paper begins with a model which is used to derive a wage change equation.

The hypothesis to be tested is that the same factors affect wage changes differently in the durable and non-durable goods industries. To undertake the testing of this hypothesis, a wage change equation is fitted for each of the industries using earnings data, price and output indexes for each of the two industrial groupings. Each of the estimated equations for the two industries is then compared and a statistical test is conducted to determine the statistical significance of the differences in the estimated coefficients of the variables for the two broad industries.

The results indicate that the rates of wage change for the two industrial groups respond differently to the same factors. In particular, variations in current selling prices of non-durable goods do not have the anticipated effect on the change in the wage rate in that industry in the same time period. In the durable goods industry, variations in current output and prices have a statistically significant positive impact on percentage changes of the current wage rate for that industry. The wage rate in both industries responds negatively to a one period lag in the change in the unemployment rate,

although the change in the unemployment rate variable is statistically more significant in the wage change equation estimated for the non-durable goods industry.

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CHAPTER 1

INTRODUCTION

This paper examines the rate of change of the money wage rate of the durable and the non-durable goods industries from the first quarter of 1961 to the third quarter of 1971.

The focus will be an examination of how these changes in wage rates occurred in order to test the hypothesis that wage rates for the durable goods industry respond differently to various factors compared to the non-durable goods industry. The paper begins in the second chapter with a brief model which will be used to explain the wage adjustment process. To avoid problems created by multicollinearity, the number of variables used in the model has been restricted.

The third chapter expands the model developed in Chapter 2. In particular, market imperfections and the labour union are introduced as relevant factors in the wage change process.

Chapter 4 discusses some of the statistical problems that were encountered in the course of the estimation procedure. It also elaborates on how these problems were dealt with.

Chapter 5 presents the statistical results. The results indicate that the hypothesis that the same factors affect wage changes differently in the durable and non-durable goods industries cannot be rejected. This conclusion follows from statistical tests conducted on the significance of the differences in the estimated coefficients of the independent variables in the wage change equation for the two industrial groups.

CHAPTER 2

A SHORT-RUN MODEL: A HYPOTHETICAL CASE

Introduction

The purpose of this Chapter is to develop a theoretical short-run model to explain wage changes within the industry.

Indexes are used to represent vectors of inputs, outputs, and prices. The index representations are weighted averages of vector components and they only approximate the real values.

A production function for the firm is developed and is made the basis for the production function of the industry. A labour demand curve for the industry is then derived from the industry production function.

The supply of labour to the industry is assumed to be a function of a nominal money wage and, together with the industry's labour demand function and prices, to determine the nominal wage rate for the industry.

The focus will be on the durable and non-durable goods producing industries rather than on manufacturing as a whole because we shall be testing hypotheses about how the two sectors might behave differently with regard to wage determinants. In particular, we investigate whether price, unemployment or output variations are more important determinants of wage change for the durable goods industry than for the non-durable goods industry. The question is of interest since the output of the durable goods industry tends to be less stable over the business cycle. In addition, the durable goods industry is characterized by higher earnings for labour in the boom years of the cycle. Another reason for studying these two industries separately is that since the durable and non-durable industries are two heterogeneous groups, aggregation bias will be reduced.

Definitions

The term "output" will refer to all of the goods produced by the firm or by the industry. The goods produced will be assumed to be homogeneous so that aggregation of these goods is possible. Output for the industry will be represented by an output index. In the statistical analysis that follows in chapter 4, two output indexes are used, one for the durable goods industry and one for the non-durable goods industry.

The term "price of output" will refer to the price of manufactured goods and will also be represented by some index. Two price indexes are used in the estimation of the wage change equation, one index for the durable goods industry and one for the non-durable goods industry.

Capital and labour inputs will be assumed to be homogeneous. "Capital" will refer to the quantity of capital stock used by the firm or industry while "labour" will refer to the number of workers employed.

The "nominal wage rate" will refer to a hypothetical hourly wage.

The Production Function

The basic relationship between the inputs and the output is referred to as a production function. Certain basic assumptions about the production function will be made. It will be assumed that the production function is continuous in its arguments and has continuous first and second-order partial derivatives.

It will be assumed that, in the short-run output, technology, and technical progress are all exogenous to the producing unit.

For convenience, we use a Cobb-Douglas production function. Let the firm's production function be represented as follows:

(1) $$Q_{it} = A_i e^{nt} L_{it}^{a} K_{it}^{b}$$

where,

Q_{it} = output level of firm i, $Q_{it} > 0$

n = rate of technical progress, assumed constant for all firms

L_{it} = number of workers employed in firm i, $L_{it} > 0$

K_{it} = quantity of capital used in firm i, $K_{it} > 0$

A_i = a constant, $A_i > 0$

a, b = constants, with a + b = 1

t = time subscript

The production function for the firm is assumed to be a first degree linear homogeneous function. This assumption will permit us to construct an aggregate production function for the industry.

In addition, each firm will be assumed to be perfectly competitive; the firm will accept the price of its product as determined in the goods market.1/

If s firms make up the industry, then the industry production function may be represented as follows:

1/ There will be available only a certain amount of labour and capital. The amount of output, capital and labour will all be constrainted from zero and bounded by some finite amount.

(2) $$Q_t = C\, e^{nt}\, L_t^{\alpha}\, K_t^{\beta}$$

where,

Q_t = level of output for base period t

$$L_t = \sum_{i=1}^{S} L_{it}$$

$$K_t = \sum_{i=1}^{S} K_{it}$$

C = constant, $C > 0$

α, β = constants with $\alpha + \beta = 1$

L_t = total number of labour units employed by the industry

K_t = quantity of capital stock used by the industry

The Labour Demand Curve for the Industry

It will be assumed that entrepreneurs take output and capital as exogenous and minimize cost subject to output and capital constraints. Since the production function of the industry is nonstochastic, a given level of output will be associated with given levels of inputs.

The conditions for cost minimization result in a labour demand function:2/

(3) $$L_{dt} = \alpha\, P_t\, Q_t / W_{nt}$$

where,

L_{dt} = labour demanded by the industry

2/ It is assumed here that a finite minimum cost exists for the firm and that profits are bounded by some finite positive number, then cost minimization may be viewed as the dual of profit maximization.

P_t = price of industry output

W_{nt} = nominal money wage rate for the industry.

The model will assume conditions of certainty. Prices will be assumed to be known with certainty by the firm belonging to the industry and to be exogenous to the model.

The Labour Supply Curve for the Industry

The supply of labour for the industry will be assumed to be a strictly increasing function of a nominal wage, to shift out over time, and to permit substitution of labour among different industries.

In this model, workers will be assumed to be subject to "money illusion" in the short run.[3/] Workers are assumed to react only to nominal wage changes. Let the labour supply curve be represented as:

(4) $$L_{st} = (W_{nt})^m e^{rt}$$

where,

L_{st} = labour supplied to the industry

m = elasticity of labour supply, a constant with $m > 0$

r = rate of growth of the labour force, $r > 0$

For a given nominal wage rate, the labour force is assumed to be growing at some constant rate r. This will determine the outward shift of the labour supply curve.

Equilibrium in the Labour Market

Labour demand and labour supply are made equal by the process of labour market equilibrium. The equilibrium nominal money wage and

3/ It is assumed that workers view prices as relatively constant in the short run. In the long run, however, they will view prices as changing.

employment are given by the point of intersection of the labour supply and labour demand curves. Since we have assumed labour to be homogeneous, a single equilibrium wage will prevail. At the equilibrium nominal money wage, the amount of labour supplied will be equal to the amount demanded. The necessary and sufficient condition for buyers and sellers of labour to be consistent in their desires is expressed by condition (5):

(5) $$L_{st} = L_{dt}$$

Substituting for L_{st} and L_{dt} gives:

(6) $$W_{nt} = \{\alpha Q_t P_t / e^{rt}\}^{(1/1+m)}$$

Equation (6) may be transformed to:

(7) $$\ln W_{nt} = \left(\frac{1}{1+m}\right) \ln\alpha + \left(\frac{1}{1+m}\right) \ln Q_t + \left(\frac{1}{1+m}\right) \ln P_t - \left(\frac{rt}{1+m}\right)$$

Differentiating (7) with respect to time gives:

(8) $$\frac{1}{W_{nt}} \cdot \frac{\partial W_{nt}}{\partial t} = -\left(\frac{r}{1+m}\right) + \left(\frac{1}{1+m}\right)\frac{1}{Q_t} \cdot \frac{\partial Q_t}{\partial t} + \left(\frac{1}{1+m}\right)\frac{1}{P_t} \cdot \frac{\partial P_t}{\partial t}$$

which may be written as:

(9) $$\overset{*}{W}_{nt} = - a_0 + a_1 (\overset{*}{Q}_t + \overset{*}{P}_t)$$

with

$$a_0 = \frac{r}{1 + m}, \; a_0 > 0$$

$$a_1 = \frac{1}{1 + m}, \; a_1 > 0$$

(10) $$\overset{*}{W}_{nt} = \frac{1}{W_{nt}} \cdot \frac{\partial W_{nt}}{\partial t}$$

$$\overset{*}{Q}_t = \frac{1}{Q_t} \cdot \frac{\partial Q_t}{\partial t}$$

$$\overset{*}{P}_t = \frac{1}{P_t} \cdot \frac{\partial P_t}{\partial t}$$

Equation (9)[4/] expresses the rate of wage change as a linear function of two variables, the rate of change of output and prices. The theory developed above suggests that a_0 and a_1 be greater than zero.

A Walrasian Case

In the preceding pages, a model has been developed to explain wage adjustments within the industry. The model operates under ideal conditions; there is no uncertainty introduced into the model and labour is assumed to be perfectly mobile. In addition, all adjustments are

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4/ The implication of (1) to (9) is $\overset{*}{W}_{nt} - \overset{*}{P}_t = -a_0 + a_1\overset{*}{Q}_t - (1 - a_1)\overset{*}{P}_t$. If there is only one industry and its selling price index represents the general price index, this equation implies that the rate of growth of equilibrium real wages is positively related to the rate of growth of output and negatively related to the rate of growth of industry selling prices if $0 < a_1 < 1$. Since $m > 0$, it follows that $0 < a_1 < 1$; that is, since the supply of labour is a strictly increasing function of the nominal wage, m will be greater than zero. The implication of this result is that the change in industry real wages will depend on how much industrial output changes relative to the change in industrial prices.

assumed to take place instantaneously. The model may be easily criticized on the following grounds:

(1) Labour and commodity markets are not cleared instantaneously in the real world.

(2) Labour is not homogeneous.

(3) There is a lack of perfect information on the part of the buyers and sellers of labour.

Some modifications will be made in the model to account for these situations in the following chapter.5/

5/ In his article, "Money-Wage Dynamics and Labour Market Equilibrium", (J.P.E., Vol. 76, 1968), E.S. Phelps argues that expectations play an important role in the wage change process and includes in his proposed wage change equation, the rate of wage change lagged one period. It is proposed by Phelps that firms extrapolate wage changes forward one period to determine the actual change in wages. In the model developed above it is proposed that changes in output and industry selling prices determine wage changes. If industrial price changes are determined by past wage changes in the industry and if changes in industrial output determine employment levels in the industry, we arrive at an estimating equation, similar to that of Phelps. On the other hand, by including past wage changes in the equation developed above, multicollinearity between that variable and $\overset{*}{P}_t$ and $\overset{*}{Q}_t$ is created in the wage equation. Preliminary regressions were made including $\overset{*}{P}_t$, $\overset{*}{Q}_t$ and $\overset{*}{W}_t$ lagged one period as independent variables. An examination of the correlation coefficients showed that $\overset{*}{W}_t$-1 was significantly correlated with $\overset{*}{P}_t$ and $\overset{*}{Q}_t$.

CHAPTER 3

MARKET IMPERFECTIONS AND THE LABOUR UNION

Introduction

The analysis of the previous chapter is essentially a supply and demand analysis under the assumptions of perfect markets. In this chapter, market imperfections and the union will be introduced and the wage change equation will be modified to account for these new factors. In fact, what we shall attempt to do is to introduce certain elements into the model so that it will become more realistic. The following discussion does not lead to testing of any hypotheses about concentration, union strength, or labour market information. Instead of this, we shall end up, with justification, testing hypotheses about the impact of $\overset{*}{Q}_t$, ΔU_{t-1}, and $\overset{*}{P}_t$ on wage changes.

The first market imperfections that we shall discuss is concentration in the product market. Since there is a correlation between concentration and union strength, some measure of union strength will also represent the effects of concentration.[1/] The union will be stronger in those industries where the level of concentration in the product market is greater. This hypothesis can be tested only if there is changing concentration in the two industrial groupings over time;

1/ The ability of the union to secure wage increases will depend on the general level of unemployment in the labour market. Union strength may be viewed as a function of the unemployment rate, the higher unemployment rates suggesting a lessening of the union's ability to secure wage increases. Since a measure of union strength and of concentration are correlated, concentration may also be viewed as a function of the unemployment rate.

however, since data was not available for this study, the hypothesis was not tested.

The second imperfection that will be discussed is the lack of a free flow of labour market information. Labour will no longer be assumed to be cognizant of all relative wage differentials and vacancies. There will, therefore, be vacancies, unemployment and similar jobs commanding different wage rates existing at the same time. Data on the flow of labour market information was not made available for this study so that it was not possible to investigate the effects of imperfections in the flow of labour market information on the rate of wage change.

Finally, the union is introduced as an organization seeking to augment the wage rate of its members but restrained from doing so by economic conditions. The ability of the labour union to push wages beyond the neoclassical equilibrium level will depend on excess labour supply. Wage rates are viewed as responding inversely to these changes in excess labour supply.

Each of these new elements is discussed in the present chapter and a link with the theoretical model of Chapter 2 is developed in a consistent manner.

(1) Concentration in the Product Market

Some empirical studies have indicated that there has been a strong relationship between interindustry rates of change in wages and the degree of monopoly in the product market.2/

2/ See, for example, Bowen, W., Wage Behaviour in the Postwar Period, (Princeton, N.J.; Princeton University, Industrial Relations Section, 1960), Ross, A.M. and Goldner W., "Forces Affecting the Interindustry Wage Structure", Q.J.E., Vol. 64, No. 2 (May 1950).

H. G. Lewis found that for a given degree of union strength in the manufacturing industry, the greater the degree of concentration in the industry, the smaller the increase in wages.3/ On the other hand, M. Segal argues that concentration does lead to higher wage gains.4/ Segal argues that a union in a more concentrated industry is more likely to maintain its strength since the mobility of capital and the freedom of entry of new firms is restricted.

Attempts to isolate the separate effects of union strength and of concentration on the rates of wage change have been unsuccessful because of the high degree of correlation existing between union strength and concentration.5/ In the analysis conducted in this section we shall take union strength as an additional determinant of wage change recognizing the fact that it may also represent the effects of concentration in the product market.

(2) Information in the Labour Market

Competitive labour market theory proposes that the equilibrium wage rates for working in a given occupation should be uniform. The equilibrium wage is realized as workers obtain information on relative wage rates and move from low-paying jobs to high-paying ones.

G. Stigler connected the differences in wage rates to a lack of

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3/ Lewis, H.G., Unionism and Relative Wages in the United States (Chicago: University of Chicago Press, 1963). See especially pages 159-161 and 177-178. See also Weiss, L.W., "Concentration and Labour Earnings", A.E.R., Vol. 56, No. 1 (March 1966), pp. 96-117.

4/ See Segal, M., "Union Wage Impact and Market Structure", Q.J.E., Vol. 78, No. 1 (February 1964), pp. 96-114.

5/ See Segal, loc. cit.

information.[6/] In the perfectly competitive theory of the labour market, information is assumed to be a free good. Stigler argues that information is not a free good and, as a result, that for a given occupation in a given area, wage rates are not uniform for workers performing similar tasks.

A lack of labour market information about vacancies and wages will create labour bottlenecks in areas where there is excess labour demand. A shortage of labour in these regions will cause employers to compete for existing labour supply and wages will be pushed up. On the other hand, in regions of excess labour supply, employers will not have to increase wages to meet labour requirements. If this condition is introduced, there will be some regions with high wages and low unemployment and some with low wages and high unemployment. There will no longer be one uniform wage but a set of different wages determined by regional labour market conditions.

(3) The Labour Union

There have been several studies investigating the effects of labour unions on wages.[7/]

Labour unions will now be introduced into our theoretical model

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6/ See Stigler, G.J., "The Economics of Information", J.P.E., Vol. 69, (June 1961), pp. 213-225.

7/ For example, see Douglas, P.H., Real Wages in the United States, 1890-1926, (Boston and New York: Houghton Mifflin Co., 1930), Lewis, H.G., Unionism and Relative Wages in the United States (University of Chicago Press 1963) Garbarino, "A Theory of Interindustry Wage Structure Variation", Q.J.E., Vol. 64 (May 1950), pp. 282-305, Levinson, H.M., "Unionism, Wage Trends, and Income Distribution, 1914-1947", Michigan Business Studies, Vol. 10, (Ann Arbor: Bureau of Business Research, 1951), Maher, J.E., "Union, Non-Union Wage Differentials", A.E.R., Vol. 46, (June 1956), pp. 336-352.

and the effect that they might have on the wage adjustment process will be briefly reviewed.

In a comparison of unionized and non-unionized industries in manufacturing, Gail Pierson found that unionized wages were generally greater than non-unionized wages and that there was a strong spillover effect from the union wage to the non-union wage. Reynolds agrees that unionism raises the wages of the union members relative to what the members would have received under non-union conditions. H. M. Douty investigated wage rates for various selected occupations within union and non-union industries and discovered that union wages tended to be higher than non-union wages.[8/]

We shall, therefore, expect to find a higher equilibrium wage when we introduce unions into the model. Non-union workers will have their wages affected as a result of union action elsewhere so that, overall, wages would be affected.[9/]

The ability of the union to push the wage rate above the equilibrium level will depend on its strength in the wage bargaining process. If the demand for the firm's product remains unchanged, the

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8/ See Pierson, Gail, "The Effects on Union Strength on the U.S. Phillips Curve", A.E.R., Vol. 58, (1968), Reynolds, L.G., Labour Economics, and Labour Relations, (Prentice-Hall, 1970), p. 652, and Douty, H.M., "Union and Non-Union Wages", in W.S. Woytinsky and Associates, Employment and Wages in the United States (New York, 1953).

9/ The argument used by some writers is that non-union employers grant wage increases to their employees in order to prevent unionism from spreading to their plants. See, for example, Hicks, J.R., The Theory of Wages (New York, 1948), Levinson, H.M., loc. cit., Slichter, S.H., "Do the Wage-Fixing Arrangements in the American Labour Market Have an Inflationary Bias?", A.E.R., XLIV (May 1954), 335. For an opposing view, see Friedman, M., "Some Comments on the Significance of Labour Unions for Economic Policy", in David McCord Wright (ed.), The Impact of the Union, (New York, 1951).

union's ability to pressure wage increases will be limited by the decrease in employment for its members. If the unemployment rate increases, the union will have less of a desire to achieve wage increases much beyond those proposed by the producer, since additional workers will become available for employment and entrepreneurs will have less of a need to grant wage increases to fulfill their labour requirements. Increases in the unemployment rate, therefore, will dampen the demand for wage increase. Although no analysis will be conducted into the wage rates of union and non-union workers, so that we shall be unable to analyze the effect of the union on wage rates, the preceding discussion provides some insight into what we might observe and gives some evidence from other researchers that has supported the proposition that the union increases wages above neoclassical equilibrium levels.

Disturbance Mechanism

As each of these new elements, concentration in the product market, a lack of information in the labour market, and the labour union are entered into the model one by one, we shall obtain a wage that will be different from the equilibrium nominal wage of the theoretical competitive model. The major factor affecting the new wage will be assumed to be the unemployment rate. In the context of a static model as the unemployment rate is increased, wages will fall. There will, therefore, be an inverse relationship between the wage rate and the unemployment rate.

The equilibrium wage of the theoretical short-run model developed in chapter 2 will be disturbed when these various factors are introduced into the model. It will be proposed that wage adjustments occur in response to changes in the expected unemployment rate.

A time dependent disturbance function, Z(t), is introduced and is assumed to alter the equilibrium nominal money wage in the following way:

(11) $W_t = Z(t)\, W_{nt}$

where,

W_t = actual wage rate

The disturbance function will be defined in the following way:

(12) $Z(t) = K\, e^{(-a_2 U_t^e)}$

where,

K = constant, $K > 0$

a_2 = constant, $a_2 > 0$

U_t^e = expected unemployment rate , $U_t^e \geq 0$

with $\frac{\partial Z(t)}{\partial U_t^e} \leq 0$

For the model developed in chapter 2, we would reach an equilibrium wage W_{nt}. When market imperfections and the union are introduced, we get a new wage rate W_t. At any time of observation, vacancies and unemployment exist and the industry, while tending towards an equilibrium position, will, in fact, be in disequilibrium.

The Modified Wage Equation

The model developed in Chapter 2 has been extended to include the union and market imperfections. The new wage will now become a more realistic approximation of the real world wage. The new wage is given by (13):

$$W_t = K\, e^{(-a_2 U_t^e)}\, W_{nt} \tag{13}$$

This may be transformed to:

$$\overset{*}{W}_t = -a_0 + a_2 \; (\overset{*}{Q}_t + \overset{*}{P}_t) \; -a_2 \frac{\partial U_t^e}{\partial t} \tag{I4}$$

CHAPTER 4

THE STATISTICAL MODEL

This chapter presents a brief discussion of some of the problems encountered in estimating the wage change equation. In addition, an explanation of the data will be provided.

Methodology

The statistical estimation method that was used was classical least squares.

The analysis of time-series data by least-squares regression techniques depends on the assumption that the error terms of the regression equation are serially uncorrelated. If this condition is not met, the least-squares estimates of the regression coefficients may be inefficient and the estimated standard errors of the estimated coefficients may be biased. To deal with this problem, a test of serial correlation formed part of the analysis of the time series data.

Another problem that often arises in many econometric studies is that of the existence of intercorrelation among explanatory variables.[1/] This problem will be investigated in the next chapter by examining the partial correlation coefficients for the set of independent variables.

The final problem that was investigated in this study was the

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1/ Various attempts were made to extend the number of independent variables in the wage change equation. Each of these efforts met with problems of multicollinearity. To arrive at an acceptable set of estimated coefficients, it was decided, therefore, to make the model as simple as possible, yet theoretically sound.

effects of seasonality on the rates of wage change. Seasonal dummy variables were introduced into the regression equation to measure the effects of seasonal factors. Since the set of dummy variables were not statistically significant, they were omitted from the preferred equation.[2/]

Time Trend

The change in wages may be due to a combination of economic, sociological, and other forces. To gain some insight into the way in which the rates of wage change moved over the period under study, the dependent variable was graphed. It was noted that the rates of wage change tended to move up over time. A variable, t, with the property that t = 1 for the first observation, t = 2 for the second observation, t = 3 for the third observation, and so on, was included in the wage change equation to explain the presence of trend factors. Including this time trend variable in the equation to be estimated gives,

$$\text{(15)} \qquad \overset{*}{W}_t = -a_0 + a_1(\overset{*}{Q}_t + \overset{*}{P}_t) - a_2 \frac{\partial U_t^e}{\partial t} + a_3 t$$

where,

$t = 1, 2, \ldots 43$

Random Disturbances

The theory developed above shows how a relationship may be derived expressing the rate of wage change as a function of the rates of change of output and prices and the change in unemployment rate in the

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2/ The F-test was used to determine the significance of the set of independent variables for the durable goods industry; the F-ratio was not significant, and the dummy variables were subsequently dropped from the preferred equation.

previous quarter while a time trend variable was added to the equation to account for the secular movement of wage changes over time. However, there may be other factors that have a direct effect on the rates of wage change, but which have not been accounted for explicitly in the theoretical derivation of the wage change relationship. It is hoped that the theory developed above will account for most of the variation in the rates of change. However, since the number of variables included in the wage change equation is by no means exhaustive, we will conclude that there are other variables which explain wage changes but which are not included in the model.[3/] Since unexplained variations in wage changes, for this analysis, were assumed to be randomly distributed, the final wage change equation may be written as:

$$(16) \quad \overset{*}{W}_t = -a_0 + a_1 (\overset{*}{Q}_t + \overset{*}{P}_t) - a_2 \frac{\partial U_t^e}{\partial t} + a_3 t + e_t$$

where,

e_t = random disturbance term

It will be assumed that workers and firms extrapolate changes in the unemployment rate forward one period to determine changes in the expected unemployment rate. Substituting the change in the unemployment rate lagged one period for the change in the expected unemployment rate provides us with (17):

$$(17) \quad \overset{*}{W}_t = -a_0 + a_1 (\overset{*}{Q}_t + \overset{*}{P}_t) - a_2 \Delta U_{t-1} + a_3 t + e_t$$

where

ΔU_{t-1} = change in the unemployment rate in period t-1

3/ As the number of variables incorporated into a model increases, the sample's basic information may be simply spread over a number of multicollinear independent variables.

The Data

Two broad industries were studied, the durable goods and the non-durable goods industries.4/

For both the durable and the non-durable manufacturing industries, the wage-change equations were estimated using earnings data, industry selling price indexes, industrial volume indexes, and unemployment rates running from the first quarter of 1961 to the fourth quarter of 1971. Quarterly earnings data, and output and price indexes were converted to simple percentage differences and were taken as discrete approximations of continuous variables. The discrete variable definitions are listed as follows:

$$\overset{*}{W}_t = \frac{W_t - W_{t-1}}{W_{t-1}} \cdot 100$$

$$\overset{*}{P}_t = \frac{P_t - P_{t-1}}{P_{t-1}} \cdot 100$$

$$\overset{*}{Q}_t = \frac{Q_t - Q_{t-1}}{Q_{t-1}} \cdot 100$$

$$\frac{\partial U^e_t}{\partial t} = \frac{\partial U_{t-1}}{\partial t-1} \approx \Delta U_{t-1}$$

$$\Delta U_{t-1} = U_{t-1} - U_{t-2}$$

4/ The durable goods industry included the following industries: wood, furniture and fixtures, primary metal, metal fabricating, machinery, transportation equipment, electrical products, non-metallic mineral products. The non-durable goods industry used in the analysis of this paper included the following industries: food and beverages, tobacco products, rubber industries, leather industries, textiles, knitting mills, clothing, paper and allied, printing, publishing and allied, petroleum and coal products, chemicals and chemical products.

W_t = average hourly earnings of the production worker in the industry (based on the 1960 S.I.C.) for the t'th quarter, seasonally unadjusted.

P_t = average industry selling price index (1961 = 100) for the t'th quarter, seasonally unadjusted.

Q_t = average industrial volume index (1961 = 100) for the t'th quarter, seasonally unadjusted.

U_t = average seasonally unadjusted unemployment rate of the nation for the t'th quarter

CHAPTER 5

STATISTICAL RESULTS

Regression Results

Tables 1 and 2 indicate the relationship existing among the set of independent variables used in the model. Since multicollinearity among the set of independent variables was not high compared to the overall degree of multiple correlation of the regression equations, we may conclude that multicollinearity in the regression estimates presented no major problems.[1/]

Large variances of regression coefficients produced by multicollinear independent variables indicate low information content of data and the unacceptability of resulting parameter estimates. The low standard errors of the estimated regression coefficients given in tables 3-4 do not support the existence of multicollinearity using this criterion.

(a) Durable Goods Industry (Table 3)

The regression results for the durable goods industry support the model. Percentage wage changes respond positively to changes in the combined percentage change of output and price indexes and negatively to the change in unemployment rate lagged one period. Six per cent of the variation in the percentage wage change was explained by the change in

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1/ See Klein, L.R., An Introduction to Econometrics (New Jersey, 1962), page 101.

the unemployment rate lagged one period while $(\overset{*}{Q}_t + \overset{*}{P}_t)$ explained nineteen per cent of the variation in the wage change variable. The results also indicated that the percentage wage change increased over time.

(b) Non-Durable Goods Industry (Table 4)

The regression estimates for the non-durable goods industry are provided in table 4. An examination of table 4 indicates that variations in $(\overset{*}{Q}_t + \overset{*}{P}_t)$ for the non-durable goods industry were not significant determinants of wage change. It may be concluded, on the basis of these results, that the wage rate for the non-durable goods industry does not respond in the same way to $(\overset{*}{Q}_t + \overset{*}{P}_t)$ as does the wage rate for the durable goods industry. On the other hand, the rate of wage change for the non-durable goods industry responds negatively to a one-period lag in the change in the unemployment rate and the change in the unemployment rate variable is significant at the 5 per cent level.

The regression results also indicated that the percentage wage change for the non-durable goods industry increased over time. Like the durable goods industry, the percentage wage change increased on the average by about .05 in each quarter.

(c) A Comparison of the Wage Change Process for Durables and Non-Durables

It is often of interest to ask if a confidence interval for a parameter estimate includes some particular non-zero value for the unknown true value. The confidence interval may be viewed as a set of all acceptable hypotheses for a given probability level. In particular, we are interested in the divergence of parameter estimates of the non-durable goods industry from those of the durable goods industry. The t-test will be used to test for the equality of parameter estimates. The ratio that is used for this test is

$$t = \frac{a_D - a_{ND}}{\sigma}$$

where,

a_D = parameter estimate for the durable goods industry

a_{ND} = parameter estimate for the non-durable goods industry

σ = sampling error of the coefficient estimate 2/

Starting out with a null hypothesis that $a_D = a_{ND}$, we then calculate the probability fo getting a t-value, or normal curve deviate, as large as the one obtained from the difference of the two estimates. The larger the t-ratio, the less willing we are to accept the hypothesis that the estimates are equal since the probability that they are equal will be vary small. The computed t-values corresponding to tables 3 and 4 are listed in table 5.

For 37 degrees of freedom, $t_{.05}$ is 2.03; therefore, the hypothesis that the coefficient estimates for the two industries are equal is rejected for $\overset{*}{Q}_t + \overset{*}{P}_t$ and ΔU_{t-1}. It may be concluded, therefore, that combined variations in current industrial output and

2/ We assume that the difference between the standard errors of the coefficient estimates is sufficiently small that it can be attributed to random variation in sampling from two populations with different means but with the same standard deviation .Our task is then to test this assumption on the basis of the evidence from the two samples.

TABLE 1

Durable Goods Industry

Correlation Coefficients

Variable	Variable	Correlation Coefficient
$\overset{*}{W}_t$	$\overset{*}{Q}_t + \overset{*}{P}_t$	.44
$\overset{*}{W}_t$	ΔU_{t-1}	-.45
$\overset{*}{W}_t$	t	.57
$\overset{*}{W}_t$	$\overset{*}{P}_t$	.45
$\overset{*}{W}_t$	$\overset{*}{Q}_t$	.40
$\overset{*}{Q}_t + \overset{*}{P}_t$	ΔU_{t-1}	-.38
$\overset{*}{Q}_t + \overset{*}{P}_t$	t	-.11
ΔU_{t-1}	t	.03
ΔU_{t-1}	$\overset{*}{P}_t$	.42
ΔU_{t-1}	$\overset{*}{Q}_t$	-.41
t	$\overset{*}{P}_t$	.34
t	$\overset{*}{Q}_t$	-.15
$\overset{*}{P}_t$	$\overset{*}{Q}_t$	.29

TABLE 2

Non-Durable Goods Industry

Correlation Coefficients

Variable	Variable	Correlation Coefficient
$\overset{*}{W}_t$	$\overset{*}{Q}_t + \overset{*}{P}_t$	-.04
$\overset{*}{W}_t$	ΔU_{t-1}	-.66
$\overset{*}{W}_t$	t	.44
$\overset{*}{W}_t$	$\overset{*}{P}_t$	-.30
$\overset{*}{W}_t$	$\overset{*}{Q}_t$	.01
$\overset{*}{Q}_t + \overset{*}{P}_t$	ΔU_{t-1}	.38
$\overset{*}{Q}_t + \overset{*}{P}_t$	t	.09
ΔU_{t-1}	t	.03
ΔU_{t-1}	$\overset{*}{P}_t$	.40
ΔU_{t-1}	$\overset{*}{Q}_t$	.38
t	$\overset{*}{P}_t$	.17
t	$\overset{*}{Q}_t$	-.14
$\overset{*}{P}_t$	$\overset{*}{Q}_t$	.28

TABLE 3

Durable Goods Industry

Regression Results

Variable	Coefficient	Standard Error	T-Value	Variation(%)[1]
$\overset{*}{Q}_t + \overset{*}{P}_t$	.05*	.02	3.14	19.2
ΔU_{t-1}	-.14*	.06	-2.46	6.5
t	.05*	.01	6.38	37.9
Intercept	.29*	.13	2.20	

F-Value 22.7

R^2 .64

Durbin-Watson Statistic 2.59

* Significant at the 5 per cent level.

1 This is the amount of variation in the independent variable explained by the dependent variable.

TABLE 4

Non-Durable Goods Industry

Regression Results

Variable	Coefficient	Standard Error	T-Value	Variation(%)[1]
$\overset{*}{Q}_t + \overset{*}{P}_t$	-.06	.05	-1.21	.2
ΔU_{t-1}	-.54*	.06	-9.83	52.3
t	.05*	.01	6.55	23.4
Intercept	.17*	.07	2.43	

F-Value 43.3

R^2 .77

Durbin-Watson Statistic 1.80

* Significance at the 5 per cent level.

1 This is the amount of variation in the independent variable explained by the dependent variable.

TABLE 5

A Comparison of Durable and Non-Durable Goods Industries

Regression Coefficients

Variable	Durables	Non-Durables	$a_D - a_{ND}$	σ[1]	T-Value
$\overset{*}{Q}_t + \overset{*}{P}_t$	.05	-.06	.11	.04	2.75*
ΔU_{t-1}	-.14	-.54	.40	.06	6.67*
t	.05	.05	.00	.01	.00
Intercept	.29	.17	.12	.10	1.20

* Significant at the 5 per cent level.

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1. An unbiased estimate of the population standard error, σ, corresponding to a given coefficient estimate is given by

$$\sigma = \sqrt{\frac{S_D^2 + S_{ND}^2}{2}}$$

where S_D^2 = variance of the coefficient estimate for the independent variable in the wage equation estimated for durables.

S_{ND}^2 = variance of the coefficient estimate for the independent variable in the wage equation estimated for non-durables.

TABLE 6

A Comparison of Durable and Non-Durable Goods Industries

Correlation Coefficients of Independent Variables
With the Dependent Variable

Variable	Durable Goods Industry	Non-Durable Goods Industry
$\overset{*}{Q}_t + \overset{*}{P}_t$	.44	-.04
ΔU_{t-1}	-.45	-.66
t	.57	.44
$\overset{*}{P}_t$	.45	-.30
$\overset{*}{Q}_t$	.40	.01

selling prices for the two industries impart significantly different impacts on the rate of wage change, and that changes in the unemployment rate are more significant determinants of wage change for the non-durable goods industry than for the durable goods industry. In addition, there is an upward trend in the rates of wage change for the two industries over the period under study.[3/]

A comparison of the correlation coefficients for each of the two industries is made in table 6. This table indicates that the correlation of $(\overset{*}{Q}_t + \overset{*}{P}_t)$ with the rate of wage change is positive for the durable goods industry but negative for the non-durable goods industry. This provides additional support for the conclusions given above.

Some Other Studies on Wage Changes in Manufacturing

The following brief discussion will centre on some of the differences and similarities of the model developed in this paper and the results of research undertaken by others.

Bodkin[4/] conducted an analysis of the rate of wage change for production workers in Canadian manufacturing industries. Unlike the analysis conducted in this thesis, Bodkin's study is an examination of the annual percentage change in average hourly earnings. The empirical results of the thesis are based on quarterly variations in the wage

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3/ The wage equations were also fitted by including $\overset{*}{Q}_t$ and $\overset{*}{P}_t$ as separate variables in the regression equation. These results are presented in the appendix, tables 7 and 8. The regression coefficients varied in sign and significance for each of the industries as far as prices were concerned while the output and unemployment variables had similar signs for each industry.

4/ See Bodkin, R.G., Price Stability and High Employment: The Options for Canadian Economic Policy (Ottawa: Queen's Printer, 1966) variable with an added emphasis on the fact that wage changes are taking place continuously. In addition, Bodkin's study uses the consumer price index as a price variable in the wage equation. The present study uses an industry selling price index. Since Bodkin uses the moving averages of explanatory variables, he should have used an appropriate estimation technique to deal with the moving-average type of autocorrelation which was introduced into his model. Since he made no attempt to remedy the problem of serial correlation, his estimates of the standard errors are biased and the t-statistics unreliable. In addition, to the serious problem of serical correlation, Bodkin did not conduct an investigation into the extent of multicollinearity existing among the explanatory variables.[5/]

Another study that was made to explain wage changes is the Perry[6/] study. Perry used moving averages of explanatory variables in his wage equation for the durable and non-durable goods industries in the United States. Unfortunately, the serial correlation introduced by the moving-average technique reduces the confidence to be placed in the t-coefficients given in Perry's study.

Although the analysis undertaken in this thesis is based on a different model than either the Bodkin or Perry study, it may be viewed

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5/ An application of the model developed above to an explanation of annual wage changes were made. Several studies were used as a basis for comparing the results. In particular, analyses of certain variables indicated that the rate of change in the average hourly earnings in U.S. manufacturing was significantly correlated with the rate of change of the Canadian consumer price index. Since these were two of the explanatory variables used in the Bodkin study, the effects of multicollinearity may have affected his estimated results.

6/ See Perry, G.L., Unemployment, Money Wage Rages, and Inflation, (Cambridge: The M.I.T. Press, 1966) as more complete, in the sense that it investigated the problems of multicollinearity and serial correlation, and where these arose, it offered a solution.

Another study that was undertaken to explain wage changes in Canadian manufacturing industries was the one by G. Reuber who developed a model to explain, empirically, the change in wages in particular 2-digit manufacturing industries in Canada.7/ An application of the Reuber model to explain quarterly variations in wages was not successful because of the limited variation in quarterly wage changes at the 2-digit industry level. In the study conducted in this paper, a more aggregative wage index was used and the problem that Reuber encountered was avoided.

7/ For a detailed analysis of the Reuber model, see Reuber, G.L., "Wage Determination in Canadian Manufacturing Industries", Task Force on Labour Relations, Study No. 19, (Ottawa, 1969).

CHAPTER 6

CONCLUSION

This paper has tried to identify some of the factors that are important in explaining quarterly wage changes in the Canadian durable and non-durable goods industries from the first quarter of 1961 to the third quarter of 1971. An emphasis has been placed on the development of a sound theoretical basis for empirical work attempting to explain wage changes.

In order to avoid problems of multicollinearity, the number of explanatory variables was restricted; in this way it has been possible to identify the influence of the independent variables on wage changes.

The results of investigation indicate that the hypothesis that quarterly wage changes for the durable and non-durable goods industries are explained by different factors cannot be rejected. For the durable goods industry, the change in the unemployment rate (representing general economic conditions), and combined variations in industrial output and prices have had a significant effect on quarterly wage changes. For the non-durable goods industry, in contrast, variations in prices and output changes[1/] in the unemployment rate do not appear to be

1/ In fitting equations to quarterly data, the question of lag relationships becomes relevant since the time in which variables can interact is quite short. Quarterly estimates, therefore, may be complicated by lag relationships and dynamic adjustments. For the non-durable goods industry, one and two period lags in the independent variables were introduced into the wage equation, with little change in the estimated coefficients.

significant determinants of the rate of change of the wage rate. Among the set of independent variables that were examined in the course of this study, changes in the unemployment rate were more significant determinants of quarterly wage change in the non-durable goods industry than for the durable goods industry. For both industries, the rates of wage change tended to move upward for the period under study.

Wage changes in the non-durable goods industry may be affected by other factors such as changes in disposable income and consumer attitudes. Additional investigation of the non-durable goods industry and how the wage adjustment process operates in the short run might provide us with other factors that determine quarterly wage changes.

APPENDIX A

TABLE 7

Durable Goods Industry

Regression Results

Price and Output Variations Considered Separately

Variable	Coefficient	Standard Error	T-Value
ΔU_{t-1}	-.15*	.06	-2.49
t	.05*	.01	5.93
P^*_t	.05*	.02	2.49
Q^*_t	.06*	.02	3.17
Intercept	.26*	.13	2.02

F-Value 16.9

R^2 .64

Durbin-Watson Statistic 2.53

* Significant at the 5 per cent level.

TABLE 8

Non-Durable Goods Industry

Regression Results

Price and Output Variations Considered Separately

Variable	Coefficient	Standard Error	T-Value
ΔU_{t-1}	-.49*	.05	-10.22
t	.05*	.01	8.43
$\overset{*}{P}_t$	-.27	.14	- 1.92
$\overset{*}{Q}_t$	.05	.03	1.67
Intercept	.31*	.07	2.21

F-Value 48.9

R^2 .84

Durbin-Watson Statistic 1.82

* Significant at the 5 per cent level.

TABLE 9

Hourly Wage Rates
(Seasonally Unadjusted)

Quarter		Durables	Non-Durables	Overall Manufacturing
1	1961	1.99	1.67	1.82
2		2.00	1.69	1.83
3		1.99	1.67	1.82
4		2.02	1.70	1.85
1	1962	2.03	1.71	1.86
2		2.05	1.74	1.89
3		2.04	1.72	1.87
4		2.07	1.75	1.91
1	1963	2.10	1.76	1.93
2		2.12	1.79	1.95
3		2.11	1.77	1.93
4		2.15	1.82	1.98
1	1964	2.17	1.83	1.99
2		2.19	1.85	2.01
3		2.21	1.84	2.02
4		2.22	1.88	2.05
1	1965	2.27	1.89	2.09
2		2.30	1.92	2.11
3		2.29	1.92	2.10
4		2.35	1.97	2.16
1	1966	2.38	2.01	2.20
2		2.41	2.04	2.23
3		2.43	2.05	2.24
4		2.48	2.11	2.30
1	1967	2.52	2.17	2.35
2		2.56	2.20	2.38
3		2.60	2.22	2.41
4		2.65	2.28	2.47
1	1968	2.68	2.31	2.49
2		2.77	2.36	2.56
3		2.81	2.37	2.59
4		2.87	2.45	2.66
1	1969	2.92	2.50	2.72
2		2.97	2.55	2.72
3		3.01	2.57	2.79
4		3.08	2.66	2.88
1	1970	3.16	2.70	2.93
2		3.24	2.74	2.99
3		3.27	2.76	3.01
4		3.34	2.87	3.10
1	1971	3.47	2.94	3.20
2		3.52	3.01	3.26
3		3.57	3.02	3.29
4		3.62	3.10	3.37

Source: Man-hours and hourly earnings (72-003) D.B.S.

Note: Based on the 1960 Standard Industrial Classification (S.I.C.). The data are based on reports from firms employing 20 persons or more and relate to the last pay periods in the month.

TABLE 10

Index of Industrial Output
(1961= 100, Seasonally Unadjusted)

Quarter		Durables	Non-Durables
1	1961	93.5	92.5
2		102.5	100.3
3		99.8	103.7
4		104.1	103.5
1	1962	105.6	100.2
2		115.9	107.3
3		113.3	109.6
4		115.9	107.1
1	1963	117.2	103.8
2		126.0	111.7
3		119.8	113.9
4		128.5	114.3
1	1964	132.5	112.3
2		141.2	120.7
3		134.6	121.9
4		141.0	123.0
1	1965	147.3	118.7
2		158.9	125.4
3		150.2	128.7
4		164.2	130.4
1	1966	166.1	128.0
2		172.3	134.5
3		161.6	134.9
4		172.6	135.5
1	1967	169.1	130.2
2		178.6	137.6
3		165.0	138.3
4		178.0	139.0
1	1968	173.1	137.3
2		194.0	144.8
3		180.3	143.3
4		198.7	148.4
1	1969	195.2	145.5
2		204.8	151.8
3		185.4	152.5
4		199.3	154.3
1	1970	194.7	148.8
2		201.8	155.4
3		181.0	151.8
4		183.7	153.4
1	1971	190.8	148.2
2		201.5	155.8
3		190.7	156.8
4		202.6	160.5

Source: Index of Industrial Variations (61-005) D.B.S.

TABLE 11

Price Indexes
(1961 = 100, Seasonally Unadjusted)

Quarter		Durables	Non-Durables	Consumer Price Index
1	1961	101.1	99.6	99.9
2		100.5	99.9	99.8
3		98.3	100.2	99.8
4		99.9	100.1	100.3
1	1962	99.3	100.1	100.4
2		99.0	100.8	100.8
3		99.1	101.7	101.5
4		99.6	102.0	102.0
1	1963	99.7	102.2	102.2
2		99.1	103.0	102.5
3		99.4	103.9	103.4
4		99.6	103.9	103.6
1	1964	98.9	104.1	104.0
2		98.8	104.8	104.5
3		98.2	105.6	105.2
4		98.6	105.1	105.3
1	1965	98.8	105.4	106.1
2		98.7	106.8	107.0
3		98.5	107.6	107.8
4		98.6	108.2	108.4
1	1966	98.2	109.8	109.8
2		99.3	111.5	111.0
3		98.9	112.7	112.0
4		99.8	112.8	112.6
1	1967	100.7	112.6	113.1
2		101.9	113.9	114.7
3		102.5	115.9	116.5
4		103.3	115.9	116.9
1	1968	103.6	117.3	118.3
2		103.9	118.2	119.4
3		103.5	119.6	120.7
4		104.2	120.7	121.8
1	1969	104.4	121.0	122.8
2		105.0	123.4	125.1
3		104.6	124.9	126.6
4		105.7	124.9	127.3
1	1970	106.0	125.9	128.6
2		106.3	126.9	129.7
3		106.0	127.1	130.4
4		106.4	125.4	130.1
1	1971	107.3	125.7	130.8
2		108.1	128.5	132.6
3		107.9	130.1	134.6
4		108.2	130.3	135.5

Source: Prices and Price Indexes (62-002), D.B.S.

TABLE 12

Unemployment Rates Seasonally Unadjusted

Quarter		Unemployment Rate
1	1961	6.8
2		11.0
3		7.4
4		4.9
1	1962	5.5
2		8.8
3		5.6
4		4.2
1	1963	5.3
2		8.4
3		5.6
4		3.9
1	1964	4.5
2		6.9
3		4.7
4		3.4
1	1965	3.8
2		5.8
3		4.2
4		2.9
1	1966	3.0
2		4.9
3		3.5
4		2.9
1	1967	3.1
2		5.3
3		4.2
4		3.1
1	1968	3.9
2		6.3
3		5.0
4		3.9
1	1969	4.2
2		5.9
3		4.9
4		3.7
1	1970	4.3
2		6.4
3		6.3
4		5.2
1	1971	5.7
2		7.9
3		6.8
4		5.3

Source: Special Surveys Division,
D.B.S.

TABLE 13

Durable Goods Industry

Means, Variances, Standard Deviations

Variable	Mean	Variance	Standard Deviation
$\overset{*}{W}_t$	1.40	.85	.92
$\overset{*}{Q}_t$	1.98	34.96	5.91
$\overset{*}{P}_t$	.15	.43	.66
ΔU_{t-1}	.04	3.47	1.86

TABLE 14

Non-Durable Goods Industry

Means, Variances, Standard Deviations

Variable	Mean	Variance	Standard Deviation
$\overset{*}{W}_t$	1.44	1.43	1.19
$\overset{*}{Q}_t$	1.34	12.24	3.49
$\overset{*}{P}_t$	.62	.46	.68
ΔU_{t-1}	.04	3.47	1.86

CHART 1

Durables

W^*_t and $Q^*_t + P^*_t$

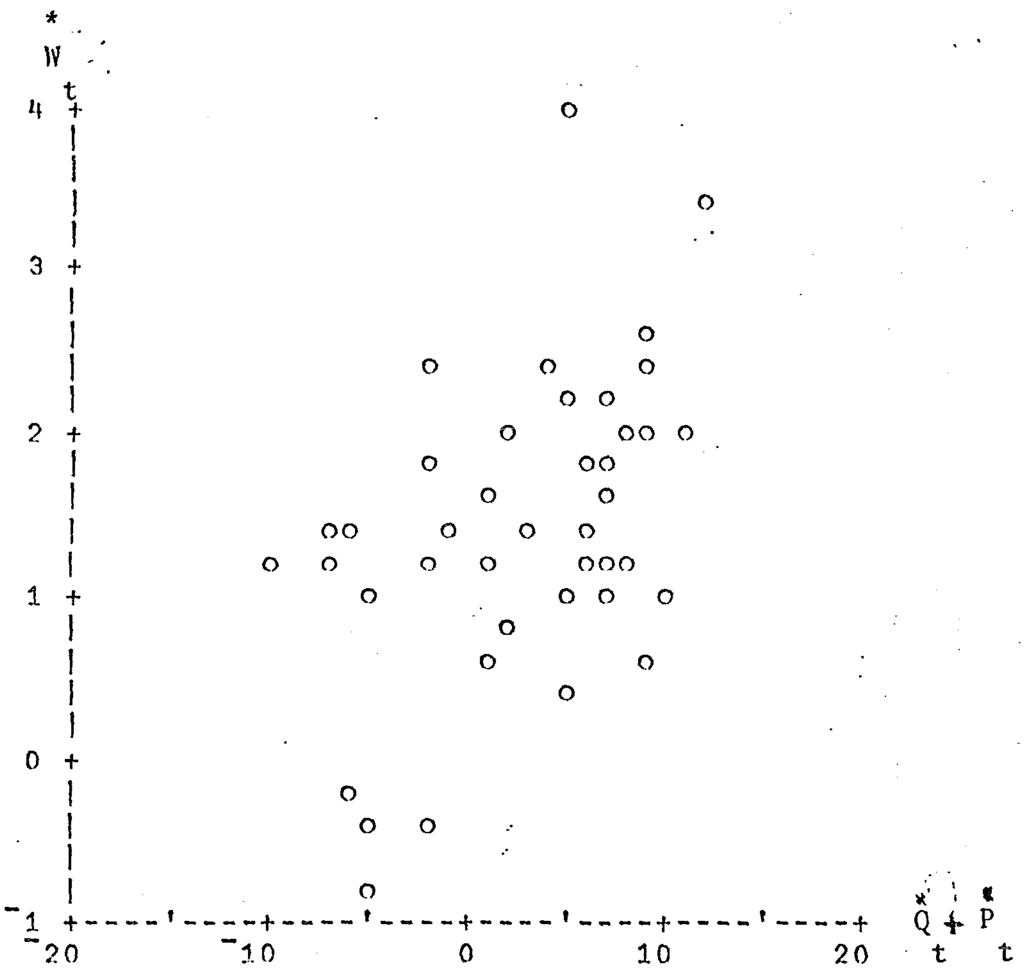


CHART 2

Durables

W^*_t and ΔU_{t-1}

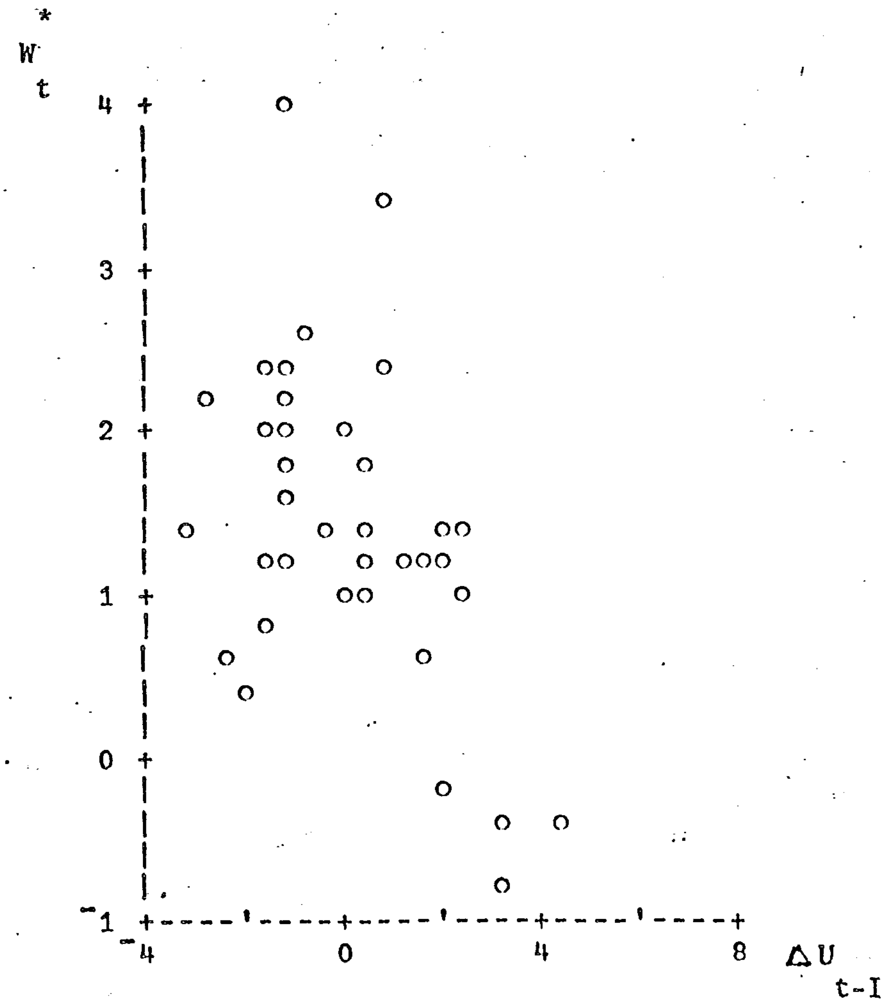


CHART 3

Durables

W^*_t and Q^*_t

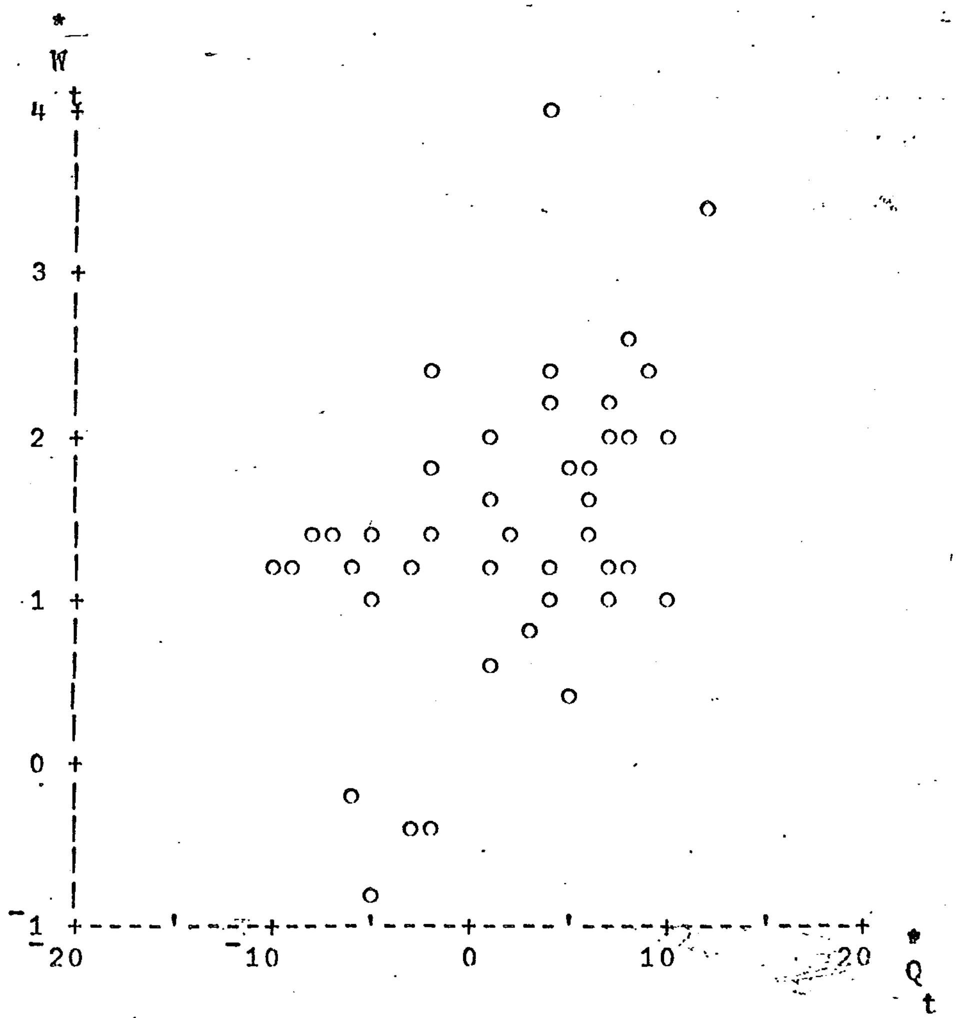


CHART 4

Durables

W^*_t and P^*_t

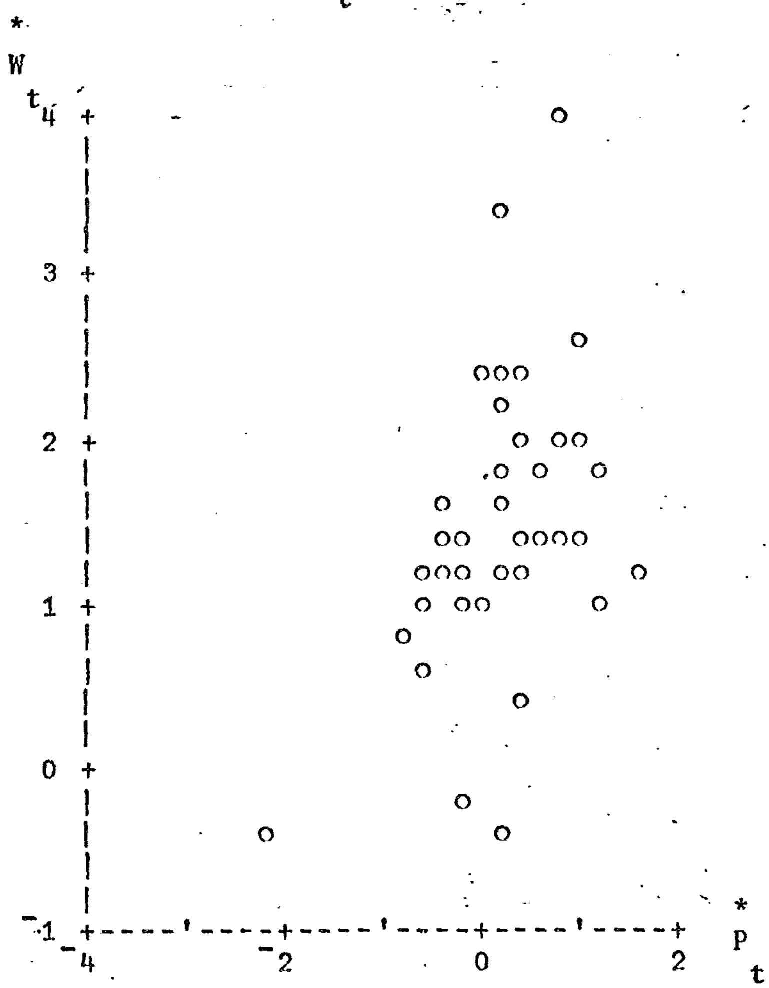


CHART 5

Non-Durables

W^*_t and $Q^*_t + P^*_t$

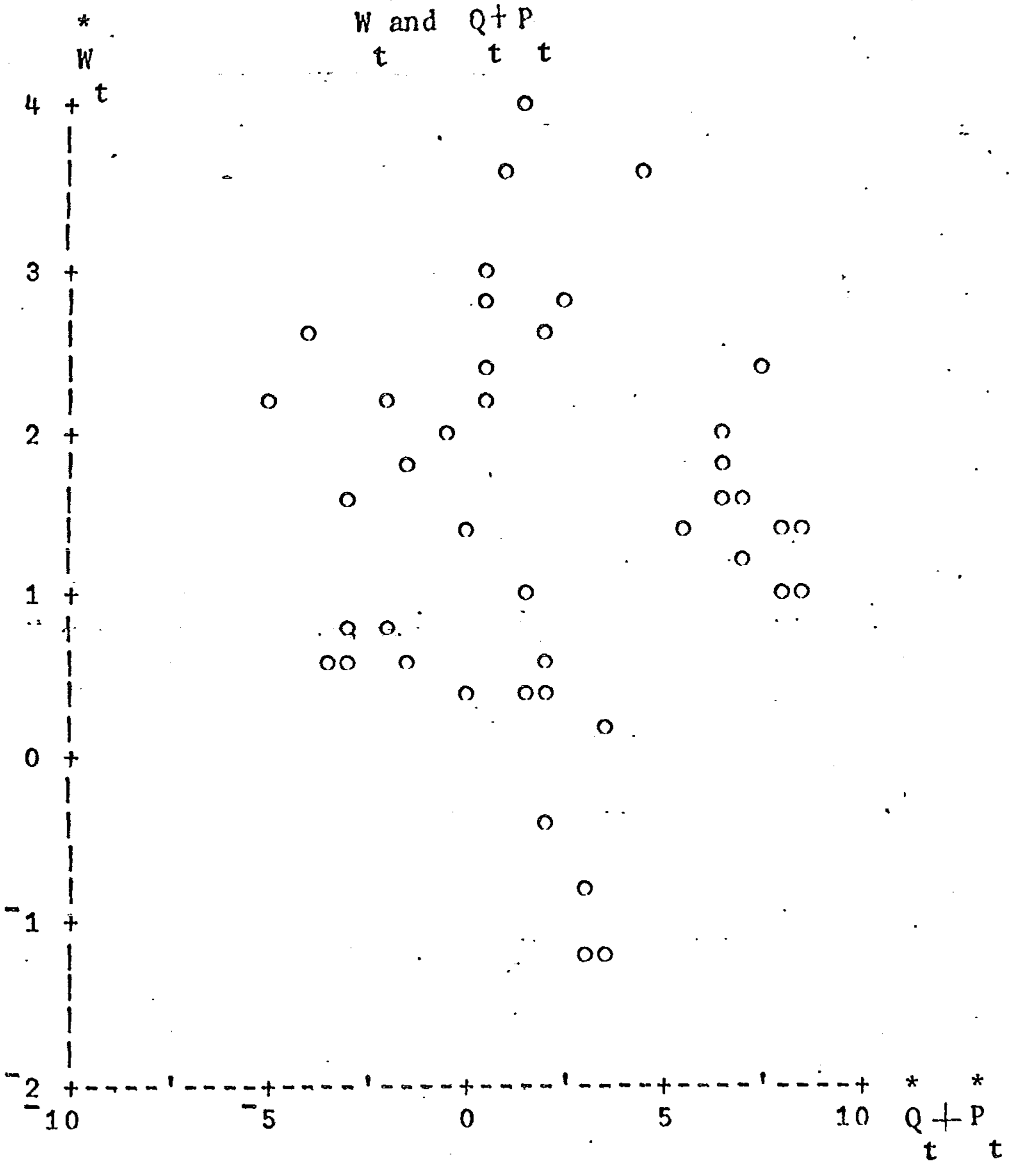


CHART 6

Non-Durables

W^*_t and ΔU_{t-1}

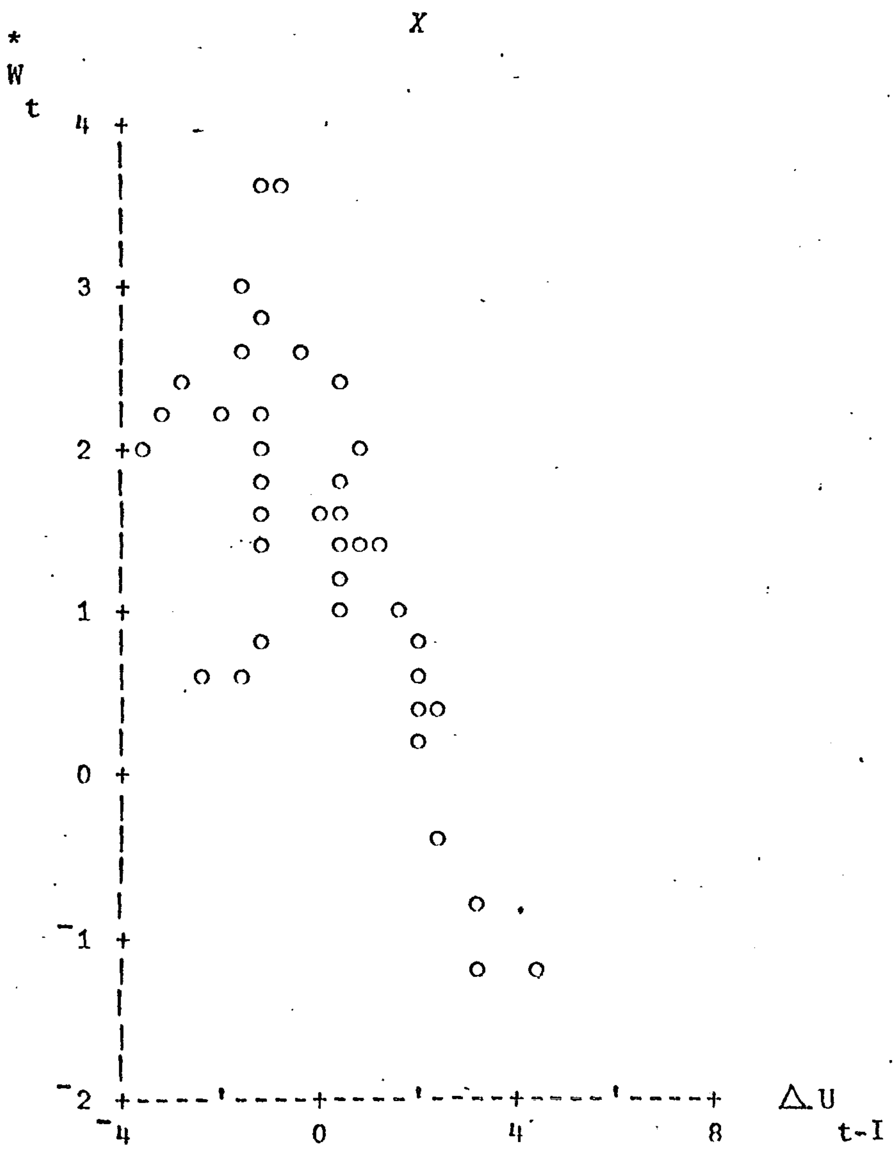


CHART 7

Non-Durables

W^*_t and Q^*_t

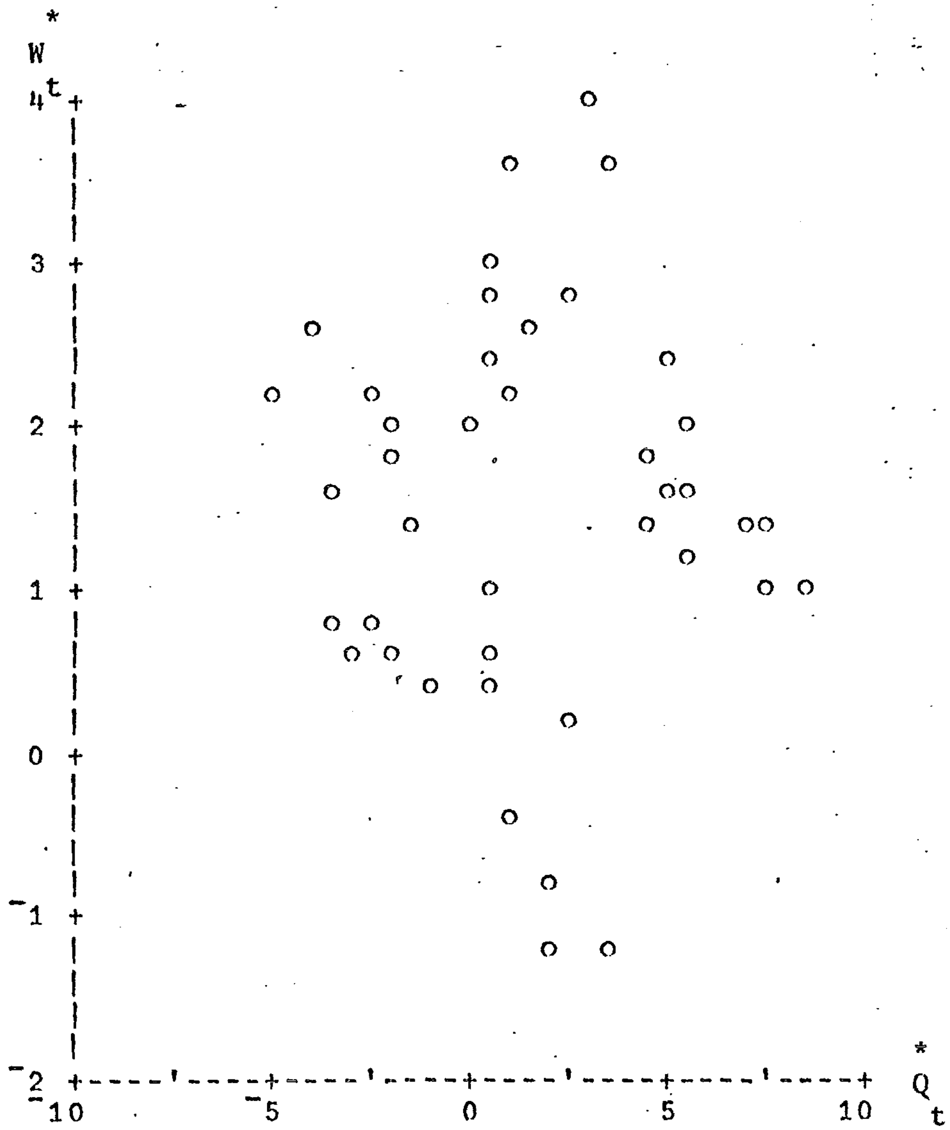


CHART 8

Non-Durables

W^*_t and P^*_t

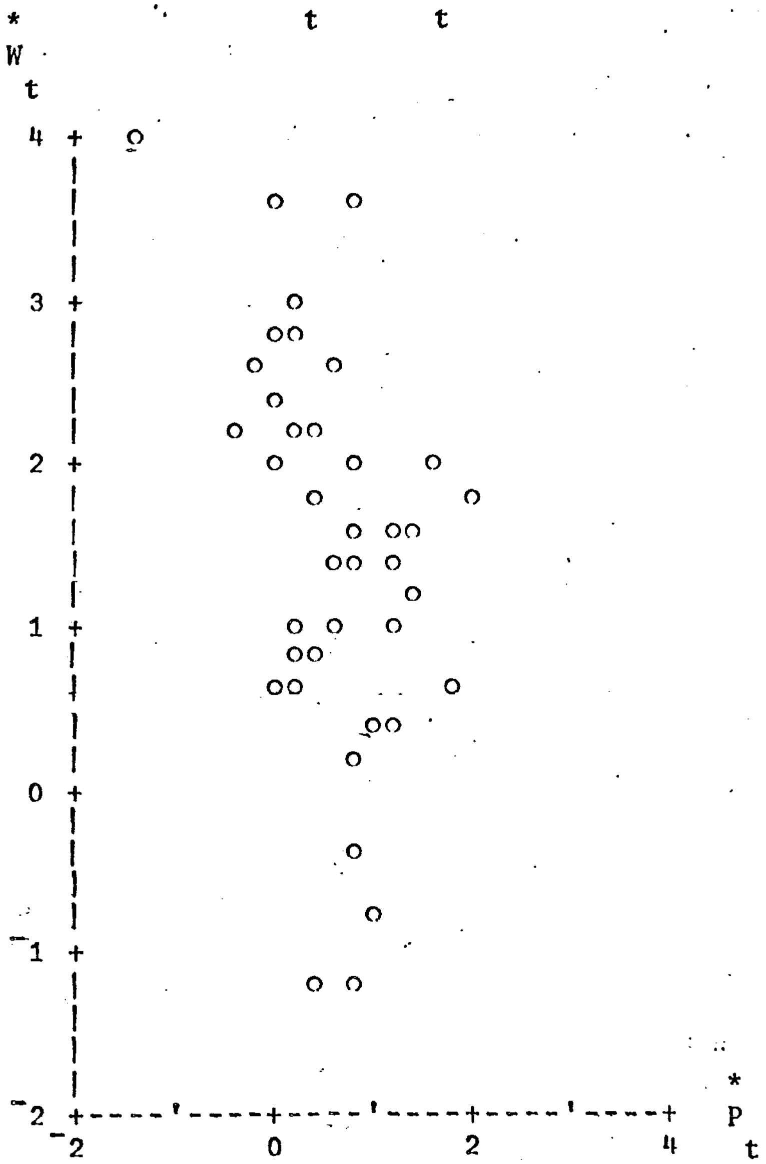


CHART 9

Durables

Rates of Wage Change

Actual and Estimated

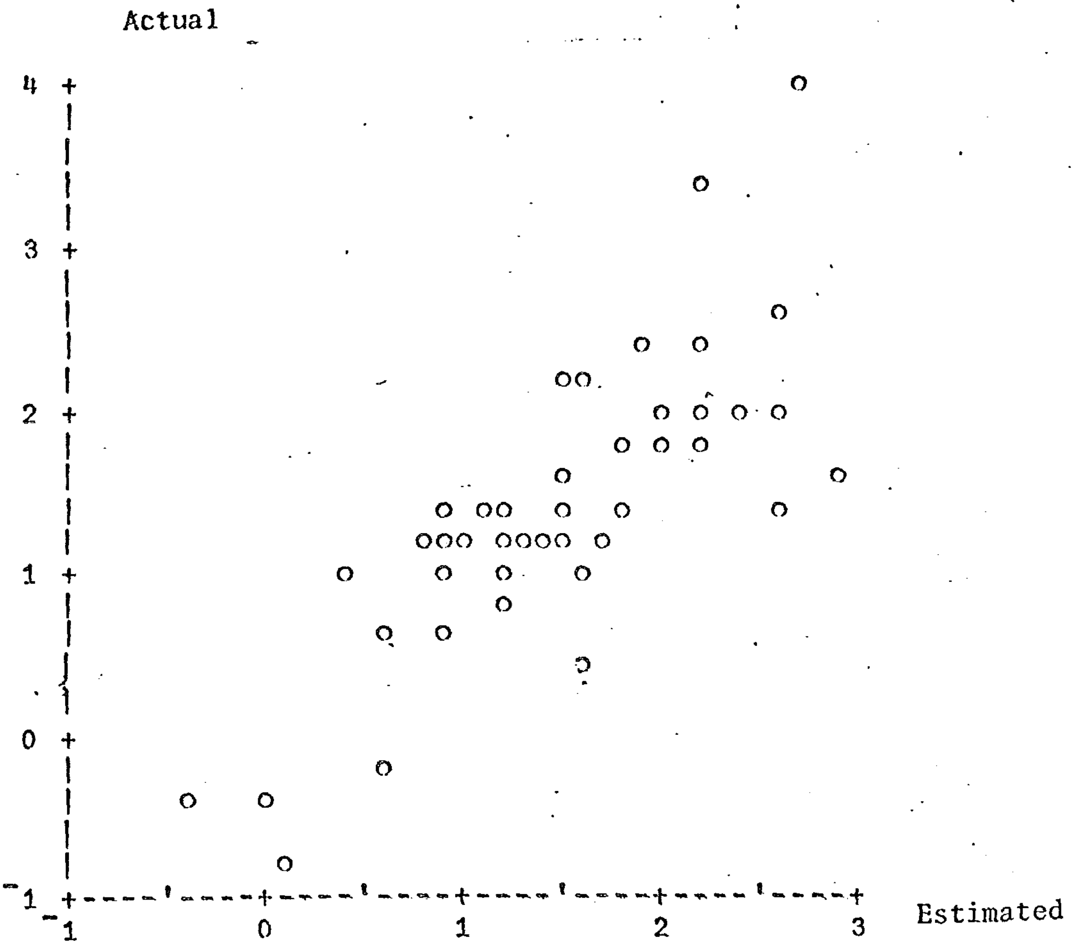
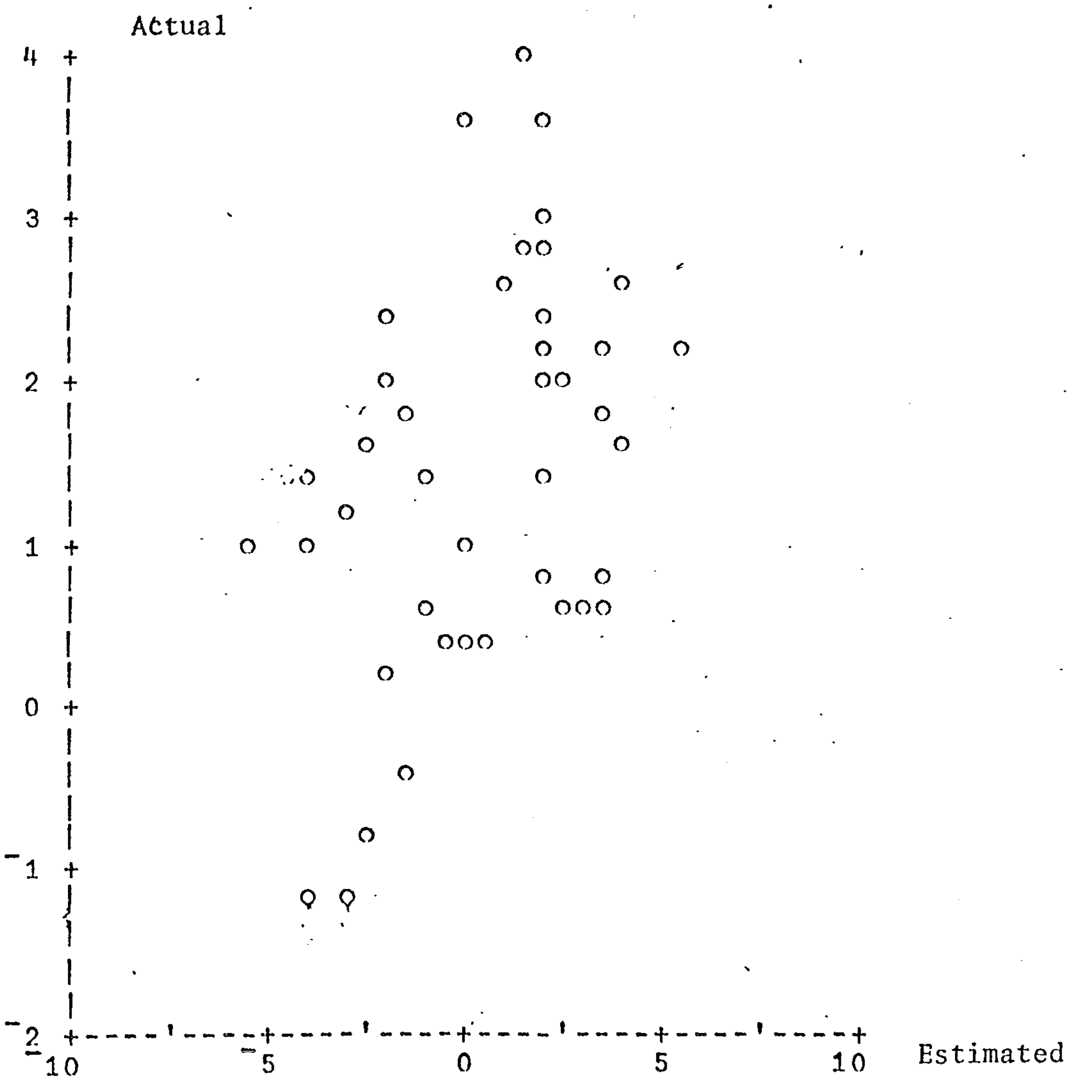


CHART 10

Non-Durables

Rates of Wage Change

Actual and Estimated



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