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The Wage-Price Productivity Nexus

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Preface

In this work I have attempted to analyze the wage and price structure of an important segment of the American economy. A strong motivating force has been a concern with basic economic goals; the compatibility or incompatibility of the goals of full employment and price level stability is, in my view, a fundamental issue. Although problems of structure occupy most of the discussion, the question of what a free community can do to defend itself against inflation is discussed, albeit briefly.

Two important related issues are not discussed, so it is perhaps well to call attention to them at this point. When policy issues are discussed, it is assumed that inflation is undesirable. Even if one were completely agnostic about distributional effects, inflation aggravates balance of payments difficulties, a problem facing the American economy at the present time. Furthermore, there is some presumption that inflation tends to induce less than maximum production, for any given level of resource utilization, through making rational calculation of future conditions more difficult and through encouraging speculative activities. This effect will depend on the degree of inflation and is likely to be quite small, if not negligible, for the "creeping inflation" of post-war experience.

A second issue is the reliability of the statistical materials used. In general, as a data-user, I have been content to accept

passively the output of data-producers. Even when duly warned that data may contain imperfections, I have taken the view that half a loaf is better than none. If theoretical relations shine through imperfect data, this seems, in my view, to testify to the strength of these relationships. Some have argued that price indices are virtually worthless, because of well-known shortcomings. For instance, it has been argued that all or nearly all of the apparent rise in prices since 1950 is fictitious and would disappear if quality change were properly taken into account. I cannot subscribe to this view. As my reservations are indicated in an earlier piece of work (Lawrence R. Klein, senior author, "Empirical Aspects of the Trade-offs among Three Goals: High Level Employment, Price Stability, and Economic Growth," Staff Papers of the Commission on Money and Credit, forthcoming), I shall not repeat this earlier discussion.

It is a pleasure to record the many obligations I have incurred in the preparation of this manuscript. The generous and sympathetic support I have received has enabled me to carry this work through to completion; it is literally true that without this aid, this work could not have been started, much less finished.

Lawrence R. Klein served as dissertation supervisor; my debt to him is enormous. The references in the text to his published works are only a small measure of his contribution to my thinking. Professor Klein was most generous with his time, his ideas, and his data. His kindnesses and his firm but gentle guidance will be forever remembered by this

student of his.

Among my former teachers, William H. Brown of Swarthmore College, Irwin Friend, and Sidney Weintraub must be named. A student always owes much to those who have taught him previously, and this is no less true for me personally.

R. James Ball is the co-author of Chapter II, which was first written during the summer of 1960 when we were both at the University of Pennsylvania. His stimulus to my thinking on these subjects has been much appreciated. We have also benefitted from the comments of Frank Brechling, George Green, Franklyn Holzman, and Sidney Weintraub on earlier drafts of this chapter.

In the course of working on this dissertation, the author received generous financial support. The Samuel S. Fels Fund provided a dissertation fellowship during the 1960-1961 academic year. I was also the recipient of a Wharton School supplementary grant during that period. During the summer of 1961, the National Science Foundation provided a summer fellowship for a graduate teaching assistant. During the summer and early fall of 1962, financial support was provided by the Cowles Foundation at Yale University. This dissertation grew out of an earlier study, during the summer of 1960, financed by the Commission on Money and Credit, which led to the published work cited above. In connection with this paper, the helpful comments and efforts of Joseph W. Conard, who represented the Commission, and Motoo Abe, who worked with Professor Klein and me, must be cited.

The computations in this work were largely done by electronic computers. A debt of thanks is due the University of Pennsylvania Computer Center, where the bulk of this work was done. It would be tedious to name the entire staff, but the kind efforts of James Guertin (the Director), David MacGonagle (programmer), William Castro, and Dolores Monzo must be mentioned. David MacGonagle's help was invaluable, and without it I would still be grinding out the statistical results. The two stage least squares calculations were done, in part, at the Yale Computer Center. James Friedman served as programmer and George Sadowsky as general advisor for these computations.

Data sources are indicated in the text. However, my debt is so great in several cases that an explicit acknowledgment at this point seems in order. Albert Rees's careful reconstruction of money wages in manufacturing over this past century proved invaluable in this study. John W. Kendrick's work on production and productivity figures were made available months in advance of publication. Professor Kendrick's assistant in his labors, Maude R. Pech, was most helpful in extending the published series up to 1957 (and, in one case, up to 1959). Stanley Lebergott's revised figures on unemployment since 1900 were made available to the author in advance of publication. Assistance with data used in Professor Klein's quarterly model, which is described in his recent paper, "A Postwar Quarterly Model: Description and Applications" (National Bureau of Economic Research, mimeographed), was provided by Kanta Marwah, Professor Klein's research assistant.

The helpful comments of Paul Davidson and Joel Popkin are gratefully acknowledged. The typing was done by Gladys Decker and Amanda Slown (the latter, of the Cowles Foundation). The full page charts were drawn by Rose Gallagher. The responsibility for any errors which may have survived the excellent aid which I have received remains, of course, my own.

I owe a debt of gratitude to my wife, Susann R. Bodkin. Her aid goes far beyond the proof-reading and checking labors to which I have subjected her. Words are forever inadequate to express thanks, and this is especially true in her case. Without her enthusiasm and warm support, this work could not have been completed.

Chapter I, "Introduction and Previous Researches"

This is a study of wage and price relationships during a period of general inflation. During the period 1900-1957, money wages in manufacturing increased roughly fourteenfold and consumer prices more than trebled. The wholesale price index of finished goods, our subject of study in Chapter V, increased to two and a half times its original value over the period 1913-1957.¹

These figures should not be taken to imply that the first six decades of the twentieth century was a time of continuously rising wages and prices. This is far from the case. There were sharp declines in all three series mentioned during the post-World-War-I readjustment of 1921; similarly, the advent of the Great Depression (1930-1933) was characterized by declines in wages and prices. In addition, there were other periods of minor downward movements in the individual series. Nevertheless, there can be little doubt that all the series mentioned above had a strong upward trend during the period of this study. (For an illustration, see Figure 6 in Chapter V below, in which the time pattern of the finished goods wholesale price index and of the manufacturing money wage is presented graphically.)

Thus, in one sense, the author's subject of study is inflation

1. Statistical series, together with sources, will be presented below prior to the more detailed analysis.

itself. Because inflation is an extremely broad topic, it seemed sensible to narrow the subject of study. Consequently, most attention will be given to empirical wage adjustment and price level relationships. These materials, which appear in Chapters III-V and in part of Chapter VI, constitute the core of this work. These relationships do not, of course, constitute a full explanation of the inflationary process; but if valid, they serve to further understanding of it. Because the author is interested in saying something about the inflationary process as a whole, a rather simple ~~macro~~-economic model is presented and analyzed in Chapter II. Within the limitations of a static analysis, the response of the economic system to potential inflation-producing forces which are not system-determined is discussed.

The plan of this work, then, is as follows. The remainder of this chapter is given over to summarizing some of the previous researches in the field of wage adjustment and price level relationships. No attempt is made to include all of the significant contributions to date; instead, a discussion of the works which have had the largest influence on the author's thinking is presented. The synopses are necessarily brief; a complete summarization of each of the works discussed below would require many pages.

Chapter II, which was written in collaboration with Mr. R. James Ball, is a static model of the aggregative economy. The function of this chapter is to provide a broad overview for the more detailed discussion of the later chapters. No attempt at empirical verification is made, at this point.

Chapters III, IV, and V are the core of this study. Chapter III deals with a basic wage adjustment or "wage bargain" relationship. Included is some preliminary discussion of a rough empirical estimate of the amount of unemployment "required" for price level stability. Chapter IV is an exploration of some possible refinements of the basic wage adjustment relationship. Here the issue of the possible irreversibility of money wages is raised, and some tests are presented. Chapter V is concerned with empirical relationships "explaining" the course of the wholesale price index of finished goods over the period 1913-1957.

Because productivity is an important link between wages and labor cost per unit of output, time patterns of productivity growth are studied in Chapter VI. Also in this chapter, two stage least squares parameter estimates of some of the empirical relationships previously examined are presented. Chapter VII discusses certain limitations of an aggregative analysis of the inflationary process, summarizing some of the arguments of other writers who have built these limitations into their analyses. In Chapter VIII, a final discussion of the author's empirical measurements of the trade-off between unemployment and price level stability is presented. A summary of the major conclusions of this work also appears in this final chapter.

1. Wage Adjustment Relationships.

This section is concerned with macro-economic studies which

offer an explanation of the change in money wages. The money wage change is typically explained by the level of unemployment and the change in consumer prices. The importance of the level of unemployment may be explained as follows. According to standard economic theory, any price will rise in response to excess demand and fall in response to excess supply. Unemployment, which may be interpreted as excess supply in the labor market, may be expected to lower wages. In a dynamic world with constantly increasing wages, this influence often merely slows down the rate of increase; but even under these circumstances, this influence can still be pronounced. The change in consumer prices has been found to exert an independent impetus to wage changes. This reflects the well-known tendency for wages to be adjusted to changes in the cost of living. Because the focus is on an explanation of changes in the level of wages, these relationships may be termed wage adjustment equations.

All of these studies except the Bowen work² are empirical in nature. (The Bowen work is included in the discussion because of the large influence it has had on the author's thoughts on these issues.) The first eight studies are based on American data, while the Phillips, Klein and Ball, Dicks-Mireaux and Dow, and Lipsey articles² rest on British data. In general, the money wage concept differs between these two sets of studies. The British studies generally use, as

2. A full citation is given below, at the point of detailed discussion.

the wage concept, wage rates, which are nationally agreed, standard rates of payment for specific kinds of jobs. The American studies are based upon average wage earnings, which are total wage payments to the individual or group involved divided by total man-hours worked. Hourly wage rates may differ from average hourly earnings because local rates of payment may differ from the nationally accepted standard rates or because premium rates are paid under certain circumstances, e.g., payment at "time and a half" for overtime work. Unless otherwise noted, the studies using American data discussed below refer to wage earnings and the studies employing British data, to wage rates.

Lawrence R. Klein has studied wage adjustment equations, in connection with his broader econometric studies of the American economy.³ In Economic Fluctuations (p. 121), the change in money wages is explained as a linear function of current unemployment, unemployment of the previous year, last year's money wage, and a time trend. The signs of the coefficients on the unemployment variables are negative, which is the expected direction of effect. A high level of wages in the preceding year tends to retard the wage increase, while over time the expected wage change increases. All of the explanatory

3. Lawrence R. Klein, Economic Fluctuations in the United States: 1921-1941 (New York: John Wiley & Sons, Inc., 1950); L. R. Klein and A. S. Goldberger, An Econometric Model of the United States: 1929-1952 (Amsterdam: North Holland Publishing Company, 1955); Lawrence R. Klein, "A Postwar Quarterly Model: Description and Applications" (New York: National Bureau of Economic Research, 1962, mimeographed).

variables are statistically significant, except for last year's unemployment. The fit is rather tight, as evidenced by a coefficient of multiple correlation corrected for degrees of freedom of 0.93, while the fitted relationship appears to be free of autocorrelation of the residuals. The method of parameter estimation is single equation least squares and so is subject to the biases characteristic of this method of analyzing economic time series.⁴ The sample period is 1921-1941.

In the Klein-Goldberger work, the wage adjustment relation is somewhat modified; here, the change in money wages is related to current unemployment, the previous year's change in the general price level, and a time trend. Only the coefficient of the time trend is significant at the 5 per cent level (with a two-tailed test), although the lagged change in the price index is nearly statistically significant. Broadly similar results are obtained whether the sample period is 1929-1952 or 1929-1950. The method of parameter estimation is limited information maximum likelihood, and once again, there is no evidence of autocorrelation in the residuals of this relationship.

In "A Postwar Quarterly Model," the difference between the current quarter's money wage (at an annual rate) and the money wage of

4. A more detailed discussion of the biases of this method of parameter estimation, when applied to empirical wage adjustment relations, appears below in Chapter III.

four quarters ago is explained as a linear function of a four quarter average of unemployment, a four quarter average of changes in the implicit price deflator of gross national product, and a time trend. The four quarter averages of unemployment and price level changes are averages of current values of these variables and values for the preceding three quarters. Thus a four and a half months average lag (one and a half quarters) is built into the response of the money wage change to the unemployment and price level change variables. The coefficients of all three of these variables are statistically significant (except, possibly, for the time trend coefficient, which is 1.95 times its standard error). The sample period is the first quarter of 1948 to the fourth quarter of 1958, and the method of parameter estimation is limited information maximum likelihood.

Before leaving the Klein econometric models, we may observe how the immediate determination of the general price level proceeds. In Economic Fluctuations and in Klein-Goldberger, there is no explicit price level equation; instead, the wage adjustment equation is interpreted by the author(s) as completing the system with respect to absolute prices and wages. In "A Postwar Quarterly Model," the Klein-Goldberger equation representing a generalization of a constant labor share (another interpretation would be an equation of entrepreneurial demand for labor services) is rewritten in terms of the total private money wage bill divided by the implicit deflator of gross national product. Hence this relationship can plausibly be interpreted, in the

latest Klein model, as a mark-up of unit labor costs into final product price.⁵

In his 1950 note,⁶ Joseph W. Garbarino made an attempt to obtain an empirical counterpart of the theoretical relationship between percentage wage changes and unemployment as a percentage of the labor force. His data refer to the United States non-agricultural sectors, during the period 1890-1935; this period was chosen to approximate the behavior of non-union labor markets. No formal methods of statistical analysis were used; instead, a tabular analysis of sub-averages was carried out. Garbarino concluded that non-union labor markets were likely to have stable money wages when unemployment as a percentage of the labor force reached some level between 8 and 12 per cent, while a rate of wage increase greater than 3 per cent was unlikely to occur unless unemployment fell below 5 per cent. Although the price level change variable was not included explicitly in the statistical analysis, Garbarino's peripheral comments suggest the importance of this variable in explaining actual money wage changes (e.g., during the World War I period).

5. "A Postwar Quarterly Model," p. 19.

6. Joseph W. Garbarino, "Unionism and the General Wage Level," American Economic Review, Volume XL, No. 5, Part 1 (December, 1950), pp. 893-896.

Stefan Valavanis-Vail constructed a long-term econometric model of the American economy.⁷ In a relation described as the "wage bargain equation," the money wage change is explained as a linear function of the percentage of the labor force employed, the change in a general price index, and the percentage of wage earners who are unionized. The method of parameter estimation is limited information maximum likelihood. The coefficients on all of these variables are statistically significant, by usual standards. The direction of effects is as expected: larger changes in money wages are associated with greater degrees of unionization and with higher percentages of labor force employment. The fact that percentage unionization has been growing over the first half of the twentieth century suggests an interpretation of the time trend variable in the Klein wage adjustment equations. In Valavanis' model, there is no equation explicitly explaining the price level. Since the general price index is an endogenous variable, it must be determined implicitly within the system. Valavanis asserts that the price level is "influenced" by the quantity of money, which, however, has its primary impact in his "liquidity preference" equation.

In an introductory chapter to The Theory of Wage Determination,⁸ John T. Dunlop presents, along with his survey of the field, an aggregative model which explains the general level of wages. Empirical

7. Stefan Valavanis-Vail, "An Econometric Model of Growth: U.S.A. 1869-1953," American Economic Review, Papers and Proceedings, Volume XIV, No. 2 (May, 1955), pp. 208-221.

8. John T. Dunlop, "The Task of Contemporary Wage Theory," The Theory of Wage Determination, ed. John T. Dunlop (London: MacMillan & Co. Ltd., 1957), pp. 3-27.

counterparts are obtained for the wage equation and for the price level equation.⁹ The wage equation relates the change in average hourly earnings to last year's percentage of the labor force unemployed and to last year's ratio of corporate profits before taxes to corporate sales. The data are American data, for the period 1929-1952; the method of parameter estimation is single equation least squares. Because the explanatory variables are lagged values, this method of parameter estimation does not entail single equation bias in Dunlop's wage adjustment equation. As the coefficient of multiple correlation is 0.76, the fit is moderately good. The wage increase tends to be large if the level of unemployment is low and/or if the profit rate is high.

Paul A. Samuelson and Robert M. Solow, in a general discussion of inflation,¹⁰ estimate an empirical relationship between percentage changes of average hourly earnings in manufacturing and percentage unemployment. (This relationship is termed a "Phillips Curve," after the work of A. W. Phillips, which is discussed below.) The data are American data, and a close reading of the article suggests that the period of the authors' survey is 1914-1958. The scatter diagram shows the points distributed fairly widely, although some of the

9. The price level equation is discussed in Section 2 of this chapter.

10. Paul A. Samuelson and Robert M. Solow, "Analytical Aspects of Anti-Inflation Policy," American Economic Review, Papers and Proceedings, Volume L, No. 2 (May, 1960), pp. 177-194.

outliers can be rationalized in terms of New Deal wage push or World War I inflation. After the outliers are taken into account, the relationship is estimated by a technique approximating a freehand fit. The authors assert that the "Phillips curve" has shifted upward in recent years, concluding that at present 8 per cent unemployment is required to keep money wages from rising and that money wages would rise at 2 or 3 per cent per year (on the average) with 5 or 6 per cent of the labor force unemployed.¹¹ Assuming a 2 1/2 per cent per annum rate of productivity growth and a constant wage share, the authors conclude that the goal of price stability requires 5 or 6 per cent unemployment of the labor force. On the other hand, they would expect unemployment rates as low as 3 per cent to be associated with a 4 or 5 per cent annual rate of price level increase.¹² Samuelson and Solow also note that these estimates will change if labor mobility increases, if labor market institutions change (e.g., if trade unions become less pushful), or if the rate of productivity advance changes.

Rattan J. Bhatia has studied the wage adjustment relationship for the United States, also.¹³ As the title of his article implies, Bhatia's sample period was 1900-1958, which he broke up into three separate periods: 1900-1932, excluding 1915-1920; 1933-1948, excluding

11. Ibid., p. 189.

12. Ibid., p. 192.

13. Rattan J. Bhatia, "Unemployment and the Rate of Change of Money Earnings in the United States, 1900-1958," Economica, N.S., Volume XXVIII, No. 111 (August, 1961), pp. 286-296.

1933-1934 and 1942-1948; and 1949-1958. The dependent variable is the percentage change in manufacturing money wage earnings; the explanatory variables are unemployment as a percentage of the labor force, percentage changes in percentage unemployment, and percentage changes in a consumer price index (the B.L.S. cost of living index). The method of parameter estimation was single equation least squares. Bhatia concluded that changes in the consumer price level were the most important variable in explaining money wage changes. (This variable was significant in all three of the sub-periods analyzed.) The level of unemployment was important in the first two sub-periods, although the coefficient on this variable was not statistically significant for the post-World-War-II period. Another conclusion of Bhatia's study was that the relation between the money wage change and unemployment was at least approximately linear, in contrast to Phillips' conclusion on this issue (discussed immediately below). Finally, the change in unemployment variable was statistically significant in neither of the two sub-periods in which it was introduced as an explanatory variable.

Turning now to British studies of the wage adjustment relation, we may start with Professor Phillips' already classic place.¹⁴ For the period 1861-1913, Phillips fitted, by somewhat unorthodox methods, a highly nonlinear relationship between percentage changes in an index

14. A. W. Phillips, "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957," Economica, N.S., Volume XXV, No. 100 (November, 1958), pp. 283-299.

of hourly wage rates and percentage unemployment. Deviations of actual observations from the fitted relationship are explained in terms of the direction of change of unemployment. Decreasing unemployment is associated with higher than average (for that level of unemployment) wage rate changes, and conversely for increases of the unemployment rate. Phillips interprets changes in unemployment as an indication (over and above the unemployment level itself) of labor market demand conditions, decreasing unemployment indicating buoyant demand for labor and so constituting additional pressure for higher wages. (Conversely with increasing unemployment.) Changes in the consumer price level are held to operate with a threshold effect: Phillips argues that until consumer prices rise faster than wages, cost of living adjustments represent wage increases that workers would have obtained anyway, from the operation of market forces. Thus, except for years in which prices rise very rapidly (owing, usually, to sharp rises in import prices), this factor plays no role in his explanation of money wage rate changes. Phillips then looks at the periods 1913-1948 and 1948-1957 and concludes that the pre-World-War-I relationship holds rather well. Thus he feels that the effects on money wages, of the 1925-1929 policy of restricting demand, could have been predicted fairly accurately from a knowledge of the prewar relationship and the levels of unemployment attained. Although he is similarly satisfied with the correspondence of the fitted relationship to post-World-War-II data, the importance of changes in unemployment does not show up during this period. Phillips concluded that the

amount of unemployment necessary to prevent wage rates from rising was 5 1/2 per cent, while with 2 1/2 per cent unemployment, wage rates would rise 2 per cent per annum, a rate consistent with stable prices if the labor share stays constant, if labor productivity grows at the same 2 per cent rate, and if wage earnings increase at the same pace as wage rates.

Phillips' work has not gone unnoticed. Nicholas Kaldor has argued¹⁵ that Phillips' work provides better support for a "bargaining strength" theory of wage rate increases than his own. Kaldor argues that the "bargaining strength" of unions rests on past increases in profits, and that Phillips obtains his correlations because of intercorrelation between the level and rate of change of unemployment, on the one hand, and changes in profits, on the other.¹⁶ Guy Routh's article¹⁷ is mainly concerned with data construction problems; the major conclusions are left unchallenged. Routh points out, however, that Phillips does not make appropriate allowance for the inexactness of the fitted relation, either statistically or in his interpretations. Routh also points out that the unemployment change

15. Nicholas Kaldor, "Economic Growth and the Problem of Inflation - Part II," Economica, N.S., Volume XXVI, No. 104 (November, 1959), pp. 287-298.

16. The influence of profits on wage changes is studied in Chapter IV, where some empirical results of other authors pertinent to this question are also discussed.

17. Guy Routh, "The Relation between Unemployment and the Rate of Change of Money Wage Rates: A Comment," Economica, N.S., Volume XXVI, No. 104 (November, 1959), pp. 299-315.

variable does not seem to be important in the post-1948 period. Finally, Routh argues that institutions and expectations should not be forgotten when forecasting from the statistical relationships. Knowles and Winsten also emphasize¹⁸ that Phillips' fitted relationship, if it is true at all, is true only under unchanging institutional conditions. Like Routh, they point to imperfections in Phillips' data. Knowles and Winsten's major point, however, is the large variability in the wage change associated with any given level of unemployment. This large variability suggests to Knowles and Winsten that other explanatory variables, such as changes in consumer prices, may be important in explaining wage changes.

Richard G. Lipsey has gone over the Phillips study, using more conventional statistical techniques.¹⁹ Lipsey's results confirm some of Phillips' rather intuitive conclusions, though by no means all of them. Lipsey fits, by least squares techniques, wage adjustment equations with unemployment, unemployment change, and the change in a retail price index as explanatory variables. Separate regressions are calculated for the pre-World-War-I period 1862-1913 and the twentieth century period 1923-1939 and 1948-1957. The non-linear relationship between unemployment and the wage change is retained for

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18. K. G. J. C. Knowles and C. B. Winsten, "Can the Level of Unemployment Explain Changes in Wages?", Bulletin of the Oxford University Institute of Statistics, Volume XXI, No. 2 (May, 1959), pp. 113-120.
 19. Richard G. Lipsey, "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom 1862-1957: A Further Analysis," Economica, N.S., Volume XXVII, No. 105 (February, 1960), pp. 1-31.

both of the periods analyzed. Unemployment has a statistically significant coefficient in both periods, though its influence is somewhat greater for the earlier period. Phillips is quite correct in pointing up the importance of unemployment changes in explaining wage changes in the earlier period; this variable plays a highly significant role in the pre-World-War-I regression equation. However, the coefficient of unemployment change reverses its sign (in a statistically significant manner) for the twentieth century relationship as a whole; Lipsey gives an explanation of this reversal in terms of a theoretical model developed in a middle section of this article.²⁰ Lipsey tests Phillips' threshold theory that only large changes in consumer prices influence the wage change. The data give a refutation to this view, and instead changes in the retail price index are introduced, as an explanatory variable, in a direct and linear fashion. This variable is statistically significant in both periods, although it is the least important explanatory variable in the earlier period and the most important in the later period, the magnitude of the partial correlation coefficient being used as the criterion. The size of the regression coefficient of price level changes is much larger for this later period. The post-World-War-I regression displays greater downward inflexibility of wage changes. (In the twentieth century, the expected wage change is always positive,

20. Lipsey's theoretical model of wage determination in the individual labor markets and its application to the aggregative relationship between wage changes and unemployment will be discussed, at some length, in Chapter VII.

with constant consumer prices, regardless of how large the level of unemployment becomes.) Nevertheless, Lipsey agrees with Phillips that the 1925-1929 wage change experience could have been predicted from the 19th century relationship. Finally, Lipsey argues against immediate application of empirical wage adjustment relationships in calculating a trade-off between unemployment and price level stability.²¹

L. R. Klein and R. J. Ball wrote an article²² on the wage-price mechanism of the post-World-War-II British economy, based on the results of a larger econometric model. The wage adjustment equation related the difference between the money wage rate of the current quarter and that of the same quarter of the preceding year to a four quarter average of the unemployment level of the current quarter and of the preceding three quarters, a similar four quarter average of changes in the consumer price level, a dummy variable representing political conditions, and three seasonality variables. (The individual variables were not adjusted for seasonal variation; instead, the influence of seasonality was estimated directly in the fitted equations.) Except for the seasonality variables, all variables were statistically significant. The method of parameter estimation was limited information maximum

21. A later paper by Lipsey and Steuer on profits versus unemployment as explanatory variables in a wage adjustment relationship is discussed in Chapter IV below, in connection with this writer's work on that issue.

22. L. R. Klein and R. J. Ball, "Some Econometrics of the Determination of Absolute Prices and Wages," Economic Journal, Volume LXIX, No. 275 (September, 1959), pp. 465-482.

likelihood. The fit was fairly tight, but there was some evidence of autocorrelation in the residuals of this relationship. Klein and Ball found that the wage change was rather sensitive to the level of unemployment. The coefficient of consumer price level changes did not differ significantly from unity, which suggests that, on the average, wage adjustments due to changing consumer prices were fully compensatory, thus maintaining real wages. By contrast, several of the other studies cited²³ concluded that less than full adjustment of money wages was the typical pattern. The dummy variable took the value zero from the first quarter of 1948 to the last quarter of 1951 and the value one (1) from the first quarter of 1952 to the last quarter of 1956. The positive coefficient of this variable suggested a more militant "pushing" for higher wages, on the part of the trade unions, under a Conservative government. Finally, Klein and Ball tried both productivity changes and profits as explanatory variables in their wage adjustment relationship, but as the resulting equations were inferior, these emendations were not included.²⁴

L. A. Dicks-Mireaux and J. C. R. Dow have also studied the wage adjustment process in the post-war British economy.²⁵ They estimated

23. Bhatia, op. cit.; Lipsey, op. cit.; Dicks-Mireaux and Dow (cited in full and discussed in the following paragraph).

24. The Klein-Ball consumer price level equation is discussed in Section 2 of this chapter.

25. L. A. Dicks-Mireaux and J. C. R. Dow, "The Determinants of Wage Inflation: United Kingdom, 1946-1956," Journal of the Royal Statistical Society, Volume CXXII, Part 2 (1959), pp. 145-184.

several logarithmic relationships between a ratio expressing the change in the average wage rate index between corresponding quarters of successive years (the dependent variable) and a measure of the excess demand for labor, a ratio expressing the change in the retail price index between corresponding quarters of successive years, and an attitudinal variable measuring trade union "pushfulness." All the independent variables were four quarter averages of the current values of the relevant series and the values of the preceding three quarters. A relationship between the dependent variable and the first two independent variables was computed for the period: fourth quarter of 1950 to fourth quarter of 1956, while the full relationship was estimated from observations running from the fourth quarter of 1946 to the fourth quarter of 1956. All three variables were statistically significant. The method of parameter estimation was single equation least squares. The fits were fairly tight, as suggested by coefficients of multiple determination higher than 0.8. The estimated relationships displayed autocorrelation of the calculated residuals, but a suitable transformation eliminated this autocorrelation in the relationship estimated for the shorter period. (The transformation produced only small changes in the parameter estimates.) Dicks-Mireaux and Dow found that the wage change is quite sensitive to variations in the excess demand for labor, a 1 per cent rise in this variable being associated with a 2 1/2 to 3 1/2 per cent rise in money wages. (The excess demand for labor index is constructed from both unemployment and vacancy statistics; zero excess demand corresponds roughly to only

frictional unemployment and a one per cent rise in this index (relative to the labor force) approximates a one per cent decrease in unemployment.) As noted in footnote 23 above, the elasticity of the wage ratio with respect to changes in the price ratio was significantly below unity, a 1 per cent increase in the consumer price level being associated with a 0.5 or 0.6 per cent increase in money wages. For the full period, the attitudinal variable had a prominent impact: money wage rates rose by 5 percentage points more, ceteris paribus, during a period of "marked pushfulness" (the authors' highest rating for this variable) than during a period of "marked restraint" (the lowest rating).²⁶

William G. Bowen has studied the wage adjustment process in a theoretical monograph.²⁷ Bowen catalogues some variables serving to explain the magnitude of the wage adjustment. Productivity change is

26. In a later paper, L. A. Dicks-Mireaux ("The Interrelationship between Cost and Price Changes 1946-1959: A Study of Inflation in Postwar Britain," Oxford Economic Papers, Volume XIII, No. 3 (October, 1961), pp. 267-292) has updated the wage adjustment relationship and discussed a relationship between the price level and aggregative measures of costs, which is summarized in Section 2 below. In this study, the wage variable is an earnings variable (average wages and salaries per employed person) and the price level variable is an index of final product prices at factor cost. A linear form of the wage adjustment equation was adopted and the final estimation of parameters was done by the method of two stage least squares. Dicks-Mireaux tried productivity changes as an explanatory variable in the wage adjustment relationship but found that its influence was negligible.

27. William G. Bowen, The Wage-Price Issue (Princeton, N.J.: Princeton University Press, 1960).

held to exert no direct effect on the wage adjustment process, since neither labor nor management will accept the principle that wage changes should be geared to productivity increases. However, Bowen asserts that high productivity increases may be associated with high increases in average hourly earnings, as workers cannot be prevented from capturing minor productivity gains under a system of piece rate payment.²⁸ Still another channel of influence of increased productivity on wages is through higher (expected) profitability. A second factor is the excess demand for labor (level of unemployment). Although, following strict economic theory, this ought to be a key determinant of the wage change, Bowen feels that in practice this link will be rather loose. This is so because with employers' setting wages unilaterally, alternative modes of adjustment (other than a wage increase) to a labor shortage exist (e.g., lower hiring standards, higher recruitment expenditures, or increasing the attractiveness of working at the firm). With union bargaining, the excess demand for labor is only one of the myriad of factors which the union must take into account. Ability to pay, which may be interpreted as the expected profitability of the firm, is a third factor; often management

28. H. A. Turner ("Wages, Productivity, and the Level of Employment: More on the 'Wage Drift'," The Manchester School of Economic and Social Studies, Volume XXVIII, No. 1 (January, 1960), pp. 89-123, asserts that this principle is the principal explanation of movements in the difference between wage earnings and wage rates (the so-called "wage drift"). He furthermore argues that the rate of productivity rise exerts a strong long-term influence on the rate of increase of wage rates themselves, because of the different ways through which timeworkers and pieceworkers receive higher wages and because of the need to avoid debilitating tensions in the work place.

adopts as a goal the reputation of being a high wage firm and high profitability permits this goal to be realized. (Under unionization, outside pressures to "share the wealth" will exist, also.) Cost of living changes are still another factor tending to produce wage adjustments. Cost of living rises unmatched by wage increases lead to a deterioration of morale and possible inefficiency on the job. Unions provide a focal point for such dissatisfaction, but are by no means necessary to make this factor operative as a pressure for higher wages. Similarly, such pressures can develop if one group of workers does not receive a wage increase equivalent to one received by another group which is viewed by the first group as "comparable."²⁹ Bowen also discusses the influence on the wage adjustment process of institutional conditions, such as the existence of industry-wide bargaining, the trend toward longer-term contracts, the presence of public scrutiny of the collective bargaining process, and the habitual nature of wage increases. Bowen asserts that the actual wage increase can be viewed as the product of r (the ratio) and the maximum wage increase needed to alleviate all pressures on the current level of wages. Thus Bowen argues that the wage-determining variables are not summative in their influence. (This is the assumption underlying a linear regression equation, of course.) Bowen may well be correct, on this point. And yet, if the wage-determining variables interact and

29. This sectoral impetus to money wage increases will be examined more fully in Chapter VII below.

reinforce each other, it would seem plausible that a linear representation might approximate the true function. In terms of Bowen's model, a large number of wage-determining pressures of a given magnitude might be systematically associated with high (towards unity) values of r , the ratio of the actual wage increase to the theoretical maximum.

In a recent study by Professor Klein and the present author,³⁰ the wage adjustment relationship was studied for seven countries (Australia, Belgium, France, Italy, Japan, and Western Germany). The percentage change in money wages between corresponding quarters of successive years was expressed as a linear function of a four quarter average of unemployment as a percentage of the labor force, of a four quarter average of percentage changes in the price level, and of a time trend. (Both four quarter averages refer to the current values of the relevant series and those of the preceding three quarters.) The method of parameter estimation was single equation least squares. In general the fits were moderately good, and almost all of the coefficients were statistically significant. For every country except Italy, the coefficient of average unemployment was negative; thus in six cases out of seven, the prediction of economic theory holds across an international sample. The coefficient of the average price level change was always

30. Lawrence R. Klein and Ronald G. Bodkin (with the assistance of Motoo Abe), "Empirical Aspects of the Trade-offs among Three Goals: High Level Employment, Price Stability, and Economic Growth," Staff Papers of the Commission on Money and Credit, forthcoming.

positive; but less than full wage adjustment to changing prices seemed to be the typical case. The signs of the trend coefficients were mixed. There are four countries in which wages rise at 2 1/2 per cent per annum, on the average, when unemployment is under 3 per cent of the labor force. The wage-setting institutions of the American economy seem to be unusually insensitive to the level of unemployment, even when one takes into account the lack of strict comparability of international comparisons of unemployment rates.³¹

2. Relationships between the Price Level and the Level of Costs.

This section examines the works of other writers who have studied the relationship between the level of prices and cost levels. According to conventional economic theory, factor prices or the level of costs influence the firm's market offer, under pure competition, or the firm's production and pricing decisions, under imperfect competition. Hence factor prices or the level of costs might be expected to be one determinant of the level of the price at which the firm sells its product. Under a regime of mark-up pricing, the connection between the level of costs (or factor prices) and the price of the firm's final product is still more direct; the interaction of demand forces with cost or supply forces is held to be of negligible importance.³² Instead, the

31. On this question, see "International Comparability of Unemployment Statistics," Monthly Review of the Federal Reserve Bank of New York, Volume XLIII, No. 3 (March, 1961), pp. 47-51.

32. Under mark-up pricing, the relevant cost concept is average cost, not marginal cost. This difference from conventional economic theory is of secondary importance in aggregative applications and for purposes of public policy.

firm is viewed as taking a conventional mark-up over the level of average costs (usually including fixed costs) at a standard volume of output. In either view, when the relationships for the individual firms are aggregated for the economy as a whole, one might expect to find a corresponding relationship between an index of the price level and indices of economy-wide levels of factor prices or of costs.

John T. Dunlop has computed, in the paper discussed above,³³ a relationship between the consumer price level, average hourly earnings, and productivity. The difference between the current year's consumer price level and that of the preceding year is the dependent variable; the two explanatory variables are the change in average hourly earnings (from the preceding year to the current year) and the annual change in output per man-hour. As was the case for the wage adjustment relationship, the sample period is 1929-1952 and the method of parameter estimation was single equation least squares. The fit is rather good, as indicated by a coefficient of multiple determination equal to 0.91. Dunlop found a positive coefficient on the wage change variable, indicating that a higher average factor price of labor is associated with higher price levels. The negative coefficient of the productivity change variable is also in accord with theoretical expectations; higher levels of productivity exert, ceteris paribus, a restraining influence on the level of costs and hence should be associated with lower levels of prices.

33. John T. Dunlop, op. cit.

In the Klein-Ball paper discussed above,³⁴ there is an equation explaining the level of consumer prices (the dependent variable). The explanatory variables are the level of weekly wage earnings, an index of import prices of two quarters previously, the ratio of indirect taxes (less subsidies) to consumer expenditures, and three seasonality variables. Thus the wage variable relevant to price level determination is not nominal wage rates, but per worker wage earnings actually paid out by employers.³⁵ As in the wage rate adjustment equation, the sample period was the thirty-six quarters spanning the period 1948-1956 and the method of parameter estimation was limited information maximum likelihood. The fit was extremely tight; the statistic representing the equivalent of the coefficient of multiple correlation had a value of 0.996. There was, however, evidence of autocorrelated residuals. The seasonality variables are statistically significant; thus, as might be expected from American experience,³⁶ the influence of seasonality is important in explaining quarter-to-quarter variations in the consumer price index. Both the coefficients

34. L. R. Klein and R. J. Ball, op. cit.

35. Klein and Ball compute the parameters of a relationship explaining the difference between wage earnings and wage rates. (Both wage variables are measured relative to a base value.) This is their "wage drift equation," which is not discussed here because it is of only peripheral interest in the present author's study.

36. For example, see the discussion of Ewan Clague ("The Consumer Price Level in the Business Cycle," Monthly Labor Review, Volume LXXXI, No. 6 (June, 1958), pp. 616-620).

of the wage earnings variable and of the import price index are many times their respective standard errors and so are statistically significant. The marginal effect on the consumer price level is approximately twice as great with a unit change in wage earnings as with a unit change in import prices. As the fitted relationship indicates, import prices are an important element of prime cost in an open economy such as that of the United Kingdom. The time lag for the import price index variable is, as noted above, two quarters; but the authors state that a somewhat longer or shorter lag or even no lag at all would not have modified the statistical results appreciably. The coefficient of the ratio of indirect taxes (less subsidies) to consumer expenditures is not statistically significant. Klein and Ball interpret this outcome as indicating that changes in indirect tax rates, which are specifically directed, have their primary impact on the prices of, and expenditures on, particular goods, but that the influence on the consumer price level as a whole is negligible. Finally, it should be noted that Klein and Ball tried the level of productivity as an explanatory variable in the price level equation, but found that its influence was not statistically significant.

Sidney Weintraub has set forth a theory of the price level in two recent publications.³⁷ Professor Weintraub starts from the definitional equation that the mark-up factor (k) equals the ratio of total product, evaluated at market prices, to total labor compensation. (Hence the mark-up factor is the reciprocal of the wage share.) One can, of course, write total labor compensation as the product of the average money wage (per worker) and the number of (full-time equivalent) employees. Similarly, one may write total product, evaluated at market prices, as total output in real terms multiplied by the price level (the implicit deflator of total product). Weintraub then makes the crucial assumption that the mark-up factor is a constant or is nearly so.³⁸ Weintraub gives a theoretical explanation of this

37. Sidney Weintraub, A General Theory of the Price Level, Output, Income Distribution, and Economic Growth (Philadelphia: Chilton Co., 1959); Sidney Weintraub, Classical Keynesianism, Monetary Theory, and the Price Level (Philadelphia: Chilton Co., 1961). For the rest of this work, the former is given the short title, A General Theory, and the latter, the short title, Classical Keynesianism. The discussion of this paragraph and the one following it will refer to A General Theory, except where otherwise noted.

38. Weintraub's equation (6.2b) on p. 59 of A General Theory may be interpreted as implying that the constancy of the mark-up factor is disturbed only by events whose influence is small enough that they may reasonably be regarded as random. It may also be interpreted to make explicit allowance for a downward trend in the mark-up factor (an upward trend in the wage share), which is recognized by Weintraub. (A General Theory, p. 42 and Classical Keynesianism, p. 58.) This downward trend in the mark-up factor might plausibly be explained by a decline in the degree of monopoly power, a rise in the power of the trade unions, sectoral shifts (such as the shift out of agriculture), or the declining capital-output ratio, which reduces user costs per unit of output. Weintraub seems to lean toward the first explanation, giving only a minor role to the decline in the capital-output ratio. (Classical Keynesianism, pp. 58-60.)

constancy in terms of his analysis in an earlier work,³⁹ but the fundamental explanation seems to the present writer to be the stability of politico-economic institutions.⁴⁰ The postulate of the constancy of the mark-up factor implies a proportional relationship between the price level and the ratio of the money wage to the average product of labor. Weintraub argues strongly, in Chapter 3 of Classical Keynesianism, that the direction of causation is from the quotient of the money wage divided by labor's average product to the price level. Thus Weintraub's mark-up relationship can be interpreted as an aggregative relationship between an index of unit labor costs and the price level.

Weintraub then turns to American data to test his hypothesis. His sample period is the years 1929-1957, and his data refer to the non-governmental sector of the American economy. (Thus the price level concept is, strictly speaking, the implicit deflator of business gross product.) Weintraub presents a scatter diagram of changes in the price level against changes in the quotient of the money wage divided by labor's average product.⁴¹ No formal measure of the degree of

39. Sidney Weintraub, An Approach to the Theory of Income Distribution (Philadelphia: Chilton Co., 1958). This book will be called by the short title, An Approach.

40. On pp. 56 and 57 of Classical Keynesianism, Weintraub points out that radical shifts in the distribution of income are quite unlikely, if we are to judge by recent experience. Furthermore, he argues that in a mass production economy, the bulk of economic goods must be bought by the mass of the population, the wage earners.

41. A General Theory, p. 53.

association between these two variables is calculated, but it is quite clear from the scatter diagram that the closeness of fit about the theoretical line of perfect association is rather high. The mark-up parameter (k) is approximately 2; a dollar of sales proceeds is, roughly and on the average, divided equally between wage costs and non-wage costs. There are also some applications of the theory of the price level to problems of prediction, to a critique of the quantity theory, and to problems of public policy. The mark-up equation is placed in an aggregative simultaneous model of the economy. Finally, the mark-up equation is used to develop some formulas integrating the theory of the price level with currently received growth theory. As these discussions are not our focal points in this chapter, they are mentioned only in passing.

Edwin Kuh has computed a price level equation, in a recent analysis of the postwar American economy.⁴² The data, which are quarterly data, pertain to the corporate sector. The dependent variable is the implicit deflator of corporate value added. The independent variables are the average hourly earnings of wage and salaried workers, lagged one quarter; a productivity variable (price level deflated net corporate output divided by man-hours worked in the

42. Edwin Kuh, "Profits, Profit Markups, and Productivity: An Examination of Corporate Behavior since 1947," Study Paper No. 15, prepared for the Joint Economic Committee of the United States Congress, Study of Employment, Growth, and Price Levels (Washington: U.S. Government Printing Office, 1960).

corporate sector), lagged one quarter; the current value of a "demand ratchet" variable; and the value of this "demand ratchet" variable of two quarters ago. The "demand ratchet" variable is the ratio of current output to "capacity output." In turn, "capacity output" is the larger of last period's output, if that output were a previous output peak, or of the previous peak output of several periods ago, multiplied by a 3.75 per cent per annum compound growth factor. (3.75 per cent is the annual rate of growth of the capital stock of the manufacturing sector, over the postwar period 1947-1957.) The method of parameter estimation was single equation least squares and the sample period is the thirty-six quarters during 1950-1958. The fit is rather tight, as indicated by a coefficient of multiple correlation equal to 0.949. The two cost variables, which statistically do most of the work, have coefficients which are many times their respective standard errors. It is interesting to note that the elasticities of the average wage variable and of the productivity variable, computed at the sample mean values of these variables, are numerically equal but of opposite sign. (Ceteris paribus, a higher wage is associated with a higher price index of corporate product, while a higher productivity level is in itself associated with a lower corporate price level, in accord with theoretical expectations.) This suggests that a labor cost variable (the money wage divided by corporate output per man-hour) would have been an appropriate explanatory variable in this regression. Both "demand ratchet" variables had positive coefficients, but only that of

the lagged value was statistically significant. This suggests that even in the highly concentrated corporate sector (largely manufacturing), buoyant demand will exert some pressure on prices and also that there will be a time lag of roughly six months before this influence is at maximum strength.⁴³

In another of the study papers of the Study of Employment, Growth, and Price Levels series,⁴⁴ Harold M. Levinson gave some attention to the determinants of changes of wholesale prices in manufacturing industries. His observations, which are data on American manufacturing industries, run from 1947 to 1958. Because his data can be considered a continuous cross-section, Levinson used both cross-section and time series analyses. These analyses included both simple and multiple correlations. Levinson reached four major conclusions. First, price changes were closely related to changes in gross hourly earnings or to changes in direct labor costs per unit of output. Secondly, changes in prices were clearly related to the level of profits. (One may question whether this is truly a behavioral relationship or only a reflection of the accounting definition of profits.) Thirdly, there seemed to be a weak

43. The Kuh study paper is further discussed in Chapter V below, where Kuh's numerical results are compared to those of the present writer.

44. Harold M. Levinson, "Postwar Movement of Prices and Wages in Manufacturing Industries," Study Paper No. 21, prepared for the Joint Economic Committee of the United States Congress, Study of Employment, Growth, and Price Levels (Washington: U.S. Government Printing Office, 1960).

relationship between changes in prices and concentration ratios. Finally, the negative relationship between changes in prices and changes in productivity, though present, appeared to be very weak. Levinson's results concerning the productivity variable appear to be closer to those of Klein and Ball, who found that this variable played no significant role in their price level equation, than to those of Dunlop and Kuh, who found that productivity was an important explanatory variable in their respective price level relationships.⁴⁵

In a recent monograph,⁴⁶ Harold G. Moulton is interested in refuting the quantity theory explanation of inflation. Moulton wishes to demonstrate that the pressure of higher costs, especially wage costs, has been the principal explanation of rising prices, during the capitalistic epoch. Thus underlying his discussion is an implicit relationship (which is not formulated in mathematical terms) between the price level, on the one hand, and the level of wage costs and raw material costs, on the other. Moulton views the pricing practices of the individual firms in a large portion of the American economy (manufacturing, mining, retail and wholesale trade, and the public utilities) as conforming to the mark-up or full cost pattern. Accordingly, he feels that aggregate demand plays only a

45. Levinson's study is further discussed in Chapter IV below.

46. Harold G. Moulton, Can Inflation be Controlled? (Washington: Anderson Kramer Associates, 1958).

minor role in influencing the general level of prices: instead, according to Moulton, its main impact is on the level of aggregate economic activity.⁴⁷ Moulton subjects his views to empirical scrutiny, although no formal statistical tests are carried out. There is an interesting chart⁴⁸ in which an average hourly wage series for manufacturing is compared to a series of the wholesale price index of finished goods, over the period 1926-1957. Moulton notes that the short-term movements in these two series coincide closely, while the long-term growth of the wage series is more rapid. His conclusion is that the great inflation of the period surveyed is attributable primarily to the extraordinary rise in wages, with improvements in productivity a mitigating factor. That a productivity rise in itself lowers labor cost per unit of output explains, in his view, the fact that over this period the rise in his price index is only one half the rise in the wage series. Moulton also examines past periods of rapid inflation (most of these are connected with war-

47. H. F. Lydall similarly regards the pricing practices of individual firms as conforming to full cost patterns and hence he views the price level as responding primarily to changes in labor cost. ("Inflation and the Earnings Gap," Bulletin of the Oxford University Institute of Statistics, Volume XX, No. 3 (August, 1958), pp. 285-304.) For this reason, he also believes that fluctuations in demand have little direct repercussion on the price level. The principal focus of this article is an explanation of the differing developments of wage earnings and wage rates (the "wage drift" issue). Lydall attributes these differential movements to productivity increases, which induce higher earnings for piece workers more or less automatically.

48. Moulton, op. cit., p. 162.

time disruptions), in an interesting attempt to show that, even during these times, his theory is more satisfactory than quantity theory or budget deficit explanations of inflation. Turning to the question of what caused the wage rises, Moulton argues that the principal explanation of the large wage increases since the 1930's is not demand forces but the politico-economic power of the trade unions, with the sympathetic support of the federal government as a secondary but reinforcing factor.⁴⁹ Thus he would seem to end up squarely in the wage-push camp of inflation theorists. (See, however, the qualifications in footnote 49 immediately below and in Chapter VII of this work.)

49. It would seem, however, that Moulton would not rule out, under all circumstances, a strong demand influence producing an upward adjustment of money wages. Thus, in discussing Jacob Viner's study of Canada's balance of payments during 1900-1913 (full citation in Moulton, *op. cit.*, p. 285), Moulton presents an alternative explanation of Canadian inflation during this period. (On a quantity theory view, this inflation had one puzzling feature: the rise in prices preceded, rather than followed, the flow of specie imports into the country.) Moulton argues that the price level increases of the Canadian economy during this period were attributable to the increases in money wages, which rose roughly twice as much as the price level. In turn, the rise in money wages is viewed as being produced indirectly by Canada's vigorous economic expansion, the proximate effect of which was a shortage of labor; higher money wages became necessary to attract immigrant workers from abroad. Moulton states, "Data contained in Viner's study suggest that the primary motivating force in the price advance was the persistent shortage of labor and the consequent rapid rise in wage rates." (*Ibid.*, p. 291. Italics mine.) Thus, under some circumstances, Moulton will admit that the demand for labor does explain upward wage adjustments. In these circumstances, a demand element plays a role in the explanation of the associated inflation.

Willard L. Thorp and Richard E. Quandt wrote a book which grew out of a conference on the problem of inflation.⁵⁰ In the view of the present writer, one of the two central theses of this work is the concept of "income claim" inflation.⁵¹ In their Chapter 3, the possibility is discussed that prices may rise because one or more of the income claimants seeks to increase his share of the national income. In particular, pressure on the general level of prices can come from increases in raw materials costs (e.g., a rise in the price of imported raw materials), from a rise in wages not offset by gains in labor productivity, or from the profit claim. Because incomes are also costs, it is not difficult to interpret this view as proceeding from a relationship (an equality) between the aggregative price level and the sum of unit factor costs, for each of the productive factors. In turn, unit factor costs may be regarded as the factor price divided by the productivity of this factor (total real output per unit of factor input), for each productive factor. Thus an attempt by one productive factor to get a greater income share, through pushing up its factor price at a more rapid rate than the rise in its productivity, will put pressure on the aggregative price level; the only way a price level rise can be avoided in this case is for some other factor to accept (or be forced to take) a lower income share. And, although all productive factors cannot

50. Willard L. Thorp and Richard E. Quandt, The New Inflation (New York: McGraw-Hill Book Company, Inc., 1959).

51. The second major strand, inflation-producing structural pressures, is discussed in (the present author's) Chapter VII, where the concept is compared to similar ideas of other recent writers.

simultaneously obtain larger income shares, all can try. The resulting rise in unit factor costs, of all the productive factors, must (by definition) be associated with a higher value of the economy-wide price level.

William G. Bowen has also discussed the determinants of the price level, in Part III of The Wage-Price Issue. As noted above, Bowen's approach in this work is theoretical, rather than empirical. Bowen begins his discussion with an examination of pricing behavior in the individual firm. Bowen points out that, with a profit-maximizing firm operating under imperfect competition, a cost increase (involving a rise in marginal costs) is certain to raise final product price, while it is problematical whether a demand increase will lead to a price increase. (Bowen assumes a constant marginal cost schedule up to a capacity level of output, where marginal cost then rises steeply. In these circumstances, the only case where a rise in demand is certain to lead to a price increase is one in which the firm is initially operating at capacity.) When Bowen relaxes the strict profit-maximizing assumption and introduces the influence of public standards, long-term horizons, the factor of uncertainty, and oligopolistic interdependence of firms as qualifications, he finds that cost factors become still more important in the pricing policy of the individual firm. Hence, upon aggregation, one would expect the relationship between the over-all price level and the economy-wide level of costs to be a tighter one than that between the

price level and aggregate demand conditions. Bowen seems, at several places, to follow through to this conclusion. Nevertheless, he considers that demand conditions are one of the "proximate determinants" of the price level. Bowen strongly emphasizes the importance of breaking down the economy-wide price level into its sectoral components; he believes that the various sectoral price levels differ with respect to their sensitivity to demand and cost conditions. Hence his list of four "proximate determinants" of the price level⁵² is rounded out by "the various modes of price determination that exist in different sectors of the economy" and by distributional considerations, i.e., the distribution of cost and demand conditions among the various sectors, with their differing sensitivities. (Bowen's discussion of sectoral influences on the aggregate price level will be presented in greater detail in Chapter VII below.)

In a theoretical paper focussing on a critique of the quantity theory explanation of inflation,⁵³ R. J. Ball sets forth an eight equation model for illustrative purposes. One of the relations of the model is the competitive demand for labor equation, in which the

52. Bowen, op. cit., p. 309.

53. R. J. Ball, "Cost Inflation and the Income Velocity of Money: A Comment," The Journal of Political Economy, Volume LXVIII, No. 3 (June, 1960), pp. 288-296.

real wage (the money wage divided by the price level) is set equal to labor's marginal product. Ball interprets this relationship as showing how the price level is proximately determined by profit-maximizing entrepreneurs who set prices in accordance with the money wage and the marginal productivity of labor. That this is his intention is clearly indicated by Ball's statement that this relation could be replaced by a "mark-up" equation, in which the price level is the dependent variable and the money wage and the average product of labor are the independent variables. Thus Ball also stresses the relationship between the price level and aggregative measures of cost, in his explanation of the phenomenon of inflation.⁵⁴

In a recent monograph,⁵⁵ John M. Clark has discussed the problem of "creeping inflation" during peacetime. The core of Professor Clark's theoretical analysis is to be found in his Chapter III, "Basic Economic Limits: The Inescapable Arithmetic of Price-Level Stability." Here, the possibility of what Thorp and Quandt would call "income claim" inflation is discussed. On page 41, an

54. Ball also has a wage determination equation in his model, in which the money wage change is related to the level of unemployment, to some past increase in prices (lag unspecified), and to a parameter representing trade union power. Thus, in this model, excess demand forces produce a higher price level only through first producing pressures in the labor market; the resulting wage increases are then marked up into higher prices.

55. John M. Clark, The Wage-Price Problem (city not indicated: Committee for Economic Growth without Inflation of the American Bankers Association, 1960).

interesting chart is presented. Here Clark compares percentage price increases and the "excess of [percentage] wage rate increases over [percentage] productivity gains," for twelve American manufacturing industries, over the period: 1955, first quarter to 1959, first quarter. These two measures are fairly close together, as Clark points out, although no formal correlation analysis or calculation of the closeness of fit is carried out. This empirical evidence suggests a familiar relationship between prices and labor costs, at the industry level. (The difference between percentage wage increases and percentage productivity increases is approximately the percentage change in labor cost (the money wage divided by the average product of labor), when small changes are involved.) Consequently, these data suggest that upon aggregation, one is likely to find a relationship between the price level of final product and an aggregative measure of labor cost, for the manufacturing sector as a whole.

L. A. Dicks-Mireaux, in his 1961 article,⁵⁶ has also computed an aggregative price level equation. The dependent variable is the annual percentage change in twelve month averages of an index of final product price, at factor cost. The independent variables are: the annual percentage change in twelve month averages of average wages and salaries per employed individual; the annual percentage change in twelve month averages of an index of import prices, with a lag equal to a quarter of a year; and the annual percentage change

56. L. A. Dicks-Mireaux, op. cit.

in twelve month averages of output per man. (Thus Dicks-Mireaux originally had monthly data, which he averaged to annual figures, presumably to avoid complications of seasonality; it should also be noted that the price level relationship was estimated in difference equation form.) The data are post-war British data, for the years 1946-1959. Dicks-Mireaux used both single equation least squares and two stage least squares techniques of parameter estimation. He found that corresponding estimates of particular parameters were quite similar, so that the single equation bias was not marked. The fit was rather tight, as suggested by a coefficient of multiple correlation of 0.95 for the simple least squares regression. The coefficients of all variables are statistically significant and have the theoretically appropriate signs: wage changes and import price changes are associated with price level changes in a positive sense, while productivity changes in themselves are negatively associated with price level changes. The marginal contribution of wage changes is roughly one and a half times that of import price changes. The productivity change variable numerically has the largest impact, with a one per cent rise in productivity producing a percentage fall in final product price nearly double the decrease in the price level associated with a one per cent decrease in the money wage variable. Dicks-Mireaux tested for the influence of demand on the price level change by using his and Dow's index of the excess

demand for labor as an imperfect proxy of ex ante excess demand for goods and services. This variable was found to be not statistically significant. Dicks-Mireaux's results, on this issue, contrast with those of Kuh as well as those of the present writer (Chapter V below).⁵⁷

3. Further Remarks.

This summary of recent literature that has guided the present writer has omitted certain works dealing largely with sectoral aspects of inflation. The omission is deliberate. Some of these works are examined at length in Chapter VII, where some limitations of an aggregative analysis of inflation are discussed and sectoral pressures culminating in an upward rise of the over-all price level are analyzed. A few of the works discussed in this chapter are re-examined in the context of Chapter VII.

57. Dicks-Mireaux also constructs a relationship between price level changes (dependent variable) and current and lagged values of wage changes, import price level changes, and productivity changes as independent variables. For all the explanatory variables, the lags go back to four years prior to the current year. Because regression analysis is not a suitable means of estimating the parameters of such a relationship, the fitting is done through a priori considerations and by trial and error. (Because this procedure loses the first four observations, this distributed lag relationship is fitted to the sub-period 1950-1959.) Dicks-Mireaux obtains a moderately good fit for this distributed lag price level relationship. He asserts that this strengthens his view that cost changes take several years to work their full impact, and hence he interprets the constant term of the standard (without distributed lags) price level change equation as the average value of delayed responses to the explanatory variables.

It may be thought a peculiar oversight that the author has not yet discussed the quantity theory explanation of inflation, if only to make a few critical comments. Again the omission is deliberate. In Chapter II, the quantity theory is analyzed in the context of a static "Keynesian" model of the aggregative economy. There, it is pointed out that, under the assumptions of the model, the quantity theory of prices holds only if particularly restrictive conditions are valid. In particular, the assumption of full employment is not sufficient to validate the quantity theory. Other works must be consulted for a more detailed and more fundamental critique of the quantity theory.⁵⁸

In Chapter II, then, an aggregative model is presented. While some of the conclusions are of interest in themselves (at least to

58. See Ball, op. cit.; Moulton, op. cit., especially pp. 1-51 and Appendices A and B; Weintraub, A General Theory, especially Chapter 8; and Weintraub, Classical Keynesianism, especially Chapters 4 and 5.

Moulton's critique is interesting because statistical materials dating from the dawn of the capitalistic epoch are assembled in support of Moulton's contention that even before the twentieth century, the quantity theory was a rather crude theoretical description of price level trends. For example, Earl J. Hamilton's classic study of sixteenth century Spanish inflation (reference in Moulton, op. cit., p. 246) is reviewed by Moulton in Appendix B, Section I. In this section, he presents rather convincing arguments that the quantity theory explanation of this period's price level trends is quite weak and incomplete. On p. 253, Moulton reconstructs in an appropriate manner a chart that was originally drawn incorrectly by Hamilton. The reconstruction shows a very loose connection between specie imports and an index of Spanish prices, over the sixteenth century.

this writer), the broader purpose of this chapter is to put into focus the more detailed empirical analysis of Chapters III through VI.

Chapter II, "Income, the Price Level,
and Generalized Multipliers in Keynesian Economics"

(R. J. BALL, Co-author)

The theory of income determination originating in Lord Keynes' The General Theory¹ has been passed down to a generation of students in the form of a variety of simple standard models. The theory has usually been presented in real terms, paralleling the treatment in The General Theory where variables are sometimes expressed in terms of wage units. Although economists have discussed the problem of price level determination in a Keynesian context, there emerges a clear lack of integration between the analysis based on the assumption of excess capacity and of constant prices and the analysis of an economy at full employment.

Economists in the Keynesian tradition have not neglected the problem of inflation since the publication of The General Theory. Keynes himself paid attention to this problem, both in that volume and in his later work How to Pay for the War.² Don Patinkin's

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1. John Maynard Keynes, The General Theory of Employment, Interest, and Money (New York: Harcourt, Brace and Company, 1936). This work is designated by the short title, The General Theory.
 2. John Maynard Keynes, How to Pay for the War (New York: Harcourt, Brace and Company, 1940).

aggregative model³ focuses on a joint determination of real income, the price level, and other relevant variables. Sidney Weintraub (An Approach, especially Chapter 2) also emphasizes a joint determination of prices, money income, and employment. Although still other exceptions could be cited, it seems fair to state that the Keynesian tradition has divorced the income determination aspects of the model from the determination of the price level.⁴ This divorce has been especially pronounced in applications (e.g., international trade theory, public finance) and in classroom teaching.

It is important to discuss, in some detail, the problems faced by the policy maker concerned with the impact of his actions on the general price level. A general approach to the problem of income determination, incorporating price level effects explicitly, is required. This chapter is aimed at taking a small step in this direction. Our approach develops price multipliers along with income multipliers, in order to break up the effects of particular policies on real income and the price level. For the purpose, a theory of

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3. This model is developed in Don Patinkin, Money, Interest, and Prices (Evanston, Illinois: Row, Peterson and Company, 1956), Part Two.
 4. As an example of this type of analysis, Alford's recent article (R. F. G. Alford, "A Taxonomic Note on the Multiplier and Income Velocity," Economica, N.S. Volume XXVII, No. 105 (February, 1960), pp. 53-62) comes to mind. Alford's multiplier analysis, which in certain respects parallels our treatment, is based on an "L-shaped" aggregate supply function, i.e., he assumes a constant price level up to full employment and a constant real income with prices flexible upward, after this point. We shall argue below that an important intermediate case has thereby been left out.

aggregate price is introduced into the familiar multiplier analysis and generalized multipliers are obtained. A fairly simple model based on essentially Keynesian considerations is employed, although no claim is made to have interpreted precisely what Keynes said (or really meant). Suffice it to say that the approach follows more closely The General Theory rather than How to Pay for the War, even though the latter has been a more direct inspiration to inflation analysis.⁵

Because the technique used is one of comparative statics, dynamic aspects of the inflationary process are given short shrift. Thus we have not taken account of such effects as changing asset preferences due to changing price levels or an increasing total product at each employment level due to an increasing stock of capital and an improving technology. The determination of the money wage is placed in a static context, instead of emphasizing dynamic forces producing a particular change in money wages. Furthermore, it can be argued that the concept of moving equilibrium (or possibly a movement toward equilibrium) is a better background for a discussion of persistent or chronic inflation which occurs over a period of years. While aware of all these limitations, we feel that generalized multiplier analysis is a useful intermediate step towards such a full dynamic system.

5. See Sidney Weintraub, "The Keynesian Theory of Inflation: The Two faces of Janus?," International Economic Review, Volume I, No. 2 (May, 1960), pp. 143-155 (reprinted as Chapter II of Classical Keynesianism), for a discussion of the two aspects of Keynesian price level theory.

1. A Static Model.

Our model is fairly conventional in its broad aspects, but contains several features deserving comment. Methodologically, the procedure adopted is the familiar one of examining the responses of the endogenous variables to changes in exogenous parameters. Thus the analysis is essentially static in character.

We have, as an accounting identity:

$$(2.1) \quad Y = C + I ,$$

where Y is national income, C consumption expenditures, and I net investment expenditures, all of which are measured in constant dollars. Consumption is assumed to depend upon the level of real income, the real stock of money M/P , the rate of interest i , and the degree of monopoly power Π (discussed below), which gives:

$$(2.2) \quad C = C \left(Y, i, \frac{M}{P}, \Pi \right) .$$

Net investment is divided into an endogenous component varying with the income level, the interest rate, and the degree of monopoly power and an exogenous or autonomous component^(α), so we have:

$$(2.3) \quad I = I (i, Y, \Pi) + \alpha .$$

We are dealing with a closed economy, so that no distinction need be made between domestic and foreign investment. As this is short-period analysis, the stock of productive equipment is taken as fixed, and

consequently the level of real income varies with the level of employment (N). Hence the production function can be written:

$$(2.4) \quad Y = f(N), f'(N) > 0, f''(N) < 0.$$

We add a profits maximizing condition:

$$(2.5) \quad f'(N)(1 - \Pi) = \frac{w}{P},$$

where w is the money wage, P is the price level, and Π represents the degree of monopoly power existing in the economy. Π is equal to $\frac{1}{|\eta_D|}$, where η_D is the elasticity of demand, on an economy-wide basis. Under pure competition, $\eta_D = \infty$ and $\Pi = 0$. In words, (2.5) states that the marginal revenue product of labor is equal to the money wage. Π is taken as an exogenous parameter, which follows the spirit of Joan Robinson's recent treatment of this factor in an aggregative context. In her The Accumulation of Capital, she seems to take this element as invariant with changes in the level of activity and as determined largely by institutional factors.⁶ An increase in the degree of

6. See Joan Robinson, The Accumulation of Capital (Homewood, Illinois: Richard D. Irwin, Inc., 1956), especially pp. 77-80.

If the marginal product of labor is always a constant proportion of the average product (this would be true with a Cobb-Douglas production function), then (2.5) reduces to the Weintraub Wage-Cost-Mark-up Equation. For if

$$(i) \quad f'(N) = k_1 \frac{f(N)}{N},$$

(2.5) becomes:

$$(ii) \quad \frac{f(N)}{N} k_1 (1 - \Pi) = \frac{w}{P}.$$

(Footnote 6 continued on bottom of next page)

monopoly power will, at any level of employment, decrease the share of total output going to wage-earners. Hence we shall assume that the shift to non-wage-earners will, for a given level of income, decrease real consumption expenditures but raise real investment outlays.

Since (2.5) constitutes essentially the relation of labor demand, a supply equation for labor is required. It is at this point that the model breaks away from the Neo-Classical formulation. As is well known, to assume that the supply of labor is a function of the real wage, together with equations (2.4) and (2.5) and a market-clearing condition, is to place the determination of the levels of real income and employment in the labor market.⁷ Some writers have avoided this situation by

(Footnote 6 continued from bottom of previous page)

It immediately follows that

$$(iii) \quad P = \frac{k w}{f(N)/N} ,$$

where $k = \frac{1}{k_1(1-\pi)}$, and this is Weintraub's Wage-Cost-Mark-up Equation, in its standard form. (Weintraub, A General Theory, p. 9.)

No close connection should be drawn between our elasticity of demand, on an economy-wide basis, and the Marshallian elasticity of a partial equilibrium demand curve. The effects of relative price changes are assumed to be "washed out," in an aggregative context.

7. See Franco Modigliani, "Liquidity Preference and the Theory of Interest and Money," Econometrica, Volume XII, No. 1 (January, 1944), pp. 45-88, and Lawrence R. Klein, The Keynesian Revolution (New York: The MacMillan Company, 1947), pp. 199-204. (Pp. 46-48 of the Modigliani article are especially relevant.)

postulating an exogenous money wage, or by introducing dynamic features into the model, so that the level of money wages is determined by a market adjustment mechanism.⁸ Either way, one escapes determining real wages in the labor market and leaving the absolute price level to be determined absentmindedly by the cash balance equation. The procedure followed here, however, is neither of these; instead, it is held that incomplete real wage adjustment characterizes the labor supply function. Individual workers are considered to be aware of changing price levels, but institutional conditions such as powerful trade unions and a working week of conventional length are held to prevent labor supply from being a simple function of the real wage alone. Taking the supply of labor services to rest upon the money wage and the price level (one can argue that the existence of escalator clauses testifies to union awareness of changing price levels), we may write:

$$(2.6) \quad N = N(w, P) .$$

Because of our assumption that the supply of labor services cannot be made into a simple function of the real wage, we have $N(\lambda w, \lambda P) \neq N(w, P)$ if $\lambda \neq 1$. With lack of homogeneity of degree zero in the labor market an equilibrium level of real income cannot be determined there. Thus our later results depend, in a crucial way, upon our assumptions about the labor supply relation. As will be shown later, the position of full employment can be interpreted as the point at

8. For a discussion of this problem, see R. J. Ball, op. cit.

which the labor supply function becomes homogeneous of degree zero in absolute prices. Under certain suitable conditions (principally the non-vanishing of (N_w)),⁹ we may invert (2.6) "in the small" and obtain:

$$(2.6a) \quad w = G(N,P) .$$

Our final form for the labor supply equation, which is the one we shall use throughout this paper, is a further modification of (2.6a). We assume that there are institutional forces operative (e.g., trade union pressures, minimum wage laws) that prevent money wages from falling below a minimum level, w_0 . w_0 is taken as exogenous; it is further assumed that the endogenous component of the wage determination mechanism $G(N,P)$ is independent of the exogenous component. Thus we may write:

$$(2.6b) \quad w = g(N,P) + w_0 ,$$

where $g(N,P) \geq 0$ so that $w \geq w_0$. It is further assumed that the "within-system" response of a change in money wages to a change in the price level is less than proportionate, when under-employment

9. This symbol (N_w) means the partial derivative of the function N with respect to the variable w . Throughout this chapter, analogous symbols should be interpreted similarly.

conditions exist. In symbols, we would have $0 < \frac{P}{W} \cdot \frac{\partial W}{\partial P} = \frac{P}{W} \epsilon_P < 1$.¹⁰

This assumption may or may not be a suitable description of economic reality. It gains plausibility if one considers the labor markets of the economy as divided into two different types: one type being characterized by escalator-clause type responses, the other type reflecting in the short run largely constant money wages, even in the face of changing prices. Hence the case intermediate between $\frac{\partial W}{\partial P} = 0$ and $\frac{P}{W} \cdot \frac{\partial W}{\partial P} = 1$ may appear reasonable. For our purposes it will be assumed that this is the case, and it will become apparent that some of our qualitative conclusions depend upon this assumption.

The final equation of the model describes the money market equilibrium. In the Neo-Classical literature the demand for money essentially determined the absolute price level, whereas Keynesian employment theory only allowed it the role of directly determining the rate of interest. The view of the demand for money adopted here is largely in accord with the latter position. According to the money market equilibrium described below, shifts in the money supply

10. In a Neo-Classical model, this partial elasticity would be exactly equal to unity. For if $N = N\left(\frac{W}{P}\right)$ is our labor supply function, then the inverted form becomes $\frac{W}{P} = G^*(N)$ or $w = PG^*(N)$.

Hence $\frac{\partial W}{\partial P} = G^*(N)$ and so $\frac{P}{W} \cdot \frac{\partial W}{\partial P} = \frac{1}{G^*(N)} \cdot G^*(N) = 1$.

Consequently, we shall say that as full employment is approached,

$$\frac{P}{W} \frac{\partial W}{\partial P} \rightarrow 1.$$

affect the price level indirectly via their effects on the rate of interest, the level of income, the volume of employment, and the money wage. (It must be remembered, however, that changes in the money supply can affect consumption expenditures directly through a real balance effect.) Effects on the money wage are also not direct but are channeled through changes in the level of employment and indirectly induced price level changes.

Some controversy has emerged over the particular form and properties of the demand for money. Patinkin has developed assumptions under which prices will rise in proportion to the quantity of money, without necessitating the hypothesis of a constant velocity of circulation.¹¹ He asserts that the particular form of the demand for money developed by Keynes does not lead to the Neo-Classical conclusions because the speculative demand for money is made independent of the price level. Hence the Keynesian demand for money is not homogeneous of degree one in the absolute price level. This view would appear to be correct, but none of Patinkin's discussion really settled the issue of which is the appropriate assumption to use, although it did hint at a possible source of confusion that seems to recur from time to time.

We wish to decompose the demand for money into two parts. The transactions demand is taken to depend upon the level of money income

11. See Patinkin, op. cit. Part Two, especially pp. 193-194.

and the rate of interest.¹² There is also a speculative component of the demand for money; this is considered to rest upon the rate of interest alone. The money market equilibrium is described by:

$$(2.7) \quad M = L (PY, i) .$$

Thus, considering the model as a whole, we have seven equations in seven endogenous variables ($Y, C, I, i, N, w,$ and P) . Equation-counting conditions are thus satisfied. Our exogenous variables are $M, H, \alpha,$ and w_0 . We shall assume that certain general conditions are satisfied, so that a unique solution of economically meaningful variable values exists, and so we are ready to discuss the response of the system to shifts in the exogenous parameters. We may call this type of discussion "generalized multiplier analysis."

2. Generalized Multiplier Analysis.

For convenience, the system of seven equations in seven unknowns is reduced to one of three equations in three unknowns. We have, after

12. In an application of inventory theory, William J. Baumol ("The Transactions Demand for Cash: An Inventory Theoretic Approach," Quarterly Journal of Economics, Volume LXVI, No. 4 (November, 1952), pp. 545-556) has shown that the interest rate will govern the allocation of working capital between cash and liquid assets of short maturity. Hence even the transactions demand for money will be sensitive to variations in the interest rate. James Tobin ("The Interest-Elasticity of Transactions Demand for Cash," The Review of Economics and Statistics, Volume XXXVIII, No. 3 (August, 1956), pp. 241-247) has extended Baumol's treatment and reached similar conclusions.

some manipulation,

$$(2.8) \quad f(N) - C \left\{ f(N), i, \frac{M}{P}, \Pi \right\} - I \left\{ i, f(N), \Pi \right\} = \alpha$$

$$(2.9) \quad L(Pf(N), i) = M$$

$$(2.10) \quad Pf'(N) (1 - \Pi) - g(N, P) = w_0 .$$

First, we obtain the traditional expenditure multipliers.

Total differentiation of the system with respect to α yields, after some manipulation,

$$(2.11) \quad f'(N) (1 - C_Y - I_Y) \frac{dN}{d\alpha} - (C_i + I_i) \frac{di}{d\alpha} + C_{\frac{M}{P}} \frac{M}{P^2} \frac{dP}{d\alpha} = 1$$

$$(2.12) \quad f'(N) P L_{Y_m} \frac{dN}{d\alpha} + L_i \frac{di}{d\alpha} + L_{Y_m} f(N) \frac{dP}{d\alpha} = 0$$

$$(2.13) \quad [Pf''(N) (1 - \Pi) - g_N] \frac{dN}{d\alpha} + 0 \cdot \frac{di}{d\alpha} + [f'(N) (1 - \Pi) - g_P] \frac{dP}{d\alpha} = 0 .$$

As indicated above, C_Y denotes the partial derivative of consumption with respect to real income, and similar symbols have analogous interpretations. Since $Y_m \equiv PY$, L_{Y_m} denotes the partial derivative of L with respect to money income.

Using Cramer's rule, we can solve for $\frac{dN}{d\alpha}$ and $\frac{dP}{d\alpha}$. This gives:

$$(2.14) \quad \frac{dN}{d\alpha} = \frac{L_i [f'(N) (1 - \Pi) - g_P]}{D} = \frac{L_i \left(\frac{W}{P} - \frac{\partial w}{\partial P} \right)}{D} ,$$

where

$$(2.15) \quad D = \begin{vmatrix} (1-C_Y-I_Y)f'(N) & - (C_1+I_1) \frac{C_M}{P} \cdot \frac{M}{P^2} \\ f'(N)PL_{Y_m} & L_1 L_{Y_m} f(N) \\ [Pf''(N)(1-\Pi) - \varepsilon_N] & 0 \left(\frac{W}{P} - \frac{\partial W}{\partial P}\right) \end{vmatrix}$$

$$= (1-C_Y-I_Y) f'(N)L_1 \left(\frac{W}{P} - \frac{\partial W}{\partial P}\right) - (C_1+I_1) L_{Y_m} f(N) [Pf''(N)(1-\Pi) - \varepsilon_N]$$

$$- \frac{C_M}{P} \cdot \frac{M}{P^2} L_1 [Pf''(N)(1-\Pi) - \varepsilon_N] + (C_1+I_1) f'(N)PL_{Y_m} \left(\frac{W}{P} - \frac{\partial W}{\partial P}\right).$$

Following standard theory, we shall assume $(1-C_Y-I_Y) > 0$, $f'(N) > 0$, $L_1 < 0$, $L_{Y_m} > 0$, $f''(N) < 0$, $\varepsilon_N > 0$, and $\frac{C_M}{P} > 0$. C_1 is of uncertain direction but is small in absolute magnitude, while $I_1 < 0$. Hence $C_1+I_1 < 0$. Our previous assumption that $\frac{P}{W} \frac{\partial W}{\partial P} < 1$ implies that $\left(\frac{W}{P} - \frac{\partial W}{\partial P}\right) > 0$. Hence $D < 0$, and thus $\frac{dN}{d\alpha} > 0$. The standard multiplier, which is $\frac{dY}{d\alpha} = f'(N) \frac{dN}{d\alpha}$, is also positive.

It should be noted that in this model, full employment is defined in terms of an inability to obtain further increments of output. However, full employment is not defined in terms of a zero marginal product of labor, which under our assumptions entails a zero real wage. Full employment results from the labor supply function "locking" so that the money wage changes in the same proportion as the price level. It

is impossible to obtain further output increases from an equilibrium position of this type, as further output and employment will require a higher real wage from the side of labor supply and a lower real wage from the demand side of the labor market.¹³ Thus we may say that as full employment is approached, $\frac{P}{w} \frac{\partial w}{\partial P} \rightarrow 1$. Under these conditions, $\frac{dN}{d\alpha} \rightarrow 0$ as $\frac{\partial w}{\partial P} \rightarrow \frac{w}{P}$.¹⁴

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13. A similar interpretation of full employment has been given by Joseph W. Conard (An Introduction to the Theory of Interest (Berkeley and Los Angeles: University of California Press, 1959), Chapter 13, especially pp. 272-279), Abba P. Lerner ("On Generalizing The General Theory," American Economic Review, Volume L, No. 1 (March, 1960), pp. 121-143, especially pp. 134-142), and Edmund S. Phelps ("A Test for the Presence of Cost Inflation in the United States, 1955-1957," Yale Economic Essays, Volume I, No. 1 (Spring, 1961), pp. 28-69). Conard distinguishes between the full capacity level of output, where the marginal product of labor is zero, and the full employment level of output, where further demand increases entail only higher levels of prices, because money wages begin to rise proportionately with the price level, at this point. Lerner constructs a curve of supply price which relates real output to the ratio of the price level to the money wage (the reciprocal of the real wage). Lerner asserts that at the full employment position, wages begin to rise as rapidly as prices (heretofore they have risen less rapidly) and further increases in output and employment are abortive. Hence only inflation results. Phelps argues (pp. 29-30) that some "money illusion" characterizes wage behavior at employment levels below full employment, but that at full employment "money illusion" is absent. Hence the fact that wages rise as rapidly as prices prevents any further output increases.
14. $\frac{dN}{d\alpha}$ is also zero if the demand for money is perfectly interest inelastic so that $L_1 = 0$. In this case money income is a monotonic increasing function of the stock of money, and neither the price level, real income, nor the employment level will change when autonomous expenditure is changed if the stock of money remains unchanged. Presumably interest rates would adjust in this case so that endogenous expenditure can be displaced by exogenous expenditure, real income remaining unchanged. Thus expenditure must display some interest elasticity if there is to be such an adjustment mechanism making the system solvable. (If both L_1 and $C_1 + I_1$ are equal to zero, D vanishes and the full system (2.11),¹(2.12), and (2.13) cannot be solved.)

Solving for $\frac{dP}{d\alpha}$, we obtain:

$$(2.16) \quad \frac{dP}{d\alpha} = \frac{-L_1 [Pf''(N)(1 - \Pi) - g_N]}{D} = \frac{L_1 [g_N - Pf''(N)(1 - \Pi)]}{D}$$

$$\text{and } \frac{dP}{d\alpha} > 0,$$

since $D < 0$, $L_1 < 0$, and $[g_N - Pf''(N)(1 - \Pi)] > 0$. In severe underemployment equilibrium, $g_N \rightarrow 0$ and $f'(N) \rightarrow K$ (a constant), so that $f''(N) \rightarrow 0$.¹⁵ Under these circumstances, $\frac{dP}{d\alpha} \rightarrow 0$, i.e., it is possible for increases in real expenditures to have negligible effects on the aggregate price level, under a special set of circumstances.¹⁶

We may similarly compute monetary multipliers, allowing M , the quantity of nominal money balances, to vary. We obtain:

$$(2.17) \quad \frac{dN}{dM} = \frac{\left(\frac{w}{P} - \frac{\partial w}{\partial P}\right) \left[L_1 \frac{1}{P} C_M + (C_1 + I_1)\right]}{D}, \text{ and}$$

$$(2.18) \quad \frac{dP}{dM} = \frac{[g_N - Pf''(N)(1 - \Pi)] \left[(C_1 + I_1) + L_1 \frac{1}{P} C_M\right]}{D}.$$

15. In order that the second order condition for profit maximization hold when $\Pi = 0$, $f''(N)$ must be negative. Consequently, we say that in "severe" underemployment equilibrium, $f''(N) \rightarrow 0^-$, i.e., $f''(N)$, which is always negative, can be made arbitrarily close to zero. Thus the quantitative importance of diminishing returns becomes negligible in "severe" underemployment equilibrium while the sufficient condition for profit maximization continues to hold. Similarly, the wage unit may be taken to be unresponsive to changes in the level of employment if the employment level is low enough.

16. $\frac{dP}{d\alpha}$ is also negligible if the demand for money is independent of the rate of interest. This is the somewhat unusual case discussed in footnote 14.

Hence $\frac{dN}{dM} > 0$ and $\frac{dP}{dM} > 0$, as both numerators are negative and D is negative. Thus an expansion of the money supply both stimulates real income and raises prices, in the typical case. Thus, on a broad level of generality, the direction of the effect on the price level is the same for this theoretical framework as for the quantity theory. Three special cases remain to be considered.

(1.) Suppose that "severe" underemployment equilibrium exists. Then, $g_N \rightarrow 0$ and $f''(N) \rightarrow 0$, as was pointed out previously. In this case $\frac{dP}{dM} \rightarrow 0$, and the quantity theory breaks down: changes in the money supply have no effect on the price level. This is not because changes in money have no significance, but merely because all expansionary forces, additions to the money stock included, result in increased output and employment with negligible price level increases. Under these circumstances, a "quantity theory" of output and employment would be valid, if in addition the demand for money were independent of the rate of interest and were related to money income in a particularly simple manner.¹⁷

17. Suppose $L = kPY$ so that $L_i = 0$ and $L_{Y_m} = \frac{\partial L}{\partial (PY)} = k$

(2.17) then becomes

$$(2.17a) \quad \frac{dN}{dM} = \frac{\left(\frac{w}{P} - \frac{\partial w}{\partial P}\right) (C_1 + I_1)}{D}$$

With "severe" underemployment conditions, $\frac{dN}{dM} \rightarrow \frac{\left(\frac{w}{P} - \frac{\partial w}{\partial P}\right) (C_1 + I_1)}{(C_1 + I_1) f'(N) P L_{Y_m} \left(\frac{w}{P} - \frac{\partial w}{\partial P}\right)}$

(Footnote continued on bottom of next page.)

(2.) Suppose the real balance effect is totally absent (i.e., $C_{\frac{M}{P}} = 0$); it may be argued that this was the view espoused by Keynes. If, in addition, expenditures are perfectly interest inelastic (this implies that $(C_i + I_i) = 0$), both $\frac{dN}{dM}$ and $\frac{dP}{dM}$ vanish, as an examination of (2.17) and (2.18) will immediately verify. In this case, changes in the money supply have no economic significance for this model, except possibly to affect the division of non-wage income among interest and other forms of property income. Alternatively, if liquidity preference becomes absolute (i.e., if $L_i \rightarrow -\infty$), the determinant D increases without limit. (We are still assuming a negligible real balance effect.) Consequently, both $\frac{dN}{dM}$ and $\frac{dP}{dM}$ become arbitrarily close to zero.

Footnote 17 continued from bottom of previous page.

as an examination of (2.15) will substantiate. Therefore,

$$\frac{dN}{dM} \approx \frac{1}{f'(N)Pk} \text{ so that } f'(N) \frac{dN}{dM} \approx \frac{1}{Pk} .$$

But $\frac{dY}{dM} = f'(N) \frac{dN}{dM}$ and $Pk = \frac{M}{Y}$ since $M = L$ in equilibrium.

Consequently, these assumptions lead to the result that

$$\frac{dY}{dM} \approx \frac{Y}{M} \text{ or } \frac{M}{Y} \frac{dY}{dM} \approx 1 .$$

In this pseudo-Neo-Classical formulation, the change in real income is proportional to the change in the money supply. This case suggests the early Real Bills theorists, who used to argue that the supply of money had to be adequate for the "needs of trade" and who consequently advocated an "elastic" money supply.

These cases illustrate the Keynesian view that monetary policy may be subject to "many a slip 'twixt cup and lip"; even with underemployment present, there are two special cases where an increase in the money supply leads to negligible employment increases. Similarly, even at full employment, a liquidity trap or negligible interest elasticity of expenditures may prevent changes in the money supply from influencing prices, if the real balance effect is absent. These special cases make apparent, also, that an essential feature of the Keynesian system is that the link between the supply of money and the level of real income is through the rate of interest. Both the Keynesian and the Neo-Classical systems, however, postulated a direct link between the volume of real spending and the rate of interest. The particular Keynesian form of the demand for money, together with the labor market assumptions, destroy the homogeneity properties of the Neo-Classical system. Hence whereas in the Neo-Classical system the property of homogeneity of degree zero in absolute prices separated changes in the money supply from changes in the equilibrium level of real income (one must implicitly assume that such an equilibrium does exist), the conditions discussed above give rise to the same result in the world of John Maynard Keynes.

(3.) Suppose that full employment exists, so that $\left(\frac{w}{P} - \frac{\partial w}{\partial P}\right) \rightarrow 0$.

If one takes account of the terms that become approximately zero in (2.15), (2.18) becomes:

$$(2.19) \quad \frac{dP}{dM} \approx \frac{[\epsilon_N - Pf''(N)(1 - \Pi)] [(C_1 + I_1) + L_1 \frac{1}{P} \frac{C_M}{P}]}{[Pf''(N)(1 - \Pi) - \epsilon_N] [(C_1 + I_1)L_{Y_m} Y + C_M \frac{L_1}{P} \frac{M}{P^2}]} \quad \text{or}$$

$$\frac{dP}{dM} \approx \frac{(C_1 + I_1) + L_1 \frac{1}{P} \frac{C_M}{P}}{Y(C_1 + I_1) L_{Y_m} + \frac{M}{P^2} L_1 \frac{C_M}{P}}$$

We shall say that a "pure" quantity theory of prices is valid if an increase in the nominal money supply leads to a proportionate increase in the aggregate price level. One set of assumptions sufficient to validate a pure quantity theory of prices is full employment and negligible interest elasticity of both the consumption and investment demand functions. Under these circumstances, $(C_1 + I_1) \approx 0$ and (2.19) becomes:

$$(2.19a) \quad \frac{dP}{dM} \approx \frac{\frac{1}{P} L_1 \frac{C_M}{P}}{\frac{M}{P^2} L_1 \frac{C_M}{P}} = \frac{P}{M}$$

This is equivalent to: $\frac{dP}{dM} \frac{M}{P} \approx 1$, which we had earlier agreed to

denote as the "pure" quantity theory case. A second set of assumptions that leads to similar results is that full employment exists and that the demand for money is of the form $L = kPY$. In this case $L_1 = 0$ (i.e., the demand for money is independent of the rate of interest)

and $L_{Y_m} = \frac{\partial L}{\partial Y_m} = k$ since $Y_m = PY$. Here (2.19) becomes:

$$(2.19b) \quad \frac{dP}{dM} \approx \frac{(C_1 + I_1)}{Y(C_1 + I_1) k} = \frac{1}{kY} .$$

Since $\frac{M}{P} = \frac{L}{P} = kY$, $\frac{dP}{dM} \approx \frac{1}{\frac{M}{P}}$ or $\frac{M}{P} \frac{dP}{dM} \approx 1$. Thus both full employment

conditions and a rather simplified form of the demand for money are sufficient to validate a "pure" quantity theory of prices, with changes in the price level proportional to changes in the quantity of money. In general, however, the "Classical" propositions will not hold, since neither set of assumptions is applicable most of the time. It follows that Keynes' claim that at full employment the "Classical" propositions come back into their own is too strong, for it requires postulates that Keynes himself would hardly have made.

We may briefly examine Π multipliers. By similar techniques, we obtain:

$$(2.20) \quad \frac{dN}{d\Pi} = \frac{(C_{II} + I_{II})L_1 \left(\frac{W}{P} - \frac{\partial W}{\partial P} \right) - Pf'(N) [(C_1 + I_1)f(N)L_{Y_m} + L_1 C \frac{M}{P} \frac{M}{P^2}]}{D}$$

$$(2.21) \quad \frac{dP}{d\Pi} = \frac{-(C_{II} + I_{II})L_1 [Pf''(N)(1-\Pi) - \epsilon_N] + P \left\{ f'(N) \right\}^2 [L_1(1-C_Y - I_Y) + PL_{Y_m}(C_1 + I_1)]}{D}$$

The evaluation of these multipliers is subject to some uncertainty.

As indicated earlier, $C_{II} < 0$ and $I_{II} > 0$, because an income

shift toward non-wage earners will depress real consumption but stimulate real investment. The effects on real spending are in doubt, as is the

sign of $(C_{II} + I_{II})$. If the consumption effects predominate, $(C_{II} + I_{II}) < 0$; consequently, $\frac{dN}{d\Pi} < 0$ but the sign of $\frac{dP}{d\Pi}$ is in doubt. If the stimulus to investment is stronger, $\frac{dP}{d\Pi} > 0$ but the sign of $\frac{dN}{d\Pi}$ is in question. It should be noted that the rise in the degree of monopoly power will also depress employment if stimulus to investment is just balanced by the decrease in consumption (i.e., if $(C_{II} + I_{II}) = 0$), or if the net increase in real spending is small. Similarly, this change will still give rise to an increase in the price level if $(C_{II} + I_{II}) = 0$, or if the net decrease in real expenditure is small. Two special cases exist: in "severe" underemployment equilibrium a rise in the degree of monopoly power is certain to raise prices, whereas in full employment a rise in Π will, in general, reduce employment. In addition, there are several special cases in which $\frac{dN}{d\Pi}$ is zero. One set of sufficient conditions is $C_{\frac{M}{P}} = (C_i + I_i) = (C_{II} + I_{II}) = 0$. The others involve the assumption of full employment in place of $(C_{II} + I_{II}) = 0$, or the assumption that liquidity preference becomes absolute as a substitute for $(C_i + I_i) = 0$.

The underconsumptionist case would entail the assumption that a reduction in monopoly power would stimulate consumption to a greater degree than it would reduce investment. Consequently, $(C_{II} + I_{II}) < 0$, and a reduction in monopoly power stimulates employment and real output. This occurs because real consumption expenditure increases directly with such a change; in addition, falling prices may induce a real

balance effect or may reduce the transactions demand for money, thereby lowering interest rates. A lower rate of interest could, in turn, stimulate real investment.

The effect of an autonomous increase in money wages can be studied also. We shall have:

$$(2.22) \quad \frac{dN}{dw_0} = \frac{-\left[C_M \cdot \frac{M}{P} \cdot \frac{L_1}{P^2} + (C_1 + I_1) L_{Y_m} f(N) \right]}{D} < 0$$

$$(2.23) \quad \frac{dP}{dw_0} = \frac{f'(N) [L_1 (1 - C_Y - I_Y) + P L_{Y_m} (C_1 + I_1)]}{D} > 0 .$$

Thus the effect of an autonomous increase in money wages is to raise prices; the direct effect on costs appears to predominate in our simultaneous system, also. But, in the usual case, there are some system effects on the levels of employment and hence output; in general an increase in the exogenous component of money wages will decrease employment. This is so because the rise in money wages raises prices and so reduces consumption through a real balance effect. Also, the rise in prices raises the rate of interest since the transactions demand depends upon the level of money income; some investment and/or consumption expenditure is thereby choked off. (This does not take account of the distributive effects on consumption. This, however, would not seem to be a serious shortcoming, since the distributive effects of a rise in

money wages are not so obvious and probably will not be substantial.)¹⁸

The employment effects will be negligible if the real balance effect and the interest elasticity of expenditures are negligible. The same result will occur if, instead of perfect interest inelasticity of expenditures, liquidity preference becomes absolute. Equation (2.5) implies that an increase in money wages through an increase in the autonomous component leads to a higher real wage, provided this change reduces the level of employment. No other special cases appear for a change in the exogenous component of money wages. The effects of a change in this component appear to be similar under "severe" unemployment, full employment, and intermediate conditions.

3. A Graphic Representation.

In this section the equations of the model are reduced to two over-all relationships between real income and the aggregate price level. With these two relationships, which are interpreted as "aggregate supply" and "aggregate demand" equations, a graphical presentation of the determination of real income and the price level can be given. After the first reduction, it becomes possible to show that the conventional pedagogic multipliers are special cases of a more general formulation. After the second reduction, some aspects of the joint determination of real income and price are discussed further.

18. A somewhat different model is developed in Franklyn D. Holzman, "Inflation: Cost-Push and Demand-Pull," American Economic Review, Volume L, No. 1 (March, 1960), pp. 20-42. With its aid, Holzman concludes that a wage push will reduce employment and raise prices because the redistributive effects are outweighed by the direct employment-decreasing effects. (See especially pp. 32-34.) Thus, the two different models, which emphasize different aspects of such a change, give similar conclusions.

The equations which are relevant to the supply aspects of the system are:

$$(2.4) \quad Y = f(N)$$

$$(2.5) \quad f'(N)(1-\Pi) = \frac{w}{P}$$

$$(2.6) \quad w = g(N, P) + w_0 .$$

We have three equations in four variables and two parameters, which we can reduce to a single equation in two variables and two parameters. We choose to eliminate w and N , leaving a single derived relation among Y , P , Π , and w_0 . Under certain general conditions Y can be made an explicit function of the P variable as well as of the two parameters. This function, which is termed an "aggregate supply" function by analogy with the supply curve of an individual industry,¹⁹ can be expressed as:

$$(2.24) \quad Y = \varphi (P; \Pi, w_0) .$$

We may also define the elasticity of supply as:

$$(2.25) \quad E_s = \frac{\partial Y}{\partial P} \cdot \frac{P}{Y} = \epsilon_F \cdot \frac{P}{Y} .$$

19. As before, the analogy with the concept of microeconomic theory is loose and imprecise. Thus the concept of the supply curve of an imperfectly competitive industry is vague and erroneous. Moreover, the supply curve of a competitive firm rests on a given wage rate, not on a given labor supply function. However, a more appropriate name for the φ function is not available, and so, desiring to maintain continuity with pre-existing literature, we have settled on the term given above.

In the appendix, a mathematical derivation of the aggregate supply function is given. There it is shown that the level of real output is an increasing function of supply price, except in special cases where the elasticity of supply approaches zero or infinity. In "severe" underemployment equilibrium, the elasticity of supply becomes nearly infinite, indicating that considerable output increases are consistent with negligible price level increases. At full employment the elasticity of supply is close to zero, indicating that only negligible output increases can be obtained only through enormous price level rises. It is further shown that an increase in either the degree of monopoly power or the exogenous component of money wages will reduce the level of output, aggregate supply price remaining unchanged. Symbolically, we have $\phi_P > 0$, $\epsilon \leq \phi_P \leq \infty$; $\phi_{\Pi} < 0$; $\phi_{w_0} < 0$.

After this reduction, our system of equations can be written:

$$(2.26) \quad Y - C(Y, i, \frac{M}{P}, \Pi) - I(i, Y, \Pi) = \alpha$$

$$L(PY, i) = M$$

$$Y - \phi(P; \Pi, w_0) = 0.$$

We shall consider only the response of income to a shift in the exogenous component of spending, $\frac{dY}{d\alpha}$. (This is the familiar multiplier of income with respect to a shift in real investment.) Following the techniques outlined in the previous section and employing the definition of the elasticity of supply, we obtain:

$$(2.27) \quad \frac{dY}{d\alpha} = \frac{L_i \frac{Y}{P} E_s}{(C_i + I_i) L_{Y_m} Y(1 + E_s) + L_i \left[\frac{Y}{P} E_s (1 - C_Y - I_Y) + C_M \frac{M}{P^2} \right]} \geq 0.$$

Because the elasticity of supply is non-negative, $\frac{dY}{d\alpha}$ is also non-negative.

We are now ready to consider some special cases. If the elasticity of supply becomes infinite, $E_s \rightarrow \infty$ and (2.27) reduces to:

$$(2.27a) \quad \frac{dY}{d\alpha} = \frac{L_i}{P(C_i + I_i) L_{Y_m} + L_i (1 - C_Y - I_Y)}.$$

As liquidity preference becomes absolute, $L_i \rightarrow -\infty$, and (2.27a) approaches:

$$(2.27b) \quad \frac{dY}{d\alpha} = \frac{1}{1 - C_Y - I_Y},$$

the familiar form of the Keynesian multiplier with induced investment. This familiar pedagogic multiplier can also be obtained under conditions of infinite elasticity of the aggregate supply curve if expenditure is also perfectly interest inelastic, so that $C_i = I_i = 0$. In this case too (2.27a) reduces to (2.27b). The simple pedagogic multiplier is also obtained if expenditure is perfectly interest inelastic and the real balance effect is negligible (i.e. $C_M = 0$), for in this case (2.27)

reduces directly to (2.27b).²⁰ If the elasticity of supply is

20. This result also holds if a liquidity trap takes the place of perfect interest inelasticity of expenditure.

negligible, $\frac{dY}{d\alpha}$ vanishes. The two cases $E_s = 0$ and $E_s \rightarrow \infty$ represent the two extreme cases often dealt with in Keynesian economics. This concentration, which has given rise to the notion of the so-called L-shaped supply curve, is perhaps unwarranted, for intermediate conditions of neither full employment nor "severe" underemployment are probably the rule over long periods of time.

The remaining relations of the model, which can be interpreted as expressions of its demand aspects, are:

$$(2.2) \quad C = C \left(Y, i, \frac{M}{P}, \Pi \right)$$

$$(2.3) \quad I = I \left(i, Y, \Pi \right) + \alpha$$

$$(2.1) \quad Y = C + I$$

$$(2.7) \quad M = L \left(PY, i \right) .$$

Here we have four equations in five unknowns (C , Y , i , P , and I) and three parameters (M , α , and Π) . By use of the identity (2.1) we can eliminate the C and I variables, thus coming down to two equations in three variables and three parameters. Under certain general conditions, discussed in the appendix, we can eliminate the i variable and write Y as an explicit function of P and the parameters M , α , and Π . This relation, which we designate the "aggregate demand" function because the economic actions which underlie it relate primarily

to expenditure decisions,²¹ is:

$$(2.28) \quad Y = \psi (P; M, \alpha, \Pi) .$$

A rigorous derivation of the aggregate demand function is provided in the appendix. There it is shown that for this relation, real income is a non-increasing function of the price level, a non-decreasing function of the money supply, a non-decreasing function of the level of autonomous spending, and an indeterminate function of the degree of monopoly power. In symbols, we would have:

$$(2.29) \quad \psi_P \leq 0, \psi_M \geq 0, \psi_\alpha \geq 0, \text{ and } \psi_\Pi \begin{matrix} \leq \\ > \end{matrix} 0 .$$

It is further shown that a necessary and sufficient condition that real income display no response to a change in the price level (i.e., $\psi_P = 0$) is that real income display no response to a change in the money supply (i.e., $\psi_M = 0$). It is also shown that ψ_P , ψ_M , and ψ_α are never zero simultaneously.

If all exogenous variables are given, the relations of aggregate supply and aggregate demand reduce to two-dimensional curves. The determination of real income and aggregate price can now be depicted

21. Conard (op. cit., pp. 255-258) derives an analogous relationship from his savings function, investment function, accounting identity of savings and investment, and his money market equation. The resulting function, which indicates a negative relationship between the price level and real income, is termed an "SI-IM curve."

graphically, as in Figure 1.²² The supply curve is invariant under shifts in the money supply and the level of autonomous expenditure, while the demand curve is unaffected by changes in the money wage floor. This suggests that in the short period monetary and fiscal policy are primarily directed toward the demand side of our economic system; on the other hand wage policy (of either a voluntary or compulsory nature) operates on the supply aspects of the system, at least initially. Anti-trust policy, while of a mixed character, would appear to affect primarily the supply side of the system; at least the direction of change is unambiguous in this regard.

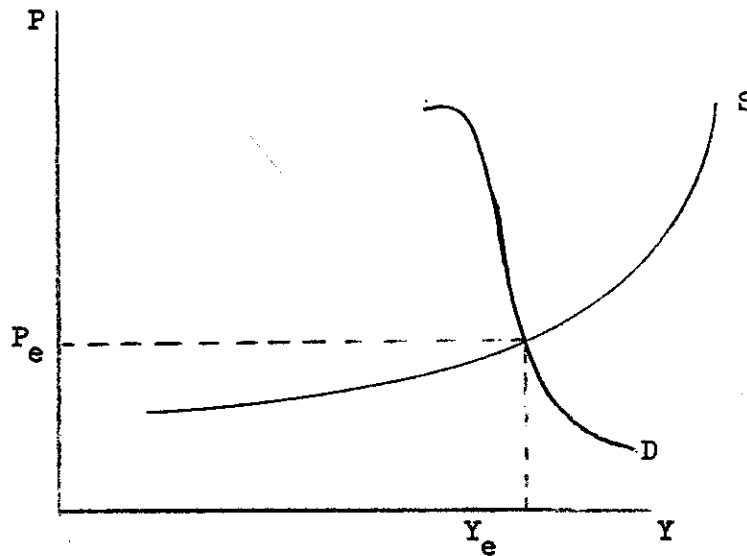


FIGURE 1.

The Aggregate Supply and Aggregate Demand Functions.

22. After the first draft of this paper was written (in the summer of 1960), Phelps' article (*op.cit.*) came to hand. Using the aggregate supply and demand curves, Phelps presents a graphical determination of real income and the price level which is almost identical with ours. His derivations of these functions would appear, however, to be verbal, not mathematical. The connection with the underlying aggregative model of the economy is only stated and not rigorously demonstrated.

This simple apparatus may be utilized to throw some light on the controversy in the recent literature between the demand and the cost inflationists. In this discussion the distinction between demand and supply price has been very much neglected. As pointed out earlier, the aggregate supply curve is invariant to changes in the money supply. In the short period traditional monetary policies will have the effect of controlling prices through the demand side. In the model considered in this paper, the price level can always be reduced, except in "severe" underemployment conditions, since the demand curve can in general be slid down the supply curve. The difficulty is that except in the limiting case $E_s = 0$, this will result in a reduction of real income and hence employment, so that the traditional monetary policies will be quite unable, subject to this qualification, to affect supply price; in particular they will have no direct effect on the money wage level.²³

Although this seems reasonably accurate, the principle remains that demand and supply jointly determine real income and aggregate price. The real issue cannot turn on whether demand or supply (cost) determines price -- the issue of which blade of the scissors does the cutting was resolved a long time ago.²⁴ In part much of the controversy

23. Weintraub makes essentially the same point in A General Theory, Chapter 9, and in Classical Keynesianism, Chapters 5 and 6.

24. An attempt is sometimes made to distinguish between "demand" and "cost" inflation on the basis of the effect of reductions in the level of monetary demand on the real income level. (See, for example, Phelps op. cit., especially pp. 32-33.) If prices can be reduced -- (say) by increases in the average tax rate -- without reducing the real income level, then we have "pure demand" inflation. An appropriate reduction in the money supply will have a similar effect. In terms of the analysis pursued above, this case will correspond to a situation in which the aggregate demand curve cuts the aggregate supply curve well above the point at which supply becomes perfectly inelastic. In this case the aggregate demand curve can be "slid down" the aggregate supply curve reducing the price level but leaving the level of real income and employment unchanged.

can be explained by the failure to distinguish between arguments relating to demand price and those relating to supply price, which in general are not mutually exclusive. This is suggestive of the fact that some of the combatants in the debate have in part been at odds since some have dealt with demand price and others with supply price. In general the "demand-pull" school has seemed more ready to deny the possibility of autonomous shifts in the schedule on which their attention has not been focussed. The Keynesian gap analysis of How to Pay for the War is largely responsible for this state of affairs. Here the cost side of aggregate price determination is removed by the assumption of fixed supply. The only price worth considering is demand price since supply is given. Some "cost inflationists" have fallen into the opposite trap of considering only the problem of supply price, assuming (usually implicitly) that demand, being plastic and passive, will follow to validate almost any increase in supply price.²⁵

Our survey of the aggregative economy as a whole is now complete. Chapters III through VI will focus on particular relationships of our

25. We should not wish to deny that under certain circumstances, such as war time, it may be appropriate to simplify and approach the problem of price level determination from an extreme point of view. Similarly, there may be occasions when the demand curve is relatively fixed and price level inelastic and the entire floor of the aggregate supply curve shifts upward; here the increase in supply price is the most interesting feature of the upward price level movement. Generally, however, the simultaneous determination of aggregate price and real income by supply and demand has to be considered.

model, with a view toward obtaining empirical counterparts. The major conclusions of this chapter are summarized in Chapter VIII.

Appendix

In this appendix the aggregate supply and aggregate demand functions discussed in the text are rigorously derived. The partial derivatives of these functions can also be evaluated, enabling one to determine the signs of these expressions. Finally, these functions and the signs of their partial derivatives are examined in some special cases.

The aggregate supply curve is derived from the following set of equations:

$$(a.1) \quad Y = f(N)$$

$$(a.2) \quad f'(N)(1-\Pi) = \frac{W}{P}$$

$$(a.3) \quad w = g(N,P) + w_0 .$$

We may combine (a.2) and (a.3) in order to eliminate w :

$$(a.4) \quad Pf'(N)(1-\Pi) - g(N,P) - w_0 = 0 .$$

Because of our assumption that $f'(N) > 0$, the inverse function of (a.1) exists for all values of Y , and (a.1) becomes:

$$(a.5) \quad N = f^{-1}(Y) .$$

Substituting (a.5) into (a.4), we obtain:

$$(a.6) \quad Pf' \left\{ f^{-1}(Y) \right\} (1-\Pi) - g \left\{ f^{-1}(Y), P \right\} - w_0 = 0 .$$

(a.6) can be written formally as:

$$(a.7) \quad H(P, Y; \Pi, w_0) = 0 .$$

Since it is presumed that $f'(N)$ has a continuous derivative and that $g(N,P)$ has continuous partial derivatives, the function H will have continuous partial derivatives. Under these conditions (a.7) has a solution in the small:

$$(a.8) \quad Y = \varphi(P; \Pi, w_0) ,$$

provided $H_Y \neq 0$. We now seek to discover whether this last condition holds.

$$(a.9) \quad H_Y = P(1-\Pi) \frac{d}{dY} [f' \{f^{-1}(Y)\}] - \frac{\partial}{\partial Y} [g \{f^{-1}(Y), P\}]$$

$$(a.10) \quad H_Y = P(1-\Pi) \frac{df'}{dN} \cdot \frac{dN}{dY} - \epsilon_N \cdot \frac{dN}{dY}$$

by the chain rule.

But,

$$(a.11) \quad \frac{dN}{dY} = \frac{1}{\frac{dY}{dN}} = \frac{1}{f'(N)} .$$

(a.10) consequently becomes:

$$(a.12) \quad H_Y = P(1-\Pi) f''(N) \frac{1}{f'(N)} - \epsilon_N \frac{1}{f'(N)}$$

or

$$(a.13) \quad H_Y = \frac{1}{f'(N)} [P(1-\Pi) f''(N) - \epsilon_N] ,$$

where N is given by (a.5).

In general, $f'(N) > 0$, $f''(N) < 0$, $\varepsilon_N > 0$ so that:

$$(a.14) \quad H_Y < 0$$

and so $H_Y \neq 0$. Conditions sufficient to guarantee the existence of the solution (a.8) of the implicit function (a.6) hold. The function (a.8) is the aggregate supply function of the text.

We may now examine partial derivatives of this function. Applying implicit function theorems, we have:

$$(a.15) \quad \varphi_P = \frac{-H_P}{H_Y} = \frac{f'(N) [\varepsilon_P - f'(N)(1-\Pi)]}{[P(1-\Pi) f''(N) - \varepsilon_N]}$$

$$= \frac{f'(N) \left(\frac{\partial W}{\partial P} - \frac{W}{P} \right)}{[P(1-\Pi) f''(N) - \varepsilon_N]} > 0,$$

$$(a.16) \quad \varphi_{\Pi} = \frac{-H_{\Pi}}{H_Y} = \frac{P \{f'(N)\}^2}{[P(1-\Pi) f''(N) - \varepsilon_N]} < 0,$$

$$(a.17) \quad \varphi_{W_0} = \frac{-H_{W_0}}{H_Y} = \frac{f'(N)}{[P(1-\Pi) f''(N) - \varepsilon_N]} < 0,$$

where $N = f^{-1}(Y)$.

Under "severe" underemployment conditions, the denominator approaches zero from a negative direction, so that:

$$\varphi_P \rightarrow +\infty$$

$$\varphi_{\Pi} \rightarrow -\infty$$

$$\varphi_{W_0} \rightarrow -\infty.$$

With full employment, $\frac{\partial W}{\partial P} \rightarrow \frac{W}{P}$ and consequently $\phi_P \rightarrow 0$.

The aggregate demand curve is derived from the following set of equations:

$$(a.18) \quad C = C(Y, i, \frac{M}{P}, \Pi)$$

$$(a.19) \quad I = I(i, Y, \Pi) + \alpha$$

$$(a.20) \quad Y = C + I$$

$$(a.21) \quad M = L(PY, i) .$$

Substituting (a.18) and (a.19) into (a.20), we may reduce the above set down to a pair of simultaneous equations:

$$(a.22) \quad C(Y, i, \frac{M}{P}, \Pi) + I(i, Y, \Pi) + \alpha - Y = 0$$

$$L(PY, i) - M = 0 .$$

Schematically, the set (a.22) may be written:

$$(a.23) \quad F(Y, i, P; M, \alpha, \Pi) = 0$$

$$G(Y, i, P; M, \alpha, \Pi) = 0 .$$

It is assumed that the C, I, and L functions all have continuous partial derivatives. Then F and G will have continuous partial derivatives also. Suppose that

$$(a.24) \quad J = \begin{vmatrix} F_Y & F_i \\ G_Y & G_i \end{vmatrix} \neq 0 .$$

In this case, the set (a.23) will yield a solution "in the small":

$$(a.25) \quad Y = \psi (P; M, \alpha, \Pi) .$$

(We could also solve for i as an explicit function of $P, M, \alpha,$ and Π under these circumstances; but this expression is of little interest and is consequently neglected.) The expression for J is:

$$(a.26) \quad J = \begin{vmatrix} F_Y & F_I \\ G_Y & G_I \end{vmatrix} = \begin{vmatrix} (C_Y + I_Y - 1) & (C_I + I_I) \\ P L_{Y_m} & L_I \end{vmatrix} \\ = L_I (C_Y + I_Y - 1) - (C_I + I_I) L_{Y_m} P .$$

We have

$$(a.27) \quad C_Y + I_Y - \frac{1}{i} < 0, \quad L_{Y_m} > 0, \\ L_I \leq 0, \quad \text{and} \quad (C_I + I_I) \leq 0 .$$

Consequently J is non-negative. It will be assumed that J is strictly positive; this entails the condition that L_I and $(C_I + I_I)$ are never zero simultaneously. (If L_I and $(C_I + I_I)$ are both zero, the interest rate plays no role in the economic system, and equations (a.22) determine, in general, both Y and P , rather than Y as a function of P .) In this case, (a.24) holds, and (a.25), which gives the required explicit function, is the aggregate demand function of the text.

We may now examine the partial derivatives of this aggregate

demand function. Using implicit function theorems, we obtain:

$$(a.28) \quad \psi_P = - \frac{\begin{vmatrix} F_P & F_I \\ G_P & G_I \end{vmatrix}}{J} = \frac{\frac{C_M}{P} \frac{M}{P^2} L_I + Y L_{Y_m} (C_I + I_I)}{L_I (C_Y + I_Y - 1) - (C_I + I_I) L_{Y_m} P} \leq 0$$

$$(a.29) \quad \psi_\alpha = - \frac{\begin{vmatrix} F_\alpha & F_I \\ G_\alpha & G_I \end{vmatrix}}{J} = \frac{-L_I}{L_I (C_Y + I_Y - 1) - (C_I + I_I) L_{Y_m} P} \geq 0$$

$$(a.30) \quad \psi_M = - \frac{\begin{vmatrix} F_M & F_I \\ G_M & G_I \end{vmatrix}}{J} = \frac{-[L_I \frac{C_M}{P} \frac{1}{P} + (C_I + I_I)]}{L_I (C_Y + I_Y - 1) - (C_I + I_I) L_{Y_m} P} \geq 0$$

$$(a.31) \quad \psi_\Pi = - \frac{\begin{vmatrix} F_\Pi & F_I \\ G_\Pi & G_I \end{vmatrix}}{J} = \frac{-L_I (C_\Pi + I_\Pi)}{L_I (C_Y + I_Y - 1) - (C_I + I_I) L_{Y_m} P} \geq 0.$$

ψ_P and ψ_M will both be zero under the following circumstances:

- (A.) $(C_I + I_I) = 0$ (here L_I must be negative so that the denominator may be strictly positive) and $\frac{C_M}{P} = 0$, or
- (B.) $L_I \rightarrow -\infty$ and $\frac{C_M}{P} = 0$.

ψ_P and ψ_M cannot be zero under any other circumstances, given our assumptions. It follows that if either one is zero, either conditions (A.) or (B.) must hold. Consequently, a necessary and sufficient

condition that $\psi_P = 0$ is that $\psi_M = 0$.

A necessary and sufficient condition that $\psi_\alpha = 0$ is that $L_1 = 0$. (This is the case, discussed in the text, where money income (PY) can be made a function of the quantity of nominal money, under certain general conditions. Here an attempt to increase money income without also increasing the money supply is futile; interest rates adjust so that endogenous real expenditure is disgorged to make room for increased autonomous real expenditure.) In addition, $\psi_\alpha = 0$ only if ψ_P is strictly negative and ψ_M strictly positive. For if $L_1 = 0$, neither condition (A.) nor condition (B.) can hold (condition (A.) cannot hold because $(C_1 + I_1)$ must be strictly negative so that J may be strictly positive), and the preceding statement follows. Moreover, if ψ_P and ψ_M are zero, ψ_α must be strictly positive. As we can see by inspecting conditions (A.) and (B.), zero values of ψ_P and ψ_M imply a non-zero value of L_1 and hence a non-zero value of ψ_α .

ψ_{II} will be zero if $L_1 = 0$ or if $(C_{II} + I_{II}) = 0$. Thus a sufficient, but not a necessary, condition that $\psi_{II} = 0$ is that $\psi_\alpha = 0$.

Chapter III, "Empirical Relationships between Wage Changes,
Unemployment, and Price Level Changes"

We now wish to examine what is an approximate empirical counterpart of the labor supply relationship, equation (2.6) of the previous chapter. Following the work of previous investigators,¹ the author will attempt to explain wage changes as a function of the level of unemployment and of price level changes. This relationship is more than a labor supply equation. Since it purports to describe the outcome of the wage-making process, demand elements will similarly be important. Our relationship is concerned primarily with market results and comes from a world in which demand and supply phenomena are not readily indentifiable. Because of its mixed character, we refer to this relationship as a "wage adjustment" equation; in symbols, it may be written:

$$(3.1) \quad \Delta w_t = f(U_t, \Delta P_t) .$$

Here, Δw_t is the change in the money wage at time t and is defined as the difference between this period's money wage and last period's. In the empirical discussions below, w is measured in dollars per hour. U_t is absolute unemployment at time t and is measured in thousands of men. ΔP_t is the absolute difference between the current level of the consumer price index and that of the previous year; the consumer price index is measured on a 1926 base.

1. For references and discussion, see Chapter I, section 1.

Empirical counterparts of this relationship were estimated from American data, from 1899 to 1957. For wages, the concept used is average hourly compensation in manufacturing, as developed by Albert Rees.² Rees' data include wages but exclude salaries; the concept used includes wage supplements. The hours divisor is hours at work (e.g., excludes paid holidays), rather than hours paid. A consumer price index was pieced together from two sources. Rees's book gives a consumer price index from 1898 to 1914,³ while the Bureau of Labor Statistics' cost of living index, as recorded in the files of the National Bureau of Economic Research and Historical Statistics,⁴ was used from 1913 to 1957. (The overlapping years were used for the purpose of linking the two series.) A homogeneous series on unemployment was obtained by using figures for the years 1900 to 1940, developed by Stanley Lebergott in a forthcoming work⁵ and made available to the

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2. Albert Rees (Assisted by Donald P. Jacobs), Real Wages in Manufacturing 1890-1914 (Princeton: Princeton University Press, 1961), p. 4; Albert Rees, "New Measures of Wage-Earner Compensation in Manufacturing, 1914-1957," Occasional Paper 75, National Bureau of Economic Research, 1960, p. 3. (The National Bureau of Economic Research is occasionally abbreviated "NBER" in the remainder of this work.)
 3. Albert Rees (Assisted by Donald P. Jacobs), op.cit., p. 4.
 4. U.S. Bureau of the Census, Historical Statistics of the United States, Colonial Times to 1957 (Washington: U.S. Government Printing Office, 1960), Table E 113, p. 125. (This work is herein called by the short title, Historical Statistics.)
 5. Stanley Lebergott, Manpower and Economic Growth: The American Record since 1800 (McGraw-Hill Book Company, Inc., forthcoming). These estimates are a revision of Lebergott's earlier figures, which appeared in his "Annual Estimates of Unemployment in the United States, 1900-1954," The Measurement and Behavior of Unemployment (Princeton, N.J.: Princeton University Press [for
- (Footnote continued on bottom of next page.)

author in advance of publication. Department of Commerce figures⁶ on unemployment are used for the years 1941 to 1957. (The former definition of unemployment is the one employed here -- thus the temporarily laid-off are counted as employed.) For a tabular presentation of these data (except the unemployment figures), see Appendix B.

1. Some Preliminary Results.

The method of parameter estimation used in this chapter is single equation least squares. Although this method is subject to well known biases, it offers certain computing economies which make it attractive for preliminary experimentation, in comparison with ~~an unbiased~~ ^{a consistent} method of parameter estimation. Perhaps the most serious short-coming of this technique is related to the problem of identification. Price level changes influence wage demands; but wage increases influence the price level, because of cost pressures. Some of this problem is ameliorated by the use of a consumer price index and of wages in manufacturing. (The immediate impact of a wage increase in manufacturing would be on certain selected wholesale prices.) In Chapter VI below, the parameters of the final wage adjustment relationships are re-estimated by

Footnote 5 continued from Page 85.

The Universities-National Bureau Committee for Economic Research], 1957), pp. 213-239. The author's immediate source was a letter from Professor Lebergott, dated January 22, 1962. In this letter, Lebergott requested that the author not present these estimates in advance of the publication of his (Lebergott's) latest book, and consequently this series does not appear in Appendix B of this Chapter.

6. Historical Statistics, Table D 46, p. 73.

the method of two stage least squares. Hence the estimates of these parameters are free of single equation bias.

Some preliminary experimentation was undertaken to determine the most appropriate form of the wage adjustment equation. Whether variables should be expressed in absolute or percentage form and whether a time trend should be included as an explanatory variable were investigated. After this preliminary study, it was decided to use the absolute wage change, the absolute unemployment level, and the absolute price level change instead of percentage wage and price level changes and unemployment as a percentage of the labor force.⁷ The coefficient on unemployment becomes significantly negative only with the absolute variables, after a time trend is included as an explanatory variable. As was pointed out in Chapter I above, our theory would lead us to expect a negative sign on unemployment, for unemployment would constitute excess supply and as such would exert a restraining force on the increase in money wages. Hence requiring this coefficient to be negative seems a reasonable economic criterion. The time trend variable permitted the negative influence of unemployment on the wage change to appear; furthermore, this variable was highly significant in its own right and so it was included. This time trend may be given several interpretations. On one view, it might represent

7. This series (unemployment as a percentage of the labor force) was obtained from Lebergott, letter of January 22, 1962 (values for 1900-1940) and Historical Statistics, Table D 47, p. 73 (values for 1941-1957).

increasing power or pushfulness from the supply side of the labor market, as could occur from a growth in the membership or the power of the trade unions.⁸ On another view, its significance might be an artifact resulting from stating the dependent variable in absolute, not percentage, terms; a given absolute wage increase means less to the participants when the base is large than when it is small. In Appendix A, the regression equations which were examined and then rejected as candidates for the final wage adjustment equation are listed.

The equations accepted for further examination were:

$$(3.2) \quad \Delta w_t = - .00619 - 0.5238 \times 10^{-5} U_t + 0.1955 \times 10^{-2} \Delta P_{t-1} \\ (.01012) \quad (0.1673 \times 10^{-5}) \quad (0.0995 \times 10^{-2}) \\ + 0.2005 \times 10^{-2} t, \quad \bar{S}_u = 0.0365, R^2 = 0.5394, \\ (0.0306 \times 10^{-2})$$

$$(3.3) \quad \Delta w_t = - .01374 - 0.2463 \times 10^{-5} U_t + 0.5845 \times 10^{-2} \Delta P_{t-\frac{1}{2}} \\ (.00817) \quad (0.1403 \times 10^{-5}) \quad (0.0967 \times 10^{-2}) \\ + 0.1677 \times 10^{-2} t, \quad \bar{S}_u = 0.0292, R^2 = 0.7055, \\ (\Delta P_{t-\frac{1}{2}} = \frac{1}{2} (\Delta P_t + \Delta P_{t-1}), \text{ by definition.})$$

8. In the "wage bargain" equation of Valavanis-Vail's model (which is analogous to the author's wage adjustment equation), there is no time trend, but one of the explanatory variables is the percentage of wage earners who are unionized. Since Valavanis-Vail effectively has the author's other two explanatory variables in his relation, the fact that he obtains a highly significant coefficient on his percentage unionized variable strengthens this interpretation of the present results. See Stefan Valavanis-Vail, op. cit.

$$\begin{aligned}
 (3.4) \quad \Delta w_t = & - .01492 - 0.1987 \times 10^{-5} u_t + 0.6200 \times 10^{-2} \Delta P_t \\
 & (.00628) \quad (0.1056 \times 10^{-5}) \quad (0.0627 \times 10^{-2}) \\
 & + 0.1628 \times 10^{-2} t, \quad \bar{S}_u = 0.0225, \quad R^2 = 0.8243 . \\
 & (0.0190 \times 10^{-2})
 \end{aligned}$$

t , the time trend, is equal to zero in 1900 and is in annual units. (Hence ΔP_{t-1} , the change in the consumer price level, lagged one time period, is equal to last year's consumer price level minus that of two years ago.) The numbers in parentheses are standard errors, while R^2 is the coefficient of multiple determination and \bar{S}_u is the estimated standard deviation of the residuals. (\bar{S}_u , but not R^2 , is corrected for degrees of freedom.) In each of these regressions, there were 58 annual observations, as the period ran from 1900 to 1957.

Some comments may be proffered on these equations. All of them indicate that an increase in the consumer price level is associated with an increase in the money wage. This is hardly surprising, for labor might be expected to exert pressure for higher wages (and business more ready to give them) when prices rise. (Even if a wage push were responsible for the price level rise, this should make no difference to the argument. In the labor market, which this equation purports to describe, a price level increase is likely to result in a higher money wage. This is so because workers desire more strongly wage advances to offset higher living costs and employers are more willing to grant these, as value productivity is now higher.) Over the period 1900-1957, the

mean money wage was \$0.7102 and the mean value of the consumer price level, in 1926 index points, was 89.8. Thus, if a rise in prices one per cent of the period's average price level were associated with a rise in wages one per cent of the average money wage of this period, the coefficient on the price level change would be 0.0079. It is to be noted that the observed discrepancies are statistically significant, if one accepts the accompanying standard errors.

Another question that arises is that of the appropriate time lag of the price level change variable. The time diagram of the money wage change, the consumer price level change, and unemployment⁹ (Figure 2) suggests that the influence of the price level change on the wage change is principally a simultaneous one, rather than one involving a time lag. This impression is confirmed by equations (3.2), (3.3), and (3.4); the shorter the time lag in the price level change variable, the higher the coefficient of multiple determination, R^2 . Hence, for the moment, the hypothesis that the unlagged form of this variable is best will be tentatively accepted. This question is further pursued in Section 2 below.

These regression equations all show a significant relationship (at the 5 per cent level, with a one-tailed test or at the 10 per cent level, with a two-tailed test) between unemployment and the money wage

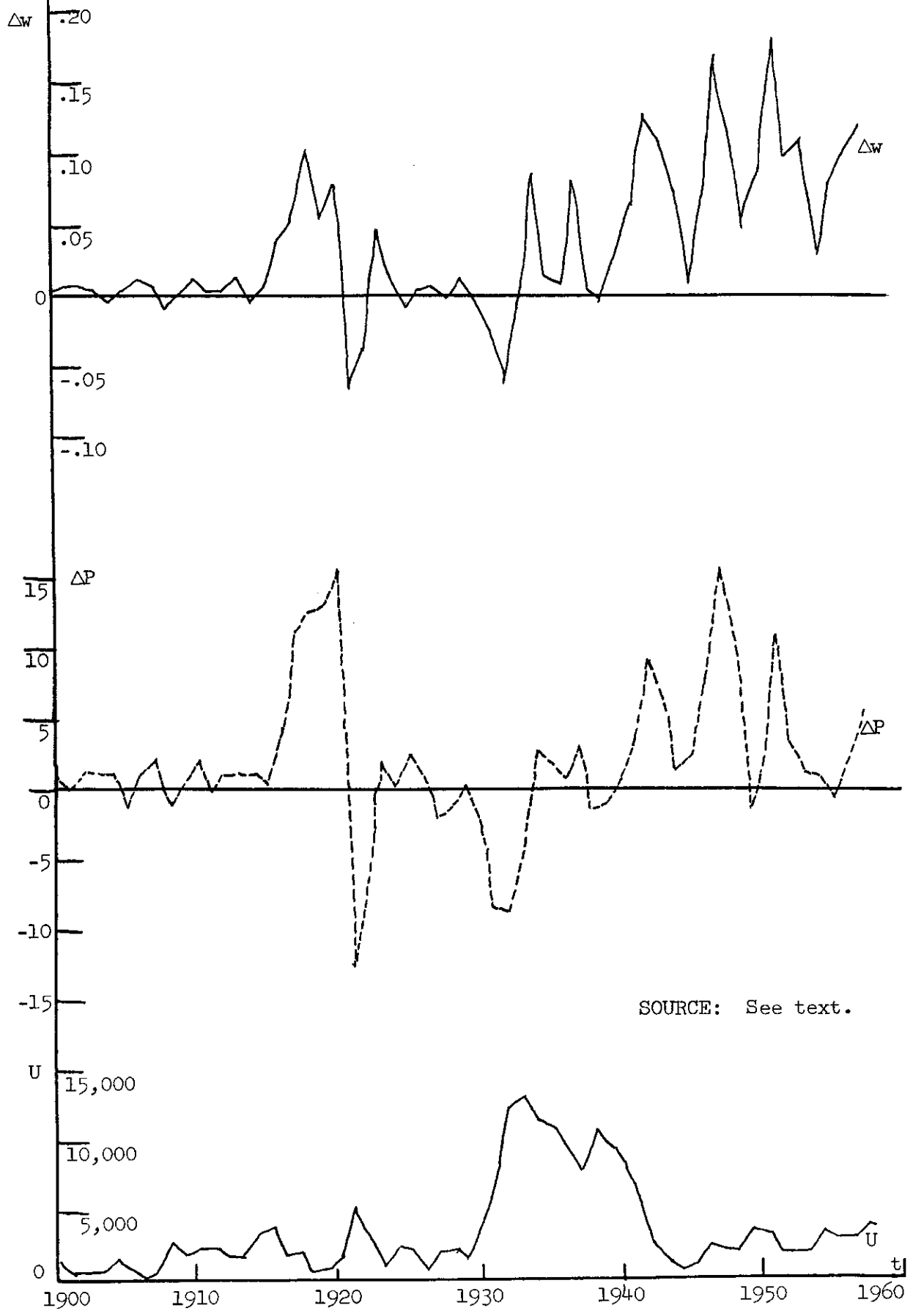
9. The unemployment series in this time diagram is taken (for the years 1900-1940) from Lebergott's published paper, "Annual Estimates of Unemployment in the United States, 1900-1954," and so it differs somewhat from the unemployment series from which the regression equations were calculated.

change. The negative sign of the coefficient of unemployment is in accord with standard economic theory, as has been pointed out. The relationship between unemployment and the money wage change is, however, very loose. Over the period 1900-1957, the mean level of the labor force was, in thousands of men, 47,679. Therefore, if an increase in the level of unemployment which was one per cent of this mean labor force were associated with a wage decrease one per cent of the period mean money wage, the coefficient of the U_t variable would be $- 1.49 \times 10^{-5}$. Since all coefficients of unemployment are much lower, this suggests that the wage change is not very sensitive to the level of unemployment. The same impression is obtained from looking at the gross scatter diagram between the wage change and unemployment¹⁰ (Figure 3). There is much dispersion about the negative relationship between wage changes and unemployment.

Figure 2 (the time diagram) suggests no obvious lag in the influence of unemployment on the money wage change. This possibility may be further tested by introducing lagged values of the unemployment variable into the wage adjustment regressions. Using a time lag of one year for the first regression, a time lag of half a year for the second, and the sample period 1901-1957 for both regressions, the author obtained the following

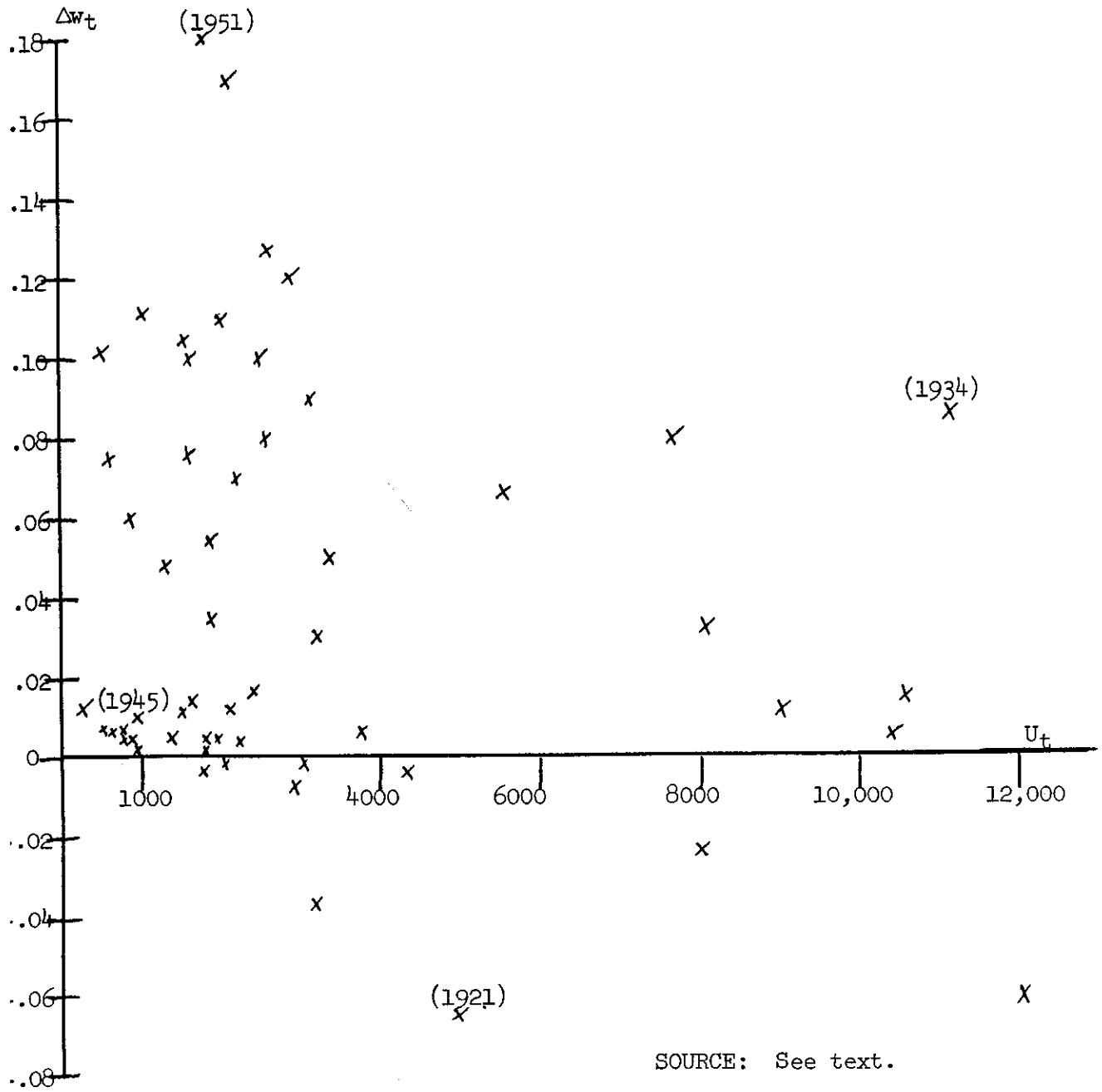
10. The unemployment series used in Figure 3 is that of Figure 2 and hence differs somewhat from Lebergott's latest unemployment series.

FIGURE 2. Time Diagram of the Money Wage Change (Δw), the Consumer Price Level Change (ΔP), and Unemployment (U), U.S.A., 1900 - 1957.



SOURCE: See text.

FIGURE 3. Gross Scatter Diagram of Money Wage Changes (Δw_t) and Unemployment (U_t), U.S.A., 1900 - 1957.



modifications of equation (3.4):

$$(3.5) \quad \Delta w_t = - .01916 - 0.0662 \times 10^{-5} U_{t-1} + 0.6606 \times 10^{-2} \Delta P_t \\ (.00656) \quad (0.1019 \times 10^{-5}) \quad (0.0603 \times 10^{-2}) \\ + 0.1578 \times 10^{-2} t, \quad \bar{S}_u = 0.0232, \quad R^2 = 0.8152, \\ (0.0199 \times 10^{-2})$$

$$(3.6) \quad \Delta w_t = - .01768 - 0.1337 \times 10^{-5} U_{t-\frac{1}{2}} + 0.6433 \times 10^{-2} \Delta P_t \\ (.00657) \quad (0.1068 \times 10^{-5}) \quad (0.0617 \times 10^{-2}) \\ + 0.1619 \times 10^{-2} t, \quad \bar{S}_u = 0.0230, \quad R^2 = 0.8191 . \\ (0.0198 \times 10^{-2})$$

A comparison with equation (3.4) suggests that this modification produces inferior results. The coefficient of multiple determination falls slightly; moreover, the coefficient of the unemployment variable fails to retain statistical significance, in either lagged formulation. The statistical evidence suggests that current unemployment is preferable to a lagged value of unemployment, as an explanatory variable in a wage adjustment relationship.

Figure 3 (the gross scatter diagram) suggests no obvious non-linearity in the relationship between wage changes and unemployment. This is in contrast with the work of Phillips and Lipsey, who, using British data from 1861 to 1957, found a pronounced non-linearity in

this relationship.¹¹ However, Samuelson and Solow, working with American data, observed that non-linearity in the relationship between unemployment and the money wage change was not so evident in their data.¹² And Bhatia concluded that the relationship between unemployment and wage changes was approximately linear, for the American economy.¹³ Hence the author's impressions agree with those of several other students of American data, and the different conclusions (about this relationship for American and for British data) may point up a genuine institutional difference between the two economies.

A further test of non-linearity may be made. We may introduce the reciprocal of current unemployment, $\frac{1}{U_t}$, into the wage adjustment

11. A. W. Phillips, op. cit.; Richard G. Lipsey, op. cit.

Recently R. J. Ball has studied the forecasting accuracy of two post-war British wage adjustment relationships, beyond the period for which they were fitted. (See R. J. Ball, "The Prediction of Wage-Rate Changes in the United Kingdom Economy 1957-60," Economic Journal, Volume LXXII, No. 285 (March, 1962), pp. 27-44. The two wage adjustment relationships are taken from L. R. Klein and R. J. Ball, op. cit., and L. A. Dicks-Mireaux and J. G. R. Dow, op. cit.) Ball found that both wage adjustment relationships predicted most poorly during the period between the third quarter of 1958 and the third quarter of 1959, a period of recession in business activity. One possible explanation of these results is a non-linearity in the relationship between unemployment and wage rate changes. Such a non-linearity, if present, would probably not have been apparent during the period for which these wage adjustment relationships were fitted because of the low level of unemployment (high level of labor demand) which existed over that entire earlier period.

12. Paul A. Samuelson and Robert M. Solow, op. cit.

13. Rattan J. Bhatia, op. cit.

regression (in place of a linear form of this variable).¹⁴ When this is done for the period 1900-1957, the results are:

$$(3.7) \quad \Delta w_t = - .02422 + 6.567 \left(\frac{1}{U} \right) + 0.6499 \times 10^{-2} \Delta P_t \\ (.00879) \quad (8.410) \quad (0.0641 \times 10^{-2}) \\ + 0.1567 \times 10^{-2} t, \quad \bar{S}_u = 0.0231, \quad R^2 = 0.8149 . \\ (0.0200 \times 10^{-2})$$

Once again, the modification proves to be statistically inferior. The coefficient of multiple determination is lower than that of equation (3.4), and the coefficient of the reciprocal of unemployment does not retain statistical significance. Hence this does not seem to be a fruitful modification, and non-linearity (of this type) between unemployment and wage changes does not appear to be present, for the American economy.

The gross scatter diagram of money wage changes and consumer price level changes is presented in Figure 4. An examination of this diagram suggests no pronounced non-linearity in the relationship between wage changes and price changes. This diagram also suggests that the price level change variable does more of the work of explaining wage changes than does the level of unemployment. This impression is confirmed by an examination of equation (3.4): the ratio of coefficient to

14. Richard G. Lipsey and M. D. Steuer ("The Relation between Profits and Wage Rates," *Economica*, N.S., Volume XXVIII, No. 110 (May, 1961), pp. 137-155) use this form of the unemployment variable, in their regression analysis. This article is discussed more fully in Chapter IV below.

standard error (the t ratio) is much higher for the price level change variable than for the level of unemployment.¹⁵

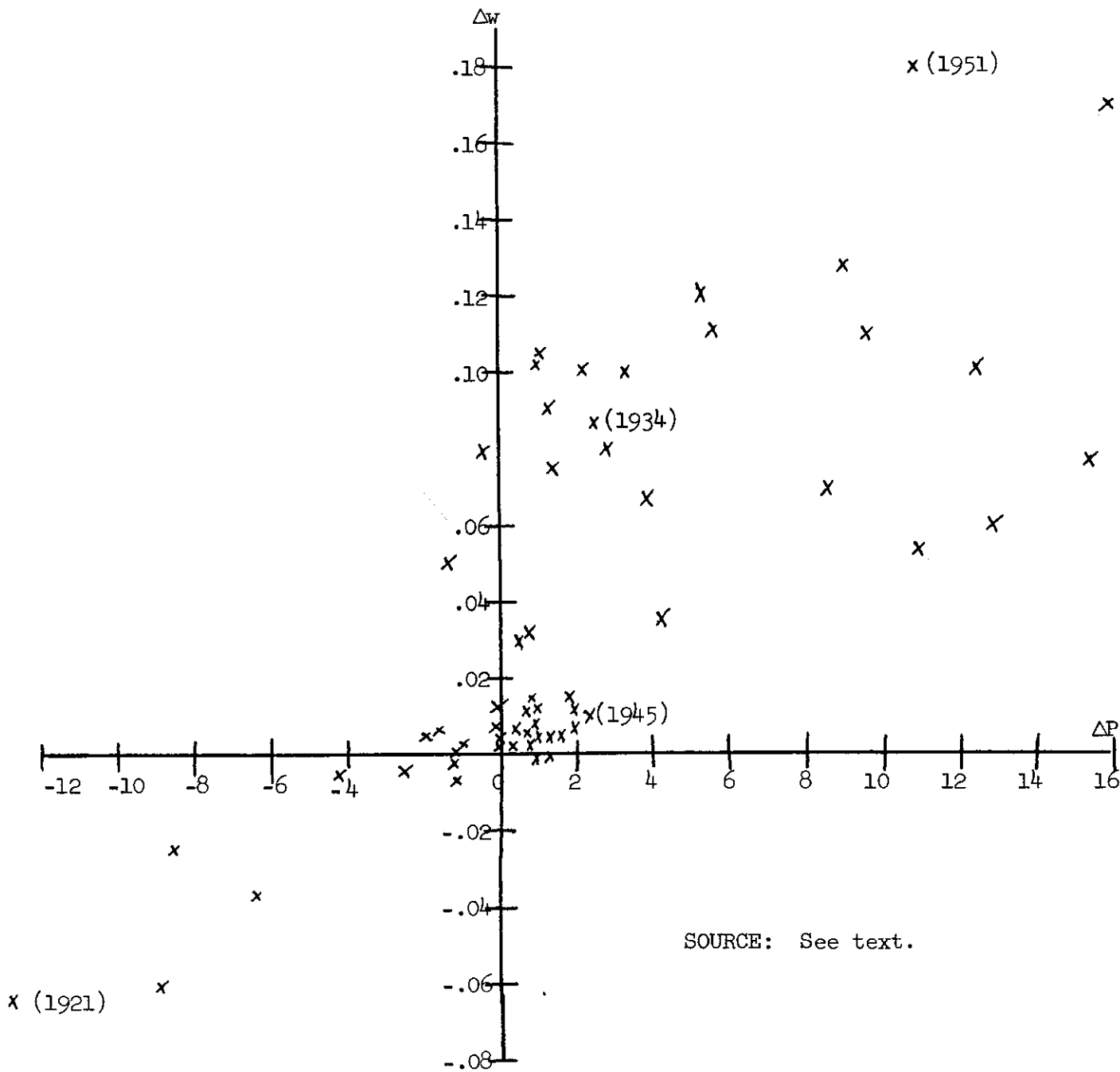
2. The Possible Lag of Wage Changes behind Price Level Changes

Let us pursue further the question of the appropriate lag for the price level change variable. In the previous section, we saw that the highest coefficient of multiple correlation is obtained when this variable is unlagged.¹⁶ Thus it might be assumed that the unlagged form is best. However, there is one consideration that might make us hesitant to accept this result at face value. In Chapter II, the existence of another relationship between wages and prices -- a marginal productivity equation or a mark-up equation -- was pointed up. Hence it is desirable to investigate this problem further, by seeing what additional evidence is available on this matter.

15. Robert L. Gustafson has shown ("Partial Correlations in Regression Computations," Journal of the American Statistical Association, Volume LVI, No. 294 (June, 1961), pp. 363-367) that the relevant partial correlation coefficients can be computed from the t ratios and the number of observations. Furthermore, for a given number of observations, the relevant partial correlation coefficient varies monotonically (in a positive sense) with the t ratio.

16. It is also interesting to note that the effect of unemployment on the wage change is diminished as the length of the price level change lag is reduced. (See equations (3.2), (3.3), and (3.4).) L. R. Klein and R. J. Ball (op. cit., p. 474) come to a similar conclusion.

FIGURE 4. Gross Scatter Diagram of Money Wage Changes (Δw) and Consumer Price Level Changes (ΔP), U.S.A., 1900 - 1957.



The National Bureau of Economic Research has completed many cyclical analyses of various economic time series. Among the series analyzed were average hourly earnings of 25 manufacturing industries (a series published by the National Industrial Conference Board) and the Bureau of Labor Statistics' cost of living index. Both were analyzed for the period 1922-1939. The following table is a summary of processed data, taken from the National Bureau files in New York:

Table I.

Summary of the National Bureau's Timing Measures, Cost of Living Index and Average Hourly Earnings of 25 Manufacturing Industries, U.S.A., 1922-1939.

Lead (-) or Lag (+) at:

	Reference Peak (No. of Months) (1.)	Reference Trough (No. of Months) (2.)	Unweighted Average of (1.) and (2.) (3.)
Cost of Living Index	+ 2.2	+ 9.0	+ 5.6
Average Hourly Earn- ings, 25 Manufactur- ing Industries	+ 12.0	+ 7.6	+ 9.8

Source: See text.

Thus average hourly earnings lag consumer prices by 4.2 months over the cycle, on the average for the period 1922-39. If this lag is the appropriate one for our regression equation, the annual data would tend to conceal this lag. This piece of evidence would lead us to accept equation (3.3) as the closest statistical counterpart of the

underlying economic structure. Before this conclusion is accepted as a working hypothesis, some further evidence may be examined.

Quarterly data on wages and consumer prices exist for the United States in the post-war period. The wage data, which are average earnings at an annual rate, were taken from the work-sheets of the Unit for Econometric Research on the Structure of the American Economy at the University of Pennsylvania.¹⁷ Unlike the annual data, this series includes the salaries of non-production workers. The consumer price index used is the implicit deflator of personal consumption expenditures, from the G.N.P. accounts.¹⁸ (The data used are given in Appendix B.) The change between the average earnings (at an annual rate) in a given quarter and the average earnings in the same quarter a year earlier was correlated with the price level change, which was lagged zero, one, two, three, and four quarters, successively. (The price level change was defined as the difference between the consumer price level in a particular quarter and the consumer price level of

17. This series is a constructed series. For a fuller description, see L. R. Klein, "A Postwar Quarterly Model." The author's special thanks go to Miss Kanta Marwah, for her time and co-operation.

18. The figures for 1945 and 1946 were estimated from the monthly values of the B.L.S.'s cost of living index for those years. (The author's immediate source was the NBER files.) The figures for 1947-1955 were taken from the U.S. Department of Commerce, Office of Business Economics, U.S. Income and Output (Washington: U.S. Government Printing Office, 1958), p. 222. The figures for 1956-1958 were taken from the Survey of Current Business, Volume XL, No. 7 (July, 1960), p. 10.

the corresponding quarter one year earlier.) If the time unit t represents quarters of a year and α , β , and θ are parameters, then the correlations computed are symbolically described by the following equation:

$$(3.8) \quad w_t - w_{t-4} = \alpha + \beta (P_{t-\theta} - P_{t-4-\theta}),$$
$$\theta = 0, 1, 2, 3, \text{ and } 4.$$

These correlations were run for the period 1947-1958. Since the principal interest is the question of the most appropriate time lag, no other explanatory variables were included. The size of the gross correlation coefficient is the criterion for the appropriate lag. While this is somewhat crude, it does appear to be a reasonably effective method which does not involve undue effort. The results of these computations are given in Table II.

Table II.

Correlation Coefficients (r) for Wage Changes
and Price Level Changes, U.S.A., 1947-1958.

	0 Quarter lag	1 Quarter lag	2 Quarter lag	3 Quarter lag	4 Quarter lag
Correlation Coefficient (r)	.6402*	.5446*	.3669*	.1565	-.0360

*indicates that the correlation coefficient is statistically significant (at least two times the sampling error of r).

Source: See text.

Similar computations have been made for the American economy during the period 1921-1940. The wage concept is average hourly earnings of 25 manufacturing industries, data originally collected by the National Industrial Conference Board. The price index is the Bureau of Labor Statistics' cost of living index. The author took both of these series from the files of the National Bureau in New York. Since these series are available on a monthly basis, the author tabulated regressions of the form:

$$(3.9) \quad w_t - w_{t-12} = \alpha' + \beta' (P_{t-\theta'} - P_{t-\theta'-12}),$$
$$\theta' = 0, 1, 2, \dots, 7, 8.$$

Here t , the time unit, is in months of the year. The results are presented in Table III.

Table III.

Correlation Coefficients for Wage Changes
and Price Level Changes, U.S.A., 1921-1940.

Time lag	Coefficient of Correlation
0 months	.8031
1 month	.8243
2 months	.8202
3 months	.7911
4 months	.7398
5 months	.6707
6 months	.5814
7 months	.4816
8 months	.3803

Note: All the r 's are statistically significant, using standard tests.

Source: See text.

It can be seen that Tables II and III tell a consistent story. The lag of the wage change behind the price level change is very short -- so short in fact that even quarterly data conceal it. The monthly data, together with the previously stated criterion, suggest that the length of this lag is roughly 1 month -- or slightly longer if the correlation coefficient associated with a lag of two months is considered to be equivalent to that associated with a one month lag.

The limitations of this technique should be emphasized. We have merely studied the appropriate lag with only one explanatory variable used in the wage adjustment equation. It is quite possible that if several explanatory variables were used, a different answer for the appropriate time lag might be obtained even with the same criterion (maximum correlation). There is also the question of the criterion. Other criteria could have been used, such as the absence of autocorrelation in the residuals or appropriate economic structure. The problem of single equation bias, however, is not present (except for the correlations with a zero time lag). This is so because the lagged value of a system-determined variable is effectively an exogenous variable; there can be no "feedback" effects on variables whose values are already a matter of record.

Returning to the annual data, the author decided to accept the tentative conclusion that the price level change variable should be included without a lag in the wage adjustment relationship. (A time lag of one or one and a half months is much too short to capture with annual data.) Accordingly, equation (3.4) was accepted as the

tentative working relationship.

A discussion of the estimated parameters of equation (3.4) may be useful. The coefficient on unemployment is 1.88 times its estimated standard error; hence it is statistically significant at the 5 per cent level, using a one-tailed test (or at the 10 per cent level, using a two-tailed test), but not at the more restrictive level (5 per cent) with a two-tailed test.¹⁹ Using the period mean values cited earlier, one can calculate that an increase in the level of unemployment 1 per cent of the mean labor force is associated with a decline in average hourly earnings equal to 0.13 per cent of the period's mean average hourly wage. Both the coefficient of the price level change and the coefficient of the time trend are highly significant. Again using period averages, one can obtain the result that a 1 per cent increase in consumer prices is associated with a 0.78 per cent increase in wages.²⁰

The author tested for serial correlation in the residuals of equation (3.4), using the von-Neumann-Hart statistic.²¹ The ratio of

19. When certain outlier years are excluded from the regression calculations, the statistical significance of the unemployment variable increases. See equations (3.14) and (3.15), together with surrounding discussion, in Section 3 below.

20. Two stage least squares estimates of the parameters of a wage adjustment relationship corresponding to equation (3.4) are presented in Chapter VI.

21. B. I. Hart and John von Neumann, "Tabulation of the Probabilities for the Ratio of the Mean Square Successive Difference to the Variance," Annals of Mathematical Statistics, Volume XIII, No. 2 (June, 1942), pp. 207-214.

the mean square successive difference to the variance of the residuals $\left(\frac{\delta^2}{S^2}\right)$ was 1.647. Thus the autocorrelation becomes statistically significant, for a sample of this size, only at the 6.8 per cent level. For standard levels of statistical significance (5 per cent, 1 per cent, etc.), the hypothesis of non-autocorrelation would be accepted. Accordingly, the standard errors of the regression coefficients would be considered reliable.

One reason why the wage adjustment regression (3.4) is considered only a tentative one is the possibility that other variables may play an important role in explaining wage changes. Inclusion of these additional variables may change the estimates of the magnitude of effect of the currently included variables. Furthermore, it is quite possible that one or more currently included variables will no longer play a statistically significant role. These questions are examined in Chapter IV, where the influence on wage changes of some possible alternative variables is studied. At present, an application of these results with public policy implications may be examined.

3. Preliminary Estimates of Unemployment Levels "Required" for Price Level Stability.

These results have certain implications for the trade-off between unemployment and price level stability. Consider the following sub-system of equations:

$$(3.4) \quad w_t - w_{t-1} = - .01492 - 0.1987 \times 10^{-5} U_t \\ + 0.6200 \times 10^{-2} (P_t - P_{t-1}) + 0.1628 \times 10^{-2} t$$

($t = 0$ in 1900 and is in annual units.)

$$(3.10) \quad P_t = k \frac{w_t}{A_t}$$

$$(3.11) \quad A_t = 1.025 A_{t-1} .$$

In this system, A_t is output per man-hour (at time t) and is interpreted as the average productivity of labor. Equation (3.4) is our working wage adjustment relationship; it plays the same role in a dynamic system that a labor supply function, such as (2.6) of Chapter II, plays in a static system. Equation (3.10) is the Weintraub wage-cost-mark-up equation. This relationship has already been derived from equation (2.5) of the previous chapter; its role in this system is considered to be the direct determination of the price level. Equation (3.11) states that output per man-hour grows at the rate of 2.5 per cent per annum. This relationship can be interpreted as a special type of production function; it implies that, as of one moment of time, output varies proportionately with man-hour inputs. This is admittedly an oversimplification, which will be discussed further in Chapter VI. Also in Chapter VI the empirical estimate of the rate of growth of labor's average productivity will be sharpened. For the moment, let us accept this model and examine its implications.

If the average product of labor grows at the rate of $2\frac{1}{2}$ per cent per annum, equation (3.10) implies that the money wage must grow at only the same rate in order to maintain price level stability. From equation (3.4), we can obtain the level of unemployment "required" to make the money wage rise at only this rate and hence "required" (in this sense) for price level stability. If unemployment is greater than this level, wages will rise less rapidly than average productivity and the price level will, according to this model, fall. If unemployment is less than this critical level, wages will rise more rapidly than average productivity and prices would be expected to rise. It is to be noted that the system is open with respect to unemployment; presumably demand conditions, taken into account in a full model, complete the sub-system.

A solution of this problem may now be obtained. Extrapolating the Rees data, the author found that the money wage was approximately equal to \$2.50 in 1959. Hence for the year 1960, the required change in money wages is given by:

$$(3.12) \quad \text{required } \Delta w_t = 0.025 w_{1959} = \$0.0625 .$$

Also, $t = 60$ in 1960 since $t = 0$ in 1900. For internal consistency, $P_t - P_{t-1} = 0$. Substitution in (3.4) yields

$$(3.13) \quad 0.0625 = -0.01492 - 0.1987 \times 10^{-5} U_t + 0.1628 \times 10^{-2} \quad (60) .$$

The solution is $U_t = 10,200$ thousand workers or 10,200,000 --

slightly more than $1/7$ of a labor force of over 70 million.²²

This is a rather surprising -- and if true, disturbing -- result. Before proceeding to qualify it, we may examine equations (3.2) and (3.3) to see whether they tell a similar story. The answer is in the affirmative. According to equation (3.2), unemployment "required" for price level stability is 9,853,000. According to equation (3.3), this figure is 9,898,000. While lower, these figures are hardly cause for optimism. If true, the conflict between low unemployment and price level stability is even more severe than currently believed.

It must be pointed out that this result is premised on given institutional conditions, and if these institutional conditions change, the results will change also. The wage adjustment relationship was estimated by single equation rather than full system methods; some estimation biases have doubtlessly crept in as a consequence. Also, the statistics indicate that the relationship between the money wage change and unemployment is not very tight. In the gross scatter

22. Samuelson and Solow, *op. cit.*, present a similar discussion of a numerical trade-off between full employment and price level stability. They conclude that price level stability requires unemployment of 5-6 per cent of the labor force. Since they also use Rees's wage series (fringe benefit concept), the discrepancy in results is not due to this source. They also use only "recent years" (1946-1958). Since two of the present author's outliers occur in 1934 and 1945, one may seek an explanation of part of the divergence in results in these facts. (See the discussion in the text below.) Samuelson and Solow also consider only the gross relationship between the wage change and unemployment, without considering other explanatory variables, such as the price level change.

diagram (Figure 3), the points are widely distributed, and the negative relationship between the wage change and unemployment is barely discernible. Even when the other explanatory variables are taken into account, the large estimated standard deviation of the residuals (more than 3 per cent of the mean level of average hourly earnings over the period, and nearly $5/8$ of the mean change in average hourly earnings) implies that this relation is still quite loose. In terms of our problem, this imparts a substantial measure of indeterminacy to the results; low levels of unemployment may accompany small money wage changes, or high levels of unemployment may accompany large money wage increases. It should also be noted that the author has extrapolated a time trend, which is always a questionable procedure, even for a short period beyond the time horizon of the sample.

Most of the above statistical qualifications generate additional uncertainty but do not lead us to suspect a bias in the results. There are several economic considerations which must also be stated as qualifications to the above analysis. These qualifications would lead to an upward bias in the stated results. Lipsey, in his recent comment upon and elaboration of Phillips' work,²³ has presented an argument showing that the aggregative wage adjustment relationship has an upward bias. If this is so, the level of unemployment "required" for price level stability, even under the above assumptions, will be smaller than

23. Richard G. Lipsey, op. cit. Parts of this article have already been discussed in some detail in Chapter I.

the previous computations suggest. Schultze has suggested²⁴ that inflation cannot be properly analyzed in an aggregative framework and that a sharp shift in demand can produce inflation even though no excess demand is present. He argues that wages tend to rise more or less uniformly throughout the economy, the pace being set by the demand-in-excess sectors. If this is true, the above conclusions are too pessimistic, provided structural maladjustments can be prevented. Both the Lipsey work and the Schultze thesis will be discussed in much greater detail in Chapter VII. Here our principal concern is with the implications of these hypotheses for the accuracy of the above calculations.

We have assumed that average productivity rises at the rate of $2\frac{1}{2}$ per cent per annum. While an approximation, this figure is of the right order of magnitude. Recently two writers²⁵ have argued that productivity is higher and rises more rapidly in boom periods than in periods of slack demand. Counter-balanced against this argument would be the classical principle of diminishing returns. If productivity does grow less rapidly under conditions of slack demand, this will work in the opposite direction from the above considerations: more unemployment

24. Charles L. Schultze, "Recent Inflation in the United States," Study Paper No. 1, prepared for the Joint Economic Committee of the United States Congress, Study of Employment, Growth, and Price Levels. (Washington: U.S. Government Printing Office, 1959).

25. Charles L. Schultze, op. cit.; H. F. Lydall, op. cit.

will be required for price level stability than if productivity always grew at the same rate regardless of demand conditions. These questions are examined further in Chapter VI.

Finally, one may question whether increased labor costs are always proportionately marked up into higher prices. Since 1913, the capital-output ratio has declined slightly²⁶ -- evidence, like rising labor productivity, of technological progress and greater efficiency on the part of the labor force. Thus, if the rate of return on capital were to stay constant, wages could rise slightly faster than labor's average productivity or the price level could drop somewhat. That real wages have in fact risen somewhat more rapidly than the average productivity of labor is indicated by the gradual increase in the wage share over the recent past.²⁷ Because the movements involved are small, this is not a major qualification to the above computations.

In periods of slack demand, one might expect prices to fall -- or at least not rise proportionately with labor costs. This is a possibility. However, even if prices are sensitive to demand conditions, it may be that a period of slack demand reduces prices and profit margins in a once-and-for-all event, rather than putting them under continuing

26. L. R. Klein and R. F. Kosobud, "Some Econometrics of Growth: Great Ratios of Economics," Quarterly Journal of Economics, Volume LXXV, No. 2 (May, 1961), pp. 173-198. Klein and Kosobud conclude (p. 180) that the downward trend alluded to in the text is statistically significant.

27. Irving B. Kravis, "Relative Shares in Fact and Theory," American Economic Review, Volume XLIX, No. 5 (December, 1959), pp. 917-949; Sidney Weintraub, A General Theory. As pointed out in Chapter I, Weintraub is skeptical, or at least agnostic, concerning this explanation of the downward trend in his mark-up factor k . (A downward trend in the mark-up factor implies, of course, a rising trend in the wage share.)

pressure. If this is true, the principal effect of slack demand is on the level of prices in the period of demand reduction, rather than on the continuing rate of growth of the price level. The empirical results of Chapter V are consistent with this supposition.

As an indication of the uncertainties and upward biases involved, the author has computed truncated regressions, which omit outlier years. An examination of the residuals of equation (3.4) indicates positive outliers in 1934 and 1951. (The residuals of equation (3.4) are tabulated in Appendix B; an outlier is defined as an observation for which the numerical value of the associated residual is more than twice the estimated standard deviation of the residuals.) Both of these years could have been excluded from the sample period on other grounds, also. 1934, a year in which unemployment was over 11 million and the wage increase was \$0.086, is at least partially explained by NRA codes and governmental wage-push pressures.²⁸ Similarly, 1951 was a year of wartime inflationary pressures without effective wartime direct controls over wages.²⁹ The regression of the same form as (3.4), in which the years 1934 and 1951 are excluded from the sample period, is:

28. Samuelson and Solow (op. cit., pp. 188-189) come to a similar conclusion.

From Figure 3, it can be seen that, aside from 1934, a wage increase of this magnitude or larger was experienced only in years when unemployment was 3.2 million or lower.

29. On this point, see Harold G. Moulton, op. cit., p. 147.

List of Symbols

- w = Average hourly compensation in manufacturing
- P = Consumer price level
- t = Time trend (measured in years; t = 0 in 1900 for chapters III and IV; t = 0 in 1935 for Section 1 of Chapter VIII.)
- U = Unemployment, thousands of men
- $\frac{U}{LF}$ = Unemployment as a proportion of the civilian labor force
- Π_T = Total corporate profits
- Π_M = Profits of manufacturing corporations
- NW_T = Total net worth of corporations
- N_M = Manufacturing employees
- A = Average productivity of labor, private domestic economy

NOTE: The time variable t is sometimes used as a subscript, for purposes of time dating. Also the Δ symbol refers to the difference between the current value of a variable and its value for the preceding period, e.g.,

$$\Delta P_t \equiv P_t - P_{t-1} .$$

$$(3.14) \quad \Delta w_t = - .01193 - 0.2974 \times 10^{-5} U_t + 0.5664 \times 10^{-2} \Delta P_t \\
\begin{matrix} (.00573) & (0.1027 \times 10^{-5}) & (0.0585 \times 10^{-2}) \end{matrix} \\
+ 0.1608 \times 10^{-2} t, \quad \bar{S}_u = 0.0204, \quad R^2 = 0.8369 . \\
(0.0175 \times 10^{-2})$$

It is to be noted that excluding these outliers increases the sensitivity of the money wage change to unemployment and increases the coefficient of multiple determination. Both of these changes were to be expected. Substitution into (3.14), in order to find the level of unemployment "required" for price level stability, according to the model of this section, yields:

$$(3.14a) \quad 0.0625 = - .01193 - 0.2974 \times 10^{-5} U_t + 0 + 60(0.001608) .$$

Solving, the author obtained 7414 thousand men or 7,414,000. This is considerably lower than the previous estimates and serves to confirm our suspicions that these previous estimates may be too high.

An examination of the residuals of equation (3.4) also uncovers a negative outlier in 1945. This outlier can also be rationalized. One plausible explanation of the 1945 wage experience is that reconversion from wartime conditions disrupted the normal relationship. Thus Moulton points out³⁰ that although wage earnings rose very little from 1944 to 1945 (and actually declined during the second half of 1945), because of fewer hours worked at overtime rates of pay, standard money wage rates continued to rise throughout 1945. Excluding the years 1934, 1945, and 1951 from the sample period and

30. Op. cit., pp. 139-143, especially p. 143.

computing a regression of the same form as (3.4), the author obtained:

$$(3.15) \quad \Delta w_t = - .01166 - 0.3488 \times 10^{-5} U_t + 0.5527 \times 10^{-2} \Delta P_t \\ (.00524) \quad (0.0952 \times 10^{-5}) \quad (0.0536 \times 10^{-2}) \\ + 0.1708 \times 10^{-2} t, \quad \bar{S}_u = 0.01863, \quad R^2 = 0.8657 . \\ (0.0163 \times 10^{-2})$$

As before, excluding these years increases both the sensitivity of the wage change to unemployment and the coefficient of multiple determination. Similar calculations indicate that unemployment "required" for price level stability, according to this equation, is 8,119,000 workers. This is moderately close to the estimate from the earlier truncated regression, from which only the 1934 and 1951 outliers were excluded.

After all these qualifications, where do we end up? The author believes that it may safely be said that with current American institutional conditions, the goals of reasonably full employment and price level stability are incompatible -- unless "reasonably" is given an unreasonable interpretation. Furthermore, he would argue that the quantitative estimates are of the right order of magnitude, even though they may be off by as much as 25 or 50 per cent. Each of the underlying relationships, though in part an oversimplification, is a generalization with theoretical as well as empirical underpinning. Hence one might expect these relations to possess a definite amount of validity and stability. These qualifications, while they point to the "first approximation" character of the model and of the derived results,

do not destroy the usefulness of the conclusions. If one is to judge by recent experience, the recession of 1960-1961 suggests that even when unemployment reaches 5 to 5 1/2 million (7-8 per cent of a labor force of approximately 70 million), prices do not cease rising. The incompatibility exists in fact as well as in the author's "theory."³¹

31. Empirical evidence leads the authors of Employment, Growth, and Price Levels (the Staff Report prepared for the Joint Economic Committee, 86th United States Congress, 1st session; Otto Eckstein, Technical Director; Washington: U.S. Government Printing Office, 1959) to be almost as pessimistic. They state, "Past evidence suggests, therefore, that unemployment would have to average at least 6 per cent to keep the rate of wage advance no greater than the rate of increase in productivity." (p. 144; italics in original.) Consequently, "It is doubtful that a secular uptrend in wages and prices can be avoided with an average level of unemployment which is considered socially acceptable, given our present types of anti-inflation weapons." (p. 144; entire passage italicized in original.)

Appendix A

In this appendix, all symbols which have appeared in the text have the meaning assigned there to them. The symbol LF_t denotes the labor force at time t ; this variable, like unemployment, is measured in thousands of workers. (The sources of the ratio of unemployment to labor force are Lebergott's forthcoming book, Manpower and Economic Growth: The American Record since 1800, for the years 1900-1940, and Historical Statistics, Table D 47, p. 73, for 1941-1957.) The six equations of the preliminary study alluded to in the text are listed below. The method of parameter estimation is single equation least squares. It might also be noted that equations (a.3) and (a.4) appeared to have strongly autocorrelated residuals, although no formal test was made.

$$(a.1) \quad \left(\frac{\Delta w_t}{w_{t-1}} \times 100 \right) = 5.325 - 0.1882 \left(\frac{U_t}{LF_t} \times 100 \right) + 0.4968 \left(\frac{\Delta P_{t-1}}{P_{t-2}} \times 100 \right),$$

(1.599) (0.1617) (0.1679)

$$\bar{S}_u = 6.881, \quad R^2 = 0.2124 .$$

$$(a.2) \quad \left(\frac{\Delta w_t}{w_{t-1}} \times 100 \right) = 1.511 + 0.1253 \left(\frac{U_t}{LF_t} \times 100 \right) + 1.193 \left(\frac{\Delta P_t}{P_{t-1}} \times 100 \right),$$

(0.884) (0.0890) (0.0925)

$$\bar{S}_u = 3.692, \quad R^2 = 0.7733 .$$

$$(a.3) \quad \Delta w_t = .03558 - 0.1647 \times 10^{-5} U_t + 0.3639 \times 10^{-2} \Delta P_{t-1},$$

(.01043) (0.2098 $\times 10^{-5}$) (0.1276 $\times 10^{-2}$)

$$\bar{S}_u = 0.0484, \quad R^2 = 0.1737 .$$

$$(a.4) \quad \Delta w_t = - .01795 + 0.1110 \times 10^{-5} U_t + 0.7716 \times 10^{-2} \Delta P_t ,$$
$$(\text{.00753}) \quad (0.1507 \times 10^{-5}) \quad (0.0914 \times 10^{-2})$$

$$\bar{S}_u = 0.0342, \quad R^2 = 0.5868 .$$

$$(a.5) \quad \left(\frac{\Delta w_t}{w_{t-1}} \times 100 \right) = 4.139 - 0.206 \left(\frac{J_t}{LF_t} \times 100 \right)$$
$$(2.113) \quad (0.1634)$$
$$+ 0.4841 \left(\frac{\Delta P_{t-1}}{P_{t-2}} \times 100 \right) + 0.04703 t ,$$
$$(0.1690) \quad (0.05459)$$

$$\bar{S}_u = 6.897, \quad R^2 = 0.2231$$

$$(a.6) \quad \left(\frac{\Delta w_t}{w_{t-1}} \times 100 \right) = 0.8328 + 0.1143 \left(\frac{U_t}{LF_t} \times 100 \right)$$
$$(1.148) \quad (0.0899)$$
$$+ 1.186 \left(\frac{\Delta P_t}{P_{t-1}} \times 100 \right) + 0.02712 t ,$$
$$(0.0930) \quad (0.02927)$$

$$\bar{S}_u = 3.696, \quad R^2 = 0.7768 .$$

Appendix B

The annual data (except the unemployment figures) used in calculating wage adjustment regressions are given in the table below. For definitions and sources, see the text. The residuals of equation (3.4) of the text are also included.

Table IV.

Average Hourly Earnings (w), the Consumer Price Level (P), and Residuals of Equation (3.4), U.S.A., 1898-1957.

Year	Average hourly earnings (\$/hour)	Consumer price index (1926 = 100)	Residuals of equation (3.4) (\$/hour)
1898		47	
1899	\$.146	47	
1900	.151	48	\$.0165
1901	.158	48	.0227
1902	.165	49	.0146
1903	.170	50	.0112
1904	.169	51	.0046
1905	.172	50	.0187
1906	.184	51	.0121
1907	.191	53	.0000
1908	.184	52	.0066
1909	.186	52	.0059
1910	.198	54	.0025
1911	.202	54	.0060
1912	.207	55	-.0023
1913	.221	56	.0049
1914	.220	57	-.0089
1915	.226	57.4	.0007
1916	.262	61.6	.0029
1917	.316	72.5	-.0227
1918	.417	85.0	.0102
1919	.477	97.9	-.0349

Table IV (Continued)

Year	Average hourly earnings (\$/hour)	Consumer price index (1926 = 100)	Residuals of equation (3.4) (\$/hour)
1920	\$.553	113.4	-\$.0335
1921	.488	101.0	.0024
1922	.451	94.7	-.0132
1923	.499	96.4	.0170
1924	.516	96.7	-.0047
1925	.513	99.2	-.0414
1926	.517	100.0	-.0268
1927	.522	98.1	-.0092
1928	.522	97.0	-.0199
1929	.534	97.0	-.0172
1930	.530	94.5	-.0138
1931	.506	86.0	.0091
1932	.446	77.2	-.0187
1933	.441	73.1	.0071
1934	.527	75.7	.0520
1935	.542	77.6	-.0178
1936	.553	78.4	-.0197
1937	.633	81.3	.0320
1938	.639	79.7	-.0104
1939	.638	78.6	-.0239
1940	.670	79.3	-.0064
1941	.737	83.2	.0020
1942	.864	92.2	.0230
1943	.975	97.8	.0233
1944	1.05	99.3	.0103
1945	1.06	101.6	-.0605
1946	1.13	110.2	-.0388
1947	1.30	126.2	.0135
1948	1.41	135.8	-.0086
1949	1.46	134.5	.0000
1950	1.55	135.8	.0217
1951	1.73	146.7	.0481
1952	1.83	150.0	.0131
1953	1.94	151.1	.0350
1954	1.97	151.7	-.0403
1955	2.05	151.3	.0131
1956	2.15	153.5	.0152
1957	2.27	158.8	.0151

The quarterly wage and price level data used in calculating the correlation coefficients listed in Table II of the text appear below. The sources are outlined in the text.

Table V

Quarterly Values of the Average Wage at an Annual Rate (w) and of the Implicit Deflator of Personal Consumption Expenditures (P), U.S.A., 1945-1958.

Period	Average Wage at an Annual Rate (\$/year)	Implicit Deflator of Personal Consumption Expenditures (1954 = 100)
1945 I		67.3
II		67.9
III		68.5
IV		68.6
1946 I	\$ 2100	68.9
II	2220	70.0
III	2314	76.2
IV	2328	80.3
1947 I	2438	82.8
II	2488	83.6
III	2503	84.9
IV	2541	86.9
1948 I	2601	88.2
II	2651	89.2
III	2715	90.4
IV	2742	90.2
1949 I	2767	89.5
II	2830	88.9
III	2765	88.1
IV	2724	88.1
1950 I	2798	88.1
II	2864	88.7
III	2983	90.6
IV	3041	92.2
1951 I	3057	95.2
II	3170	95.8
III	3201	96.0
IV	3232	97.1
1952 I	3286	97.5
II	3373	97.8
III	3400	98.1
IV	3424	98.7

Table V (Continued)

Period	Average Wage at an Annual Rate (\$/year)	Implicit Deflator of Personal Consumption Expenditures (1954 = 100)
1953 I	\$3466	98.7
II	3582	98.7
III	3670	99.2
IV	3656	99.2
1954 I	3639	100.1
II	3721	100.0
III	3712	99.9
IV	3700	100.0
1955 I	3738	100.3
II	3800	100.2
III	3825	100.4
IV	3794	100.6
1956 I	3906	100.9
II	4005	101.7
III	4019	102.6
IV	4051	103.2
1957 I	4154	104.1
II	4245	104.8
III	4289	105.6
IV	4324	106.1
1958 I	4347	107.0
II	4407	107.4
III	4412	107.3
IV	4386	107.5

Chapter IV, "A Further Examination of the Wage Adjustment
Equation"

In Chapter III the author found, using empirical methods, a working relationship between money wage changes and unemployment, a consumer price level change, and a time trend. In this chapter some further possible modifications of this relation will be examined, in order to determine whether such refinements would improve the relationship. Some evidence concerning the irreversibility of money wages will also be presented.

1. The Possible Role of Profits.

The possible role of profits in the wage adjustment relationship may be investigated. One argument often heard at bargaining tables is that profits are high and that therefore a large wage increase is feasible. In John T. Dunlop's wage adjustment regression,¹ the previous year's ratio of corporate profits (before taxes) to corporate sales is included along with last year's percentage unemployment of the labor force as an explanatory variable. William G. Bowen has argued that once it is recognized that firms have goals other than maximum profits, profits (in the sense of expected profitability) become a determinant of the wage increase.² Nicholas Kaldor, in his

1. John T. Dunlop, *op. cit.*, pp. 23-24. This article has already been discussed above in Section 1 of Chapter I.

2. William G. Bowen, *op. cit.*, pp. 113-124. See the discussion in Section 1 of Chapter I above.

comment on Phillips' work,³ suggested that the basic structural relationship was between money wage changes and profits and that the observed results merely reflect the intercorrelation between unemployment and profits. It is interesting to see, therefore, whether the profits variable is significant in the wage adjustment relation or can become significant, if the relationship is reformulated slightly.

Because we are dealing with such a long time period, any profits variable in an absolute form would show a pronounced time trend. Also a variable like corporate profits would show variability because of changing economic organization as well as changing economic conditions -- variations in the extent of incorporation could easily affect the recorded level of corporate profits. For these reasons, it seemed reasonable to deflate the level of profits by a scaling variable. Two scaling variables were chosen: corporate net worth and the number of employees (in manufacturing). Consequently, two types of profits explanatory variables were used. The first was total corporate profits (Π_T) divided by corporate net worth (NW_T), which can be interpreted as a type of rate of return on corporate capital. The second was manufacturing corporations' profits (Π_M) divided by the number of employees in manufacturing establishments (N_M), which is (roughly) profits per man in the manufacturing sector. (This measure

3. Nicholas Kaldor, op. cit., especially pp. 292-297. It should be noted that Kaldor argues that the money wage change is associated with the rate of change of profits and not their absolute level, which is the explanatory variable used (with modifications) below.

was restricted to the manufacturing sector because of the unavailability of data on the number of employees in the corporate sector, at least for the earlier years.)

The first task was to gather data. This has been done, and the author's series of total corporate profits, corporate net worth, profits of manufacturing corporations, and employees of manufacturing establishments are presented in Appendix A of this chapter. The data on total corporate profits come from two sources. For the years 1900-1922 the estimates are Goldsmith's,⁴ while the estimates from 1923 to 1956 are based on those of the Internal Revenue Service, as published in the various issues of Statistics of Income.⁵ These are net profits after taxes; hence not only corporate income taxes are deducted but also depreciation, amortization, and depletion. While Department

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4. Raymond W. Goldsmith, A Study of Saving in the United States, Volume I (Princeton, N.J.: Princeton University Press, 1955). The observations for 1900-1915 come from Table C-5 on p. 917; those for 1916-1922 from Table C-28, p. 939. The observation for 1922 is the same as the corresponding figure in that year's issue of Statistics of Income.
 5. U.S. Treasury Department, Internal Revenue Service [formerly, Division of Internal Revenue], Statistics of Income (Washington: U.S. Government Printing Office), various issues. After 1954, corporate earnings were reported on a fiscal year basis, rather than for a calendar year. Consequently, the net corporate profits (after taxes) of all corporations, for the calendar years 1955 and 1956, are computed from the 1955-1956 and 1956-1957 fiscal year figures, using linear interpolation and extrapolation. The interpolator is the quarterly values of corporate profits after taxes, for the years 1954-1957, as reported in U.S. Income and Output, Table VII-18, pp. 230-231.

of Commerce figures on corporate profits, corrected for underreporting and inappropriate conceptual treatments, exist, these were not used because the author thought that the reported figures were more relevant in the actual wage negotiations.

A continuous series on corporate net worth was much harder to obtain. In the end, the author settled for a series of his own (rather crude) construction. The starting point was Goldsmith's estimates⁶ of the total equity of corporations, for the bench-mark years 1900, 1912, 1922, 1929, 1933, 1939, 1945, and 1949. The non-bench-mark years between 1900 and 1949 were estimated with the help of Goldsmith's series on total national wealth in current values;⁷ it was assumed that the change from the bench-mark date in both series, for an intervening year, was proportional to the change in both series, between two contiguous bench-mark years.⁸ Then, to extend the

6. Raymond W. Goldsmith, "National Balance Sheets and National Wealth Statements, 1896 to 1949," Part I of Raymond W. Goldsmith, Dorothy S. Brady and Horst Mendershausen, A Study of Saving in the United States, Volume III (Princeton, N.J.: Princeton University Press, 1956), pp. 3-135. The series cited is taken from Table W-30 on p. 79.

7. Ibid., Table W-1, p. 14.

8. Let y be corporate net worth and x total national wealth. Basically, we know x_0, x_1, \dots, x_n and y_0 and y_n . Our problem is to estimate y_j , $j = 1, 2, \dots, n-1$, from this information. To do this, we assume

$$(i) \quad \frac{y_j - y_0}{y_n - y_0} = \frac{x_j - x_0}{x_n - x_0} .$$

Thus our estimate of y_j is given by

$$(ii) \quad \text{est. of } y_j = y_0 + (x_j - x_0) \frac{(y_n - y_0)}{(x_n - x_0)} .$$

estimates of corporate net worth beyond 1949, the following procedure was employed. A regression of corporate net worth on total national wealth was run, for the bench-mark years. Substituting Goldsmith's estimate⁹ of total national wealth in 1956 into the estimating equation, the author obtained an estimate of corporate net worth for the year 1956. Estimates of corporate net worth for the years 1950-1955 were then obtained by linear interpolation. If these techniques seem crude, the purpose for which they were employed must be kept in mind. Corporate net worth, the denominator of the ratio which represents the rate of return on corporate capital, is large relative to the numerator, corporate profits. Hence even moderate errors in the denominator will produce only small distortions in the ratio.

The figures on the profits of manufacturing corporations come from similar sources. The figures for the years 1919-1922 were compiled by Goldsmith.¹⁰ The figures for 1923-1957 are taken from or based on various issues of Statistics of Income.¹¹ The series of

9. Historical Statistics, Table F 197, p. 151.

10. Raymond W. Goldsmith, A Study of Saving in the United States, Volume I, Table C-28, p. 939.

11. The profits of manufacturing corporations for the years 1923-1954 were taken directly from this source. The 1955, 1956, and 1957 values were estimated by the author, using the method of interpolation that was employed for total corporate profits.

employees in manufacturing establishments comes directly from Historical Statistics.¹²

Next, we may turn to the time diagram of the money wage change and of total corporate profits divided by corporate net worth. (See Figure 5; the productivity change series is not under discussion until Section 3 below.) The mean value of the ratio of total corporate profits to corporate net worth, over the period 1900-1956, is 0.06195. The time diagram suggests that current profits are a slightly superior explanatory variable, although the relationship between money wage changes and profits appears to be a loose one.¹³ Hence the current profits variable was tried first; but the parameters of a formulation employing lagged values of the better variant of scaled profits have also been estimated.

We now seek to determine whether the addition of a profits variable will improve the tentative wage adjustment relationship. Hence a regression of the form:

$$(4.1) \quad \Delta w_t = \alpha_0 + \alpha_1 U_t + \alpha_2 \Delta P_t + \alpha_3 t + \alpha_4 \left(\frac{\Pi}{S}\right)_t + u_t$$

was computed. ($\frac{\Pi}{S}$ is a profits variable, divided by one of the two

12. Table D 51, p. 73.

13. In Bowen's discussion (op. cit., pp. 113-124) of the influence of expected profitability on wage increases, he asserts that past profits play a role only as a guide to possible levels of future profits. Hence this line of reasoning would lead one to prefer current profits to lagged profits as an explanatory variable, unless one believes that business men do a poorer job of forecasting than can be obtained by a simple projection of past profits.

scaling variables described above. u_t is a disturbance term, and the α 's are regression parameters. All other symbols retain their previous definitions. (See Chapter III.) In particular, t is equal to zero in 1900 and is in annual units.) Using single equation least squares methods of parameter estimation, the author computed the following regressions:

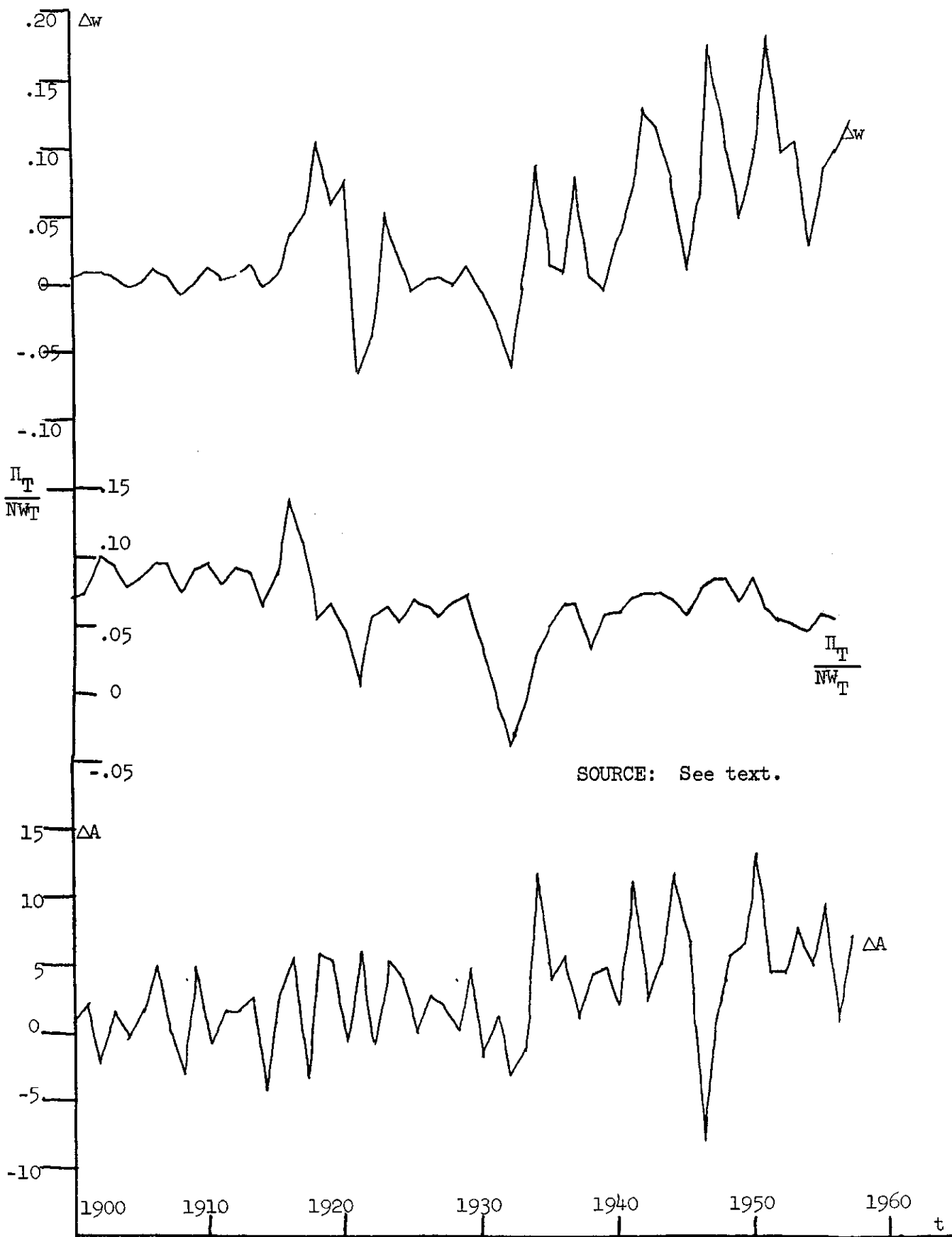
$$(4.2) \quad \Delta w_t = - .02490 - 0.1420 \times 10^{-5} U_t + 0.5990 \times 10^{-2} \Delta P_t \\
 (.01485) \quad (0.1259 \times 10^{-5}) \quad (0.0684 \times 10^{-2}) \\
 + 0.1650 \times 10^{-2} t + 0.1217 \left(\frac{\Pi_T}{N^W T} \right)_t, \quad \bar{S}_u = 0.0227, \\
 (0.0209 \times 10^{-2}) \quad (0.1568) \quad R^2 = 0.8197,$$

$$(4.3) \quad \Delta w_t = - .0520 - 0.0600 \times 10^{-5} U_t + 0.6147 \times 10^{-2} \Delta P_t \\
 (0.1529 \times 10^{-5}) \quad (0.0804 \times 10^{-2}) \\
 + 0.2231 \times 10^{-2} t + 0.1518 \times 10^{-4} \left(\frac{\Pi_M}{N^M} \right)_t, \\
 (0.0538 \times 10^{-2}) \quad (0.3236 \times 10^{-4}) \\
 \bar{S}_u = 0.0249, \quad R^2 = 0.8380.$$

Equation (4.2) is based on the years 1900-1956, while equation (4.3) was calculated from observations over the period 1919-1957.¹⁴

14. The unemployment series on which regression (4.3) is based comes from Lebergott's published paper, "Annual Estimates of Unemployment in the United States, 1900-1954," for the years 1919-1940. Lebergott's revisions after 1918 are not extremely extensive, and the author judged that substitution of the revised series would change the parameter estimates only slightly. (This was the case with regressions estimated for the full period 1900-1957, for which the unemployment estimates were revised more extensively.)

FIGURE 5. Time Diagram of the Money Wage Change (Δw), the Ratio of Total Corporate Profits to Corporate Net Worth ($\frac{\Pi_T}{NW_T}$), and Changes of the Average Productivity of Labor (ΔA), U.S.A., 1900 - 1957.



As one can see by inspection, both variants of the profits variable have coefficients which are smaller than their respective standard errors. Accordingly, the profits variable does not seem to be important in this formulation. But before we reject the profits variables, one other fact should be noted. The standard error of the coefficient on unemployment is larger (and this coefficient itself is smaller) than is the case for equation (3.4). This suggests that there is intercorrelation between the profits variables and the unemployment variable, and that this intercorrelation is preventing the full effects of either variable from appearing in the statistical relation. (The coefficient of correlation between unemployment (U_t) and total corporate profits divided by corporate net worth $\left[\left(\frac{\Pi_T}{NW_T} \right)_t \right]$ is - 0.667.) Thus, while we cannot have both unemployment and a profits variable together in the wage adjustment relation, it is still possible that profits alone might be a better explanatory variable than unemployment alone. (A somewhat weaker possibility is that profits alone would be statistically significant in the wage adjustment relation.) To test this possibility, the author computed wage adjustment equations similar to (4.2) and (4.3) but omitted unemployment as an explanatory variable. The results are:

$$\begin{aligned}
 (4.4) \quad \Delta w_t = & - .03507 + 0.6095 \times 10^{-2} \Delta P_t + 0.1625 \times 10^{-2} t \\
 & (.01183) \quad (0.0680 \times 10^{-2}) \quad (0.0208 \times 10^{-2}) \\
 & + 0.2154 \left(\frac{\Pi_T}{NW_T} \right)_t, \quad \bar{S}_u = 0.0228, \\
 & (0.1334) \quad R^2 = 0.8153,
 \end{aligned}$$

$$\begin{aligned}
 (4.5) \quad \Delta w_t = & - .05405 + 0.6185 \times 10^{-2} \Delta P_t + 0.2141 \times 10^{-2} t \\
 & (0.0789 \times 10^{-2}) \quad (0.0482 \times 10^{-2}) \\
 & + 0.2265 \times 10^{-4} \left(\frac{\Pi_M}{N_M} \right)_t, \quad \bar{S}_u = 0.0246, \\
 & (0.2585 \times 10^{-4}) \quad R^2 = 0.8373.
 \end{aligned}$$

Corresponding to previous calculations, equation (4.4) is based on the years 1900-1956 and equation (4.5) on the years 1919-1957.

The ratios of the coefficients of the profits variable to their respective standard errors increase somewhat, especially in the case of the corporate rate of return variant. However, neither variable has yet a statistically significant influence. In the case of the corporate rate of return variant, the t ratio (the ratio of regression coefficient to estimated standard error) is 1.615, which just falls short of 1.68, the value (for the size of sample used) of the t ratio at the 5 per cent level of statistical significance, with a one-tailed test (the 10 per cent level, with a two-tailed test). Moreover, the coefficient of multiple determination associated with equation (4.4) is lower than of a regression identical in form to equation (3.4), fitted to the period 1900-1956. (The value of this comparison coefficient of multiple determination is 0.8176.) Consequently the unemployment variable alone would appear to be better than a profits variable alone.

Before concluding definitely that the profits variables are inferior explanatory variables, we may investigate the behavior of lagged profits in a wage adjustment regression. The author chose the

corporate rate of return profits variable, as this appeared to be a stronger explanatory variable than profits per man in the manufacturing sector. Regressions similar to (4.2) and (4.4) were computed, with the exception that the corporate rate of return variable now refers to the value of the previous year. The results, which are based on observations for the years 1901-1957, are:

$$(4.6) \quad \Delta w_t = - .02305 - 0.1583 \times 10^{-5} U_t + 0.6093 \times 10^{-2} \Delta P_t$$

$$(\text{.01592}) \quad (\text{0.1341} \times 10^{-5}) \quad (\text{0.0672} \times 10^{-2})$$

$$+ 0.1690 \times 10^{-2} t + 0.0781 \left(\frac{\Pi_T}{NW_T} \right)_{t-1},$$

$$(\text{0.0208} \times 10^{-2}) \quad (\text{0.1643})$$

$$\bar{S}_u = 0.0228, \quad R^2 = 0.8258,$$

$$(4.7) \quad \Delta w_t = - .03560 + 0.6195 \times 10^{-2} \Delta P_t + 0.1677 \times 10^{-2} t$$

$$(\text{.01190}) \quad (\text{0.0669} \times 10^{-2}) \quad (\text{0.0209} \times 10^{-2})$$

$$+ 0.1953 \left(\frac{\Pi_T}{NW_T} \right)_{t-1}, \quad \bar{S}_u = 0.0229, \quad R^2 = 0.8212.$$

$$(\text{0.1314})$$

The general conclusions are not changed if the profits variable is a lagged one. Indeed, lagged profits appear to be slightly poorer as an explanatory variable, thus corroborating our visual impression from Figure 5. For equation (4.7), the ratio of the coefficient of the lagged corporate rate of return variable to its own standard error is only 1.49. Again, the coefficient of multiple determination of equation (4.7), 0.8212, is lower than that of a comparison coefficient of multiple determination, 0.8251, associated with a regression identical

in form to (3.4) and fitted to the period 1901-1957.¹⁵ Hence the influence of the lagged corporate rate of return variable with unemployment excluded is neither statistically significant nor stronger than that of the unemployment variable with lagged profits excluded.

Two recent studies which attempt to discriminate between a profits variable and an unemployment variable as an influence on the money wage change may be discussed at this point. Richard G. Lipsey and M. D. Steuer¹⁶ found that their unemployment variable was more important than their profits variables, in two out of the three periods studied. Where their profits variables are less important than the unemployment variable, they are typically not statistically significant. Lipsey and Steuer analyzed United Kingdom data; the three periods examined were 1870-1913, 1926-1938, and 1949-1958. For the later two periods, they also investigated cross-section data, which in general confirmed the conclusions drawn from the aggregative data.

Harold M. Levinson has also written on this subject.¹⁷ His dependent variable is the percentage change in straight time hourly

15. The coefficients of multiple determination appear to be higher for the lagged profits regressions than for the corresponding unlagged (current) profits regressions. But this is principally due to the use of a different period for the two sets of regressions (the period 1901-1957 for the lagged profits regressions and the period 1900-1956 for the current profits regressions). That there is no real improvement in explanatory power from using lagged profits may be seen by the fact that the estimates of the standard deviation of the residuals are also higher for the lagged profits regressions!

16. Lipsey and Steuer, op. cit.

17. Levinson, op. cit.

earnings, a concept that is closer to a wage rate than the Rees data. Because his data (observations of United States manufacturing industries over the period 1947-1958) can be considered a continuous cross-section, Levinson used both cross-section and time series analyses. The method of analysis included both simple correlations and multiple correlations. Levinson found that his profits variables gave a better explanation than either the percentage change in output, the percentage change in productivity (output per production worker man-hour), or the percentage change in employment. He concluded that the before-tax rate of return on equity, lagged one year, was the best profits explanatory variable, but that the current rate of return on equity, before taxes, and the current after-tax rate of return on equity were both adequate explanatory variables. Levinson's results are not strictly comparable to the above regressions since the measure of labor market tightness is the percentage change in industry employment, not the level of unemployment. It is quite possible that factors other than labor market tightness (technological forces or product market demand conditions, for example) may influence the growth of industry employment. Also, in his time series regressions, Levinson does not include the change in the consumer price level as an explanatory variable: correspondingly, his coefficients of multiple determination are lower than those of the present study. It is also possible that the significance of his profits variables would ^{diminish} diminish or disappear altogether, if this additional explanatory variable were introduced.

Such speculation should not be carried too far. Levinson's work

must be admitted a contradictory evidence, just as the study of Lipsey and Steuer serves to corroborate the present author's results. It is also interesting to note that Levinson appears to prefer the level of profits to the rate of change of profits, since he uses the former variable. Lipsey and Steuer, who try both, conclude that absolute profits are generally a better explanatory variable.

2. The Possible Role of Changes in Unemployment.

The next subject for investigation is whether changes in unemployment are a significant explanatory variable. It will be recalled, from the discussion of Chapter I, that both Phillips and Lipsey concluded that changes in unemployment were important in explaining changes in money wages, for long-term British data. On the other hand, Bhatia, who worked with long-term American data which was divided into sub-periods, concluded that the unemployment change variable did not advance his explanation of money wage changes very far.¹⁸

It is therefore of some interest whether including changes in unemployment in a wage adjustment regression for the entire period will improve the relationship. The unemployment change variable, ΔU_t , is defined as the previous year's level of unemployment subtracted from the current level. (Hence $\Delta U_t = U_t - U_{t-1}$.) The sources of this series are, of course, the same as those of the absolute level of unemployment

18. See the more detailed discussion of Chapter I. The references to these works are cited in this discussion.

itself. All other symbols used in this section have been defined previously and retain their earlier meanings. When the unemployment change variable is introduced into the working wage adjustment relation, equation (3.4), the results, which apply to the period 1901-1957, are:

$$(4.8) \quad \Delta w_t = - 0.01539 - 0.1788 \times 10^{-5} U_t - 0.5472 \times 10^{-5} \Delta U_t \\ (0.00622) \quad (0.1015 \times 10^{-5}) \quad (0.2213 \times 10^{-5}) \\ + 0.5663 \times 10^{-2} \Delta P_t + 0.1651 \times 10^{-2} t, \\ (0.0639 \times 10^{-2}) \quad (0.0187 \times 10^{-2}) \\ \bar{S}_u = 0.0216, \quad R^2 = 0.8435.$$

Some matters of statistical interpretation may be examined, before broader economic implications are discussed. The t ratio (the ratio of regression coefficient to estimated standard error of this coefficient) for the unemployment change variable is 2.47. Thus this variable has a statistically significant impact, by the usual standards. The long-term American data appear to display the "loops" (importance of the unemployment change variable) that Phillips and Lipsey found in long-term British data. Furthermore, the introduction of this additional variable improves the fit; the coefficient of multiple determination of equation (4.8) is 0.8435, an increase of almost two percentage points over 0.8243, the coefficient of multiple determination associated with equation (3.4). The t ratio for the absolute unemployment variable drops to 1.76. Thus this variable remains statistically significant at the 5 per cent level if a one-tailed test is used, but not if a two-tailed test is used. Thus its influence remains somewhat open to question. The value of the

ron-Neumann-Hart statistic associated with regression (4.8) is 1.682.

For a sample of this size, the hypothesis of non-autocorrelated residuals can be rejected only at the 7.9 per cent level of statistical significance¹⁹; consequently, this hypothesis would be accepted at standard significance levels (5 per cent, for example).

According to equation (4.8), a rise in unemployment over the previous year's level equal to 1 per cent of the period's mean labor force is associated with a decline in money wages, 0.367 per cent of the period mean level. If the model of Section 3 of Chapter III is applied to calculate the level of unemployment "required" for price level stability, the conclusions are even more pessimistic than those of the earlier discussion. Equation (4.8), combined with the earlier assumptions, implies that a persisting level of unemployment equal to 11.8 million workers (roughly 17 per cent of a labor force of 70 million) is "required" for price level stability. The rather extensive earlier qualifications should again be reiterated, however.

The broader question of economic interpretation remains with us. One section of Lipsey's article²⁰ explained the importance of the unemployment change variable as an aggregation phenomenon. In this interpretation, the importance of the unemployment change variable, in the economy-wide wage adjustment relation, is not a macro-counterpart of

19. B. I. Hart and John von Neumann, op. cit.

20. Richard G. Lipsey, op. cit.

a basic structural relationship at the behavioral level but instead arises in the process of aggregation. This view will be further discussed in Chapter VII. Another possibility is that, with falling unemployment, the labor market is "tighter" (the excess demand for labor is algebraically higher), for a given level of unemployment, than with constant or rising unemployment. In this view, the importance of the unemployment change variable merely reflects the adjustment of money wages in accord with the laws of the market place. It should be noted that the sign of the unemployment variable in equation (4.8) is consistent with this interpretation. A third possibility is that the reaction of the market place to given levels of excess demand for labor varies, depending upon whether unemployment is rising or falling. These latter two interpretations are also discussed further in Chapter VII.

A final possibility may be briefly noted. In connection with the discussion of the possible role of a profits variable, Bowen's view that the appropriate profits variable is expected profitability was cited. It is possible that changes in unemployment are a better proxy for expected future profits than past or current profits themselves. If this is the case, the role of the unemployment change variable may be one of substituting for the influence of possible levels of future profits on money wage increases.²¹ This, it should be pointed out,

21. Lloyd G. Reynolds ("Wage Push and All That," American Economic Review, Papers and Proceedings, Volume L, No. 2 (May, 1960), pp. 195-204) appears to lean toward this view. Reynolds states, "Insofar as unemployment is taken to indicate the state of aggregate demand, profits, and employers' ability to pay, it is the direction and rate of change of unemployment which is important." (P. 198; see also the immediately following discussion.)

is no more than a surmise, and the exact interpretation of the statistical results appears, to the author, to be an open question.

3. The Possible Role of Productivity Changes.

The next subject of study is the possible role that productivity may play in a wage adjustment equation. Neo-Classical economic stressed the role of marginal productivity in the determination of real wages. The wage adjustment equations under study, however, explain the money wage change and hence determine (subject to a statistical disturbance) the level of money wages, given an initial level. Thus there is no necessary reason for believing that money wages depend upon productivity, even with a Neo-Classical view of equation (2.5), the marginal productivity condition.²² However, one can certainly entertain the tentative hypothesis that a productivity variable might play some role in explaining money wage changes. The fact that productivity increases are sometimes mentioned at the bargaining tables of formal wage negotiations as a reason for a wage increase strengthens this conjecture.

In this connection, it may be recalled that Klein and Ball experimented with a productivity change variable in their wage adjustment equation, while Dicks-Mireaux tried two variants of a productivity change variable in his wage adjustment relationship.²³ Klein and

22. As argued in Chapter II, the author interprets this relation as completing the system with respect to the price level, rather than as being instrumental in the determination of the real wage.

23. L. R. Klein and R. J. Ball, op. cit.; L. A. Dicks-Mireaux, op. cit.

Ball concluded that the resulting wage adjustment relation was inferior to the one they finally accepted. Dicks-Mireaux found that the coefficient of the productivity change variable was but a fraction of its standard error. Consequently, one must conclude that productivity changes do not appear to be an important explanatory variable, for post-war British wage adjustment relationships.

The author's first problem was to obtain an empirical counterpart of the theoretical productivity concept. Because data corresponding to marginal productivity are difficult to find, an empirical counterpart of the average productivity of labor was used. John W. Kendrick has calculated the ratios of the real gross product of the private domestic economy to the corresponding labor input in man-hours. (He uses the Department of Commerce concept of gross product.) This ratio, which may be interpreted as the average productivity of labor, is denoted by the symbol A. Numerical values of A are given in Appendix A of this chapter. For the period 1898-1954, the figures are taken directly from Kendrick's book.²⁴ The values of A for 1955 through 1959 represent revisions and extensions of Kendrick's data and were obtained by the author through an interview with Maude R. Pech, Kendrick's statistical assistant, at the National Bureau on April 20, 1961.

24. John W. Kendrick (Assisted by Maude R. Pech), Productivity Trends in the United States (Princeton, N.J.: Princeton University Press, 1961), Table A-XXII, pp. 333-335.

Next, one must decide whether to use the level or the change in labor's average productivity, as an explanatory variable in a wage adjustment equation. The author decided to use the change in average productivity, ΔA , for four reasons. First, the theoretical relation is between the level of wages and the level of productivity so that an empirical relationship between the change in wages and the change in productivity would seem to be more consistent. Secondly, arguments at the bargaining table usually assert that a wage increase is merited because productivity has increased rather than because productivity is high. (The evidence on this point is not unambiguous, however.) Thirdly, Klein and Ball and Dicks-Mireaux both used productivity changes as their tentative additional explanatory variable; hence use of the change rather than the level maintains continuity with these two earlier studies. Finally, time diagram analysis suggested that there was a closer relation between Δw and ΔA . (See Figure 5 above.) A time diagram (not reproduced) of Δw and the absolute level of A showed no obvious relation between the two. Δw was marked by pronounced swings, while the A variable displayed only minor perturbations from its smooth trend.

There might also be a question as to whether ΔA should be lagged one year or should be included as a simultaneous variable. Two considerations are relevant at this point. A recent National Bureau

study²⁵ presented some evidence that productivity might lead the reference cycle. As money wages are a well known lagger,²⁶ there is some basis for suspecting that productivity changes might take some time to work their effect on the money wage change. If this is true, the better productivity change variable would be lagged values of ΔA . On the other hand, the author interpreted Figure 5 as suggesting that the current productivity changes were slightly superior, as an explanatory variable.

Because of this uncertainty, both lagged and unlagged productivity changes were included as additional explanatory variables (in separate regressions) in the working wage adjustment equation of Chapter III. (Because of difficulties of interpretation, the unemployment change variable is temporarily excluded; it is, however, reintroduced below.) The method of parameter estimation is still single equation least squares, and the observations run from 1900 to 1957. The

25. Thor Hultgren (Assisted by Dorothy Dorfman Green), "Changes in Labor Cost during Cycles in Production and Business," Occasional Paper 74, National Bureau of Economic Research, 1960. (It is hard to single out a particular page reference but see especially Table 22 on p. 51.) The evidence on productivity's being a leading series refers to individual industries; as Hultgren notes, the picture becomes blurred when one attempts to aggregate components into a productivity index.

26. See Table I in Chapter III above. See also Daniel Creamer (with the assistance of Martin Bernstein), "Behavior of Wage Rates during Business Cycles," Occasional Paper 34, National Bureau of Economic Research, 1950.

results are:

$$\begin{aligned}
 (4.9) \quad \Delta w_t = & - .01435 - 0.2249 \times 10^{-5} U_t + 0.6233 \times 10^{-2} \Delta P_t \\
 & (.00618) \quad (0.1049 \times 10^{-5}) \quad (0.0617 \times 10^{-2}) \\
 & + 0.1763 \times 10^{-2} t - 0.1377 \times 10^{-2} \Delta A_{t-1}, \\
 & (0.0203 \times 10^{-2}) \quad (0.0808 \times 10^{-2}) \\
 & \bar{S}_u = 0.0221, \quad R^2 = 0.8335,
 \end{aligned}$$

$$\begin{aligned}
 (4.10) \quad \Delta w_t = & - .01585 - 0.1596 \times 10^{-5} U_t + 0.6358 \times 10^{-2} \Delta P_t \\
 & (.00597) \quad (0.1013 \times 10^{-5}) \quad (0.0598 \times 10^{-2}) \\
 & + 0.1408 \times 10^{-2} t + 0.2046 \times 10^{-2} \Delta A_t, \\
 & (0.0199 \times 10^{-2}) \quad (0.0776 \times 10^{-2}) \\
 & \bar{S}_u = 0.0214, \quad R^2 = 0.8447.
 \end{aligned}$$

We may focus on equation (4.9) first. Its coefficient of multiple determination is 0.8335, an increase of nearly 1 percentage point over that of equation (3.4). The feature of this regression equation most in need of explanation, however, is that the sign of the lagged productivity change variable is in an unexpected direction, higher productivity changes being associated with lower money wage increases rather than with higher wage increases. The t ratio for the ΔA_{t-1} variable is 1.705. Thus this variable is statistically significant at the 10 per cent level, with a two-tailed test, but not at the 5 per cent level, with such a test. If the negative influence on the wage change of last year's productivity change is considered significant, two explanations come to mind. The first rests on the proposition that productivity increases in themselves constitute a negative pressure on cost of living increases. In this view, the negative influence of the lagged productivity change

variable would represent a lagged response to the previous year's change in the consumer price index. This influence would be different from, and in addition to, the influence of current changes in the consumer price level, as this variable is already included in the wage adjustment regression. The second possibility is that the importance of the lagged productivity changes is a statistical artifact. The negative influence of this variable on wage changes can be explained by the apparent negative autocorrelation of the productivity change series, which is suggested by Figure 5, and the positive association of current changes in productivity with wage changes, as indicated by equation (4.10).

In either interpretation, equation (4.9) does not represent a fundamental (or structural) relationship. Consequently, we may move on to consider equation (4.10). This regression is preferable to (4.9) on two bases: its productivity change coefficient has the appropriate sign and its coefficient of multiple determination (0.8447) is higher by slightly more than 1 percentage point. The t ratio for the current productivity change variable is 2.64; this variable is statistically significant, by usual standards. The mean value of the A variable over the period 1900-1957 is 108.25; consequently, a current increase in the average productivity of labor 1 per cent of this period mean value is associated with a rise in money wages 0.312 per cent of its period mean. The t ratio on the unemployment level drops to 1.58 in equation (4.10). Hence this variable cannot be considered statistically significant in this relationship, even if one uses the 5 per cent level with a one-tailed test. (By contrast, the t ratio of the unemployment

variable is 2.14 in equation (4.9) and so the influence of the unemployment level is statistically significant there.) The ratio of the mean square successive difference of the residuals to the estimated variance (the von-Neumann-Hart statistic) is 1.641. With the sample size used, such a ratio could occur by chance roughly 6.5 times out of 100, if the drawings were made randomly from a truly non-autocorrelated universe.²⁷ Hence the hypothesis of non-autocorrelated residuals may be accepted at the 5 per cent level of statistical significance.

One can also compute unemployment "required" for price level stability according to equation (4.10) and the somewhat restrictive model of Section 3 of the previous chapter. For the year 1960, we have, as before:

$$(4.11) \quad t = 60; \text{ required } \Delta w_t = 0.025 (\$2.50) = 0.0625; \\ \text{and } \Delta P_t = 0 .$$

Since we assume that average productivity increases by $2\frac{1}{2}$ per cent per annum and since the level of average productivity was 222.9 in 1959, the productivity change for 1960 implicit in these circumstances is 5.5725 index points. Substitution into equation (4.10) yields:

$$(4.12) \quad .0625 = - 0.01585 - 0.1596 \times 10^{-5} u_t + 0 \\ + 0.001408 (60) + 5.5725 (0.2046 \times 10^{-2}) .$$

The solution is a level of unemployment equal to 10,980,000 workers.

27. B. I. Hart and John von Neumann, op. cit.

This result, slightly more pessimistic than that generated by equation (3.4) of Chapter III, is subject to all of the qualifications of the earlier discussion.

The larger problem of economic interpretation remains to be considered. The negative findings of Klein and Ball and Dicks-Mireaux, in their two separate studies of post-war British data, should be recalled at this point. Furthermore, the author is not convinced that equation (4.10) should be taken at face value as a wage adjustment equation in which there is a structural relationship between money wage changes and productivity changes. This agnosticism is especially applicable if the wage concept is a standard rate, instead of the earnings data actually used. Thus it is quite possible that if changes in money wage rates were the dependent variable in a wage adjustment equation, the productivity change variable might not play a significant role. Two recent studies²⁸ have suggested that changes in productivity are a key determinant of the "wage drift," the differential movement between wage earnings and standard wage rates. Thus the productivity change variable may be positively associated with money wage changes only because earnings generally are abnormally higher than standard rates when the productivity increase is large. If this view is correct, productivity changes

28. H. F. Lydall, op. cit.; H. A. Turner, op. cit.

need have no direct influence on standard wage rate adjustments.²⁹

Still other possibilities exist. In Appendix B, a simple model, in which the structural wage adjustment equation does not contain productivity changes as an independent variable, is presented. A relationship between wage changes, as the dependent variable, and several independent variables, including productivity changes, is then derived. If the results of that appendix can be transferred to a more complex economic "reality," then the statistical importance of the productivity change variable may be illusory. Another possibility is that the productivity change variable is serving as a proxy for some other variable, such as the excess demand for labor or expected future profitability. Rapid increases in productivity often accompany business recoveries; furthermore, in that a direct impact of large productivity gains is a reduction of unit costs, the impact on profit margins might be expected to be a favorable one. Hence possible proxy effects of the productivity change variable are at least one plausible interpretation of the statistical results.

29. As noted in Chapter I, Bowen (op. cit., Chapter 5) argues that the change in productivity has no direct impact on the change in wage rates, because neither labor nor management accepts the principle that wages should be geared to productivity increases. (Labor wants a larger share; management holds that labor is entitled to only those productivity gains for which it is directly responsible.) With piece rate payments, however, Bowen is willing to concede that productivity gains may increase wage earnings, because workers cannot be prevented from capturing minor productivity gains under this system.

We may introduce changes in unemployment and changes in productivity into a single wage adjustment regression, in order to see whether the working relationship is thereby improved. (The absolute level of unemployment is included in the first regression and excluded from the second.) Using the period 1901-1957, the author obtained:

$$\begin{aligned}
 (4.13) \quad \Delta w_t = & - .01622 - 0.1570 \times 10^{-5} U_t - 0.3665 \times 10^{-5} \Delta U_t \\
 & (.00613) \quad (0.1005 \times 10^{-5}) \quad (0.2419 \times 10^{-5}) \\
 & + 0.5953 \times 10^{-2} \Delta P_t + 0.1495 \times 10^{-2} t + 0.1460 \times 10^{-2} \Delta A_t \\
 & (0.0650 \times 10^{-2}) \quad (0.0205 \times 10^{-2}) \quad (0.0857 \times 10^{-2}) , \\
 & \bar{S}_u = 0.0212 , \quad R^2 = 0.8519 .
 \end{aligned}$$

$$\begin{aligned}
 (4.14) \quad \Delta w_t = & - .01965 - 0.3695 \times 10^{-5} \Delta U_t + 0.6360 \times 10^{-2} \Delta P_t \\
 & (.00580) \quad (0.2452 \times 10^{-5}) \quad (0.0604 \times 10^{-2}) \\
 & + 0.1382 \times 10^{-2} t + 0.1630 \times 10^{-2} \Delta A_t \\
 & (0.0195 \times 10^{-2}) \quad (0.0862 \times 10^{-2}) , \\
 & \bar{S}_u = 0.0215 , \quad R^2 = 0.8448 .
 \end{aligned}$$

The results are not too encouraging. In the first regression, the t ratios for the U_t , ΔU_t , and ΔA_t variables are 1.56, 1.52, and 1.70, respectively. Thus none of the variables have a significant influence at the 5 per cent level with a two-tailed test and only ΔA_t is significant at that level with a one-tailed test. For equation (4.14), the t ratios of ΔU_t and ΔA_t are 1.51 and 1.89 respectively, and similar conclusions about levels of statistical significance apply. Although the coefficient of multiple determination is higher for

equation (4.13) than for any other regression covering the full period, the picture of economic structure is obscured, rather than advanced, by the inclusion of so many explanatory variables. The gross correlation coefficient between ΔA_t and ΔU_t is 0.380, and hence it is likely that the intercorrelation between these two explanatory variables is preventing a clear estimate of the separate effect of either variable. These results also tend to confirm the possibility that at least one of these two variables is serving as a proxy for some other influence.³⁰

4. The Question of Irreversibility.

The data studied may now be examined for evidence of asymmetry in the movement of money wages. From Keynes onward, many writers have argued that money wages move upward more readily than downward. Some limited tests of this hypothesis may be made for the entire period 1900-1957. If downward rigidity of money wages is a recent phenomenon, it is quite possible that these tests will not be sensitive to such a change of economic structure.

If wages move upward more easily than downward, one way in which this asymmetry might appear is in response to changes in the consumer price level. Thus, one might expect the money wage to change quite readily (increase) with an increase in the consumer price level but to change very little (decrease slightly or be only slightly retarded on

30. The parameters of equations (4.8) and (4.10) have been re-estimated in Chapter VI below by the method of two stage least squares.

its upward path) because of a decrease in the consumer price level.³¹

To test this hypothesis, we may partition ΔP_t , the change in the consumer price index, into positive and negative components by defining:

$$(4.15) \quad \begin{aligned} \Delta_1 P_t &= \Delta P_t \quad \text{if } \Delta P_t > 0 \\ &= 0 \quad \text{otherwise;} \end{aligned}$$

$$(4.16) \quad \begin{aligned} \Delta_2 P_t &= |\Delta P_t| \quad \text{if } \Delta P_t < 0 \\ &= 0 \quad \text{otherwise.} \end{aligned}$$

As the test of this particular asymmetry hypothesis, one may compute a regression of the form:

$$(4.17) \quad \Delta w_t = \beta_0 + \beta_1 U_t + \beta_2 \Delta_1 P_t + \beta_3 \Delta_2 P_t + \beta_4 t + v_t .$$

(The beta's are the regression parameters, while v_t is a stochastic disturbance. All other terms have been defined previously.) The theorist who held that money wage changes are subject to this type of asymmetry of response would expect that the numerical value of the coefficient of the positive price level changes would be greater (in a statistically significant manner) than that of the negative price level changes.

The data used is that employed previously, while the method of

31. Bowen (op. cit., pp. 127-128) argues that this is likely to be true, because of employee resistance to downward wage adjustments.

parameter estimation remains single equation least squares. The empirical counterpart of equation (4.17) is:

$$(4.17a) \quad \Delta w_t = - .01401 - 0.1845 \times 10^{-5} U_t + 0.5910 \times 10^{-2} \Delta_1 P_t \\ (.00646) \quad (0.1084 \times 10^{-5}) \quad (0.0773 \times 10^{-2}) \\ - 0.6999 \times 10^{-2} \Delta_2 P_t + 0.1633 \times 10^{-2} t, \\ (0.1387 \times 10^{-2}) \quad (0.0192 \times 10^{-2}), \\ \bar{S}_u = 0.02265, \quad R^2 = 0.8257.$$

Several comments on equation (4.17a) may be offered. The numerical value of the coefficient of the negative price level changes ($\Delta_2 P_t$) is larger than that of the positive price level changes, although this discrepancy is not statistically significant.³² Thus,

32. Because the numerical value of the negative price level changes has been used, the appropriate question to test is whether the sum of the coefficients of the price level change components is statistically indistinguishable from zero. (The asymmetry hypothesis discussed above would lead to a prediction of a significant deviation from zero in a positive direction.) Using previous symbols, one may write:

$$(i) \quad \beta_2 + \beta_3 = - 0.1089 \times 10^{-2}.$$

Taking account of the estimated covariance between the two regression coefficients, the author has computed:

$$(ii) \quad S(\beta_2 + \beta_3) = 0.1682 \times 10^{-2}.$$

Forming the ratio, one obtains:

$$(iii) \quad t = \frac{|\beta_2 + \beta_3|}{S(\beta_2 + \beta_3)} = \frac{0.1089 \times 10^{-2}}{0.1682 \times 10^{-2}} = 0.65.$$

Consequently the discrepancy would not be considered statistically significant.

money wages appear to respond symmetrically to upward and to downward movements in the consumer price level. It is also true that equation (4.17a) has a coefficient of multiple determination which is slightly higher than that of equation (3.4), which is 0.8243. When account is taken of the greater forcing of the fit in (4.17a) (because one more parameter is estimated and hence one more degree of freedom is used up), equation (3.4) displays the tighter fit. Thus, (3.4) has an estimated standard deviation of residuals, corrected for degrees of freedom, equal to 0.02253, which is lower than 0.02265, the value of this measure for (4.17a). Hence it appears, as a result of this consideration also, that it is not fruitful to distinguish between positive and negative price level changes.

A more crudely empirical method of testing for asymmetry in the movement of money wages is to compute separate wage adjustment relations for non-negative wage changes and then for negative wage changes. Proceeding analogously to the previous definitions, one may write:

$$(4.18) \quad \Delta_1 w_t = \Delta w_t \quad \text{if } \Delta w_t \geq 0 ,$$

and is undefined otherwise;

$$(4.19) \quad \Delta_2 w_t = |\Delta w_t| \quad \text{if } \Delta w_t < 0 ,$$

and is undefined otherwise.

Calculating the familiar type of wage adjustment regression, the author obtained:

$$(4.20) \quad \Delta_1 w_t = - \begin{matrix} .01321 \\ (.00732) \end{matrix} - \begin{matrix} 0.1584 \times 10^{-5} U_t \\ (0.1334 \times 10^{-5}) \end{matrix} + \begin{matrix} 0.5885 \times 10^{-2} \Delta P_t \\ (0.0783 \times 10^{-2}) \end{matrix} \\ + \begin{matrix} 0.1630 \times 10^{-2} t \\ (0.0207 \times 10^{-2}) \end{matrix}, \quad \bar{S}_u = 0.0235, \\ R^2 = 0.7803,$$

$$(4.21) \quad \Delta_2 w_t = \begin{matrix} .00926 \\ (.00914) \end{matrix} - \begin{matrix} 0.0696 \times 10^{-5} U_t \\ (0.1468 \times 10^{-5}) \end{matrix} - \begin{matrix} 0.4942 \times 10^{-2} \Delta P_t \\ (0.0908 \times 10^{-2}) \end{matrix} \\ - \begin{matrix} 0.01865 \times 10^{-2} t \\ (0.0520 \times 10^{-2}) \end{matrix}, \quad \bar{S}_u = 0.0123, \\ R^2 = 0.8219.$$

Equations (4.20) and (4.21) bear further comment. In the first place, both equations have coefficients of multiple determination which are lower than that (0.8243) of equation (3.4). Hence the first impression is that nothing is gained by making this partition. But examining the coefficients closely, one finds an asymmetry in the response to unemployment and also to the time trend. It appears that negative wage changes are less responsive to unemployment and show less of a trend upward (in the actual values) than non-negative wage changes. If the examination is pushed further, the sum of the coefficients of unemployment in equations (4.20) and (4.21) do not differ significantly from zero: however, the sum of the coefficients of the time trend do.³³ There seems to be this

33. The t ratio for the sum of the coefficients of unemployment from these two equations is:

$$(i) \quad \frac{|-0.2280 \times 10^{-5}|}{0.1984 \times 10^{-5}} = 1.15,$$

which is not statistically significant. The t ratio for the sum of the time trend coefficients is:

$$(ii) \quad \frac{0.1444 \times 10^{-2}}{0.05596 \times 10^{-2}} = 2.58,$$

(Footnote continued on bottom of next page.)

slight evidence of asymmetry in the movement of money wages over the period surveyed.

Finally, the author wishes to point out that this analysis says little about downward rigidity during particular sub-periods of the total period studied. Thus money wages may have displayed a substantial amount of downward rigidity during the post-war period. Indeed, the fact that we cannot use the post-war data for similar tests because wage and price level series for this period almost uniformly move in only one direction -- upward -- suggests this conclusion.

Footnote 33 continued from bottom of previous page.

which is statistically significant. The t ratios for the sum of the constant terms and the sum of the price level change coefficients are 0.34 and 0.79 respectively. Hence these sums do not differ significantly from zero.

Appendix A

Variables employed in the analysis above are presented in the following table. For definitions and sources, see the text.

Table VI

Total Corporate Profits (Π_T), Corporate Net Worth (NW_T), Manufacturing Corporate Profits (Π_M), Manufacturing Employees (N_M), and Average Productivity (A), U.S.A., 1898-1959.

Year (1)	Total Corporate Profits (\$ mill.) (2)	Corporate Net Worth (\$ mill.) (3)	Manufacturing Corp. Profits (\$ mill.) (4)	Manu. Employees ('000) (5)	Average Productivity (1929 = 100) (6)
1898					53.7
1899					54.7
1900	\$1522	\$22,844			55.6
1901	1750	23,738			59.4
1902	2434	25,120			57.2
1903	2460	26,270			58.5
1904	2095	27,287			58.4
1905	2393	28,978			59.9
1906	2894	30,981			64.4
1907	2972	32,467			64.2
1908	2423	33,247			61.1
1909	2994	34,767			65.6
1910	3285	36,268			64.4
1911	2921	37,463			65.7
1912	3382	39,025			66.9
1913	3553	41,399			69.2
1914	2714	42,817			64.7
1915	4110	48,573			67.2
1916	7908	61,116			72.3
1917	8340	78,186			68.6
1918	4964	92,539			74.1
1919	7292	113,529	\$3919	10,534	79.0

Table VI (Continued)

Year (1)	Total Corporate Profits (\$ mill.) (2)	Corporate Net Worth (\$ mill.) (3)	Manufacturing Corp. Profits (\$ mill.) (4)	Manu. Employees ('000) (5)	Average Productivity (1929 = 100) (6)
1920	\$4855	\$114,031	\$2454	10,534	78.3
1921	517	97,612	-345	8,132	83.8
1922	5183	99,621	2528	8,986	83.0
1923	6697	111,388	3419	10,155	87.8
1924	5914	116,792	2649	9,523	91.7
1925	8146	125,287	3562	9,786	91.6
1926	8281	132,837	3640	9,997	94.1
1927	7538	140,536	3050	9,839	95.7
1928	9553	149,117	3935	9,786	95.7
1929	10,676	153,492	4537	10,534	100.0
1930	3947	141,140	1424	9,401	97.5
1931	-1176	119,870	-521	8,021	98.4
1932	-4115	104,138	-1616	6,797	95.0
1933	-1353	107,139	237	7,258	93.5
1934	2379	107,304	1166	8,346	104.5
1935	4688	107,347	2122	8,907	108.0
1936	6580	107,655	3116	9,653	113.3
1937	6554	107,892	3069	10,606	114.0
1938	3271	107,907	1228	9,253	117.8
1939	5946	108,066	2946	10,078	122.2
1940	6800	121,144	3764	10,780	124.0
1941	9507	143,539	5493	12,974	134.6
1942	11,132	158,240	5432	15,051	136.6
1943	12,201	166,375	6051	17,381	141.5
1944	11,663	173,372	5473	17,111	152.6
1945	10,551	188,191	4145	15,302	159.0
1946	16,524	220,427	7073	14,461	150.9
1947	20,634	255,438	10,336	15,290	151.5
1948	22,668	275,575	11,296	15,321	156.7
1949	18,569	285,164	8753	14,178	162.7

Table VI (Continued.)

Year (1)	Total Corporate Profits (\$ mill.) (2)	Corporate Net Worth (\$ mill.) (3)	Manufacturing Corp. Profits (\$ mill.) (4)	Manu. Employees ('000) (5)	Average Productivity (1929 = 100) (6)
1950	\$25,514	\$315,484	\$13,088	14,967	175.4
1951	21,717	345,805	10,703	16,104	179.4
1952	19,588	376,125	8903	16,334	183.5
1953	19,932	406,446	9267	17,238	190.9
1954	19,860	436,766	8817	15,995	195.4
1955	25,542	467,086	12,688	16,563	204.3
1956	26,020	497,407	12,621	16,903	205.3
1957			11,739	16,782	211.9
1958					214.5
1959					222.9

Appendix B

A simple wage-price model, in which wage changes do not depend upon productivity changes, is presented in this appendix. With the aid of this model, one can derive an equation in which wage changes are the dependent variable and productivity changes are one of the independent variables.

The variables employed are: P^I , the industrial price level; P , the consumer price level; w , the money wage; A , the average product of labor; U , the level of unemployment; and t , a time trend.

(Variables are time-dated, through the use of the variable t as a subscript. Greek letters, which will be introduced shortly, serve as parameters.)

The structural equations of the model are:

$$(b.1) \quad P_t^I = \gamma_0 + \gamma_1 w_t + \gamma_2 A_t, \quad \gamma_1 > 0 \quad \text{and} \quad \gamma_2 < 0.$$

$$(b.2) \quad \Delta w_t = w_t - w_{t-1} = \delta_0 + \delta_1 U_t + \delta_2 (P_t - P_{t-1}) + \delta_3 t.$$

$$(b.3) \quad P_t = \eta_0 + \eta_1 P_t^I, \quad \eta_1 > 0.$$

(b.1) is a mark-up equation. An empirical counterpart of this equation will be presented and discussed in Chapter V. (b.2) is the familiar wage adjustment equation. (b.3) represents the simplifying assumption that the industrial price level and the consumer price level are linearly related. The term η_0 can be viewed as a composite of all non-industrial

price indices that enter the consumer price index; the term η_1 may be interpreted as the average retailing mark-up on those industrial goods that are sold to households.

Differencing equation (b.1) yields:

$$(b.4) \quad \Delta P_t^I = \gamma_1 \Delta w_t + \gamma_2 \Delta A_t .$$

(b.4) may be rewritten:

$$(b.5) \quad \Delta w_t = \frac{1}{\gamma_1} \Delta P_t^I - \frac{\gamma_2}{\gamma_1} \Delta A_t .$$

Differencing equation (b.3) yields:

$$(b.6) \quad \Delta P_t = \eta_1 \Delta P_t^I , \text{ or}$$

$$(b.7) \quad \Delta P_t^I = \frac{1}{\eta_1} \Delta P_t .$$

Substitution of (b.7) into (b.5) yields:

$$(b.8) \quad \Delta w_t = \frac{1}{\gamma_1 \eta_1} \Delta P_t - \frac{\gamma_2}{\gamma_1} \Delta A_t .$$

Let λ_1 and λ_2 be any two numbers such that:

$$(b.9) \quad \lambda_1 > 0 , \lambda_2 > 0 , \text{ and } \lambda_1 + \lambda_2 = 1 .$$

If we multiply (b.2) by λ_1 , (b.8) by λ_2 , and add the resulting two equations together, we obtain:

$$(b.10) \quad \Delta w_t = \lambda_1 \delta_0 + \lambda_1 \delta_1 U_t + \left(\lambda_1 \delta_2 + \lambda_2 \frac{1}{\gamma_1 \eta_1} \right) \Delta P_t \\ + \lambda_1 \delta_3 t - \lambda_2 \frac{\gamma_2}{\gamma_1} \Delta A_t .$$

This is the result that we set out to demonstrate. It should be observed that $\lambda_2 \frac{\gamma_2}{\gamma_1} < 0$, and so the sign of the coefficient of ΔA_t in equation (b.10) is the same as in the text regression equation (4.10). (The sign of the coefficient of consumer price level changes in (b.10) is an appropriate one, also.)

Chapter V, "The Influence of Costs and Other Factors on Price Levels"

We now turn to the problem of explaining the general level of prices. This issue may be viewed as the task of obtaining an empirical counterpart of equation (2.5) of Chapter II. Although this equation is set forth as the labor demand relation, it may be interpreted as describing behavior immediately relevant to the level of prices. The actions underlying the determination of price levels are those of profit-maximizing entrepreneurs, setting the prices of their products with the level of costs clearly in mind. Hence two variables that would play a direct role in the determination of price levels are the level of money wages and labor productivity. Even if one believes that mark-up pricing is a more appropriate hypothesis (for the economy as a whole, or for one particular sector), these variables are still important causal influences because of their relationship to cost levels.

In this chapter some price level equations are estimated. The data are American data, for the period 1913-1957. The price index employed is the Wholesale Price Index for Finished Goods.¹ This index was chosen because it corresponded most closely to the money wage series, which is the Rees series of average hourly compensation in manufacturing. Using these and other data (to be described subsequently), the author

1. This index, formerly known as the Wholesale Price Index of Manufactured Goods, was collected by the Bureau of Labor Statistics. It was obtained from Historical Statistics, Table E 53, p. 118, and is reproduced in Appendix A of this chapter.

examined the influence of costs on this particular price index. Raw materials prices, abnormal wartime conditions, and the role of demand are also investigated. Some tests for irreversibility in the tentatively final price level relationships are made, with generally negative results. Some concluding comments on these relationships are also offered.

1. Some Preliminary Price Level Relationships.

The first task is to estimate the relationship between prices and wage costs. The B.L.S. Wholesale Price Index for Finished Goods (to be represented by the symbol P^f) is reproduced in Appendix A. (This series is measured in index points, with 1947-1949 as the base period; the mean of this series is 74.2.) The figure for 1946 is an interpolation, obtained by using the Wholesale Price Index for all Commodities for the years 1945, 1946, and 1947 and then assuming that the finished goods wholesale price index had proportional movements over this period. The Rees wage series (designated by the symbol w) appears in Appendix B of Chapter III. (The units of this series are dollars per hour, and its mean for the period 1913-1957 is \$0.863.) In order to obtain manufacturing wage costs, the author needed a series for labor productivity in manufacturing. This has been obtained by taking Kendrick's series of manufacturing output per man-hour;² this series,

2. John W. Kendrick, op. cit., Appendix Table I-II, p. 465. The numerator of this series, manufacturing output, is a weighted average of the gross (intermediate product inputs included) output of component manufacturing industries. For a further description and sources, see Kendrick, op. cit., especially pp. 403-463.

reproduced in Appendix A of this chapter, is represented by the symbol A_m . (This series also has index points as its units, with the value for the year 1929 equal to 100. The mean is 113.2.) Manufacturing labor costs can therefore be represented by the quotient $\frac{W}{A_m}$ as this ratio is equivalent to total wage payments divided by total manufacturing output. This series also appears in Appendix A. (The units of this series are dollars per hour, as the quotient series $\frac{W}{A_m}$ was multiplied by 100 to eliminate the effects of dividing by a variable whose units are index points. This operation makes the units of the derived series the same as those of the money wage series. The mean value of $\frac{W}{A_m}$, for the period 1913-1957, is \$0.702.) The time paths of the four series are plotted in Figure 6.

The time diagrams suggest that the influence of these variables on the finished goods wholesale price index is principally a simultaneous one; no important lags are evident in scanning the diagrams. Accordingly, the following relationships were estimated from the data:

$$(5.1) \quad P^f = (k + u_1) \frac{W}{A_m}$$

$$(5.2) \quad P^f = \alpha_2 + \beta_2 \frac{W}{A_m} + u_2$$

$$(5.3) \quad P^f = \alpha_3 + \beta_3 W + \gamma_3 A_m + u_3 .$$

(k and the Greek letters are parameters; the u's are stochastic disturbances.) Because all variables have the same date, a time

subscript is omitted. Equation (5.1) is a variant of Professor Weintraub's Wage-Cost-Mark-Up equation; a relationship similar to equation (5.3) has been estimated by Edwin Kuh for the United States corporate sector, for the post-war period.³

Equations (5.2) and (5.3) have been estimated by single equation least squares. Because of the assumed probability structure of equation (5.1), an appropriate method of estimating k is to take the arithmetic mean of the ratios of P^f to $\frac{W}{A_m}$ for the individual years. With the numbers in parentheses denoting standard errors, the results are:

$$(5.1a) \quad P^f = 109.01 \left(\frac{W}{A_m} \right), \quad \hat{R}^2 = 0.835, \\ (1.915)$$

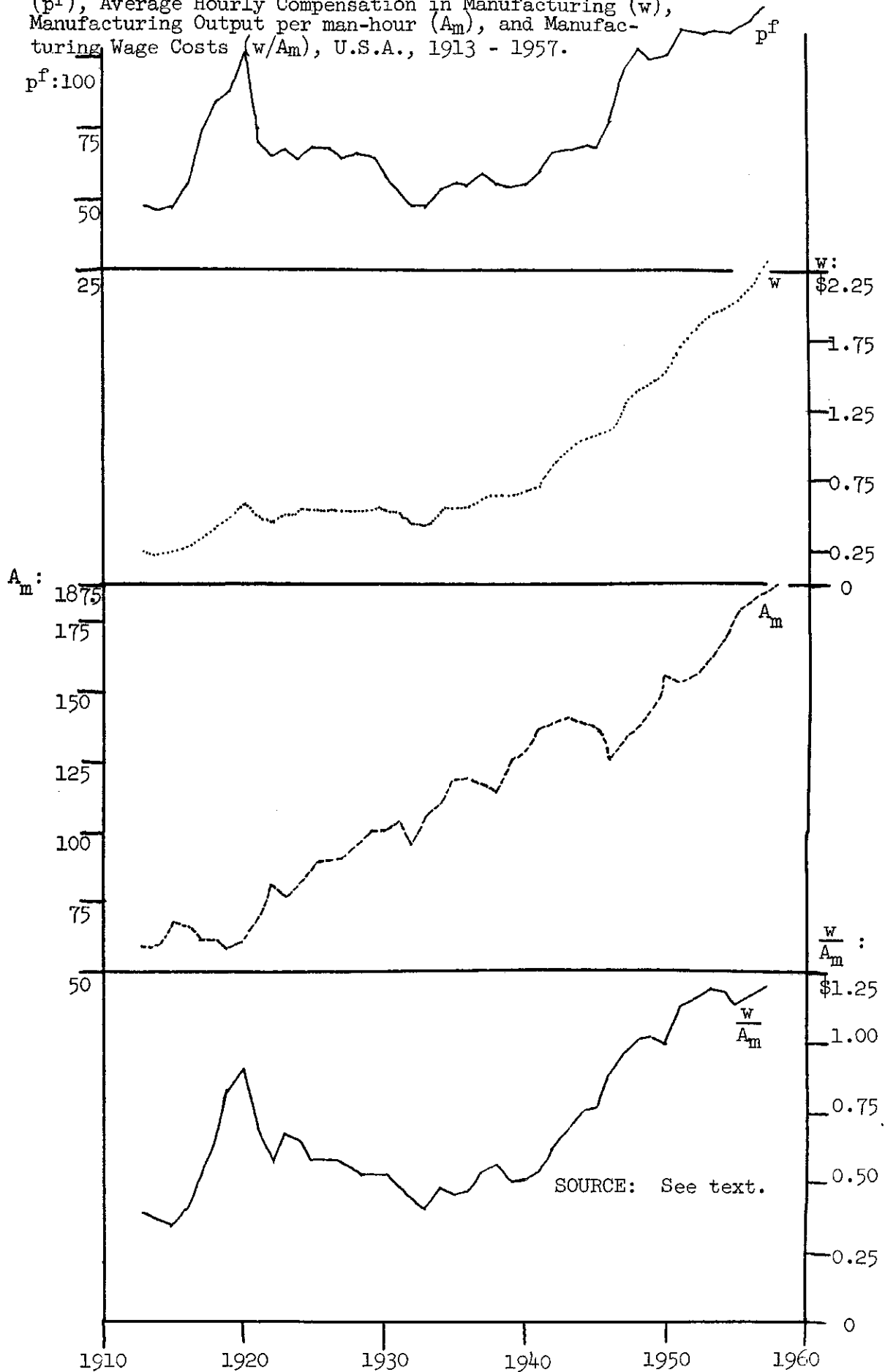
$$(5.2a) \quad P^f = 16.37 + 82.38 \left(\frac{W}{A_m} \right), \quad \bar{S}_u = 5.361, \\ (2.279) \quad (3.041) \quad r^2 = 0.9446,$$

$$(5.3a) \quad P^f = 80.08 + 63.89 w - 0.5392 A_m, \quad \bar{S}_u = 6.889, \\ (4.419) \quad (3.970) \quad (0.06260)^m \quad R^2 = 0.9107.$$

(\bar{S}_u is the estimated standard deviation of the residuals, corrected for degrees of freedom; r^2 and R^2 are the coefficients of simple

3. Weintraub, A General Theory; Kuh, op. cit. It should be recalled that the Kuh results are based on a value-added output concept and that the price index is the implicit deflator of this output series.

FIGURE 6. Time Diagram of the Wholesale Price Index for Finished Goods (p^f), Average Hourly Compensation in Manufacturing (w), Manufacturing Output per man-hour (A_m), and Manufacturing Wage Costs (w/A_m), U.S.A., 1913 - 1957.



determination and multiple determination, respectively.)⁴ The scatter of P^f against $\frac{W}{A_m}$ and equations (5.1a) and (5.2a) are presented in Figure 7.

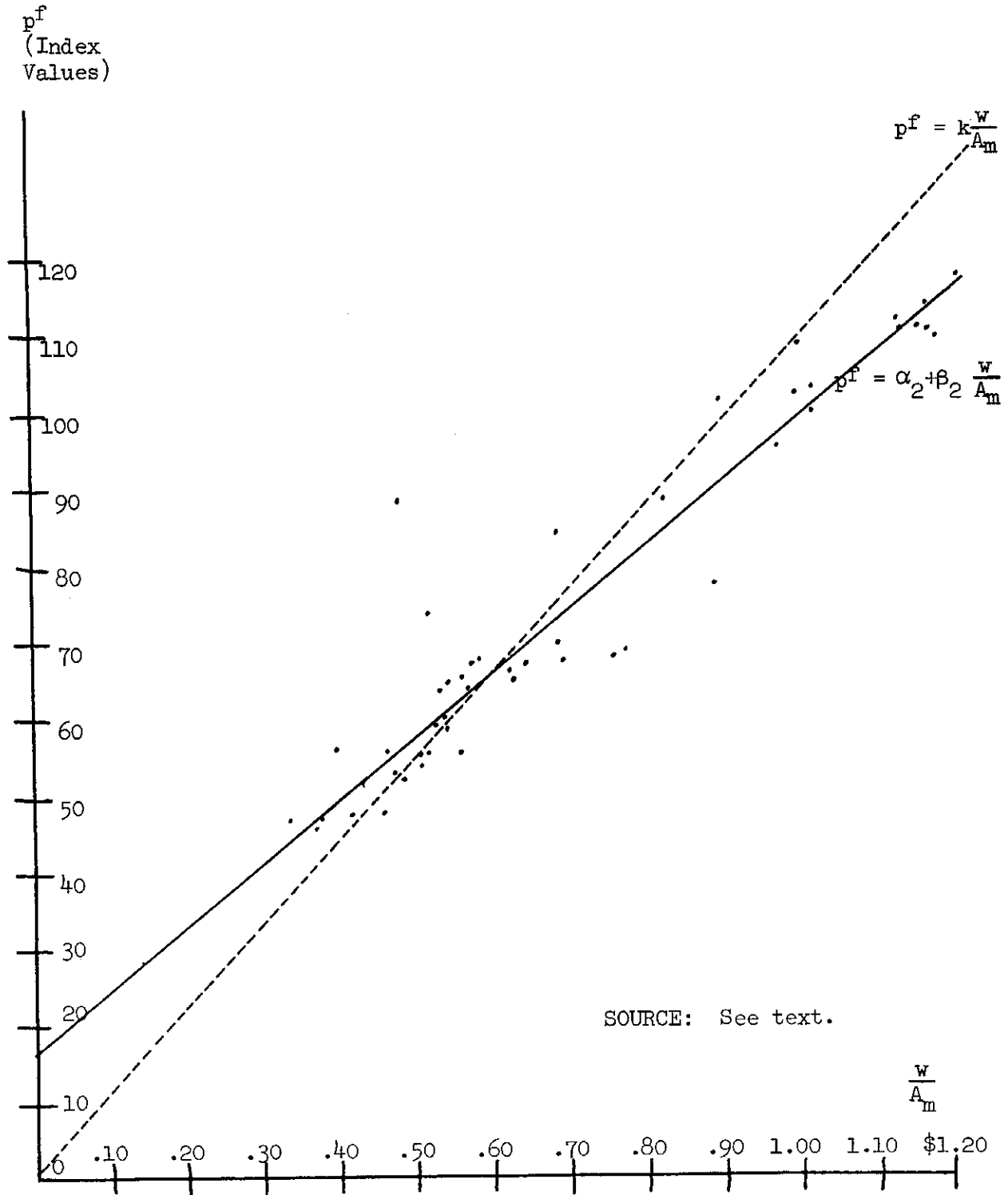
If one is to choose the relationship with the tightest fit as the most promising candidate for further study, equation (5.2a) must be selected. There is another reason for dropping (5.3a). Using period means, one can calculate that a 1 per cent rise in w was associated, *ceteris paribus*, with a 0.74 per cent rise in P^f , while a 1 per cent rise in A_m was associated with a 0.82 per cent drop in P^f , if the other variable (in each case) did not change.⁵ The difference

4. For equation (5.1a), \hat{R}^2 is defined as $1 - \frac{\frac{1}{N} \sum_{t=1}^N (P_t^f - \hat{P}_t)^2}{\frac{1}{N} \sum_{t=1}^N (P_t^f - \bar{P})^2}$,

where \hat{P}_t represents the predicted value of P^f for a particular year, N is the total number of years, t is a time subscript, and \bar{P} is the mean of P^f over the period 1913-1957. Consequently, this measure may be interpreted as the fraction of "explained" variance.

5. Kuh (*op. cit.*, p. 83) also found that the partial elasticities of the price index with respect to changes in his wage and productivity variables were not far apart -- .648 and -.616 respectively. Although these values are lower than the partial elasticities associated with equation (5.3a), they are somewhat closer to the present author's later estimates of the elasticity of wholesale prices of finished goods with respect to wage costs. See the discussion of the parameters of equation (5.10) in Section 6 below.

FIGURE 7. Scatter Diagram of the Wholesale Price Index of Finished Goods (p^f) and Manufacturing Wage Cost (w/A_m), with Two Fitted Relationships, U.S.A., 1913 - 1957.



SOURCE: See text.

between the elasticities of these two variables is small and inconsequential.⁶ This suggests that the quotient formulation adequately represents the influence of movements in both of these variables.

Before abandoning the mark-up formulation, it should be noted that there is a strong time trend in the individual year ratios of P^f to $\frac{W}{A_m}$. (This may be seen by scanning Figure 7; the observations in the upper right-hand corner occur at later points in time.) Consequently, a relation of the following form, permitting a trend in the mark-up factor but requiring rigidity at any one point in time, may be fitted:

$$(5.4) \quad P^f = (k_0 + k_1 t + u_4) \frac{W}{A_m} .$$

For comparison purposes, the author added a time trend to the non-zero constant term relationship between P^f and $\frac{W}{A_m}$. (t is equal to zero in 1935 and is in annual units.) The results are:

$$(5.4a) \quad P^f = [109.0 - 0.7591 t] \frac{W}{A_m}, \quad \hat{R}^2 = 0.9456, \\ (1.228) \quad (0.09456)$$

$$(5.5) \quad P^f = 7.035 + 95.68 \frac{W}{A_m} - 0.3590 t, \quad \bar{S}_u = 4.385, \\ (2.718) \quad (3.758) \quad (0.07605) \quad R^2 = 0.9638 .$$

Once again, the non-zero constant term equation gives the tightest fit. On theoretical grounds, one might prefer this formulation

6. Calculation of an appropriate t ratio yields the value 1.37. This would not be considered statistically significant, by usual standards.

because it implies that even if wage costs were to become negligible, prices would still have a positive lower limit. The presence of fixed costs makes this possibility seem realistic. An interpretation of the trend coefficient will be suggested in the next section.

2. The Role of Raw Materials Prices.

Because we are seeking to explain the prices of finished goods output, not merely the value added portion, a likely determinant is a raw materials price index. Two such indices are readily available for the sample period. The first is the Wholesale Price Index of Crude Materials for Further Processing, which is designated by the symbol P^r . This series is published in Historical Statistics⁷ and is reproduced in Appendix A. The units of this series are index values, the base period being 1947-1949. The mean value of this variable is 66.5. The second index is a Unit Value Index of Imported Crude Materials, the symbol for which will be I^r and which also appears in Appendix A.⁸ This series is also measured in index points, the base period being 1923-1925, and the mean value of I^r is 83.7. The series P^r and I^r

7. Table E 43, p. 118. The Bureau of Labor Statistics is the original source.

8. This series also appears in Historical Statistics (Table U 36, p. 541). The two separate series were joined together by placing them on a common base.

appear in Figure 8.

This time diagram suggests that the influence of raw materials prices on the wholesale prices of finished goods is principally a simultaneous one. Consequently, the current values of these variables are introduced as explanatory variables (in separate regressions). After this modification, the computed price level relations are:

$$(5.6) \quad P^f = 9.724 + 74.99 \left(\frac{W}{A_m}\right) - 0.1249 t + 0.1414 I^r,$$

$(2.623) \quad (7.494) \quad (0.1024) \quad (0.0456)$

$$\bar{S}_u = 3.993,$$
$$R^2 = 0.9707,$$

$$(5.7) \quad P^f = 8.544 + 61.33 \left(\frac{W}{A_m}\right) - 0.2034 t + 0.3397 P^r,$$

$(2.266) \quad (8.155) \quad (0.0714) \quad (0.07462)$

$$\bar{S}_u = 3.617,$$
$$R^2 = 0.9760 .$$

On statistical grounds, the P^r variable appears to give better results. The coefficient of multiple determination is higher, while the trend variable retains statistical significance. Moreover, the price of domestic raw materials, no less than imported raw materials costs, might be expected to play a role in price formation. Consequently equation (5.7) is selected for further study and experimentation.

The significance of the time trend may reflect the savings in raw materials requirements that accompany technological progress. While the author has taken into account the prices of raw materials

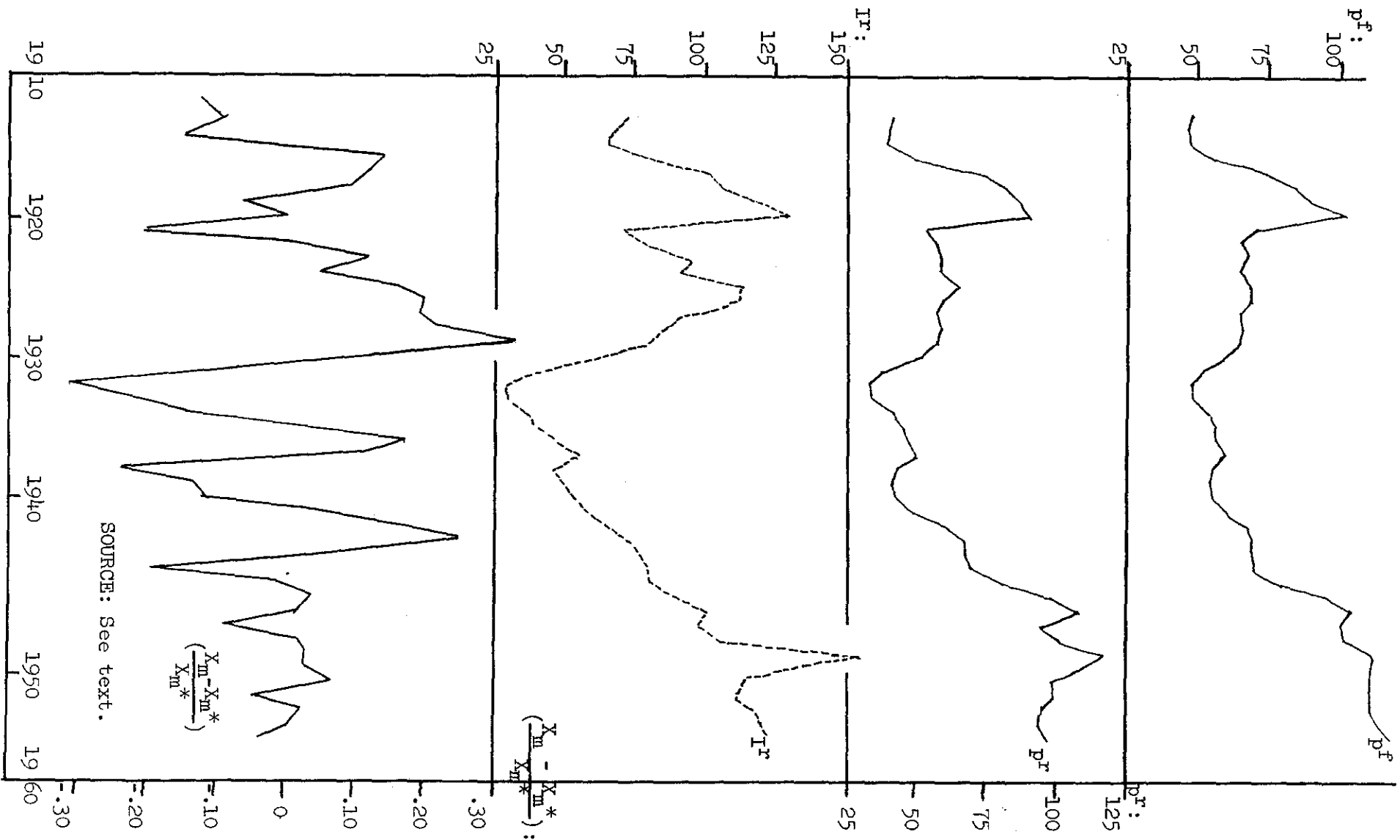


FIGURE 8. Time Diagram of the Wholesale Price Index of Finished Goods (p^f), the Wholesale Price Index of Crude Materials for Further Processing (p^r), the Unit Value Index of Imported Crude Materials (I^r), and the Deviation from Trend of Manufacturing Output ($\frac{X_m - X_m^*}{X_m^*}$), U.S.A., 1913 - 1957.

inputs, raw materials costs depend not only on their prices but also on the physical input requirements per unit of real output, if these change in any significant degree. Kendrick's work suggests that there were savings in unit raw materials requirements in manufacturing over this period.⁹ Hence the time trend may be acting as a proxy for the ratio of real output to real raw materials input. This interpretation is consistent with the negative sign of this variable, as rising output per unit of raw materials input (which would be the expected secular pattern) gives rise, ceteris paribus, to lower costs. In turn, the lower costs from this source would constitute a downward pressure on the finished goods wholesale price level.

3. An Examination of an "Abnormal" Period.

The next influence to be considered is abnormal wartime conditions. During America's involvement in the Second World War and for a short period thereafter, price controls and rationing characterized the American scene. If the controls were effective, one would naturally expect them to exert a depressing effect on prices. Examining the residuals of equation (5.7), one finds negative values for four out of the five years during the period 1942-1946. The single positive residual (for 1942) is less than \bar{S}_u , the estimated standard deviation of the residuals; three of the four negative residuals are larger than twice \bar{S}_u . The residuals for the period 1917-1918 are positive (but

9. Kendrick, op. cit., especially pp. 191-195. On pp. 94-96, Kendrick presents some statistical evidence of raw materials economies for the American economy as a whole, over the period 1900-1952.

not significantly so), which appears to correspond to the absence of widespread price controls during that war period.¹⁰

The dummy variable z is defined by the conditions:

$$(5.8) \quad \begin{aligned} z &= 1 \quad \text{during the years 1942-1946 and} \\ z &= 0 \quad \text{otherwise.} \end{aligned}$$

When this variable is introduced into the regression equation, the results are:

$$(5.9) \quad \begin{aligned} P^I &= 11.19 + 56.14 \left(\frac{W}{A_m}\right) + 0.3668 P^I - 0.1110 t \\ &\quad (1.871) \quad (6.544) \quad (0.05936) \quad (0.05950) \\ &\quad - 7.220 z, \quad \bar{S}_u = 2.866, \\ &\quad (1.435) \quad R^2 = 0.9853. \end{aligned}$$

The sign on z is in the expected direction; with other influences remaining unchanged, prices were lower during the "abnormal" period. Statistically, z is a highly significant variable. Not only is its coefficient more than five times its standard error, but the coefficient of multiple determination rises by almost one per cent, which is noteworthy when it is already so high. Although the t ratio for the time trend variable drops to 1.87, this value is still significant at the 5 per cent level if a one-tailed test is used. Moreover,

10. The 1950 residual of equation (5.7) is positive, while the residuals for 1951-1953 are negative. However, the numerical values of all of these residuals are smaller than the estimated standard deviation of the residuals. Again, this is not surprising in view of the somewhat limited nature of price control during the Korean War period.

after the next introduction, the t ratio for this variable rises above 2.02, the value for statistical significance at the 5 per cent level with a two-tailed test. Consequently, the time trend is retained as an explanatory variable.

4. The Role of Two Proxies for Excess Demand.

The next task is to measure the influence of sectoral demand on these wholesale prices, if this is possible. It is not immediately apparent how to approach this question. Our statistics on manufacturing output, for example, give the outcome between supply conditions, demand conditions, and possibly incomplete market-clearing, rather than measuring demand per se. Indeed, it would be difficult to find any statistical series that gauges perfectly ex ante demand for the products of the manufacturing sector.

Nevertheless, it is possible to construct series which, hopefully, will serve as imperfect proxies for the theoretical concept of ex ante demand. One approach is to take a series on manufacturing output¹¹ and find a "normal" value of this series for all years. (The symbol X_m denotes manufacturing output; this series is measured in index points, with the 1929 value equal to 100.) The relative discrepancy of the series from its "normal" value then becomes the explanatory variable which, in aspiration, measures the effects of ex ante demand.

11. Kendrick, op. cit., p. 465. This series and the two "normal" value series appear in Appendix A of this chapter.

Two such "normal" variables were tried. The first is the geometric mean of manufacturing in the current year and in the eight preceding years; this variable is represented by the symbol MA (for moving average). The second such variable is the trend value of the manufacturing output series; the trend chosen is a semi-logarithmic one for each of three sub-periods. (The sub-periods are 1912-1935, 1936-1945, and 1946-1957; a separate equation between the logarithm of X_m and calendar time was fitted for each of the sub-periods.) The trend variable is designated by the symbol X_m^* . The series on manufacturing output and the two "normal" levels of manufacturing output appear in Figure 9. The large circles represent the geometric means of current manufacturing output and the output of the previous eight years, while the three dashed lines are the segmented semi-logarithmic trend values, already described.

We thus consider two possible demand-proxy variables. The first, the relative deviation of manufacturing output from the moving geometric mean variable, can be represented symbolically as $\frac{X_m - MA}{MA}$. The second demand-proxy variable, also a relative deviation, is analogously represented by the quotient $\frac{X_m - X_m^*}{X_m^*}$. This latter demand-proxy variable is plotted against P^f in the time diagram, Figure 8. As no apparent lagged influences are evident and as the current values appear most relevant in price formation, the current values of this variable are also used as the pertinent explanatory variable. Introducing the demand-proxy variables into the finished goods

wholesale price regressions, the author obtained the following results:

$$(5.10) \quad P^f = 9.303 + 62.40 \left(\frac{W}{A_m} \right) + 0.3155 P^r - 0.1458 t - 9.716 z$$

$$\quad \quad \quad (1.794) \quad (6.241) \quad (0.0561) \quad (0.05491) \quad (1.520)$$

$$\quad \quad \quad + 6.202 \left(\frac{X_m - MA}{MA} \right), \quad \bar{S}_u = 2.591,$$

$$\quad \quad \quad (1.968) \quad \quad \quad R^2 = .9883,$$

$$(5.11) \quad P^f = 11.26 + 62.89 \left(\frac{W}{A_m} \right) + 0.2937 P^r - 0.1279 t - 7.569 z$$

$$\quad \quad \quad (1.784) \quad (6.927) \quad (0.06532) \quad (0.05721) \quad (1.377)$$

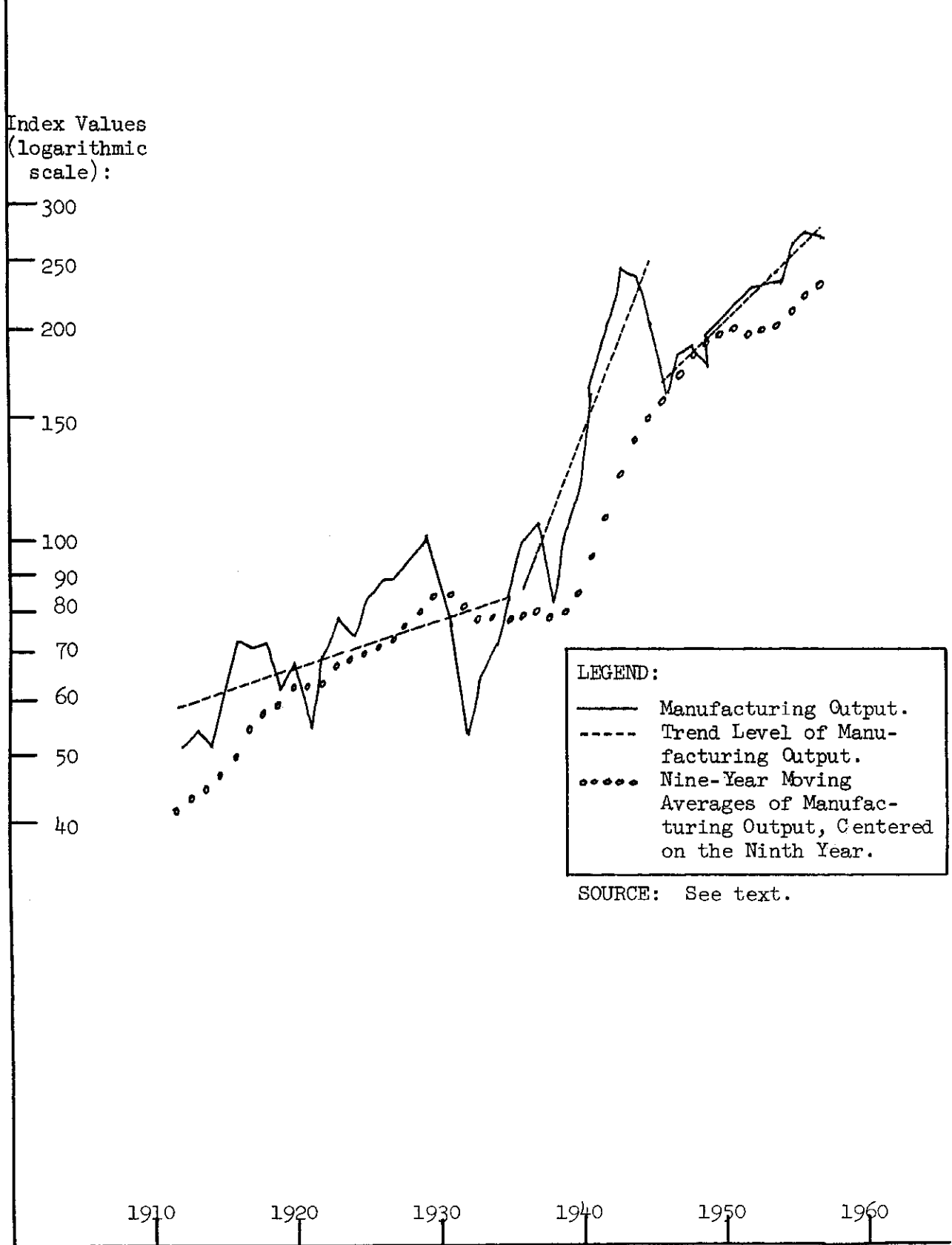
$$\quad \quad \quad + 7.831 \left(\frac{X_m - X_m^*}{X_m^*} \right), \quad \bar{S}_u = 2.731,$$

$$\quad \quad \quad (3.493) \quad \quad \quad R^2 = .9870.$$

The coefficient of the first demand-proxy variable is 3.15 times as large as its own standard error, while for the second demand-proxy variable, this ratio is 2.24. Thus both of these variables are statistically significant, by customary standards. It should be noted that the coefficients of all the other variables and the constant term are more than twice their own standard errors and hence are statistically significant, by usual tests. A further discussion of equations (5.10) and (5.11) will be presented in Section 6.

The wartime period 1942-1946 was not only a period of restrained price rises, but also a period of high demand. Thus if this period were not separately distinguished, as by the z variable, the influence of the demand-proxy variables on the finished goods wholesale price index might be obscured. That this is indeed true may be seen by inspecting regression equations (b.1) and (b.2) of Appendix B. On

FIGURE 9. Manufacturing Output and Two Normal Values of This Series, U.S.A., 1912 - 1957.



SOURCE: See text.

the other hand, if this period is discarded altogether, one of the two demand-proxy variables regains statistical significance.

(Equations (b.3) and (b.4) of Appendix B.) After the z variable is included in the regression for the entire period, 1913-1957, the coefficients of both demand-proxy variables are no smaller than those of the regressions from which the years 1942-1946 are excluded. (In fact, these coefficients are higher for the full period regressions, though not in a statistically significant manner.) This suggests that demand influences did exert some upward pull on prices even during the Second World War era, after allowance for abnormal conditions is made.

5. The Question of Irreversibility.

Another subject of interest is the possible presence of irreversibility in these relations. Is there any evidence that prices move upward more easily than downward? One possible type of irreversibility is a greater responsiveness to high demand than to low demand. This can be tested by partitioning the demand-proxy variable $\frac{X_m - MA}{MA}$ as follows:

$$(5.12) \quad \left(\frac{X_m - MA}{MA} \right)_1 = \frac{X_m - MA}{MA} \quad \text{when the latter is positive,}$$

$$= 0 \quad \text{otherwise;}$$

$$(5.13) \quad \left(\frac{X_m - MA}{MA} \right)_2 = \left| \frac{X_m - MA}{MA} \right| \quad \text{when } \frac{X_m - MA}{MA} \text{ is negative,}$$

$$= 0 \quad \text{otherwise.}$$

Analogous definitions apply to $\left(\frac{X_m - X_m^*}{X_m^*}\right)_1$ and $\left(\frac{X_m - X_m^*}{X_m^*}\right)_2$.

When these split variables are substituted for the regular demand-proxy variables, the regression results become:

$$(5.14) \quad P^f = 7.392 + 61.40 \left(\frac{W}{A_m}\right) + 0.3439 P^x - 10.34 z - 0.1564 t$$

$$(2.107) \quad (6.140) \quad (0.05758) \quad (1.536) \quad (0.05415)$$

$$+ 8.691 \left(\frac{X_m - MA}{MA}\right)_1 + 5.690 \left(\frac{X_m - MA}{MA}\right)_2, \quad \bar{S}_u = 2.536,$$

$$(2.452) \quad (7.499) \quad R^2 = 0.9891,$$

$$(5.15) \quad P^f = 11.62 + 62.93 \left(\frac{K}{A_m}\right) + 0.2901 P^x - 7.521 z - 0.1276 t$$

$$(2.345) \quad (7.014) \quad (0.06782) \quad (1.408) \quad (0.05793)$$

$$+ 6.515 \left(\frac{X_m - X_m^*}{X_m^*}\right)_1 - 9.411 \left(\frac{X_m - X_m^*}{X_m^*}\right)_2,$$

$$(6.559) \quad (7.517)$$

$$\bar{S}_u = 2.765, \quad R^2 = 0.9870.$$

If there is symmetry of response (i.e., no irreversibility), then the sum of the coefficients of the partitioned demand-proxy variables should not be significantly different from zero. Equation (5.14) suggests, on the surface, that such irreversibility was present. Thus the influence of the positive deviations of output from the moving geometric mean is stronger than the influence of all the values of this demand-proxy variable. Furthermore, negative values of this variable influence price levels perversely, although not in a statistically significant manner. In addition, this distinction raises the coefficient of multiple determination slightly. However, the standard error of the sum of these two coefficients, if the estimated covariance

term is taken into account, is 8.765. The t ratio becomes $\frac{14.381}{8.765}$ or 1.64. This discrepancy is not statistically significant, even at the 5 per cent level with a one-tailed test. Hence while intriguing, this apparent asymmetry is not conclusive evidence that these prices moved upward more easily under the pressure of high demand than they moved downward when demand was low.

The same conclusion easily falls out of equation (5.15). Here the modification worsens the fit after a correction for degrees of freedom is made. (\bar{S}_u is lower for equation (5.11) than for this equation.) The t ratio of the sum of these two coefficients to the estimated standard error of this sum is 0.24. This corroborates the apparent symmetry of movement and is consistent with the final conclusion about equation (5.14).

Another possible irreversibility is that high past levels of costs may have a persisting influence. A plausible hypothesis is that one determinant of current prices is the previous peak level of costs, as this high structure of costs becomes built into particular prices, which are slow to readjust downwards. To test one variant of this thesis, we may define w_{peak} as the highest value of the money wage in manufacturing, w , from the beginning of the period to the current date. In symbols, this variable is defined by the expression:

$$(5.16) \quad w_{\text{peak}} \text{ at time } t = \text{Max. } (w_1, w_2, \dots, w_t),$$

where w_1 refers to the value of w in 1913, w_2 refers to the

value of w in 1914, and so on up to the current value of this variable. (The symbol Max. denotes the maximum value of the numbers enclosed by the succeeding parentheses.) An analogous definition applies to $\left(\frac{w}{A_m}\right)_{\text{peak}}$.

A method of testing for this type of irreversibility is to introduce both of these variables, one at a time, into the finished goods wholesale price regressions. The relations then become:

$$(5.17) \quad P^f = 9.448 + 55.26 \left(\frac{w}{A_m}\right) + 0.3392 P^r - 8.995 z - 0.2159 t$$

$$(1.797) \quad (9.229) \quad (0.06042) \quad (1.666) \quad (0.08643)$$

$$+ 5.518 \left(\frac{X_m - MA}{MA}\right) + 3.794 w_{\text{peak}},$$

$$(2.070) \quad (3.617)$$

$$\bar{s}_u = 2.587, \quad R^2 = 0.9886,$$

$$(5.18) \quad P^f = 11.16 + 52.82 \left(\frac{w}{A_m}\right) + 0.3293 P^r - 6.890 z - 0.2303 t$$

$$(1.759) \quad (9.658) \quad (0.06877) \quad (1.433) \quad (0.08952)$$

$$+ 6.758 \left(\frac{X_m - X_m^*}{X_m^*}\right) + 5.375 w_{\text{peak}},$$

$$(3.519) \quad (3.650)$$

$$\bar{s}_u = 2.691, \quad R^2 = 0.9877,$$

$$(5.19) \quad P^f = 6.067 + 59.92 \left(\frac{w}{A_m}\right) + 0.3326 P^r - 9.438 z - 0.1825 t$$

$$(3.517) \quad (6.648) \quad (0.05822) \quad (1.539) \quad (0.06468)$$

$$+ 6.521 \left(\frac{X_m - MA}{MA}\right) + 4.209 \left(\frac{w}{A_m}\right)_{\text{peak}},$$

$$(1.987) \quad (3.937)$$

$$\bar{s}_u = 2.586, \quad R^2 = 0.9886,$$

$$\begin{aligned}
 (5.20) \quad P^f &= 12.37 + 64.29 \left(\frac{W}{A_m}\right) + 0.2822 P^x - 7.734 z - 0.1166 t \\
 &\quad (3.824) \quad (8.201) \quad (0.07469) \quad (1.480) \quad (0.06722) \\
 &\quad + 8.315 \left(\frac{X_m - X_m^*}{X_m^*}\right) - 1.486 \left(\frac{W}{A_m}\right)_{\text{peak}} \\
 &\quad (3.826) \quad (4.503) \\
 \bar{S}_u &= 2.763, \quad R^2 = 0.9870 .
 \end{aligned}$$

The t ratios for the w_{peak} variable are 1.05 and 1.47, while the ratios of the coefficient of $\left(\frac{W}{A_m}\right)_{\text{peak}}$ to its standard error are 1.07 (for equation (5.19)) and 0.33. Thus neither of these variables is statistically significant in the regression relationships, and so there is no evidence of this type of irreversibility.

It should be noted, however, that these tests do not constitute conclusive evidence of the absence of irreversibility. Different or more sensitive tests might uncover asymmetry of response. Furthermore, it is quite possible that irreversibility characterized a portion of this era (e.g., the post-World-War-II years), but not the entire period. Thus the conclusion of reversibility in these relationships, over the period studied, is a tentative one.

6. Further Discussion.

In this section, equations (5.10) and (5.11) are examined more closely. Some discussion of autocorrelation in the residuals of these relations and of possible single equation biases is also presented.

Using mean values over the period studied, one may obtain average elasticities of the wholesale price index of finished goods with respect to the explanatory variables. For equation (5.10), a 1 per cent rise in $\frac{W}{A_m}$ is associated, on the average, with a 0.590 per cent increase in P^f . Similarly, the partial elasticity of P^f with respect to P^x , at the means of these variables, is 0.283. Ceteris paribus, P^f falls by 0.146 index points a year, which is approximately 0.2 per cent of the mean value of the wholesale price index of finished goods. During the period 1942-1946, P^f was 9.72 index points lower than it otherwise would have been; this magnitude represents 13.1 per cent of its mean value. Also from equation (5.10), one may calculate that a 1 per cent rise in manufacturing output, X_m , relative to its "normal value," MA , was associated with a rise in P^f which was 0.084 per cent of the mean value of this price level variable. Thus, although the demand-proxy variable (the relative discrepancy of manufacturing output from its logarithmic moving average) was found to have a statistically significant influence (by ordinary tests), its importance would appear to be decidedly secondary.¹²

12. Kuh (op. cit.) also introduced a demand variable into his price level equation. As summarized in Chapter I above, this variable is the ratio of current output to "capacity output," where "capacity output" is defined as previous peak output adjusted, in certain cases, for the growth of capacity in the corporate sector. Kuh also found that this demand-proxy variable had a statistically significant influence, though it was of lesser importance than his two labor cost variables. The sensitivity of the corporate product price index to variations in Kuh's demand-proxy variable is somewhat greater than that of P^f to the present author's demand-proxy (Footnote 12 continued on bottom of next page.)

The constant term is 12.54 per cent of the mean value of the wholesale price index of finished goods.¹³

Scanning the residuals of equations (5.10) and (5.11), the author was led to suspect autocorrelation. Calculation of the von-Neumann-Hart statistic $\left(\frac{s^2}{S^2}\right)$ yielded the value 1.236 for equation (5.10) and 1.045 for equation (5.11). For samples of the size employed (45 observations), the hypothesis of positive autocorrelation must be accepted at the 1 per cent level of statistical significance.¹⁴ Thus the results are less certain and the statistical tests involving the estimated standard errors less valid, because of the presence of this phenomenon.

Footnote 12 continued from bottom of previous page.

variables, as measured by equations (5.10) and (5.11). The elasticity of Kuh's price index with respect to his demand-proxy variable is 0.22. This elasticity corresponds closely to the present author's measure in the text above, because the mean of Kuh's demand-proxy variable is very close to unity.

In this connection, it may be recalled that L. A. Dicks-Mireaux experimented with his and J. C. R. Dow's index of the excess demand for labor as a proxy for the influence of ex ante demand for goods and services. Dicks-Mireaux found, however, that this variable did not contribute very much to his explanation of the index of final prices at factor cost.

13. For equation (5.11), the numerical analysis yields similar conclusions, as one might expect. Thus the elasticity of P^f with respect to $\frac{W}{A_m}$ is 0.595, while with respect to P^x it is 0.263. From this equation, one may calculate that a 1 per cent rise in X_m (relative to X_m^*) leads to a rise in P^f which is 0.106 per cent of the period mean value of this price level variable.

14. B. I. Hart and John von Neumann, op. cit.

In Appendix C, t ratios for the variables of equation (5.10), adjusted for the disturbing effects of autocorrelation of the estimated residuals, are tabulated. The method of adjustment is one outlined by H. Theil.¹⁵ In general, the adjusted standard errors are much larger than their respective unadjusted values. In strict statistical theory, only the coefficients of the $\frac{W}{A_m}$ variable and of the z variable remain statistically significant. The influence of the other three variables becomes little more than an interesting suspicion, which receives only small support from the evidence at hand.

Another possible source of inaccuracy is the presence of single equation bias. Thus the author has estimated, by ordinary least squares, the parameters of a relationship which really belongs in a larger model. Thus wage costs influence prices, but price changes in turn influence the change in money wages, as the results of Chapters III and IV suggest. Similarly, just as high ex ante demand is a factor in producing high prices, the level of prices can be expected to be a determinant of demand and hence of the observed level of output.

15. H. Theil, Economic Forecasts and Policy (Amsterdam: North Holland Publishing Company, 1961), pp. 224-225. In applying this technique, one assumes that only the first order autocorrelation is non-negligible, that the residuals have a constant variance, and that the different explanatory variables have no lagged intercorrelations, i.e., that each explanatory variable is not correlated with the lagged values of any other explanatory variable. This last assumption permits a great reduction of the computational burden and so it was used, even though it is not strictly true. In view of the magnitude of the corrections, it seems unlikely that the standard errors would be increased much more if this assumption were relaxed.

Nevertheless, the bias from these sources could be mild. The price index used as the dependent variable is the wholesale price index of finished goods, while the price index most relevant to wage determination is the consumer price index. Some prices included in this wholesale price index do not enter the consumer price index (e.g., capital goods prices), and even those which do have retailing mark-ups applied to them. Furthermore, the prices of manufactured goods account for only 35 per cent (roughly) of the weights in the Bureau of Labor Statistics' Cost of Living Index. The main direction of causation should be from raw materials prices to finished goods prices, so that the error from this feedback is likely to be mild. t and z are, of course, exogenous variables. Only with regard to the demand-proxy variables does single equation bias appear to present serious difficulties. But prolonged speculation is futile, if not dangerous; the appropriate way to resolve this issue is to use ^{a Con-} ~~an un-~~ ^{sistent} biased method of parameter estimation. The method of two stage least squares has been employed to re-estimate the parameters of equation (5.10), and the results are presented at the end of the following chapter.

Appendix A

The data underlying the text calculations are given below. Definitions and sources are stated in the text.

Table VII

The Wholesale Price Index for Finished Goods (P^f), Manufacturing Output per Man-Hour (A_m), Manufacturing Wage Costs ($\frac{W}{A_m} \times 100$), the Wholesale Price Index of Crude Materials for Further Processing (P^r), the Unit Value Index of Imported Crude Materials (I^r), Manufacturing Output (X_m), Nine Year Moving Average of Manufacturing Output (MA), and Trend Level of Manufacturing Output (X_m^*), U.S.A., 1905-1957.

Year	P^f (1947-1949 = 100)	A_m (1929 = 100)	$\frac{W}{A_m} \times 100$ (\$ per hour)	P^r (1947-1949 = 100)	I^r (1923-1925 = 100)	X_m (Index points: 1929 = 100)	MA (Index points: 1929 = 100)	X_m^* (Index points: 1929 = 100)
1905						39.0		
1906						41.6		
1907						42.1		
1908						33.7		
1909						43.4		
1910						45.1		
1911						42.7		
1912						51.3		
1913	47.1	58.8	\$0.376	40.9	72	53.8	43.3	59.7
1914	46.0	59.1	0.372	40.2	67	51.1	44.6	60.6
1915	46.7	66.7	0.339	39.9	65	59.9	46.4	61.5
1916	55.8	65.6	0.399	49.1	82	71.2	49.2	62.4
1917	74.0	61.0	0.518	72.9	101	70.6	53.4	63.3
1918	84.6	60.9	0.685	80.7	106	69.8	56.3	64.2
1919	88.6	58.0	0.822	86.7	117	61.0	58.3	65.1
1920	101.6	61.5	0.899	90.2	129	66.0	61.1	66.1

Table VII (Continued)

Year	P^f (1947-1949 = 100)	A_m (1929 = 100)	$\frac{w}{A_m} \times 100$ (\$ per hour)	P^r (1947-1949 = 100)	I^r (1923-1925 = 100)	X_m (Index points: 1929 = 100)	MA (Index points: 1929 = 100)	X_m^* (Index points: 1929 = 100)
1921	70.0	71.0	0.687	52.5	72	53.5	61.4	67.0
1922	65.4	80.4	0.561	57.0	80	68.1	63.0	68.0
1923	67.3	77.4	0.645	58.5	95	76.9	66.0	69.0
1924	65.3	82.3	0.627	58.0	92	73.4	67.5	70.0
1925	68.2	87.7	0.585	63.4	113	81.9	68.6	71.0
1926	67.8	89.4	0.578	59.4	112	86.2	70.1	72.1
1927	64.4	91.5	0.570	57.3	94	87.1	71.8	73.1
1928	65.0	95.6	0.546	58.9	86	90.1	75.0	74.2
1929	64.1	100.0	0.534	57.9	80	100.0	78.6	75.3
1930	59.7	100.7	0.526	50.1	63	85.6	82.8	76.4
1931	52.2	103.9	0.487	39.0	43	72.0	83.3	77.5
1932	47.7	97.1	0.459	32.7	30	53.8	80.0	78.6
1933	47.8	105.7	0.417	33.6	31	62.8	78.7	79.8
1934	53.0	110.4	0.477	40.8	37	69.1	77.2	80.9
1935	55.7	117.6	0.461	45.8	40	82.8	76.8	82.1
1936	55.6	118.5	0.467	47.5	47	96.8	77.8	83.0
1937	59.1	116.9	0.541	50.4	56	103.3	78.9	93.5
1938	55.7	114.9	0.556	42.8	47	80.9	77.1	105.3
1939	54.5	125.8	0.507	41.7	51	102.5	78.7	118.7
1940	55.3	131.9	0.508	42.7	56	118.6	83.2	133.8
1941	60.4	136.7	0.539	49.6	58	157.9	93.7	150.7
1942	66.9	139.1	0.621	59.8	66	197.2	106.4	169.8
1943	67.9	141.0	0.691	66.6	73	238.1	122.1	191.4
1944	68.4	139.4	0.753	67.3	77	232.5	137.0	215.6
1945	69.0	137.5	0.771	69.4	80	196.5	148.1	243.0
1946	77.9	126.4	0.894	80.0	81	160.6	155.6	164.9

Table VII (Continued)

Year	P^f (1947-1949 = 100)	A_m (1929 = 100)	$\frac{W}{A_m} \times 100$ (\$ per hour)	P^r (1947-1949 = 100)	I^r (1923-1925 = 100)	X_m (Index points: 1929 = 100)	MA (Index points: 1929 = 100)	X_m^* (Index points: 1929 = 100)
1947	95.9	133.8	0.972	98.6	90	178.3	169.9	172.8
1948	103.5	138.6	1.02	108.0	101	184.2	181.3	181.0
1949	100.6	143.7	1.02	93.4	97	173.5	189.2	189.7
1950	102.4	155.3	0.998	101.8	106	201.1	194.3	198.8
1951	112.1	153.3	1.13	116.9	155	214.3	196.1	208.2
1952	111.5	157.1	1.16	107.4	128	223.6	194.8	218.1
1953	110.4	163.9	1.18	99.2	115	243.4	195.8	228.5
1954	110.7	168.5	1.17	98.3	112	228.2	199.0	239.4
1955	110.9	179.7	1.14	94.5	118	255.9	209.6	250.8
1956	114.0	183.2	1.17	95.0	121	264.3	219.0	262.8
1957	118.1	187.1	1.21	97.2	125	264.6	227.9	275.3
Mean	74.2	113.2	0.702	66.5	83.7			

Appendix B

In this appendix, all symbols have the same meaning as in the text. Equations (b.1) and (b.2) are calculated from data for the entire period; for equations (b.3) and (b.4), the period 1942-1946 is not included. The method of parameter estimation is single equation least squares.

$$(b.1) \quad P^f = 8.702 + 60.87 \left(\frac{w}{A_m} \right) + 0.3432 P^x - 0.1997 t \\ (2.532) \quad (8.811) \quad (0.07901) \quad (0.07667) \\ - 0.3507 \left(\frac{X_m - MA}{MA} \right), \quad \bar{S}_u = 3.661, \\ (2.373) \quad R^2 = 0.9760.$$

$$(b.2) \quad P^f = 8.503 + 66.39 \left(\frac{w}{A_m} \right) + 0.2859 P^x - 0.2188 t \\ (2.252) \quad (9.073) \quad (0.08592) \quad (0.07205) \\ + 5.658 \left(\frac{X_m - X_m^*}{X_m^*} \right), \quad \bar{S}_u = 3.593, \\ (4.566) \quad R^2 = 0.9769.$$

$$(b.3) \quad P^f = 9.227 + 62.87 \left(\frac{w}{A_m} \right) + 0.3147 P^x - 0.1513 t \\ (1.744) \quad (6.066) \quad (0.05457) \quad (0.05324) \\ + 4.758 \left(\frac{X_m - MA}{MA} \right), \quad \bar{S}_u = 2.507, \\ (2.265) \quad R^2 = 0.9901.$$

$$(b.4) \quad P^f = 10.54 + 63.80 \left(\frac{w}{A_m} \right) + 0.2949 P^x - 0.1423 t \\ (1.692) \quad (6.556) \quad (0.06201) \quad (0.05391) \\ + 5.943 \left(\frac{X_m - X_m^*}{X_m^*} \right), \quad \bar{S}_u = 2.560, \\ (3.564) \quad R^2 = 0.9896.$$

Appendix C

The following table refers to equation (5.10) of the text. The method of adjusting the standard errors for autocorrelation of the estimated residuals is cited in the text.

Table VIII

Calculation of Adjusted t Ratios for the Variables of Equation (5.10)

Statistic Variable	$\frac{W}{A_m}$	P^r	t	z	$\frac{X_m - MA}{MA}$
Coefficient	62.40	0.3155	-0.1458	-9.716	6.202
Standard Error (Unadjusted)	6.241	0.05609	0.05491	1.520	1.968
t Ratio (Unadjusted)	9.998	5.625	-2.655	-6.392	3.151
Standard Error (Adjusted)	28.04	0.2448	0.1829	2.252	3.945
t Ratio (Adjusted)	2.23	1.29	-0.797	-4.31	1.57

As a result of these corrections, only the coefficients of $\frac{W}{A_m}$ and of z retain statistical significance. The t ratio for $\frac{X_m - MA}{MA}$ is still suggestive, however.

Chapter VI, "Time Patterns of the Average Product of
Labor and Some Full System Parameter Estimates"

Our attention now focuses on trends in the average product of labor. These movements are of interest because of the importance of labor productivity for labor costs. High labor productivity is associated, ceteris paribus, with low labor costs; furthermore, rapidly rising labor productivity allows money wages to rise rapidly without increasing labor costs. If, however, money wages rise more rapidly than output per man-hour, labor costs increase and pressures on the existing level of prices appear. In Chapter III, this proposition was combined with the wage adjustment relations of that chapter and other assumptions, in an attempt to estimate approximate unemployment "required" for price level stability. In this chapter, the task is primarily one of describing productivity trends over the period 1900-1957. Is the assumption that the growth rate of output per man-hour is $2\frac{1}{2}$ per cent per annum (the rate assumed in Chapter III) a reasonable one? Is there any evidence that productivity growth has accelerated over this period? The author will address himself to these two questions and to a possible relationship between productivity and a variable representing the degree of utilization of the labor force. (After several alternatives were tried, the percentage of the labor force unemployed was selected for this purpose.)

In the final section of this chapter, the two stage least squares method of parameter estimation is briefly described, in

relation to the wage-price-productivity nexus. The first stage results are tabulated in outline, and then the parameters of the final working wage change, price level, and productivity equations (in Chapters III through VI) are re-estimated in the second stage. Finally, the statistical results are discussed with regard to some of the earlier questions of economic structure.

The measure of the average productivity of labor is the real gross output of the private domestic economy divided by total man-hours of labor input. This measure was described in Chapter IV; the original source of this series is Kendrick's work.¹ This series, which is designated by the symbol A, appears in Appendix A of Chapter IV. A graphical presentation of labor's average product is given in Figure 10. The units of this variable are index points, the base year being 1929, and its mean level over the 1900-1957 period is 108.25.

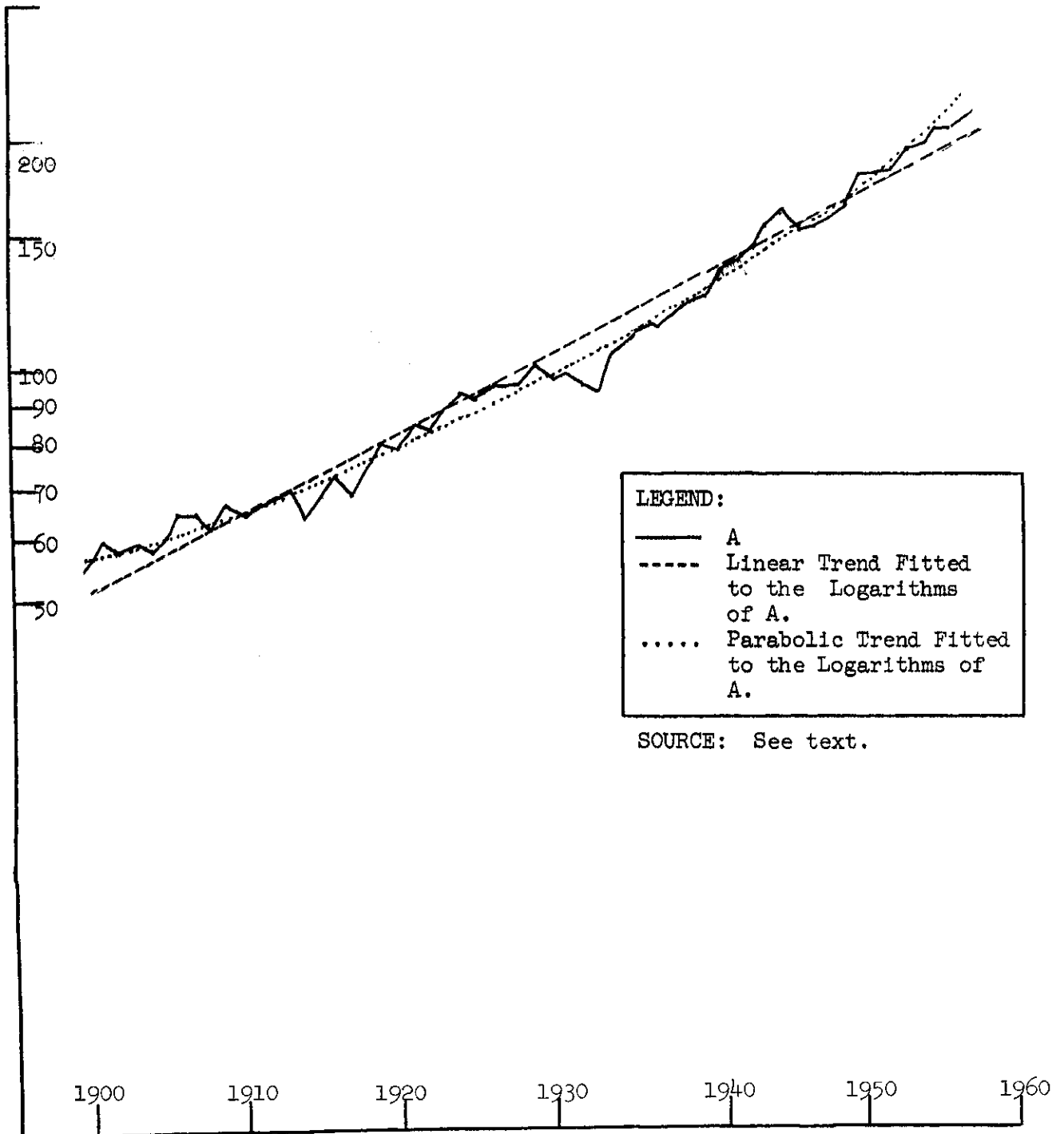
In one sense, it is enough to know that productivity rises, year after year; these rises are the source of higher living standards and, more relevant to our problem, of reduced labor cost pressures. But it is also interesting to inquire as to the place of these productivity growth relationships in a theoretical, macro-economic description of the economy, such as the model of Chapter II. If we write:

$$(6.1) \quad A \equiv \frac{Y}{N} = f(t),$$

1. John W. Kendrick, *op. cit.*, Table A-XXII, pp. 333-335. (The figures for 1900-1954 were taken directly from this source.) The source of the 1955-1957 values was the present author's interview with Mrs. Maude R. Pech on April 20, 1961, at the National Bureau.

FIGURE 10. The Average Productivity of Labor (A), with Two Fitted Trend Equations, U.S.A., 1900 - 1957.

Index Values of A
(logarithmic
scale):



SOURCE: See text.

where Y is real output, N is man-hours input, and t is a time trend, several propositions can be stated. First, at any point in time A is constant. This implies that as of an instant of time, total output is proportional to man-hour inputs. This statement suggests that the productivity equation can be viewed as an empirical counterpart of a production function. It is an extremely simple production function for, even with a fixed stock of capital, one might expect to have increasing returns to this fixed factor or (at a different stage) diminishing returns. At one point in time, equation (6.1) will permit only proportional returns and so it is not a general formulation. But it nevertheless is one formulation of the aggregate production function, and this simplification may prove useful, for certain purposes.

If we postulate that the first derivative of the f function is positive, A will grow over time. In the past, this growth has principally reflected technological progress, higher capital-labor ratios, and improving quality of the labor force.² It is not the

2. See Kendrick, op. cit., especially Chapters 3 and 4. Other references which may be cited in defense of this rather bald statement include Theodore W. Schultz, "Investment in Human Capital," American Economic Review, Volume LI, No. 1 (March 1961), pp. 1-17, and Robert M. Solow, "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, Volume XXXIX, No. 3 (August, 1957), pp. 312-320.

Another influence which may have contributed to the growth of output per man-hour is economies of scale. Improving efficiency in the allocation of resources is another possibility, of which the effects, in the present author's view, were at most of minor importance.

author's purpose to inquire into the fundamental causes of productivity growth. It should be noted, however, that these underlying forces shift the static production function over time; at a later date it is possible to get a larger real output with the same man-hour inputs than was possible at an earlier date. The patterns of productivity growth are one of the two subjects of study of this chapter.

1. Two Empirical Equations of Productivity Growth

An examination of Figure 10 suggests that a semi-logarithmic trend is a suitable start in describing productivity growth. The time variable t is equal to zero in 1900 and is in annual units. The least squares regression of the logarithm to the base 10 of A ($\log A$) on t is:

$$(6.2) \quad \log A = 1.7066 + 0.01025 t, \quad r^2 = 0.9765, \\ (0.00702)(0.00021) \quad \bar{S}_u = 0.0271.$$

(As before, the numbers in parentheses are standard errors, r^2 is the coefficient of determination, and \bar{S}_u is the estimated standard deviation of the residuals, corrected for degrees of freedom. The productivity variable A is not given a time subscript.) Equation (6.2) is represented by the dashed line of Figure 10. Both the constant term and the trend coefficient are many times their respective standard errors and so are highly significant. Equation (6.2) implies that output per man-hour grew at an average rate of 2.39 per cent per annum, for the private domestic economy. This is only slightly lower than

the rate of growth of labor productivity assumed in Chapters III and IV.

An examination of Figure 10 suggests the possibility of an accelerating relative rate of growth of productivity, over the 1900-1957 period. To test for this possibility, the author introduced a t^2 term into the productivity equation. The results are:

$$(6.3) \quad \log A = 1.7507 + 0.005532 t + 10^{-4} \times 0.8281 t^2, \\ (0.00651) \quad (0.000528) \quad (10^{-4} \times 0.0896), \\ R^2 = 0.9908, \\ \bar{S}_u = 0.0171.$$

The coefficient of t^2 is more than nine times its standard error and so is highly significant by ordinary standards. Moreover, the fit is improved by this introduction; the coefficient of determination increases by more than one percentage point. Consequently, we may tentatively conclude that there is evidence of a speeding up of productivity growth over this period. From equation (6.3), one can calculate that in 1900, the predicted rise in output per man-hour, in the private domestic economy, was 1.30 per cent per annum. By 1929 this predicted productivity growth had risen to 2.43 per cent per annum, while in 1957 the predicted growth rate was 3.53 per cent. Equation (6.3) is represented by the dotted curve of Figure 10.³

3. In studying these and related data, Kendrick (*op. cit.*, Chapter 3) also noted that productivity increased more rapidly in a more recent period than at an earlier date. Kendrick prefers to consider this acceleration as a break in the linear trend (of the logarithm of A) around 1919, the growth rate being greater after (Footnote 3 continued on bottom of next page.)

2. The Influence of the Degree of Labor Force Utilization.

It is sometimes asserted that productivity is higher if the economy-wide utilization of the labor force is greater. (This possibility was discussed in Chapter III above.) In order to test this proposition, one must obtain a variable representing the degree of utilization of the labor force.

One variable which can be taken to represent the degree of utilization of the labor force is unemployment as a proportion of the civilian labor force. Although this variable is not a perfect proxy, because it does not allow for underemployment from involuntary part-time work, it nevertheless would seem to be a good first approximation. The source of this variable, for the earlier years, is Lebergott's forthcoming book.⁴ Unemployment as a proportion of the labor force is designated by the symbol $\frac{U}{LF}$; its mean over the period 1900-1957 is 7.005×10^{-2} .

Footnote 3 continued from the bottom of the previous page.

this date than before. Kendrick suggests that the rise of "scientific management" around 1920 is a possible explanation of this break in trend. Kendrick works with the period 1889-1953 and his fundamental productivity measure is output per unit of weighted factor input, which includes both labor and capital inputs. Hence Kendrick's view that there was no additional acceleration after 1919 may depend, in part, upon these differences. This question is further discussed in Sections 2 through 4 below.

4. Stanley Lebergott, Manpower and Economic Growth: The American Record since 1800. The source of the more recent values of this variable is given in Chapter III above. As explained in that chapter, this series is not reproduced in the present work.

An alternative measure of labor force utilization may be constructed from a series of average weekly hours worked. From Kendrick's work, one can easily obtain estimates of average weekly hours worked per full-time engaged person, in the private economy.⁵ (This variable is measured in hours and is represented by the symbol h . The mean of h over the period studied is 47.92.) If the deviation of h from some "normal" value of itself is taken, hopefully one can isolate variations in the average work week which are attributable to cyclical fluctuations in labor utilization. In this manner, one can attempt to "wash out" the effects of the long-term downward movement in the average work week.

Two possible "normal" values of average weekly hours worked may be constructed. The first is a seven year moving average of the h series, centered on the fourth year. This variable, which is denoted by the symbol h_{MA} , may be represented in equation form as:

$$(6.4) \quad h_{MA} \text{ at time } t = \sum_{i=t-3}^{t+3} h_i,$$

5. This series was obtained by dividing Kendrick's series of Total Man-Hours for the Private Economy (Kendrick, *op. cit.*, Table A-X, 311-313) by his series of Persons Engaged in the Private Economy (*ibid.*, Table A-VI, pp. 305-307). The quotient is then divided by 52 to put it on a weekly basis. The h series appears in Appendix A of this chapter. The source of the figures for 1953-1957 is a letter dated January 25, 1962, from Mrs. Pech to the present writer.

where the subscript i refers to a time date.⁶ The second possible "normal" value of average weekly hours worked is a trend value of the h series, designated by the symbol h^* . h^* is a two segment linear trend, with a break in trend in 1926. (Thus the linear regression of h on t was calculated separately for the two sub-periods 1900-1926 and 1927-1957.) Both sets of possible "normal" values of average weekly hours worked are presented in Appendix A of this chapter. These two series, along with the h variable, appear in Figure 11. h^* is represented by the two dashed linear segments; h_{MA} is the dotted curve.

Each of these three possible labor force utilization variables may now be introduced into the productivity regressions. (A time diagram, not presented, suggested that there are no important lags in the influence of these variables on productivity growth. Consequently, the A variable remains without a time subscript and the labor force utilization variables are not time dated, either.) The computations yield:

$$(6.5) \quad \log A = 1.7518 + 0.006735 t + 0.6299 \times 10^{-4} t^2$$

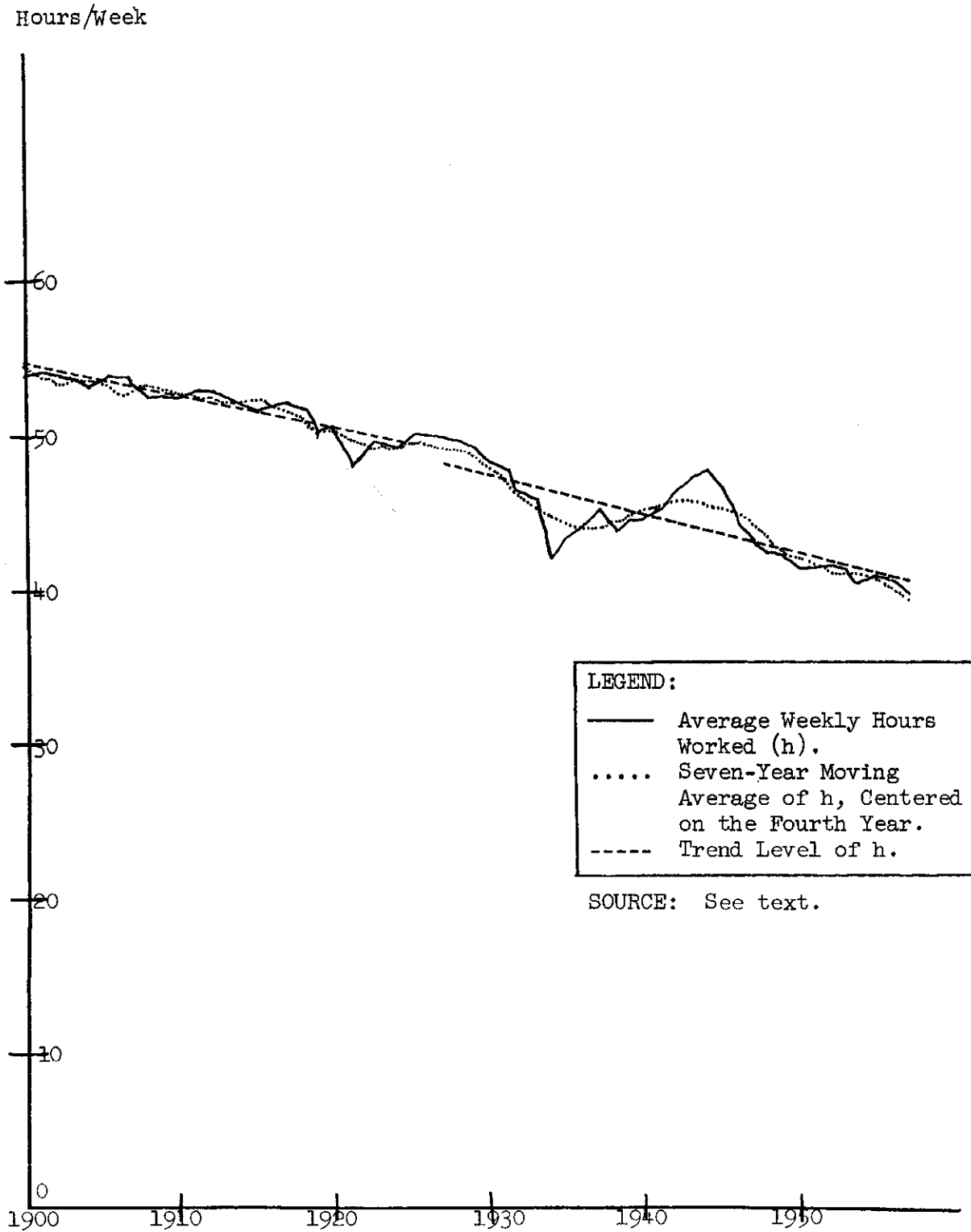
$$\quad \quad \quad (0.00505) \quad (0.000454) \quad (0.07665 \times 10^{-4})$$

$$\quad \quad \quad - 0.1957 \left(\frac{U}{LF} \right), \quad \bar{S}_u = 0.01325,$$

$$\quad \quad \quad (0.0320) \quad \quad \quad R^2 = 0.9946,$$

6. The h_{MA} values for 1900-1902 were computed by backward extrapolation of the line of semi-averages of this series for the period 1903-1908. The 1955-1957 figures were computed by a similar forward extrapolation of the values for 1949-1954.

FIGURE 11. Average Weekly Hours Worked per Full-Time Engaged Person (h) and Two "Normal" Values of This Series, U.S.A., 1900 - 1957.



$$(6.6) \quad \log A = 1.7508 + 0.005530 t + 0.8275 \times 10^{-4} t^2$$

$$\quad \quad \quad (0.00640) \quad (0.000520) \quad (0.0882 \times 10^{-4})$$

$$\quad \quad \quad + 0.2506 \left(\frac{h-h_{MA}}{h_{MA}} \right), \quad \bar{S}_u = 0.0168,$$

$$\quad \quad \quad (0.1504) \quad \quad \quad R^2 = 0.9913,$$

$$(6.7) \quad \log A = 1.7510 + 0.005493 t + 0.8352 \times 10^{-4} t^2$$

$$\quad \quad \quad (0.00612) \quad (0.000496) \quad (0.0842 \times 10^{-4})$$

$$\quad \quad \quad + 0.2233 \left(\frac{h-h^*}{h^*} \right), \quad \bar{S}_u = 0.0161,$$

$$\quad \quad \quad (0.07791) \quad \quad \quad R^2 = 0.9920.$$

Several comments on these equations may be offered. The coefficients of t and of t^2 remain many times their respective standard errors; thus we may tentatively conclude that the previously observed acceleration of productivity growth does not disappear when a cyclical variable is introduced into the regression relationships. Although the $\frac{h-h_{MA}}{h_{MA}}$ variable is not quite statistically significant, it should be noted that the coefficients of $\frac{U}{LF}$ and of $\frac{h-h^*}{h^*}$ are more than two times their respective standard errors and hence are statistically significant, by usual standards. From equation (6.5), one may calculate that a rise in unemployment 1 per cent of the civilian labor force gives rise, on the average, to a 0.45 per cent fall in output per man-hour. Similarly, equation (6.7) leads to the conclusion that an increase in average weekly hours worked, 1 per cent of the trend value of this variable, is associated with a 0.51 per cent increase in labor's

average productivity.⁷ The varying yearly rates of productivity growth predicted by equations (6.5) and (6.7) are tabulated in Table IX. The coefficient of multiple determination is highest for equation (6.5) and indicates that only half of one per cent of the variance of log A is "unexplained" by this relationship. For this reason, and because the coefficient of $\frac{U}{LF}$ is more than six times its standard error, equation (6.5) is tentatively selected as the final productivity equation for further discussion and study.

7. Both Kendrick and Kuh calculate similar regressions in order to gauge the effects of cyclical influences on productivity levels. For the period 1919-1953, Kendrick calculates the regression of the logarithm of his total factor productivity variable on a linear time trend variable, using the ratio of employment to the civilian labor force as an additional explanatory variable. He finds that a 1 per cent decline in this employment ratio (a 1 per cent rise in percentage unemployment) is associated with a 0.6 per cent decrease in productivity, on the average. Thus his estimate of the sensitivity of productivity to the level of unemployment is nearly the same as the present writer's despite differences in the period studied and the productivity concept employed. (See Kendrick, op. cit., pp. 67-68.)

Kuh (op. cit., p. 85) introduces absolute output as a cyclical variable into his productivity trend regression. He also finds that the level of productivity is higher when the cyclical explanatory variable is high than when it is low.

Table IX.

Calculated Rates of Growth of Labor Productivity (A), Based on Equations (6.5) and (6.7), U.S.A., Selected Years.

Year	1900	1929	1957
Rate of Growth from (6.5)	1.58%	2.44%	3.27%
Rate of Growth from (6.7)	1.29%	2.43%	3.54%

Source: See text.

The preceding results indicate that the level of productivity is sensitive to cyclical variations in the utilization of the labor force. It is interesting to inquire whether the rate of growth of productivity is similarly sensitive. Thus it might be thought that periods of slack employment would be periods of low productivity growth, as the percentage of net national product devoted to capital formation tends to be lower during such periods. In addition, it is possible that technological change itself proceeds less rapidly during such periods, as the stimulus of producing beyond present output limits is no longer so pressing.

The author tested this possibility by calculating two regressions of the form:

$$(6.8) \quad \log A_t - \log A_{t-1} = \alpha + \beta t + \gamma z_t^* + u_t .$$

Here the t subscript indicates a time date, u_t is a disturbance term, and α , β , and γ are parameters. z^* is a cyclical variable representing the degree of utilization of the labor force. (The cyclical variables employed were the two which were significant in the

productivity level regressions.) This test yielded very little additional information, and so the results are relegated to Appendix B of this chapter. For both regressions, the coefficients of multiple determination were so low that no definite conclusions may be drawn from these results. For instance, these regressions call into question the growth of the productivity series itself, which is almost certainly incorrect. The errors of observation inherent in the productivity series may be preventing an accurate regression analysis of productivity changes.⁸

Before leaving this question, we may observe that a portion of Kendrick's work is relevant here. Kendrick subdivides the period 1889-1957 into years of expansion and years of contraction, following the chronology of the National Bureau's dating of reference cycles. He then calculates average percentage changes in productivity for the two sets of years separately. Kendrick finds that the average percentage change in productivity is higher for the years of expansion than for the years of contraction. This is true without regard to whether the productivity concept is total factor productivity or output per unit of labor input.⁹ (Labor inputs are weighted man-hours.) Because the

8. In discussing his data, Kendrick states, "Trend movements are more accurate than shorter period changes...." (Op. cit., p. 13.)

9. Ibid., pp. 73-74, especially Table 5. One piece of conflicting evidence is that for the subperiod 1919-1957, the average annual productivity changes are slightly higher for the years of reference contraction, if the productivity concept is output per unit of labor input. (Even for this subperiod, however, total factor productivity grows more rapidly, on the average, in the expansion years than in the contraction years.)

labor force is more fully utilized during the years of reference expansion than during the years of contraction, this suggests that productivity growth may also be higher during periods of fuller utilization of the labor force.

3. Further Discussion of the Productivity Relationships.

Some further comments may be appropriate. Examining the residuals of equations (6.5) and (6.7), the author suspected the presence of autocorrelation. Calculation of the von-Neumann-Hart statistic $\left(\frac{\delta^2}{S^2} \right)$ yields the value 1.307 for equation (6.5) and 1.173 for equation (6.7). For the sample size employed, the hypothesis of positive autocorrelation must be accepted at the 1 per cent level of statistical significance.¹⁰ The Theil technique¹¹ has been used to adjust the standard errors of equation (6.5) for autocorrelation of the estimated residuals, and the adjusted *t* ratios for the variables of this regression are tabulated in Appendix C. The correction procedure calls into question the statistical reliability of the observed acceleration of productivity growth, although the presence of growth itself and the responsiveness of the level of productivity to cyclical influence remain fairly firm conclusions.

10. B. I. Hart and John von Neumann, op. cit.

11. H. Theil, op. cit., pp. 224-225. For a brief statement of the underlying assumptions, see footnote 15 of Chapter V.

Another problem is the possibility of single equation bias. Productivity growth, as an aspect of an aggregative production function, properly belongs in a full model of the economic system. Feedback relationships may distort the values of parameters estimated by single equation methods. Thus the degree of utilization of the labor force affects productivity levels, as we have seen; but in turn the level or rate of growth of productivity may influence the unemployment rate or another measure of the degree of labor force utilization. (For example, discussions of technological unemployment have demonstrated that increased unemployment may accompany increased productivity, if aggregate demand does not increase sufficiently to absorb the additional output which the economy is capable of producing after such changes.) For this reason, single equation bias may be vitiating to some extent the estimates of the parameters of equations (6.5) and (6.7). In the following section, the method of two stage least squares, which is ^{asymptotically} free of such a bias, is used to re-estimate the parameters of equation (6.5).

Some further comments on the direction of effect of the cyclical variables of relations (6.5) and (6.7) may be offered. For both of these equations, it is found that labor's average product (output per man-hour, in the private domestic economy) rises as the degree of labor force utilization increases. This might be thought to contradict the existence of diminishing returns for the short run aggregative production function, which was postulated in Chapter II. This is indeed one possibility. Another is that most

of our observations are taken from periods during which labor's average product was in a rising stage while its marginal product, though of course higher than the average product, was falling. This is no more than a conjecture, substantiated by no empirical evidence presented herein. But the presence and the importance of overhead labor, emphasized by Schultze and Lydall,¹² suggest that this view is at least plausible. However, it must be admitted that the results of this chapter, although they can be rationalized so as to be consistent with aggregative diminishing returns (a falling marginal product) to labor, are not a strong confirmation of this hypothesis.

Finally, what is the likely average rate of productivity growth in the near future? If the average growth rate is extrapolated from equation (6.2), the simplest productivity equation fitted, the answer is roughly 2.4 per cent per annum. This, however, makes no allowance for the fact that the average growth of productivity was higher in the later years of this period than in the earlier years. Still, it would seem overly optimistic to extrapolate indefinitely the estimated accelerating trends of productivity. Thus Kendrick points out that the rapid growth of output per man-hour from the end of World War II to 1957 was associated with an extremely high rate of increase of capital per worker.¹³ At least some portion of

12. Charles L. Schultze, op. cit., especially Chapter 4; H. F. Lydall, op. cit.

13. Kendrick, op. cit., p. 70.

this high rate of investment must have been associated with wartime shortages and the wastage of the Great Depression of the 1930's, and so it would represent a temporary "catching up" of actual capital stocks to desired levels. Indeed, the performance of the American economy between 1957 and the present (1962) has led some observers to assert that productivity growth has "slowed down" in recent years. Although this "slowing down" view may prove to be a premature conclusion, nevertheless it would seem unrealistic to expect an indefinite continuation of accelerating productivity growth. However, it does seem plausible that productivity will continue to grow and to grow more rapidly than at its historical average rate. The assumption of a 2.5 per cent per annum growth rate, used in Chapter III, may perhaps be as good as any; while not extremely precise, this would seem to be of the right order of magnitude. Furthermore, any exact prognostication of productivity growth would seem to be beside the point since this phenomenon is, to some extent at least, susceptible to control by public policy. Education outlays, expenditures on research and measures to encourage private research, and monetary policy designed to stimulate capital formation can each affect productivity levels and growth, to some extent.

4. Estimates of the Parameters of the Wage, Price, and Productivity Equations by the Method of Two Stage Least Squares.

In this section, the parameters of the working relationships of this chapter and the preceding two chapters are re-estimated by the method of two stage least squares. After the estimation procedure is

outlined and the results presented, the implications for questions of economic structure are briefly explored.

Parameters are re-estimated for the following six regressions: equation (3.4), the final wage adjustment relationship of Chapter III; equation (3.15), the working wage adjustment relation of Chapter III with three outlier years omitted; equation (4.8), a wage adjustment relationship with changes in unemployment as an explanatory variable; equation (4.10), a wage adjustment relation with productivity change as an explanatory variable; equation (5.10), the working price level relationship of Chapter V; and equation (6.5), the final productivity relation of this chapter. In this section, all of the variables appearing in these relationships are denoted by the symbols originally assigned to them, with one exception. The time trend variable t is still measured in annual units but is now equal to zero in 1935. (This was the definition of t in Chapter V, but not in Chapters III and IV and the first three sections of this chapter.) For all calculations, the period of analysis is 1913-1957.

For the method of two stage least squares, the explanatory variables must be divided into an endogenous group and an exogenous group. The set of endogenous variables is determined within the system, while the exogenous variables are not explained by the researcher's full economic model, which may be implicitly or explicitly formulated. Scanning the six equations listed above, the author decided to take as exogenous only the time trend t and the dummy variable z . The following eight explanatory variables are considered endogenous: the

level of unemployment (U), the change in the consumer price level (ΔP), unemployment changes (ΔU), the change in labor's average productivity (ΔA), manufacturing wage costs ($\frac{W}{A_m}$), the raw materials price index (P^r), the relative deviation of manufacturing output from its "normal" geometric moving average value ($\frac{X - MA}{MA}$), and unemployment as a proportion of the civilian labor force ($\frac{U}{LF}$). In the exposition below, a member of this group of variables is occasionally designated by the symbol S_i , $i = 1, 2, \dots, 8$.

The first task is to obtain calculated values of these endogenous variables. This is done by regressing, in the first stage, each endogenous variable on the entire set of exogenous variables. In this manner, one obtains series which look very much like the original endogenous variables but which are not correlated with the disturbance terms of the relations to be estimated. The calculated series may then be used in estimating the parameters of these final relations without incurring biases. At present, however, we have only two exogenous variables. Considerations of statistical efficiency necessitate a larger number of exogenous variables. Consequently, some variables which do not appear in the original relationships but which may reasonably be expected to be exogenous in a larger system may be employed. After some experimentation, the author selected the following additional exogenous variables for use in the first stage: real government purchases of goods and services, denoted by the symbol G ; a quantity index of U.S. merchandise exports, designated by the symbol E ; a unit value index

of imported crude materials, which was assigned in Chapter V the symbol I^r ; the effective rate of income tax liability for a family with 4 exemptions and \$5000 of net income, represented by the symbol R ; total deposits (demand deposits and time deposits) adjusted and currency outside banks, denoted by the symbol M ; and the previous year's values of the unemployment level, of the change in the consumer price index, of manufacturing wage costs, and of the relative deviation of manufacturing output from its "normal" MA value.¹⁴

For the particular estimation problem at hand, the first stage regressions take the form:

$$(6.8) \quad S_{it} = \alpha_{i0} + \alpha_{i1} t + \alpha_{i2} z_t + \alpha_{i3} G_t + \alpha_{i4} E_t + \alpha_{i5} I_t^r \\ + \alpha_{i6} R_t + \alpha_{i7} M_t + \alpha_{i8} U_{t-1} + \alpha_{i9} \Delta P_{t-1} + \alpha_{i10} \left(\frac{W}{A_m} \right)_{t-1} \\ + \alpha_{i11} \left(\frac{X_m - MA}{MA} \right)_{t-1} + v_{it}, \quad i = 1, 2, \dots, 8.$$

In these equations, the alphas are regression parameters, v_{it} is a disturbance term, and the variables are time dated by the t subscript. The i subscript, which is also attached to the regression

14. The G variable is obtained (for the years 1913-1953) from Kendrick, *op. cit.*, Table A-IIa, pp. 293-295; the 1954-1957 values are taken from Mrs. Pech's letter of July 16, 1962. The E , R , and M variables are taken from Historical Statistics. (The respective sources are Table U 21, p. 540; Table Y 323, p. 717; and Table X 266, p. 646. For the merchandise exports variable, two separate series have been put on a common base.) The I^r variable is reproduced in Appendix A of Chapter V, and its source is given in that chapter.

parameters and to the disturbance term, refers to the particular endogenous variable which has its calculated values generated by the regression equation under consideration.

These regressions have been fitted to the data for 1913-1957. The associated coefficients of multiple determination are presented in the table below.

Table X.

Coefficients of Multiple Determination (R^2) Associated with First Stage Regressions (of a Two Stage Estimation Procedure), U.S.A. Data, 1913-1957.

Dependent Variable (S_i)	Coefficient of Multiple Determination (R^2)
U	0.9247
ΔP	0.8258
ΔU	0.6237
ΔA	0.4394
$\frac{w}{A_m}$	0.9798
P^F	0.9644
$\frac{X_m - MA}{MA}$	0.8364
$\frac{U}{LF}$	0.9160

Source: See text.

The second stage consists of regressing each dependent variable on its regular explanatory variables, after the calculated

values of the endogenous variables are substituted for the original series. The exogenous explanatory variables (z , t , and t^2) are employed in unmodified form. In equation (6.10) below, the observations for 1934, 1945, and 1951 are omitted, as explained in Chapter III; all other regression relations are based on the entire set of observations over the period 1913-1957. The second stage computations yield:

$$(6.9) \quad \Delta w_t = .03071 - 0.0363 \times 10^{-5} U_t + 0.7186 \times 10^{-2} \Delta P_t \\
\begin{matrix} (.00760) & (0.1351 \times 10^{-5}) & (0.0835 \times 10^{-2}) \end{matrix} \\
+ 0.2060 \times 10^{-2} t, \quad \bar{S}_u = 0.02562, \\
\begin{matrix} (0.0298 \times 10^{-2}) & R^2 = 0.8058, \end{matrix}$$

$$(6.10) \quad \Delta w_t = .03979 - 0.2432 \times 10^{-5} U_t + 0.6514 \times 10^{-2} \Delta P_t \\
\begin{matrix} (.00715) & (0.1315 \times 10^{-5}) & (0.0791 \times 10^{-2}) \end{matrix} \\
+ 0.2180 \times 10^{-2} t, \quad \bar{S}_u = 0.02265, \quad R^2 = 0.8338, \\
\begin{matrix} (0.0270 \times 10^{-2}) \end{matrix}$$

$$(6.11) \quad \Delta w_t = .03580 - 0.1051 \times 10^{-5} U_t - 0.5382 \times 10^{-5} \Delta U_t \\
\begin{matrix} (.00854) & (0.1447 \times 10^{-5}) & (0.4240 \times 10^{-5}) \end{matrix} \\
+ 0.6221 \times 10^{-2} \Delta P + 0.2058 \times 10^{-2} t, \\
\begin{matrix} (0.1125 \times 10^{-2}) & (0.0295 \times 10^{-2}) \end{matrix} \\
\bar{S}_u = 0.02543, \quad R^2 = 0.8133,$$

$$(6.12) \quad \Delta w_t = .02309 - 0.0410 \times 10^{-5} U_t + 0.7175 \times 10^{-2} \Delta P_t \\
\begin{matrix} (.00898) & (0.1330 \times 10^{-5}) & (0.0822 \times 10^{-2}) \end{matrix} \\
+ 0.1783 \times 10^{-2} t + 0.2430 \times 10^{-2} \Delta A_t, \\
\begin{matrix} (0.0344 \times 10^{-2}) & (0.1586 \times 10^{-2}) \end{matrix} \\
\bar{S}_u = 0.02521, \quad R^2 = 0.8166,$$

$$(6.13) \quad P_t^f = 8.811 + 69.12 \left(\frac{W}{A_m} \right)_t + 0.2491 P_t^r - 0.1758 t$$

$$(3.243) (13.29) (0.1205) (0.1042)$$

$$- 10.13 z_t + 7.456 \left(\frac{X_M - MA}{MA} \right)_t, \quad \bar{S}_u = 4.486, \quad R^2 = 0.9649,$$

$$(2.749) (3.873)$$

$$(6.14) \quad \log A_t = 2.0733 + 0.011306 t + 0.1846 \times 10^{-4} t^2$$

$$(0.0056) (0.000163) (0.1680 \times 10^{-4})$$

$$- 0.2217 \left(\frac{U}{LF} \right)_t, \quad \bar{S}_u = 0.01415, \quad R^2 = 0.9918.$$

$$(0.0399)$$

These results necessitate some qualifications of the earlier conclusions concerning economic structure, but in general these modifications are not major ones.¹⁵ The influence of unemployment on the wage adjustment process is even weaker than previously envisaged. This variable has a statistically significant coefficient only in equation (6.10), from which the outlier years of the earlier computations have been excluded. Even here, the t ratio for the U variable is 1.85, which is significant at the 5 per cent level with a one-tailed test, but not at that level with a two-tailed test.

The previous importance of the time trend variable and of changes in the consumer price level, in explaining money wage changes, continues to hold. In all four cases, the two stage estimates of the coefficients of the consumer price index change and of the time trend

15. L. A. Dicks-Mireaux (*op. cit.*, pp. 272-273) finds that his view of the structure of the wage and the price level equations is changed only slightly, after the parameters of these relationships are re-estimated by the two stage least squares procedure.

variable are higher than in their analogues of Chapters III and IV. (This may largely reflect the use of a different period for parameter estimation.) For equations (6.9) and (6.12), but not for equations (6.10) and (6.11), the evidence is consistent with the hypothesis that wages are adjusted in proportion to changes in the consumer price level.¹⁶

The contribution of unemployment changes and of changes in the level of productivity, as measured by equations (6.11) and (6.12), appears to be of marginal significance, when the two stage estimation technique is used. The t ratios for the unemployment change variable and for changes in productivity are 1.27 and 1.53, respectively. Hence

16. Over the period 1913-1957, the mean value of w (average hourly compensation in manufacturing) was \$0.86344 and the mean of P (the consumer price index) was 100.93. If a rise in consumer prices, 1 per cent of its mean level, were associated with a rise in money wages, 1 per cent of this variable's mean level, the coefficient of ΔP_t would be 0.855×10^{-2} . Calculation of an appropriate t ratio for each of the four wage adjustment equations yields the values 1.63, 2.58, 2.08, and 1.67 for equations (6.9), (6.10), (6.11), and (6.12), respectively. Thus, in the case of equations (6.9) and (6.12), this difference is not significant at the 5 per cent level with a one-tailed test, while for the other two relations, the difference is significant at the 5 per cent level with a two-tailed test. Hence for the first and the last wage adjustment relationships, the evidence is consistent with a complete adjustment of wages to changes in the consumer price level; for the other two, it is not. It must be pointed out, however, that no allowance has been made for variability in the estimates of the means of w and P . Consequently, the standard errors are probably too small (slightly, it is to be hoped), biasing the test toward failure of full wage adjustment.

these variables do not have significant coefficients at the 5 per cent level, with a one-tailed test. However, the failure of these two variables to play a larger role may be attributable to the lack of a close fit in the first stage (see Table X), especially for the productivity change variable.

The price level relationship looks very similar to the simple least squares analogue, although the coefficients of two variables (the raw materials price index and the demand-proxy variable) decrease slightly, while the numerical values of the coefficients of the other three are somewhat larger. For the P^r , t , and $\frac{X_m - MA}{MA}$ variables, the t ratios are 2.06, 1.69, and 1.925. Hence, with ordinary tests, the influence of each of these variables is significant at the 5 per cent level, with a one-tailed test. However, if one takes into account the likelihood of autocorrelation in the estimated residuals (not tested formally), the statistical basis for the importance of these marginal variables is probably quite weak. Wage costs $\left(\frac{W}{A_m}\right)$ and the variable (z) proxying for price control and other wartime disturbances during 1942-1946 remain strong influences.

The productivity equation presents a slightly different picture, also. The coefficients of the linear (unsquared) time trend variable and of unemployment as a proportion of the labor force are many times their respective standard errors; hence the influence of these variables is statistically significant, by ordinary standards. The t^2 variable has a coefficient only slightly greater than the associated standard

error; hence for equation (6.14), the acceleration of productivity growth cannot be considered statistically significant. The divergence from the tentative conclusions of Sections 1 and 2 above may merely reflect the use of a different sample period; but it should be recalled that the adjustment of the standard errors to allow for autocorrelated residuals also called into question the significance of the coefficient of t^2 . The per annum rate of growth of productivity computed from equation (6.14) is 2.64 per cent, if the (non-significant) coefficient of t^2 is discarded. (If the acceleration term were included, the predicted rate of productivity growth would be 2.64 per cent per annum for 1935 and would increase to 2.86 per cent for 1957.) This growth rate is only slightly higher than that used in Chapter III in the preliminary exploration of the trade-off between unemployment and price level stability.

Finally, it should be noted that all six equations have slightly lower coefficients of multiple determination than their simple least squares analogues. For this study, it would appear that ^{consistency of} ~~freedom from bias for~~ the parameter estimates is obtained only by accepting a somewhat looser fit.

Appendix A

The h series and those of h_{MA} and h^* , which are derived from it, are listed below. For definitions and sources, see the text.

Table XI

Average Weekly Hours Worked per Full-Time Engaged Person (h), Seven Year Moving Average of Average Weekly Hours Worked (h_{MA}), and Trend Level of Average Weekly Hours Worked (h^*), U.S.A., 1900-1957.

Year	h (hours per week)	h_{MA} (hours per week)	h^* (hours per week)
1900	53.79	54.16	54.43
1901	53.88	54.00	54.23
1902	53.83	53.83	54.03
1903	53.81	53.62	53.84
1904	53.25	53.56	53.64
1905	53.40	53.35	53.44
1906	53.39	53.16	53.24
1907	53.36	52.98	53.04
1908	52.38	52.92	52.84
1909	52.54	52.85	52.64
1910	52.57	52.73	52.45
1911	52.78	52.58	52.25
1912	52.91	52.47	52.05
1913	52.56	52.38	51.85
1914	52.29	52.30	51.65
1915	51.63	52.15	51.45
1916	51.89	51.74	51.25
1917	52.06	51.44	51.06
1918	51.74	50.82	50.86
1919	50.02	50.43	50.66
1920	50.42	50.10	50.46
1921	48.01	49.71	50.26
1922	48.89	49.42	50.06
1923	49.58	49.41	49.86
1924	49.28	49.30	49.67
1925	49.71	49.54	49.47
1926	49.98	49.60	49.27
1927	49.68	49.42	48.38
1928	49.64	49.19	48.12
1929	49.30	48.67	47.86

Table XI (Continued)

Year	h (hours per week)	h_{MA} (hours per week)	h^* (hours per week)
1930	48.38	48.07	47.60
1931	47.64	47.02	47.34
1932	46.04	46.11	47.08
1933	45.79	45.43	46.82
1934	42.34	45.00	46.56
1935	43.27	44.48	46.31
1936	44.56	44.28	46.05
1937	45.38	44.14	45.79
1938	43.97	44.55	45.53
1939	44.67	44.98	45.27
1940	44.79	45.36	45.01
1941	45.22	45.68	44.75
1942	46.26	46.04	44.49
1943	47.22	45.98	44.23
1944	47.64	45.75	43.97
1945	46.46	45.38	43.72
1946	44.26	44.81	43.46
1947	43.17	44.04	43.20
1948	42.67	43.19	42.94
1949	42.28	42.50	42.68
1950	41.80	42.06	42.42
1951	41.69	41.70	42.16
1952	41.65	41.44	41.90
1953	41.17	41.21	41.64
1954	40.61	40.98	41.38
1955	40.86	40.62	41.13
1956	40.66	40.33	40.87
1957	40.20	40.04	40.61

Appendix B

The variables appearing in the following regressions retain the definitions assigned to them in the text. (The time trend variable t is equal to zero in 1900 and is in annual units.) For the sources of the data, see the text. The method of parameter estimation is simple (single equation) least squares, and the sample period is 1900-1957.

$$\begin{aligned}
 \text{(b.1)} \quad \log A_t - \log A_{t-1} &= 0.007586 + 1.450 \times 10^{-4} t \\
 &\quad (0.004762) \quad (1.295 \times 10^{-4}) \\
 &= 2.252 \times 10^{-2} \left(\frac{U}{LF} \right)_t, \quad \bar{S}_u = 0.0164, \\
 &\quad (3.590 \times 10^{-2}) \quad R^2 = 0.0269,
 \end{aligned}$$

$$\begin{aligned}
 \text{(b.2)} \quad \log A_t - \log A_{t-1} &= 0.006252 + 1.364 \times 10^{-4} t \\
 &\quad (0.004238) \quad (1.282 \times 10^{-4}) \\
 &= 7.398 \times 10^{-2} \left(\frac{h-h^*}{h^*} \right)_t, \\
 &\quad (7.923 \times 10^{-2}) \\
 \bar{S}_u &= 0.0163, \quad R^2 = 0.0352.
 \end{aligned}$$

Appendix C

The following table applies to equation (6.5) of the text. The standard errors are adjusted for autocorrelated residuals according to the Theil method cited in Chapter V.

Table XII

Calculation of Adjusted t Ratios for the Variables of Equation (6.5).

Statistic Variable	t	t^2	$\frac{U}{LF}$
Coefficient	0.6735×10^{-2}	0.6299×10^{-4}	0.1957
Standard Error (Unadjusted)	0.0454×10^{-2}	0.0766×10^{-4}	0.03198
t Ratio (Unadjusted)	14.83	8.22	6.12
Standard Error (Adjusted)	0.2321×10^{-2}	0.3915×10^{-4}	0.08136
t Ratio (Adjusted)	2.90	1.61	2.41

The influence of t^2 is no longer statistically significant, even at the 5 per cent level with a one-tailed test. However, the coefficients of t and of $\frac{U}{LF}$ retain statistical significance, by ordinary standards.

Chapter VII, "Some Limitations of Aggregative Analyses of Wages
and Prices"

In the previous chapters, some aggregative relations have been discussed. The theoretical model of Chapter II is a highly aggregative one; using its oversimplified relationships, one is able to discuss inflation in the context of comparative statics. The empirical relations of Chapters III through VI are only slightly less global. Thus the price level employed in the statistical determination of the money wage change in the manufacturing sector was a general consumer price index. (Chapters III and IV.) The absolute money wage in manufacturing entered, however, as the numerator of a structural variable in the determination of the Wholesale Price Index for Finished Goods. (Chapter V.) In general, the empirical relations have dealt with highly global variables, and the distinction between separate sectors of the economy has been of peripheral importance.

In this chapter some limitations of an aggregative discussion of inflation are suggested. Most of this discussion draws heavily on other writers, whose arguments gradually convinced the author that something vital might be missing if inflation were analyzed solely in an aggregative context. This is not to imply that under most, if not all, circumstances the aggregative model is not a useful first approximation. Nor can one deny that under some circumstances (e.g., a runaway inflation associated with war or some similar disruption) the argument running in terms of the macro-variables provides an insight close enough for all practical purposes, including that of public

policy. But there would appear to be other historical epochs when something crucial is omitted if sectoral effects are not considered. The second half of the 1950's, in the United States, may well be such a period. Thus it is important to examine the validity of the arguments for scrutinizing the separate sectors of the economy. In particular it is important to see how the outcome will differ from a discussion running solely in terms of global variables.

If this distinction is important, then one consequence may be stated immediately. There are explanations of the phenomenon of inflation other than the pure "demand-pull" or pure "cost-push" ones. In the first place, one can legitimately be eclectic, arguing that the first influence is more pronounced in some markets and the second in others. Secondly, something new may occur in the interaction of the various sectors of the economy, and this "something new" phenomenon may be opposed to either of the two aggregative explanations. Charles L. Schultze's explanation of the 1955-1957 U.S. experience stresses this interaction, and the present author examines Schultze's explication in some detail below. Indeed, part of the conflict between the two schools of thought may be traced to the fact that both schools analyze the problem solely in aggregative terms.¹ If this is true, both views may be contrasted with a theory emphasizing sectoral effects. Such a theory has implications for practical public policies and for empirical studies of inflation, both of which are discussed in the final section of this chapter.

1. As suggested in Chapter II, part of the disagreement may also stem from exclusive concentration on solely one of two relevant schedules.

1. Bent Hansen's A Study in the Theory of Inflation.

In his A Study in the Theory of Inflation,² Bent Hansen presents a discussion of this phenomenon. Although Hansen recognizes the existence of "spontaneous" (autonomous or cost-determined) price and wage increases, the attention is focused on overfull employment and generalized excess demand. There is, however, one important distinction from the usual "inflationary gap" type of analysis. Hansen insists on separating the commodity and the factor markets and on looking at the degree of excess demand in each. He stresses that the demand for commodities is not the same thing as the demand for labor. This emphasis on separate markets for commodities and factors leads easily into a multi-sector analysis, which Hansen carries through.

In his Chapter 7, a simple model of the inflationary process is presented. Hansen postulates that the aggregate demand for commodities is a decreasing function of the ratio of the price level of goods to the money wage; this occurs because consumption demand decreases when the real wage and hence the wage share is lower, while real levels of investment outlays and government expenditures are determined autonomously. Planned or attempted aggregate supply is an increasing function of the ratio of the price level to the money wage, because of the assumptions of pure competition and rising marginal costs. It is assumed that there are full employment limits

2. Bent Hansen, A Study in the Theory of Inflation (New York: Rinehart & Company, Inc., 1951). Chapter 1 and Chapters 7 through 10 are central to the present author's discussion.

to output and that the aggregate demand and aggregate supply curves intersect at an output level greater than the full employment maximum. In consequence, the static solution is inconsistent. If one postulates that the rate of change over time of the price of goods is an increasing function of the excess demand for goods and that a similar relationship connects the rate of change of the money wage and the excess demand for labor, then an inflationary process is generated. The discrepancy between the level of real demand and the full employment level of output is the excess demand for goods. The amount by which planned production exceeds the full employment level of output is the unrealizable part of planned production, which part is an index of the excess demand for labor. For both the price and the wage reaction equations, the rate of change of either price is zero if there is no excess demand (positive or negative) in the relevant market. Thus static equilibrium is a special case, which occurs when the three equations of aggregate demand, aggregate supply, and full employment maximum output are mutually consistent.

Hansen investigates the solution time paths of this model and concludes that it is possible for both the price level and the money wage to increase over time at the same rate. In this manner the ratio of the two is maintained unchanged, even though the absolute levels are rising. He calls this a quasi-equilibrium solution and shows that, for this case, it is unique. It can also be shown that the quasi-equilibrium level of this ratio is stable; the assumptions of the model are sufficient for a proof that if the ratio of the price level

to the wage rate is displaced slightly from its quasi-equilibrium level, the economic forces will push it back to this original value. Consequently, once the system settles down, the ratio of the price level to the money wage and hence the real wage are determined within the dynamic context, as surely as though the money wage and the price level were constant.

Next, Hansen examines the response of the system to changes in economic structure. A rise in productivity is neither inflationary nor deflationary, since it decreases the excess demand for goods but increases the excess demand for labor. (This latter change occurs because with diminishing returns, the rightward shift of the marginal cost curve is even greater than the increase of the full employment limits to output.) Consequently the price level falls relative to the money wage (i.e., the real wage rises) in the new quasi-equilibrium position, but that is all that can be said. Whether absolute prices and/or the money wage rise more rapidly than previously is indeterminate. It is interesting to note that already we see one instance where a sectoral model gives a different explanation from both aggregative theories of inflation. In the usual "inflationary gap" or "excess monetary demand" explanations of inflation, a rise in productivity is anti-inflationary because it narrows the excess demand for goods. The cost-push school would stress the mitigating effects of productivity increases on factor price increases, and so, in this view, a rise in productivity would similarly be considered anti-inflationary. But in Hansen's sectoral model, the effects of productivity increases are

ambiguous. In the Schultze explication of recent U.S. inflation, we shall see an instance of how particular increases in productivity may analogously have ambiguous effects.

Another possible disruption may occur if there is a disturbance whose initial or partial effect is to increase excess demand in the commodity market alone. (Increased real demand by the state, which would lead to a rightward shift in the aggregate demand curve, will suffice to produce this.) After the new quasi-equilibrium position is reached, excess demand in the commodity market is higher than the old quasi-equilibrium level but lower than the initial level of excess demand (i.e., the level of excess demand at the old ratio of price to money wage, after the partial increase in excess demand). In the new quasi-equilibrium position, some of the increased excess demand has "spilled over" from the commodity market so that the level of excess demand in the labor market is higher than before. Thus the new outcome entails both a higher ratio of price to money wage and a faster rate of rise of both wages and prices. In this model, such a change is unambiguously inflationary.

In his Chapter 8, Hansen extends these results to the case where there are $n+1$ commodities and factors. (The last commodity is money.) He proceeds to set up the relations of general equilibrium, but his assumption that the demand and supply functions are homogeneous of degree zero in absolute prices means that the static system is

over-determined, if one attempts to determine relative prices.³ (If the demand and supply functions are homogeneous of degree zero in absolute prices, only relative prices can be determined, since multiplying all values of a solution set of absolute prices by a constant also yields a solution set.) Consequently, one can replace the market-clearing equations with market reaction or adjustment equations and investigate whether a quasi-equilibrium solution exists. Under certain general conditions, such a solution can be found. Then all prices increase (or decrease) together, in such a manner that relative prices stay constant. With positive excess demands, one obtains a general inflation while general deflation is characterized by negative

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3. Hansen gets this result because he sets the price of the money good (the $n+1$ st good) equal to unity and in addition postulates that demand and supply functions are homogeneous of degree zero in absolute prices, so that he may determine prices relative to the price of the n th good. The usual treatment is either to add the equation stating that the price of the numeraire is unity, or to drop a variable by considering only relative prices but not to do both. Doing both would appear to involve Hansen in an unrealistic description of the economy, since according to this system there is one commodity which serves as money and a second which serves as numeraire! Presumably the economy would enjoy both a commodity which serves as a medium of exchange and modern, fiat money. It need hardly be remarked that such an economy has never existed. It should also be pointed out that Hansen does not need to set up the model in this way to get one more equation than unknown and hence overdetermination in the usual case. He has already demonstrated, in an earlier section of his Chapter 8, that Walras' law may not hold when demand and supply quantities are interpreted in an ex ante sense. (For instance, demand may exceed planned purchases if a buyer places orders at several outlets but plans to accept only the first shipment.) With Walras' law failing, all the equations of the system are independent and so in this manner one can have an overdetermined system (in general) with one more equation than unknown.

excess demands. Under general circumstances, the quasi-equilibrium solution will be a stable one, in the sense that a small displacement of one of the relative prices sets up forces which return the actual values of the relative prices to their quasi-equilibrium values. One special case of these stability conditions is one set of stability conditions for the equilibrium Walrasian system. This is not surprising, because a static equilibrium solution is a special case of the quasi-equilibrium system. Here the overdetermination does not prevent a consistent set of solution values of the variables, and absolute prices as well as relative prices are constant over time.

It is of interest to examine how the system reacts to an increase in the excess demand in one particular market and to compare the conclusions with those of the one factor, one commodity model. An increase in the excess demand for one particular commodity will lead to a rise in its relative price, as the system moves from the initial quasi-equilibrium solution to a second one. This is a conclusion which is analogous to that stated above for the simpler model. (In the unlikely case where all goods are substitutes, all prices will rise relative to the price of the n th good.) In the case of the simple model, we saw that an increase in the excess demand in the commodity market will "spill over" into the factor market. In the case of the $n+1$ commodity model, it is not certain that partial increases in the excess demand in one particular market will necessarily "spill over" into other markets; in the new quasi-equilibrium position, excess demand will be greater in all markets only in the rather special case where all goods are

substitutes. Furthermore, the primary (partial change) level of excess demand in the initially affected market may be smaller than the new quasi-equilibrium level. In the two commodity model discussed above, this could never happen; the effect of moving toward a new quasi-equilibrium solution was to lessen the initial impact of an increase in the excess demand for goods. These differences between the simpler model and the multi-commodity model are at a high level of abstraction, but they serve to illustrate the view that one may come to different conclusions about the inflationary process if sectoral effects are taken into account.

In his Chapter 9, Hansen states some very interesting conclusions, which are developed from the price reaction equations for the various commodity markets. A price reaction or adjustment equation, in which the relative change in the price of a commodity is proportional to its relative excess demand (absolute excess demand divided by the quantity supplied of the good), is assumed. If the price reaction coefficients (the factors of proportionality) are constant, then a necessary and sufficient condition that the Laspeyres price index be unchanged from period 1 to period 2 is that there should be no monetary excess demand in the market for goods. (By definition, no monetary excess demand for goods is equivalent to having the sum of the particular excess demands weighted by their own prices, equal to zero.) However, if the price reaction coefficients are different for the various goods submarkets, no such general result holds. In particular, the Laspeyres index may still change, even though there is no aggregate

excess demand in the market for goods. A price index of which the weights are period 1 supplies divided by the price reaction coefficients is unchanged, but this is hardly the usual type of price index. In Section 3 below, the present author will show, following Schultze, that if prices move upward more easily than downward, the Laspeyres index can rise, despite the absence of excess demand in the goods markets as a whole. This is an important strand of Schultze's explanation of the 1955-1957 inflation in the United States. Once again, a non-aggregative analysis provides an insight that could not be obtained from aggregative theory alone.

2. Interaction of Competitive Agriculture and Non-Competitive Industry: The Explanations of Duesenberry and Ackley.

In an article published in 1950,⁴ James Duesenberry set out a model of the inflationary process. In the model, agricultural prices are determined by continuous market-clearing between the competitive forces of supply and demand. (Duesenberry works with the simplifying assumption of unitary price elasticity of demand for agricultural goods.) Industrial prices are determined by mark-up pricing, the mark-up being applied to labor costs, which are interpreted as the money wage divided by the average product of labor. Money wages

4. James Duesenberry, "The Mechanics of Inflation," The Review of Economics and Statistics, Volume XXXII, No. 2 (May, 1950), pp. 144-149.

are adjusted, with a lag of one period, to the cost of living index, so as to maintain real wages. Thus this model has two sectors (the industrial and the agricultural) and four actors (farmers, industrial wage-earners, rentiers and fixed salary recipients, and corporations). The consumer services sector is excluded from explicit consideration, although one component of the consumer price index is composed of prices other than agricultural or industrial prices.⁵ The Duesenberry model yields a first order, linear difference equation with constant coefficients for the determination of the money wage (or any of the three price level concepts). Starting with excess demand for agricultural products and cost absorption in industry (the situation in the immediate postwar period, according to Duesenberry), one finds that the solution time path of the difference equation traces out a wage-price spiral. Under certain moderately realistic assumptions, the wage and price variables converge to new higher equilibrium levels. The inflationary process need not continue indefinitely but may eventually cease due to the internal mechanism.

5. This third component of the consumer price index is constant throughout the inflationary process. Thus, if it represents a price index for consumer services, this index is unchanged over time. In that the prices of consumer services have risen, over the postwar period, more rapidly than any other component of the consumer price index, the Duesenberry assumption is inappropriate. This is not a severe shortcoming of the model, however, since the author probably intended it as a useful abstraction, not as a detailed empirical description.

What are the differences between this model and the "orthodox" inflationary gap model? In this model, the pace of the inflation depends upon the period of the lag for wage adjustment and the fact of immediate adjustment in agricultural markets, not on the magnitude of aggregate excess demand. Furthermore, Duesenberry points out that it is possible for the inflationary spiral to continue, provided that the new higher equilibrium levels of wages and prices have not yet been attained, even after inflation has cut down on real demand and closed the inflationary gap. Duesenberry's view is that if unemployment and excess capacity are sufficiently widespread, this will break the cost-oriented nature of industrial prices and money wages. But this is obviously some point beyond the elimination of the "inflationary gap."

Gardner Ackley presented a similar discussion of inflation in a recent paper.⁶ Ackley distinguishes three sectors of the economy: the industrial, the agricultural, and the non-agricultural raw materials sectors. Prices are set competitively in only the last two sectors; in industry, administered pricing, based on moderately fixed mark-ups over costs, is the rule. Ackley argues that inflation does not result directly from excess demand for industrial products, but occurs only when the excess demand has filtered down into the agricultural sector and into the markets for non-agricultural raw materials and for labor. When excess demand has resulted in an increase in these

6. Gardner Ackley, "Administered Prices and the Inflationary Process," American Economic Review, Papers and Proceedings, Volume XLIX, No. 2 (May, 1959), pp. 419-430.

factor prices, mark-up pricing will effect higher prices for industrial goods. Nevertheless, Ackley is not a "demand-pull" theorist. He argues that even for raw materials, prices rise in response to speculative factors as well as under the pressure of excess demand.⁷ As for the labor market, Ackley holds that wages rise because of rising consumer prices and, by implication, because of trade union power, as well as because of excess demand. These considerations lead him to deny the validity of the distinction between "cost-push" and "demand-pull" inflation and to argue that inflation is essentially a political or administrative phenomenon, reflecting a conflict over distributive shares. One need not agree with Ackley's obliteration of this important distinction in order to assert that his discussion of sectoral effects adds something to our knowledge of the phenomenon of inflation.

Ackley compares his explanation of the inflationary process with one in which continuous market-clearing is assumed. He argues that the existence of administered prices slows down the rate of rise of prices emanating from excess demand pressures. On the other hand, the inflationary process, once in motion, is capable of continuing for a

7. As Richard T. Selden pointed out in his comment on this paper (loc. cit., p. 456), speculative factors can be included under the rubric of excess demand. Thus the rise in raw materials prices during the Korean conflict, which reflected a high degree of speculative activity, is consistent with an excess demand explanation of raw materials prices. Bent Hansen (op. cit., pp. 247-248) makes essentially the same point in arguing that the excess demand explanation must be modified but need not be abandoned in the face of speculative influences on prices.

considerable length of time after the original source of inflationary pressure -- the excess demand -- has been eliminated. Finally, Ackley argues that there is irreversibility in the general price level. Prices will move upward more readily than downward, because of a greater downward rigidity of raw materials prices and money wages, particularly the latter.

The contrasts that both Ackley and Duesenberry point up, in comparing their explanations with that of the "inflationary gap," are significant and seem quite realistic to the present writer. These conclusions are based on analyses stressing the interaction of several sectors of the economy. While several of these conclusions are suggested by an aggregative cost-push account of inflation, this is not true for all of these conclusions. Thus Duesenberry's explanation of the factors responsible for the pace of the inflation is derived from an examination of the relevant sectors. Similarly, Ackley's assertion that excess demand may set off an inflationary movement which continues after the original pressure is eliminated rests on sectoral analysis. Excess demand and increased cost influences may have a different importance in producing price increases in the different sectors of the economy. These two explanations of inflation clearly acknowledge and make use of the differing sectoral characteristics.

3. Charles L. Schultze's "Recent Inflation in the United States."

In a recent monograph for the Joint Economic Committee of the U.S. Congress,⁸ Charles L. Schultze presented an explanation of the 1955-1957 U.S. inflation. Schultze's work, amply supported by empirical materials, leads to the conclusion that aggregative explanations may be inadequate for particular inflationary experiences and that 1955-57 was, in all likelihood, just such a period. Schultze asserts that a sharp shift in the composition of demand may initiate an upward movement of the price level, even though excess aggregate demand is not present, because prices are more flexible upward than downward. Cost pressures transmit the upward price level movement throughout the economy; raw materials prices rise for non-integrated firms and wages rise due to pressures on all firms to match the wage increases granted by the leaders.⁹ Each of these points may be

8. Charles L. Schultze, op. cit.

9. Schultze also argues that during this period, overhead costs rose substantially because of rising salary costs and rising capital costs. Salary costs rose principally because of an increased ratio of non-production personnel to total output; capital costs were higher because of a slight postwar rise in the capital-output ratio, a substitution of short-lived equipment for long-lived plant, and a rise (both absolutely and relatively to other prices) in the price capital goods. Schultze argues that the abortive attempt to recoup these increased overhead costs is part of the explanation of the 1955-57 inflationary experience. Since this strand of Schultze's explanation of the 1955-57 inflation does not concern us here, it will not be developed further. Although Schultze argues that the larger part of increased overhead costs resulted from a failure of output to keep pace with capacity, his explanation is still consistent with a full cost theory of industrial pricing. Although only increased unit fixed costs at the standard volume of output (Footnote continued on bottom of next page.)

examined in turn.

If prices are more flexible upward than downward, a shift in demand, producing positive excess demands in some commodity markets and negative excess demands in others, can result in a general price rise despite the absence of over-all excess demand for goods. This proposition rests on the intermediate result that the upward price movements will outweigh the price decreases. Using a slight modification of Schultze's exposition, one may demonstrate this proposition algebraically. Let p_i be the price of the i th good, q_i the quantity exchanged, x_i the associated excess demand, and k_i its price reaction coefficient (discussed below). There are n goods altogether. p_i , q_i , and x_i all refer to an initial period. Let Δp_i be the change in the price of the i th good from the initial period to the current period. It is initially assumed that the relative change in price is proportional to the relative excess demand, the factor of proportionality depending on the particular market under examination. This postulate is expressed by the market adjustment equations:¹⁰

$$(7.1) \quad \frac{\Delta p_i}{p_i} = k_i \frac{x_i}{q_i}, \quad i = 1, 2, \dots, n.$$

Footnote 9 continued from bottom of previous page.

are marked up into higher prices, a firm experiencing a substantial increase in capacity and a disappointingly slight increase in output might increase its standard volume output only slightly, so as to decrease its standard volume as a percentage of capacity. In this manner, the firm, attempting to recover at least some of its rising overhead costs, would raise prices via the full cost principle.

10. As discussed above, Bent Hansen also works with this type of price reaction equation. (Op. cit., Chapter 9.)

A standard Laspeyres commodity price index is defined by the following equation:

$$(7.2) \quad L = \frac{\sum_{i=1}^n (p_i + \Delta p_i) q_i}{\sum_{i=1}^n p_i q_i} = 1 + \frac{\sum_{i=1}^n \Delta p_i q_i}{\sum_{i=1}^n p_i q_i} .$$

Suppose that the system had previously been in general equilibrium, with all x_i 's equal to zero. Suppose further a shift in the composition of demands producing particular excess demands, positive and negative, but leaving neither excess demand nor excess supply in the market for goods as a whole. It is assumed that there are m goods with positive or zero excess demand, and so there are $n-m$ goods which display negative excess demand (excess supply). (m can range from 1 to $n-1$, in any particular instance.) After the shift in the composition of demand, the individual x_i 's are no longer zero, but we would still have:

$$(7.3) \quad \sum_{i=1}^n p_i x_i = 0 .$$

A particularly simple form of the asymmetry hypothesis may now be introduced. Suppose that all price reaction coefficients take only two values, which do not depend upon the particular market under examination but only upon whether a particular market is experiencing positive excess demand or negative excess demand. Let \bar{k} be the value of the price reaction coefficients for those markets characterized by positive

excess demand and let k^* be the value associated with negative excess demand. The assertion that prices display greater upward flexibility (greater downward rigidity) implies that \bar{k} exceeds k^* . (This type of asymmetry is illustrated by the dashed lines of Figure 12, in Section 6 below.) The exposition is facilitated if the commodities are renumbered so that the first m goods are those which are characterized by the non-negative excess demands. Under this renumbering scheme, the last $n-m$ goods are those with negative excess demands. To avoid confusion, the author wishes to emphasize that the renumbered position of any commodity is applicable for one period (the current period) only. It is also true that the result below could have been demonstrated (with more effort) without such a renumbering scheme.

The proposition that such a demand shift produces a rise in the price level may now be attacked. From (7.3), we have:

$$(7.4) \quad \sum_{i=1}^m p_i x_i = \sum_{i=m+1}^n p_i |x_i| .$$

It immediately follows that:

$$(7.5) \quad \bar{k} \sum_{i=1}^m p_i x_i > k^* \sum_{i=m+1}^n p_i |x_i| .$$

In turn, this yields:

$$(7.6) \quad \sum_{i=1}^m \bar{k} p_i x_i - \sum_{i=m+1}^n k^* p_i |x_i| > 0 .$$

Using (7.1), we obtain:

$$(7.7) \quad \sum_{i=1}^m \bar{k} p_i x_i + \sum_{i=m+1}^n k^* p_i x_i = \sum_{i=1}^n \Delta p_i q_i > 0 .$$

From this result, it is a simple matter to observe that the Laspeyres price index (7.2) has increased.

The simplifying assumption that the price reaction coefficients for markets with price increases had one common value and that a second common value held for markets with price decreases was not necessary; the result could have been obtained with more complex assumptions, given the basic postulate that there is greater ease of upward movement of prices. The simple case illustrates the essential mechanics, and so the author did not consider a refinement particularly important. In applying this model to the United States during the period 1955-1957, Schultze argued that there was a sharp shift in the composition of demand, with capital goods, military hard goods, and some exports experiencing excess demand and automobiles and residential construction having deficient demand. In consequence, the price level rose, even though excess demand in the aggregate was not present, except possibly briefly, late in 1955.¹¹ Low output increases, which prevailed

11. In "Full Employment and Wage Stability," The Theory of Wage Determination, John T. Dunlop ed., pp. 66-78, Bent Hansen argues that on theoretical grounds alone, it is not possible to say whether stability of a money wage index requires more unemployment (sum of excess supplies) than vacancies (sum of positive excess demands), if the price reaction coefficients are different for the various labor submarkets. Nevertheless, when he considers that in the Scandinavian countries during the 1940's, upward wage drift was far more important than downward wage drift, he asserts that this proposition is quite likely to be true. Hansen's propositions relating to the labor market as a whole are analogous to the above conclusions about the over-all market for goods.

generally, were indicative of the sharp shift in demand, which largely dissipated money demand increases into price rises.

Schultze argues that full cost pricing is the rule in most industrial markets. In consequence, the asymmetry of price movement fans out, and prices are raised quite generally due to increased costs. These increased costs result from rising prices of raw materials and intermediate factors of production. Through such a mechanism, the initial inflationary impetus is magnified, and even in sectors with stable or deficient demand, prices may eventually rise.

A potent source of cost pressure will be wage increases. Schultze argues that firms in industries with excess demand have high levels of productivity, due to near-capacity operation. Thus, either because excess demand is transmitted to their particular labor markets or because they wish to avoid the embarrassment of excessively high profits, these firms grant large wage increases. Schultze asserts that other firms are forced to match these wage increases; the argument is corroborated by data which show a high degree of uniformity in the wage increases recorded during this period. These pressures do not arise because of great mobility on the part of the labor force, as this characteristic does not exist generally. However, if wages drop behind in any one sector, worker dissatisfaction will result and "worker dissatisfaction is a marvelously efficient way of insuring inefficient production." (Schultze, op. cit., p. 68; italics in original.)

The costs of not giving in exceed those of granting similar wage

increases, and wages tend to rise uniformly.¹² Thus wage increases are adjusted upward to the wage increases in the most rapidly expanding sectors of the economy and will typically be in excess of average productivity gains. Consequently, labor costs increase for nearly all firms, and some of these labor cost increases are marked up into higher prices.

As these inflationary pressures spread out from the excess demand sectors, their force is somewhat damped by deficient or neutral demand in the lagging sectors. A realignment of relative prices takes place, but the center about which such a readjustment is made is itself

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12. Schultze's view is that unions reinforce this process, even though they are not absolutely essential to it. (He would assign a similar role to the union in the downward rigidity of particular money wage rates.) In the excess demand sectors, unions are an instrument for pressing employers to "share the wealth" from productivity gains or the gains of an improved market position. In the lagging sectors, the union organizes dissatisfaction and so hastens the spread of high wage increases.

The classic statement of such pressures tending to elicit wage increases is found in Arthur M. Ross, Trade Union Wage Policy (Berkeley: University of California Press, 1948). Ross used the term "coercive comparisons" to describe this phenomenon.

In Chapter 5 of Employment, Growth, and Price Levels (the Staff Report), the institution of "pattern bargaining," which became prevalent in the post-war American economy, is discussed. Such "patterns" (similar wage settlements in different firms or industries, regardless of economic circumstances) would facilitate the functioning of such a mechanism, even though the wage agreements were rarely identical, for two different settlements.

moving upward. The downward rigidities and the generally cost-determined nature of prices and wages produces an inflation which is neither demand-pull nor cost-push in nature, and which cannot be understood in aggregative terms alone.¹³

Romney Robinson, in a perspicacious review article,¹⁴ argued that Schultze's demand-in-excess strand of inflation theory was inconsistent with his emphasis on full cost pricing. Thus under full cost pricing, there should be no price increase when demand increases. For if the mark-up is truly rigid, the only impact of increased demand would be increased volume. Schultze's reasoning leads to the conclusion that both profits and profit margins would be higher, because a larger volume of output improves labor productivity and lowers unit fixed costs. Furthermore, there is no reason to expect that entrepreneurs would be dissatisfied with their mark-ups and would desire to change them in order to achieve a more satisfactory target rate of return.

Two replies may be made to this objection. In the first place, it is possible that within a single market, a price rise

13. Schultze briefly points out that the downward rigidities and the cost-determined nature of wages and prices have another consequence for the price level. If aggregate excess demand does appear, wages and prices may move upward immediately and continue to move upward, in lagged response, even after the global excess demand disappears. The downward rigidities build a floor under the new higher levels of wages and prices, perpetuating these advances.

14. Romney Robinson, "Employment, Growth, and Price Levels: The Joint Economic Committee Report (Review Article)," American Economic Review, Volume L, No. 5 (December, 1960), pp. 996-1010.

will occur either if there is (positive) excess demand or if cost pressures exist. In Ackley's terms, mark-ups may be flexible when demand conditions change, but not so flexible as they would be under profit-maximization. Neither explanation, in its pure form, may be an accurate description of most commodity pricing in the American economy. But in the second place, even if it were true that both determinants were never relevant in explaining changes in one particular price, Schultze could still be correct for the economy viewed as a whole. For this is precisely the advantage of an analysis that emphasizes sectoral effects. It may well be that in some markets prices respond only to cost changes and in others only to excess demand; as long as there are some markets of each type, the Schultze explanation is logically consistent. Thus, Ackley and Dusenberry work with an agricultural sector in which prices are responsive to excess demand, while in their view, full cost pricing prevails in the industrial sector. A theory which stresses sectoral effects has richness just because it can deal with mixed or intermediate cases. By contrast, an aggregative theory tends to be straight-jacketed into one of the two alternatives -- "demand-pull" or "cost-push," and even eclecticism does not seem to be extremely appealing in such a setting.

4. Structural Pressures on the General Price Level: The Discussions of Bowen, Moulton, and Thorp and Quandt.

In Chapter I above, William G. Bowen's discussion of the determinants of the general price level¹⁵ was briefly presented. In that summary, Bowen's four "proximate determinants" were listed: (1) demand conditions, (2) cost conditions, (3) the types of price determination in the various sectors of the economy, and (4) distributional considerations. Bowen holds that this final determinant is important, because the price levels of the various sectors differ with respect to their sensitivity to demand and cost conditions. Consequently, the impact of demand pressures or of cost increases on the economy-wide level of prices may depend upon their distribution among the various sectors of the economy. For example, sectoral excess demand is likely to have a larger influence on the price level as a whole if it arises in competitive agriculture or in that portion of manufacturing which is demand-sensitive. Conversely, demand pressures in the public utilities, in the retail or wholesale trade sectors, or in that segment of manufacturing which is highly concentrated are likely to produce only small rises in the over-all price level, as pricing in these sectors is generally cost oriented. Similarly, the price level will respond most strongly to a given rise in costs if these rising costs are concentrated in sectors characterized by mark-up pricing.

15. William G. Bowen, op. cit., especially pp. 300-314.

When Bowen relaxes the assumption of a fully integrated economy, two related propositions follow. First, the timing of increases in the price level emanating from cost increases may be changed. A cost increase at an early stage of the production process is likely to require some time to reach the final consumer. Secondly, cost increases may be pyramided (give rise to price increases greater than the initiating cost increases) or may be partially absorbed, depending on market structure and the state of demand.

Bowen also sets forth a Schultze-type proposition. From his earlier discussion of pricing in the individual firms, Bowen asserts that firms are more likely to raise prices when costs increase than to lower prices if costs fall. (Bowen argues that the reverse type of asymmetry characterizes the firm's response to demand changes, so that "it is much more likely that decreasing demand will provoke a price cut than that increasing demand will lead to a price increase."¹⁶) The asymmetry in the responses to cost changes implies that "a given increase in the cost index will lead to a greater increase in the general price level if it is made up of a few cost reductions and some fairly substantial cost increases than if it is composed entirely of more moderate cost increases."¹⁷ This proposition may be demonstrated by algebraic reasoning similar to that of the previous section; in the case of the non-uniform cost increases, the substantial cost increases have a stronger effect than the cost decreases, which in turn raises the (average) increase of the over-all price level.

16. Ibid., p. 296. The entire passage is italicized in the original.

17. Ibid., p. 312.

Harold G. Moulton's description of American inflation during the World War I period¹⁸ suggests the presence of structural influences similar to those pointed up by Schultze and Bowen. It will be recalled that Moulton is very critical of quantity theory or budget deficit explanations of inflation. His views appear to be confirmed by the behavior of the United States economy during the 1914-1920 period; the greater part of the price rise occurred prior to American participation in the war, and from 1914 to mid-1917, the Treasury had a large surplus, not a deficit. Moulton traces the initial inflationary impetus to the fact that the belligerent powers demanded heavily the products of American industry, during the period of American neutrality. This heavy demand bid up prices in the war and war-related industries, such as industrial raw materials. According to the quantity theory, one might expect prices to fall in the non-war industries, if the supply of money were held rigid. In actual fact, prices in these industries also tended to rise, though not by as much as in the war industries. Moulton's explanation is that raw materials costs increased for all industries, as the war and non-war industries had many common raw materials inputs. The overall rise in the consumer price level brought demands for compensating increases in wages from those workers not enjoying large wage increases from high wartime demand. Thus, in the lagging sectors, strong cost pressures tending to raise prices formed. To avoid disruption of the production process and possibly a depression,

18. Harold G. Moulton, op. cit., especially pp. 100-105.

the newly formed Federal Reserve had to permit the money supply to increase adaptively. Moulton's description of this era (1914 to mid-1917) resembles Schultze's account of the American economy during 1955-1957. In turn, this suggests that "demand shift" inflation (pressures on the general price level from a shift in the composition of demands) may be more recent as a concept than as a phenomenon.

In Chapter 3 of The New Inflation (especially pp. 71-75), Willard L. Thorp and Richard E. Quandt assert that "structural pressures"¹⁹ can produce inflation. One example of this type of pressure is "coercive comparisons." Thorp and Quandt argue that high wage increases tend to occur in the leading sectors of the economy, which, in their view, are those sectors enjoying high productivity gains and/or high levels of demand. This mechanism (the wage comparisons) spreads such gains to other sectors, inducing average wage increases greater than average productivity gains. This pressure from the side of increased costs is likely to lead to a higher price level. It should be noted that the argument of Thorp and Quandt is quite similar to Schultze's discussion of this point.

Thorp and Quandt also assert that an increase in demand in one particular sector may have economy-wide ramifications. (They point out that the differing magnitudes of sectoral price increases, over the period 1947-1958, suggests that such differential demand increases did occur.) Cost increases induced by the rise in particular prices tend to spread, supported by the accompanying higher incomes which constitute greater purchasing power. The result can thus be a

19. This term, which the present author has borrowed freely, is originally that of Thorp and Quandt.

general inflation instead of the downward movement of some prices as a counterpoise to those which have increased. Again, the similarities to the discussions of Schultze and Moulton should be noted.

5. Sectoral Analyses of Wages and Prices: Three Joint Economic Committee Studies.

In Chapters 1 and 5 of Employment, Growth, and Price Levels (the Staff Report),²⁰ there is a discussion of the wage-price nexus, which in general emphasizes sectoral analysis. In analyzing the labor market as well as the market for goods, a separate analysis of the individual components may be desirable. Employing this approach, the authors of Chapter 5 present (p. 142) the gross scatters of the percentage change in earnings against the percentage of workers unemployed for four economic sectors: manufacturing, mining, construction and Class I railroads. The data in general cover 10 observations for the years 1948-1958, though there are a few gaps. The negative relationship between unemployment and wage change is quite apparent in the first three sectors: the recession years, 1949, 1954, and 1958 are years with low wage increases, while the boom years 1948 and 1951-1953 are typically years of high wage increases. The relationship is quite poor for the Class I railroads, but this is explicable partially in terms of institutional conditions within the industry. (There is a long lag in wage adjustments due to extensive procedural

20. The Joint Economic Committee of the United States Congress, op. cit. Chapter 5 was written by Harold M. Levinson, assisted by Stanley Heckman and Hamilton Gewehr; Thomas Wilson aided with the statistical computations.

provisions of the National Railway Act.) It is concluded, "Taken as a whole, the evidence supports the general conclusion that the level of unemployment -- or alternatively, the degree of demand pressures in the labor market -- does have an important effect on the rate of change in the wage level." (P. 142; entire passage italicized in original.) Another appropriate conclusion is that unemployment may be of varying importance in affecting the money wage change in the different sectors of the economy, and that there may be instances where an analysis recognizing these differing sectoral sensitivities may be an appropriate refinement.

A study of the separate sectors or subsectors is appropriate in analyzing the postwar rises in the prices of consumer services. Despite the fact that over the period 1947-1958 rising prices of consumer services accounted for 55.6 per cent of the total increase in the B.L.S. cost of living index,²¹ most aggregative models of the inflationary process do not take explicit account of the services sector. Nevertheless, this omission is not necessarily crucial, since service prices are affected by many of the same forces that are stressed in an aggregative model. Thus excess demand at a global level can bid up the prices of consumer services along with the prices of consumer commodities. Similarly, rising wage rates, whether due to general excess

21. This result is calculated from data provided in Employment, Growth, and Price Levels, p. 105. Although services had, in December, 1952, a weight of only 32.1 per cent in this price index, the 50.7 per cent increase in service prices as a group generates this outcome. By contrast, the cost of living index as a whole rose by 29.3 per cent over this period (1947-1958).

demand in the labor market, to a rising consumer price index, to pressures from a high wage increase subsector, or simply to an autonomous push, can lead to higher labor costs in the service sector as well as elsewhere and so be an influence in producing higher prices of consumer services.

In the postwar inflation, however, service prices were also affected by factors peculiar to the subsector in which they operated, and in a complete analysis, as for policy purposes, it would appear advisable to take these factors into account. The price of medical services rose substantially (57.9 per cent) over the period, carrying with them hospitalization insurance premiums. The demand for medical services displays a high income elasticity, while the supply of medical personnel did not even keep pace with the general population. For these reasons, the authors of Chapter 5 of the Staff Report attribute the rise in the price of medical services to "pure supply and demand." (While excess demand may have been the proximate cause of the price rise, the question of the influence of professional organizations in restricting the supply of newly trained personnel can at least be raised.) Urban transportation, a case typical of the regulated public utilities, was characterized by low productivity increases and reduced demand; the resulting rise in costs was eventually passed on to consumers as rate-making bodies gave their consent to higher prices based on the higher level of costs. The increases in the prices of services requiring low levels of skill, such as domestic services and laundry and dry-cleaning, seem attributable to

low productivity increases, as neither excessive demand nor the relatively slight increases in the relevant wages appear responsible for the substantial price increases.²² Low productivity increases also marked automobile repair services, although the price increases here also reflected high wage increases, similar to those obtained in the primary metals manufacturing sector. (This "spillover" of manufacturing wage increases is consistent with the Schultze explanation of the spread of inflationary pressures.) Short supplies marked housing services and rents responded appropriately, even though higher construction costs and a lagged response to the abolition of rent control may have also played a role. Similarly, excess demand appeared to characterize the market for personal care, such as barber and beauty shop services; but an element of market power may have been instrumental in these price rises. Enough has been said to indicate that varying forces were at work in the different consumer services subsectors, and that forcing this discussion into an aggregative mold is likely to produce some distortion.

Similar mixed patterns appear when one considers several sectors which mainly produce intermediate goods. Thus, the rise in machinery prices over the period 1954-1958 was attributable primarily

22. The increases over the period in the price indices for household operation, laundry, and dry-cleaning services were 34 per cent, 51 per cent, and 34 per cent respectively; over this period, wages paid in the laundry and dry-cleaning sector rose by 47 per cent. By contrast, all-manufacturing wages increased 74 per cent. (*Ibid.*, pp. 132, 134, and 135.)

to demand pressures, according to a recent study.²³ On the other hand, the exercise of market power, both on the part of the union and of the management, appeared to characterize the sharp rise in steel wages and prices that occurred during most of the decade of the 1950's. Finally, a mixed pattern appeared in the construction industry. We shall examine each of these in turn.

In the study paper cited above, Thomas A. Wilson argues forcefully that the rather large increase (19 per cent) in machinery prices over the period 1954-1957 was a consequence of sectoral demand pressure. Many indications of excess demand can be cited, including rising profit margins, high levels of overtime hours worked, and the behavior of plant and equipment expenditures (or of capital appropriations). The behavior of present output relative to previous peak output suggests that there was greater pressure on capacity in the machinery sector than in manufacturing as a whole. Turning to orders data, which he regards as a good proxy for demand, Wilson finds strong confirmation for his sectoral excess demand hypothesis. A graphical analysis suggests that the rise in machinery prices was related to the discrepancy between new orders and sales and to the level of unfilled orders. The importance of the first orders variable was confirmed by a multiple regression analysis; the variable $\frac{\text{New Orders} - \text{Sales}}{\text{New Orders}}$, lagged one

23. Thomas A. Wilson, "An Analysis of the Inflation in Machinery Prices," Study Paper No. 3, prepared for the Joint Economic Committee of the United States Congress, Study of Employment, Growth, and Price Levels (Washington: U.S. Government Printing Office, 1959).

quarter, was statistically significant in a multiple regression explaining the change in machinery prices. (Its partial correlation coefficient, based on 72 observations, was 0.36.) It is interesting to note that neither orders variable was statistically significant in an analogous multiple regression explaining the change in steel prices; this confirms the Eckstein-Fromm view that demand factors were of minor importance in the recent steel inflation. (This study is discussed in the next paragraph.) But one should not conclude from this discussion that market power is totally absent from the machinery sector. The downward rigidity of machinery prices, over the longer period 1947-1957, reflects in large measure the downward rigidity of the wages paid in the machinery sector, the downward rigidity of the prices of raw materials (especially steel), and also the feedback effects of higher machinery prices themselves. But Wilson concluded that market power may have been a reinforcing factor, "particularly where specialization leaves a small number of firms producing a product." (P. 54.)

Turning to the steel sector, one finds market power much in evidence. Otto Eckstein and Gary Fromm, in their recent Joint Economic Committee study,²⁴ concluded that both the union and the companies exercised considerable autonomous pressure on steel wages

24. Otto Eckstein and Gary Fromm, "Steel and the Postwar Inflation," Study Paper No. 2, prepared for the Joint Economic Committee of the United States Congress, Study of Employment, Growth, and Price Levels (Washington: U.S. Government Printing Office, 1959).

and prices respectively. Despite the absence of tightness in the labor market for the steel industry as a whole or of tightness in the labor markets of the localities which are steel centers, steel wages not only rose absolutely but increased more rapidly than wages in most industries. The market power of the union played a dominant role, although Eckstein and Fromm consider that the political factor was a reinforcing influence during the postwar period. (Federal government intervention in the collective bargaining process, which in general tended to produce a more generous settlement, occurred in 1946, 1949, 1952, 1956, and one might add, in 1959.) Because productivity rose slightly less rapidly than in manufacturing as a whole, labor costs increased relatively in the steel industry. Nevertheless, the management was able to obtain increased profit margins, despite slack demand (as measured by the ratio of unfilled orders to monthly sales) and excess capacity over most of the period. Examining the gross scatter diagram between profit margins and the capacity utilization rate, the authors discern a possible upward shift of this relationship after 1954, which suggests a profit-push.²⁵ Thus the

25. John M. Blair ("Administered Prices: A Phenomenon in Search of a Theory," American Economic Review, Papers and Proceedings, Volume XLIX, No. 2 (May, 1959), pp. 431-450) comes to a similar conclusion, based also on his examination of a gross scatter diagram. A comparison of the rate of return (on net worth) in the steel industry with rates of return in other manufacturing industries (Eckstein and Fromm, op. cit., pp. 27-28) suggests that the improved profit margins are only partially explained by the increasing capital intensity of steel production.

state of demand in the product market played at most a minor role; even though demand may have exerted some pull on steel prices during peak periods, the strong downward rigidity of steel prices alone would belie the general applicability of this explanation. The entire steel experience, during the postwar period, looks very much like a successful conspiracy on the part of the union and the management to shift income from the general public to themselves.

Still a third type of sector is the construction industry. Here much of the rather large increase in the implicit G.N.P. deflator for construction can be attributed to demand pressures.²⁶ Thus immediately after World War II (1946-1948), demand for all types of construction was high. During most of the postwar period, demand in at least one of the two major segments of the construction industry has been strong. For example, demand for residential construction was heavy in the 1954-1955 recovery, while non-residential construction was strong during the 1955-1957 investment boom. The market power of the construction unions, which are generally much stronger than the contractors, appears to have been a reinforcing factor in the rise of construction prices; the large wage increases of construction workers probably reflected, to some extent, the market power of their unions. While the historical evidence does not allow one to distinguish sharply the role played by each, it

26. Levinson and his colleagues (Chapter 5 of Employment, Growth, and Price Levels, p. 109 and pp. 127-128) point out that the rise in this implicit deflator may be partially a statistical illusion, due to an inadequate accounting for productivity increases.

seems clear that the construction industry is a mixed case, in which either cost increases or the pressure of excess demand can elicit price increases.

6. Richard G. Lipsey's "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom 1862-1957: A Further Analysis": The Functioning of the Individual Labor Markets.

In this section, we turn to a possible interpretation of the importance of an unemployment change variable in an aggregative wage adjustment relationship. In the brief survey of Chapter I, it was pointed out that Phillips and Lipsey both found that, for pre-World-War-I British data, falling unemployment was associated with higher money wage changes and rising unemployment with lower money wage changes, if the other relevant variables were held constant.²⁷ It will also be recalled that the present author has obtained results which tend to confirm the importance of an unemployment change variable in an aggregative wage adjustment equation. (The unemployment change variable had a statistically significant regression coefficient when the parameters were estimated by the simple least squares procedure of Chapter IV but not with the two stage least squares technique employed in Chapter VI.) Following Lipsey, one may examine how the workings of the various labor submarkets can

27. A. W. Phillips, op. cit.; Richard G. Lipsey, op. cit.

generate the "loops"²⁸ (the importance of the unemployment change variable) as "errors of aggregation."

Lipsey starts with a labor market adjustment equation for the individual labor markets. Following Bent Hansen, he postulates that the relative wage change is proportional to the relative excess demand in a particular labor market. (See Figure 12.) Next, Lipsey develops a relationship between relative excess demand and its operational counterpart, the percentage of the labor force unemployed for the particular labor market. The two are inversely related, with low unemployment being associated with (positive) excess demand and high unemployment being associated with excess supply. Furthermore, the relationship between relative excess demand and percentage unemployment is non-linear, largely as a consequence of the assumption that as excess demand becomes infinite, unemployment approaches a non-negative limit. The reader is referred to Figure 13 below. At unemployment level a , where excess demand is zero, there is only frictional unemployment. Frictional unemployment will be a positive quantity as long as workers change jobs for any reason whatsoever, and so long as changing jobs takes time. It is probably true, however, that less time will be required, the greater the tightness of a particular labor market.

28. In illustrating the significance of the unemployment change variable, Professor Phillips presented diagrams with observations over a trade cycle plotted in relation to the statistical curve connecting the money wage change with the level of unemployment. As years of falling unemployment generally lay above the curve and years of rising unemployment were generally below, the resulting visual pattern was a "loop." This term may be used as a short-hand expression for the importance of an unemployment change variable in an aggregative wage adjustment relation.

As an immediate consequence, one can easily combine these two relationships and obtain the (relative) money wage change as a function of (percentage) unemployment. (See Figure 14.) This relationship will be non-linear because the relationship between relative excess demand and percentage unemployment is non-linear. Although the wage-determination process may be affected by the institution of the trade union, Lipsey argues that the same types of relationships between the variables will continue to hold. It is possible that the unions may modify these relationships; thus the money wage may be more flexible upward than downward, due to the market power of the union. (The dashed lines of Figure 12 illustrate this possibility.)

Figures 12, 13, and 14 summarize the above discussion. $\frac{d-s}{s}$ is the relative excess demand in the labor submarket; $\frac{u}{l.f.}$ is submarket unemployment relative to the relevant labor force; and $\frac{\Delta w}{w-1}$ is the relative change in the submarket wage.

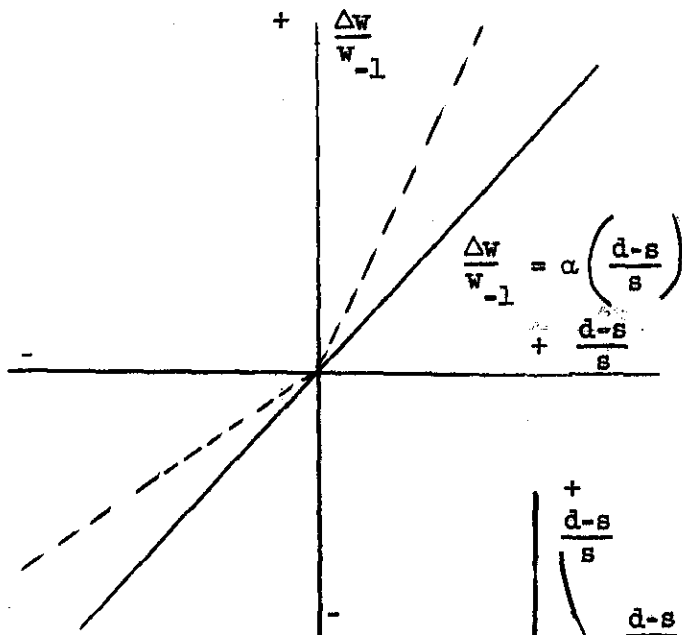


FIGURE 12.

The Relationship between Relative Wage Changes and Relative Excess Demand, for a Particular Labor Submarket.

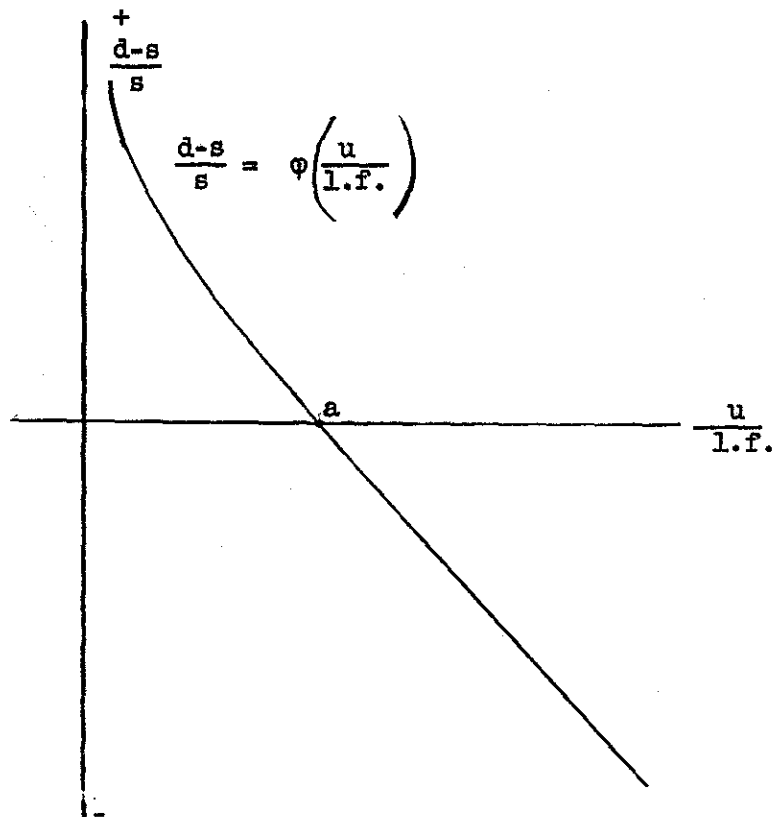


FIGURE 13.

The Relationship between Relative Excess Demand and Percentage Unemployment, for a Particular Labor Submarket.

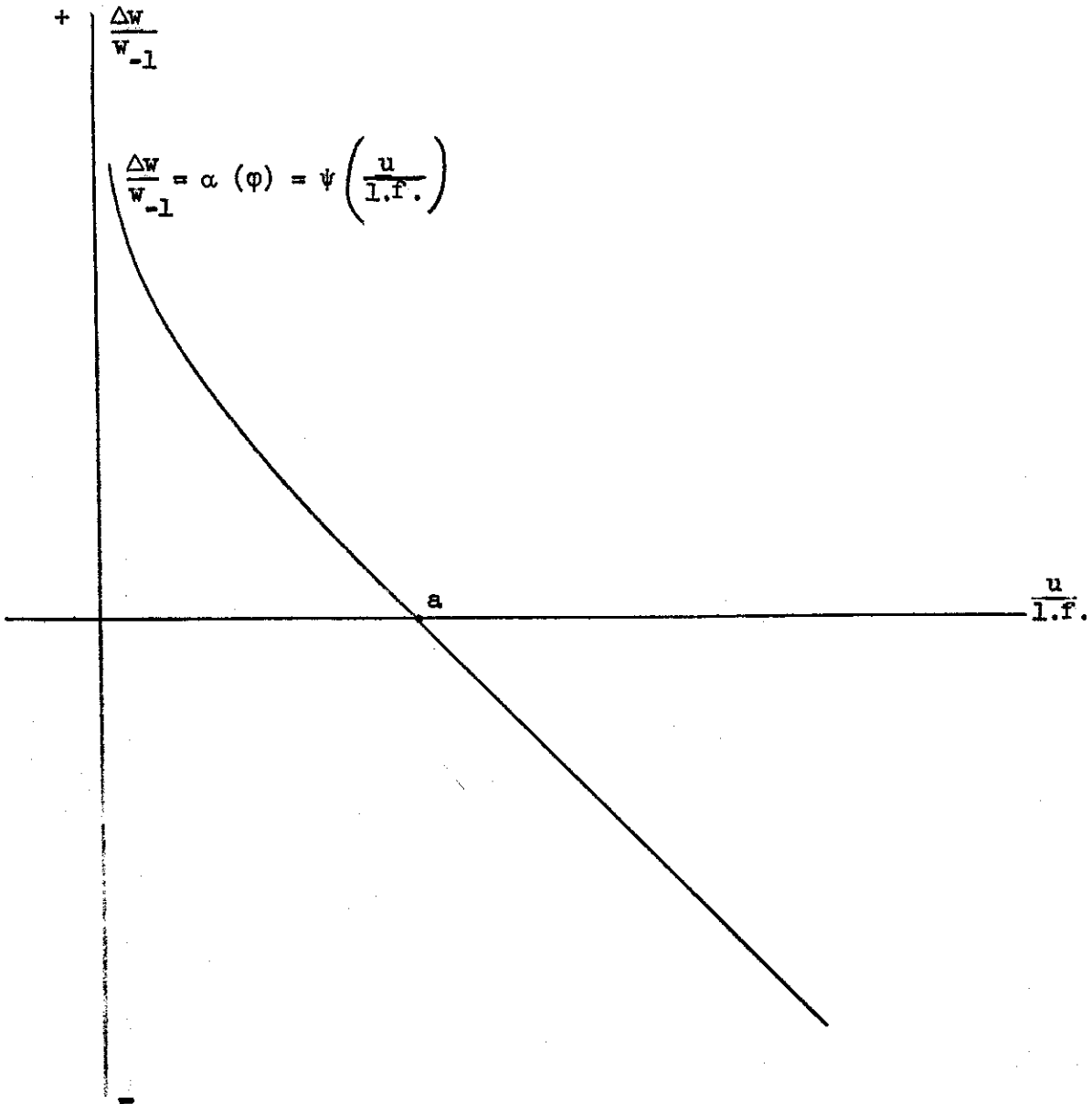


FIGURE 14.

The Derived Relationship between Relative Wage Changes and Percentage Unemployment, for a Particular Labor Submarket.

At this point, Lipsey aggregates (in principle) these individual labor market relations in order to obtain an economy-wide relationship between the relative wage change and the unemployment percentage. This aggregative wage adjustment equation has the same general shape

as the adjustment functions for the individual labor markets. However, the aggregative relationship will depend on the distribution of unemployment in the individual labor markets. If there is always an identical percentage of the labor force unemployed in each labor market at all levels of unemployment, then the aggregative function will coincide with the identical individual market functions (or with their weighted average, if they are not identical). If, however, there is inequality in the distribution of unemployment among labor markets, with unemployment in at least one market being in the non-linear portion of the individual labor market adjustment function, the aggregative function will be lifted above the weighted average of the individual functions. Furthermore, the upward displacement will, in general, be greater the more unevenly is unemployment distributed among the individual labor markets.²⁹ Thus, the aggregative function can never lie below the individual labor market adjustment functions (or their weighted average). Furthermore, because of this upward displacement, Lipsey argues that a fitted aggregative relation will always tend to overstate the upward wage flexibility and to understate

29. Phillips (op. cit.) makes in passing a similar application of the strong curvature of his fitted relationship, asserting that an uneven distribution of unemployment (either geographically or over the months of the year) will result in a higher money wage increase than if unemployment were distributed equally. Phillips argues that the existence of wage rate increases during the 1934-1937 period tends to corroborate this view.

the downward wage flexibility to be found in a typical labor market.³⁰

We are now ready to turn to Lipsey's explanation of the "loops," which appear in his, Phillips', and the present author's aggregative wage adjustment equations. Lipsey argues that these "loops" are an aggregation phenomenon and not a characteristic of the individual labor markets. He argues that when unemployment in general is falling, the recovery affects the different individual labor markets at different times, producing an increase in the inequality in the distribution of unemployment among sectors. This type of change will increase the upward displacement of the aggregative function. On the other hand, he holds that the downturn affects most labor markets rather evenly, and so unemployment rates in the individual labor markets tend to be more nearly equal during the recession. Thus the upward displacement of the aggregative relationship would be smaller, in comparison to a

30. Lipsey makes a related point which is relevant to a discussion of the unemployment "required" for price level stability. He argues that one cannot infer from a statistically fitted aggregative relation how the money wage change will develop if unemployment were held at a given level for a long period of time. He asserts that if unemployment stayed constant for some length of time, the distribution of unemployment among labor markets would change "substantially." Hence the aggregative relationship would shift. Since Lipsey is unable to decide the direction of the change, one might consider this qualification to be of minor importance. The possibility of statistical illusion in the fitted aggregative relation may, however, be a clue as to why "the facts [of recent inflation experience] are more comforting than the logic," as Romney Robinson said (op. cit., p. 1006) in his recent comment on Schultze's work.

period of recovery. As a consequence, one would have falling unemployment associated with high money wage increase (for a given level of unemployment) and rising unemployment associated with low money wage increases. In this manner, Lipsey explains the statistical significance of an unemployment change variable in the aggregative relationship. It is to be noted that the "loops" do not consist of both positive and negative deviations from a "true" relationship between the money wage change and unemployment. Instead, the greater degree of sectoral inequality in the upswing merely induces a greater upward displacement than during the downswing.

Finally, we may ask how relevant this is for explaining the "loops" observed in the present author's aggregative wage adjustment relationships, which were computed from American data. The author is agnostic, if not sceptical, about this particular explanation. In the first place, Lipsey works with relationships formulated in terms of relative wage changes, percentage unemployment, and relative excess demand, while the best statistical results of this study were obtained with the variables in absolute, not relative, form. This is not a serious limitation on the applicability of Lipsey's model, as his aggregation algebra can be suitably modified (with some additional assumptions) so that it becomes relevant to the aggregate wage adjustment relations of Chapters III and IV. A more serious difficulty is the fact that Lipsey's model implies that the aggregative function is non-linear, at least for low levels of unemployment, while the present author's fitted relation between the money wage change and unemployment

is apparently linear. It may possibly be that the "true" relationship between these two variables is non-linear, and that the scatter is too great to detect this non-linearity, with the statistical techniques employed. But this implies a strong belief in the Lipsey hypothesis, a belief perhaps inappropriate to a relatively untested theory.

Two other objections may be raised. One may question Lipsey's view that whether net hirings or net dismissals are occurring can have any influence on the wage outcome of the individual labor markets. Falling unemployment might lead to the expectation of labor shortages; in an effort to avoid the ill effects of labor shortages, employers might rush in to demand labor. Thus bid up, money wages might rise more rapidly than usual. (In terms of the graphs, with falling unemployment, excess demand for labor might be higher than it would be normally, and so the ϕ function of Figure 13 would be displaced upward.) Or falling unemployment might engender the anticipation of still tighter labor markets, which might lead workers to push for wage increases higher than normal for a given level of unemployment.³¹ (This type of modification, which might reflect the short-period rigidity that unions introduce into the wage determination process, would involve an increase in the wage reaction coefficient α and hence an upward movement of the function of Figure 12.) Either of these two possible types of changes, it should be noted, will evoke an upward shift in

31. Phillips (op. cit.) seems to suggest, at various points, a similar explanation of the significance of an unemployment change variable.

the ψ function of Figure 14. These arguments are also reversible. Hence rising unemployment might lower the money wage change associated with a given level of unemployment (the ψ function of Figure 14), either by reducing the wage reaction coefficient α or by producing an unusual degree of relaxation of excess demand, for a given level of unemployment. If this view is correct, the "loops" are merely positive and negative deviations from the exact (unchanging unemployment) aggregative relationship.

7. Summary and Implications for Research and Policy.

A summary may be presented. The common strand underlying all of these discussions is an emphasis on sectoral effects in a complete analysis of the inflationary process. Thus in Hansen's discussion one sees, at a high level of abstraction, how the inflationary process may be modified when one considers a multi-sector model. Duesenberry and Ackley show how the interaction of a competitive agricultural sector with an industrial sector where mark-up pricing rules can lead to a modification in our picture of inflation. Schultze's discussion, focusing on the greater upward flexibility of most commodity prices, places sectoral effects at the very center of inflation analysis. Schultze's work offers a third alternative to the aggregative explanations of "demand-pull" or "cost-push." Bowen emphasizes sectoral determinants of the general price level, and Thorp and Quandt assert that structural pressures may, on occasion, induce inflation. Moulton's discussion of the World War I era suggests that these concepts are relevant to the American economy of nearly half

a century ago. The importance of looking at special factors in particular industries is pointed up by Employment, Growth, and Price Levels (the Staff Report) and by the Wilson and the Eckstein and Fromm study papers. Here it was concluded that price and wage rises in the particular sectors examined were elicited in part by conditions peculiar to these sectors as well as by forces impinging on the over-all economy. Finally, Lipsey's discussion illustrates how an analysis of sectoral effects emanating from the individual labor sub-markets can modify one's view of the aggregative wage adjustment equation.

These remarks carry implications for empirical testing. Thus if one wishes to determine whether cost or demand pressures were predominant in a particular inflation, an examination of aggregative data will give only inconclusive answers. If, for example, the economy-wide wage share increases during the course of an inflation, this is not conclusive evidence of wage-push. One might expect the composition of demand to change during a demand inflation and so demand might shift toward those sectors for which the wage share is relatively high. Thus, even though within an industry high demand tends to shift income to profit recipients, it is logically possible that during a mild demand inflation the wage share may increase. Similarly, a slackening in the rate of growth during an inflationary period, while suggestive, is not proof positive of cost inflation. The growth rate can fall off due to a lessened rate of growth of productivity, which might reflect autonomous factors. The growth rate

might also slow down because of a sharp shift in the composition of demand; the widespread excess capacity might be attributable to this factor, rather than to autonomous cost increases, as Schultze has pointed out. Similarly, an increase in the unemployment rate during an inflationary period could reflect ~~shifts~~^{Shifts} in the composition of demand.³²

It would seem advisable to take account of particular sectors and of sectoral effects when prescribing anti-inflation policy. Thus, to counteract the inflation in consumer services, several specific measures seem advisable. The continuing rise in the price of medical services would probably be mitigated by government policies designed to increase the supply (absolutely and relatively) of trained personnel.³³ The consumer services subsectors which display lagging productivity -- urban transportation, laundry and dry-cleaning, automobile repair services -- might respond to the establishment of productivity centers, which the United States instituted in some European countries immediately after the Second World War. Any

32. For an article in which these limitations on the usefulness of aggregative materials are taken into account explicitly, see Edmund S. Phelps, *op. cit.* Phelps examines data for 34 U.S. industries during 1955-1957 and also (for comparative purposes) during 1946-1948 and 1950-1952. His substantially qualified conclusion is that wage-push was more aggressive during the 1955-1957 inflation than during the other two inflationary postwar periods.

33. Aid to new and old medical schools and scholarships to medical students of moderate means are two obvious possibilities. These measures, which many would advocate for other reasons as well, will not cure the problem immediately; but they would be a start.

improvement in the rate of increase in productivity in these sub-sectors would be valuable, not merely in mitigating the inflationary pressures emanating from average wage increases, but as a means of furthering the goal of faster growth as well. More generally, the impact of a demand-shift can be mitigated if selective credit controls are directed toward the sectors with localized excess demand. Finally, in those few sectors in which market power has been flagrantly exercised, some form of public regulation might be advisable. There would be problems associated with regulating the steel industry, but it is difficult to believe that they would be much greater than those associated with the regulation of the public utilities.

It would seem that there is no easy formula, no obvious way that the particular actors can avoid inflationary behavior even if they so wished. One proposed solution is that all workers should receive wage rate increases proportional to the economy-wide increase in productivity, while firms would adjust prices upward or downward, depending upon whether the firm's increase in productivity fell short of or exceeded this average change. This method prevents relative wage rates from changing, and so impedes the labor market from performing its allocation function. Furthermore, it freezes the existing pattern of wages, which may contain some inequities in the view of some of the participants. The product market will also perform its allocation function less than optimally, since changes in relative prices result only from differential productivity movements and never from shifts in demand. The same objections could be raised against

the proposal that wage rates in each firm should rise proportionately with the firm's productivity, leaving not only the price level but all prices unchanged. In addition, such a policy would soon produce strong tensions, as the wage structure would depart from established patterns and produce feelings of inequity in the losers.

Thus thrown on their own thinking, both management and unions are likely to find more reasons why particular prices and wages should rise than why they should fall. (In the case of a particular wage, an increase must be interpreted as an increase in excess of the economy-wide productivity gain.) Exhortations to "responsible" action in the national interest are likely to fail; they provide oratory always, guideposts never, and motivation for only a short time. The reason why motivation can be expected to be weak, at least after some time elapses, is that if a particular actor refrains from pressing his advantage while others press theirs, he loses without making a material contribution to price level stability. A periodic conference of government, labor, and business leaders would seem admirably suited to break this impasse.³⁴ The discussions at such a conference might point the way, in particular cases, to non-inflationary behavior consistent with other goals (e.g., efficiency in resource allocation,

34. After examining a long series of anti-inflationary policy measures, John M. Clark concludes (op. cit., pp. 61-67) that this measure is best for combating the type of inflation which the United States is likely to face in the decade of the 1960's. Clark is careful to point out that he believes that such an organization will function effectively only after a thorough job of public education. Too much, therefore, should not be expected from the first several conferences. Clark also emphasizes that he is proposing that the private actors merely temper the pursuit of their self-interest with altruism -- not that they substitute entirely altruism for self-interest.

correction of intolerable differentials in the wage structure, and hopefully, grudging agreement about distributive shares). A permanent staff arm advising the policy-makers, the functions of which would be research on the particular problem areas and education, would aid the smooth functioning of the periodic conferences. If the public had been properly enlightened, the pressure of public opinion could act as a moral force tending to make binding the recommendations of the conference. Perhaps this method will not work. Nevertheless, it certainly seems desirable to give it a trial, before anything more drastic is instituted in peacetime.

The present author's comments, based largely on the works of other writers, do not mean that he considers aggregative analysis worthless. This is far from his view; aggregative analysis is one of the most valuable tools which economists have developed for the larger policy issues of a private enterprise economy. Aggregative tools provide a powerful first approximation, cutting through many issues of secondary importance. Often this first approximation is good enough for all practical purposes. Thus few would quarrel with a general excess demand explanation of wartime inflation, or with policy measures based on such an explanation. Similarly, there may be circumstances (not necessarily found in recent United States experience) for which an aggregative "cost-push" theory gives a good over-all picture of a particular inflation. But there are other times when the first approximation character of aggregative analysis can be usefully supplemented with an analysis of sectoral effects. The U.S. "creeping inflation"

of the second half of the 1950's is probably such an example. Our failure to arrest this upward price level movement may well stem from theories that pay inadequate attention to particular sectors and sectoral effects.

Chapter VIII, "Concluding Reflections"

This chapter serves a twofold purpose. In the first section, the author once again wrestles the knotty problem of the trade-off between full employment and stability of the price level. The two stage least squares estimates of the parameters of the wage adjustment relationship are used in this connection, and some of the other results are brought into the discussion, also. In the second section, a brief summary of the author's major conclusions is presented.

1. A Further Examination of the Trade-Off between Unemployment and Inflation.

Consider the following subsystem:

$$(6.10) \quad \Delta w_t \cong w_t - w_{t-1} = .03979 - 0.2432 \times 10^{-5} U_t \\ + 0.6514 \times 10^{-2} (P_t - P_{t-1}) \\ + 0.2180 \times 10^{-2} t ,$$

$$(3.10) \quad P_t = k \frac{w_t}{A_t} ,$$

$$(3.11) \quad A_t = 1.025 A_{t-1} .$$

(The symbols employed have been defined previously; all definitions continue to hold. t , which is equal to zero in 1935 and is in annual units, is also used as a time subscript.)

This subsystem is basically the one used in Section 3 of Chapter III, in which the trade-off between unemployment and price level stability was examined; however, the wage adjustment relation used in this section is taken from the final section of Chapter VI. In the earlier discussion of the trade-off, the author stated some reservations with regard to all of these relationships. Is there anything further that may be said?

The parameters of equation (6.10) have been estimated by the method of two stage least squares. Consequently, the biases associated with using a single equation method to estimate the parameters of one relation taken from a full system are absent. On the other hand, it must be pointed out again that the two stage procedure called into question the strength of the relationship between unemployment and the wage change; only when three outlier years were omitted from the sample period was the regression coefficient of the unemployment variable statistically significant. The years 1934, 1945, and 1951 are not included in the sample period on which equation (6.10) is based.

Equation (3.10) is a mark-up equation. This simplified relationship draws some support from the empirical results of Chapter V (and the final section of Chapter VI). There it was found that, for the manufacturing sector, unit labor costs were a key determinant of the wholesale price level of finished goods. Furthermore, the formulation used in the empirical analysis implies that the state of demand influences primarily the level of prices. If this is true, then demand

conditions do not play a large role in explaining the magnitude of continuing price level changes; demand pressures merely exert a once-and-for-all influence. One qualification that remains is the downward trend in the mark-up factor k (a rise in labor's share of the total product). The downward trend in k tends to mitigate the conflict between full employment and a stable price level, as such a movement of the mark-up factor allows some absorption of rising labor costs.

Equation (3.11) expresses the assumption that labor productivity grows at the rate of $2\frac{1}{2}$ per cent per annum. This is obviously an average rate of productivity growth, and deviations for particular years must be expected. From Chapter VI, one finds that this growth rate is moderately close to average U.S. experience -- if anything, it is slightly too conservative if the first decade and a half of the twentieth century is discarded. In Chapter VI, it was also found that the level of productivity varies inversely with the unemployment rate. Although it is far less certain that productivity will grow less rapidly if resources are underutilized, this possibility cannot be dismissed. Insofar as low productivity growth is associated with high unemployment, this increases the amount of unemployment "required" for stable prices.

One can now solve for the level of unemployment "required" for price level stability, subject to the above qualifications. (Some further qualifications are stated at the end of this section.) In this model, a stable price level occurs when unemployment is high enough to hold the wage increase (in percentage terms) to the gain in

productivity. As before, an extrapolation of the Rees series gives w equal to \$2.50 in 1959. For the year 1960, we have:

$$(8.1) \quad t = 25 ; \quad \Delta w_t = .025w_{1959} = \$0.0625; \text{ and}$$

$$\Delta P_t = 0 .$$

Substitution into equation (6.10) yields:

$$(8.2) \quad 0.0625 = 0.03979 - 0.2432 \times 10^{-5} U_t + 0 \\ + 0.2180 \times 10^{-2} (25) .$$

The solution is 13,070 thousands or 13,070,000 workers, which is 18.6 per cent of a labor force of roughly 70 million. Thus, with two stage parameter estimates for the wage adjustment equation, the trade-off of unemployment for price level stability appears to be even greater than with single equation parameter estimates.

One can obtain, from the model, an estimate of the amount of inflation associated with "full employment." Algebraic manipulation of equation (3.10) yields:

$$(8.3) \quad \frac{\Delta P_t}{P_{t-1}} = \frac{A_{t-1}}{A_t} \left[\frac{\Delta w_t}{w_{t-1}} - \frac{\Delta A_t}{A_{t-1}} \right] ,$$

where the Δ symbol refers to the difference between the current value of the variable in question and its value in the preceding year. Using equation (3.11), (8.3) simplifies to:

$$(8.3a) \quad \frac{\Delta P_t}{P_{t-1}} = \frac{1}{1.025} \left[\frac{\Delta w_t}{w_{t-1}} - 0.025 \right] .$$

For the year 1959, P is 164.6.¹ Substituting this value and that for w into (8.3a), one obtains, for the year 1960:

$$(8.3b) \quad \frac{\Delta P_t}{164.6} = \frac{1}{1.025} \left[\frac{\Delta w_t}{2.50} - 0.025 \right] .$$

This gives a linear relationship between the wage change and the change in the consumer price level:

$$(8.4) \quad \Delta w_t = \overset{0.062499}{\underset{0.024390}{\cancel{0.024390}}} + 0.015568 \Delta P_t .$$

If the level of unemployment is fixed at a "full employment" value, one can obtain a second linear relationship between the wage change and the price level change. The author takes 3 per cent of a labor force of roughly 70 million as the "full employment" level of unemployment. This level is 2100 thousand men, and for the year 1960, equation (6.10) becomes:

$$(8.5) \quad \Delta w_t = 0.03979 - 0.2432 \times 10^{-5} (2100) \\ + 0.006514 \Delta P_t + 0.2180 \times 10^{-2} (25) .$$

1. The value of the consumer price index is derived from the value given in Table B-42 of Economic Report of the President (Washington: U.S. Government Printing Office, 1962). (This table appears on p. 258.) The 1959 value of the consumer price index for all items was converted to a 1926 base, so that consistency with the previously utilized series is maintained.

Combining (8.5) with (8.4), we have:

$$(8.6) \quad \begin{array}{l} 0.062499 \\ 0.024390 \end{array} + 0.015568 \Delta P_t = 0.03979 - 0.005107 \\ + 0.006514 \Delta P_t + 0.0545$$

The solution value of ΔP_t is equal to $\frac{2.947}{7.156}$ index points. Thus, in this model, "full employment" is associated with a $\frac{1.79}{4.35}$ per cent annual increase in the consumer price level, for the year 1960.

The conflict between full employment and price level stability seems to be no less severe if two stage least squares estimates of the parameters of the wage adjustment relation are used to gauge the degree of incompatibility between these two goals. (Indeed, with the two stage estimates, the conflict appears more severe, as the preceding footnote implies.) However, the qualifications implicit in the discussion of Chapter VII should be emphasized. Some of the observations are drawn from periods during which there were imbalances in particular markets. As argued earlier, these disequilibria could have exerted an upward impetus to wages and prices, even in the absence of excess demand for the economy as a whole. Moreover, if such structural pressures could be averted, the goals of full employment and price level stability

2. Similar calculations based on equations (3.4) and (3.15) yield an expected rate of annual increase in the consumer price index equal to 3.51% per cent and 3.58% per cent respectively, if the text definition of full employment is retained and if t remains at its 1960 value. Thus, these single stage estimates of the wage adjustment equation generate a somewhat lower predicted rate of price increase under full employment conditions.

would probably become more compatible. A second consideration involving sectoral analysis is Lipsey's assertion that there is an upward bias of aggregation in the typical fitted wage adjustment relation describing the economy as a whole. If this is true, the tendency for full employment and price level stability to conflict is overstated. These qualifications can account for some of the surprisingly great incompatibility between these two goals, but, in the view of the present author, they can hardly account for all of it.

2. Some Conclusions.

A summary of the author's major conclusions may now be presented. In Chapter II, R. James Ball and the author of the entire work analyzed the separate effects of changes in the exogenous economic variables on real income and the aggregate price level. The technique was generalized multiplier analysis, based on a fairly simple model of the economy. In general, expected results held true. Some special cases were examined; for example, it was found that the conditions under which a "pure" quantity theory holds are stringent indeed, if one accepts the Keynesian description of the money market and the conditions of labor supply. The system was then reduced to two relations, the aggregate supply and aggregate demand functions. This reduction enables one to obtain a pedagogic multiplier as a special case of a more general formulation and to give a graphical determination of real income and the price level. In turn, this latter device suggests that demand price and supply price must be considered jointly in most comparative statics

discussions of price level movements. This principle has not always been given appropriate emphasis in the debate between the demand and cost inflationists.

In Chapter III, several empirical relationships explaining money wage changes were estimated by simple least squares techniques. The final working relation of this chapter is one in which the explanatory variables are the level of unemployment, the current change in the consumer price index, and a time trend. Recalculation of the parameters by the method of two stage least squares suggests that the influence of unemployment on the money wage change is even weaker than the preliminary calculations indicate. (Section 4 of Chapter VI.) The other two independent variables remain important influences. Also in Chapter III, a preliminary examination of the trade-off between full employment and price level stability suggested a severe conflict between these goals. This incompatibility does not appear any less severe when a wage adjustment equation for which the parameters were estimated by a full system method was employed. (See Section 1 of this chapter.) The model used in this analysis is a particularly simple one, and the earlier qualifications should be recalled.

Chapter IV was concerned with possible modifications of the working wage adjustment relation. Corporate profits did not appear to play a significant role in explaining wage changes. Changes in productivity and changes in the level of unemployment were significant explanatory variables for the simple least squares calculations but not for the two stage computations of Chapter VI. A final result of

Chapter IV was that there was only very slight evidence of irreversibility in the movement of money wages, over the full period 1900-1957.

Price level relationships were the focus of Chapter V. It was found that a good fit was obtained for a mark-up relationship between manufacturing wage costs and the Wholesale Price Index for Finished Goods, both without and with a time trend in the mark-up factor. Nevertheless, this type of relation was abandoned in favor of a linear (non-zero constant term) relationship between the finished goods price index and wage costs, which allows the introduction of other explanatory variables. With simple least squares estimates, four other explanatory variables had statistically significant regression coefficients: a raw materials price index, a time trend, a proxy for demand conditions, and a dummy variable representing the influence of abnormal conditions (principally price control) during 1942-1946. Although, by usual standards, the coefficients of these supplementary variables generally remained significant for the two stage estimates, the presence of autocorrelated residuals vitiates customary tests. When a Theil formula was used to adjust the standard errors for autocorrelation of the estimated residuals, the adjusted t ratios implied that only the influence of wage costs and of the dummy variable remains statistically significant. Finally, several tests of irreversibility in the working price level relationships gave negative results.

In Chapter VI, time patterns of productivity growth were studied. Some tentative evidence that productivity evolved at an increasing rate of growth was uncovered, but further considerations

(autocorrelated residuals and re-estimates of the parameters by the method of two stage least squares) indicated that this acceleration was not statistically significant. The level of productivity appears to vary directly with the degree of utilization of the labor force, which was ultimately represented (inversely) by the unemployment rate. The negative relationship between productivity level and the percentage of the labor force unemployed survived an adjustment for autocorrelated residuals and a re-estimation of the coefficients by the two stage method. For the period 1913-1957, the magnitude of average productivity growth, at a constant rate of unemployment, is only slightly higher than the 2 1/2 per cent per annum rate used for illustrative purposes.

With the forbearance of the reader, several more remarks may be appended. At the risk of attempting to be his own critic, the author wishes to state that this work does not attempt to give definitive answers for all the issues examined. Unlike Alexander, future researchers need not fear that there will be no new worlds to conquer. The present author is satisfied if this work serves to advance, in some small degree, our understanding of wage and price level relationships.