

A Study on Phillips Curve

Model Building for the Case of Manufacturing Industry in Australia

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I. Introduction

A.W. Phillips, in his paper "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861—1957", presents a hypothesis based on a demand curve analysis that unemployment and the rate of change of wage rates are related.¹⁾ The philosophy is that when unemployment is low, the demand for labour will be high and wage rates will be bid up. Therefore, at low rates of unemployment, rate of change of wage rates will be high. In the converse situation, however, when unemployment is high, workers will not offer their services at less than the prevailing rates, so that as unemployment increases, the rate of change of wage rates may tend to flatten out.

R. G. Lipsey presents the similar argument by introducing changes in cost of living as an additional contributory variable in the model.²⁾ The purpose

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1) A.W. Phillips, "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861—1957," *Economica*, Vol. 25 (November 1958), pp. 283—299.

2) R.G. Lipsey, "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the U.K., 1862—1957, A Further Analysis", *Economica*, Vol. 27(1960), pp. 1—31.

of this paper is to investigate the applicability of such a philosophy to Australia to illustrate some aspects of overall price movements. Further, the emphasis will be made on the interpretation of the labour market because the labour market plays an important role in the process of inflation. The steady drift of money wages probably arises in the labour market and is transmitted recursively to prices through a markup process that determines the price level.

II. The Models

Phillips argued that the principle of supply and demand should be one of the factors determining the rate of change of money wage rates. He argued that when the demand for labour is high and there are very few workers unemployed, employers will bid up wage rates rapidly in order to retain qualified workers. However, when business activity falls, with the demand for labour decreasing and the percentage unemployment increasing, workers will be in a weaker position to press for high wages. Employers will be reluctant to grant excessive wage claims because the increasing supply of unemployed workers gives them security as to future staff availability. Since workers are reluctant to offer their services at less than the prevailing rates when unemployment is rising, wage rates will tend to fall but very slowly. Consequently, the relation between unemployment and inflation is likely to be non-linear.

Seven hypotheses will be tested in this study,³⁾ and they are

Model 1:	$\dot{W}=f(U)$
Model 2(a):	$\dot{W}=f(UN)$
Model 2(b):	$\dot{W}=f(UNP)$
Model 2(c):	$\dot{W}=f(\dot{U})$
Model 3(Phillips):	$\dot{W}=f(\dot{U}^{-1})$
Model 4(Phillips):	$\dot{W}=f(\dot{U}^{-1}, \dot{U})$
Model 5(Phillips):	$\dot{W}=f(\dot{U}^{-1}, \dot{U}, \dot{P}_{-4})$
Model 6(Friedman):	$\dot{W}=f(U^{-1}, \dot{P}_{-4})$
Model 7(Holt):	$\dot{P}=f(U^{-1}, \dot{P}_{-4})$

here U =quarterly statistic of unemployment, expressed as a percentage of workforce by 4 quarters

3) J.W. Lee, "A Re-examination of Phillips Curve", *Essays in Economic Theory, Application, and Practice*, (Back Young Sa, Seoul, 1974), pp. 28-31.

UN =level of unemployment (in 1,000)

$UNP=(UN/\text{workforce})\times 100$

W =quarterly statistic of average weekly earnings per employed male unit, by seasonally adjusted 4 quarters

\dot{W} =percentage quarterly change in average weekly earnings

$U^{-1}=1/U$

\dot{U} =quarterly change in the rate of unemployment

$=U_n - U_{n-4}$

$\dot{U}^{-1}=\frac{1}{\dot{U}}$

P =quarterly statistic of consumer price index, by 4 quarters

\dot{P} =percentage change in consumer price index

P_{-4} =quarterly statistic of consumer price index, lagged by 4 quarters

\dot{P}_{-4} =percentage in the lagged consumer price index

III. The Data

The data were obtained from various issues of the Statistical Bulletin of the Reserve Bank and the Quarterly Summary of Australian Statistics published by the Australian Bureau of Statistics. The figures for total civilian employment are based on comprehensive data from the Population Census 1961 and 1966. For the periods subsequent to the Censuses, the employment data are obtained from three main sources: (1) current pay-roll tax returns, (2) current returns from government bodies, and (3) some other current returns of employment such as hospitals. Wage earners in rural industry and female private domestics are excluded from employment estimates.

(A) Unemployment:

Seasonally adjusted, quarterly statistics of the rate of unemployment are not readily available for an extended period. Quarterly statistics for the rate of unemployment are available from February, 1964, and the December quarter in 1974 is set as the final quarter for the data collection.

The figures for registered unemployed refer to those people registered at the end of the period with the Commonwealth Employment Service. These are people who claimed when registering that they were not employed and were recorded as unplaced. It also includes those who are referred to employers and who may have obtained employment without notifying the Commonwealth Employment Service.

(B) Wages:

The index for average weekly earnings refer to manufacturing industry.

For the years 1958—59 to 1967—68, the data are collaborated from the average weekly earnings of male wage and salary earnings employed in manufacturing industries as disclosed in the Manufacturing Census. For the periods subsequent to June 1968, the figures are the estimates based on pay-roll tax return, and this series has been seasonally adjusted with the base of 1953—54⁴⁾

(C) Consumer Price Index

This information is available for 25 years. Two base years, 1953—54 and 1966—67, were applied throughout the study, that is the basis of 1966—67 is applicable to the period of February, 1964, to December, 1974. Cost of Living is the term often incorrectly applied to the Consumer Price Index. It began as a "C" Series Retail Price Index in 1921, revised in 1936 and continued almost unchanged until 1960. During World War II, war time controls enforced changes in consumption patterns necessitating a reconstruction of the index. The Consumer Price Index currently in use was first compiled in 1960, retrospectively to September quarter in 1948. It covers a wide range of goods classified under food, clothing and drapery, housing, household supplies and equipment, and miscellaneous. It is, therefore, not meant as an accurate measure of the cost of living as an indicator of the trend in the cost of a representative collection of consumer goods.

IV. The Statistical Results

(A) Model 1

Unemployment figures used were based on the number of recipients of unemployment benefits. These statistics closely correspond to the registered number of unemployed. The recipient benefit figures are not quite as large in magnitude, as not all unemployed receive social security benefits but the trend of both variables is similar.

The 44 observations for all variables in the model were obtained by quarters for the 10 year period of 1964—1974. Quarterly average figures for 10 year period were used since they proved more efficient and less cumbersome to test representative values for the entire information.

By using a trial and error procedure with the use of computer program

4) Figure 3 in the Appendix shows a comparison of average weekly earnings and the index of average weekly earnings in manufacturing in *inuy.strd*

CALC and the BMD package program,⁵⁾ the following result was obtained:

$$W = 2.4 + 0.07943 U^{-0.455}, F = 0.265, R^2 = 0.0812 \\ (0.15429)$$

where () indicates the standard error of estimate. The output from the CALC to estimate power value is in the following table.

Table 1. Powers and the Range of Residuals

Power to which average is raised	Range of residuals
+1.0	2.241
-0.15	2.349
-0.25	2.333
-0.40	2.320
-0.43	2.319
-0.44	2.319
-0.45	2.318
-0.455	2.318
-0.456	2.319
-0.458	2.319
-0.47	2.319
-0.48	2.319
-0.51	2.320
-1.0	2.361
-1.25	2.372

As the rate of unemployment approaches zero, hourly earnings tended to rise sharply, but as unemployment rates rise, earning has been declining very slowly. This is indicated in Figure 1 in the Appendix, and the model was specified as above.

(B) Model 2(a)

The relation between \dot{W} and UN is unusual as it is curvilinear to the X -axis as in the Appendix Figure 2(a). As unemployment increases initially, \dot{W} rises at an increasing rate and then continues to rise at a decreasing rate. The derived relationship is as follows:

$$\dot{W} = 8.17 - 31.86 UN^{-0.5}, F = 4.0487, R^2 = 0.5744 \\ (15.83625)$$

The statistical results for the Models 1 through 7 are shown in Table II.

5) Program CALC was written in Fortran IV language to compute $\dot{W}, \dot{W}, \dot{U}, U^{-1}, \dot{P}, \dot{P}_{-1}$, and BMD 03R (Multiple Regression Techniques) originally written at the Health Sciences Computing Facilities, USLA, U.S.A., was applied with the Computer System at the James Cook University, Townsville.

Table II. Statistical Estimates of Phillips' Models

Estimation of	Independents Variables									
	Constant	$U_{-0.455}$	$UN^{-0.5}$	UNP	$\dot{U}_{0.6}$	\dot{U}_{-1}	\dot{P}_{-4}	U^{-1}	R^2	F
Model 1: ($W=f(U)$)	2.4	0.07943 (0.15429)							0.0812	0.265
Model 2(a)	8.17		-31.86 (-15.83625)						0.5744	4.0487
Model 2(b)	0.89565			2.57929 (0.3642)					0.9436	50.1568
Model 2(c)	1.295			78242.122					0.83	
Model 3	2.64					-0.04 (0.106)			0.0682	
Model 4	2.67				-0.59 \dot{U} (-1.485)	-0.02 (0.1192)			0.0965	
Model 5	0.58				-1.68 \dot{U} (-1.3967)	-0.05 (-0.1084)	1.80 (0.6207)		0.4589	
Model 6	-2.84					52.79 (45.827)	1.84 (0.666)		0.4286	
Model 7: ($P=f(U^{-1}, \dot{P}_{-4})$)	-0.3156 (-0.131)						0.395 (0.091)	1.196 (0.254)	$R^2=0.904$	$d=3.18$

V. Summary and Conclusion

It may therefore be concluded from the above statistical results that the effect of unemployment on the rate of change of money earnings is not significant. Phillips' introductory philosophy is certainly most acceptable, that is, when labour is scarce, wage rates will be bid up. Such bidding up, however, will most likely come in the form of bonus and over-award payments spread irregularly and infrequently through the wage earners and fringe benefits such as private use of company transport and concessional purchasing. These factors would not necessarily appear then as an increase in wage rates or earnings.

At the other end of the scale where the level of employment is high, the following factors must be considered:

1. the inflexibility of downward wage rates as Phillips also considered initially,
2. the strong advocations of employee groups for increases in wage rates in the face of rising unemployment,
3. the stagflation situation that has existed during the past 4 years, and
4. the interference of central government to reduce unemployment by direct and indirect means and to increase unemployment benefits, thereby increasing the numbers of those not willing to seek work.

The process of wage rate setting which incorporates cost of living considerations and the price fixing processes which incorporate the cost of labour clearly establish a case for a relationship of the functional form of $\dot{W}=f(P)$. By following this relation, the statistical result indicates the following model, which depicts the Phillips curve of Australian manufacturing industry:

$$\dot{W}=0.4538+1.4133P, \\ (0.39609)$$

with $R=0.5165$ and the standard error of estimate of 2.8935 and $F=12.732$.

Unlike Phillips' non-linear relationship for \dot{W} and UNP , it was found that the case in Australia exhibited an increasing linear trend for the period of 1964–74. As the level of unemployment rose, so did the rate of change of money wage rates. It seems that this situation is peculiar to the last decade as money wage rates have persistently risen during increasing unemployment levels. This may be due to a combination of comparatively low levels of unemployment Australia experienced during this period and also to strong union bargaining power. Australia's unemployment reached 2.75 percent in 1972, this being relatively low compared to world standards.

Unions in Australia have enjoyed fairly strong persuasive bargaining powers. Wage rates have always been known to have a downward rigidity so that in periods when demand for labour was high, higher wages would be demanded and in most cases, the demand was granted. But when unemployment climbed, wage rates did not correspondingly fall, but in fact could increase as unemployment may have affected only certain sectors while other industries with high demand could still opt for high wages. Demand in these fields existed because of labour immobility or because the professions involved specialists. Thus when unemployment in the sectors affected eventually declined, higher wage rates were often demanded here as workers felt that their relativity of incomes must be maintained in relation to the workers who had already received wage increases. Thus, money wage rates tended to have an increasing tendency even when levels of unemployment rose or fell.

The relation between \dot{W} and \dot{U} also demonstrated a steep upward slope line suggesting that percentage changes in money wage rates sharply escalated with very small quarterly variations in the unemployment rate, whereas the relation between \dot{W} and \dot{U}^{-1} exhibited the opposite tendency. While \dot{U}^{-1} was less than 4 percent, percentage change in money wage rates dropped sharply only to level off at the 4 percent level for any further increases in \dot{U}^{-1} . The former relation of \dot{W} and \dot{U} seems to contradict Phillips' findings for the United Kingdom example. He found that the change in money wage rates was greater than would otherwise be expected when unemployment was falling and less than would otherwise be expected when unemployment was rising. In contrast, the upward sloping relation between \dot{W} and \dot{U} found in this study can primarily be explained by the union's bargaining strength in their claims for wage increases.

As to the models 4 and 5, it appears that higher wages have been affected by the changes in the cost of living, represented by \dot{P}_{-4} . As Lipsey noted and quantitated, the simple but weak relation increases in the cost of living make trade unions more aggressive in demanding increases and employers and arbitrators more willing to grant them, while a decrease in the cost of living acts in the reverse direction.⁶⁾ In other words, \dot{W} was related in a straightforward manner to \dot{P}_{-4} .

Phillips curve analysis has important applications on the issue of inflation. Economists have employed the Phillips curve in trade-off analysis, sacrificing

6) R.G. Lipsey, "The Relation between Unemployment and the Rate of Change of Money Wages in the U.K., 1862—1957: A Further Analysis", *Economica*, Vol. 27 (1960), pp.1—31.

increasing unemployment at the expense of higher prices or vice versa. With the use of monetary and fiscal policies, they have repeatedly tried to manipulate and employ successful policy mixes. By the analysis presented in this study it appears that the emphasis must be placed more on money wages rate increases since this is the significant factor that has been greatly escalating in recent years.

Admittedly unemployment has increased but nowhere as near the extent that wages have escalated. Perhaps with the introduction of wage indexation, wages can be regulated more sensibly in accordance with price changes so that wage levels may be kept to a minimum. On the other hand, if wages are left to rise in an upward spiral, employers will be forced to retrench workers and therefore unemployment level will be aggravated.

The importance of Phillips curve analysis lies not only on its statistical implications but on its policy implications. The results give policy makers a better insight into inflation and other relevant issues, thus enabling them to formulate better policy mixes. However, it must be kept in mind that although the Phillips curves are a useful tool for the inflation-unemployment issue, they are at best only one of the various elements involved in economic decision-making.

Although there have been some significant regressions, as shown throughout this paper, it appears that unemployment may not be as significant an explanatory variable as it once was. In particular, it may be that the percentage of the workforce that is unionized is a more significant variable in explaining inflation. When Hines conducted his study he found that in the post-war period, in the presence of the unionization variable, the level of unemployment was not significant.⁷⁾ In contrast, the rate of unionization, that is the index of union activity, is becoming a significant variable. Also the size and significance of its coefficient has increased over time. Even the argument that the rate of change of earnings is more highly correlated with some future level of unemployment is not well supported empirically.

One may accept the empirical evidence of Phillips but dispute the postulated chain of causation. It could be argued that any observed relationship between ΔW and U is consistent with the hypothesis of no causal connection between the two variables since the two variables could be concomitants of variations in the level of activity. It appears that, because of the emergence

7) A.G. Hines, "Unemployment and the Rate of Change of Money Wage Rates in the U.K., 1862-1963: A Reappraisal", *The Review of Economics and Statistics*, Vol. 1, No. 1 (February, 1968).

of new economic institutions both financial labour and government, unemployment has become less important as an explanation of inflation.

The wide variations in results could further be a result of specification problems. Solution of the dual problems of inflation and unemployment will provide a challenge to governments and social scientists. Although the traditional Phillips curve and the variables it employs are becoming less suitable, these studies and the more recent innovations provide valuable insight into the inflation-unemployment process.

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APPENDIX

Table I: Data

Data Col. No.	1	2	3	4	5	6	7	8		
Year/Qtr.	Average Weekly Earnings		Unemployment				C.P.I. 1966-67=100			
	\$ W	\dot{W}	U	U^{-1}	\dot{U}	\dot{U}^{-1}	P	\dot{P}	P_{-4}	\dot{P}_{-4}
1964 Mar.	48.40		1.8				90.7	0.67	89.7	
June	52.10	7.6	1.4	0.071	-0.4	-2.5	91.5	0.88	90.0	0.33
Sept.	53.50	2.7	1.2	0.083	-0.2	-5.0	92.6	1.20	90.1	0.11
Dec.	57.00	6.5	1.2	0.083	0.0	*-5.0	93.7	1.19	90.1	0.00
1965 Mar.	52.20	-8.4	1.4	0.071	0.2	5.0	94.3	0.64	90.7	0.67
June	55.80	6.9	1.2	0.083	-0.2	-5.0	95.2	0.95	91.5	0.88
Sept.	56.80	1.8	1.2	0.083	0.0	*-5.0	96.2	1.05	92.6	1.20
Dec.	59.00	3.9	1.4	0.071	0.2	5.0	97.4	1.25	93.7	1.19
1966 Mar.	54.60	-7.5	1.8	0.056	0.4	2.5	97.6	0.21	94.3	0.64
June	57.70	5.7	1.4	0.071	-0.4	-2.5	98.4	1.23	95.2	0.95
Sept.	61.10	4.1	1.4	0.071	0.0	*-2.5	98.8	1.42	96.2	1.05
Dec.	60.90	-0.2	1.4	0.071	0.0	*-2.5	99.7	0.91	97.4	1.25
1967 Mar.	62.10	2.0	1.8	0.056	0.4	2.5	100.1	0.40	97.6	0.21
June	63.30	1.9	1.6	0.063	-0.2	-5.0	101.3	1.20	98.4	1.23
Sept.	64.50	1.9	1.5	0.067	-0.1	-10.0	102.7	1.38	98.8	1.42
Dec.	65.10	0.9	1.5	0.067	0.0	*-10.0	103.8	1.07	99.7	0.91
1968 Mar.	66.10	1.5	1.8	0.056	0.3	3.3	103.4	-0.38	100.1	0.40
June	67.00	1.4	1.6	0.063	-0.2	-5.0	104.2	0.77	101.3	1.20
Sept.	68.00	1.5	1.3	0.077	-0.3	3.3	104.6	0.38	102.7	1.38
Dec.	70.20	3.2	1.4	0.071	0.1	10.0	105.7	1.05	103.8	1.07
1969 Mar.	71.50	1.9	1.8	0.056	0.4	2.5	106.4	0.66	103.4	-0.38
June	72.30	1.1	1.4	0.071	-0.4	-2.5	107.2	0.75	104.2	0.77
Sept.	74.00	2.4	1.3	0.077	-0.1	-10.0	107.8	0.75	104.6	0.38
Dec.	75.40	1.9	1.6	0.063	0.3	3.3	108.7	0.83	105.7	1.05
1970 Mar.	76.80	1.9	1.6	0.063	0.0	*3.3	109.8	1.01	106.4	0.66
June	79.10	3.0	1.3	0.077	-0.3	-3.3	111.2	1.28	107.2	0.75
Sept.	80.40	1.6	1.2	0.083	-0.1	-10.0	111.9	0.63	107.8	0.75
Dec.	82.20	2.2	1.4	0.071	0.2	5.0	114.0	1.88	108.7	0.83
1971 Mar.	87.00	5.8	1.7	0.059	0.3	3.3	115.2	1.05	109.8	1.01
June	88.60	1.8	1.5	0.067	-0.2	-5.0	117.2	1.74	111.2	1.28
Sept.	90.20	1.8	1.4	0.071	-0.1	-10.0	119.4	1.88	111.9	0.63
Dec.	91.70	1.7	1.8	0.056	0.4	2.5	122.2	2.35	114.0	1.88

1972 Mar.	94.10	2.6	2.4	0.042	0.6	1.7	123.4	0.98	115.2	1.05
June	95.20	1.2	2.0	0.050	-0.4	-2.5	124.5	0.89	117.2	1.74
Sept.	98.00	2.9	2.2	0.050	0.2	5.0	125.2	1.37	119.4	1.88
Dec.	100.10	2.1	2.4	0.042	0.2	5.0	127.7	1.19	122.2	2.35
1973 Mar.	102.00	1.9	2.5	0.040	0.1	10.0	130.4	2.11	123.4	0.98
June	106.30	4.2	1.8	0.056	-0.7	-1.4	134.7	3.30	124.5	0.89
Sept.	110.90	5.3	1.4	0.071	-0.4	-2.5	139.6	3.64	126.2	1.37
Dec.	115.00	2.8	1.8	0.056	0.4	2.5	144.6	3.58	127.7	1.19
1974 Mar.	119.10	3.6	2.0	0.050	0.2	5.0	148.1	2.42	130.4	2.11
June	126.30	6.0	1.6	0.063	-0.4	-2.5	154.1	4.05	134.7	3.30
Sept.	140.10	10.9	2.0	0.050	0.4	2.5	162.0	5.13	139.6	3.64
Dec.	146.90	4.9	3.7	0.030	1.7	0.6	168.1	3.77	144.6	3.58

* Because of computational problem, the immediately precedent quarterly figures were used for these columns.

Sources:

Australian Bureau of Census and Statistics, *Labour Report*.

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Figure 1: Rate of Unemployment and Hourly Earnings.

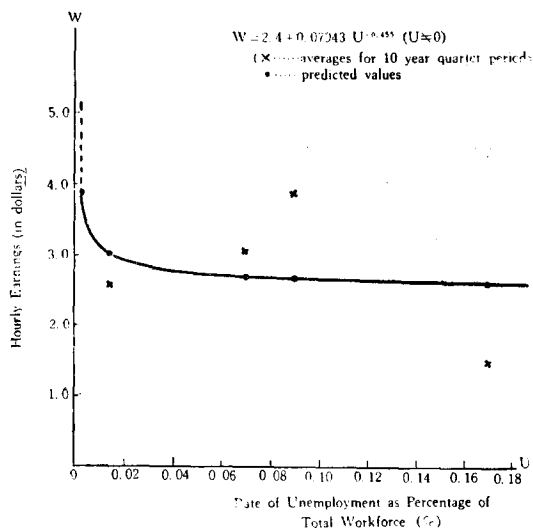


Figure 2(a): Unemployment and Wage Rate.

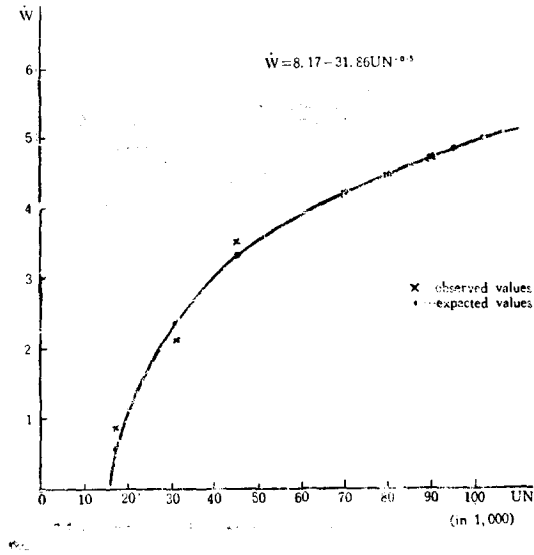


Figure 2(b): Unemployment and Wage Rate.

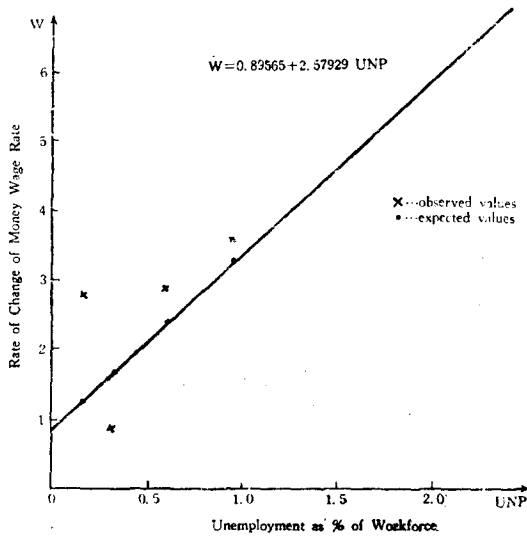


Figure 2(c): Money Wage and Unemployment

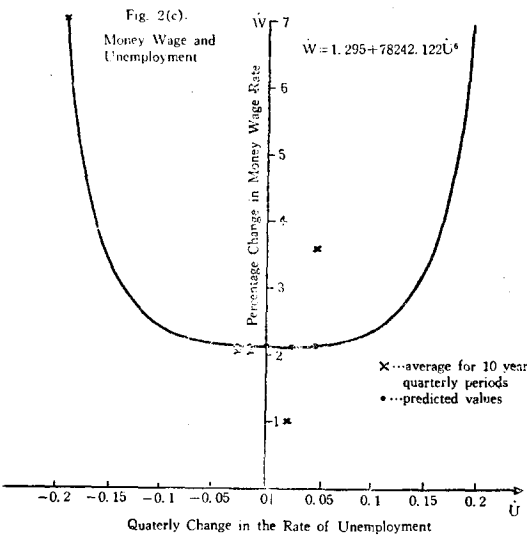


Figure 3: Comparison of Average Weekly Earnings per Male Unit and Index of Average Weekly Earnings in Manufacturing Industry.

