*Gerald W. Scully and Lowell E. Gallaway**

A Spectral Analysis of the Demographic Structure of American Unemployment

I. INTRODUCTION

A number of analyses of structural unemployment in the United States have been conducted. These have focused on the occupational, industrial, regional, and demographic (age, sex, and race) aspects of unemployment structure, and the results have been varied and ofttimes controversial.[1] In general, these studies have emphasized the relationship between unemployment rates in various sectors of the American labor market and some measure of the aggregate level of unemployment, with their general conclusions being that there is little basis for determining that there has been any change in the structure of unemployment when industrial, occupational, or regional labor market classifications are considered.[2] However, when demographic characteristics are used to determine sectoral labor-market classifications, some evidence of structural change seems to emerge.[3] Our analysis will deal exclusively with the demographic aspects of the structure of unemployment.

The previous analyses of the structure of unemployment in the United States have paid primary attention to the relative amplitude of cyclical variations in unemployment in various sectors of the labor market.[4] A common way of evaluating this is to estimate a regression

* The authors are, respectively, associate professor of economics at Southern Methodist University and professor of economics at Ohio University. The various calculations were made at the Ohio University and Southern Illinois University Computer Centers. Professor Scully's research was partially supported by PHS research grant 1–R01–HD05989–01, National Institutes of Health. We are indebted to the referees of this *Journal* for useful comments.

1. Perhaps the most comprehensive summary of this question is contained in Richard G. Lipsey, "Structural and Deficient-Demand Unemployment Reconsidered," *Employment Policy and the Labor Market*, ed. A. M. Ross (Berkeley: University of California Press, 1965), pp. 210–55.

2. See, e.g., Lowell E. Gallaway, "Labor Mobility, Resource Allocation, and Structural Unemployment," *American Economic Review* (September 1963), pp. 694–716.

3. One of the earliest determinations of this was provided by Harold Demsetz, "Structural Unemployment: A Reconsideration of the Evidence and the Theory," *Journal of Law and Economics* (October 1961), pp. 80–92. More recent evidence of the operation of this phenomenon is contained in Lowell E. Gallaway, "Unemployment Levels among Nonwhite Teen-Agers," *Journal of Business* (July 1969), pp. 265–76; and Lowell E. Gallaway and Zachary Dyckman, "The Full-Employment Unemployment Rate: 1953–1980," *Journal of Human Resources* (Fall 1970), pp. 487–510.

4. For example, see U.S., Congress, Joint Economic Committee, *Higher Unemployment Rates, Structural Transformation or Inadequate Demand*, 87th Cong., 1st Sess., 1961; Gallaway, "Labor Mobility"; Robert A. Gordon, "Has Structural Unemployment Worsened?" *Industrial Relations* (May 1964), pp.

equation of the form:[5]

$$U_i = a + bU_p + ct + v, \tag{1}$$

where U_i denotes the unemployment rate in a particular sector of the labor market, U_p is some measure of aggregate unemployment (for convenience sake denoted as the "prime" unemployment rate), t is a time-drift variable, and v is a stochastic error term. With this type of approach, significance of the time-drift variable suggests systematic temporal shifts in the value of the coefficient b. Previous analyses indicate that there have been such shifts for certain age, sex, and/or race sectors of the labor market.[6] While useful, this approach is narrow in that it ignores a number of other aspects of unemployment structure that are meaningful. First, very little consideration has been given to variations in subgroup unemployment not related to either the prime unemployment rate or measured by the time-drift variable (t). This variation can be called extraprime cycle variation in subgroup unemployment, and its presence introduces an additional element of uncertainty into the lives of any subgroup where such variation exists. Consequently, it merits consideration. Second, the possibility that b is unstable cyclically has not been adequately investigated, that is, the amplitudes of the subgroup unemployment rates may vary cyclically relative to the amplitude of the prime labor-force unemployment rate. Finally, variations in the phase of the cycles in unemployment series have not been extensively explored. This factor has not been ignored completely among economists: in at least one instance—the labor market for nonwhites—this question has been broached in the form of the first-fired–last-hired thesis.[7] However, the notion has not been fully examined and has not been generally integrated into an overall consideration of unemployment structure.

This article is devoted to developing insights into various aspects of the demographic structure of unemployment through the use of spectral and cross-spectral analysis.[8] The next section reports our investigation into the demographic structure of unemployment by applying spectral techniques to seasonally adjusted monthly unemployment data for the period 1954–68. We then report our findings with respect to

---

53–77; and Vladimir Stoikov, "Increasing Structural Unemployment Re-considered," *Industrial and Labor Relations Review* (April 1966), pp. 368–76.

5. This is exactly what was done in Joint Economic Committee, *Higher Unemployment Rates*

6. See Gallaway and Dyckman.

7. For a discussion of this question see Harry J. Gilman, "Economic Discrimination and Unemployment," *American Economic Review* (December 1965), pp. 1077–96. The first-fired–last-hired thesis is also an implicit part of James Tobin's description of the economic problems confronting Negroes in his "On Improving the Economic Status of the Negro," *Daedalus* (Fall 1965), pp. 878–98.

8. A good general reference to the subject of spectral analysis of time series data is G. S. Fishman, *Spectral Methods in Econometrics* (Cambridge, Mass.: Harvard University Press, 1969).

the first-fired–last-hired hypothesis and, finally, conclude with a summary of the implications of our results for questions of public policy.

II. STRUCTURAL DIFFERENCES IN THE AMERICAN LABOR MARKET

The data available for this study consist of Bureau of Labor Statistics (BLS) deseasonalized monthly observations of unemployment rates of households by certain age, sex, and race categories over the period 1954–68 ($N = 180$). Eight data series are available: (1) white males, 20 years and over; (2) white males, 16–19; (3) nonwhite males, 16–19; (4) nonwhite males, 20 years and over; (5) white females, 16–19; (6) nonwhite females, 16–19; (7) white females, 20 years and over; and (8) nonwhite females, 20 years and over. Logically, we selected series 1 as the "prime" labor group and compared the behavior of series 2–8 with it using 1 as the base series. Degrees-of-freedom limitations restrict the selection of the maximum lag to $L = 60$ months. Therefore, one limitation of our study is that we are restricted to comparing cycles of 60 months or less. Since the data are deseasonalized, frequencies of 12 months or less are of little or no interest. We choose 15 months as the highest frequency to study, and, therefore, the analysis is concerned with cycles or frequencies over the range of 15–60 months. However, as will be seen below, a clear enough pattern of intergroup differences and similarities emerges through the spectral analysis of these frequencies to indicate that the findings would not be substantially modified if we could have studied frequencies lower than 60 months.

Table 1 presents the spectral estimates for each of the eight demographic groups. The spectral estimates originate from a transformation of the variance in a time series into the frequency domain. In other words, the spectral estimate in each frequency is interpreted as the variance or power of the time series in that particular frequency or cycle. The spectral density function can be summed over the entire frequency band and each frequency can be divided by the sum so that the relative power of each frequency can be determined. If there is dominant power in the low (high) frequencies, the process being investigated is said to be a low (high) frequency process. Most economic processes are low frequency. If there is equal power in all frequencies, the process is termed "white noise"—that is, the phenomenon is a random process. Therefore, differences in power spectra offer some insight into whether various series originate from similar stochastic processes.

In comparing the estimates in table 1, one first notices that in general the variances (power) of the subgroups (series 2–8) are higher frequency by frequency than they are for the base series—white males, 20 years and over. The only exception is the series for white female adults. Such a general finding is not surprising, for it simply reflects the usually greater amplitude of the subgroup cycles. The spectra of

series 1, 2, 4, 7, and 8 in general take on the classical shape of a power spectral function of economic time series data. The greatest variance is in the low frequencies, and the power falls off rapidly as one moves to higher and higher frequencies. While such an examination does not indicate very precisely the degree of conformity among these time series frequency by frequency, it does suggest a certain similarity and indicates the most important cycles in each series. For series 1, 2, 4, 7, and 8 the 60-month cycle clearly emerges as dominant, although the 40-month and 30-month cycles contribute substantially to the variance. However, series 3, 5, and 6 emerge with a rather different distribution of the variance. While these series also have a clearly dominant 60 month cycle considerable variance remains in the higher frequencies and there is no rapid decline in the variances as one moves to the higher frequencies. Extracycle (i.e., cycles of relatively high frequency) unemployment activity, therefore, appears to be a characteristic of all teen-agers except white males.

Comparisons of the spectral estimates, of course, do not permit us to indicate with any acceptable degree of precision the extent of conformity between the subgroup series and the prime labor force. For such comparisons, cross-spectra must be estimated, whereupon the coherence square statistic emerges and permits meaningful comparisons. The coherence, $C(\omega)$, is a measure of the covariance between time series at each frequency. It is analagous to and interpreted in the same way as the coefficient of determination, R^2. Like R^2, the coherence is bounded between zero and one. Table 2 presents the coherence square statistic for each frequency. In each case the subgroup series has been crossed with series 1, white males 20 years and over, as the base series. The results indicate that the unemployment rates of two subgroups, nonwhite male and white female adults, behave cyclically very similarly to white male adults. All of the $C(\omega)$ are significant at the 5 percent level, indicating that the pattern of unemployment over the various cycles from 15 to 60 months is very similar between these groups. Two other series, nonwhite female adults and white male teen-agers, while not quite as highly coherent with the base series as were 4 and 7, are similar enough frequency by frequency to conclude that their unemployment rates behave like those of white male adults over the various cycles. The only discrepancies are for the 60-month (required $C(\omega) = .805$ for the 10 percent level) and 15-month cycles for nonwhite female adults and the 18-month cycle for white male teen-agers.

When we turn to the remaining teen-agers (Series 3, 5, and 6), however, we find almost no similarity in the structure of their unemployment to that of white male adults. Some coherence is found in the very high frequencies (18 months for white female and nonwhite male teen-agers and 24 and 15 months for nonwhite female teen-agers). However, there is no coherence in the low frequencies. Therefore, these groups exhibit an entirely different pattern (structure) of cyclical un-

Table 1

Spectral Estimates for Eight Unemployment Times Series by Age, Sex, and Race, 1954–68 Monthly Observations

Frequency (Months)	White Male Adults (1)	White Male Teen-Agers (2)	Nonwhite Male Teen-Agers (3)	Nonwhite Male Adults (4)	White Female Teen-Agers (5)	Nonwhite Female Teen-Agers (6)	White Female Adults (7)	Nonwhite Female Adults (8)
60	3.0772	16.8802	64.4063	18.1249	10.1294	34.3896	1.7910	4.0927
40	2.0940	6.7502	6.8978	9.1393	2.7744	18.8334	1.2889	2.7971
30	1.4375	4.3894	8.9823	4.6048	2.1673	26.3084	1.0604	3.1572
24	0.8371	2.6096	9.5657	2.0289	2.3860	9.2660	0.5996	1.6737
20	0.4680	1.4111	13.5911	1.8444	2.7339	3.8989	0.2803	1.1500
18	0.3068	0.8207	16.7896	1.2613	1.6689	10.5702	0.2578	0.5343
15	0.1596	1.2520	14.9910	0.4030	1.6487	10.7252	0.1348	0.2780

NOTE.—In all cases $N = 180$, $L = 60$. Column numbers refer to series numbers in tables 1–5.

Table 2

Coherence Square Statistics

Frequency (Months)	White Male Teen-Agers (2)	Nonwhite Male Teen-Agers (3)	Nonwhite Male Adults (4)	White Female Teen-Agers (5)	Nonwhite Female Teen-Agers (6)	White Female Adults (7)	Nonwhite Female Adults (8)
60	.8319*	.2831	.9480**	.4231	.1630	.9516**	.7134
40	.8798**	.0166	.9652**	.2815	.3644	.8954**	.7676**
30	.9108**	.2626	.8824**	.4484	.5048	.8932**	.8607**
24	.7035**	.2156	.8979**	.2673	.8659**	.8390**	.9421**
20	.5635*	.4035	.9208**	.3433	.2980	.9026**	.9387**
18	.4258	.7039**	.7870**	.6374**	.0345	.8918**	.6355**
15	.6949**	.3864	.7263**	.3470	.4447*	.8986**	.3585

NOTE.—In all cases the base series was white male adults.
* 10% level of significance.
** 5% level of significance.

Table 3
Coherence Square Statistics for Teen-Age Unemployment Series

Frequency (Months)	Nonwhite Male Teen-Agers (3)	White Female Teen-Agers (5)	Nonwhite Female Teen-Agers (6)
60	.6636	.8009	.6797
40	.4858	.5422	.4302
30	.6490*	.7593**	.6306*
24	.8807**	.7202**	.7581**
20	.6412**	.8069**	.6003**
18	.1034	.3788	.2480
15	.7291**	.0810	.0674

NOTE.—In all cases the base series was white male teen-agers.
* 10% level of significance.
** 5% level of significance.

employment than was found for the various adult groups. The question, of course, arises as to what extent this differential pattern is a teen-age phenomenon and to what extent color and sex are ingredients in the structural differences in cyclical unemployment. We noted that the coherence between the white male teen-age unemployment series and that of white male adults was generally significant, but it can be seen from table 2 that the $C(\omega)$ on the whole are lower for white male teen-agers than they are for series 4, 7, and 8. Possibly, we might find a greater degree of intergroup (teen-agers) coherence if series 3, 5, and 6 were compared with series 2. The coherence squares for series 3, 5, and 6 using white male teen-agers as the base series, are given in table 3. No significant coherence exists between nonwhite teen-agers and white female teen-agers and white male teen-agers at the 60- and 40-month cycles. Significant coherence between the three teen-age groups and white male teen-agers, however, does exist in the intermediate cycles of 20–30 months. These results, therefore, tend to support the view that the structural differences in unemployment among teen-agers is less a phenomenon of being a teen-ager per se than it is of being one of a certain sex or color. While sex has its impact on the pattern of unemployment, color seems to be the more important variable. Comparing the $C(\omega)$ over the range 20–60 months one notes a higher degree of coherence between nonwhite female and white male teen-agers than between nonwhite female and white male teen-agers but very little difference between the $C(\omega)$ of nonwhite male and nonwhite female teen-agers.

III. THE FIRST-FIRED–LAST-HIRED PROBLEM

We now turn to the question of whether a first-fired–last-hired mechanism operates against the various demographic subgroups over the prime labor group unemployment cycles. The possibility of such a difference

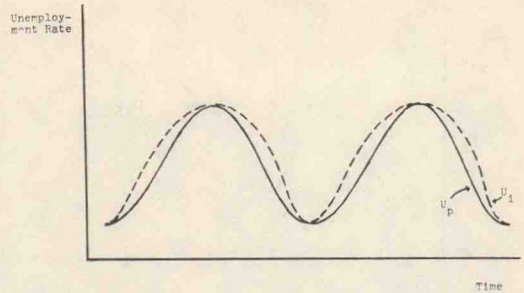

FIG. 1.—Graphic representation of the first-fired–last-hired thesis

has been raised by Tobin with respect to the case of nonwhites. The mechanism could emerge as a phase or as an amplitude difference between the subgroup and the prime group unemployment cycles. It may be such that the subgroup cycle leads during the upturn (period of increased unemployment) and lags during the downturn (period of reduced unemployment). Alternatively, it may be that there is no timing difference, but that the subgroups are fired more quickly during the period of increased unemployment and hired more slowly during the recovery.

We illustrate all of these possibilities in figures 1–4. In figure 1, the subgroup is being fired first during the period of rising unemployment and is being hired last during the recovery. Another empirical possibility is the reverse hypothesis of last-fired–first-hired (LFFH) illustrated in figure 2. Of course, there is no theoretical support for this possibility. The differences in U_i and U_p in figures 1 and 2 are not

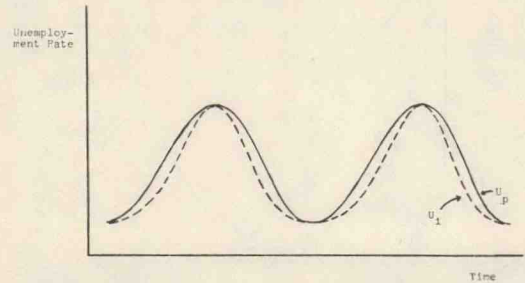

FIG. 2.—Graphic representation of the last-fired–first-hired thesis

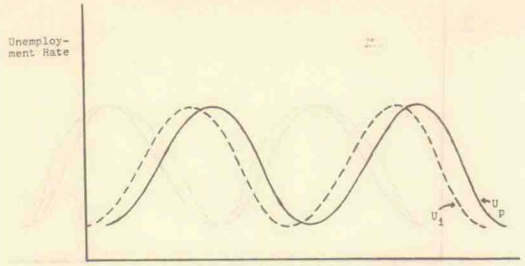

FIG. 3.—Graphic representation of the first-fired–first-hired thesis

phase differences, they are amplitude differences. The nature of the cycles is such that U_i is coincident with U_p at the peaks and troughs but divergent at all other points. Phase differences give rise to two more empirical possibilities between the U_p and U_i series illustrated in figures 3 and 4. The phase difference in figure 3 is such that the U_i series leads the U_p series. We refer to this possibility as the first-fired–first-hired (FFFH) hypothesis. In figure 4 a lag difference between U_i and U_p is hypothesized and we call this the last-fired–last-hired (LFLH) case.

To test which of these possibilities describes the true nature of the differences between the subgroup and the prime group cycles, we first calculated the phase differences from the cross-spectral density functions. The phases are given in radians in table 4. The indication from the distribution of the leads and lags, particularly for the cases where the coherences are significant, is that there are no meaningful phase differences between the subgroup series and the prime (base) group series. These results appear to rule out the FFFH and LFLH hypotheses.

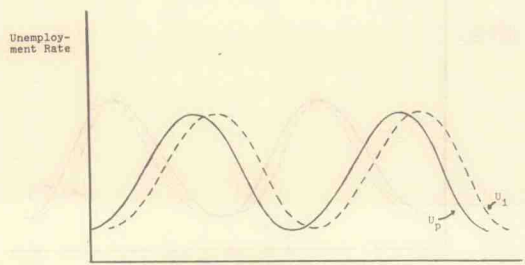

FIG. 4.—Graphic representation of the last-fired–last-hired thesis

What about amplitude differences in the unemployment rates between the various demographic subgroups and white male adults? From the cross-spectral density function, a measure known as the gain statistic can be obtained. The gain is calculated at each frequency and is the coefficient that the input sinusoid must be multiplied by to equal the amplitude of the output sinusoid. More technically, the gain is calculated at each frequency by dividing the amplitude of the cross-spectrum (the sum of the covariances in phase and in quadrature) by the spectrum of the input sinusoid. The gain is in essence a frequency regression coefficient. The analogy with the regression coefficient is clear when we consider that it is a measure of the covariance divided by the variance of the independent or input variable.[9]

What should be our expectations with regard to the magnitude of the gain statistics? If a first-fired–last-hired mechanism operates in the labor market, the gain statistics should be greater than unity. That is, the amplitudes of the subgroup unemployment rates should be greater than that of the primary group. However, there is one complicating factor. It is well known that secondary workers, such as some of the demographic subgroups represented here, suffer from cyclical sensitivity in labor force participation rates.[10] The operation of a discouraged or additional worker effect on these groups would tend to reduce the amplitude of their unemployment rates relative to primary workers. This is due to the effect on the subgroup unemployment rates of higher relative labor force entry and withdrawal over the cycle. Accordingly, where the discouraged or additional worker effect operates there will be a downward bias in the gain statistics. It is possible, unfortunately, that a first-fired–last-hired mechanism may operate against a demographic subgroup but be obscured by hidden unemployment.

The gain statistics are presented in table 5. A number of interesting characteristics about the cyclical behavior of demographic subgroup unemployment relative to white male adults emerge. First, the average gain coefficients indicate that nonwhite teen-agers and nonwhite male adults suffer significantly from a first-fired–last-hired mechanism. These groups have about twice the amplitude in unemployment as white male

9. For a good discussion of the interpretation of the gain statistic see B. V. Hamon and E. J. Hannan, "Estimating Relations between Time Series," *Journal of Geophysical Research*, November 1, 1963, pp. 6033–41; and E. J. Hannan, "Regression for Time Series," in *Time Series Analysis*, ed. M. Rosenblatt (New York: John Wiley & Sons, 1963), chap. 2.

10. The literature on cyclical variations in labor force participation rates is quite extensive. See, for example, Peter S. Barth, "Unemployment and Labor Force Participation," *Southern Economic Journal* (January 1968), pp. 375–82; Thomas F. Dernburg and Kenneth T. Strand, "Hidden Unemployment 1953–1962: A Quantitative Analysis by Age and Sex," *American Economic Review* (March 1966), pp. 71–95; and Alfred Tella, "Labor Force Sensitivity to Employment by Age and Sex," *Industrial Relations* (February 1965), pp. 69–83. Also see Lowell E. Gallaway, "A Note on the Incidence of Hidden Unemployment," *Western Economic Journal* (March 1969), pp. 71–83.

Table 4

Phase Statistics

Frequency (Months)	White Male Teen-Agers (2)	Nonwhite Male Teen-Agers (3)	Nonwhite Male Adults (4)	White Female Teen-Agers (5)	Nonwhite Female Teen-Agers (6)	White Female Adults (7)	Nonwhite Female Adults (8)
60	.0150	.9349	.0132	.0405	.0934	.9999	.0432
40	.9847	.8734	.0484	.9361	.2210	.9997	.0607
30	.0065	.9732	.0380	.9921	.1644	.0344	.0573
24	.0400	.0297	.0035	.9266	.1430	.0147	.0138
20	.0188	.9897	.0021	.9316	.0431	.9454	.9712
18	.0165	.1044	.9493	.0765	.5926	.9477	.9637
15	.8566	.1116	.9017	.9857	.7186	.9010	.9204

NOTE.—Values less than .5 denote a lag and values greater than .5 a lead between the subgroup series and the base series (white male adults). See the coherences in table 2 for the significance of the phase.

Table 5

Gain Statistics

Frequency (Months)	White Male Teen-Agers (2)	Nonwhite Male Teen-Agers (3)	Nonwhite Male Adults (4)	White Female Teen-Agers (5)	Nonwhite Female Teen-Agers (6)	White Female Adults (7)	Nonwhite Female Adults (8)
60	2.0497	2.0729	2.3545	1.0620	1.1111	0.7227	0.9500
40	1.6451	0.1830	2.0407	0.5761	1.6910	0.7268	0.9830
30	1.6403	1.1847	1.6829	0.7583	2.8414	0.8028	1.3444
24	1.4566	1.4909	1.4770	0.8089	2.9401	0.7702	1.3428
20	1.2883	3.3311	1.8745	1.3667	1.4850	0.7405	1.4808
18	1.0931	6.0459	1.7835	1.8595	1.1091	0.8662	1.0095
15	2.4026	5.4766	1.4429	1.7746	5.6429	0.8894	0.8122
Average*	1.7067	2.2229	1.9244	1.0469	2.0461	0.7640	1.1008

NOTE.—For significance of the gain see the coherences reported in table 2.

* Weighted average where the weights are the frequencies.

adults. White male teen-agers also suffer from the phenomenon, although not as severely. It is not clear that the mechanism operates against white female teen-agers and nonwhite female adults. White female adult unemployment rates have less amplitude than those of white male adults. The finding of gains less than unity is not surprising for white female adults because of the additional worker effect. It is possible that the additional worker effect obscures the verification of a first-fired–last-hired mechanism which may operate against nonwhite female adults.

It is not clear that the first-fired–last-hired phenomenon operates uniformly over the cycle. It is possible that demographic subgroups suffer more from the mechanism during a downtown than during a recovery. Quite conceivably, the true relation between the subgroup cycle and the prime cycle may be that posited in figure 5, namely, that the first-fired portion of the hypothesis (the upturn in unemployment) may be the dominant factor in the hypothesis (segment AB in the diagram) while the last-hired portion of the hypothesis may be a relatively weak phenomenon (segment BC). If this is the case, an estimate of the amplitude differences between the two series is not likely to show this difference between U_i and U_p.

We can determine whether this is the case as follows. Let the hypothesis be that figure 5 describes the true relation between the U_i and U_p series. The nature of the relationship between U_i and U_p posited in figure 5 suggests that over the range AB a linear approximation of the slope of the unemployment function of U_p with respect to time (U'_p) is greater than the slope of the unemployment function of U_i with respect to time (U'_i). Thus,

$$U'_p - U'_i > 0. \tag{2}$$

Over the range BC we would expect a similar relationship to hold. However, U'_p will exceed U'_i by a greater amount over the range AB (the upward movement) than it will over the range BC (the downward

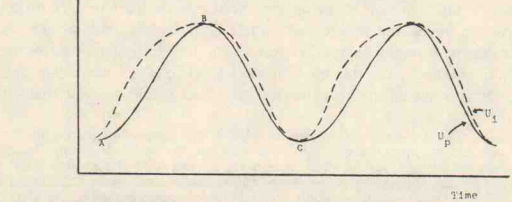

FIG. 5—Alternative form of the first-fired–last-hired thesis

movement). Denoting the former with the subscript u and the latter with the subscript d it follows that

$$(U'_p - U'_i)_u - (U'_p - U'_i)_d > 0. \tag{3}$$

This clearly suggests

$$(U'_i/U'_p)_u < 1, (U'_i/U'_p)_d < 1,$$

and

$$(U'_i/U'_p)_u < (U'_i/U'_p)_d. \tag{4}$$

Confirmation of the strong first-fired, weak last-hired version of the hypothesis is a straightforward matter of estimating the regression coefficient for $(U'_i/U'_p)_u$ and $(U'_i/U'_p)_d$ and comparing the coefficients. Accordingly, the detrended data series were divided into a series of observations on the upward movements in unemployment ($N = 81$) and a series of observations for the various downward movements in unemployment ($N = 108$) (turning-point observations are included in both series). Regression equations of the form

$$U_i = a + bU_p + cD_2 + dD_3 + eD_4 + fD_5 + v, \tag{5}$$

were estimated where U_i denotes the unemployment rate of the ith subgroup, U_p is the prime labor force group unemployment rate, $D_2 - D_5$ are dummy variables denoting each period of upward (downward) movement of the unemployment rate, and v is a stochastic error term.[11] The results for periods of upward movement in unemployment rates are presented in table 6 and for downward movements in table 7. The observations have been transformed from their original state into index form. The particular method of transformation was to divide the observation by the mean of the respective series of observations. The rationale for such a transformation is obvious, that is, to remove amplitude differences between the series.

With respect to the question of whether subgroups are first-fired the regression results confirm our expectation that the subgroups are fired first during periods of increasing unemployment. All of the regression coefficients for $(U'_i/U'_p)_u$, which are significant at the 1 percent level, are less than unity. The range of the regression coefficients indicates that the phenomenon of being first fired has its least impact on adult nonwhite males and its greatest impact on nonwhite female teen-agers. Turning now to the regression results for the declining unemployment series, we find that the coefficients for $(U'_i/U'_p)_d$ are again highly significant, and all are less than unity. These results suggest that all of

11. The dummy variables are included in the regression equation to correct for any unusual circumstances associated with the various cycle swings. In effect, they insure that the various cycle swings are aligned with one another, i.e., they correct for any differences in the means of the data for the various cycles. In this fashion, we avoid spurious results stemming from our combining the data for several different cycle swings into one set of observations.

Table 6

Regression Results for the Upward Phases of the Unemployment Series

Dependent Variable Series	Constant	U_{wm} Adults	D_2	D_3	D_4	D_5	R^2
White male teen-agers	.5647	.4499	—.0582	.0345	—.0115	—.0213	.7614
		(12.16)*	(1.76)	(0.78)	(0.31)	(0.55)	
Nonwhite male teen-agers	.4263	.4206	.1559	.3985	.2527	.1120	.5701
		(6.40)	(2.65)	(5.07)	(3.77)	(1.64)	
Nonwhite male adults	.0185	.8474	.1030	.2591	.1265	.2442	.9069
		(21.11)	(2.87)	(5.40)	(3.09)	(5.84)	
White female teen-agers	.7704	.2537	—.0687	.0170	.0061	—.0236	.5291
		(6.27)	(1.90)	(0.35)	(0.15)	(0.56)	
Nonwhite female teen-agers	.7665	.1603	.0236	.1485	—.0214	.1167	.1870
		(2.37)	(0.39)	(1.83)	(0.31)	(1.65)	
White female adults	.5486	.5517	—.1257	—.1068	—.1156	—.1081	.8964
		(21.06)	(5.37)	(3.41)	(4.32)	(3.96)	
Nonwhite female adults	.5589	.4059	.0095	—.0531	.0376	.1357	.6153
		(7.94)	(0.21)	(0.87)	(0.72)	(2.55)	

* *t*-values in parentheses under the regression coefficient.

Table 7

Regression Results for the Downward Phases of the Unemployment Series

Dependent Variable Series	Constant	U_{wm} Adults	D_2	D_3	D_4	D_5	R^2
White male teen-agers	.2883	.7482 (13.47)*	—.1028 (2.20)	—.0846 (1.53)	—.1116 (2.24)	—.0008 (0.03)	.7187
Nonwhite male teen-agers	.3620	.5073 (6.15)	.2332 (3.36)	.3916 (4.76)	.0719 (0.97)	.1206 (2.79)	.5661
Nonwhite male adults	.2208	.7465 (14.27)	.1251 (2.85)	.1005 (1.93)	.1496 (3.19)	.0042 (0.15)	.8576
White female teen-agers	.3724	.6503 (8.68)	—.1849 (2.93)	.0655 (0.88)	—.0801 (1.19)	.0165 (0.42)	.5124
Nonwhite female teen-agers	.6089	.3794 (3.96)	.0609 (0.76)	—.0775 (0.81)	—.0246 (0.29)	.0365 (0.73)	.2365
White female adults	.3917	.5767 (16.54)	.0262 (0.89)	—.0073 (0.21)	.0777 (2.48)	.0377 (2.07)	.8582
Nonwhite female adults	.4391	.6241 (10.47)	—.1487 (2.97)	—.1624 (2.73)	—.0071 (0.13)	—.0510 (1.63)	.6674

* *t*-values in parentheses under the regression coefficients.

the subgroups experience the last-hired phenomenon during an upswing in economic activity. The range of the regression coefficients indicates that with coefficients in the neighborhood of unity, nonwhite male adults and white male teen-agers suffer least from the last-hired phenomenon, while once again nonwhite teen-agers suffer the most. Finally, in comparing the regression coefficients for the two series, it is fairly clear that the coefficients associated with declining unemployment are greater on the whole than those associated with upward movements in unemployment. This would seem to indicate that the first-fired portion of the FFLH hypothesis is stronger than the last-hired portion of the hypothesis.

IV. CONCLUSIONS

Two problems of subgroup labor-market unemployment have been investigated. The first problem deals with the question of whether all subgroup unemployment rates behave cyclically similarly to the prime group. Through spectral and cross-spectral analysis it has been found that (like white male adults) white teen-age males, nonwhite adult males and females, and white adult females have most of their unemployment variance in the cycles of longer duration and that, in general, these subgroups are highly coherent with the base series. There is little evidence, therefore, to suggest that the unemployment cycles for these groups are dissimilar to that of white adults. However, white female teen-agers and nonwhite teen-agers exhibit unemployment cycles quite in contrast to those of the other subgroups as well as the prime group. The labor market for nonwhite teen-agers is particularly volatile and extraprime cycle activity is a very pronounced characteristic of their unemployment. The evidence from this analysis, therefore, suggests that among certain subgroup labor markets, unemployment difficulties may be exacerbated by structural cyclical differences from the main labor force in society in addition to the already well-documented structural trend and amplitude differences.[12]

The second problem investigated was whether a first-fired–last-hired mechanism operated in the American labor market between the various demographic subgroups and white male adults. We found that the unemployment rates of nonwhite male adults and nonwhite teen-agers have twice the amplitude of those of white male adults, and this suggests that a first-fired–last-hired mechanism works against them. We could not confirm the existence of such a phenomenon for white female teen-agers and female adults. While our cross-spectral and regression results in general support the Tobin thesis, some modifications emerge. First, the FFLH hypothesis seems to apply, albeit unequally, to several of the demographic subgroups. Second, teen-agers, and particularly nonwhite teen-agers, suffer the greatest impact from the phenomenon. Third, the first-fired portion of the hypothesis, that is, the phenomenon

12. For evidence along these lines, see Demsetz; Gordon; Gallaway, "Unemployment among Nonwhite Teen-Agers"; and Gallaway and Dyckman.

Table 8
Coefficients of Variation for Each of the Employment Series

Series	Coefficient of Variation (1)	Coefficient of Variation U_p Subtracted from U_i (2)	Percentage Reduction in Coefficient of Variation (3)
1. White male adults	92.54	...	...
2. White male teen-agers	224.69	155.97	30.58
3. Nonwhite male teen-agers	473.31	419.45	11.38
4. Nonwhite male adults	214.94	134.30	37.52
5. White female teen-agers	198.66	156.69	21.13
6. Nonwhite female teen-agers	487.24	459.80	05.63
7. White female adults	72.93	38.39	47.37
8. Nonwhite female adults	142.16	94.57	33.47

of being fired first during the upturn in unemployment, appears to be the more important element in the thesis.

Some interesting policy implications emerge from these results. Clearly, nonwhite teen-agers are the single subgroup that is most isolated from the impact of changes in the level of aggregate demand in the economy. Since the nonwhite-white relative unemployment differential tends to remain fairly stable over the cycle, a period of sustained high levels of economic activity has certain spillovers to nonwhite adult labor. The argument that sustained economic growth and high levels of aggregate demand will draw marginal nonwhite workers into the ranks of the employed appears to have a certain degree of validity for nonwhite adults. However, nonwhite teen-agers appear to be relatively unaffected by sustained high levels of aggregate demand. The degree of isolation from the mainstream of American economic activity can be seen clearly in table 8, which shows the coefficients of variation for each series where the observations have been detrended and the mean subtracted. The variance measured, therefore, consists of amplitude and cyclical differences within each series.[13] In column 1 we note that the coefficient of variation is highest for the nonwhite teen-ager and lowest for the white adults. In column 2 we subtract the white male adult cycle from the cycles of each of the subgroups and recalculate the coefficient of variation. All of the coefficients are smaller than those in column 1, but column 3 indicates that the major reduction in subgroup variation due to eliminating prime group variation accrues to the adults, white and nonwhite. Nonwhite female teen-agers gain less than a 6 percent reduction in variation. Of course, this procedure is somewhat crude, but it does amplify the basic structural differences between certain labor subgroups and the prime group.[14]

13. Included in these differences are any random components of variation in the series.

14. These results are quite consistent with the conclusions reached in Gallaway, "Unemployment Levels among Nonwhite Teen-Agers."