8.

Market Structure for Hired Farm Labor[1]

A PRINCIPAL orthodox means suggested for solving the farm income problem is adjustment or decrease in the size of the farm labor force. Greater knowledge of the factors which affect the demand and supply of farm labor is important in analysis of factors related to the supply of farm products and income of the industry.

Labor, of course, is not an inanimate resource that can be shunted abruptly out of agriculture in immediate response to relative price changes. Rather, labor represents a human resource with a consuming unit attached to it. It has many sociological attributes which relate to its mobility. This chapter, however, emphasizes the economic aspects of hired labor as a resource and examines responses by it in respect to farm income, wage rates, and other relevant variables.

Two categories of farm labor, hired and family, are considered in this and the next chapter. Most of the estimates are by single-equation, least-squares methods. However, some use is made of limited information and other simultaneous equation methods. The procedure in this chapter is to describe historic trends in employment of farm labor, to discuss the nature and basis of various estimates by government agencies of the number of workers in the farm labor force, and to present empirical estimates of coefficients and elasticities based on supply and demand functions for hired farm labor.

It is hoped that the analysis might lead to useful knowledge for such questions as: (a) How much time must elapse, given the specified differentials between farm and nonfarm wages, before a specified amount of labor leaves agriculture? (b) What is the effect of varying rates of unemployment in the national economy on the rate of migration from agriculture? (c) What is the elasticity of supply response for farm labor in respect to farm and nonfarm wage rates? (d) What are the important variables which affect the demand for farm labor and the

[1] The study reported in this chapter was initiated in 1956. An important portion of the early work was conducted by Stanley S. Johnson, formerly a graduate student and research associate at Iowa State University (currently employed by the USDA). He is a co-author of this chapter. For earlier reports on this study, see Heady, Earl O., and Johnson, Stanley S. The labor resource; its demand in agriculture. Iowa State University Center for Agricultural and Economic Development. CAEA Report No. 13; and Johnson, Stanley S., and Heady, Earl O. Demand for labor in agriculture. Iowa Agr. Exp. Sta. Bul. (forthcoming).

amount of labor held on farms in the various geographic regions of the United States? (e) Is the supply of farm labor highly responsive to changes in the farm wage? The results of this study provide some initial answers to questions such as these, and to questions which are related in judging adjustment rates and potentials in agriculture.

TRENDS IN FARM LABOR AND RELATED INPUTS

Total labor employment in agriculture has undergone a large change, the general trend since 1910 being mainly downward. The total number of farm workers declined 47 percent between 1910 and 1960 (see Figure 8.1). Estimated requirements for man-hours in agriculture declined

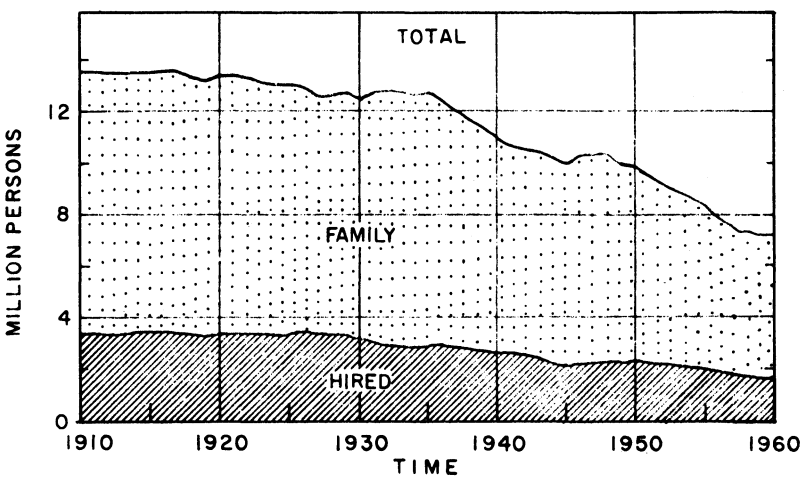

Figure 8.1. Total farm employment, 1910-60, with comparisons for hired and family labor.

50 percent during the same period (Figure 8.2). The rate of decrease was far from constant over the 50-year period. Total farm employment increased from 1910 to 1916 and dropped by only 8 percent from 1910 to 1930. Due to depression and lack of off-farm opportunities, farm employment increased 2 percent between 1930 and 1935. After 1935, however, the rate of net migration from farms increased. Farm employment declined 19 percent between 1935 and 1946, and by 31 percent between 1946 and 1960.

The hired labor force has constituted about 25 percent of the national farm labor force since 1910. Hence, national or aggregative changes in the numbers of hired and family workers over time have been similar to changes in the total farm labor force. However, this relative stability in mix of hired and total family labor does not hold true on a regional basis. The changes in Table 8.1 for farm labor in

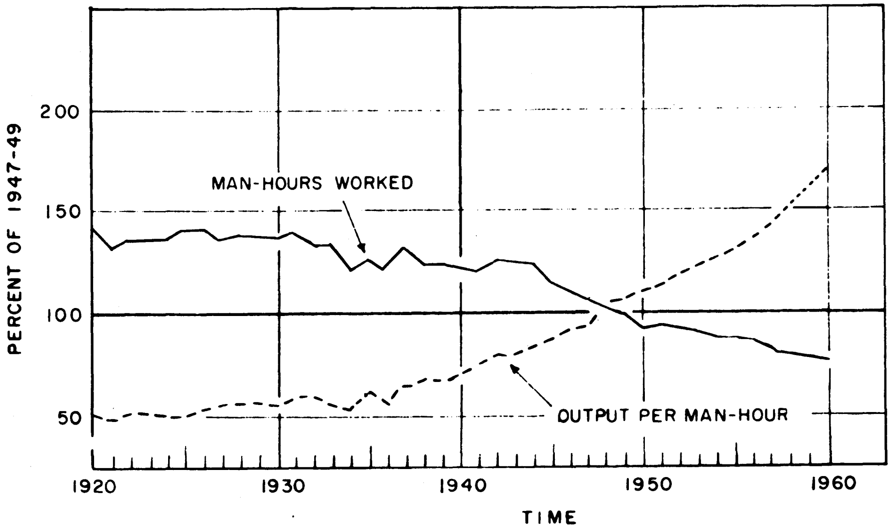

Figure 8.2. Man-hour requirements in agriculture and agricultural output per man-hour, 1920-60.

nine geographic regions indicate no consistency among areas. These differences likely are due to level of income, race of workers, employment opportunities and other variables analyzed in this chapter at the national level.

SOURCES AND NATURE OF DATA

The data used in this study are time series observations of employment, prices and other relevant variables. The data are taken from USDA sources for the nation, except as otherwise indicated on a regional basis. Several sources of farm employment data exist, and each has somewhat different implications for empirical analysis. Accordingly, these several sources are discussed as a basis for indicating limitations in the data and for explaining the logic in selecting particular measurements and variables.

Major Sources of Employment Data

The major sources of data on farm employment are: (a) employment estimates of the Agricultural Marketing Service of the USDA (hereafter indicated as the AMS series[2]); (b) estimates published by the Bureau of the Census, the Current Population Survey (hereafter

[2]USDA. Agricultural Marketing Service. Farm employment. USDA Sta. Bul. 236. 1958.

Table 8.1. Size of the Farm Labor Force, by Regions, for 1957, and the Percentage Change in the Hired and Family Labor Force, by Regions, 1910-57 and 1929-57, as a Percentage of 1910*

Region	Size of Farm Labor Force, 1957	Percentage Change, 1910-57	Percentage Change, 1929-57		
		Total farm employment	Total farm employment	Hired workers	Family workers
	(Thousands)	(Percent)	(Percent)	(Percent)	(Percent)
New England	172	-53	-36	-33	-38
Middle Atlantic	444	-53	-36	-47	-30
East North Central	1,307	-36	-22	-54	-12
West North Central	1,398	-36	-35	-65	-24
South Atlantic	1,345	-49	-42	-36	-44
East South Central	969	-58	-56	-47	-58
West South Central	1,000	-54	-57	-46	-61
Mountain	354	-18	-35	-46	-27
Pacific	588	+14	+1	+2	+1
United States	7,577	-44	-40	-44	-39

*USDA. Agricultural Marketing Service. Farm employment. USDA Sta. Bul. 236. 1958; USDA. Agricultural Marketing Service. Farm labor. Oct. 1953.

indicated as CPS[3]); (c) man-hour requirements estimated by the Agricultural Research Service of the USDA (hereafter indicated as FERD[4]); (d) estimates of the hired farm working force of the Agricultural Marketing Service of the USDA, and based on a survey of the Bureau of the Census (hereafter indicated as HFWF[5]). Though the source is not described here, a rough estimate of the number of available farm workers also may be derived from farm population estimates.

Comparison of the Major Employment Series

The most important sets of farm employment estimates are the AMS and the CPS series. They are emphasized in the discussion below. The remaining series are accorded separate analysis later.

The CPS and AMS total farm employment series on an annual basis are presented in Table 8.2. The AMS series of average annual employment is higher than the CPS series in every year. The difference

[3]U.S. Bureau of the Census. Current population reports: labor force. Series P-50, Nos. 72-89. March 1957-June 1959.

[4]USDA. Agricultural Research Service. Changes in farm production and efficiency. USDA Sta. Bul. 233. Revised September 1959.

[5]Maitland, Sheridan T., and Fisher, Dorothy Ann. The hired farm working force of 1957. USDA Info. Bul. 208. 1959.

Table 8.2. Annual Average of Farm Employment From CPS and AMS Series and Differences, 1940-57, Family and Hired Workers

Year	CPS*	AMS†	Excess of AMS Over CPS Series
		(Thousands of persons)	
1940	9,540	10,979	1,439
1941	9,100	10,669	1,569
1942	9,250	12,504	1,254
1943	9,080	10,446	1,366
1944	8,950	10,219	1,269
1945	8,580	10,000	1,420
1946	8,320	10,295	1,975
1947	8,266	10,382	2,116
1948	7,973	10,363	2,390
1949	8,026	9,964	1,938
1950	7,507	9,926	2,419
1951	7,054	9,546	2,492
1952	6,805	9,149	2,344
1953	6,562	8,864	2,302
1954	6,504	8,639	2,135
1955	6,504	8,639	2,135
1956	6,585	7,820	1,235
1957	6,222	7,577	1,355

*U.S. Bureau of the Census. Current population reports: labor force. Series P-50, Nos. 72-89. March 1957-June 1959.

†USDA. Agricultural Marketing Service. Farm employment. USDA Sta. Bul. 236. 1958.

between the two series gradually widened from 1940 to 1950, but narrowed from 1951 to 1957. The difference between the two series may have decreased after 1951 as the Bureau of the Census enlarged its samples in 1954 and in 1956.

Table 8.3 contains hired seasonal employment for the AMS, CPS and HFWF series for 1957. During this year the AMS estimates were higher than the CPS series for the summer months, but were lower during the winter months. The HFWF data are similar to the CPS estimates, since both sets of data are collected by the Census Bureau. However, the employment estimates for the HFWF are much below the CPS estimates for the earlier months of the year, but similar over the latter months. This bias in the HFWF series will be discussed later in this section.

While the three hired employment series in Table 8.3 agree on the months of minimum employment (December, January and February), they differ on periods of peak employment. The AMS series indicates July, August and September to be similar in the number employed,

Table 8.3. Average Employment of Hired Farm Workers by Months, United States, AMS, CPS, and HFWF Series, 1957

Month	AMS*	CPS†	HFWF	
			Original	Adjusted‡
	(Thousands of persons)			
January	896	1,154	757	827
February	1,040	1,180	768	839
March	1,284	1,209	856	935
April	1,543	1,322	1,085	1,177
May	1,985	1,710	1,394	1,538
June	2,684	2,138	1,924	2,058
July	2,983	2,354	2,189	2,364
August	2,883	1,971	2,058	2,219
September	2,805	1,911	1,872	2,121
October	2,237	2,112	1,706	1,944
November	1,450	1,654	1,405	1,568
December	951	1,533	1,073	1,174
Average	1,895	1,687	1,424	1,564

*USDA. Agricultural Marketing Service. Farm employment. USDA Sta. Bul. 236. 1958.

†U.S. Bureau of the Census. Current population reports: labor force. Series P-50, Nos. 72-89. March 1957-June 1959.

‡Adjusted to include foreign workers. From Maitland, Sheridan T., and Fisher, Dorothy Ann. The hired farm working force of 1957. USDA Info. Bul. 208. 1959.

while the CPS series is bimodal. In previous years the AMS series also has been bimodal, with September being the month of greatest employment.[6]

Discrepancies between the CPS and AMS series exist because of differences in concept and method of enumeration. The AMS series essentially estimates the number of farm jobs, while the CPS series estimates the number of farm workers. Both series have relative advantages and disadvantages. There are five main differences between the AMS and CPS employment estimates. First, the data are compiled in the two series by means of different enumerative techniques. The AMS derives farm employment estimates from selected representative farmers who report on their own particular farm. This method of data collection is referred to as the "establishment" method, since the information is obtained about all workers on the establishment. On the other hand, the CPS series is derived from Bureau of Census data which are collected from households. The "household" method obtains information only on actual members of the household. Consequently, a worker employed on more than one farm during the survey period may be counted more than once under the establishment method, but only once

[6]USDA. Agricultural Marketing Service. Farm employment, op. cit.

under the household method. Double counting under the establishment method has been estimated to be at a minimum of a quarter of a million persons, and may be considerably larger seasonally.[7]

A second source of difference between the two series is in the counting method in relation to age limits. The AMS series sets no age limit while the CPS enumeration includes only persons 14 years of age or over. When unpaid members of the family who work 15 hours or more a week are included, the number of children under 14 years of age is estimated by the USDA to be as high as a million.[8] A private estimate by Johnson placed the maximum at 2 million during peak periods.[9]

A third difference arises over multiple job holding. The requirements for a worker to be included in the AMS enumeration are minimal for the survey week: 1 or more hours of farm work for a hired worker, any work at all for an operator and 15 or more hours for unpaid family workers. However, to be included in the CPS enumeration, the worker not only must be 14 years of age or over, but also must have earned a major share of his income in agriculture. Persons with multiple jobs who actually do some farm work, but who are not included in the CPS enumeration, number from 1/2 to 1 million seasonally.[10]

A further difference between the two series may arise because the CPS includes categories of farm workers who engage in nonfarm occupations, such as bookkeepers, typists and persons engaged in some processing activities.[11] It also includes some unemployed farm operators. A difference between the two series also may occur because of different dates of the surveys. While the dates of the surveys of the CPS relate to the week ending nearest the 15th of the month, AMS estimates relate to the last full calendar week of the month.

Besides these five differences between the two major series, other factors are important in the selection of a series to use in the analysis. The estimates of the CPS series are derived from a statistically selected sample, so that standard errors of the estimates can be computed. Standard errors of the estimates are not obtainable from the AMS series. A further and important consideration is the length of time covered by the two series. The AMS estimates cover the period 1910 to the present, include separate series for hired and family labor and include regional as well as national estimates. The CPS series, inaugurated in 1940, presents estimates of hired and family labor on a national basis only.

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[7] USDA. Major statistical series of the U.S. Department of Agriculture, how they are constructed and used. Vol. 7. USDA. Agr. Handbook 118. 1957.

[8] Ibid.

[9] Johnson, D. Gale, and Nottenburg, M. C. A critical analysis of farm employment estimates. Journal of the American Statistical Association 46:191-205. 1951.

[10] USDA. Major statistical series of the U.S. Department of Agriculture, Vol. 7, op. cit.

[11] An estimate of the number of nonfarm workers included in the CPS series may be obtained by subtracting the number of persons employed in agricultural occupations (farm operators and farm laborers) from the total number of persons employed in agriculture. For 1957 an annual average of 198,000 persons were estimated to be engaged in these nonfarm activities. (See Maitland and Fisher, op. cit.)

The Hired Farm Work Force (HFWF)

The HFWF series is relatively new, being started in 1945 for the purpose of providing more detailed information on work done by hired workers. It was derived from information obtained by the Agricultural Marketing Service from the Bureau of the Census through supplementary questions included in one of the regular Current Population Surveys. Employment data for the year are collected at the beginning of the following year, and questions are asked about any farm work done over the past year. Consequently, the HFWF estimates are subject to memory bias, and provide a relatively low estimate of employment in the earlier months of the year. Since the enumeration covers work for the whole month rather than for a survey week and is derived from the same sample as the CPS, the HFWF employment estimates are expected to be larger than the monthly CPS estimates. The HFWF series is not available by regions.

The Series of Man-Hour Requirements (FERD)

Another farm employment estimate not directly comparable to the three previously discussed sets of estimates is the FERD series of man-hour requirements. The purpose of the series is to estimate the number of man-hours required for annual farm output, rather than man-hours actually expended. Compiled by the Agricultural Research Service of the USDA, these estimates are "built up" by multiplying estimated average man-hours per acre of crops and per head or unit of livestock production by the official estimates of total acres and numbers of livestock reported by the Crop Reporting Board of the USDA.[12] A limitation of this series is that errors in the magnitude of the estimates of man-hours per acre or per head of livestock are greatly enlarged when these initial estimates of requirements are multiplied by the total number of acres and animals. Too, a test of statistical reliability cannot be applied to them. The series includes both national and regional estimates, and covers the period 1910 to the present.

Employment and Other Variables Used in Chapter 8

Each of the employment series has been derived for a particular purpose. Each estimate, because of its particular advantages and disadvantages, is unique and suitable only for specific analyses. The AMS series has been utilized more than the other series for labor analyses. It also is used in this study for the following reasons: (a) the series covers a relatively long period, from 1910 to the present; (b) the series

[12] USDA. Major statistical series of the U.S. Department of Agriculture, how they are constructed and used. Vol. 2. USDA. Agr. Handbook 118. 1957.

encompasses both the hired and family components of farm labor; (c) since no age limits are imposed in the enumeration and all farm work is included, the series is a better measure of marginal changes in the farm labor force than is the CPS series.[13] The FERD series is used for one set of long-run predictions since it best reflects changes in labor productivity.

Except as otherwise specified, the variables used in this chapter and Chapter 9 are as follows. The variable is measured in the current year, except where noted otherwise (where t is used, it refers to measurement in the current year also, and t-1 is the same variable lagged one year).

Q = the annual quantity of labor employed on farms, with Q_H designating the quantity of hired labor, and Q_F the quantity of family labor.

Q' = the annual quantity of labor supplied by households, with Q'_H designating the quantity of hired labor, and Q'_F the quantity of family labor.

P_H = the index of the annual farm wage rate as an aggregate for the United States. The data were deflated principally by the index of prices paid by farmers for living expenses, not including wages, and the index of prices paid by farmers for production expenses. The wage rate was included because it is the price of hired labor and perhaps is the "going" price of family labor.

P_R = the index of annual prices received by farmers for all commodities as an average for the United States, deflated by the index of prices paid by farmers for production expenses and the index of farm machinery prices. The series thus deflated is the ratio of product price to factor price and is lagged by 1 year in all equations.

P_M = the annual aggregate index of farm machinery prices for the United States, deflated as for P_H. This variable is included to allow expression of the substitution relationships of farm machinery for farm labor. (Empirical labor demand functions which included the price of farm machinery had regression coefficients which were inconsistent in sign and nonsignificant. Hence, equations for labor demand containing the price of farm machinery as a variable are accorded a separate analysis later in Chapters 8 and 9.)

S_m = the index of the value of farm machinery on hand Jan. 1 for the United States, deflated by the prices paid by farmers for living expenses, to indicate the stock of resources which substitute for labor. The series was compiled commencing with a deflated value of farm machinery on farms from the 1930 census. For succeeding

[13] Hathaway, Dale. Agriculture in an unstable economy revisited. Journal of Farm Economics 41:496. 1959.

years, the deflated increments to (or depreciation of) the nation's stock of machinery and equipment were added (or subtracted) from the prior year's total.

T = time as a variable. Time in linear form is used to represent technological and other changes which have occurred but are not readily quantified as separate and explicit variables.

P'_N = a nonfarm wage-rate variable. This variable is a "composite" of the annual index of hourly factory wages altered to reflect the percentage of unemployment in the total work force. It was assumed arbitrarily that when unemployment of the total work force reached 20 percent, no further off-farm opportunities would exist. Consequently, with unemployment equal to or greater than this level, changes in nonfarm wage rates are expected to have no effect in causing net migration from agriculture. To reflect conditions where nonfarm wage rates would not cause migration when unemployment is 20 percent or greater, this variable was constructed:

$$P'_N = P_N (1 - 5U)$$

where P_N is the hourly earnings of factory workers and U is the percent of unemployment in the national economy. When the unemployment rate reaches 20 percent or more, P'_N becomes zero; when the unemployment rate is zero, the variable reaches the average level of earnings by factory workers.

Variations in regression models are made for these purposes: (a) to examine the effect of the inclusion or noninclusion of variables assumed to have important effects on the use of farm labor; (b) to compare results from variables deflated by different price series; (c) to use different time periods for estimation; (d) to compare equations containing observations entered in linear and in logarithmic form; (e) to compare estimation techniques such as single equations (some taken with a distributed lag), simultaneous-equations estimation by the reduced-form, the limited information and Theil-Basmann methods, and autoregressive least-squares methods;[14] and (f) to include the quantity of farm labor, lagged one period (Q_{t-1}), as an additional independent variable (i.e., as a predictor of Q_t). The results of the empirical analysis are presented in a later section. Further variations in notation from that listed above will be defined in the appropriate section.

[14] Theil, Henri. Estimation and simultaneous correlation in complete equation systems. Central Plan Bureau, The Hague, Netherlands. Mimeo. report. June 23, 1953. (Original not available for examination; cited in Wallace, T. D., and Judge, G. G. Discussion of the Theil-Basmann method for estimating equations in a simultaneous system. Oklahoma State University. Processed series P-301. Aug. 1958.); and Basmann, R. L. A generalized classical method of linear estimation of coefficients in a structural equation. Econometrica 25:77-83. 1957.

EMPIRICAL PROCEDURES

Since the models derived in this study are all "shock" models, the data are presumed to be measured without error. The results may be invalidated to some extent, since errors of observation in economic time series are usually present. A method of dealing with this problem is presented by Tintner,[15] and an example involving labor has been analyzed by Mosback.[16]

Equations taken with a distributed lag, as well as the more common form of equations, have been used in this study. For several of the national demand and supply functions for hired labor, distributed lag equations were used. Both conventional and autoregressive least-squares equations were estimated for national data.[17] Tests for residual correlation have typically been made by the Durbin-Watson test.[18] However, Fuller and Martin illustrate that this test is not always "effective." It is likely that the lagged dependent variable "extracts" some of the autocorrelation from the residuals, biasing the coefficient and use of the d statistic.

Koyck[19] proposed the model in equation (8.1) to obtain consistent estimators when the error term u_t is generated by an autoregressive scheme.

$$u_t = Bu_{t-1} + e_t \tag{8.1}$$

The assumptions are that e_t has a zero mean and a constant variance, is not correlated with u_{t-1} and is not autocorrelated with lagged values of e. Further, he assumes specific values of B, the autoregressive coefficient. Estimation by this technique is referred to in this study as autoregressive least squares or A.L.S.

In an equation such as in (8.2), assuming that a first-order autoregressive scheme applies, the cases in which a variable b′ is a consistent estimator of the real b has been outlined by Fuller.[20]

$$w_t = ap_t + bw_{t-1} + u_t \tag{8.2}$$

He shows that Koyck's basic equation combined with the autoregressive scheme of equation (8.1) leads to

[15] Tintner, Gerhard. Econometrics. John Wiley & Sons. New York. 1952. Chap. 7.

[16] Mosback, Ernest J. Fitting a Static Supply and Demand Function for Labor. Unpublished Ph.D. Thesis. Library, Iowa State University. Ames. 1957.

[17] Fuller, W. A., and Martin, J. E. The effects of autocorrelated errors in the statistical estimation of distributed lag models. Journal of Farm Economics 43:71-82. 1961.

[18] Durbin, J., and Watson, G. S. Testing for serial correlation in least squares regression, II. Biometrika 38:159-78. 1951.

[19] Koyck, L. M. Distributed Lags and Investment Analysis. New Holland Publishing Co. Amsterdam, Netherlands. 1954.

[20] Fuller, Wayne. A Non-Static Model of the Beef and Pork Economy. Unpublished Ph.D. Thesis. Iowa State University Library. Ames. 1959. See also Fuller, Wayne A., and Ladd, George W. A quarterly model of the beef and pork economy. Journal of Farm Economics 43:797-812. 1961.

(8.3) $$u_t = B(w_{t-1} - ap_{t-1} - bw_{t-1}) + e_t.$$

By substituting equation (8.3) into equation (8.2), he shows that the probability limit of b′ is given by

(8.4) $$\text{plim } b' = b + \frac{B}{1 + Bb} \left\{ \frac{\left(1 - r^2_{p_t w_t}\right) - b^2}{\left(1 - r^2_{p_t w_{t-1}}\right)} \right\}$$

where w is labor quantity and p is labor price. Under these assumptions, b′ is a consistent estimator of b only when B = 0. These results indicate that a more accurate estimate of b could be obtained if the value of B were known. (Since there is usually autocorrelation among economic time series, it is likely that estimates of b have an upward bias, depending on the value of B.) Methods for estimating B have been presented by Klein and Orcutt and Cochrane.[21] A simplified method for estimating B by an iterative process has been developed by Fuller.[22] Basically the method is as follows, using the notation of equations (8.2) and (8.3). By substituting (8.3) into (8.2) the following equation is formed:

(8.5) $$w_t = ap_t + (b + B)w_{t-1} - aBp_{t-1} - bBw_{t-2} + e_t.$$

A regression on these variables provides initial values of estimates of a, b and B. By a method of ~~nonlinear~~ regression,[23] a function containing the estimates of the coefficients is expanded in a first-order Taylor expansion about the point defined by the initial values above. The sums of squares and cross products from the Taylor expansion become linear combinations of those in equation (8.5). Retaining only the first-order terms, the results of the Taylor expansion yield:

(8.6) $$w_t = w_0 + m_1 \Delta\hat{a} + m_2 \Delta\hat{b} + m_3 \Delta\hat{B}$$

where $w_0 = w_t - \hat{w}_t$, the residuals in equation (8.5),

$$m_1 = p_t - B\hat{p}_{t-1},$$

$$m_2 = w_{t-1} - B\hat{w}_{t-2},$$

$$m_3 = w_{t-1} - a\hat{p}_{t-1} - bw_{t-2},$$

[21] Klein, op. cit.; and Cochrane, D., and Orcutt, G. H. Application of least squares regression to relationships containing autocorrelated error terms. Journal of the American Statistical Association 44:36-61. 1949.

[22] Fuller, Wayne. Autocorrelated errors and the estimation of distributed lag models. (Typewritten.) Statistical Laboratory, Iowa State University. Ames. 1960.

[23] Levenberg, Kenneth. A method for the solution of certain non-linear problems in least squares. Quarterly Journal of Applied Mathematics 2:114-68. 1944.

where $\hat{a}$, $\hat{b}$ and $\hat{B}$ are the initial estimates of the coefficients, and $\Delta \hat{a}$, $\Delta \hat{b}$ and $\Delta \hat{B}$ represent changes for each iteration. The least-squares method applied to equation (8.6) produces further changes in the estimates; the iterative method continues until the change becomes sufficiently small. The final estimates are consistent estimates of the coefficients.

EMPIRICAL ESTIMATES OF THE NATIONAL DEMAND FUNCTIONS FOR HIRED FARM LABOR

This section presents the empirical results testing the hypothesis that the demand for hired labor is a function of its own price (the farm wage rate); the prices of other inputs such as farm machinery, the scale of farming as exemplified by the value of farm machinery, and the return on or price of products sold.[24] In contrast to family labor, hired labor has an explicit wage or price which is reported nationally and regionally. The price of inputs such as the series of aggregate farm machinery prices, was originally included in the regression model. However, farm machinery price resulted in inconsistent results when this variable was included with other explanatory variables. Because of the importance of farm machinery to the demand for hired labor, it is accorded a separate analysis later in this chapter.

The demand functions for hired labor in Tables 8.4 and 8.5 have been estimated using a variety of algebraic forms and estimating methods and are from the earlier phase of this study. Results for hired labor demand using an alternative set of models will follow in a later section. The statistics in Table 8.4 are the results of the estimated equations, while Table 8.5 includes the elasticities of hired labor with respect to the variables indicated. Standard errors are included in parentheses under the regression coefficients in Table 8.4. The form of equations and variables and the estimating technique is that indicated in column 2. The periods for which the variables are measured are included in the middle of the table. The value of R^2 is included in the third column. The deflators of the farm wage rate and prices received variables are listed in Table 8.5. Wherever a space is blank, the

[24] For other empirical studies of the demand for hired farm labor, see Griliches, Zvi. The demand for inputs in agriculture and a derived supply elasticity. Journal of Farm Economics 41:309-22. 1959; and Schuh, George E. The demand and supply relations for hired labor in agriculture. Paper presented at the Joint Meetings of the Econometric Society and the American Farm Economic Association, Washington, D.C., December 28-30, 1959. (Mimeo.) Department of Agricultural Economics, Purdue University, Lafayette, Indiana. 1959. Griliches specified a distributed lag model representing the demand for hired labor for the period 1912-56, containing one independent variable, the farm real-wage rate. Schuh estimated demand functions for hired labor over the period 1929-57 simultaneously with hired-labor supply functions. Schuh's time period and model specification are similar to equation (8.14) of Table 8.4 (to be presented further in this study). The demand functions in this study, other than the A.L.S. equations, were estimated simultaneously with Schuh's work and without knowledge of it.

Table 8.4. Regression Coefficients and Standard Errors (in Parentheses) for United States Hired-Labor Demand Functions*

Equation Number	Form and Method†	R^2	Constant	P_{Ht}	P_{Rt}	S_{mt}	T	Q_{Ht-1}
				1910-57 period				
(8.7)	O, least squares	.983	40.74	-.077 (.045)	--	--	-.297 (.141)	.777 (.082)
(8.8)	O, least squares	.981	15.23	-.091 (.044)	--	--	--	.931 (.047)
(8.9)	O, least squares	.983	27.89	-.098 (.055)	.054 (.033)	--	-.179 (.119)	.826 (.073)
(8.10)	O, least squares	.982	12.86	-.122 (.053)	.079 (.029)	--	--	.907 (.054)
(8.11)	L, least squares	.984	.35	-.095 (.034)	.057 (.022)	--	-.021 (.017)	.871 (.054)
(8.12)	O, least squares	.982	23.86	-.046 (.058)	.048 (.064)	--	-.240 (.114)	.851 (.073)
				1920-39 period				
(8.13)	O, least squares	.935	68.40	-.054 (.187)	.248 (.111)	--	-.686 (.262)	.478 (.271)
				1929-57 period				
(8.14)	O, reduced form	.970	52.47	-.168 (.108)	.099 (.069)	--	-.335 (.119)	.658 (.041)
(8.15)	O, Theil-Basmann	.988	116.32	-.341 (.122)	.243 (.112)	--	-.687 (.523)	.206 (.195)
(8.16)	O, Theil-Basmann	.980	94.49	-.287 (.091)	.245 (.081)	.00207 (.00085)	-1.635 (.674)	.237 (.265)
				1940-57 period				
(8.17)	O, least squares	.980	122.03	-.458 (.091)	.119 (.040)	--	-.311 (.244)	.236 (.159)
(8.18)	O, least squares	.936	98.22	-.232 (.081)	--	--	-.120 (.325)	.530 (.491)
(8.19)	O, least squares, not distributed lag	.979	153.23	-.475 (.178)	.127 (.031)	--	-.492 (.504)	--

*The price variables are deflated as indicated in Table 8.5. The variables, in index form, are:

P_{Ht} = the index of the average hired farm wage rate for the United States where t refers to measurement in the current year.

P_{Rt} = the index of average prices received by farmers for all commodities for the United States.

S_{mt} = the average value of farm machinery and equipment for the United States.

T = time as a linear variable.

Q_{Ht-1} = the number of hired workers lagged 1 year for the United States.

†O refers to original observations introduced in models in linear form; L refers to observation in logarithmic form; reduced forms and Theil-Basmann method refer to the technique used to solve simultaneous equations. Equations (8.7), (8.8), (8.15) and (8.16) were estimated using autoregressive least-square methods.

corresponding variable was omitted from the model. The forms and estimating methods include: (a) linear observations in all equations other than for equation (8.11), which is in logarithms; (b) least-squares method for equations (8.7) to (8.13) and (8.17) to (8.19), inclusive, and simultaneous-equation estimation by reduced forms for equation (8.14) and by the Theil-Basmann technique in equations (8.15) and (8.16); [25]

[25]Theil, Henri, op. cit., and Basmann, R. L., op. cit.

Table 8.5. Elasticities of Demand Computed From the Demand Equations for Hired Labor (United States) Presented in Table 8.4

Equation Number	Form and Method	Deflator of the Farm Wage Rate	Elasticity of the Farm Wage-Rate Variable				Deflator of Prices Received	Elasticity of the Prices Received Variable				Adjustment Coefficient	Time Variable Included
			Short run		Long run			Short run		Long run			
			Mean	1957	Mean	1957		Mean	1957	Mean	1957		
					1910-57 period								
(8.7)	O, least squares	--*	-.0529	-.1374	-.2376	-.6173	--	--	--	--	--	.223	Yes
(8.8)	O, least squares	--*	-.0627	-.1646	-.9092	-2.387	--	--	--	--	--	.052	No
(8.9)	O, least squares	--†	-.0576	-.1301	-.331	-.7747	--‡	.0347	.0394	.1995	.2265	.174	Yes
(8.10)	O, least squares	--†	-.0718	-.1621	-.7754	-1.751	--‡	.0519	.0584	.5603	.6302	.039	No
(8.11)	L, least squares	--†	-.0953	-.0953	-.7365	-.7365	--‡	.0574	.0574	.4434	.4434	.129	Yes
(8.12)	O, least squares	--§	-.0276	-.0663	-.1737	-.4173	--	.0338	.0474	.2128	.2984	.159	Yes
					1920-39 period								
(8.13)	O, least squares	--¶	-.0245	--	-.0469	--	--	.1715	--	.3283	--	.523	Yes
					1929-57 period								
(8.14)	O, reduced form	--†	-.1261	-.2229	-.3683	-.6510	--	.0826	.0982	.2412	.2868	.342	Yes
(8.15)	O, Theil-Basmann	--†	-.256	-.552	-.32	-.57	--	.20	.241	.255	.303	.794	Yes
(8.16)	O, Theil-Basmann	--†	-.215	--	-.28	--	--#	.203	--	.266	--	.7635	Yes
					1940-57 period								
(8.17)	O, least squares	--†	-.4595	-.608	-.6010	-.795	--#	.1016	.0887	.1329	.1160	.7645	Yes
(8.18)	O, least squares	--*	-.2517	-.4142	-.5351	-.8805	--	--	--	--	--	.4704	Yes
(8.19)	O, least squares, not distributed lag	--§	-.4803	-.6813	--	--	--	.1238	--	--	--	--	Yes

*Index of average prices received by farmers.
†Index of prices paid by farmers for living expenses.
‡Index of average farm machinery prices.
§Index of prices paid by farmers for production expenses.
¶Index of average farm machinery prices, lagged 1 year.
#Index of prices paid by farmers for production expenses, lagged 1 year.

(c) autoregressive least squares were employed for equations (8.7), (8.8), (8.15) and (8.16); and (d) equations (8.9) and (8.12) have variables deflated by different indices. All equations in Table 8.4 other than (8.19) include a distributed lag variable.

Inclusion of Additional Independent Variables

The price of hired labor, the farm wage rate, was the principal explanatory variable in each equation of Table 8.4. Inclusion of other variables in the specification of the model caused the values of the coefficients of the original variables to be altered substantially. The rationale for the inclusion of time as a variable was indicated earlier. Equations (8.7) through (8.10) were estimated to allow comparisons of estimates using various deflators with and without time. The major difference between the two sets of equations, equation (8.7) as compared to (8.8) and equation (8.9) as compared to (8.10), is in the size of the coefficient of the lagged dependent variable Q_{Ht-1}. The coefficients of Q_{Ht-1} in equations (8.8) and (8.10), not containing time, are larger than the coefficients of Q_{Ht-1} in equations (8.7) and (8.9). The coefficients are used to estimate the adjustment coefficient and long-run elasticities of demand for hired labor.[26] The estimated long-run elasticities of labor quantity with respect to the farm wage rate were high for equations (8.8) and (8.10), respectively, being -2.39 and -1.75 for 1957 (Table 8.5). The long-run elasticities of equations (8.7) and (8.9) were considerably less than one. The time variable materially reduced the estimate of the long-run elasticity of demand quantity with respect to the price of hired labor.

The effect of adding the index of the value of farm machinery and equipment is demonstrated by equations (8.15) and (8.16), both estimated by A.L.S. Specifications of the two were identical except for the farm machinery variable in the latter. The value of the regression coefficient for the time variable changed from -.687 to a significant -1.635 between the two equations. The coefficient of the farm machinery variable S_m is significant at the 90 percent level of probability. Otherwise, the values of the other regression coefficients were not changed substantially.

The Effect of Different Deflators and Forms of Equations

The effect of different deflators upon demand elasticities is illustrated in the first six equations, estimated with data from 1910 to 1957.

[26]See Chapter 3 and Nerlove, Marc. Distributed lags and the estimation of long-run supply and demand elasticities: theoretical considerations. Journal of Farm Economics 40:301-11. 1958; and Koyck, L. M. Distributed Lags and Investment Analysis. North Holland Publishing Co. Amsterdam, Netherlands. 1954.

Only the long-run elasticities of hired-labor demand were substantially changed by the use of different deflators. However, the regression coefficient for the farm wage rate was not statistically significant in equation (8.12) where the deflator was the index of prices paid for all production items.

Observations for the time variable, along with other variables, were converted to logarithmic values in equation (8.11). Since the time variable in this equation is significant only at an extremely low level, as compared to the other equations, we suppose this function to be less appropriate than equations linear in original observations. Aside from the time variable, there was little difference between coefficients of comparable equations using variables in logarithms or in linear form.

The Effect of the Assumption of an Autoregressive Scheme

Four hired-labor demand functions taken with a distributed lag were estimated initially using autoregressive least squares (A.L.S.). Because of the time and expense involved in performing the necessary iterations, not all of the equations were estimated in this manner. The results of the A.L.S. equations are presented in Tables 8.4 and 8.5 as equations (8.7), (8.8), (8.15) and (8.16). Equations (8.7) and (8.8) are analyzed first. They cover the period 1910-57, and include the variables hired labor lagged 1 year and the farm wage rate. In addition, equation (8.7) contains time as a trend variable.

Equation (8.8), the A.L.S. equation which does not include time as a variable, may be compared with the ordinary least-squares equation using the same variables.[27]

$$(8.20)\qquad Q_{Ht} = 11.97 + \underset{(.039)}{.9480Q_{Ht-1}} - \underset{(.037)}{.0783P_{Ht}}$$

The simple least-squares equation (not A.L.S.) corresponding to equation (8.7) in Table 8.4 which included time as a variable was estimated as:

$$(8.21)\qquad Q_{Ht} = 29.02 - \underset{(.0643)}{.8397Q_{Ht-1}} - \underset{(.0383)}{.0530P_{Ht}} - \underset{(.1080)}{.2252T}\ .$$

The coefficients of the lagged dependent variables were highly significant in equations (8.20) and (8.21) as well as in equations (8.7) and (8.8). The coefficient of the lagged variable in equation (8.20), not including time as a variable, was .948, while the corresponding coefficient in A.L.S. equation (8.8), Table 8.4, was .931. For the equations including time, (8.21) and (8.7), the coefficients of the lagged endogenous

[27] The variable P_{Ht} in equations (8.20) and (8.21) was deflated by the index of prices received by farmers for all commodities, United States.

variable were .840 and .777, respectively. In both comparisons the value of the lagged endogenous variable in the A.L.S. equation was slightly less than in the ordinary least-squares equations. But in the A.L.S. equations, the coefficients of the farm wage rate and time were larger than the comparable coefficients in the non-A.L.S. equations. The residual sums of squares is reduced by A.L.S. in both cases — from 461.4 to 441.9 for the equations containing time and from 507 to 490 for the other two equations.

In summary, the slight differences between the A.L.S. equations and the ordinary least-squares equations were: (a) the A.L.S. equations reduced the residual sum of squares, implying a better "fit"; (b) the regression coefficients of the lagged endogenous variables in the A.L.S. equations were lower with an accompanying shorter time period of adjustment; and (c) in the A.L.S. equations the regression coefficients of the other independent variables increased and became significant at higher probability levels. The long-run elasticities were less in the A.L.S. equations because of the decrease in the value of the lagged coefficients.

The estimate of B, the autoregression coefficient, is expected to decrease when a trend variable is included in the equation. However, in the case of equations (8.7) and (8.8) of Table 8.4, the results were indeterminate. The estimated values of B are the numerical coefficients in these two estimated equations — see equation (8.1):

$$u_t = \underset{(.1385)}{.2534} u_{t-1} \qquad (8.22)$$

for equation (8.7), and

$$u_t = \underset{(.1338)}{.1710} u_{t-1} \qquad (8.23)$$

for equation (8.8). Neither of the estimates of B were significant at high probability levels, although the estimate of B in equation (8.22) was significant at the 90 percent level. Since the initial value of the coefficient of the lagged dependent variable in equation (8.8) approached one, it is possible that the autoregressive structure of the equation could not be adequately ascertained. Though the results indicated that the B's are small, their statistical significance was such (along with the differences of the A.L.S. equations as described above) that the A.L.S. equations estimated for 1910-57 were preferred over the non-A.L.S. equations.

Further comparison of the autoregressive assumption is made for hired-labor demand functions over the period 1929-57. Equation (8.14) of Table 8.4 was estimated by reduced form with no autoregressive assumptions. Equations (8.15) and (8.16) were estimated by the Theil-Basmann technique under the assumption of an autoregressive scheme.[28]

[28]See Theil, H., op. cit., and Basmann, R. L., op. cit.

In equation (8.14) the regression coefficients for the farm wage rate and prices received variables were nonsignificant. Both regression coefficients were significant in A.L.S. equations (8.15) and (8.16). The adjustment coefficient in equation (8.14) is .34, but .79 and .76 respectively for A.L.S. equations (8.15) and (8.16). Since the lagged endogenous coefficient "picks up" part of the residual term, the autoregressive assumption perhaps provides a better estimate of the adjustment coefficient. In this sense, equations (8.15) and (8.16) may serve most effectively in the analysis of demand for hired labor.

The estimated autoregressive coefficient, B, of equations (8.15) and (8.16), respectively, is the numerical quantity in the following two equations:

(8.24) $$u_t = \underset{(.120)}{.753} u_{t-1}$$

(8.25) $$u_t = \underset{(.326)}{.339} u_{t-1} .$$

The estimate of B for equation (8.15) was large and significant, while the value of B for equation (8.16) was small though larger than its standard error. Evidently the inclusion of the additional variable in equation (8.16) aided in the specification of the model, and reduced the value of B. We again conclude that the A.L.S. equations are preferable statistically to non-A.L.S. equations when distributed lags are used. However, because of the time and costs involved in the A.L.S. estimates, the autoregressive scheme was not assumed for other equations.

Analysis of Major Variables in the National Demand Functions for Hired Labor

Demand Relative to Farm Wage Rate

The values of the above single-equation regression coefficient for the farm wage rate estimated over the entire period, 1910-57, were low relative to their standard errors, the estimates in the six equations ranging in value from -.046 to -.122. For the linear equations (8.7), (8.9) and (8.12), including time as a variable, the regression coefficients of the farm wage rate were significant at the 90 percent level in the first two and nonsignificant in the third. The 48-year period, however, stretches over a span of time when the structure of agriculture and labor demand changed greatly. For this reason, equations have been estimated for subperiods of this span. For the period 1920-39 the value of the wage-rate regression coefficient was -.054 and was not significantly different from zero (equation (8.13), Table 8.4). This lack of significance may not have great importance, however, since the period included was one of agricultural recession. In the 1940-57 period, a period of relative prosperity in agriculture, single-equation regression coefficients for the price of farm labor in equations (8.17), (8.18) and (8.19), Table 8.4, ranged from -.232 to -.475 and were significant at a probability level of 95 percent or higher. Significant response of demand for labor in respect to the price is indicated in this period. Lack of significance of the wage-rate regression coefficient in equations estimated from 1910-57 data does not reflect accurately the response of labor quantity to wages for intervening periods. The years 1910-57 combine periods both of great depression and great prosperity, as well as periods varying greatly in the structure of technology.

This conclusion also tends to be substantiated for estimates over a shorter period, 1929-57, by simultaneous-equation methods. The "system" of demand functions for hired labor are equations (8.14), (8.15) and (8.16) in Table 8.4. The regression coefficient of the farm wage rate for equation (8.14) was -.168, but nonsignificant. The corresponding regression coefficients for the demand functions (8.15) and (8.16), estimated under the assumption of autocorrelated errors, were -.341 and -.287, respectively. The coefficients were significant at the 99 percent level. These results correspond with the findings of the demand functions for the shorter period 1940-57: that hired farm labor employment is responsive to changes in the farm wage rate.

Price Elasticities of Demand

For equations (8.7) through (8.12), estimated over the period 1910-57, the short-run price elasticities (labor demand with respect to farm wage rate) at the mean of the observations ranged from -.03 to -.10. Basically, the price elasticities for the over-all period were low.

The short-run price elasticities taken at the mean of observations for the 1929-57 period ranged from -.13 to -.26. For the 1940-57 period, the short-run elasticities at the mean ranged from -.25 to -.48. These statistics suggest that the short-run elasticity of labor demand with respect to farm wage rate has been increasing, although it has remained considerably smaller than unity.

Long-run price elasticities of demand also were derived and are included in Table 8.5. In a distributed lag equation, the long-run elasticity depends on the size of the adjustment coefficient. The adjustment coefficients for the six demand functions covering the 1910-57 period ranged from .05 to .22. Correspondingly, the long-run price elasticities (demand quantity relative to wage rate) at the mean ranged from -.17 to -.91 for the six equations. (In comparison, the short-run elasticities for the same period ranged from -.03 to -.10.) With the assumption that the errors in the equations follow an autoregressive scheme, the long-run demand elasticities for equations (8.7) and (8.8) were -.24 and -.91, respectively. The long-run price elasticities at the mean observation for the 1929-57 period ranged from -.28 to -.37.

For the 1940-57 period they ranged from -.53 to -.60. These results again suggest a higher level of response of labor demand relative to the farm wage rates, given time to adjust.

Demand Relative to Farm Product Prices

The cross elasticity of demand for hired farm labor with respect to the index of prices received indicates the responsiveness of labor employment to changes in agricultural product prices. The series, deflated by an index of prices paid for production items, relates product prices to factor prices and serves as an indicator of the relative profitability of farming. The deflator of the index of prices received for each equation is listed in Table 8.5. The index of prices received has been lagged 1 year in all of the hired-labor demand functions other than those for the period 1910-57. The assumption is that farmers react to product price changes in the previous year, since the present year's price is known relatively late in the year.

In general, the regression coefficients relating hired-labor demand to prices received were significant at acceptable levels of probability for the several time periods analyzed. Similarly, the signs of the regression coefficients were positive for all equations and all time periods. We conclude that the demand for hired farm labor has been responsive to farm product prices and the profitability of farming in all of the time periods analyzed.

The cross elasticities of labor demand with respect to farm product prices again were considerably higher for the long run as compared to the short run. This difference is, of course, consistent with the original hypothesis that time is required before farmers can change the organization of their farms and increase resource inputs in response to more favorable product prices. The long-run elasticity is much less than unity, however, for all time periods and equations or estimating techniques.

Demand in Relation to Farm Machinery Inventory

The stock of machinery and equipment on farms, January 1, was constructed and added to equation (8.16) of Table 8.4 for the period 1929-57. The equation was estimated using the A.L.S. method so that, except for S_m, the farm machinery variable, the specifications of equation (8.16) and equation (8.15) are the same. Theoretically, the variable should indicate the response of the demand for hired labor to changes in the scale of farming as exemplified by the value of the stock of farm machinery and equipment. The resultant coefficient of the farm machinery variable is positive and significant at the 95 percent level, and has a short-run elasticity at the mean of .13. The results suggest that as the scale of farming (investment in machinery) has increased, the number of hired workers has increased. This result could bear closer examination on a less aggregated level.

Trends and Predictions of Hired Labor Employment

Figure 8.3 indicates both actual numbers and predicted numbers of hired farm workers from 1910 to 1957 based on equation (8.9), Table 8.4. From 1935 to 1945 and from 1950 to 1957 the decline in employment was quite uniform and, as expected, equation (8.9) predicts well.

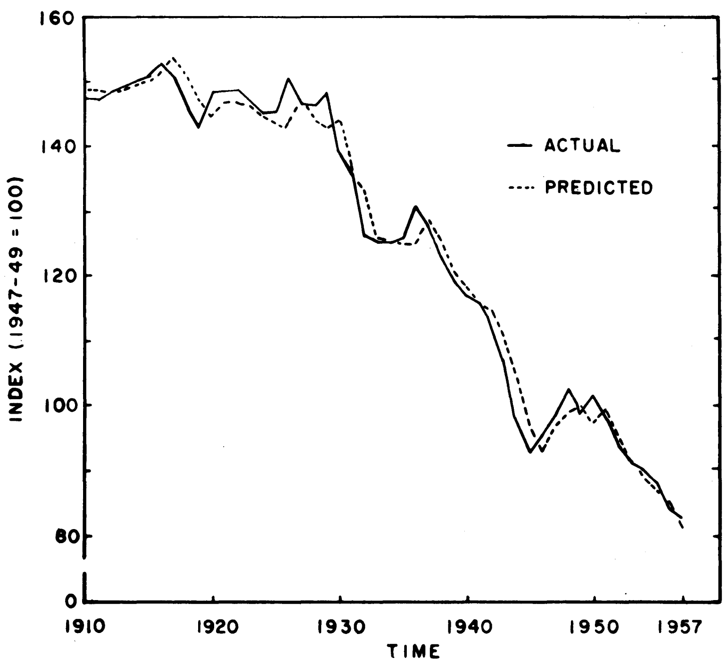

Figure 8.3. Actual and predicted number of hired farm workers in the United States, 1910-57 (demand equation (8.9), Table 8.4).

In other periods of less stability in labor trends, the equation predicts less accurately. The total period is heterogeneous, and a high degree of precision in predicting year-to-year changes is not expected. The high R^2, .983, indicates, however, that the actual values are predicted with some accuracy by equation (8.9). Projections beyond 1957 are not attempted from the equation.

Table 8.6. Regression Coefficients, Standard Errors (in Parentheses) and Elasticities of the Demand Functions for Hired Labor for the Nine Geographic Regions, United States*

Equation Number	Time Period	R^2	Region†	Q_{Ht-1}	P_{Ht}	P_{Rt}	T	Adjustment Coefficient	Elasticities (Mean): Farm wage rate, Short-run	Farm wage rate, Long-run	Parity ratio, Short-run	Parity ratio, Long-run
(8.26)	1929-57	.945	NE	.721 (.126)	-.031 (.056)	--	-.457 (.241)	.28	-.05	-.17	--	--
(8.27)	1929-57	.967	MA	.750 (.122)	-.343 (.122)	32.2 (9.98)	-.201 (.467)	.25	-.19	-.75	.16	.64
(8.28)	1929-57	.980	ENC	.830 (.107)	-.440 (.200)	.101 (.148)	.162 (.939)	.17	-.15	-.90	--	--
(8.29)	1940-57	.986	WNC	.278 (.110)	-1.06 (.167)	101.0 (16.8)	-.659 (.731)	.72	-.51	-.71	.36	.50
(8.30)	1929-57	.933	SA	.615 (.172)	-.862 (.608)	-2.25 (34.8)	-.921 (1.21)	.39	-.12	-.32	--	--
(8.31)	1929-57	.955	ESC	.573 (.110)	-1.71 (.413)	83.7 (19.9)	-.251 (.656)	.43	-.35	-.82	.29	.68
(8.32)	1929-57	.930	WSC	.612 (.123)	-1.59 (.477)	94.0 (34.9)	-.127 (1.46)	.39	-.26	-.67	.19	.50
(8.33)	1940-57	.906	MTN	.351 (.273)	-.133 (.132)	2.34 (13.2)	-2.12 (1.17)	.65	-.11	-.18	--	--
(8.34)	1947-57	.839	PAC	.299 (.053)	-.356 (.395)	--	-2.16 (.802)	.70	-.19	-.27	--	--

*The regional variables are:

Q_{Ht-1} = the number of hired workers for each region, lagged 1 year.

P_{Ht} = the average hired farm wage rate for each region, deflated by the index of prices paid by farmers for living expenses.

P_{Rt} = the regional "parity ratio," the ratio of the index of prices received by farmers for all commodities for each region to the index of prices paid by farmers for production items, interest, taxes and wages (as computed for a "typical" state within each region).

T = time (linear).

†The identifying letters under the "Region" heading stand for the nine regions, as follows: NE, New England; MA, Middle Atlantic; ENC, East North Central; WNC, West North Central; SA, South Atlantic; ESC, East South Central; WSC, West South Central; MTN, Mountain; PAC, Pacific.

EMPIRICAL ESTIMATES OF THE REGIONAL DEMAND FOR HIRED LABOR

In addition to the demand functions for hired labor derived for the United States, demand functions for hired labor were estimated for each of nine geographic regions. Although the data are highly aggregated, they do present the response to the important variables on a less aggregated scale than the national analysis. We wish to examine differential response in labor demand among regions.

Methodology Used for the Regional Analysis

Demand functions using the general approaches outlined above, derived for hired labor in each of nine geographic regions, are presented in Table 8.6. Given the hypothesis that the variables affecting the regional demand for hired labor are the same as those affecting national demand, the specification of the regional equations essentially is the same as the national equations explained above. The principal independent variables are the farm wage rate, the parity ratio, time as a trend variable and the hired-labor force lagged 1 year.

All of the regional demand functions for hired labor were estimated by single-equation least-squares methods. Equations were estimated in original observations covering the period 1929-57, except for the Mountain, Pacific and West North Central regions which were made for the more recent time periods listed in Table 8.6. For these regions the regression coefficients for the whole period were either inconsistent in sign or nonsignificant.

All relevant regional data are included in Table 8.6. The coefficient of determination, R^2, is high for each region. It ranges from .839 in the Pacific region to .986 in the West North Central region. Tests for serial correlation in the residuals were not made.

Analysis of the Results of the Regional Demand Functions for Hired Labor

The order of presentation for the regional demand functions for hired labor is: First, the significance of the farm wage regression coefficients will be analyzed. Second, the short-run and long-run elasticities will be compared. Third, the parity ratio will be examined as it relates to the demand for hired labor. Finally, the time trend will be evaluated.

The Farm Wage Rate

Paralleling the demand functions for the United States, the important independent variable in the regional functions is the farm wage rate. The regression coefficients for the farm wage rate were significant at the 95 percent level or better in five of the nine regions. Regression coefficients for the farm wage rate were consistently negative in sign. The short-run elasticities of labor quantity in respect to wage rate varied from -.05 in New England to -.51 in the West North Central region. Disregarding the elasticities derived from regression coefficients at low significance levels, the range was from -.15 to -.51.

The regions in which regression coefficients of the wage-rate variable were significant at low levels included New England, South Atlantic, Mountain and Pacific. The South Atlantic and Pacific regions use a large number of seasonal hired workers commonly paid by piece rates, which are not included in the reported farm wage rate. Hence, the reported regional wage rates may not have been as appropriate in these two regions as for other regions.

Long-run elasticities of the price variable also were estimated for each region. Excluding estimates for regression coefficients at low levels of significance, the long-run elasticities of demand in respect to wages ranged from -.67 to -.90. Similar to the long-run price elasticities for the national demand functions, the long-run price elasticities were less than unity but much larger than the short-run elasticities.

The Parity Ratio Variable

The ratio of the index of prices received by farmers for all commodities to the index of prices paid by farmers for production items, interest, taxes and wages, was used as the indicator of farming profitability for the regions. The "parity ratio" is not computed by federal sources on a regional basis. As a consequence, the index of the parity ratio for each region was computed for a typical state in each region. The ratio could not be computed for a state of the New England or Pacific regions because data were not available for the desired years.

The regression coefficients for the parity ratio variable were significant at the 95 percent level of probability in four of the regions, only beyond the 60 percent level in three, while the data were not available in two regions. The regions with regression coefficients significant at low probability levels were East North Central, South Atlantic and Mountain. For regions with regression coefficients significant at the 95 percent level of probability, the short-run cross elasticities estimated at the mean observation ranged from .16 to .36. The long-run cross elasticities for these four regions ranged in value from .50 to .68. While the cross elasticities for the parity ratio variable were less than 1.0 in the long run, they again were much larger than the short-run elasticities.

The Trend Variable As an Indicator of Technological Change

Time as a variable was included in each of the regional hired-labor demand functions as a technology variable and to complete the specification. This variable was significant at a probability level of 95 percent in only one region, the Pacific region. Consequently, the time variable is not considered to be a reasonable indicator of changes in technology by region.

The adjustment coefficients, which differentiate the magnitude of short-run and long-run elasticities, ranged in value from .17 in the East North Central to .72 in the West North Central. The higher the value of the adjustment coefficient, the more rapid is the rate of adjustment to the equilibrium or desired level of employment. The results suggest that the New England, Middle Atlantic and East North Central regions have been slower than other regions in adjusting to sustained price changes.

As a note of caution it is well to remember that hired as well as family workers are not a homogeneous group. Family workers include old persons "on the way out," young persons temporarily on the farm but ready to leave the agricultural labor force, low-income farmers being squeezed by economic pressure, well-established operators "well fixed" in farming and others. To be qualified as a family worker, a person must be (a) a member of the operator's family and (b) spend 15 or more hours at farm work during the survey week. Part of these same problems of enumeration show up in the hired work force, and the heterogeneity is easily represented in the overly simplified functions of this and the next chapter.

FURTHER ANALYSIS OF THE HIRED LABOR MARKET

After the year's plans have been initiated on farms, ability to contract labor is somewhat limited. Hence, the lagged rather than current wage and price variables may better explain changes in the numbers of hired laborers on farms in the current year. The subsequent analysis also differs from the foregoing analysis by excluding observations for 1942 to 1945. The market structure for hired labor was not considered normal during World War II because of the drafting of farm workers into the armed forces. After presentation of the results of the following functions, all estimates for the period 1926-59, interpretation of policy implications will be made.

Specification of the Demand Function

Estimates of hired-labor demand functions are made by means of a conventional least-squares equation and by a limited information simultaneous-equation system. All single equations have only linear

Table 8.7. Demand Functions for Hired Labor, Q_H, Estimated by Least Squares With Annual Data From 1926 to 1959, Excluding 1942 to 1945; Coefficients, Standard Errors (in Parentheses) and Related Statistics Are Included*

Equation and Transformation †	R^2	d ‡	Constant	P_H/P_R t	P_H/P_R t-1	P_H/P'_P t	P_H/P'_P t-1	S_P t	G t	T	Q_H t-1
(8.35-O)	.982	1.08	345.13	-.0043	-.69		.30	1.99	-.56	-5.19	
				(.2260)	(.22)		(.19)	(.70)	(.24)	(.38)	
(8.36-O)	.978	1.06	335.58		-.45		-.027	2.24		-5.49	
					(.16)		(.137)	(.62)		(.37)	
(8.36-L)	.985	1.34	2.18		-.199		-.0011	.49		-.00800	
					(.051)		(.0350)	(.19)		(.00054)	
(8.37-O)	.973	.78	339.78	-.33		-.0079		2.10		-5.59	
				(.20)		(.1670)		(.85)		(.43)	
(8.37-L)	.979	1.83	2.21	-.157		.012		.42		-.00820	
				(.066)		(.043)		(.26)		(.00065)	
(8.38-O)	.978	1.06	337.56		-.46			2.21		-5.50	
					(.15)			(.59)		(.37)	
(8.38-L)	.985	1.34	2.18		-.200			.49		-.00800	
					(.046)			(.18)		(.0053)	
(8.39-O)	.982	1.56	196.42		-.056					-1.88	.56
					(.097)					(.61)	(.12)
(8.39-L)	.987	1.75	1.66		-.072					-.00390	.44
					(.033)					(.00086)	(.11)

*Sources and composition of the dependent variable Q_H and of the indicated independent variables are discussed in the text.

† Equations designated O are estimated linear in original values, those specified L are estimated linear in logarithms. The time variable T is untransformed in the L equations. The annual percent shift in demand through time in the L equations is computed from the coefficient c of T as: 100(antilog c - 1).

‡ The Durbin-Watson autocorrelation statistic d.

terms, and observations are expressed both in original values and in logarithms. (See Table 8.7 for indication of each.) In the interdependent system, the market for hired farm labor is estimated jointly with demand and supply functions for other inputs and farm output. The number of hired workers in the single-demand equations is specified as a function of the wage of hired labor, prices received by farmers for operating inputs and machinery, the stock of all productive assets, a variable representing government policies and slowly changing influences represented by a time variable. These variables are defined explicitly as follows:

Q_{Ht} = the number of hired workers employed in agriculture during the current year, measured in 10 thousands.

$(P_H/P_R)_t$ = the current year index of the ratio of the farm wage rate to prices received by farmers for feed and livestock, expressed as a percent of the 1947-49 average. In addition, the past year ratio is also included.

$(P_H/P_P')_t$ = the current year index of the ratio of the farm wage rate to prices paid by farmers for operating inputs and machinery, expressed as a percent of the 1947-49 average. The past year ratio is also specified.

S_{pt} = the total stock of productive farm assets on January 1 of the current calendar year. The variable is in billions of 1947-49 dollars.

G_t = an index of government agricultural policies.

T = time, an index composed of the last two digits of the current year.

All variables are national aggregates for the calendar year from 1926 to 1959, excluding 1942 to 1945. A t is added to the subscript to note the current year observation, and t-1 is added to note a one-year lag of the same variable.

The Least-Squares Demand Equations

The coefficient of $(P_H/P_R)_{t-1}$ is the only significant coefficient of the three price variables in equation (8.35), Table 8.7. The coefficient of the government program variable is negative and statistically significant in the equation where it occurs. This result is consistent with the hypothesis that government programs have served unimportantly as an obstacle to farm labor mobility. No strong inferences can be made about this relationship, however, because of the crude formulation of the variable. The variable is not included in subsequent equations.

Equations (8.36) and (8.37) are included to evaluate the role of current and past prices in the hired-labor demand function. The magnitude and significance of the coefficients of lagged price tend to be greater than of current price. If the price of operating inputs and farm machinery influences the demand for hired labor, it is not apparent because of the nonsignificant coefficients for P_H/P'_P in equations (8.35), (8.36) and (8.37). Sound a priori basis exists for supposing these variables to be important in explaining demand for labor. Some possible reasons why their coefficients are not significant include: (a) the variables may have an important influence, but only in the long run; (b) the level of aggregation is too great, the individual effects offsetting each other and leaving the coefficient not significantly different from zero; (c) the correlation between P_H/P'_P and P_H/P_R is high ($r = 0.88$) and causes the former variable to be overshadowed; and (d) the short-run influence of machinery and operating inputs on demand for hired labor largely arises from technological and other nonprice influences.

Since the price of related inputs is not significant, an attempt is made to let this resource category have an influence on labor demand. The expected effect is allowed by including the predetermined stock of related inputs in the demand function. This is a principal reason for including S_p in the demand function. The coefficient of S_p is positive and significant in the demand equations. The coefficient of S_p in the logarithm equations L indicates that a 1 percent increase in the stock of productive assets increases the demand for hired labor .5 percent. The sign of the coefficient likely is consistent with the short-run influence of investment in machinery and other stock on labor demand: an increase in the stock of machinery might raise the marginal product of labor. A stronger hypothesis for the long run, however, is that machinery and other assets substitute for labor, with a negative coefficient expected.

The coefficients of the three explanatory variables $(P_H/P_R)_{t-1}$, S_p and T are highly significant in equation (8.38). Together the variables explain 98 percent of the variance in the number of hired laborers over the period. The slightly higher R^2 and the smaller degree of autocorrelation in the residuals indicated by $d = 1.34$ in equation (8.38-L) suggest a small advantage of the logarithm form for expressing hired labor demand.

The distributed lag or adjustment model (not presented), formed by including a lagged employment variable in equation (8.39), had a coefficient for Q_{Ht-1} which is not significant when S_p, the asset stock, is included. This condition would suggest that there is no long-run adjustment given the size of the agricultural plant (stock of productive assets). The stock variable is omitted in equation (8.39), and the coefficient of lagged employment then is significant. The significant coefficient indicates an adjustment coefficient of approximately .5. The coefficients of price and time are lower in adjustment equation (8.39) than in the conventional equation (8.38). It is difficult to ascertain the structural validity of adjustment equation (8.39), but its high R^2 indicates that it might have somewhat greater short-run predictive value than the other equations presented in Table 8.7.

Demand for Hired Labor Estimated by Limited Information

Numerous bases exist for supposing that the interdependence between supply and demand may be stronger for hired farm labor than for any other major agricultural input. The assumption of the simultaneous-equation model for hired labor is that current agricultural employment and wage rates are determined simultaneously by farm variables, as well as by nonfarm variables including factory wages and unemployment. Hence, a limited information model has been estimated from variables specified for the single-equation plus a farm numbers variable, N. Prices are deflated by the implicit price deflator of the Gross National Product. The limited information simultaneous-equation demand relationship estimated with annual data from 1926 to 1959, excluding 1942 to 1945, is:

$$(8.40) \quad Q_{Ht} = 1566 - \underset{[1.69]}{4.30P_{Ot}} + \underset{[.81]}{2.06P_{Mt}} - \underset{[-.46]}{1.55P_{Ht}} + \underset{[.68]}{2.28P_{Rt}}$$

$$- \underset{[-2.12]}{9.16N} - \underset{[-.15]}{.44(P_H/P_R)_{t-1}} - \underset{[-.14]}{.38S_{pt}} - 1.18T$$

where P_O is the price of operating inputs, P_M is the price of farm machinery, P_H is the current hired wage rate and P_R is the current index of prices received for feed and livestock. Standard errors were not estimated; elasticities are included in brackets below the coefficients. The last three variables in (8.40) are predetermined, the remainder being endogenous. The signs of the coefficients in the equation again would indicate that operating inputs (through the price variable P_{Ot}) are complements but that machinery inputs are substitutes for hired labor in the market. Based on equation (8.40) and inputs at the mean of the period, a 1 percent fall in the price of machinery is predicted to be associated with a .8 percent decrease in demand quantity of hired labor. The negative coefficient of N indicates that a decrease in the number of farms (expansion in farm size) is associated with an increasing demand for hired labor. It is reasonable that as farms expand in size, family labor must be supplemented with hired labor.

The coefficients of P_H and P_R possess the expected signs, but the magnitudes of the coefficients and dominance of current variables conflict with the single-equation estimates. The least-squares estimates appear to be more reasonable, however. The results in equation (8.40) conform with those of other limited information estimates of input demand in this study; namely, the magnitudes of the coefficients appear unusually large. The cause is difficult to pinpoint, but may arise from multicollinearity and underidentification. Because the signs of the coefficients generally are consistent with logic and because there is no exact test of the structural reliability of equation (8.40), it is considered to be one of the more logical estimates of the demand function for hired labor. However, structural inferences in the following pages are based primarily on single-equation results because of inability to estimate the structural reliability of equation (8.40).

Price Elasticity of Demand

The demand elasticities estimated from the single equations in Table 8.7 are relevant only for "average" national employment conditions from 1926 to 1959. The heroic assumption of the single equations in Table 8.7, as well as in Table 8.4, is that a shift in the farm wage or price variable will shift the demand quantity, irrespective of the level of unemployment in the nonfarm sector. The estimated coefficients actually would be much lower for periods of high unemployment, as suggested later by the demand functions for family labor.

The logarithm equations displayed some slight advantages for expressing demand for hired labor. Hence, the elasticity estimates are based on equations (8.38-L) and (8.39-L). Equation (8.38-L) indicates that the "point estimate" and 95 percent confidence interval of the demand elasticity with respect to P_H or - P_R is -.20 ±.095. The adjustment equation (8.39) estimates the short-run demand elasticity with respect to P_H or - P_R to be -.072 ± .068. The long-run elasticity, found by dividing the short-run elasticity by the adjustment coefficient .56, is estimated to be -.14. Approximately 90 percent of the long-run adjustment is predicted to be completed in five years. These findings generally are consistent with results from equations fitted to 1929-57 data and with specification in Tables 8.4 and 8.5. The combined results from equations (8.14), (8.15), (8.16) and (8.38-L) and (8.39-L) suggest that the short-run elasticity of hired-labor demand with respect to P_H or - P_R approximately is -.2 in the short run and is no more than -.4 in the long run. The results indicate that a 10 percent drop in farm product prices (or 10 percent increase in farm wage rates) would decrease the number of hired farm laborers by 2 percent in one or two years and by 4 percent in approximately five years. These results are most applicable during periods of "average" national unemployment. The elasticity of demand for labor is nearly zero when national unemployment is high and may be considerably greater than the above estimates when national unemployment is low. Equations fitted to 1940-57 data and presented in Table 8.4 indicate that the short-run elasticity of labor demand with respect to farm wages may be as high as -.5. Some possible reasons for the high estimate are: (a) inclusion of data for the war years when the draft of workers from agriculture correlated with increasing wage rates, (b) estimation of the demand function from a period with an unusually high rate of national employment, and (c) a secular increase over time in the labor demand elasticity. The responsiveness of laborers to a change in wages may be rising because of increased education and skills, improved communications and transportation and because of other factors influencing mobility. The elasticity of labor demand may be increasing since a given change in the absolute number of workers causes a greater percentage change in employment because the base or total number of hired laborers in farming is less. But while the elasticity of labor demand appears to be increasing over time, it evidently remains highly inelastic.

EMPIRICAL ESTIMATE OF NATIONAL SUPPLY FUNCTIONS FOR HIRED FARM LABOR

Nonfarm variables such as national unemployment influence employment and wage rates in agriculture. The influence of these and other variables on the labor structure in agriculture is analyzed in the following supply functions for hired labor estimated by limited information and Theil-Basmann methods.

The Limited Information Supply Equation

The supply equation for hired farm labor estimated by limited information with annual time series from 1926 to 1959, excluding 1942 to 1945, is:

$$(8.41) \qquad P_{Ht} = -36 + \underset{(.056)}{.183Q_{Ht}} + \underset{(.10)}{.43P_{Nt}} + \underset{(.051)}{.147P'_{Nt-1}} + \underset{(.056)}{.374C}$$

where C is a shift variable with values of zero from 1926 to 1941, and values of 100 from 1946 to 1959, P_N is the wage rate of factory workers and P'_N is $P_N(1 - 5U)$ where U, as explained earlier, is the proportion of the national labor force unemployed. P_H and Q_H are endogenous in the equation, and the limited information estimate is independent of the direction of normalization. (Price or quantity can be to the left of the equal sign and the computed supply elasticity is the same.) The price variables are deflated by the implicit price deflator of the Gross National Product. Standard errors, indicated in parentheses below the coefficients, are less than one-half the coefficients. All coefficients display signs expected from theory. The elasticity of supply of hired farm labor with respect to the own-price, computed from equation (8.41), is 1.63.

The result from equation (8.41) indicates that a sustained 1 percent rise in P_N tends, as an average of the period, to increase P_H by approximately .62 percent when U is at the 1926-59 average level. The coefficient of C would indicate that there has been a significant upward shift in supply during the postwar period.

A Just-Identified (Reduced-Form) Supply Function for Hired Labor

A two-equation just-identified system of equations also was utilized to estimate a supply function for hired labor for the period 1929-57 and, in variables specified, parallels regression equations in Table 8.5. The just-identified demand function of this system for hired labor was presented as equation (8.14) of Table 8.4. The corresponding supply function of the system is equation (8.42) where the coefficient of adjustment is .1855:[29]

$$(8.42)\quad Q'_{Ht} = 22.869 + .8145Q'_{Ht-1} + .1757P_{Ht} - .3654T - .1036P'_{Nt}.$$

The composite nonfarm wage variable, P'_N, was described previously where P_N is the average hourly earnings of the factory workers, and U is the percentage total unemployment. As mentioned above, this model supposes that when unemployment rises to 20 percent, the nonfarm wage rate has zero effect in pulling labor from farms. The standard errors of the regression coefficients were not estimated because the Theil-Basmann estimates presented elsewhere contain standard errors and because of the added cost of computing them.

The signs of the regression coefficients appeared to be consistent with theory and the hypotheses underlying the estimates. The elasticity of supply quantity with respect to the farm wage rate is estimated to be low, .13, in the short run. It is estimated to be .71 in the long run, a magnitude lower than that for equation (8.41). In the past, as the farm wage rate has increased by 10 percent, ceteris paribus, there has been a corresponding rise of 1.3 percent in the supply of hired labor in the short-run period and 7.1 percent in the long-run period. On the basis of this function, the long-run elasticity is predicted to be more than five times the short-run elasticity.

The cross elasticity of supply quantity with respect to the nonfarm wage-rate variable is predicted to be -.06 in the short run and -.31 in the long run. Based on equation (8.42), an increase of 10 percent in the nonfarm wage-rate variable has been accompanied by a decrease in the supply of hired labor of .6 percent in the short run and 3.1 percent in the long run. Again, from this equation, the long-run elasticity is predicted to be more than five times the short-run elasticity.

A Supply Function for Hired Labor Estimated by Autoregressive Least Squares From a System of Equations

A two-equation system also was used in estimating a supply function for hired labor by autoregressive least-squares methods for the period 1929-57. The variables included in the system of equations are the same as those used in the just-identified system of Table 8.4, except that the nonfarm variable was lagged 1 year for the former. The demand function estimated from this equation system was presented in Table 8.4 as equation (8.15).

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[29] The variable, P_{Ht}, is deflated by the index of prices paid by farmers for living expenses.

When the estimation of the supply function for hired labor was initially attempted using the autoregressive system, difficulty was encountered in the iteration procedure. All of the coefficients of the supply function increased in absolute value with successive iterations, rather than following a converging sequence. The source of difficulty evidently was the failure of the demand shifter — the prices received variable — to provide sufficient identification of the supply function.[30] Hence, use of another demand shifter was deemed necessary to derive a satisfactory supply function for hired labor. The system of equations was enlarged by the addition of another demand shifter — the value of farm machinery and equipment — lagged 1 year. With the inclusion of this variable in the system, a supply function for hired labor was identified and is presented as equation (8.43), where standard errors are included in parentheses:

$$Q'_{Ht} = \underset{}{140.95} + \underset{(.357)}{.4862Q'_{Ht-1}} + \underset{(.237)}{.1667P_{Ht}} - \underset{(.574)}{.8548T} - \underset{(.095)}{.1411P'_{Nt-1}}. \tag{8.43}$$

The value of R^2 for this equation is .974, while the adjustment coefficient is .51. The signs of the regression coefficients are consistent with theory and expected effect of variables. The coefficients of the wage rate, P_{Ht}, and the composite nonfarm wage rate and employment variable, P'_N, are of magnitudes somewhat similar to those in equation (8.42). The coefficient of the farm wage-rate variable is smaller than the corresponding standard error. The remaining coefficients are significant at the 80 percent level. Autoregressive least-squares equations were used, and the estimate of B, the autoregressive coefficient, is .5155. The standard error of B is .3305, and B is significant at the 80 percent level.[31]

From equation (8.43) the corresponding elasticity of supply quantity with respect to the farm wage rate is still estimated to be low, at .13 in the short run. It is estimated at .24 in the long run. The supply response (elasticity) to an increase in the farm wage rate is estimated to be twice as great in the long run as in the short run, if we accepted the regression coefficients of equation (8.43), which are small relative to their standard errors.

The supply elasticity of the composite nonfarm wage-rate and employment variable, $P_N(1 - 5U)$, is estimated to be -.078 in the short run and -.15 in the long run, magnitudes much lower than for equation (8.41). Again, however, the regression coefficient is significant only at an 80 percent level of probability.

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[30] An equation specified like the supply function in equation (8.42) is insufficiently identified when the autoregressive assumption is applied.

[31] See equation (8.1).

In general, the signs of the coefficients in the supply functions for hired labor are consistent with theory and expected "real world" effects of relevant variables. Although emphasis in this chapter was on labor demand, it is hoped that the supply equations provide information useful in analysis of hired labor employed in agriculture. Because of the relatively large standard errors and inconsistencies among supply models in magnitudes of coefficients and elasticities, the results are regarded as tentative. Additional work is needed.

GENERAL IMPLICATIONS

Our analysis of demand for hired labor in agriculture indicates that its elasticity has been extremely low in the short run. The elasticity with respect to the hired-labor wage rate is much larger in the long run, however. This result is consistent with actual observations of the structure of the farm organization. Farms have a stock of machinery, buildings and other capital items with which they operate. A rise or decline in the farm wage rate relative to product price, or the prices of other factors, does not allow an immediate change in the fixed organization of the plant. Where machinery is substituted for labor, time is required either to depreciate out machines on hand, or to allow time for decision and acquiring capital for new machine purchases. Too, machinery substituted for labor often has capacity beyond that of the farm's original acreage. Hence, decisions to lessen labor input, through substitution of machinery, also may await the farm operator's ability to buy or rent additional land. Furthermore, adjustment to a higher relative farm wage rate and use of less hired labor may require reorganization of farming systems. Enterprises with lower labor requirements may be substituted for those on hand, but only after enough time has elapsed to allow for the necessary farm reorganization. Major farm reorganization requires time for the manager to acquire additional information and, in some cases, new buildings. Within a year, of course, some labor is under contract, and crop production has already been initiated. Short-run response is necessarily small under these conditions.

Our analysis leads us to believe that the demand elasticity for hired labor in respect to its own price has been increasing with time. Some of the reasons for the increased elasticity such as improved education and communication were discussed earlier. Another reason arises from the interrelationship of hired and family markets in agriculture. While it is not analyzed in the models of this study, changes in the supply elasticity of family labor are inseparable from changes in the demand elasticity for hired labor. The reason revolves around the element of long-run adjustment mentioned above; namely, substituting machinery for hired labor, in response to increasing wage rates. Where the machinery is costly and can be best added if the operator has a larger acreage, a more complete adjustment must await abandonment of farming by other farm families. Hence, to the extent that the mobility of family labor (the elasticity of family labor numbers with respect to the relative earnings in agriculture) is increasing over the long run, we would expect that the elasticity of demand for hired labor similarly would increase in the long run.

We believe the estimates of supply elasticity for hired labor are "less firm" than those of demand for this resource. With some greater degree of uncertainty granted, the estimates generally suggest a much higher supply elasticity in the long run than in the short run. Too, they suggest that the supply elasticity is increasing with time. The estimates on supply indicate an important link between the supply of hired labor to agriculture and the rate of unemployment in the national economy. Again, a smaller short-run elasticity is indicated.

Given the direction of relative factor prices and of technology under economic development, a further decline in the hired-labor work force in agriculture is predicted. The rate of decline may remain relatively close to the average compound rate of 1.75 percent per year over the period 1926-59. An increase in farm size tends to increase the demand for hired labor, partly as a substitute for family labor, but a rise in hired wage rates relative to machinery and product prices decreases the demand for hired labor. The relative price of hired labor is expected to increase, along with a higher nonfarm wage rate under further national economic development and perhaps some further increase in the supply elasticity of hired labor to agriculture. The demand for hired labor also will depend on the extent of new technologies which increase the marginal rate of substitution of capital for labor. This has been an extremely important force, probably dominating the relative increase in price of hired labor — although both are theoretically important as outlined in Chapter 3. The relative price of farm labor, P_H/P_R, increased 43 percent in the 33 years 1926-59. Using equation (8.38-L), we would predict, as an example, that 10 percent of the decline in hired workers during this period resulted from the increase in the relative wage rate. After allowing for errors in measurement, specification biases and failure to include other relevant prices, and adjustment for unemployment in the national economy, a large proportion of the total decrease in hired-labor employment remains to be explained by variables other than short-run relative prices in hired labor. The statistics for time in equation (8.38-L) suggest that hired-labor employment declined 1.8 percent per year, due alone to the technological and other forces which are aggregated under the time variable.

Not only is technology expressed in the time variable, but also other institutional and "over-all social capital" variables are related to time. A greater amount of education to a larger proportion of the farm population, employment services, much greater communication through improved transportation, radio and television and similar developments affect both the supply and demand for labor in agriculture. We should expect the effect of these forces to increase with time and the response of labor in agriculture to be more closely interrelated with nonfarm income or wage levels. Need exists to extend the public investment in education and employment services for the hired-labor force, to allow it to be better skilled and to allow more flexibility and opportunity to take advantage of favorable nonfarm employment opportunities. The above equations indicate that an increase in the supply price of hired labor would lower the demand quantity for it. But in so doing, the marginal productivity of hired labor should increase and its return in agriculture should be brought much closer to the nonfarm level of real wage return.