

An Analysis of Labor Demand and Supply in the Sugarcane Industry of Puerto Rico

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INTRODUCTION

In the last 15 years, labor availability in the agricultural sector of the sugarcane industry has gone down steadily from 109,000 field workers in 1950-51 to 45,000 in 1965-66 (1).² During the same period the average daily wage paid to hired farm labor increased from \$2.96 to \$4.86. Wage increases, however, were not sufficient to suppress migration of the most productive age groups from the industry. On the surface, this might reflect a strong negative attitude by members of the labor force to employment in the sugarcane plantations. However, during the above 15-year period, the total area of sugarcane grown in Puerto Rico fell from 423,123 to 306,900 acres (3).

The extent to which labor productivity in some phases of the production process has increased, due to technological innovations in the sugarcane industry, is also a relevant factor to consider for a more comprehensive analysis of the labor problem. Since the labor situation experienced a structural transformation over time, careful attention must be given to estimating the parameters of labor supply and demand in this sector of the sugarcane industry.

PROCEDURE

Multiple regression analysis was used to estimate the structural relations of labor demand and supply. For this study a linear regression model has been used because of its suitability and convenience. The analysis is based on time-series data for the period covering 1950-51 to 1965-66.

FARM-DEMAND FUNCTION

The following analysis is based on the assumption that farm labor demand is a function of: 1, Annual acreage of sugarcane grown, 2, labor productivity per man-day, and 3, average wage paid for hired farm labor.

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² *Italic numbers in parentheses refer to Literature Cited, p. 32.*

The following regression model was used to estimate the farm labor demand:

$$Y_1 = a_1 + b_1X_1 + b_2X_2 + b_3X_3$$

where

Y_1 = Demand for labor in units of man-days

X_1 = Number of acres of sugarcane grown

X_2 = Tons of sugarcane produced per man-day

X_3 = Average daily wage paid for hired farm labor

The analysis indicated that about 89 percent of the observed variation ($R^2 = 0.8908$) in the dependent variable was accounted for by the combined effects of the three independent variables listed above. In other words, the explained variation in farm labor requirement is appreciable and within the realm of logical expectations. The coefficient of multiple correlation ($R = 0.944$) is significant at the 1-percent level of probability.

Farm-labor demand is directly associated with acreages of sugarcane grown, but inversely related to labor productivity and to the average wage paid for hired farm labor.

The equation for the postulated functional relationship is:

$$Y_1 = 22,290,000 + 16.23X_1 - 9,028,000X_2 - 1,809,500X_3$$

The regression coefficients in the response function show the aggregate change in man-days requirements for hired farm labor at various levels of the explanatory variables. For instance, the regression coefficient for acreages of sugarcane grown is 16.23. This means that an increase of 1 acre of sugarcane land is associated with an increase in demand of 16.23 man-days of farm hired labor.

The coefficient for labor productivity is $-9,028,000$. Hence, an increase in labor productivity of 0.10 ton of cane per man-day tends to reduce the demand for farm hired labor by 902,800 man-days. There is also a negative relationship between labor demand and the average wage paid for hired farm labor. An increase of \$1 in average daily wage is associated with a decreased demand of 1,809,500 man-days.

The simple relationship between each of the independent variables in the equation and farm-labor requirements was also estimated by individual correlation analyses. Each of them is individually correlated with farm-labor requirements at the 0.01 level.

The three correlation coefficients are: $r_{X_1Y_1} = 0.8955^{**}$, $r_{X_2Y_1} = 0.9106^{**}$, $r_{X_3Y_1} = 0.9085^{**}$.

FARM SUPPLY FUNCTION

The extent to which labor availability will continue to change in the agricultural sector of the sugarcane industry will depend upon a combina-

tion of factors. In this study, it is postulated that farm-labor availability depends on the average wage paid for hired farm labor, population growth, and period of time. Hence, the farm-labor supply equation is expressed as a function of: 1, The average wage paid for farm hired labor, 2, change in population, and 3, period of time.

As in the case of the demand function, a linear regression equation of the following form has been used:

$$Y_2 = a_2 + b_4X_4 + b_5X_5 + b_6X_6$$

where

Y_2 = Labor availability at the farm level measured in man-days

X_4 = Average daily wage paid for hired farm labor

X_5 = An index of population change

X_6 = Period of time (1950-51 to 1965-66)

The results obtained in this analysis indicate that approximately 96 percent of the variation ($R^2 = 0.9596$) of the quantity of annual labor availability for the farm sector in the sugarcane industry is explained by these three independent variables: 1, Average wage paid for hired farm labor, X_4 ; 2, change in population, X_5 ; and 3, period of time X_6 . The multiple correlation coefficient ($R = 0.9796$) is appreciable and highly significant.

The estimated response function is:

$$Y_2 = -9,522,000 + 845,000X_4 + 367,000X_5 - 1,607,000X_6$$

It may be observed that farm-labor availability is directly associated with average wage paid for farm hired labor and with population growth, but inversely related to time. Both factors, population growth and high wage for hired farm labor, tend to increase labor availability in the agricultural sector of the sugarcane industry, but, in the long run, changing conditions related to time cause the opposite.

For instance, an increase of \$1 in average daily wage for farm labor and one unit change in the index of population are associated, respectively, with an increase of 845,000 and 367,000 man-days in the quantity of labor availability. But, over time, the quantity of labor available in this sector of the sugarcane industry is associated with a reduction of 1,607,000 man-days.

Individual correlations between the three independent variables in the equation and farm-labor supply were computed. Each of them is individually correlated with labor supply and significant at the 0.01 level. The three individual correlation coefficients are $r_{Y_2X_4} = 0.9033^{**}$; $r_{Y_2X_5} = 0.8178^{**}$, and $r_{Y_2X_6} = 0.9623^{**}$.

SUMMARY

Farm-labor demand and supply relations were estimated for the agricultural sector of the sugarcane industry. The analysis is based on time-series data for the period covering 1950-51 to 1965-66. A linear regression model was used because of its suitability and convenience.

The results indicated that about 89 percent of the variation ($R^2 = 0.8908$) of farm-labor requirements could be accounted for by the combined effects of: 1, Annual acreages of sugarcane grown; 2, labor productivity per man-day; and 3, average wage for hired farm-labor. The equation for the postulated functional relationship indicates that an increase of 1 acre of sugarcane land is associated with an increase in demand of 16.23 man-days of farm hired labor. In the opposite direction, an increase in labor productivity of 0.10 of cane per man-day and \$1 in average daily wage tend to reduce farm labor demand by 902,800 man-days and 1,809,500 man-days, respectively.

On the other hand, it was postulated that the quantity of labor available to the agricultural sector of the sugarcane industry is a function of: 1, Average daily wage paid for hired farm labor; 2, population change; and 3, period of time. The estimated response function strongly supported this postulation. About 96 percent of the variation ($R^2 = 0.9596$) in labor availability in the agricultural sector of the sugarcane industry is explained by these three variables.

Both factors, population growth and higher wages for hired farm labor, tend to increase labor availability in the agricultural sector of the sugarcane industry, but in the long run, changing conditions related to time cause the opposite. For instance, an increase of \$1 in average daily wage for farm labor and one unit change in the index of population are associated, respectively, with an increase of 854,000 and 367,000 man-days in the quantity of labor available. But, over time, labor availability in this sector of the sugarcane industry is associated with a reduction of 1,607,000 man-days according to the estimated response function.

RESUMEN

Las relaciones en la estructura de la demanda y la oferta de trabajo se estimaron en la fase agrícola de la industria azucarera. El análisis se basó en series cronológicas que cubrían el periodo comprendido entre 1950-51 y 1965-66. Para calcular los parámetros en dichas estructuras se utilizó un modelo de regresión múltiple lineal, ya que los datos se ajustaban bastante bien a esta forma de ecuación.

La demanda de trabajo en ese sector de la industria se expresa como una función de: 1, El área total de caña bajo cultivo, 2, productividad hombre-día por tonelada de caña, y 3, jornal promedio que se paga anualmente en esta empresa. El coeficiente de determinación explica el 89 por ciento de la

variación ($R^2 = 0.8908$) anual en la demanda de trabajo. Según la ecuación obtenida, un acre de caña está directamente asociada con 16.23 hombres-días en la demanda de trabajo. En dirección contraria, un aumento de una 0.10 toneladas de caña en la productividad hombre-día y de un dólar en el jornal promedio que se paga por el trabajo agrícola, tienden a reducir la demanda de trabajo en 902,800 hombres-días y 1,809,500 hombres-días, respectivamente.

Por otro lado, la oferta de trabajo en ese mismo sector de la industria se expresa como una función de: 1, El jornal promedio que se paga anualmente por trabajo agrícola, 2, cambios en la población, y 3, el periodo de tiempo. Estos tres factores explican alrededor del 96 por ciento de la variación ($R^2 = 0.956$) anual en la oferta de trabajo. La ecuación de regresión indica que, un aumento de un dólar en el jornal promedio que se paga por trabajo agrícola y de una unidad de cambio en el índice de población, están asociados con un incremento de 845,000 hombres-días y de 367,000 hombres-días, respectivamente, en los recursos humanos disponibles en esa fase de la industria. Pero, por cada año que transcurre la cantidad de trabajo humano disponible está asociada con una reducción de 1,607,000 hombres-días.

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