THE AVERAGE AND MARGINAL PRODUCT OF FARM LABOR IN UNDERDEVELOPED AREAS:

the Case of the North-Central Region of Turkey

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It has been frequently argued that the marginal productivity of farm labor is either zero or negative in many underdeveloped areas. Although many theoretical attempts have been made to prove or disprove the possibility of the existence of such a condition (see, e.g., Lewis, 1954; Leibenstein, 1957; and, Rottenberg, 1956), only a relatively few empirical investigations of its existence have been undertaken. Generally, these empirical investigations have used indirect methods, such as deriving agricultural production functions from farm labor samples (see, e.g., Mellor and Stevens, 1956; and, Paglin, 1965), or comparing the total labor supply to the labor required to produce a given amount of agricultural output (see, e.g., Rosenstein-Rodan, 1957; and, Cho, 1963).

In this paper, we attempt an empirical test which involves the derivation of average and marginal product functions of farm labor in the North-Central region of Turkey by techniques that differ from others, e.g., Mellor and Stevens (1956: 784-788). Since appropriate data for early 1970's were not available, we have used the 1965 census year figures.

I. Methodology

The production capital employed in the region consists mainly of plowing animals, wooden or iron plows, and an insignificant number of tractors (Turkish State Institute of Statistics -TSIS-, 1966: 18). The use of chemical fertilizers, pesticites, and purchased seed is limited (Özfırat, et. al, 1970: 66). We will assume that the small capital input of the region is both thinly and evenly distributed over the land input(1). This assumption enables us to stress the relati-

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(1) Since an accurate measurement of the region's capital input would be extremely difficult, if at all possible, we decided to employ this assumption rather than attempting an investigation based on unreliable capital figures. Nevert heless, available statistics suggest that the distribution of capital among the provinces of the region may not be perfectly even (see: TSIS, 1944-1965: 18).

onship between output and two other major inputs, land and labor.

The average and the marginal productivities of labor can be estimated from data for a sample. Such an estimate indicates the functional relationship between output and labor, assuming no variations either in the level of technology or the number of units of land area cultivated.

The customary approach is to take the farms of a given geographical area as sampling units. In this approach, however, the assumption of the even distribution of capital on land is implausible, even though it has been implicitly and erroneously employed in some studies (see, e.g., Mellor and Stevens, 1956; and, Paglin, 1965). The implausibility of such an assumption is due to the probability that the capital intensity of production is likely to vary with variations in the size of the farms in a given geographical area. Our approach is to use a sample that consists of the provinces of an agricultural region. The same hazard might exist in our approach as in that of others if, for example, a given province consisted only of small farms and another province only of relatively larger ones. However, in general, this would be an unlikely situation at the provincial level in the same agricultural region(2).

While the area cultivated figure for the sample did not prove a problem, we did encounter some difficulty in reaching a meaningful agricultural labor force figure. The economically active agricultural population figure for 1965, and it includes all persons fifteen years of age or older, was available (TSIS, 1969 a: 570-572). However, these statistics considered all women residing with a farmer family head as economically active in agriculture whether or not they were actually directly engaged in agricultural activity. According to a Turkish study, only about 50 per cent of the female economically active farm population is actually engaged in agricultural activity (Türkay, 1968; 81-84). We decided to use this percentage in our estimation of the female agricultural labor force. Furthermore, another study of Turkish male and female productivity in harvesting found that the female harvest work was only two-thirds that of the male harvest work(3). Consequently, we elected to further adjust

(2) Available statistics suggest that there are some differences in the size distribution of agricultural holdings among the provinces of the North-Central region (see: Keten, 1971). Although this may somewhat weaken our assumption of 'even distribution of capital' in the region, the weakness would have been much more pronounced, had the sample used consisted of farms.

(3) The study by Christiansen-Weniger is mentioned in (Hirsch, 1960: 40).

the figure for the female agricultural labor force by the application of this two-thirds ratio.

Provincial output figures, by volume, and the cropped area figures were available for 1965 (TSıS, 1969 b: 33-99). The output figures were converted into value terms by multiplying them by Eskişehir-Commodity-Exchange prices (TSIS, 1969 c: 2-313). Finally, we calculated the workers per hectare and the output per worker. These figures are given in Tables 1 and 2, respectively.

TABLE : 1
WORKERS PER CROPPED HECTARE (1965)

Provinces	Cropped Area (hectares)[1]	Agricultural Labor Force	Workers Per Cropped Hectare
Ankara	968,268	104,942	.108
Kırşehir	228,714	25,177	.110
Eskişehir	289,045	43,331	.150
Yozgat	414,127	70,588	.170
Uşak	122,438	25,974	.212
Çankırı	171,678	39,371	.229
Çorum	332,693	76,362	.230
Bilecik	88,595	22,564	.255
Kütahya	225,236	61,523	.273
Bolu	169,118	58,860	.348

ı) 1 hectare = 2.47 acres.

TABLE : 2
OUTPUT PER WORKER (1965)

Provinces	Agricultural Labor Force	Value of Output (Turkish Liras)[1]	Output Per Worker
Ankara	104,942	1,222,643,139	11,651
Kırşehir	25,177	249,682,980	9,917
Eskişehir	43,331	345,634,016	7,977
Çorum	76,362	531,470,470	6,970
Yozgat	70,588	473,479,077	6,708
Uşak	25,974	135,754,838	5,226
Bilecik	22,564	110,843,748	4,912
Çankırı	39,371	173,142,322	4,398
Kütahya	61,523	246,098,451	4,000
Bolu	58,860	211,344,690	3,591

i) Official exchange rate between the U.S. dollar and the Turkish lira in 1965 was: $1 =9 T.L.

II. Estimate of the Average and Marginal Value Product of Labor from Cross-Sectional Data

In Figure 1, provincial output per worker figures are plotted against the corresponding values of workers per cultivated hectare. To find an estimated average value product (AVP) function for labor, a curvilinear least-squares function was fitted to the data. The regression yielded the equation below:

(1) $$AVP = -4{,}064.5 - 6{,}496.3 \log X$$

where AVP stands for output per worker. or average value product, and X stands for labor per hectare. The coefficient of correlation is .94, i.e., the variations in labor input per hectare explain 89 per cent of the variations in output per worker.

An estimated total value product (TVP) function can also be derived from the estimated AVP function by multiplying both sides of equation $\neq$1 by X. Thus:

(2) $$TVP = X\,(-4{,}064.5 - 6{,}496.3 \log X)$$

where TVP is output per hectare, or total value product.

Furthermore, by differentiating the TVP with respect to X, we can find an estimated marginal value product (MVP) function of labor :

(3) $$\frac{\delta\ (TVP)}{\delta X} = MVP = -4{,}064.5 - 6{,}496.3\ (1 + \log X)$$

The MVP function is also graphed on Figure 1.

Estimated AVP, TVP, and MVP of labor for the provinces of the region are shown in Table 3. The figures indicate that as the number of workers per hectare increases, the average productivity falls. The marginal productivity of labor is negative for some of the provinces in the region. In the region, as a whole, the MVP becomes zero at .196-workers-per-hectare level.

FIGURE I

AVERAGE AND MARGINAL PRODUCTIVITY
OF FARM LABOR (1965)

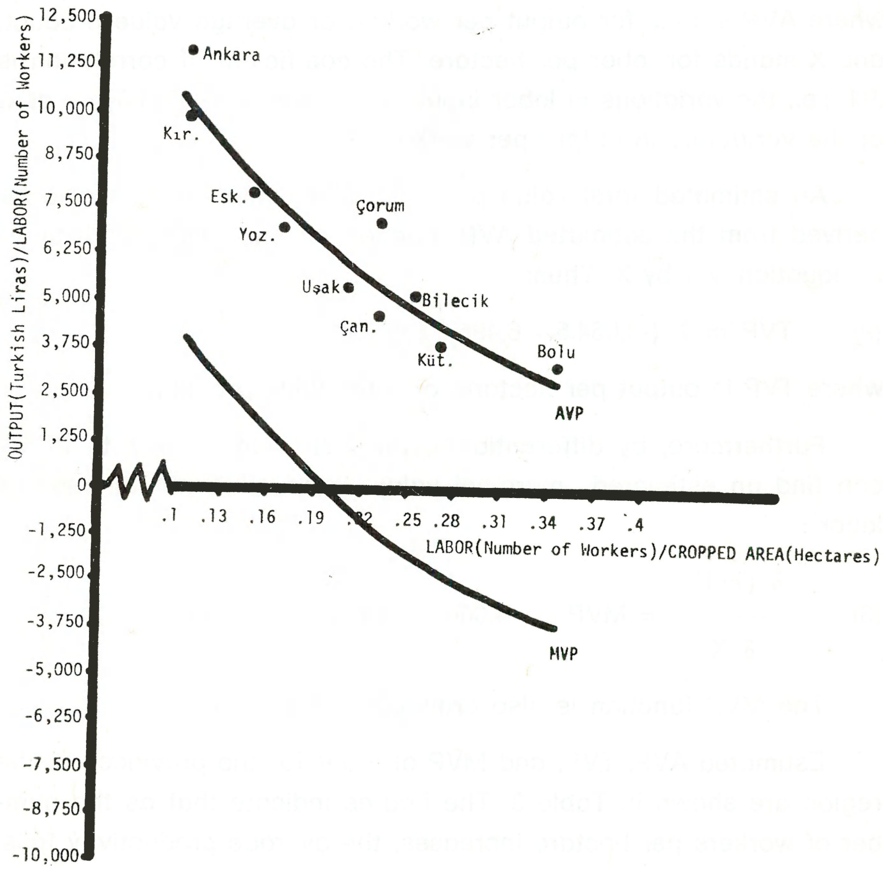

TABLE : 3

VALUES OF MARGINAL PRODUCT OF LABOR

Province	Labor Per Hectare	Estimated Output Per Worker (AVP)[i]	Estimated Output Per Hectare (TVP)[i]	Marginal Value Product[i]
Ankara	.108	10,393.7	1,122.5	3,897.4
Kırşehir	.110	10,274.8	1,130.2	3,778.5
Eskişehir	.150	8,259.6	1,238.9	1,763.3
Yozgat	.170	7,446.9	1,266.0	950.6
Uşak	.212	6,012.6	1,274.7	—483.7
Çankırı	.229	5,511.0	1,262.0	—985.3
Çorum	.230	5,483.1	1,261.1	—1,031.2
Bilecik	.255	4,812.7	1,227.2	—1,683.6
Kütahya	.273	4,369.6	1,192.9	—2,126.7
Bolu	.348	2,792.3	971.7	—3,704.0

i) In Turkish liras.

III. **Refined Cross-Sectional Findings**

Weather conditions can have an important influence on agricultural output, especially in countries with limited irrigation facilities. If we can determine whether 1965 was a good, bad, or normal crop year in the North-Central region, we can improve the findings of the cross-sectional analysis by taking into account the effect of weather on that year's agricultural output. For this purpose, we attempted to derive weather indexes for the 1957-1967 period.

A weather index attempts to measure the year-to-year variation in yield (output/land) due primarily to weather. A trend line is fitted to data to describe the yield effect due to changes in the volume of productive agents employed, and in technology. To measure the influence of weather, a weather index for each year is then derived by stating the actual yield of that year as a percentage of the computed trend (Shaw, 1964). The index number calculated for each year is the measure of the influence of weather on production for that year. For example, an index number of 110 shows that yields were 10 per cent higher than expected that year due to favorable weather. To adjust a given year's output for the influence of weather, it is divided by the weather index and multiplied by 100.

A United States Department of Agriculture study (1962) found moving-average trend lines to be quite suitable for the derivation of weather indexes. By fitting a 7-year moving-average trend line to the average yield data for the North-Central region for the 1957-1967 period, we calculated the weather index numbers presented in Table 4.

TABLE : 4

WEATHER INDEXES

Years	Weather Index
1957	97.606
1958	109.159
1959	103.623
1960	99.390
1961	94.537
1962	99.286
1963	103.731
1964	100.628
1965	94.511
1966	101.186
1967	98.876

The index number for the year 1965 is 94.511. It indicates that yields in 1965 were below normal due to weather. To adjust the provincial outputs of the year for the influence of weather, we divide them by 94.511 and multiply by 100. Thus, when adjustes in this manner, provincial outputs are actually increased by 5.8 per cent. Given the labor and land figures, when the provincial outputs are increased by 5.8 per cent, the AVP and MVP functions move upward. Their slopes remain the same. The new AVP function becames:

(4) $AVP = -3{,}828.8 - 6{,}496.3 \log X$

The new TVP and MVP functions respectively are:

(5) $TVP = (-3.828.8 - 6{,}496.3 \log X)$

and

(6) $MVP = 3{,}828.8 - 6{,}496.3 (1 + \log X)$

The refined AVP, TVP, and MVP estimates of the provinces are presented in Table 5.

TABLE : 5
MARGINAL PRODUCTIVITY OF LABOR

Province	Labor Per Hectare	Estimated Output Per Worker (AVP)[i]	Estimated Output Per Hectare (TVP)[i]	Marginal Value Product[i]
Ankara	.108	10,629.4	1,148.0	4,133.1
Kırşehir	.110	10,510.5	1,156.2	4,014.2
Eskişehir	.150	8,495.3	1,274.3	1,999 0
Yozgat	.170	7,682.6	1,306.0	1,186.3
Uşak	.212	6,248.3	1,324.6	—248.0
Çankırı	.229	5,746.7	1,316.0	—749.6
Çorum	.230	5,718.8	1,315.3	—777.5
Bilecik	.255	5,048.4	1,287.3	—1,447.9
Kütahya	.273	4,605.3	1,257.2	—1.891.0
Bolu	.348	3,028.0	1,053.7	—3,468.3

i) In Turkish liras.

IV. **Conclusions**

if the role of capital input is relatively insignificant in a given region's agricultural production and if the volume of capital used changes proportionally to changes in land cultivated, it may be possible to derive a simple cross-sectional production function for the region's agricultural labor by assuming capital input to be evenly distributed on land and by determining the functional relationship between labor and output, holding land constant. On the other hand, if the capital intensity of production is likely to differ among various size farms, then a sample consisting of farms would not be suitable for this purpose. Consequently, in this study, we have argued that a sample consisting of the provinces of an agricultural region can give more satisfactory results.

We also attempted to show that cross-sectional production functions can be improved through the use of time series data and weather indexes. No such improvement, of course, would be necessary if the year chosen for cross-sectional analysis happens to be a normal yield year.

Our findings in this study show the marginal productivity of farm labor to be negative in some of the provinces in the North-

Central region of Turkey(4). This fact can be attributed to the relatively large amount of labor, the relatively small amount of capital, and the relatively low level of technology in the region. The adoption of labor-using advanced technology, and the greater use of non-labor-saving production capital such as chemical fertilizers, pesticites, and purchased seed, etc., could raise marginal productivity of the farm labor by shifting the production function upward. Another solution might be the transfer of some farm labor to more productive employment in the secondary and tertiary sectors. However, since labor was used as a stock variable in our study, negative marginal productivity does not necessarily imply the presence of a permanently removable labor force. It is possible that all existing labor may be fully utilized at the peak season. Thus, though largely unemployed, its permanent withdrawal could reduce output.

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(4) However, because of the admitted weaknesses in our assumptions regarding the even distribution of capital on land and the size distribution of agricultural holdings among the provinces of the North-Central region (footnotes 1 and 2), the marginal productivity figures calculated in this study should be treated as tentative until accurate statistics on the capital input become available.

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ÖZET

EKONOMİK BAKIMDAN AZ GELİŞMİŞ ÜLKELERDE TARIMSAL İŞGÜCÜNÜN ORTALAMA VE MARJİNAL ÜRÜNÜ : Kuzey-Orta Anadolu Bölgesindeki Durum :

Ekonomik literatürde, az gelişmiş bölgelerde tarım işçilerinin marjinâl veriminin sıfıra eşit veya negatif olduğuna dair iddialara sık, sık raslanmaktadır. Durumun böyle olabileceğine dair pek çok teorik açıklamalar yapılmış olmasına rağmen, bu konudaki deneysel çalışmaların sayısı gayet azdır.

Bu araştırmada, Kuzey-Orta Anadolu bölgesinde bitkisel tarımla uğraşan işçilere ait ortalama, marjinâl ve toplam ürün fonksiyonları elde edilmeye çalışılmıştır. Kullanılan örnek, bölgedeki illerden oluşmaktadır. Çalışma 1965 yılı verileri kullanılarak yapılmıştır. Hava koşullarının etkisi dikkate alınarak hazırlanmış bir indeksle de düzeltildikten sonra, bölgenin tarımsal işgücü için elde edilen marjinal ürün fonksiyonu aşağıdaki gibidir:

$$MVP = -3.828,8 - 6.496,3 (1 + \log X)$$

Burada MVP, marjinal ürün değerini, X ise, hektar başına işgücünü göstermektedir.

Elde edilen rakamlar, bitkisel tarımla uğraşan işgücünün marjinal veriminin Ankara, Kırşehir, Eskişehir, gibi bazı illerde yüksek ve pozitif, Bilecik, Kütahya, ve Bolu, gibi illerde de negatif olduğunu ortaya koymaktadır.