MEASUREMENT OF PRODUCTION EFFICIENCY IN AGRICULTURE :

A Case Study of the Hazelnut Production in the Provinces of Ordu and Giresun - 1970

Halûk Kasnakoğlu*

In an article that has recently appeared in this journal, in addition to a brief review and a systematic comparison of the methodologies and the implications of various efficiency measures suggested in the literature, we have proposed an extended model for efficiency measurement (Kasnakoğlu, 1976). The purpose of this paper is to demonstrate how the proposed model can be applied in practice and to present an application of the model to the case of hazelnut production in the provinces of Ordu and Giresun[1].

THE DATA

The data employed in this study for efficiency estimations come basically form a survey conducted by the Turkish Ministry of Agriculture in 1970 on a sample of 300 hazelnut farmers[2]. The sample

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(*) Assistant Professor of Economics, Middle East Technical University, Ankara.
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(1) The two provinces account for more than 65 percent of the total hazelnut production in Turkey. More than 10 percent of the total population in Turkey and more than 75 percent of the population in the two provinces studied earn their living solely from hazelnut production. Hazelnut is the third largest export crop and constitutes close to one fifth of the total Turkish agricultural exports. Turkey is the largest exporter of hazelnuts in the world (with a 70 percent share) followed by Italy, Spain, Russia and the U.S.A. in that order. Hazelnut is basically an export crop with only 5 percent of the total production consumed in the country.

(2) However only 256 of the 300 sampled units are used in this study. The remaining are exluded due to missing relevant information or inconsistencies in the information given. See Kasnakoğlu (1975 : 65-66, 244-246) for details on the procedures used in handling missing and inconsistent data.

units were selected through stratified sampling. First, from each of the two provinces, Ordu and Giresun, three towns are selected which in the opinion of the agricultural experts best represented the characteristics of hazelnut production in the studied region. Second, from each of the six towns three villages are chosen at different altitudes (i.e. one from low, medium and high altitudes)[1]. Then, for each of the 18 villages lists of the farm families are prepared. From these lists 25 percent of the farms in each village are selected at random to be interviewed.[2] We have also made use of another survey conducted by FİSKO in 1974 in Ordu and Giresun on 54 hazelnut producers. This survey contained rather detailed and accurate information on the costs of plantation and land values which we used to estimate rents on land and hazelnut trees[3].

THE MODEL

The efficiencies of the hazelnut producers are first measured for the overall production and marketing processes. Then the overall production and marketing processes are divided into two partial production processes, namely cultivation and harvesting, and the efficiencies of the hazelnut producers are measured for the two partial production processes separetely.

A. Overall Production Process :

The overall production process involves the cultivation, harvest, maintenance and marketing activities of the hazelnut producers in a given year. The inputs of the overall production process are aggregated under four categories, namely, land, labor, capital expenditures, and hazelnut trees[4]. The output is the quantity of hazelnuts

(1) Low altitute : 0-250 m; Medium altitute : 251-500 m; High altitute : 501 m or more.

(2) In hazelnut production, most of the hazelnut producers own several pieces of land which are not necessarily concentrated in a given area. Therefore the survey was conducted only on one piece of the total land owned and operated. See Kasnakoğlu (1975 : 189-208) for the questionnaire used for this survey, together with some statistics on the characteristics of the sample and maps of the sampled regions.

(3) See Kasnakoğlu (1975 : 52, 199, 200, 209) for more detail on FİSKO survey.

(4) Whenever we refer to the number of hazelnut trees in this study we imply number of hills. A hill contains 5-8 trees in Turkey, as compared to 3-5 in Italy, and 1 in the U.S.A. Use of the number of hazelnut hills instead of the number of hazelnut trees (due to data limitations) is likely to bias our results to the extent variations in the number of hazelnut trees in hills among the hazelnut producers are substantial.

marketed. In the long-run all the inputs are assumed to be variable, whereas in the short-run land and hazelnut trees are assumed to be fixed. The actual observed production, cost and profit functions of the individual hazelnut producers can be written as :

(1) $Y_{oak} = f_{oak} (L_{oak}, T_{oak}, K_{oak}, O_{oak})$

(2) $C_{oak} = P_{olk} L_{oak} + P_{otk} T_{oak} + P_{okk} K_{oak} + P_{ook} O_{oak}$

(3) $\pi_{oak} = P_{oyk} Y_{oak} - C_{oak}$

where,

Y : Quantity of hazelnuts marketed (Kgs.),

L : Quantity of labor employed (Hours),

T : Size of land cultivated (Decars),

K : Value of capital expenditures (TL.),

O : Number of hazelnut trees,

C : Costs of production and marketing (TL.),

$P_{.L.}$: Unit wage of labor (TL/Hour),

$P_{.T.}$: Unit rent on land (TL/Decar),

$P_{.K.}$: Unit interest on capital expenditures (TL/TL.),

$P_{.O.}$: Unit rent on hazelnut trees (TL/Hill),

π : Profits (TL.),

$P_{.Y.}$: Weighted unit price of output (TL/Kg.),

f_{oak} : Observed production function of the k^{th} producer in the overall production process.

Subscript (o) denotes the overall production process,
» (a) » » actual or observed,
» (k) » » k^{th} producer, $k = 1, 2, ... 256$[1]

Efficiencies of the hazelnut producers are measured relative to a technologically efficient production function (f_{ot}). Therefore the first step to estimating the efficiencies is the specification and estimation of the efficient production function. The efficient production function for the overall production process is estimated by fitting a boundary function to the "potentially technologically efficient" observations. An observation (i.e., an observation on Y_{oai}, L_{oai}, K_{oai}, T_{oai}, O_{oai}) is said to be "potentially technologically efficient" if there does

(1) For more detail on the specifications and estimations of the variables see Kasnakoğlu (1975 : 53-66). Also note that the notations used in this paper are slightly different than the general notations used in Kasnakoğlu (1976) and Kasnakoğlu (1975).

not exist another observation such that $Y_{oak} > Y_{oai}$ and $L_{oak} \leq L_{oai}$, $K_{oak} \leq K_{oai}$, $T_{oak} \leq T_{oai}$, $O_{oak} \leq O_{oai}$ for $i \neq k$.[1] The number of such observations in our case is 12[2]. It is assumed that the technologically efficient production function is of the Cobb-Douglas type with constant return to scale[3]. Let,

$$(4) \quad Y_{oai} = A\,(L_{oai})^{a_L}\,(K_{oai})^{a_K}\,(T_{oai})^{a_T}\,(O_{oai})^{a_O}\,e_i$$

such that $a_L + a_K + a_T + a_O = 1$,

where, i denotes the i[th] potentially technologically efficient producer, i=1, 2, ... 12.

A, a_L, a_K, a_T, a_O are the parameters of the efficient production function and,

e : error term.

Our problem is then to estimate,

$$(5) \quad Y_{oti} = \hat{Y}_{oai} = A\,(L_{oai})^{a_L}\,(K_{oai})^{a_K}\,(T_{oai})^{a_T}\,(O_{oai})^{a_O}$$

such that

$$(6) \quad Y_{oti} \geq Y_{oai}$$

and

$$(7) \quad \hat{a}_L + \hat{a}_K + \hat{a}_T + \hat{a}_O = 1$$

If we take the logarithms of both sides of equation (4) and rewrite equations (5), (6) and (7) in matrix notation :

$$(8) \quad Y_{oa} = X_{oa}\,C + e$$

$$(9) \quad X_{oa}\,C \geq Y_{oa}$$

(10) $mC = 1$ where,

$Y'_{oa} = (\log Y_{oa1}, \log Y_{oa2}, \ldots\ldots, \log Y_{oa12})$,

$L'_{oa} = (\log L_{oa1}, \log L_{oa2}, \ldots\ldots, \log L_{oa12})$,

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(1) See Kasnakoğlu (1975 : 210-3) for an algorithm on the selection of potentially efficient observations.

(2) Note that the efficient production function is fitted as a boundary function to only the potentially efficient observations as opposed to Aigner and Chu who fit the boundary function to all the observations and Kurz and Manne who fit an average function to the potentially efficient observations. See Kasnakoğlu (1975 : 75-7) and Kasnakoğlu (1976 : 88-9) for further discussions on this issue.

(3) See Kasnakoğlu (1975 : 77-81) for the implications of the assumption of constant returns to scale and justifications for its introduction in this study.

$K'_{oa} = (\log K_{oa1}, \log K_{oa2}, \ldots\ldots, \log K_{oa12})$,
$T'_{oa} = (\log T_{oa1}, \log T_{oa2}, \ldots\ldots, \log T_{oa12})$,

$C' = (\log A, a_L, a_K, a_T, a_o), (1, L_{oa}, K_{oa}, X_{oa} = T_{oa}, O_{oa})$,
$m = (0, 1, 1, 1, 1)$,

and $O'_{oa} = (\log O_{oa1}, \log O_{oa2}, \ldots\ldots\ldots\ldots, \log O_{oa12})$.

The parameters of the efficient production function can be estimated by minimizing the sum of squared residuals (e'e) subject to (9) and (10)[1].

The estimation problem can therefore be formulated as :

(11) Minimize $e'e = C'X'_{oa} X_{oa} C - 2C'X'_{oa} Y_{oa} + Y'_{oa} Y_{oa}$

(12) Subject to $X_{oa} C \geq Y_{oa}$

(13) and $C \geq 0$

(14) and $mC = 1$

This is a typical quadratic programming problem which can be solved by Wolfe (1969)'s or Cottle (1968)'s algorithms. The efficient production function estimated from the quadratic programming problem above is :

(15) $Y_{otk} = 11.4025 \, (L_{oak})^{.4489} \, (K_{oak})^{.1459} \, (T_{oak})^{.2991} \, (O_{oak})^{.1055}$

A.1 Technological Efficiency (TETLR) in the Overall Production Process :

Technological efficiency of a producer compares the actual output (Y_{oak}) to the maximum output (Y_{otk}) that could have been produced, given the initial level of resources (X_{aok}), had the producer used the best technology (or operated on the efficient production function f_{ot})[2].

(1) Sum of errors rathen than the sum of squared errors could be minimized since errors are forced to be of one sign. See Aigner and Chu (1968 : 832) for further discussions on this issue.

(2) Technological efficiency could also be measured by comparing the resources required to produce a given level of output on the producer's actual production function, to the level of resources that would be required to produce the same level of output on the efficient production function. The two measures of technological efficiency are not in general equal except under constnat returns to scale.

Therefore,

(16) $TETLR_k = (Y_{oak}/Y_{otk}) \times 100$

where, $Y_{oak} = f_{oak} (L_{oak}, K_{oak}, T_{oak}, O_{oak})$ and

$$Y_{otk} = \hat{A}\,(L_{oak})^{\hat{a}_L}\,(K_{oak})^{\hat{a}_K}\,(T_{oak})^{\hat{a}_T}\,(O_{oak})^{\hat{a}_O}.$$

If a producer is operating on the efficient production function (i.e. $f_{oak} = f_{otk}$) then $Y_{oak} = Y_{ot}$ and $TETLR_k = 100$. As he produces a level of output smaller than the level of output possible on f_{ot}, the distance between Y_{oak} and Y_{otk} increases and $TETLR_k$ decreases.

The frequency histogram for the estimated technological efficiencies of the 256 hazelnut producers are given in Figure 1. The average level of TETLR when the production process is taken as a whole is 35.3. The coefficients of skewness and kurtosis suggest a normal distribution of efficiencies with almost half of the farmers producing less than one third of what they could produce had they used the efficient technology.

A.2 Long-Run Cost Efficiency (TECLR) in the Overall Production Process :

Cost efficiency is a measure independent of technological efficiency and measures the degree to which producers are using their resources in optimal combinations by comparing the costs of producing a given level of output on the efficient production function with initial (observed) factor proportions to the costs of producing the same level of output on the efficient production function with optimal factor proportions. When all the factors of production are variable, the least cost (optimal) combinations of inputs and the minimum costs of production can be found by solving the following constrained minimization problem[1].

(17) Minimize $C_{olr} = P_{ol} L_{olr} + P_{ok} K_{olr} + P_{ot} T_{olr} + P_{oo} O_{olr}$

(18) Subject to :[2] $\bar{Y}_{ot} = \hat{A}\,(L_{olr})^{\hat{a}_L}\,(K_{olr})^{\hat{a}_K}\,(T_{olr})^{\hat{a}_T}\,(O_{olr})^{\hat{a}_O}$

(1) Subscript k's denoting individual producers are omitted to avoid crowding of the notations.

(2) It is important to note that, what is being minimized is the costs of producing the level of output that would be possible on he efficient production function with initial levels of factors. The bar on Y_{ot} denotes the fixed quantity costs of producing which is minimized.

where, $\bar{Y}_{ot} = \hat{A}\,(L_{oa})^{\hat{a}_L}\,(K_{oa})^{\hat{a}_K}\,(T_{oa})^{\hat{a}_T}\,(O_{ao})^{\hat{a}_O}$ and,

$L_{olr}, K_{olr}, T_{olr}, O_{olr}$: Cost minimizing levels of labor, capital, land, hazelnut tress required in the long run, to produce $\bar{Y}_{ot}$,

C_{olr} : Minimum cost of producing Y_{ot} on f_{ot} in the long-run.

The augmented objective function can be written as :

(19) $Z = P_{ol} L_{olr} + P_{ok} K_{olr} + P_{ot} T_{olr} + P_{oo} O_{olr} +$

$$\lambda\,(\bar{Y}_{ot} - A\,(L_{olr})^{a_L}\,(K_{olr})^{a_K}\,(T_{olr})^{a_T}\,(O_{olr})^{a_O})$$

Solving the first order conditions for minimum, for the least cost levels of the four inputs, and substituting them into the cost equation (17), the minimum cost function can be obtained :[1]

(20) $\hat{C}_{olr} = (\bar{Y}_{ot}/\hat{A})\,(P_{ol}/\hat{a}_l)^{\hat{a}_L}\,(P_{ok}/\hat{a}_k)^{\hat{a}_K}\,(P_{ot}/\hat{a}_t)^{\hat{a}_T}\,(P_{oo}/\hat{a}_o)^{\hat{a}_o}$

The long-run cost efficiency of a producer in the overall production process can now be computed by :

(21) $TECLR = (\hat{C}_{olr}/C_{oa}) \times 100$ where,

$C_{oa} = P_{ol} L_{oa} + P_{ok} K_{oa} + P_{ot} T_{oa} + P_{oo} O_{oa}$.

The frequency histogram for the estimated long-run cost efficiencies of the 256 hazelnut producers are given in Figuure 2. The average TECLR is 59.7. Coefficients of skewness and kurtosis suggest a standard normal distribution of the efficiencies, with more than half of the producers incurring costs more than twice as much as costs associated with optimal combination of resources required by the efficient production function.

A.3 Short-Run Cost Efficiency (TECSR) in the Overall Production Process :

In the previous section, we have compared actual costs of producing a given level of output to the minimum costs of producing that output, assuming that all inputs were variable. It is however unlikely that all resources are readily variable in the short-run. It is useful to know how much of the deviations from the least cost utilization of the inputs in the short-run are due to resource fixities.

(1) See Kasnakoğlu (1975 : 85) for details of computations.

TECSR therefore compares actual costs of producing a given level of output to the minimum costs, given that the producers are not able to vary some of their inputs. Here we assume labor and capital expenditures to be the variable inputs and land and hazelnut trees to be the fixed inputs.

The least cost combinations of the two variable inputs and the minimum cost of producing the technologically efficient level of output can be found by solving the following constrained minimization problem :

(22) Minimize $C_{osr} = P_{ol} L_{osr} + P_{ok} K_{osr} + P_{ot} \bar{T}_{oa} + P_{oo} \bar{O}_{oa}$

(23) Subject to : $\bar{Y}_{ot} = \hat{A} (L_{osr})^{\hat{a}_L} (K_{osr})^{\hat{a}_K} (T_{oa})^{\hat{a}_T} (O_{oa})^{\hat{a}_O}$

where, L_{osr} , K_{osr} : Cost minimizing levels of labor and capital in the short-run to produce $\bar{Y}_{ot}$,

C_{osr} : Minimum cost of producing Y_{ot} on f_{ot} in the short-run.

Again solving the first order conditions for the augmented objective function for the least cost levels of the two variable inputs and substituting these and the efficient production function parameters into the cost function in (22) :

(24) $\hat{C}_{osr} = ((\hat{a}_L/\hat{a}_K)^{\hat{a}_K/(\hat{a}_L + \hat{a}_K)} + (\hat{a}_K/\hat{a}_L)^{\hat{a}_L/(\hat{a}_L + \hat{a}_K)}) +$

$P_{ot} \bar{T}_{oa} + P_{oo} \bar{O}_{oa}$

The short-run cost efficiency of a producer can then be estimated by :

(25) TECLR $= (\hat{C}_{osr}/C_{oa}) \times 100.$

The frequency histogram for TECSR is given in Figure 3. For the overall production process, average level of TECSR is 97.9. The distribution of TECSR is highly skewed and asymetric with more than 90 percent of the producers having efficiencies over 95. The results, when compared to TECLR, suggest that most of the cost inefficiencies are due to the deviations of the two fixed inputs from their least-cost levels. Given that the two inputs, land and trees are fixed, hazelnut producers are utilizing the remaining two variable inputs, labor and capital, very close to their least cost levels on the efficient production function.

A.4 Long-Run and Short-Run Unit Output Cost Efficiencies (TEULR&TEUSR) In the Overall Production Process :

Unit output cost efficiencies compare the actual costs of producing a unit of output to the minimum costs. They incorporate both technological and cost efficiencies and are defined as :

(26) $TEULR = ((\hat{C}_{olr}/Y_{ot})/(C_{oa}/Y_{oa})) \times 100$
$= (\hat{C}_{olr}/C_{oa})/(Y_{oa}/Y_{ot})) \times 100$
$= (TETLR \times TECLR)/100.$

(27) $TEUSR = ((\hat{C}_{osr}/Y_{ot})/(C_{oa}/Y_{oa})) \times 100$
$= ((\hat{C}_{osr}/C_{oa})/(Y_{oa}/Y_{ot})) \times 100$
$= (TETLR \times TECSR)/100.$

The frequency histogram for TEULR and TEUSR are given in Figures 4 and 5. The arithmetic mean level of TEULR is 21.8 with more than 50 per cent of the producers' unit output costs almost seven times as much as their long-run minimum costs. The picture is much better when their unit output cost are adjusted for resource fixities in the short-run. Average TEUSR is 58.6. TEUSR's are normally distributed with more than 50 percent of the producers' unit output costs more than twice as much as the short-run minimums.

A.5. Short-Run Price Efficiency (TEPSR) in the Overall Production Process :

To be economically efficient, a producer must not only produce a given level of output with minimum possible resources and use resources in optimal (least-cost) proportions, but must also select the levels of inputs and thus output in such a way to maximize (or minimize) an overall objective (such as profits). The efficiencies calculated in the previous sections judge the optimization performances of the producers with respect to their technology and factor proportions. In this section, a new dimension, namely output price, is introduced to assess their efficiencies in selecting the optimal levels of inputs and outputs. Short-run price efficiencies compare the levels of unit output cost efficient profits (when firms are both technologically and cost efficient) to the maximum possible short-run profits (when the firms are both unit output cost and price efficient).

The profit maximizing levels of the two variable inputs, labor and capital, can be found by solving the following constrained maximization problem :

$$\text{(28)} \quad \text{Maximize } \pi_{oe} = P_{oy} Y_{oe} - (P_{ol} L_{oe} + P_{ok} K_{oe} + P_{ot} \bar{T}_{oa} + P_{oo} \bar{O}_{oa})$$

$$\text{(29)} \quad \text{Subject to : } Y_{oe} = \hat{A} (L_{oe})^{\hat{a}_L} (K_{oe})^{\hat{a}_K} (\bar{T}_{oa})^{\hat{a}_T} (\bar{O}_{oa})^{\hat{a}_O}$$

where, P_{oy} : Output price; Y_{oe} : Profit maximizing output level;

L_{oe} , K_{oe} : Profit maximizing levels of labor and capital in the short-run;

π_{oe} : Maximum possible profits in the short-run on the efficient production function in the overall production process.

The profit function can be rewritten by substituting in the constraint as :

$$\text{(30)} \quad \pi_{oe} = P_{oy} (\hat{A} (L_{oe})^{\hat{a}_L} (K_{oe})^{\hat{a}_K} (\bar{T}_{oa})^{\hat{a}_T} (\bar{O}_{oa})^{\hat{a}_O})$$

$$-P_{ol} L_{oe} - P_{ok} K_{oe} - P_{ot} \bar{T}_{oa} - P_{oo} \bar{O}_{oa}$$

The two first order conditions for maximum can be solved for the profit maximizing levels of labor and capital. Substituting these optimal factor levels into the production function in (29), the profit maximazing output level can be obtained. Finally, substituting in the optimal input and output levels and the estimates of the efficient production function parameters into the profit equation (30), maximum profit function below can be derived :

$$\text{(31)} \quad \hat{\pi}_{oe} = P_{oy} \left((P_{ol}/\hat{a}_L)^{\hat{a}_L} (P_{ok}/\hat{a}_K)^{\hat{a}_K} (P_{oy}\hat{A})^{-1} (\bar{T}_{oa})^{-\hat{a}_T} \cdot (\bar{O}_{oa})^{-\hat{a}_o} \right)^{(1/(\hat{a}_L + \hat{a}_K - 1))}$$

$$- P_{ol} \left((P_{ol}/\hat{a}_L)^{1-\hat{a}_K} (P_{ok}/\hat{a}_K)^{\hat{a}_K} (P_{oy}\hat{A})^{-1} (\bar{T}_{oa})^{-\hat{a}_T} \cdot (\bar{O}_{oa})^{-\hat{a}_o} \right)^{(1/(\hat{a}_L + \hat{a}_K - 1))}$$

$$- P_{ok} \left((P_{ol}/\hat{a}_L)^{\hat{a}_L} (P_{ok}/\hat{a}_K)^{1-\hat{a}_L} (P_{oy}\hat{A})^{-\hat{a}_T} (\bar{T}_{ao} \cdot (\bar{O}_{oa})^{-\hat{a}_o} \right)^{(1/(\hat{a}_L + \hat{a}_K - 1))}$$

The short-run price efficiencies of the producers can then be estimated as :

$$(32) \quad TEPSR = (\hat{\pi}_{ouc}/\hat{\pi}_{oc}) \times 100$$

where, $\hat{\pi}_{ouc}$ = Unit Output Cost Efficient Profits,

$$= P_{oy}\hat{Y}_{ot}-P_{ol}\hat{L}_{osr}-P_{ok}\hat{K}_{osr}-P_{ot}\bar{T}_{oa}-P_{oo}\bar{O}_{oa}$$

$$= P_{oy}\left(\hat{A}\,(\hat{L}_{osr})^{\hat{a}_L}\,(\hat{K}_{osr})^{\hat{a}_K}\,(\bar{T}_{oa})^{\hat{a}_T}\,(\bar{O}_{oa})^{\hat{a}_O}\right)$$

$$-P_{ol}\hat{L}_{osr}-P_{ok}\hat{K}_{osr}-P_{ot}\bar{T}_{oa}-P_{oo}\bar{O}_{oa}$$

The distribution of the short-run price efficiencies are given in Figure 6. Average TEPSR is 32.6, with an asymmetric distribution where 85 percent of the producers are making less than half of the maximum possible profits even after their inefficiencies in factor proportions and technology are accounted for.

A.6 Short-Run Economic Efficiency (TEOSR) in the Overall Production Process :

Overall economic efficiency measures the success of a producer in all three of the short-run optimization problems (i.e., technological, cost and price). It compares the actual levels of profits realized by the producers on their actual production functions to the maximum possible profits on the efficient production function in the short-run.

Therefore :

$$(33) \quad TEOSR = (\pi_{oa}/\hat{\pi}_{oe}) \times 100.$$

Figure 7 illustrates the distribution of the estimated TEOSR's for the 256 hazelnut producers in the sample. Average TEOSR is -2.76 meaning that more than half of the hazelnut producers are making losses in the short-run, whereas they could have made positive profits had they operated on the efficient production function and maximized profits on it[1].

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(1) It should be noted that, losses of the hazelnut producers observed do not necessarily imply monetary losses, but they rather imply negative economic profits. What it means in other words is that, the returns to the owned resources of the hazelnut producers (such as family labor, owned land, etc.) are below their opportunity costs.

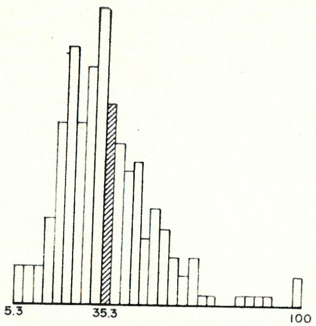

Figure 1
Frequency Histogram for TETLR

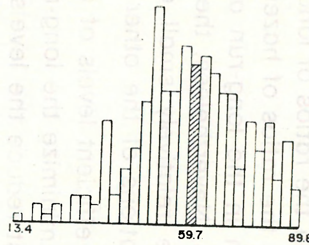

Figure 2
Frequency Histogram for TECLR

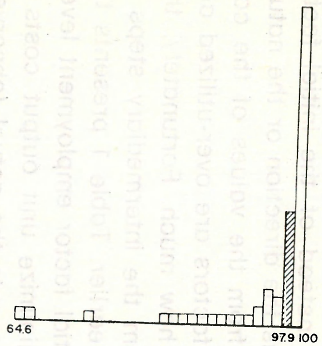

Figure 3
Frequency Histogram for TECSR

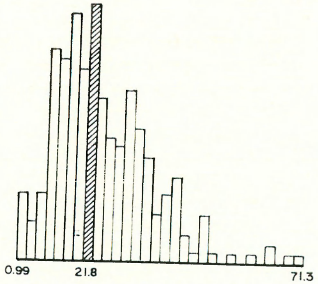

Figure 4
Frequency Histogram for TEULR

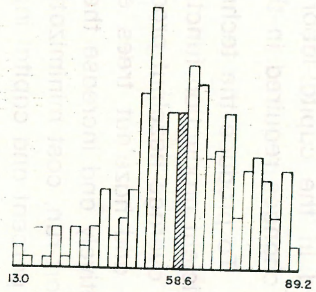

Figure 5
Frequency Histogram for TEUSR

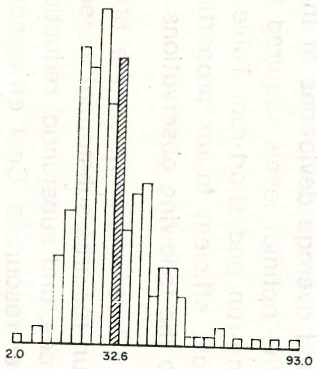

Figure 6
Frequency Histogram for TEPSR

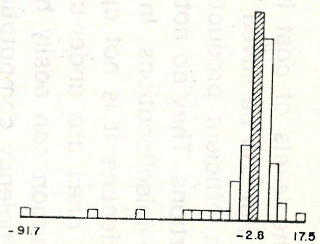

Figure 7
Frequency Histogram for TEOSR

A.7 Implications of the Efficiencies on Factor Allocations :

The levels of cost inefficiencies tell us the magnitudes of the costs that can be saved by employing the optimal factor proportions on the efficient production function, instead of the initial factor proportions. They do not however tell us the direction or the nature of the misallocations. In other words, from the values of the cost inefficiencies it is not apperant which factors are over-utilized and which ones are under-utilized and by how much. Fortunately, this information can easily be obtained from the intermediary steps of the efficiency computations presented earlier. Table 1 presents the total and average deviations of the initial factor employment levels from the optimal levels required to minimize unit output costs in the long-run and short-run. Table 2 presents the actual (observed) and cost efficient factor proportions. Analysis of the two tables lead to the following observations :

i. Cost efficiency on the efficient production function in the long-run requires substantial increases in the ratios of land to other resources, and substantial reductions in the ratios of hazelnut trees to other resources. Cost efficiency both in the long-run and short-run, requires a lower capital-labor ratio. Nevertheless, the changes required in the capital-labor ratios are relatively small compared to the changes required in the combinations of the other factors.

ii. To produce the technologically efficient levels of output on the efficient production function and to minimize the long-run costs, on the average hazelnut producers must reduce the levels of labor, capital and hazelnut trees employed by 31, 35 and 86 percents respectively and increase the level of land input by 504 percent. In the short-run, cost minimization requires labor inputs to be reduced by 3.3 percent and capital inputs to be reduced by 3.4 percent.

Table 1
Actual and Optimal Levels of Inputs

Total Deviation	Mean Deviation	Actual Total	Actual Mean
$\Sigma (L_{olr}-L_{oa}) = -$ 78,160.4	— 305.314	$\Sigma (L_{oa}) =$ 250,642.5	979.072
$\Sigma (K_{olr}-K_{oa}) = -$ 40,362.4	— 157.670	$\Sigma (K_{oa}) =$ 114,070	445.586
$\Sigma (T_{olr}-T_{oa}) =$ 9,913.7	38.725	$\Sigma (T_{oa}) =$ 1,968,5	7.689
$\Sigma (O_{olr}-O_{oa}) = -$ 133,984.2	— 523.376	$\Sigma (O_{oa}) =$ 156,182	610.086
$\Sigma (L_{osr}-L_{oa}) = -$ 8,223.8	— 32.124	$\Sigma (L_{oa}) =$ 250,642.5	979.072
$\Sigma (K_{osr}-K_{oa}) = -$ 3,825.9	— 14.945	$\Sigma (K_{oa}) =$ 114,070	445.586

NOTE : Mean Deviation = Total Deviation/256; Actual Mean = Actual Total/256

Table 2
Actual and Cost Efficient Factor Proportions

Actual Mean Ratio	Cost Efficient Mean Ratio	Percentage Change
K_{oa}/L_{oa} = 0.455	K_{olr}/L_{olr} = 0.427	— 6.15
K_{oa}/T_{oa} = 57.950	K_{olr}/T_{olr} = 6.203	— 89.30
K_{oa}/O_{oa} = 0.730	K_{olr}/O_{olr} = 3.320	354.79
L_{oa}/T_{oa} = 127.330	L_{olr}/T_{olr} = 14.516	— 89.60
L_{oa}/O_{oa} = 1.605	L_{olr}/O_{olr} = 7.770	384.11
T_{oa}/O_{oa} = 0.013	T_{olr}/O_{olr} = 0.535	4164.03
K_{oa}/L_{oa} = 0.455	K_{osr}/L_{osr} = 0.454	— 0.22

B. Partial Prdouction Processes :

In Part A we looked at the hazelnut production process as a whole and developed efficiency indexes to assess the performances of the hazelnut producers in terms of technology, factor allocation and scale of operation. In this part, we disaggregate the overall production process into two parts or partial production processes and measure the efficiencies of the hazelnut producers in minimizing their unit output costs in each of the parts seperately. This we do by comparing the actual performances of the producers with the optimal performances on the best observed production functions in each of the two parts. The two parts we will study are the "Cultivation" and "Harvest" stages. The cultivation stage involves all the activities up to harvesting, including such activities as trenching, cultivating, fertilizing, truncating, etc. The harvest stage involves the harvesting, threshing and marketing activities. The two parst can be studied independently since each part involves a limited array of farm inputs, constitutes a technological entity and the combinations of the inputs employed in the parts can be determined independently.

The observed hazelnut production process can be represented as :

(34) $Y_{cak} = f_{cak} (L_{cak}, K_{cak}, T_{cak}, O_{cak})$
(35) $Y_{hak} = f_{hak} (L_{hak}, K_{hak})$
(36) $Y_{oak} = f_{oak} (L_{oak}, K_{oak}, T_{oak}, O_{oak})$
(37) $Y_{hak} = Y_{cak} - Y_{uhak} + Y_{sak}$
(38) $Y_{oak} = Y_{hak} + Y_{uhak}$
(39) $L_{oak} = L_{cak} + L_{hak}$
(40) $K_{oak} = K_{cak} + H_{hak}$
(41) $T_{cak} = T_{oak}$
(42) $O_{cak} = O_{oak}$

where, subscript "c" denotes the cultivation stage and "h" the harvest stage,

Y_{uhak} : Quantity of hazelnuts presently produced but unharvested,
Y_{sak} : Quantity of hazelnut stocks from previous years, that are marketed during the present year.

It is assumed that $Y_{uhak} = Y_{sak} = 0$, thus

(43) $Y_{oak} = Y_{cak} = Y_{hak}$

B.1 Cultivation Stage Efficiencies :

In the cultivation stage, hazelnut producers are assumed to employ four inputs; labor, capital, land and trees to produce a given level of output. Their actual input-output relationships (technology) and costs in this stage are judged against the best observed cultivation technology and minimum costs with the efficient cultivation technology. Five efficiency indexes are computed for each of the hazelnut producers in their cultivation activities. They are : Technological Efficiency (CETLR), Cost Efficiency in the Long-Run with all factors variable (CECLR), Cost Efficiency in the Short-Run with land and hazelnut trees fixed (CECSR), Unit Output Cost Efficiency in the Long-Run (CEULR), Unit Output Cost Efficiency in the Short-Run (CEUSR). Since the methodology involved in the estimations of the above efficiencies is very similar to the one presented in detail for the overall production process efficiencies, we will only outline the major steps[1].

(1) See Kasnakoğlu (1975 : 113-133) for details on the partial production process efficiency estimations. Also note that the subscript "k" s denoting individual producers are ommited in the remaining of this part to avoid the crowding of the notations.

(44) CETLER = $(Y_{ca}/\hat{Y}_{ct})\times 100$ where $\hat{Y}_{ct} = B(L_{ca})^{b_L}(K_{ca})^{b_K}(T_{ca})^{b_T}(O_{ca})^{b_O}$

The coefficients of the efficient cultivation function are estimated by fitting a frontier to the potentially efficient observations as in the case of the efficient overall production function. The estimated efficient cultivation function is given below:

(45) $$\hat{Y}_{ct} = 41.8794(L_{ca})^{.1971}(K_{ca})^{.1468}(T_{ca})^{.4773}(O_{ca})^{.1770}$$

(46) $$\text{CECLR} = (\hat{C}_{clr} / C_{ca}) \times 100 \quad \text{where,}$$

$$C_{ca} = P_{cl}L_{ca} + P_{ck}K_{ca} + P_{ct}T_{ca} + P_{co}O_{ca},$$

$$\hat{C}_{clr} = P_{cl}\hat{L}_{clr} + P_{ck}\hat{K}_{clr} + P_{ct}\hat{T}_{clr} + P_{co}\hat{O}_{clr}$$

The least cost combinations of the resources and the minimum costs of cultivation when all the factors are variable in the long-run can be found by solving:

(47) $$\text{Minimize} \quad C_{clr} = P_{cl}L_{clr} + P_{ck}K_{clr} + P_{ct}T_{clr} + P_{co}O_{clr}$$

$$\text{Subject to: } \bar{Y}_{ct} = \hat{B}(L_{clr})^{\hat{b}_L}(K_{clr})^{\hat{b}_K}(T_{clr})^{\hat{b}_T}(O_{clr})^{\hat{b}_O}$$

(48) $$\hat{C}_{clr} = (\bar{Y}_{ct}/\hat{B})(P_{cl}/\hat{b}_L)^{\hat{b}_L}(P_{ck}/\hat{b}_K)^{\hat{b}_K}(P_{ct}/\hat{b}_T)^{\hat{b}_T}(P_{co}/\hat{b}_O)^{\hat{b}_O}$$

In the short-run, the least cost combinations of the variable inputs and the minimum costs of cultivation for a given level of output can be found by solving:

(49) $$\text{Minimize} \quad C_{csr} = P_{cl}L_{csr} + P_{ck}K_{csr} + P_{ct}\bar{T}_{ca} + P_{co}\bar{O}_{ca}$$

$$\text{Subject to: } \bar{Y}_{ct} = \hat{B}(L_{csr})^{\hat{b}_L}(K_{csr})^{\hat{b}_K}(\bar{T}_{ca})^{\hat{b}_T}(\bar{O}_{ca})^{\hat{b}_O}$$

(50) $$\hat{C}_{csr} = \left((\bar{Y}_{ct}/\hat{B})(P_{cl})^{\hat{b}_L}(P_{ck})^{\hat{b}_K}(\bar{T}_{ca})^{-\hat{b}_T}(\bar{O}_{ca})^{-\hat{b}_O}\right)^{(1/(\hat{b}_L+\hat{b}_K))} \cdot \left((\hat{b}_L/\hat{b}_K)^{(\hat{b}_K/(\hat{b}_L+\hat{b}_K))} + (\hat{b}_K/\hat{b}_L)^{(\hat{b}_L/(\hat{b}_L+\hat{b}_K))}\right) + P_{ct}\bar{T}_{ca} + P_{co}\bar{O}_{ca}$$

The short-run cost efficiency in the cultivation stage is then defined as:

(51) CECSR = $(\hat{C}_{csr}/C_{ca}) \times 100$.

(1) There are 17 potentially efficient observations for the cultivation stage.

The unit output cost efficiencies in cultivation stage in the long-run and in the short-run are merely the products of cost and technological efficiencies :

(52) $CEULR = ((\hat{C}_{clr}/\bar{Y}_{ct}/(C_{ca}/Y_{ca})) \times 100 = (\hat{C}_{clr}/C_{ca})x(Y_{ca}/\bar{Y}_{ct})x100$
$= (CETLR \times CECLR)/100$

(53) $CEUSR = ((\hat{C}_{csr}/\bar{Y}_{ct})/(C_{ca}/Y_{ca}))x100 = (\hat{C}_{csr}/C_{ca})x(Y_{ca}/\bar{Y}_{ct})x100$
$= (CETLRxCECSR)/100.$

The frequency histograms for the five cultivation efficiencies estimated as explained above are given in Figures 8-12.

B.2 Harvest Stage Efficiencies :

Two inputs, labor and capital are assumed to be empolyed in harvesting activities. Both of the inputs are assumed to be variable in the short-run. Three efficiency indexes computed for each of the hazelnut producers in their harvesting activities are : Technological Efficiency (HETLR), Cost Efficiency (HECLR) and Unit Output Cost Efficiency (HEULR). Major steps of the computations for these efficiencies are outlined below :

(54) $HETLR = (Y_{ha}/\hat{Y}_{ht}) \times 100$ where

$$\hat{Y}_{ht} = M(\hat{L}_{ha})^{m_L}(\hat{K}_{ha})^{m_K}$$

The coefficients of the efficient harvest function are again estimated by fitting a frontier to the potentially efficient harvest stage observations.[1]

(55) $\hat{Y}_{ht} = 12.1964(L_{ha})^{.7770}(K_{ha})^{.2230}$

(56) $HECLR = (\hat{C}_{hlr}/C_{ha}) \times 100$ where

$$C_{ha} = P_{hl}L_{ha} + P_{hk}K_{ha},$$

$$C_{hlr} = P_{hl}\hat{L}_{hlr} + P_{hk}\hat{K}_{hlr}$$

The least cost combinations of labor and capital expenditures and the minimum cost function can be found by solving :

(1) There are two potentially efficient observations for the harvest stage.

(57) Minimize $C_{hlr} = P_{hl}L_{hlr} + P_{hk}K_{hlr}$

Subject to: $\bar{Y}_{ht} = \hat{M}(L_{ha})^{\hat{m}_L}(K_{ha})^{\hat{m}_K}$

(58) $\hat{C}_{hlr} = (\bar{Y}_{ht}/\hat{M})(P_{hl}/\hat{m}_L)^{\hat{m}_L}(P_{hk}/\hat{m}_K)^{\hat{m}_K}$

The unit output cost efficiency in harvest activities combines technological and cost efficiencies and is defined as :

(59) $HEULR = ((\hat{C}_{hlr}/\bar{Y}_{ht})/(C_{ha}/Y_{ha}))\times 100$

$= (\hat{C}_{hlr}/C_{ha}) \times (Y_{ha}/\bar{Y}_{ht})/100$

$= (HETLR \times HECLR)/100$

The frequency histograms for the three harvest efficiencies above are given in Figures 13-15.

B.3 General Distributions of the Partial Production Process Efficiencies :

From the frequency distributions of the eight partial production process efficiencies, following observations can be made :

i. The technological efficiencies of the hazelnut producers are lower in both the cultivation and harvest stages than the cost efficiencies. In the cultivation stage, on the average, hazelnut producers are cultivating little more than one third of the output they could have on the efficient cultivation function with their initial levels of factor employment. In the harvest stage the average falls down to one-fifth of the efficient level.

ii. In the cultivation stage hazelnut producers would incur more than twice the optimal costs on the efficient cultivation function with the initial factor proportions in the long-run. In the short-run when land and hazelnut trees are fixed, they would be very close to minimiizng costs on the efficient cultivation function with their initial combinations of the two variable inputs.

ii. In the harvest stage, again the actual factor combinations are very close to those required to minimize costs of harvesting a given level of output on the efficient harvest function.

iv. The unit output cost efficiencies are very low in both the cultivation and harvest stages. The distributions of the unit output cost efficiencies in both stages are dominated by the distributions of the technological efficiencies.

B.4 Implications of the Partial Production Process Efficiencies for Factor Allocations :

Minimizing unit output costs in the two stages of the production process require not only cultivating and harvesting on the efficient partial production functions but also adjusting the factor proportions to the levels required by the efficient cultivation and harvest functions. Table 3 presents the total and average deviatinos of the actual levels in the cultivation and harvest stages from their unit output cost minimizing levels given that the producers are operating on the efficient partial production functions (ie., they are technolo-

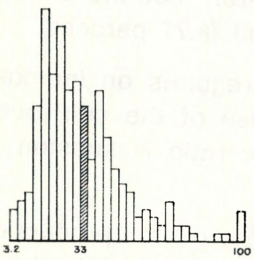

Figure 8
Frequency Histogram for CETLR

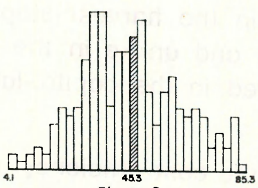

Figure 9
Frequency Histogram for CECLR

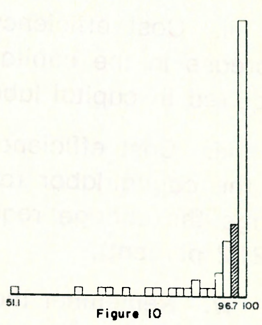

Figure 10
Frequency Histogram for CECSR

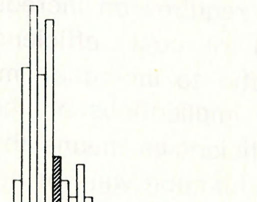

Figure 11
Frequency Histogram for CEULR

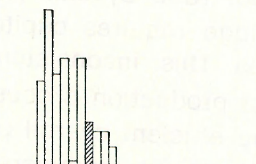

Figure 12
Frequency Histogram for CEUSR

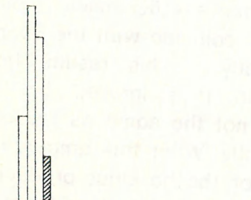

Figure 13
Frequency Histogram for HETLR

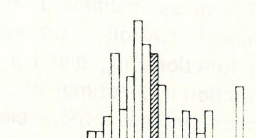

Figure 14
Frequency Histogram for HECLR

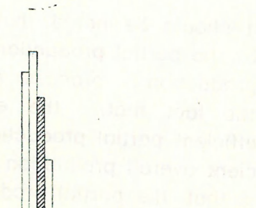

Figure 15
Frequency Histogram for HEULR

gically efficient in their harvest and cultivation activities). Table 4 summarizes Table 3 further and presents the implications of cost minimizations on the efficient cultivation and harvest functions for factor proportions. Analysis of Table 3 and 4 lead to the following conclusions :

i. Cost efficiency on the efficient cultivation function in the long-run requires substantial increases in the ratios of land to trees and substantial reductions in the ratios of land to other cultivation inputs. This result is consistent with the results regarding the requirements of cost efficiency in the overall production function.

ii. Cost efficiency in the cultivation stage also requires an increase in the capital-labor ratio in the long-run, but the change required in capital labor ratio is relatively small (8.77 percent).

iii. Cost efficiency in the harvest stage requires an increase in the capital-labor ratio and unlike in the case of the cultivation stage the change required in the capital-labor ratio is substantial (321.2 percent).

iv. Remember that the cost efficiency in the overall production function required a reduction in the capital-labor ratio in the long-run by 6.15 percent (see Table 2). In the long-run on the other hand cost efficiency in the cultivation stage requires an increase in the capital-labor ratio by 8.77 percent and the cost efficiency in the harvest stage requires capital-labor ratio to increase more than three times. This inconsistency in the implications of the overall and partial production process cost efficiencies means that operating on the efficient overall production function will not necessarily bring the hazelnut producers closer to minimizing the cost in the parts of the overall production function[1].

---

(1) It should be noted that the overall production process efficiencies implied by the partial production process efficiencies do not coincide with the overall production process efficiencies estimated directly. This results from the fact that, the efficient overall production ($f_{ot'}$) implied by the efficient partial production functions (f_{ht} and f_{ct}) is not the same as the efficient overall production function (f_{ot}) estimated directly. What this amounts to is that, the partial production process efficiencies of the hazelnut producers are judged relative to a more optimistic efficient overall production function than the overall production process efficiencies estimated in Part A. For a rather detailed discussion on this issue see Kasnakoğlu (1975 . 134-138).

Table 3
Actual and Optimal Levels of Inputs In the Cultivation and Harvest Stages

Total Deviation	Mean Deviation		Actual Mean
$\Sigma\ (L_{hlr}-L_{ha}) = -\ 44{,}478.6$	— 173.745	$\Sigma\ (L_{ha}) = 133{,}774.4$	522.556
$\Sigma\ (K_{hlr}-K_{ha}) = 27{,}870.8$	108.870	$\Sigma\ (K_{ha}) = 15{,}396.1$	60.141
$\Sigma\ (L_{clr}-L_{ca}) = -\ 71{,}996.6$	— 281.237	$\Sigma\ (L_{ca}) = 116{,}868.1$	456.516
$\Sigma\ (K_{clr}-K_{ca}) = -\ 57{,}479.2$	— 224.528	$\Sigma\ (K_{ca}) = 98{,}673.9$	385.445
$\Sigma\ (T_{clr}-T_{ca}) = -\ 6{,}821.4$	26.646	$\Sigma\ (T_{ca}) = 1{,}968.5$	7.689
$\Sigma\ (O_{clr}-O_{ca}) = -\ 135{,}779.1$	— 530.387	$\Sigma\ (O_{ca}) = 156{,}182.0$	610.086

NOTE: See note to Table 1

Table 5
Actual and Cost Efficient Factor Proportions in the Cultivation and Harvest Stages

Actual Mean Ratio	Cost Efficient Mean Ratio	Percentage Change
K_{ca}/L_{ca} = 0.844	K_{clr}/L_{clr} = 0.918	8.77
K_{ca}/T_{ca} = 50.126	K_{clr}/T_{clr} = 4.687	— 90.65
K_{ca}/O_{ca} = 0.632	K_{clr}/O_{clr} = 2.019	219.46
L_{ca}/T_{ca} = 59.369	L_{clr}/T_{clr} = 5.105	— 91.40
L_{ca}/O_{ca} = 0.748	L_{clr}/O_{clr} = 2.199	193.98
T_{ca}/O_{ca} = 0.013	T_{clr}/O_{clr} = 0.431	3215.38
K_{ha}/L_{ha} = 0.115	K_{hlr}/L_{hlr} = 0.485	321.74

B.5 Relationships Between the Partial and Overall Production Process Efficiencies :

Looking at the partial correlation matrix for the 15 efficiency indexes developed and on the basis of various regressions ran between the efficiencies following observations can be made :[1]

i. In the overall production processes, hazelnut producers who are relatively more cost and technologically efficient are more but those who are relatively more short-run price efficient are less short-run economic efficient.

ii. Hazelnut producers who are relatively efficient in the cultivation activities are also relatively efficient in the harvesting and marketing activities.

iii. The distributions of the techological and cost efficies in the cultivation activities dominate the distributions of these efficiencies in the overall production process.

(1) See Kasnakoğlu (1975 : 98-103, 139-41, 147-51) for a more detailed analysis of the relationships between the estimated efficiencies.

B.6 A Digression on Methodological Limitations : [1]

Measuring the efficiencies of the hazelnut producers in their overall and partial production processes involve camparing actual performances to the best possible performances on the efficient overall and partial production functions. The estimated efficiency indexes except those pertaining to technology do not tell us anything about the efficiencies of the hazelnut producers on their actual production functions. A producer can be very efficient in minimizing costs and maximizing profits on his actual production function, but he can be very inefficient in minimizing the costs and maximizing the profits on the efficient production function with his actual factor proportions and output level, if the actual production elasticities are different than the efficient production elasticities. The policy relevance of this study could be substantially improved by supplementing its results with information on the performances of the hazelnut producers on their actual production functions.

One of the most critical elements of the methodology used in this study is the estimation of the efficient production functions. The shapes of the estimated functions affect the magnitudes of price and especially cost efficiencies very significantly. Although we believe that the approach used in this study in estimating the efficient production functions are justified for our purposes, one nevertheless must be careful in interpreting the results and in applying the same model to different cases.

Perhaps the most important short coming of the methodology used in this study is that the results cannot readly by be generalized for the population which the sample represents. The models used in the estimations of the cost and price efficiencies are micro models assuming that the firms in the sample cannot influence output and factor prices. This assumption fails to hold when we try to generalize the results except in very special circumstances.[2]

RELATIONSHIPS BETWEEN EFFICIENCIES AND SELECTED EXOGENOUS VARIABLES

Methods of efficiency measurement developed in the earlier chapters based the relative efficiencies of the hazelnut producers

(1) See Kasnakoğlu (1975 : 186-7) for data limitations.

(2) A rather detailed account of the methodological limitations and theri implications on our results can be found in Kasnakoğlu (1975 : 181-5).

on four basic inputs (Land, Capital, Labor and Trees), factor prices, levels of output and output prices. Analysis of the relationships between the distributions of various levels of efficiencies and their implications gave us insights into the internal or endogenous causes of the variations in efficiencies. In this section, we look at the impacts of some exogenous factors on variations in efficiencies. Due to the limitations of readily available data, we are able to study only eight of the many relevant factors. The eight external factors studied in this section are : i. Altitute of hazelnut field, ii. Ages of hazelnut trees, iii. Location of hazelnut field, iv. Size of total hazelnut land owned by producers, v. Kinds of hazelnuts produced, vi. Channels of marketing, vii. Place where hazelnuts are sold, and viii. Quality of hazelnuts sold. To determine how well variations in above exogenous factors can explain variations in efficiencies we run multiple regressions of efficiencies on these exogenous variables which are categorized as dummy variables. Then we study the coefficients as well as significance levels of these variables both individually and as groups to determine their importance in explaining efficiency differentials. The categories of exogenous factors used in the regressions are given in Table 5. The regression results are presented in Tables 6-8 and group tests of significance are summarized in Table 9. In the rest of this section each of the exogenous variables is studied separately.

Table 5
Categories and Definitions of Regression Variables

1. Location of Hazelnut Land (PROVINCE) :
   - i. GİRESUN
   - ii. ORDU
2. Age of Hazelnut Trees (AGE) :
   - i. 0-10 years old (AGE1)
   - ii. 11-20 years old (AGE2)
   - iii. 21-50 years old (AGE3)
   - iv. 51 + years old (AGE4)
3. Altitute of Hazelnut Field (HEIGHT) :
   - i. 0- 50 meters (VLOW)
   - ii. 51-250 meters (LOW)
   - iii. 251-350 meters (MEDIUM)
   - iv. 351-550 meters (HIGH)
   - v. 551 + meters (VHIGH)

Table 5 - Continued

4. Total Hazelnut Land Owned (THA) : *
   - i. 0- 5 decars (THA1)
   - ii. 5.1-11 decars (THA2)
   - iii. 11.1-20 decars (THA3)
   - iv. 20.1-30 decars (THA4)
   - v. 30.1 + decars (THA5)

5. Quality of Hazelnuts Produced (QUALITY) : **
   - i. 0-5.50 TL/Kg. (PR1)
   - ii. 5.51-6.00 TL/Kg. (PR2)
   - iii. 6.01-6.50 TL/Kg. (PR3)
   - iv. 6.51-7.00 TL/Kg. (PR4)
   - v. 7.01 + TL/Kg. (PR5)

6. Kind of Hazelnuts Produced (KIND) : ***
   - i. Less than 60 % rounded (KIND1)
   - ii. More than or equal to 60 % rounded (KIND2)

7. Marketing Channel (MARKCH) :
   - i. Produce sold to local intermediaries, or private processors (MARKCH1)
   - ii. Produce sold to Hazelnut Cooperative (MARKCH2)

8. Place of Sale (PLSALE) :
   - i. Output sold in the village or at the field (PLSALE1)
   - ii. Output sold in the town or province (PLSALE2)

NOTES : In the regressions categories of the variables listed above take values of 0 and 1. The first category of each variable goes into the intercept.

* THA is the total hazelnut area owned by farmers, not the amount of hazelnut land used in the computation of efficiencies.

** Price of hazelnut produced is taken as a proxy for quality.

*** Based on the kinds of hazelnut trees planted.

Table 6

Regression Coefficients for Technological Efficiencies

	TETLR	CETLR	HETLR
CONSTANT	37.188[a]	40.470[a]	13.995[a]
ORDU	—.064	.149	1.178
AGE2	4.749	2.473	4.215[d]
AGE3	2.722	1.987	2.951
AGE4	2.016	—1.368	2.192
THA2	—1.952	—4.839[d]	2.218
THA3	—7.599[c]	—10.661[a]	—1.552
THA4	—1.136	—5.950[d]	2.181
THA5	—3.435	—10.025[a]	7.093[b]
LOW	—.954	—.320	1.090
MEDIUM	—1.320	—2.629	4.849[c]
HIGH	—3.479	—5.271[e]	.955
VHIGH	—.472	—1.665	1.864
KIND2	—.345	—.657	—.903
R^2	.054	.093	.086
F	1.030	1.850[b]	1.690[b]

NOTE : In this and the following tables in this chapter superior letters a, b, c, d and e refer to less than 1, 5, 10, 15 and 25 percent levels of significance, respectively.

Table 7

Regression Coefficients of Cost Efficiencies

	TECLR	TECSR	CECLR	CECSR	HECLR
CONSTANT	64.735[a]	98.283[a]	50.124[a]	98.041[a]	79.371[a]
ORDU	6.708[b]	—.623	7.273[a]	—.010	2.154[d]
AGE2	1.952	—.063	3.448	—.364	—1.405
AGE3	1.690	.629	2.250	—.124	—.729
AGE4	—2.464	.111	—1.324	—.128	.294
THA2	—2.937	—.074	—3.404	—.492	5.086[a]
THA3	—3.038[e]	—.012	—3.828[e]	.027	2.025[e]
THA4	—4.084[e]	.023	—5.139[e]	—2.103	5.229[a]
THA5	—4.009	.623	—4.496[e]	—.914	7.804[a]
LOW	—1.527	1.130[e]	.510	.382	—2.054
MEDIUM	1.015	.211	.991	.129	—3.440[c]
HIGH	—2.488	.132	—2.920	—.413	.367
VHIGH	.495	.873	1.659	—.323	—1.342
KIND 2	—6.879[a]	—1.231[c]	—7.158[a]	—.916	.963
R^2	.215	.035	.149	.020	.114
F	4.930[a]	.650	3.420[a]	.360	2.310[a]

NOTE : See note to Table 6.

Table 8
Regression Coefficients for Unit Output Cost, Price and Overall Efficiencies

	TEULR	TEUSR	TEPSR	TEOSR
CONSTANT	24.746	63.712[a]	45.987[a]	—13.466
ORDU	2.718[e]	6.196[b]	—.138	1.689
AGE2	3.636[e]	2.056	.461	—1.117
AGE3	1.662	2.251	—1.684	1.325
AGE4	.003	—2.185	—3.680[c]	1.583
THA2	—2.012	—3.002	—5.824[a]	3.862
THA3	—5.068[b]	—3.142[e]	—4.084[b]	1.864
THA4	—2.539	—4.226[e]	—5.377[b]	3.170
THA5	—3.910[d]	—3.917[e]	—8.561[a]	4.290
LOW	—.003	1.911	4.959[b]	—1.822
MEDIUM	—.489	1.035	3.625[e]	—3.265
HIGH	—3.024[e]	—2.398	1.804	—1.350
VHIGH	.825	1.028	2.471	—1.011
MARKCH2			—.102	—.030
PLSALE2			1.189	—.169
PR2			—10.256[a]	7.174
PR3			—11.798[a]	9.739
PR4			—12.623[a]	11.273
PR5			—15.048[a]	11.414
KIND2	—2.849[c]	—7.221[a]		
R^2	.125	.199	.278	.179
F	2.580[a]	4.480[a]	4.890[a]	2.770[a]

NOTE : See note to Table 6.

Table 9
F Tests for Group Significance

	PROVINCE	AGE	HEIGHT	LAND OWNERSHIP	KIND	MARKCH	PLSALE	QUALITY
TETLR	.00055	.63686	.31932	2.12173[c]	.02180			
TECLR	8.48090[a]	1.09929	.70555	.75251	12.08460[a]			
TEULR	1.90806[e]	1.00872	.73164	1.70443[e]	2.82445[c]			
TECSR	.66751	.25057	.61275	.15469	3.51143[c]			
TEUSR	6.67939[a]	1.03124	.72940	.71377	12.23012[a]			
HETLR	.29155	.76723	.98674	2.76185[b]	.23090			
HECLR	2.17766[d]	.23543	1.62129[e]	5.67993[b]	.58700			
CETLR	.00252	.47183	.69764	3.55237[b]	.06560			
CECLR	6.96373[a]	.80903	.56483	.76299	9.09459[a]			
CECSR	.0010	.02783	.14284	.70173	1.00955			
TEPSR	.00437	1.59771[e]	1.25632	3.70932[a]		.00415	.54540	7.72320[a]
TEOSR	1.00128	1.08448	69115	1.83204[d]		.00056	.01672	8.19470[a]

NOTE : See note to Table 6.

Altitude of Hazelnut Land :

Altitude of hazelnut fields (with the exception of HECLR) does not appear to be a significant factor in explaining the variations in efficiencies. One, for example, would expect technological efficiencies to drop as altitude increases due to rougher environmental conditions, poorer soil quality and greater distance from markets. The regression results showing the relationships between altitude and various efficiencies are mixed. In the cultivation stage, technological and long-run cost efficiencies decrease as altitude increases up to 550 meters, then contrary to expectations start to increase again as altitude increases further. Still the cultivation efficiencies at very low altitudes (0-50 meters) are higher than those of all higher altitudes. In the harvest stage, technological and cost efficiencies increase as altitude increases up to 350 meters and than decrease between 351-550 meters and increase again for altitudes greater than 550 meters. Producers at lowest altitudes are the least efficient in harvest activities. Keeping in mind that the coefficients of altitude variables are not significantly different from zero, one can make the following generalizations : i. The relationships between altitude and efficiencies are not the same in harvest and cultivation stages. ii. The relationships between altitude and efficiencies are similar within stages of production. iii. The relationships between altitude and technological, cost and unit output cost efficiencies are dominated by the relationships in the cultivation stage with respest to technological efficiencies. iv. Short-run overall economic efficiencies do not show a stable relationship with altitude.

Place of Sale and Marketing Channels :

Both of these variables are insignificant meaning that, selling the output in the town or city as opposed to selling it at the field or in the village, and selling it to the cooperative as opposed selling it to local intermediaries or private processors are not significantly associated with the levels of price and overall economic efficiencies in the short-run.

Ages of Hazelnut Trees :

Ages of hazelnut trees (except in TEPSR) like altitudes of hazelnut fields do not appear to be significant factors in explaining the variations in efficiencies. Although age variables as a group do not significantly contribute to the variations in the efficiencies, the estimated coefficients and their signs are consistent with expectations. Except in HECLR, TECSR, TEOSR efficiencies reach their maximum between ages 11-20 and then start to decline for ages greater than 20. Unlike altitude the effects of ages of hazelnut trees on efficiencies do not differ substantially for different stages of the production process.

Location of Hazelnut Land :

Locations of hazelnut fields are introduced to account for variations in efficiencies due to climatic, topographic differences as well as levels of education of hazelnut producers and market conditions. The estimated location coefficients are significant in explaining the variations in TECLR, TEULR, TEUSR, HECLR and CECLR. The signs of the regression coefficients for the efficiencies listed above are all positive favoring Ordu over Giresun. Our results are consistent with i. lower percentage of non-bearing hazelnut trees in Ordu, ii. newer hazelnut fields in Ordu with more recent technology, iii. a more suitable topographic environment in Ordu, iv. higher rates of literacy in the villages of Ordu.

Size of Total Hazelnut Land Ownership :

One of the most common features of the existing literature on production efficiency in agriculture, involves the comparison of the efficiencies of small and large farms. In many studies this forms the single purpose of efficiency measurments. The size of land ownership according to the regression results of this study appear to be the most important and significant factor in explaining the variations in the efficiencies of hazelnut producers among all the exogenous variables studied. As a group size of land ownership variables are significant in six of the efficiency regressions (See Table 9). They are significant at 15 percent level of significance in explaining the variations in short-run overall economic efficiencies. Looking at the regression results in Tables 5-8, one can make the following interesting observations.

i. In the cultivation stage as well as in the overall production process, the smallest land owners are the most technological and long-run cost efficient.

ii. In the cultivation and overall production process, both technological and long-run cost efficiencies fall up to 20 decars as size of land ownership is increased from 0-5 decars. As they are increased further than 20 decars, efficiencies start to increase but do not reach the level of smallest farmer's efficiencies.

iii. The medium sizes of land ownership (11-20 and 20-30 decars) are associated with least efficiencies in cultivation and overall production process.

iv. The picture in the case of short-run and long-run unit output cost efficiencies in the overall production process, is similar to the one given above.

v. In the harvest stages, the picture is a different one. With the exception of 11-20 decars of land ownership size in HETLR, as size of land ownership increases, the levels of technological as well as cost efficiencies also increase. The less than 5 decars land owners groups are only superior to 11-20 decars land owners groups in case of harvest technological and cost efficiencies.

vi. The short-run price efficiencies in the overall production processes reach their maximum at the smallest sizes of land ownership (0-5 decars) and their minimum at the largest land ownership size (more than 30 decars). The short-run overall economic efficiencies on the other hand behave in exactly the reverse manner with price efficiencies.

vii. It is important to note that optimizing the size of land ownership contibutes in general more to the levels of efficiencies than optimizing the ages of hazelnut trees and optimizing the altitute of hazelnut fields

Kinds and Quality of Hazelnuts Produced :

There are various kinds of hazelnuts produced that differ in shape, weight, kernel/shell ratio, oil content, and requirement for production. Basically kinds of hazelnuts are classified into two : i. Giresun (rounded) and ii. Levant (others). Giresun hazelnuts due to their flavor and high proportion of oil content are claimed to be the most demanded hazelnuts in the world. One of the major complaints raised againist the government support price policies for hazelnuts is that the government support prices discriminate againist the producers of rounded hazelnuts which are relatively more demanding on inputs and give lower yields per tree. The Giresun hazelnuts also on the average have a lower kernel/shell ratio which results in an unfavorable situation for them in the output market in terms of the price per Kg. of output.

We have therefore included two variables (one at a time) to the regressions to study the relationships between efficiencies and kinds and qualities of hazelnuts produced and marketed. Note that KIND variable represents the kinds of hazelnut trees and QUALITY variables represent the kernel/shell ratio of the output sold, which is influenced by not only the kind of hazelnuts but also how well the produce is cared during harvest stage. Therefore hazelnuts of the same kind can have different qualities, but it is likely that Giresun hazelnuts will have a lower quality than the others. Also note that quality is approximated by the sale price of the hazelnuts which is not only determined by the quality of hazelnuts but also by the places of sale and marketing channels, etc. Therefore when QUALITY variables are introduced, MARKCH and PLSALE variables are also introduced to account for these factors and free price variables to represent quality. The regression results are given in Tables 6-9. Kinds of hazelnuts produced are significant in explaining the variations in TEULR, TECLR, TECSR, TEUSR, CECLR, but insignificant in explaining the variations in other efficiencies. The signs of KIND2 variable (which represents more than 60 percent rounded hazelnut trees) are consistent with the concerns mentioned above. More rounded hazelnut trees are associated with less efficiencies in all cases. Quality of hazelnuts outputed on the other hand are significantly and negatively related with short-run price efficiencies but positively and significantly related with short-run overall economic efficiencies. Remembering that rounded hazelnuts are lower in quality for price purposes and price efficiencies in general are associated with actual output being lower than the optimal level of output, the results are consistent with the arguements about the discrimination of the support prices againist rounded hazelnuts.

A SUMMARY OF THE FINDINGS

In this study we have estimated efficiency indexes to measure the successes of the hazelnut producers in their choice of technology, factor proportions and scale of operation. Then we have studied the relationships between the estimated efficiencies and their implications on factor allocations. Finally the variations in the efficiencies of the individual hazelnut producers are studied in relation to various exogenous factors. The major findings of the study are briefly summarized below :

i. Hazelnut producers in the sample studied are very inefficient in maximizing profits. Most of them are making negative economic profits on their actual production functions. With the adoption of best observed technology in the sample and by utilizing the factors in optimal proportions and by operating with the optimum scale, in the short-run on the average unit output costs could be reduced by 40 percent and the profits could be increased to positive levels of close to three times the actual losses.

ii. Cost minimization in the short-run requires reduction in the capital-labor ratios in the short-run and long-run. Also in the long-run cost minimization requires substantial reductions in the ratios of number of hazelnut trees to other inputs and substantial increases in the ratios of land to other inputs.

iii. While the hazelnut producers are more efficient in optimizing their technology in the cultivation activities, they are more efficient in optimizing their factor proportions in the harvesting and marketing activities.

iv. Of the eight exogenous variables considered three, namely, size of total hazelnut land ownership, the kinds of hazelnuts produced and the location of the hazelnut field appear to be the most significant factors explaining the variations in efficiencies among the hazelnut producers.

REFERENCES

Aigner, D.J., and Chu, S.F. "On Estimating the Industry Production Function". **American Economic Review 58** (September 1968) : 826-39.

Cottle, R.W. "The Principal Pivoting Method of Quadratic Programming:" **Mathematics for Decision Sciences 1** (1968) : 144-62.

Fındık Tarım Satış Kooperatifleri Birliği (FİSKO), "Survey of Hazelnut Plantation and Hazelnut Production Costs." **Unpublished** Giresun 1974.

Kasnakoğlu, H. "Measurement of Production Efficiency" **Studies in Development 11** (Spring 1976) : 81-103.

Kasnakoğlu, H. "Measurement of Production Efficiency in Agriculture. A Case Study of the Hazelnut Production in Turkey 1970" Unpublished Ph. D Thesis Submitted to the University of Wisconsin, Department of Economics. 1975.

Türkiye Cumhuriyeti, Tarım Bakanlığı, Plânlama ve Araştırma Dairesi Başkanlığı "Giresun ve Ordu İllerinde Fındık Üretiminin Ekonomik Analizi Anketi (Survey for the Economic Analysis of Hazelnut Production in the Provinces of Giresun and Ordu." Ankara, 1970.

Wolfe, P. "The Simplex Method for Quadratic Programming." **Econometrica 27** (July 1969) : 382-98.

ÖZET

TARIMDA ÜRETİM ETKİNLİĞİNİN ÖLÇÜLMESİ

Giresun ve Ordu İllerinde 1970 Yılında Fındık Üretimi İçin Bir Uygulama

Bu çalışmada Giresun ve Ordu illerindeki fındık üreticilerinin göreli üretim etkinlikleri, teknolojik etkinlik, girdi bileşiminde etkinlik, üretim ölçeğinde etkinlik, kısa ve uzun dönemde etkinlik ve üretim süreçlerinde etkinlik gibi alt kavramlara indirgenerek incelenmekte, etkinlik farklılıklarının nedenleri ve etkin olmayan davranışların doğurduğu sonuçlarla bunların giderilmesi için gerekli değişiklikler araştırılmaktadır. Çalışmanın bulguları şöyle özetlenebilir :

1. Fındık üreticilerinin kısa dönemde kârlarını en üst düzeye çıkarmaktaki etkinlikleri çok düşüktür. Çevredeki en etkin teknoloji kullanılarak ve buna en uygun girdi bileşimi ile birim üretim maliyetleri kısa dönemde % 40 uzun dönemde ise % 80 azaltılabilinir.

2. Üretim maliyetlerinin en alt düzeye indirilmesi uzun dönemde fındık ağacı sayılarının diğer girdilere oranlarında azalma, toprak girdilerinin diğer girdilere oranlarında ise bir artma gerektirmektedir. Yine üretim maliyetlerinin en alt düzeye indirilebilmesi için hem uzun hem kısa dönemde sermaye-emek oranlarında bir azalma gerekmektedir.

3. Fındık üreticileri arasındaki etkinlik farklılıklarının açıklanmasında toplam fındıklık mülkiyeti, yetiştirilen fındık cinsleri ve yöresel farklılıklar önemli etkenler olarak ortaya çıkmaktadır.