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An Evaluation of Turkish Agricultural Production Performance

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ABSTRACT

In this study, productivity growth and technical changes in Turkish agriculture is measured for 1961 - 2001 period using Cobb-Douglas production function. Ridge regression estimating technique is used. The results indicate that the annual output growth rates ranged from 1.30% to 3.40% for the Turkish agricultural production in each of the 10-years period. Farm output growth is mainly due to the use of tractors, labor, irrigation and fertilizer, which shows that most of the growth rate in output has been driven by continued increases in inputs. According to the results of analysis, technical change growth rates ranged from -0.15% to 5.53% over the 40-years period. Although the change has been low, there is a potential to achieve higher growth rates in agricultural production in the future if resources are used efficiently.

Key Words: Productivity; Technical change; Growth rate; Ridge regression

INTRODUCTION

Besides rich agricultural resources, Turkey has important deposits of lignite, black coal, iron ore, chromium and petroleum. Since 1950, Turkish agricultural output has increased through the use of more machinery and skilled labor, irrigation, fertilizer and better plant varieties. The diversity of climates in Turkey allows many types of crops to grow, such as tea, apple, various nuts, onions, egg-plants, nuts, cabbage, potatoes, rye, oats, sunflower and other oilseeds, olives and citrus fruit.

Turkish agriculture suffers from a number of chronic structural and institutional problems. Farms are characteristically small and fragmented and most farms rely on family labor only. The objectives of the country's agricultural policy have changed little over time. Un-like the other OECD countries, the emphasis has been primarily focused on increasing agricultural production and thus food supplies support a growing domestic food market in Turkey. Economically efficient domestic production ensures the security of the country's food supplies at a lower cost compared to the world market prices.

Landlessness and associated poverty are not significant features of Turkish agriculture. Historically, agriculture in the country has been characterized by the predominance of a small, independent peasantry. This characteristic persists to the present days. Typically the parties involved are small-scale peasant farmers with sufficient livelihood from agriculture, who prefer not to emigrate permanently and large-scale farmers, mostly growing cotton and grains, whose demand for permanent labor is very low. This agrarian structure gives rise to a particular pattern of labor demand and supply in seasonal employment.

Turkish agricultural land is fixed and it is hard to increase land input, the only thing that can be done to increase agricultural output is to increase the productivity of inputs, production and yield per hectare. In this situation, the optimal input level and the optimal input combination are very important in increasing both productivity and technical change. For these reasons, Turkey needs to increase its agricultural potentials in order to sustain its future generations and to contribute the economic development.

The research problem to be addressed by this study is to analyze and identity agricultural productivity and technical change for the last four decades for this country. The basic reasons of low/high rate of technical change and inadequate/adequate productivity and recommendations for the higher technical change and productivity will also be discussed.

The objectives of this study are to; (i) examine the structure of Turkish agriculture, (ii) estimate the annual production growth in the agriculture, (iii) determine the sources of productivity in agricultural production and (iv) calculate the rate of technical change in the agriculture. To achieve these objectives, Cobb-Douglas production function is used. As an econometric model; Ridge regression (RR) estimating procedures will be used.

The measurement of productivity and technical change is interesting for two purposes. First, under certain carefully documented situations, the measures can be used for comparative purposes. That is, one can compare productivity and technical change in one period or region with another period or region. Second, productivity and technical change measures can be used to evaluate the statistical association of productivity change with certain explanatory variables. For both purposes, productivity and technical change measures at a relatively detailed level are useful, particularly for policy analysis.

Previous studies have investigated various sources of productivity growth and technical change in agricultural production and other sectors of an economy. Suer (1995) conducted a study on technological change and productivity in the United Kingdom (UK) food, drink and tobacco industries for the 1955 - 1981 period. By using a trans-log cost function, Suer found that technical change was input-biased in the industries.

Fare *et al*. (1995), in their study of "Productivity in Taiwanese Manufacturing Industries", concluded that total factor productivity (TFP) growth in the long run was dominated by technical change. Also, Fare *et al*. (1994) used a non-parametric programming model to count productivity growth for 17 OECD countries. Japan's productivity growth was the highest in the sample, with almost half of the productivity growth due to technical change.

Jorgenson (1988) investigated productivity growth in Japan and the US for the period of 1960 - 1979. The economic growth rate in Japan was 10% - 11% per year, while the US growth rate was 4.3%.

Kim and Sachish (1986) investigated the 1966 - 1983 period and the result of their analysis indicated that technical change has been labor saving and capital using. TFP grew at an annual average of 0.11 from 1966 to 1983. On the average, 85% of the TFP growth has been the result of containerization and 15% has been the result of scale economies and output growth.

McIntosh (1986) applied a 2-factor vintage model to aggregate time series data for the period of 1950 - 1978. He concluded that "input - output coefficients show that technical progress and capital accumulation have been aimed at reducing the amount of labor needed to produce one unit of output rather than expanding output.

Bloch and Madden (1995) used a model of technical change embodied in capital equipment to analyze average labor productivity growth in a cross-section of Australian manufacturing industries. Determinants of productivity growth in their analysis were (1) the rate of labor-saving technical change, (2) the differential in the rates of changes of the wages and the rental price of capital and (3) the rate of growth of industry productive capacity. Bloch and Madden concluded that each of the identified factors had a positive and statistically significant relationship to the average labor productivity growth.

Frisvold and Ingram (1995) used an aggregate agricultural production function in their work. Land productivity was the main source for agricultural productivity growth. According to their results, growth in modern input use was of secondary importance, but still accounted for a 0.2 - 0.4%.

In "Agricultural Productivity in China and India: A Comparative Analysis", Wong (1987) said that, "like all less developed countries, any gains from technical change were often overshadowed by misallocation of resources".

MATERIALS AND METHODS

Total factor productivity (*TFP*) is the average product of all inputs. On the other hand, productivity growth represents the increase in output produced per unit of input used. In the production function or productivity concept, it can be shown that technical change affects output. Technical change is a shift in the production function over time (Chambers, 1994). Following Chambers, the relationship between output, input and technical change (as defined by t) can be specified as:

$$Y = f(X_1, X_2, X_{3,}........, X_n, t) \qquad (1)$$

According to this functional form, technical change can be measured by how output changes as time elapses with a constant input.

Basically there are two types of technical change: (1) - Embodied technical change, which results from improved quality and/or quantity changes in production inputs. This type of technical change requires analytically differentiating the production function itself as well as the input bundle over time. Embodied technical change is very difficult to analyze. (2) - Disembodied technical change results from changes in the technique of combining inputs and production "know how" (Chambers, 1994) Following Chambers, disembodied technical change with Cobb-Douglas production function can be expressed as follows:

$$Y = f(X_i, t) = AX_i^{\alpha} t \qquad (2)$$

Where *Y* is the total output produced, X_i is the inputs used in the production process, and *t* is the effect of technical change. The application of the Cobb-Douglas production function in the measurement of technical change was first conducted by Solow (1957). Taking the total differentiation of equation (2), rewriting in growth rate, having the logarithms and rearranging terms according to the technical change the Equation 3 can be achieved.

$$\frac{\partial \ln Y}{\partial t} = \frac{d \ln Y}{dt} - \sum \frac{\partial \ln Y}{\partial \ln X_i} * \frac{d \ln X_i}{dt} \qquad (3)$$

Where $\frac{\partial \ln Y}{\partial t}$ is the rate of disembodied technical change, $\frac{d \ln Y}{dt}$ is the growth rate of output through time, $\frac{\partial \ln Y}{\partial \ln X_i}$ is the input/ output elasticity and $\frac{d \ln Y}{dt}$ is the growth rate of input through time.

In this study there are seven explanatory variables (Work Animals, land, irrigation, Tractor, Fertilizer, labor & seed), which are postulated to influence the dependent variable (output) in the model. In the production function, output is specified as a function of these seven variables. Productivity and technical change will be investigated in this study using the production function. In this study, because of the possibility of having multicollinearity problem, ridge regression econometric approach will be used.

RESULTS

The data used in this study cover a period of 1961 - 2001. The data set is specified in index numbers for ease of comparison. In this situation 1961 is the base year, with all data for 1961 normalized to 100.

The mean, standard deviation, minimum and maximum values of the data for Turkish agriculture are given in Table I. Over the 41 year period, fertilizer has the highest mean and standard deviation. On the other hand, the lowest mean belongs to animals and land has the smallest standard deviation value. The small variation in the amount of the land area used shows that all land, which is available for agricultural production have been used by Turkish farmers.

βi statistics of the model for each 10-years period are given in Table II. The *βi* parameter for animals is significant but has a negative sign. A possible reason for the negative sign is that the work animals have traditionally been used in agricultural production and this practice is being continued regardless of their marginal efficiency. Generally, work animals have been used the most in Turkish agricultural production in places, where tractors cannot be used because of the structure of the land, such as the northern part of Turkey, which is predominantly mountainous. Land is still a very important input in Turkish agriculture, but because there is not much variation in the first two decades, the *βi* values were negative. On the other hand, in the third and fourth decades the LAND has effected the production positively.

The amount of irrigation is very important for the places, which do not have sufficient rain for agricultural production. In the places, where the land gets enough rain, irrigation may not be needed and has negative effects. The amount of rainfall may vary from year to year or decade to decade. Although in the third decade IRRIGATION had negative effect, in general it has positive effect on production.

The use of tractors and fertilizer in Turkish agriculture has seen enormous increases over the 40-years period. But the knowledge to use them at optimal levels may not be sufficient. The total increase in FERTILIZER and TRACTORS generally had positive effect on production. On the other hand, because of having better knowledge and better variety of seed, the LABOR and SEED variables generally had positive effects on the amount of production.

To further evaluate productivity growth for Turkish agricultural production, the annual growth rates are aggregated for each of the 10-years periods since 1961 and given in Table III.

Table I. The Mean, Std. Deviation, Maximum and Minimum Values of Data

Variables	Mean	Std Dev	Minimum	Maximum
Production	183.70	55.37	100.00	273.32
Animals	68.39	28.05	19.68	102.76
Land	105.65	3.26	100.00	113.76
Irrigation	217.41	83.50	100.00	343.51
Tractor	1050.00	728.73	100.00	2232.00
Fertilizer	1601.00	930.47	99.12	2951.00
Labor	110.92	10.32	100.00	131.17
Seed	127.02	10.00	100.00	146.34

Table II. βi Statistics of Ridge Regression Estimation Technique

Variables	1961-1970	1971-1980	1981-1990	1991-2001
Intercept	-0.808	24.113	0.101	0.422
Animals	-0.199	-0.178	-0.041	-0.032
Land	-0.483	-1.969	0.330	0.094
Irrigation	0.122	0.213	-0.019	0.324
Tractor	0.067	0.070	0.229	0.090
Fertilizer	0.022	0.031	-0.051	0.153
Labor	1.380	-2.734	0.650	0.100
Seed	0.262	0.367	-0.088	0.111

As can be seen from the Table III, the average production growth rate for first 10-years period is 2.6%. In the same period there is not much difference in the land area. The production growth rate in the first period was influenced by the use of more machinery, irrigation and fertilizer. Because agricultural production has a big share in national gross domestic product (GDP), the Turkish government tried to increase the domestic production to increase exports.

The second 10-years plan (1971 - 1980) reached a 3.6% of growth rate, which is a remarkable achievement compared to the previous period. In this period, instead of importing, domestic production was increased, by using more machinery, irrigation and fertilizer than in the previous period. And agriculture was given preferential policies such as subvention on fertilizer prices during this period. Although the Turkish economy was affected by the first oil price increase in the early 1970s, Turkish agricultural production was not heavily affected.

In the third period (1981 - 1990), a 3.10% growth rate was achieved. This was good but less than that of the previous period. During this period, the government tried to increase the rate of industrial production in GDP and as a result its share increased and the share of agricultural production in GDP decreased. The decreasing share of agricultural production in national GDP was not because of a decline in agricultural production, but because of the large increases in industrial production.

After December of 1980, important decisions were made for economic stability by the Turkish government. Those decisions were not only for the 5-years plan (1979 -

1983), but also for the next 20 years. Those economic stability decisions affected the growth rate of output positively. In this period, the decrease in oil prices also had a significant effect on agricultural production.

At the beginning of the last period, the agricultural output growth rate was negative. A possible reason for negative rate of growth of output is the Gulf War. The price of oil was increased and the Turkish economy showed a decline due to war. Before the war, a major proportion of exports to the Middle East countries was from agricultural production. After the war, exports of agricultural goods to the Middle East countries decreased, which also affected the overall growth rate of agricultural output. In June 1992, to solve the economic problems in Turkey, the third Izmir Economic Congress was formed and according to the decisions of this congress, the goal of the Turkish government was to put Turkey among the 15 most developed countries in the 21st century. The overall growth rate of output for last period was 1.30%, which is less then the previous decades.

The increase in cultivated land areas is not remarkable. Even in the third and fourth periods, land utilization has continued to decline. Labor growth rate in the third period was more than in the other periods. The amount of work animals' growth rate has been decreased overtime and replaced by machinery. Possibly with the increased use of tractors, farmers became less dependent on work animals and thus the output growth rate has been increasing over time. There is a remarkable increase in the fertilizer growth rate in the first period. After the first period the growth rate of fertilizer use has been increased in decreasing rate. The important mechanization in Turkish agriculture started after 1950. The growth rate of tractors increased from the first period and reached its peak in the second and then increased at a decreased ratio in the following periods. Since 1950, agricultural output growth rate has been increasing through the use of more machinery, irrigation, fertilizer and better plant varieties.

Table IV presents the average factor sources of productivity growth, which were estimated based on the last component of the technical change. These measures were taken from the growth rate of input through time, weighted by their respective marginal physical products.

The tractor input provided the highest contribution to productivity growth. The second, third and fourth most important input sources of productivity growth were labor, fertilizer and irrigation, respectively while the land input source continued to have an effect on productivity growth.

According to the model, the best factor source of productivity growth was tractors. Fertilizer was the second best input source. As shown in the empirical results, over the 40 years period, as the utilization of tractors and fertilizer increased, the rate of output growth increased as well. The RR model distributed the sources of tractors, fertilizer, animals and labor more evenly.

The rates of technical change are calculated by estimating the annual output and input growth rates based on the index number ratio approach. The rates of technical change in Turkish agriculture are summarized in Table IV and calculated for 10 years periods.

Table III. The Rate of Increase per Year

Variables	1961-1970	1971-1980	1981-1990	1991-2001
Production	0.026	0.034	0.031	0.013
Animals	0.002	-0.014	-0.068	-0.074
Land	0.005	0.000	0.007	-0.003
Irrigation	0.037	0.042	0.032	0.014
Tractor	0.106	0.153	0.046	0.033
Fertilizer	0.230	0.130	0.031	0.007
Labor	0.003	-0.001	0.014	0.010
Seed	0.013	-0.009	0.004	0.005

Table IV. Productivity Growth of Inputs, and Technical Change

Variables	1961-1970	1971-1980	1981-1990	1991-2001
Animals	0.000	0.251	0.280	0.238
Land	0.000	0.057	0.244	0.000
Irrigation	0.457	0.889	0.000	0.444
Tractor	0.712	1.073	1.049	0.299
Fertilizer	0.507	0.402	0.000	0.113
Labor	0.429	0.175	0.885	0.096
Seed	0.348	0.000	-0.000	0.052
Technical change	-0.150	5.530	-0.010	0.710

Even though the first and second economic plans were implemented, because of lower level of education, technical change in the first 10-years period was negative. On the other hand, in the second period, the rate reached its highest level compared to the other years. The highest rate of technical change occurred in the second period, which can be explained by the favorable government policies for agriculture during mentioned period. In the third period, because of the Iraq-Kuwait war, the rates of technical change are negative.

DISCUSSION

The accounting for production growth showed that a significant share of average production growth can be attributed to the increase in both traditional and modern input sources. Among all inputs, increased tractors, irrigation and fertilizer were the most important sources of production growth. The sign of land input source on average productivity growth was negative in the first two 10-years period, meaning that the farmers have not used land efficiently. It is important that the productivity of land should be increased. The main goal of the GAP project in Turkish agriculture is to improve the productivity of land and yield of output per hectare. Increases in machinery input utilization will have little effect on agricultural productivity, unless it increases land productivity. Thus, a top priority in mechanization involves increased land productivity. The mechanization of irrigation can be given as a good example.

For some years, favorable policies of Turkish government have remarkably increased agricultural production. The labor input source seems to have a positive effect on the average productivity growth. However, by increasing mechanization in agricultural production, the amount of labor force should be decreased on agricultural land area and some other job areas must be open by the government. Instead of the traditional techniques, modern techniques should be used in agriculture and both optimal input source and plant pattern should be chosen to increase agricultural production.

Generally, the agricultural sector has been characterized by the predominance of a small group of independent peasants. This characteristic persists to the present day. Because too many people work in agriculture, some of them should be moved to the industrial production areas. To establish regular labor, new plant patterns should be used in agricultural production. With the right mix of input combination only, technical change can be increased. It should be shown to the farmers that by combining inputs optimally, higher technical change can be achieved.

Like some developing countries, the Turkish governments should make enough favorable policies for agricultural production. It should be noted that in the most developed countries both the industrial and agricultural sectors are developed also. In Turkey, generally the policies of the government have been done to increase industrial production. Because the prices of inputs are expensive, it sometimes becomes impossible for farmers to buy adequate quantities for use in agricultural production. Because the Turkish agriculture is seasonal, generally farmers can not have sufficient amount of money in the other seasons.

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