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Decomposition of Total Factor Productivity Growth of Pistachio Production in Rafsanjan Region of Iran

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Abstract: The stochastic frontier production model is one of the most used ways to estimate efficiency and productivity. The purpose of this paper was to decompose the sources of total factor productivity (TFP) growth into technological progress, changes in technical efficiency and changes in economies of scale. In this paper, we also used Divisia index in order to estimate production function. A random sample of 298 farmers selected from Rafsanjan Township for three years, 2004, 2005 and 2006, which was a larger data set with a wider spatial coverage than used in previous studies of pistachio production. Sampling approach of this paper was "Two stage cluster sampling" and the data for outputs and inputs were obtained during 2007 and the spring and summer of 2008, by filling questionnaires and interviewing 298 farmers in the region. Results showed that technological progress includes the majority of TFP growth, but that differences in efficiency change explained cross-region differences in TFP growth. Efficiency in the 19 contiguous regions averaged 52.52% from 2005 to 2007. Experience and firm size were both positively associated with efficiency, whereas age, education and farm size, were negatively associated with efficiency.

Jel: D21, D24, E23
Key words: TFP growth % Technical efficiency % Pistachio % Rafsanjan % Iran

INTRODUCTION

Productivity is basically a standard of measurement and its purpose is to organize the scarce resources and to earn more effective outputs. The 200-year history of industry and the entrance to the new world, the world of information and communication, is due to increases in productivity. Many studies have been done to measure and identify sources of productivity change and the cases provided below are some of them:

Fisher (1922), Tornqvist (1936) and Malmquist (1953) are the earliest examples of productivity indices. Solow (1957) has shown the methodology on how to measure aggregate productivity growth using the neoclassical growth model. He decomposes the output growth into two parts: one can be attributed to the input growth and the other to changes in aggregate productivity, which is termed as the Solow residual. His procedure has been replicated for many other countries, time periods and sets of inputs. Nonetheless, a defect of using this approach is that it does not identify sources of TFP growth. For example, it does not show that TFP growth originate from technological progress or from efficiency gains.

To overwhelm this defect, the issue becomes how to decompose TFP growth into its components. Researchers used some approaches to reach this aim. There are two general approaches: nonparametric techniques to create productivity indexes and stochastic frontier models. Girma, Holger and Strobl (2006) uses the semi-parametric approach to survey the effect of government grants on plant level productivity, using a plant level data set from Ireland. Based on the results obtained, only grants that support productivity enhancing activities increase total factor productivity. Salehirad and Sowlati (2007) studied the efficiency and productivity of British Columbia (BC) primary wood producers using Data Envelopment Analysis and Malmquist total factor productivity index, from 1990 to 2002. Based on results, BC sawmills were highly scale efficient and the major cause for their inefficiency was technical capability rather than scale of

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operations. A disadvantage of nonparametric techniques is that it is deterministic and so it labels any deviation from the frontier as inefficiency. It does not allow for the possibility of random events or for other factors to affect output. Only stochastic frontier models can account for the sources of TFP growth while also allowing for a stochastic environment. Stochastic frontier models consider both inefficiency and random disturbances as reasons why production is not at the technological frontier and distinguish between the two objects[1]. Graham. D.J, (2006) compares parametric productivity estimates and non-parametric efficiency scores for urban rail firms. It summarizes a decomposition of TFP change and proposed some hypotheses about how this relates to an analysis of efficiency using DEA. The results show that while estimates of returns to scale differ using the TFP and DEA methods, the ranking of urban rail efficiency is broadly similar.

Several applications of stochastic frontier models have been used by researchers. For example, Battese and Coelli (1992, 1995) examine efficiency levels of paddy farmers in India. Lundvall and Battese (2000) studied the relationship between firm's efficiency and its size and age of Kenyan manufacturing industry and concluded that the relation between efficiency and firm age is not significant. Mehrabi Boshrabadi and Gilanpour (2005) study the correlation between farm size and the level of mechanization and the productivity of agricultural machinery, in eight major farming products of Kerman province in Iran. In order to classify the farm size they used the Dalenius approach and to study the correlation between the farm size and mechanization, used the variance analysis and partial coefficient of correlation. They also used the production function approach to study the relation between the farm size and average and marginal productivities of machinery. Their results show the positive correlation between the farm size and level of mechanization and also the significant positive correlation between the farm size and productivity (marginal and average) of machinery. Yazdinpanah and Hejazi (2005) survey the productivity growth in farming sector of Iran with emphasize on the role of government investing during the period 1985-2003. This study shows that productivity growth is dependent on technical change, economies of scale and government investing. Margono and Sharma (2006) uses stochastic frontier model to estimate the technical efficiencies and total factor productivity (TFP) growths in food, textile, chemical and metal products industries from 1993 to 2000 in Indonesia. The results show that the food, textile, chemical and metal products sectors are on average 50.79%, 47.89%, 68.65% and 68.91% technically efficient, respectively and that the decomposition of TFP growth indicates that the growths are driven positively by technical efficiency changes and negatively by technological progress in all four sectors. Sharma, Sylwester and Margono (2006) surveys the sources of total factor productivity (TFP) growth for lower 48 U.S. states from 1977 to 2000 using the stochastic frontier production model. They found that technological progress comprises the majority of TFP growth but that differences in efficiency change explain cross-state differences in TFP growth. Bloch and Tang (2007) clarify a new technique to measure the effect of export demand on the conventional TFP growth index at the industry level. They apply the technique to Singapore's electronics industry and find that rapid growth in exports accounts for most of the TFP growth in this industry.

Some studies have been done on pistachio production in Iran. For example, Najafi and Abdollahi (1997) surveyed the efficiency of pistachio production in Rafsanjan using stochastic production frontier. Results showed that the mean efficiency for three regions of this township, Rafsanjan, Nugh and Anar are 52%, 40% and 50% respectively. Farbood, Abdollahi, Esmayelpur and Mirzayee (2006) also investigated the viewpoint of producers about turnover of pistachio product in this region. Results showed that 72% of producers are illiterate or have low literacy and 30% of producers are older than 60 years old and 40% of gardens are smaller than 2 hectares. Mehrabi Boshrabadi, Villano and Feleming (2007) used the stochastic frontier production function assuming a translog form to analyze the inefficiency in pistachio farming system in Iran. They also reported the productivity and efficiency differences between varieties of pistachio trees and provided estimates of age-yield and density-yield functions. Results showed that Farmers cultivating the more traditional mixed-variety plantation are significantly more technically efficient than those specializing in one of the tree varieties. They found a positive relation between technical efficiency and experience and suggested that extension programs should be done at the less experienced farmers.

The main objective of this paper was to decompose the sources of total factor productivity growth into technological progress, changes in technical efficiency and changes in economies of scale. And also the

[3] Sharma S. C. et al., Decomposition of total factor productivity growth in U.S. states, The Quarterly Review of Economics and Finance (2006), doi:10.1016/j.qref.2006.08.001

secondary objectives of this paper were to assess the inefficiency components in pistachio production in the study region and to examine the relation between managerial characteristics including age, education, experience, firm size farm size and efficiency.

This paper is organized as following Section 2 presents the methodology. It describes how we measure technical efficiency and how this methodology also allows us to estimate input elasticities as well as to decompose total factor productivity growth into its components. Section 3 describes the data and characteristics of study area and section 4 presents the results. A conclusion follows.

MATERIALS AND METHODS

Stochastic Production Frontier Estimation

Technical Efficiency: In many economic contexts, it is considered that producers are operating at the frontier, except for a randomly distributed error term with the aim of maximizing production at given level of inputs. But empirical evidences don't allow for this consideration because of inefficiency. On the other word, in the real world producers are operating inside the frontier, because of both error term and inefficiency [2]. So, you can see the deterministic component of stochastic production frontier for cross-sectional time series data, because we are estimating the frontier for 298 producers over a 3-year time span, in the Eq. (1).

$$y_{it} = f(x_{it}, t, b)e^{-u_{it}} \; or \; \ln y_{it} = \ln f(x_{it}, t, b) - u_{it} \quad (1)$$

Where, y_{it} denotes the output of the *i*th producer at time *t*.

And the stochastic production frontier with a random error term is:

$$y_{it} = f(x_{it}, t, b)e^{e_{it}} \text{ With } e_{it} = v_{it} - u_{it} \text{ and } u_{it} \geq 0 \quad (2)$$

Where *i*=1, 2. . . *m*, denotes the producer and *t*=1, 2, . . . *T* denotes the time trend and used as a proxy for technological change. The vector x_{it} represents inputs for producer *i* at time *t* and $ is a vector of coefficients to be estimated. Lastly, $å_{it}$ is the stochastic error term, which is made-up of the two unobservable v_{it} and u_{it} which are independent of each other. The v_{it} denotes a two-sided error term representing statistical noise and is assumed to be normally distributed with mean zero and variance s_v^2.

The u_{it} represents a one-sided error term representing output oriented technical inefficiency. Following Battese and Coelli (1995), we assume that the u_{it} is obtained by the truncation at zero of the normal distribution with mean $*z_{it}$ and variance s_v^2. The z_{it} denotes a (*g*×1) vector of region and managerial specific variables considered to be factors contributing to the inefficiency of the region and * is a (1×*g*) vector of unknown coefficients. Thus, the technical inefficiency components, u_{it}, in (2) are specified as:

$$U_{it} = d_{2it} + w_{it} \quad (3)$$

Where the w_{it} denotes truncated normal random variables with zero mean and variance s_v^2. Thus the u_{it} are distributed as N+ ($*z_{it}$, s_v^2). In other words, this truncation occurs at the point $-*z_{it}$ so that u_{it} is nonnegative.

From one aspect, Jondrow, Lovel, Materov and Schmidt (1982), suggest to estimate the mean or mode of the conditional distribution of u_i given $å_i$, which can be used as a point estimate of u_i. And from the other aspect, because the production function is generally defined for its logarithm, Battese and Coelli (1988) claim that technical efficiency for the *i*th unit should be defined as *E*[exp(-u_i)|$å_i$]. They also extended the Jondrow *et al.* (1982) results to the case of a cross-sectional and time series model. Therefore, for the cross-sectional time series set up in this study, we estimate technical efficiency as in Battese and Coelli (1988): TE*it* = *E*[exp(-u_{it})|$å_{it}$]. But for achieving to estimates of TE*it*, we should determine the functional form *f*(x_{it}, *t*, $) in (1). In this paper we use the translog function[3].

We choose the inputs as water, W, labor, La, Divisia index, D and Technological change is captured by the time trend, *t* .about Divisia index, water, labor and time are out if it and other inputs including; chemical and animal fertilizer, poison and machinery are inside of it. The Divisia index is calculated as:

[2] For more information about stochastic frontier model, interested reader is referred to Coelli et al. (2005) and Kumbhakar and Lovell (2000).

[3] For more information about translog function, interested reader is referred to the following references:
Christensen, L. R., Jorgenson, D.W., & Lau, L. J. (1971). Conjugate duality and the transcendental logarithmic function. Econometrica, 39, 255-256.
Christensen, L. R., Jorgenson, D. W., & Lau, L. J. (1973). Transcendental logarithmic production frontiers. Review of Economics and Statistics, 55, 28-45.

$$D_{w,la,t} = \prod_{i=1}^{4} x_i^{b_i} \tag{4}$$

Where $D_{w,la,t}$ is Divisia index used for water, labor and time; x_i represents *i*th input (including chemical and animal fertilizer, poison and machinery) and $\$_i$ represents share of *i*th input in variable cost. Thus, the translog specification of $f\,(x_{it},\, t,\, \$)$ is given by:

$$\ln f(x_{it},t,b) = b_0 + b_1 \ln w_{it} + b_2 \ln la_{it} + b_3 \ln D_{it} + b_4 t + 0.5\left[b_5 (\ln w_{it})^2 + b_6 (\ln la_{it})^2 + b_7 (\ln D_{it})^2 + b_8 t^2 \right] \\ + b_9 \ln w_{it} \ln la_{it} + b_{10} \ln w_{it} \ln D_{it} + b_{11} t \ln w_{it} + b_{12} \ln la_{it} \ln D_{it} + b_{13} t \ln la_{it} + b_{14} t \ln D_{it} \tag{5}$$

Substituting (5) into (2) gives the translog production frontier which is estimated by maximum likelihood.

Total Factor Productivity: Taking total differential from ln $f(x_{it},\, t,\, \$)$ in (1) with respect to time results:

$$\frac{d \ln f(x,t,b)}{dt} = \frac{\partial \ln f(x,t,b)}{\partial t} + \sum_j \frac{\partial \ln f(x,t,b)}{\partial x_j} \frac{dx_j}{dt} \tag{6}$$

The first term on the right hand side of (6) gauges technological progress, TP, Which for the translog production function in (5) is:

$$TP_{it} = b_4 + b_8 t + b_{11} Ln(w_{it}) + b_{13} Ln(La_{it}) + b_{14} \ln D_{it}) \tag{7}$$

The second term on the right hand side of (6) can be written as:

$$\sum_j \frac{\partial \ln f(x,t,b)}{\partial x_j} \frac{dx_j}{dt} = \sum_j e_j \dot{x}_j \tag{8}$$

Where e_j is the output elasticity of the *j*th input $ej = \frac{\partial Lnf}{\partial x_j}$ and $\dot{x}_j$ is the change of the *j*th input over time. The output elasticities with respect to water, labor and Divisia for the translog production function in (5) are given by:

$$e_{wit} = \frac{\partial Ln(Y_{it})}{\partial Ln(w_{it})} = b_1 + b_5 Ln(w_{it}) + b_9 Ln(la_{it}) + b_{10} \ln(D_{it}) + b_{11} t \tag{9}$$

$$eLa_{it} = \frac{\partial Ln(Y_{it})}{\partial Ln(La_{it})} = b_2 + b_6 Ln(La_{it}) + b_9 Ln(w_{it}) + b_{12} (\ln D) + b_{13} t \tag{10}$$

$$eD_{it} = \frac{\partial \ln(y_{it})}{\partial \ln(D_{it})} = b_3 + b_7 \ln(D_{it}) + b_{10} \ln(w_{it}) + b_{12} \ln(La_{it}) + b_{14} t \tag{11}$$

Finally, total differential of ln $f(x,\, t,\, \$)$ with respect to time is:

$$\dot{y} = \frac{d \ln f(x,t,b)}{dt} - \frac{du}{dt} = TP + \sum_j e_j \dot{x}_j + \Delta TE \tag{12}$$

Where *) TE =-Mu/Mt* is the change in technical efficiency. Therefore, from Eq. (12) changes in output is not only due to technological progress, TP and changes in input use but also by changes in technical efficiency.

To show the effect of TP and)TE on)TFP growth, $\dot{TFP}$ is defined as output growth not described by input growth:

$$T\dot{F}P = \dot{y} - \sum_j S_j \dot{x}_j \qquad (13)$$

Where, s_j is *j*th input share in production costs. By substituting (13) in (12), we obtain:

$$T\dot{F}P = TP + \Delta TE + (e-1)\sum_j l_j x_j + \sum_j \left(l_j - S_j\right)\dot{x}j \qquad (14)$$

Where $e = \sum e_j$ denotes a standard of returns to scale, $\ddot{e}_j = e_j/e$.

Data and Statistical Characteristics of Study Area: For accomplishment of this research we spot farmlands of Rafsanjan Township which is north-western region of Kerman province in Iran including 110000 hectare of land with 1400 well that are under management of almost 40000 farmers. The sampling approach of this paper is "Two stage cluster sampling" and the main clusters of this research are wells. From 1400 well we stochastically chose 93 well as the main clusters. Data for outputs and inputs are obtained during 2007 and the spring and summer of 2008 by filling questionnaires and interviewing 298 farmers in the region about data on production (4 different varieties) and seven inputs including land (L), labor (La), water (w), chemical fertilizer (F), animal fertilizer (AF), poison (P) and machinery (Ma).

Since in many farms a mixture of different varieties is being produced, for these farms we consider the aggregate production of different varieties. For water, we use the annual aggregate consumption of water at cube meter. For labor, we use the annual aggregate labor (permanent, seasonal and domestic). Since the final function is at production in one hectare of land, both two sides of function are divided on land and so land input is omitted. For chemical fertilizer, we use annual aggregate usage at kg. For animal fertilizer, we use the annual aggregate usage at tone. For poison, we use aggregate usage at litter. And for machinery, we use annual aggregate usage at hour.

The Z vector including inefficiency characteristics is adding to the deterministic component of production function: farmer's age, Z_1, farmer's education, Z_2, farmer's experience, Z_3, firm size, Z_4 (overall cultivated land on hectares), garden size, Z_5 and finally we use a set of regional dummies including Rafsanjan, Z_6, koshkuiye, Z_7, Nugh, Z_8, on the base of control region, Anar.

Based on information from Jihad-e-Agriculture (2004) the average product for this region is 1200 kg dried pistachio per hectare, whereas in this study the mean obtained 2598 kg dried pistachio per hectare. The reason for this deference is in the approach of accounting average product. In Jihad-e-Agricultural approach, they divide sum of export and domestic sale to the total recorded cultivated land. Whereas, there are many gardens that do not reach to the production period and also a large amount of recorded agricultural lands have been change their usage to commercial or residential and also a large amount of agricultural lands have been changed to arid lands because of water leakage and drought. Therefore real total cultivated land is less than recorded cultivated land and so decrease to the denominator results increase to the average product.

Regarding managerial characteristics there are some points; 41% of producers in this sample have low literacy or are illiterate (reported 70% in Farbood. et. al). 14.5% of producers are older than 60 years old (reported 30% in Farbood. et. al). 72% of gardens are smaller than 2 hectare (farm size in this study) (reported 40% in Farbood. et. al). 40% of producers have less than 2 hectare of total cultivated land (firm size in this study).

RESULTS AND DISCUSSION

Table 1 presents estimates of the translog production function and some of the coefficients in the production function are not individually statistically significant. But the null hypothesis that the coefficients $5-$14 all are equal to zero is rejected at significance levels with a Chi-square statistic of 565.936 and this means that the translog functional form is preferred over a Cobb-Douglas.

(in the Table 1 shows the variance of the inefficiency component of the error term . It is nearly one and shows that the majority of the variation in å is due to inefficiency component and is not measurement error. The likelihood ratio test statistic is 1355.57 whereas the critical value is 25.18 (for 10 d.f.). This means that null hypothesis that (=0 and $*_0 = *_1 = \ldots = *_8 = 0$ with 10 degrees of freedom is refused. If the null hypothesis would have been accepted, this would indicate that s_u^2 is inconsiderable relative to s_v^2 and that producer characteristics are not the cause of inefficiency. The u_{it} term should then be removed from the model and thus the model could be consistently estimated using ordinary least squares.

Table 1: Coefficient estimates of translog production function and inefficiency components

Parameter	Variable	Estimate	Standard error
Production function			
β_0	Intercept	1.41*	0.1712
β_1	$Ln(W_i)$	0.2362*	0.1115
β_2	$Ln(La_i)$	0.5549*	0.122
β_3	$Ln(D_{w,l,la})$	0.1909	0.1045
β_4	T	-0.5386*	0.1888
β_5	$(Ln(W_i))^2$	0.1741	0.1097
β_6	$(Ln(La_i))^2$	-0.0026	0.1116
β_7	$(Ln(D_{w,l,la}))^2$	-0.0762	0.0599
β_8	t^2	0.3001*	0.0925
β_9	Ln(w)*Ln(La)	-0.1488	0.0789
β_{10}	Ln(w)*Ln(D)	0.0469	0.0766
β_{11}	Ln(w)*t	-0.0163	0.0529
β_{12}	Ln(La)*Ln(D)	0.0267	0.0769
β_{13}	Ln(La)*t	0.0023	0.0557
β_{14}	Ln(D)*t	-0.0331	0.0469
Inefficiency components			
δ_0	Intercept	-35.53*	5.019
δ_1	Age	4.079*	0.6468
δ_2	Education	3.467*	0.3831
δ_3	Experience	-3.014*	0.4205
δ_4	Firm size	-0.1091	0.0605
δ_5	Farm size	0.6866*	0.2571
δ_6	Rafsanjan	-8.708*	1.6
δ_7	Koshkuiye	2.155*	0.9992
δ_8	Nugh	1.6917*	0.3741
σ_u^z	Variance of inefficiency	30.347*	2.7032
γ	$\frac{\sigma_u^2}{\sigma_u^2+\sigma_v^2}$	0.9966*	0.00052

Ref: research results

* Denotes significance at 5% level.

Table 2: (TFP) growth, technological progress and efficiency change on the base of cities, villages and geographical regions.

Region	City/village	$\dot{TFP}$	S.D	TP	S.D	ΔTE	S.D	Scale	S.D
	Rafsanjan	0.231	0.244	0.211	0.154	0.019	0.217	0.002	0.056
	Davaran	0.217	0.219	0.211	0.156	0.02	0.145	-0.014	0.04
Rafsanjan	Darrejoze	0.209	0.241	0.195	0.159	0.013	0.136	0.001	0.013
	Jafarabad	0.183	0.309	0.195	0.159	-0.023	0.325	0.012	0.057
	Kamalabad	0.149	0.192	0.199	0.156	-0.049	0.256	-0.002	0.016
	Kabutarkhan	0.142	0.155	0.17	0.155	-0.022	0.21	-0.006	0.029
	Region average	0.2058	0.2296	0.2028	0.152	0.0025	0.2209	0.0005	0.0516
Koshkuiye	koshkuiye	0.234	0.067	0.221	0.159	0.003	0.172	0.011	0.028
	lotfabad	0.247	0.255	0.219	0.16	0.031	0.197	-0.003	0.007
	Region average	0.2405	0.1613	0.2182	0.1543	0.0172	0.1845	0.0046	0.0175
Nugh	Bahrahman	0.198	0.213	0.211	0.166	-0.006	0.102	-0.008	0.029
	Javadiye	0.216	0.257	0.212	0.158	0.006	0.215	-0.002	0.022
	Elahiye	0.14	0.281	0.203	0.161	-0.066	0.209	0.003	0.01
	Ravamehran	0.209	0.41	0.223	0.159	-0.018	0.308	0.004	0.021
	Daghughabad	0.203	0.238	202	0.157	-0.002	0.141	0.002	0.015
	Ahmadiye	0.213	0.258	0.207	0.153	0.011	0.22	-0.005	0.035
	Roknabad	0.192	0.327	0.227	0.163	-0.021	0.294	-0.013	0.048
	Region average	0.2071	0.2661	0.21	0.1547	-0.0007	0.2212	-0.0022	0.0274
Anar	Anar	0.362	0.595	0.167	0.198	0.044	0.323	0.151	0.359
	Aminshahr	0.239	0.238	0.214	0.152	0.017	0.224	0.007	0.065
	Gholshan	0.256	0.242	0.227	0.155	0.02	0.205	0.009	0.037
	Gholestan	0.22	0.154	0.194	0.153	0.042	0.198	-0.016	0.038
	Region average	0.2464	0.2433	0.2165	0.1536	0.0199	0.2179	0.01	0.0789
	Total average	0.214	0.258	0.206	0.16	0.001	0.216	0.007	0.049

Ref: research results

Table 3: Technical efficiency estimates on the base of cities, villages and geographical regions.

Region	Average efficiency	Rank based on average	S.D	Efficiency in 2005	Rank in 2005	Efficiency in 2007	Rank in 2007
Rafsanjan	0.63	2	0.034	0.5941	4	0.6325	1
Davaran	0.5424	10	0.033	0.5384	9	0.5779	5
Darrejoze	0.5319	11	0.033	0.536	10	0.563	9
Jafarabad	0.6108	4	0.034	0.6191	1	0.5734	7
Kamalabad	0.6116	3	0.108	0.6048	3	0.5069	13
koshkuiye	0.3867	19	0.091	0.2844	19	0.4141	17
lotfabad	0.5602	8	0.03	0.5851	5	0.5694	8
Kabutarkhan	0.6689	1	0.094	0.6156	2	0.613	2
Bahrahman	0.5532	9	0.025	0.5729	7	0.5617	10
Javadiye	0.438	16	0.005	0.4312	17	0.4425	14
Elahiye	0.4513	14	0.067	0.5259	11	0.3947	18
Ravamehran	0.4012	17	0.098	0.4749	15	0.4389	15
Daghughabad	0.5648	7	0.019	0.5775	6	0.5744	6
Ahmadiye	0.5697	6	0.012	0.5555	8	0.578	4
Roknabad	0.4483	15	0.029	0.4578	16	0.4148	16
Anar	0.5339	5	0.055	0.5205	12	0.6085	3
Aminshahr	0.5208	12	0.023	0.4939	13	0.5287	11
Gholshan	0.5128	13	0.028	0.4811	14	0.5204	12
Gholestan	0.3916	18	0.098	0.3206	18	0.35	19
Total average	0.5252		0.033	0.5152		0.5191	

Ref: research results

Table 2 represents the TFP growth results. Because the number of producers is great, these results are presented on the base of cities, villages and geographical regions. But the overall results on the base of firm are available from the authors upon request. The first column presents the average TFP growth rate for each region during the period along with the standard deviation.

The remaining columns present averages and standard deviations for technological progress, changes in efficiency and changes in scale.

There are two important points in Table 2: First: results of Table 2 regarding technological progress show that TP is greater than efficiency change. It means that, technological progress has greater role in contributing to TFP growth than changes in efficiency. Therefore, TFP growth is due more to outward shifts of the production frontier than by movement towards it. Second: there is less variability in technological progress relative to changes in efficiency: Anar had the least technological progress at the average annual growth rate of 0.167 whereas Gholshan and Roknabad had the highest at 0.227. Whereas the changes in efficiency of Elahiye is the least, with the average annual growth rate of -0.066 and of Anar is the highest, with the average annual growth rate of 0.044. Therefore, what we can say from second point is that, what distinguishes regions with high TFP growth from those with low TFP growth is changes in efficiency. Putting the two points together, we conclude that TFP growth across regions is largely due to technological progress whereas differences in TFP growth are due to differences in efficiency changes. As one can see, regions with the highest (Anar: 0.0362) and lowest (Elahiye: 0.140) TFP growth are the ones with the greatest changes in efficiency (Anar: 0.044, Elahiye: -0.066).

In Table 3 we survey technical efficiency and its changes across regions. In this table, there are estimates of technical efficiency for each region in 2005 and 2007 as well as provides an average over time. Estimates for all years and producers are provided upon request. As one can see, the average efficiency score increased from 51.52% in 2005 to 51.91% in 2007. The minimum efficiency score in 2005 was 28.44% (koshkuiye) whereas the maximum was 61.91% (Jafarabad). In 2007, their respective counterparts were 35.00% (Gholestan) and 63.25% (Rafsanjan).

Finally, Table 3 also includes the rank (1 is most efficient, 19 is least efficient) based on this average. From this ranking, producers in Rafsanjan are most efficient whereas those in koshkuiye are least efficient. Producers of Anar and Nugh are distributed throughout the middle.

To continue our progress, we surveyed managerial characteristics that are associated with efficiency and the coefficient estimates for these characteristics were represented in the Table 1. A positive coefficient denotes a negative relation with efficiency (positive relation with inefficiency).

Table 4: Elasticity estimates on the base of cities, villages and geographical regions.

Region	Mean e_w	S.D	Mean e_{la}	S.D	Mean e_D	S.D	Mean $_{ew+ela+eD}$
Rafsanjan	0.176	0.123	0.579	0.072	0.097	0.057	0.852
Davaran	0.162	0.099	0.574	0.082	0.102	0.039	0.838
Darrejoze	0.176	0.054	0.546	0.041	0.094	0.036	0.816
Jafarabad	0.131	0.108	0.558	0.083	0.091	0.041	0.78
Kamalabad	0.244	0.059	0.525	0.043	0.105	0.038	0.874
koshkuiye	0.199	0.12	0.539	0.111	0.136	0.052	0.874
lotfabad	0.248	0.133	0.518	0.127	0.14	0.057	0.905
Kabutarkhan	0.178	0.165	0.458	0.177	0.112	0.079	0.748
Bahrahman	0.199	0.055	0.529	0.049	0.127	0.031	0.855
Javadiye	0.23	0.131	0.535	0.138	0.12	0.039	0.886
Elahiye	0.226	0.1	0.506	0.074	0.125	0.046	0.857
Ravamehran	0.089	0.019	0.596	0.092	0.117	0.082	0.803
Daghughabad	0.217	0.105	0.557	0.065	0.092	0.047	0.866
Ahmadiye	0.219	0.112	0.545	0.076	0.107	0.038	0.871
Roknabad	0.044	0.048	0.627	0.021	0.111	0.024	0.782
Anar	0.293	0.156	0.546	0.079	0.033	0.17	0.873
Aminshahr	0.192	0.079	0.586	0.076	0.095	0.069	0.874
Gholshan	0.193	0.103	0.561	0.064	0.132	0.056	0.887
Gholestan	0.192	0.104	0.547	0.079	0.133	0.056	0.842
Total average	0.188	0.099	0.549	0.081	0.109	0.056	0.847

Ref: research results

The coefficients of age and education are positive, which mean producers with higher education and those who are older than others have lower levels of efficiency. Being old does not mean that one is experienced. There are some people who are old but have recently entered in production of pistachio and so they are not experienced. From the other aspect, increase in age results in decrease in management power and in risk taking. So the older producers are satisfied with a livelihood return. Regarding education; many of educated producers are not experienced enough to developed producing. From the other aspect, since educated producers are in scientific environments, they have a great tendency to utilize new inputs and approaches. This behavior results in increase in risk taking and not to use some experiences and traditional approaches that are efficient. Putting the three together, inadequate experiences, high risk taking and not using efficient experiences and traditional approaches result in lower levels of efficiency regarding educated producers.

The coefficient on experience is negative meaning producers with higher experience have higher levels of efficiency. Experienced producers have the tendency to utilize the efficient traditional and tried new scientific approaches, so they have high levels of efficiency. The coefficient on firm size is negative meaning producers who have the greater total cultivated land have higher levels of efficiency. One possible explanation is the intensive use of variable inputs such as labor and also divisibility of fixed inputs such as machinery, capital and land. In addition, because of the greater finance power, the greater firms have the ability of utilizing expensive inputs and approaches, such as expensive chemical or animal fertilizers, or the use of soil conservation approaches and also annual fertilizing instead of alternate fertilizing- which is common in intermediate producers-. In addition, because of high finance power and bargain power, which result from widespread relations, which is the result of grandeur of a firm, these firms con use the seasonal water and this ability has an important effect on increasing the efficiency. Herein one should pay attention to this point that since pistachio production is a long time production, (at least it takes 6-7 years to start breeding and 10-12 years to reach to the peak of production), there is the possibility that some small firms don’t reach to the peak of production yet and this issue could be the reason for the low degree of efficiency obtained by this firms. Whereas for larger firms which have variety of gardens with different ages, it is possible that older gardens compensate the negative effect of younger gardens and this possibility could be the reason for high degree of efficiency for great firms.

The coefficient on farm size is positive, indicating that the greater farms have lower efficiency levels. This event is the result of non intensive use of inputs such as land and water. In great farms in order to simplify the spraying, fertilizing and harvesting they should design the farms so that medium tractors and not small tractors, con work in these farms. This matter causes the not optimal use of land in respect with smaller farms.

Regarding the regional dummies, all of three are significant (the Anar region is the control). The coefficient on Rafsanjan is negative, while coefficients on Nugh and Koshkuiye are positive. These coefficients indicate that producers in the Rafsanjan are found to have greater efficiency in respect with Anar. However, producers of Nugh and Koshkuiye have lower efficiency in respect with producers of Anar.

In the final step, we surveyed the economies of scale component of TFP growth. As one can see from Table 4, the mean value of labor elasticity is 0.549, while that for water is 0.188 and for Divisia index is 0.109. Adding the three together, the returns to scale, e, is 0.847 and implies that the assumption of constant returns to scale that is often made in the literature when examining aggregate economies, to some extent is appropriate here. This also shows why the economies of scale component of TFP growth is so small since this component drops out of Eq. (13) when e = 1. Anar has the highest water elasticity and the lowest Divisia index elasticity whereas Roknabad has the lowest elasticity of water and highest elasticity of labor and Kabutarkhan has the lowest elasticity of labor and Lotfabad has the highest elasticity of Divisia index.

Conclusion and Recommendation: This paper examined decomposition of total factor productivity growth across producers of pistachio in Rafsanjan by filling questionnaires and interviewing 298 farmers in the region. Our findings are summarized as follows:

TFP growth mainly stems from technological progress. However, differences in TFP growth across regions mainly stem from differences in efficiency change.

Efficiency in the 19 contiguous regions averaged 52.52% from 2005 to 2007.

Experience and firm size are both positively associated with efficiency. Whereas, age, education, farm size are negatively associated with efficiency.

Mean efficiency of this region is low and the reasons are:

- Some farms still don't gain the peak of their production. This matter can affect the results of any research. So we can say that region mean efficiency is higher than 52.52. The process of gaining the peak of production is so long that in the Akbari variety it takes 15- 20 years.
- Low quality inputs. Specially water.
- Risk avoidance of farmers which is due to: oldness of farmers; low being the acceptance degree of new technologies; low finance ability of farmers.
- The low speed of information transmission among farmers.

The mean production in one hectare shows increase with respect to the past. The reasons are:

- Implementation of agricultural production insurance.
- We can divide the agricultural technology into two branches; machinery and chemical technologies. The impact of chemical technologies on production growth is higher than machinery.

Based on the obtained results, we recommend that:

- TFP growth mainly stems from technological progress. As a result, we suggest preparing required conditions for technological progress, such as promotional classes with farmer's cooperation or promotional leaflets.
- Although agricultural production insurance has undeniable effect on farmer's relief, but farmers believe that reimbursement does not reimburse all loss. Therefore, increase to reimbursement could be a good solution that can cause agriculture to move toward modern agriculture.
- We recommend leading the technology toward the chemical technologies mid increase to the reimbursement which will cause increase to the finance ability and therefore increase to risk acceptance of farmers and movement of agriculture toward modern agriculture.

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