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Determining the Role of Inefficiency on Elasticity of Output Supply and Input Demand: A Case Study of Irrigated Wheat in 27 provinces of Iran

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Abstract

This article appraises the impressions of technical and price or allocative inefficiency on elasticity of the supply of wheat and demand of its inputs in 27 provinces of Iran. To this purpose, first the technical, price and economic efficiency has been calculated utilizing the stochastic frontier functions of production and cost. The influencing factors of efficiency including: the degree of scale economies, the share of technology in manufacturing process, the share of governmental supports, the cost of production processes and the experience have been estimated via a panel data approach. At the end, rejecting the hypothesis of perfect efficiency of farmers in production, the functions of output supply and input demand have been assessed in two scenarios (concerning efficiency and inefficiency) using a profit function and the impact of general (economic) inefficiency on relative and crossover elasticities of output and input are evaluated. The results show that the average of technical, price and economic efficiency of irrigated wheat respectively equal to 69, 63 and 45 percent. The estimated parameters have been affected, concerning the inefficiency. Although relative elasticities of output and inputs are appeared with expected signs, entering the inefficiency, elasticity of irrigated wheat is generally increased.

Keywords: Stochastic frontier function, profit function, output supply and input demand function, irrigated wheat

Introduction

Agriculture has been always one of the most important economic subsectors in Iran's economy; so that averagely about 15 percent of the gross domestic product (GDP) in the period 2000-2009 belongs to this sector, based on central statistics (Central Bank of the Islamic Republic of Iran). Therefore, the growth and development of this sector can play a key role in Iran's economic development. The presence of basic commodities in cultivation subgroup of agriculture, high proportion of cultivation vintages in productions of agricultural sector and over 30 percent weight of basic cultivation commodities in foods and drinks index of household basket have turned this subgroup into the center of economic planners' attention for quite a while. Wheat is

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the most strategic product of Iran among agricultural products which government is ever trying to be independent in its production and secure its need inside the country. So, the raise of its production has been always one of the most influential objectives. Change in wheat production can be due to more hiring of production inputs or increase of its producers' efficiency. Considering the fact that there are limitations for the inputs in economy, politicians have to plan to increase the efficiency of productions. So efficiency calculation has a high level of importance as the first step in determining the optimal level of inputs usage.

This sector's producers just like it in other economic sectors, are in pursuit of their efficiency increase (especially in cases with economies of scale). The most efficient level of agricultural production output is achieved in a point in which producer is able to attain the maximum output with specefic amount of input. Nevertheless, it should be noticed that the type and amount of farmer's costs have a determining role in his efficiency in devotion of costs to inputs (allocative efficiency). Surely, there is a straight relationship between efficiency (whether technical, allocative or economic) and the extent of firm's ability to manufacture the product. Also the point which is often left disregarded in most studies is the effects which changes of efficiency have on the price fluctuations - as one of the essential parts of agricultural sector; the reason is that efficiency is in relationship with production and supply and they have also relation with price. The empirical studies done on agricultural production efficiency have been classified in two main groups during last four decades. First, studies which estimate inefficiency of different producer, regardless of the price reactions (like Battese and Seiford), while the second group have investigated the price reactions of agricultural production supplies and input demand with obvious efficiency (like Ball; Shumway, Saez, and terttoG). In the first group on which studies are usually done, there isn't the possibility of scrutinizing the impacts of price changes on inefficiency. The study of inefficiency impact on the price functions is neither possible in the second group. The simultaneous study of the relationship between efficiency and price enables the researcher to survey the impacts of inefficiency on price without concerning the assumption of exogenous efficiency or price fluctuations. As, the reaction of the prices to which producers are in touch is presented in output supply and input demand, the study of inefficiency impacts on the price of agricultural sector can be realized thanks to its impacts on the output supply and input demand. Hence, this study aims to scrutinize the changes of inputs elasticity as it appraises the effective factors on efficiency and effects of output supply and input demand to be able to offer policy recommendations for increasing the efficiency of Iranian wheat farmers.

Data and methodology

Types of efficiency

The issue of efficiency started with the study of Farrell (1957) based on the study of Debrev and Coopeman. Farrell suggested that the efficiency of an economic unit consists of two parts: 1. Technical efficiency and 2. Price (allocative) efficiency. The combination of these two touchstones together presents the general (economic) efficiency. According to Farrell's definition, there are two approaches to investigate the precise definition of efficiency and its calculating relations.

Measuring the efficiency based on minimizing the factors of production (input oriented)

Farrell presented the definition of varieties of efficiency, using a simple sample in which a firm uses two inputs of x_1 and x_2 for manufacturing one unit product of "q" under the fixed economies of scale. The isoquant curve of an economic unit that the distance function of which stands on the production possibilities frontier curve, is illustrated by (SS') in diagram(2).

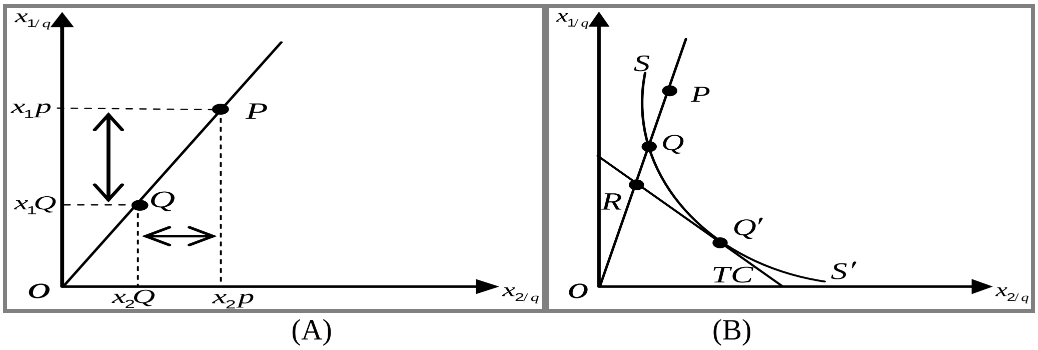

Diagram 1: The definition of different types of efficiency based on minimizing the production factors

If an assumed firm hires the inputs in a level which could be defined by the P situation; It is possible to present different types of efficiency based on diagram (1) from Farrell's perspective by the use of distance functions characteristics:

Technical efficiency: It is predicated as the firm's ability to produce the maximum product by the specific collection of input. If the production of assumed firm P, using inputs x_1P, x_2P only equals the production level which is shown by the SS' isoquant curve at the point Q, so this firm will reach the same production by decreasing the use of input. From diagram perspective, the firm P can preserve its production level by decreasing the x_1P-x_1Q for the first input and x_2P-x_2Q for the second input (part B diagram 1). This means that by decreasing QP/OP percent of the x_1P and x_2P, the firm can reach the point in which it has used the minimum of inputs for the production. Based on this explanation, the proportion OQ/OP represents the technical efficiency of the firm P which is less than 1 (equation 1). It is obvious that if the firm was in the Q point, this proportion would be equal to "1" which meant that the firm was technically efficient.

$$TE = OQ/OP \qquad (1)$$

Price efficiency (Allocative): It refers to the ability of the firm in choosing a collection of optimal inputs with minimal cost. Therefore, the price and technical efficiency is presented as equation (2) about the assumed firm P.

$$AE = \frac{W'X^*}{W'\hat{X}} = \frac{OR}{OQ} \qquad (2)$$

Where: W is the vector of inputs price, X is the vector of inputs observed at point P, $\hat{X}$ is the vector of a technically efficient input (point Q) and X^* is demonstrator of input vector with the minimal cost (Q' point). If production accomplishes in Q' (price and technical efficiency) instead of Q point (technical efficiency and price inefficiency) on an isoquant curve, the above equation would be demonstrator of decrease of production costs. Refer to diagram (2) for further explanation.

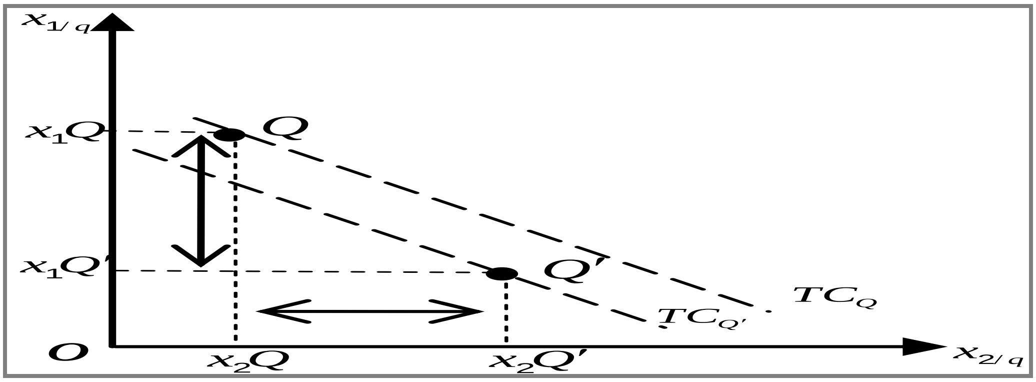

Diagram 2: Definition of price efficiency from Farrell's perspective

The firm's cost at the point Q is calculated by summing up the first ($P_{x1}x_1Q$) and second ($P_{x2}x_2Q$) purchasing cost of input which is on the TC_Q isocost line. If producing at the point Q', the cost would be calculated by summing up the first($P_{x1}x_1Q'$) and second ($P_{x2}x_2Q'$)purchasing cost of input which is on the $TC_{Q'}$ isocost line. So, the firm can do the same production with decreasing the cost of ($P_{x1}x_1Q'$-$P_{x1}x_1Q$) for the first and ($P_{x2}x_2Q'$-$P_{x2}x_2Q$) for the second input.[2] This means that the firm can reach the primary levels of production by decreasing the cost of $P_{x1}x_1Q$ two $P_{x2}x_2Q$ with the proportion $\frac{RQ}{OR}$. So, the price efficiency equals to the fraction $\frac{OR}{OQ}$.

The economic (general) efficiency: It indicates the firm's ability in the maximal production of output, selecting the optimal collection of inputs (the highest output with the lowest cost in the technical frontier) (equation 3). When the input price is determined, this kind of efficiency can be calculated. If W is the inputs price vector and X is the observed vector of inputs at the point P, $\hat{X}$ is also the demonstrator of the technically efficient input frontier (Q point) and X^* is demonstrator of input vector with minimal cost (Q' point). Thus, the general efficiency of the firm is equal to the proportion of input costs related to the input vectors in X and X^* which are related to P and Q'.

$$EE = \frac{W'X^*}{W'X} = \frac{OR}{OP} \quad (3)$$

The distance is RQ. This can be shown drawing two isocost lines from the points Q and Q'. Also, economic efficiency is calculated by multiplying technical and allocative efficiency. (Equation 4)

$$TE \times AE = \frac{OQ}{OP} \times \frac{OR}{OQ} = \frac{OR}{OP} = EE \quad (4)$$

Technical, price and general efficiency will fluctuate between zero and one that reveals that the general efficiency is always less than or equal to the technical efficiency.

The practical action mentioned above to measure different types of efficiency, began by publishing Farrell's article in scrutinizing the efficiency of agricultural sector in the economy of United States. Farrell's method is

[2] It is assumed that the cost of factors hasn't changed.

based on the comparison of the actual performance of production in the firm and the best performance on the frontier production. As a whole, measuring the efficiency is possible by two methods of 1. Non-arametric and 2. Parametric. The nonparametric method in measuring efficiency is highly affected by quantitative and qualitative variables' categorization in the form of Data Envelopment Analysis. In this analysis, measuring different types of efficiency is only possible by integrating the amounts of inputs and outputs and by the linear planning method. In parametric method, the econometric calculation methods are used for estimation of different types of efficiency which are typically done in the form of stochastic frontier analysis (Parmeter and *et al.*, 2013*)*. Both methods are used in various papers and they have their own particular advantages and disadvantages.

Table (3) presents the concise comparison of the weak and strength points of both methods.

"The Stochastic Frontier Analysis method has more popularity through the research methodology and innumerable empirical studies during recent decades." (Kuosmanen & Kortelainen, 2012*)* Econometric methods in efficiency estimation by frontier analysis method (in parametric method) can be categorized in two branches of primary and dual. The primary method (or straight based on production function) is the most popular method for the estimation of efficient frontier which the invalidity of model parameters through being biased and inconsistent, are the most vital problems of this method (Henderson & Parmeter, 2013*)*. Noting the existence of uncontrollable factors like climatic changes, a "stochastic frontier analysis" is preferred over a "data covering analysis" for estimation. Furthermore, as dual method has the possibility of presenting the replacement behavioral objectives (minimal cost or maximal profit) and gives the researcher the possibility of estimation of multiple products, it is a more valid method for estimation (*Greene2003).* So, the frontier production function is used for technical efficiency estimation and the frontier cost is used for allocative efficiency estimation (Battese and Coelli 1992).

$$Y_{it} = f(x_{ijt}, \beta_{ij}) \exp (V_{it} - U_{it}) \quad \forall i = 1,2,\ldots,n \qquad (5)$$

$$TC_{it} = f(Y_{it}, X_{ijt}, \beta_{ij}) + (V_{it} + U_{it}) \qquad (6)$$

$$\forall \quad i = 1,\ldots, N; t = 1,\ldots,T; \ j = 1,\ldots,k$$

In model (5), Y is the produced wheat of each province, X is the vector of inputs including the under cultivation level, sowing, labor force (number of labor force used in plowing, flattening, fertilizing, sowing, irrigation, and other operations), poisons (including the used amount of poisons for feeds, insects, molds and other kinds of poison), animal an chemical fertilizers (including phosphate, nitrogen, potassium and other kinds of fertilizers and their prices that achieved from Ministry of Jihad Agriculture in 2000-2009 period), β is the vector of these inputs parameters, V is the stochastic disturb term (related to the uncontrollable economic variables of each economic unit), U is the effects of inefficiency (Aigner and Lovell 1977).

It is necessary to mention that the difference of two terms $(V_{it} - U_{it})$ is asymmetric and abnormal and the degree of asymmetry depends on the fraction of σ_u / σ_v . If $\sigma_u^2 = 0$, the mentioned function would change to a normal regression with a disturb term with the normal distribution.[3] In mode (6) TC is the wheat production cost in each province, X is the price vector of mentioned inputs in model (5) and other variables are the same variables of first model. $f(0)$ Is an appropriate functional shape for estimating

[3] See Kim (2006), Kim and Nelson (2006), and Kutlu and Sickles (2010)

the model. As what Coelli, Rao, Donnell and Battese emphasize in the book "efficiency and productivity analysis", the feature of an appropriate mathematic function is to have capablities such as the flexibility, linearity, order and similarity of the parameters. In order to estimate the model of "symmetry imposition" on inputs own cross, the price of inputs and outputs is necessary (Coelli, 1996) The study information has been extracted for different years from statistical yearbook of Ministry of Agriculture Jihad, provincial information and Iran's Center of Statistic for the period 2000-2009.

To eliminate the impact of inflation on the estimated pattern (equations 5 and 6), all of variables have been changed to actual value based on price index of 2004 (as the basic) and this data have been used for the estimation. The calculations have been done by the use of Frontier 4,1 and Stata11 software. Before estimation, it is needed to test the stationarity of variables and according to the data structure the method of Im, Pesaran and Shin is used for this mean. The results show stationarity of the variables.

Therefore, by insuring the stationarity of variables, there is no need to do the variables convergence and nonliarity tests. In next stage, in order to estimate (5) and (6) equations , it is necessary to perform the data poolability test in the form of a panel data pattern against pooled data pattern or F Leymer test that this test's amount is equal to 13,45 percent for the production level and 22.08 per cent for the cost model which confirms the panel model. In this state, the inefficiency is estimated based on Coelli's assumptions without any change during time (pattern1) or with change during time (pattern 2). The results of calculated efficiency for irrigated wheat are presented in tables (1).

Table 1: The average of irrigated wheat different kinds of efficiency in the period 2000-2009 divided to country's states

Row	State Name	Technical	Allocative	Economical
1	Kermanshah	0.9	0.88	0.79
2	Mazandaran	0.89	0.85	0.75
3	Fars	0.89	0.88	0.79
4	Tehran	0.89	0.87	0.78
5	Zanjan	0.87	0.77	0.67
6	Kohgiluye	0.86	0.73	0.64
7	Koerdestan	0.86	0.75	0.65
8	Ardebil	0.85	0.81	0.69
9	Esfehan	0.84	0.88	0.74
10	Bushehr	0.84	0.52	0.44
11	Ghazvin	0.83	0.87	0.72
12	Semnan	0.83	0.86	0.71
13	Markazi	0.82	0.84	0.68
14	Charmahal	0.82	0.75	0.61
15	Ilam	0.8	0.71	0.58
16	Yazd	0.8	0.8	0.63
17	Hamedan	0.8	0.88	0.71
18	Hormozgan	0.8	0.88	0.7
19	Qom	0.79	0.91	0.71
20	Western Azarbayjan	0.78	0.69	0.54
21	Sistan	0.76	0.49	0.38
22	Eastern Azarbayjan	0.76	0.73	0.55
23	Kerman	0.75	0.75	0.57
24	Lorestan	0.75	0.71	0.54

25	Golestan	0.72	0.75	0.55
26	Khorasan	0.53	0.69	0.37
27	Khoozestan	0.51	0.79	0.42

Source: Research calculations

According to table (1), technical, price (allocative) and economic efficiency of irrigated wheat in the discussed provinces respectively equal to 69, 63 and 45 per cent for the studying period. This amount of efficiency proves the existence of widespread inefficiency in the wheat production. The primary investigation shows that every kinds of efficiency react to the under cultivating level of wheat. All kinds of efficiencies have been confronted a decrease in 2008; is directly related to the decrease of under cultivating level of wheat[4]. Surveying the under cultivating level shows that in the studying period , 77 per cent of whole used lands in the wheat production relates to dry lands and only 23 per cent of them relates to the irrigated wheat. As, any decrease or increase in under cultivating level in, the supply of wheat will increase or decrease. In 2008, we witness a harsh decrease on the technical efficiency because of straight effect on output wheat supply and also on the allocative efficiency because of inputs purchase and no utilization of index advantages in smaller lands. As technical and allocative efficiency change, economic efficiency would also change.

The investigated statistics show that the most shares of cost relate to the cost of agricultural land renting which straightly influence the technical and price efficiency. Despite the 8 per cent increase in irrigated wheat production, we see the salient increase in usage of inputs; so that, by 3 per cent increase of under cultivating level, the amount of variable inputs like labor force, seed, chemical fertilizer, poisons in every irrigated wheat hectare have increased respectively up to 25, 5, 18 and 45 per cent. The increase of governmental subsidies to chemical fertilizers and poisons in 2002, on the one hand and the on time distribution of agricultural fertilizer and poisons in the planting and harvesting period on the other hand have had important role in increasing the amount of inputs use. Other kinds of agricultural poisons have had an important role in increase of inputs usage in planting and harvesting period on the other hand. Other important cases can be presented as below:

At the end of 2002 and after three years of relative drought which ended in lowering the level of water sources used for planting the irrigated wheat, the atmospheric status kind of improved; so that , the atmospheric downfalls increased up to 40 percent. This issue led to improving the level of function in level unit and increasing the technical efficiency during 1382 and 1383. The economic efficiency increased too following the increase of technical efficiency.

In 2002 and after three respective continuous droughts, the financial need of farmers made them to desire to increase the amount of production by any probable method and after significant increase in guaranteed price, in order to acquire more financial resources by selling the product out to the government. It has been also effective in the amount of inputs usage like chemical fertilizer and poisons.

The fluctuations of under cultivating level of irrigated wheat in country are not so high. Meanwhile, what matters most is the usage of other inputs used for cultivation that highly depends on the governmental

[4] In order to discuss the state of under cultivated level on wheat supply refer to article of Garshasbi *et al*. (2012) agriculture economics journal as Survey of Affected Price and Non price Factors on Wheat Supply in Country's States by the Use of Panel Data.

policies. According to the article number (103) and fourth law of development plan about reforming the targeted subsidies act of agricultural inputs in 2005 and its significant decrease, a tangible decrease in price efficiency (allocative) and conclusively decrease of general (economic) efficiency is seen. This point should be noted that wheat production has experienced a developing process for years except in 2008 which confronted a significant decrease. Indeed, the amount of increase has been salient from 2002. A main share of wheat production is bought by government guaranteed. Wheat is consumed in three ways of human, bestial and medical in Iran. Human consumptions specify 80 per cent which are mainly consumed as bakery flour.5 Bakery flour suppliants are the bakers.

Technical and price efficiency effect on output supply and input demand

The condition of optimization is reached by solving the problem of maximization of profit along with the price and technical (allocative) inefficiency in profit function as in equation (7).

$$\Pi(\theta(p-\alpha), w) = \max_{y} \; (p-\alpha)y - \theta^{-1} C(y, w) \quad (7)$$

Where: II is profit function, θ is the technical inefficiency, α is price or allocative inefficiency, y is output vector and C(y,x) is the production cost. Derivation from profit function to output price, results in equations (8) and (9).

$$\frac{\partial \Pi(\theta(p-\alpha), w)}{\partial p_i} = y_i - \theta^{-1} \frac{\partial C(y,w)}{\partial y_i} \times \frac{\partial y_i}{\partial \theta_i (p_i - \alpha_i)} \times \frac{\partial \theta_i (p_i - \alpha_i)}{\partial p_i} \quad (8)$$

$$\frac{\partial \Pi(\theta(p-\alpha), w)}{\partial p_i} = y_i - (p_i - \alpha_i) \times \frac{\partial y_i}{\partial \theta_i (p_i - \alpha_i)} \times \theta_i = 0 \quad (9)$$

$$\Rightarrow y_i = -(p_i - \alpha_i)\theta_i \frac{\partial y_i}{\partial \theta_i (p_i - \alpha_i)}$$

Similarly, Derivations to input prices is presented by equation (10).

$$\frac{\partial \Pi(\theta(p-\alpha), w)}{\partial w_j} = o - \theta^{-1} \frac{\partial C(y,w)}{\partial w_j} + \theta^{-1} \frac{\partial C(y,w)}{\partial y_i} \times \frac{\partial y_i}{\partial w_j} \quad (10)$$

Using equation (11) we have:

$$\frac{\partial \Pi(\theta(p-\alpha), w)}{\partial w_j} = \theta^{-1} x_i + \theta^{-1} (p_i - \alpha_i)\theta \times \frac{\partial y_i}{\partial w_j} = \left(\frac{x_i}{\theta}\right) + (p_i - \alpha_i) \times \frac{\partial y_i}{\partial w_j} \quad (11)$$

The relations of output supply and input demands can be easily estimated in equations (10) and (11). According to theoric discussions and in order to survey the inefficiency effects on output supply and input demands, a normal profit function in tanslog form is used in equation (12).

[5] Ministry of trade (2010)

$$Ln\Pi_{it}^{\ *} = \ln\left(\frac{\Pi_{it}}{P_{it}}\right) = \beta_o + \sum_{i=1}^{n}\beta_{it}Ln\left(w^*_{\ it}\right) + \sum_{i=1}^{n}\beta_{it}Ln\left(w^*_{\ it}\right)^2 + (1/2)\sum_{j=1}^{6}\sum_{k=1}^{6}\beta_{jkt}Ln\left(w^*_{\ jt}\right)Ln(w^*_{\ kt}) + U_{it} \quad (12)$$

$$i = 1,2,...,n \qquad k, j = 1,2,...,7$$

Where: $\Pi_{it}^{\ *}$ is normal profit function which is attained from division of profit (Π_{it}) by the product price (p_{it}). $w^*_{\ jt}$ and $w^*_{\ kt}$ are the price of production inputs including renting price of the land, seed, labor force, poisons, animal and chemical fertilizers which have become normalized with the product's price. In order to examine th effects of technical and price inefficiency (allocative) on output supply and input demand, it is necessary to consider the profit function regarding inefficiency.

$$Ln\Pi_{it}^{\ *} = \beta_o\theta_{it}(1-\alpha_{it}) + \sum_{i=1}^{n}\beta_{it}\theta_{it}Ln\left(w^*_{\ it} - \alpha_{it}\right) + \sum_{i=1}^{n}\beta_{it}\theta_{it}Ln\left(w^*_{\ it} - \alpha_{it}\right)^2 + (1/2)\sum_{j=1}^{6}\sum_{k=1}^{6}\beta_{jkt}\theta_{it}Ln\left(w^*_{\ jt} - \alpha_{jt}\right)Ln(w^*_{\ kt} - \alpha_{kt}) + U_{it} \quad (13)$$

$$i = 1,2,...,n \qquad k, j = 1,2,...,7$$

We can reach to the functions of input and product share from profit by profit function derivation of outputs prices and product price and by utilizing Hotelling's Lemma (Arnade and Trueblood 2002). Equation (14) shows the share function of input profit and equation (15) shows the share function of product's profit.

$$S^{w_j}{}_{it} = -\frac{\left(w_{it}^* - \alpha_{it}\right)X_{it}}{\Pi^*} = \frac{\partial Ln\Pi^*}{\partial Ln\left(w_{it}^* - \alpha_{it}\right)} = \beta_{it}\theta_{it} + 2\beta_{ikt}\theta_{it}Ln\left(w^*_{\ kt} - \alpha_{kt}\right) + (1/2)\beta_{ijt}\theta_{it}Ln\left(w^*_{\ jt} - \alpha\right) \quad (14)$$

$$i = 1,2,...,n \quad k, j = 1,2,...6$$

$$S^{y}{}_{it} = \frac{\partial Ln\Pi^*}{\partial LnP_{it}^{y}} = \frac{y}{\Pi^*} \quad (15)$$

According to equation (15), $S^{w_j}{}_{it}$ is the share of jth input profit, $\left(w_{it}^* - \alpha_{it}\right)$ is the price of ith input considering the price inefficiency which have been normalized by the price of product. θ_{it} is technical inefficiency, β_{it}, β_{ikt}, and β_{ijt} are the passive parameters. As before, inputs includes under cultivating level of wheat (X1), seed (X2), labor force (X3), poisons (X4), animal fertilizer (X5), chemical fertilizer (X6) and inputs price also includes renting price of land (W1), seed price (W2), labor force wage (W3), poisons price (W4), animal fertilizer price (W5) and chemical fertilizer price (W6).

In equation (16), $S^{y}{}_{it}$ is the share of the profit, P_{it}^{y} is the guaranteed price of wheat and y represents the product supply which is resulted from its multiplying by the product price and total income and profit

(II) is attained after subtraction of costs and the normal profit Π^* is attained after division of profit by P_{it}^y .

Considering the existence of common parameters in equations (15) and (16), the estimation should be done simultaneously. As coefficients are equal in input demand and output supply, symmetry and similar coefficients restrictions have been applied in ultimate level too. These restrictions are presented as equation (16).

$$\frac{\partial Ln\Pi^*}{\partial Ln\left(w_{it}^* - \alpha_{it}\right) Ln\left(w_{jt}^* - \alpha_j\right)} = \frac{S_{it}^{w_i}}{\partial Ln\left(w_{jt}^* - \alpha\right)} \quad k, j = 1,2,...6 \qquad (16)$$

In order to investigate the effectiveness of inefficiency on the share of demand supplies, equations (17) and (18) are respectively the demonstrators of the mentioed functions for the states of considering and not considering inefficiency.

$$S_{x_j} = \frac{\partial Ln\Pi_{it}^*}{\partial Ln\left(w_{jt}^*\right)} = b_{jt} + b_{jjt} Ln\left(w_{jt}\right) + 0.5 b_{jkt} Ln\left(w_{kt}\right) \quad k, j = 1,2,...6 \qquad (17)$$

Without inefficiency

$$S_{x_j} = \frac{\partial Ln\Pi_{it}^*}{\partial Ln\left(w_{jt}^* - \alpha_{jt}\right)} = b_{jt}\theta_{jt} + b_{jjt} Ln\left(w^*_{jt} - \alpha_{jt}\right) + 0.5 b_{jkt} Ln\left(w^*_{kt} - \alpha_{kt}\right) \quad k, j = 1,2,...6 \qquad (18)$$

With inefficiency

According to equations (17) and (18), considering the inefficiency, intercept would decrease, but a precise opinion cannot be given about price variables coefficients. For the same reason, it is not possible to give a precise opinion about the share function of supply profit. In other words, these coefficients can be increased or decreased. These conditions are indefeasible for both irrigated and dry land wheat.

The changes of elasticity of irrigated and dry land wheat

One of the most important usages of the attained functions in previous part, is the changes of relative and cross elasticities of inputs and supply.[6] In order to obtain the relative price elasticity of input X demand, we should act like equation (19).

[6] Hojabr Kiani and Haji Ahmad (2002)

$$\eta_{ii} = \frac{\partial LnX_i}{\partial LnP_i} = \frac{\partial Ln\pi}{\partial LnP_i} - 1 + \frac{\partial Ln}{\partial LnP_i}\left(-\frac{\partial Ln}{\partial LnP_i}\right) = S_i - 1 + \frac{b_{ii}}{S_i} \quad (19)$$

In order to obtain the cross price elasticity of input X demand, we should proceed as equation (20).

$$\eta_{ik} = \frac{\partial LnX_i}{\partial LnP_k} = \frac{\partial Ln\pi}{\partial LnP_k} + \frac{\partial Ln}{\partial LnP_k}\left(-\frac{\partial Ln}{\partial LnP_i}\right) = S_k + \frac{b_{ik}}{S_i} \quad (20)$$

In order to obtain input X supply elasticity to the product price, we should proceed as equation (21).

$$\eta_{iy} = \frac{\partial LnX_i}{\partial LnP_y} = \frac{\partial Ln\pi}{\partial LnP_y} - \frac{\partial LnP_i}{\partial LnP_y} + \frac{\partial Ln}{\partial LnP_y}\left(-\frac{\partial Ln}{\partial LnP_i}\right)$$

$$\eta_{iy} = \sum_{i=1}^{n} \frac{\partial Ln\pi}{\partial LnP_i} \times \frac{\partial LnP_i}{\partial LnP_y} - (-1) - \sum_{k=1}^{n} \frac{b_{ik}}{S_i} \quad (21)$$

$$\eta_{iy} = \sum_{i=1}^{n} S_i + 1 - \sum_{i=1}^{n} \frac{b_{ik}}{S_i}$$

In order to obtain supply elasticity to input X_i price, we should proceed as equation (22).

$$\varepsilon_{yi} = \frac{\partial Lny}{\partial LnP_i} = \frac{\partial Ln\pi}{\partial LnP_i} + \frac{\partial Ln}{\partial LnP_i}\left(1 - \sum_{k=1}^{n} \frac{\partial Ln\pi}{\partial LnP_k}\right) \quad (22)$$

$$\varepsilon_{yi} = S_i - \sum_{k=1}^{n} \frac{b_{ki}}{1 - \sum_{k=1}^{n} S_k}$$

In order to obtain relative elasticity of supply, we should proceed as equation (23).

$$\varepsilon_{yy} = \frac{\partial Lny}{\partial LnP_y} = \frac{\partial Ln\pi}{\partial LnP_y} + \frac{\partial Ln}{\partial LnP_y}\left(1 - \sum_{k=1}^{n} \frac{\partial Ln\pi}{\partial LnP_i}\right) \quad (23)$$

$$\varepsilon_{yy} = \sum_{i=1}^{n} \frac{\partial Ln\pi}{\partial LnP_i} \times \frac{\partial LnP_i}{\partial LnP_y} - \sum_{i=1}^{n}\sum_{k=1}^{n} \frac{b_{ki}}{1 - \sum_{k=1}^{n} S_k}$$

$$\varepsilon_{yy} = -\sum_{i=1}^{n} S_i + \sum_{i=1}^{n}\sum_{k=1}^{n} \frac{b_{ki}}{1 - \sum_{k=1}^{n} S_k}$$

The changes of irrigated wheat elasticity are shown in table (2)

Table 2: Elasticity of irrigated wheat inputs and output

Price							Input. output	
Wheat	Chemical fertilizer	Animal fertilizer	Poisons	Labor	Seed	Land		
0.23	-0.11	-0.11	-0.19	-0.22	-1.43	-0.34	land	Without considering inefficiency
1.78	-0.09	-0.01	-0.11	-0.36	-0.86	-0.59	seed	
2.03	-0.30	-0.09	0.07	-0.13	-0.16	0.21	Labor force	
0.32	0.24	-0.10	-0.26	0.09	0.59	0.11	poisons	
0.03	0.21	-0.54	-0.13	0.06	-0.16	0.11	Animal fertilizer	
0.45	-0.12	0.16	-0.16	-0.18	-0.19	0.32	Chemical	

							fertilizer	
1.23	-0.14	-0.11	-0.08	-0.21	-0.15	-1.34	Irrigated wheat	
Wheat	Chemical fertilizer	Animal fertilizer	Poisons	Labor	Seed	Land	Input. output	
0.71	-0.39	0.09	0.09	-0.16	-1.13	-0.27	land	with considering Technical and price inefficiency
2.54	0.51	-0.11	-0.07	-0.31	-0.71	-0.31	seed	
2.89	-0.07	-0.07	0.04	-0.12	0.10	0.27	Labor force	
0.56	0.11	0.15	-0.23	0.04	0.51	0.17	poisons	
0.16	0.17	-0.65	0.11	0.13	-0.12	0.19	Animal fertilizer	
1.13	-0.38	0.26	-0.23	-0.07	0.23	0.12	Chemical fertilizer	
1.88	0.53	0.06	0.32	-0.36	0.24	-0.77	Irrigated wheat	

Source: Research calculations

According to results of table, it is denoted that all of the relative elasticities have been appeared with expected signs. The investigation of calculated elasticities proves that:

All inputs of irrigated wheat are a little elastic. The irrigated wheat product input with the lowest elasticity is chemical fertilizer which shows that the demand of this input does not conspicuously react to the price. Considering the negative effects of the share of chemical fertilizer's cost on the economic efficiency of irrigated wheat, the low elasticity of chemical fertilizer demand can be contriving of decrease of the efficiency along with increase in the price of this input in production.

The relative price elasticity of seed has the highest level and therefore, it is the most sensitive input that this issue is because of the variety of used seeds and the possibility to substitute them with each other (more than 79 kinds of seed are used in provinces of Iran).

The price elasticity of wheat supply is more than one which expresses that the wheat supply is highly elastic. Hence, the change of guaranteed price of wheat can have significant effects on the raise of its supply. Therefore, announcing the guaranteed purchasing prices by government will directly impacts on the increase of wheat output.[7]

The cross elasticity also indicates the following items: The cross elasticity of land and all other inputs is negative which shows that land is a complement for other inputs.

[7] Considering the importance of the function of wheat supply output, this issue has been attentively discussed in the appendix of article.

The cross elasticity of seed and all other inputs is also negative which shows that seed is a complement for other inputs.

The cross elasticity of labor force and seed is positive (complement), animal and chemical fertilizer and negative (substitute) with poisons.

The cross elasticity of poisons and animal fertilizer is negative and positive with seed, labor force and chemical fertilizer.

The cross elasticity of chemical fertilizer and other inputs but animal fertilizer is negative.

The elasticity of all inputs to the wheat price is positive. By the increase of the wheat price, the most sensitivity belongs to input demand of poisons and animal fertilizer. Considering the inefficiency, the relative elasticities of inputs price has remained negative. However, elasticity of all inputs except animal and chemical fertilizer increases.

Considering the inefficiency, inputs elasticity except labor force has increased to wheat price, Considering the inefficiency, the relative elasticity of wheat supply price has increased. In other words, the reaction of supply increases.

The elasticity of irrigated wheat supply to the price of all irrigated wheat production's inputs except land is low. Therefore, the price of land has the highest effect on the irrigated wheat supply. Whereas, the inputs with the lowest elasticity in the irrigated wheat supply are animal fertilizer and poisons which reveals the absence of reaction by wheat supply to animal fertilizer and poisons.

Policy recommendations

As inefficiency is not considered in estimation of supply and demand functions of inputs and outputs of agricultural sector inputs and regarding the effectiveness of inefficiency on the output supply and input demand, it is recommended that all studies of this district lay away the assumption of perfect efficiency of producers in estimation of the mentioned functions.

Considering the congeniality between efficiency trend and under cultivating level of wheat on one hand and positive effectiveness of guaranteed rate of wheat and negative effectiveness of guaranteed rate of barley, the government should act in annual rates in a way that the planting pattern would not change harmfully to the wheat. (The current under cultivating level suffices internal production and more production can be achieved by developing the efficiency).

Considering the inefficiency of the irrigated and dry wheat in country, planning for improving the technical efficiency of irrigated land wheat, can improve the country's wheat production 21 per cent. Therefore, the self sufficiency (independency) pattern of wheat should be codified and executed based on the technical efficiency in Iran.

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