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Which Will Overcome? The Productivity or Risk Premium

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Abstract

Risk-averse farmers are prudent to use different inputs because every input has a distinct effect on output fluctuations and production risk as well. This paper examines the effect of input using growth on producer welfare of date farmers in Sistan and Baluchestan province which is the second greatest producer and exporter of date in Iran. It is well known that input using growth impresses both productivity and risk premium. These two factors contribute to producer welfare so that increasing the productivity will boost the welfare and an addition to risk premium shall detract the welfare of risk-averse farmers. Results showed that technical change has reduced both productivity and production risk in 2011/2012 and the welfare increased as 912727.21. But, in 2010/2011, productivity and risk premium had a positive growth and finally the producer's welfare experienced a reduction as 1041478.41.

Keywords:
Production risk, Total Factor Productivity, Risk Premium, Sistan and Baluchestan

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INTRODUCTION

Production risk has long been a staple issue in many agricultural economics subjects but there have been some controversy recently about it. Farmers often due to changes take place between the decisions and consequences time, see that even their best decisions do not reach their expected goals. The most important risk sources in agriculture are price and production risks. Price risk comes mainly from natural fluctuations of agricultural markets and such a variation may be due to instability of agricultural products demands (Sabuhi, 2012). Production risk can enhance price risk. Many factors contribute to production risk like technological change, weather or disease, etc. Generally agricultural output is significantly uncertain. So, risk-averse farmers are supposed to take into account both of the expected output which is obtained from a specific input vector and also of the risk associated with this output. Furthermore, technical change over time will affect expected output and also production risk. Therefore, when evaluating production performance of a farmer, risk considerations have to be taken into account. For measuring production performance, it needs to construct a Total Factor Productivity index to measure productivity growth. Commonly, Increases in productivity as measured by TFP will be thought to be to farmer's benefit because positive productivity growth will be expected to increase producer welfare. But it is well known that technical change will affect production risk and thereby the producer welfare if they are not risk-neutral. Taking chemical fertilizer or new seed varieties as an example, it is likely that using these types of inputs which contribute positively in productivity growth may cause a higher production risk. Similarly, using more pesticide which is mentioned by Orea, *et al.* (2012) may not affect output quantity remarkably but reduces the production risk while productivity falls. But it could increase risk-averse producer's welfare if the risk premium reduction had a far stronger effect on his/her welfare than the effect of productivity decline. Date is kind of fruit and food that is eaten around Sistan and Baluchestan by people and also animals. Date palms have been cultivated because they have provided almost all rural people's necessities (Saeedian, *et al.,* 2012). Now this province is the second largest producer of date in Iran because of its weather condition; 76 kinds of dates are produced and sold from 30 regions of the province, 46000 hectares of Sistan and Baluchestan agricultural lands are under date palms with over 200000 tones dates produced in 2012 Although, Date consumption is about 7 *Kg* per man in Iran (Ministry of jihad-e-Agriculture, 2012). Date production is so sensitive to weather condition, geographical situation, soil type, farmer experience and input usage, etc. Due to the above reasons, date producers face an uncertain output. Previously, some researchers have studied the role of risk in agricultural production in Iran. Majority of them have focused on the effect of input usage in production risk by Just-Pope (1979) production function, i.e. to determine which input is risk increasing and which is risk decreasing (Moghaddasi *et al.,* 1997, Torkamany *et al.,* 1998, Sharzei *et al.,* 2002, Naghshine fard, 2007). Musanejad *et al.* (2001) investigated farmers risk aversion by experimental, econometric and mathematical programming. Karbasi *et al*. (2006) specified the effective factors impacting on production risk of irrigated and dry cumin in Khorasan province. None of them paid attention to the relationship between production risk and productivity or producer welfare. Also, they ignored the endogeneity of inputs which will persuade the Just-Pope stochastic production function to result inconsistent parameters. Several studies have been conducted to survey the productivity growth and its decomposition. For instance, Lovell (1996) compared deterministic frontier analysis (DFA), stochastic frontier analysis (SFA), and data envelopment analysis (DEA) for use in a panel data context and showed how DFA and DEA had a more satisfactory reorientation toward productivity measurement than SFA. Balk (2003), reviews a number of methods for analyzing productivity change and productivity differences, whether at the individual firm level or t aggregate level, into partial measures relating to technological change and efficiency change. Buccola (2004) proposed a TFP index with using certainty equivalent to measure productivity when producers encounter an uncertain output. Chambers (2008) defined the stochastic productivity indicators and derived the superlative measures of those indicators. Also Applebaum (1991), provided an empirically framework to study the relation between price uncertainty and total factor productivity and applied the model to the U.S textile industry by a non-parametric approach. Orea, *et al.* (2012) proposed a framework for measuring changes in producer welfare which takes account production risk and risk preferences and which substantiates the fact that producers will weigh the impact of technological change on both production risk and expected production. This welfare change index which is drawn out from expected utility-maximizing attitude has two main components. The first component measures the technical change (TFP) and the second part evaluates the effect of technical change on the cost of risk as represented by the risk premium. We provide an empirical application of this framework to examine the effect of different input's usage on productivity, production risk, and date producer's welfare through 2010/2011 and 2011/2012 in Sistan and Baluchestan region, Iran using a sample of 340 date farmers in Sistan and Baluchestan, Iran.

Analytical framework

As the production, profits are uncertain in agricultural economics. Taking the expected utility of predicted profit maximization as an assumption and defining the profit as $\pi = p.F(x, \phi, t) - \Psi. x$, where p is the output price, $F(x, \phi, t)$ is a stochastic production function, ϕ is a random variable reflecting production risk, t is time variable, x represents a vector of inputs and Ψ indicates the input prices, Decision makers intent to maximize the expected utility of profits so that the inputs x satisfy this equation:

$$Max_x E[U(\pi)] = Max_x E[U(p.F(x, \phi, t) - \Psi.x)] \quad (1)$$

Where $U(\pi)$ has to be a continuous and differentiable function of profits (π).

Pratt (1964) showed that maximizing the equation (1) is equipollent to maximizing the corresponding certainty equivalent. He defined the certainty equivalent as CE=E[π]-R(π), where R(π) vouches the Arrow-Pratt risk premium. Following Orea *et al.* (2012), if $w(t)$ denotes a monetary welfare index of production decisions under risk (considering both price and production risks), optimal inputs must apply to:

$$W(t) = Max\{CE(x, t)\} = Max\{E[pF(x, \phi, t) - \Psi.x] - R(x, t)\}. \quad (2)$$

It is clear from equation (2) that welfare is affected by a technology (t). Conditional on a value of ϕ,

$$\frac{dw}{dt} = [E(p.\frac{\partial F(x,\phi,t)}{\partial x}) - w - \frac{\partial R(x,t)}{\partial x}].\frac{dx}{dt} + E[p.\frac{\partial F(x,\phi,t)}{\partial t}) - \frac{\partial R(x,t)}{\partial t}]. \quad (3)$$

Administering the envelop theorem to equation (3), it comes to:

$$\frac{dw}{dt} = E[p.\frac{\partial F(x,\phi,t)}{\partial t}) - \frac{\partial R(x,t)}{\partial t}]. \quad (4)$$

Technical change over time implies the pure productivity change. The rate of technical change is defined by $\varpi_t = \partial \ln F(\cdot)/\partial t$. So, the equation (4) which comprises the rate of technical change can be expressed as:

$$\frac{dw}{dt} = E[p.F(.).\varpi_t] - \frac{\partial R(.)}{\partial t}. \quad (5)$$

Indeed, equation (5) indicates how productivity changes which are measured by only the change in output growth (which is understood as growth) impact monetary welfare. It means, welfare will increase by increasing the technical change through the time. Albeit, technical change will affect risk premium thereby risk premium affects welfare. If technical change reduces the risk premium ($\partial R / \partial t < 0$), then welfare increases ($dw/dt > 0$), whereas welfare falls if the risk premium increases (Orea *et al.* (2012)). In order to show that, productivity is also affected by changes in inputs not only by output, consider the basic definition of :

$$TFP = \frac{E(y|x,t)}{x} = \frac{F(x,t)}{x} \quad (6)$$

Where y implies output index, x is the index of multiple inputs $g(x, t)$. Represents the expected output; more specifically, by taking logs and differentiating with respect to time and dividing by the expected average productivity level, the rate of growth reveals:

$$\frac{T\dot{F}P}{TFP}=\frac{F(\dot{x},t)}{F(x,t)}-\frac{\dot{x}}{x}=\varpi_t, \tag{7}$$

Where the dot notation implies derivatives with respect to time and has the same afore-mentioned definition as $\varpi_t = \partial \ ln \ F(\cdot)/\partial t$. As it is seen, the rate of expected output growth minus the rate of growth in inputs will give the growth. Expected average productivity changes not only due to technical change but also due to the effect of non-constant returns to scale (Orea, *et al*., 2012). Incorporating the growth of inputs over time, captures changes in expected average productivity as it was mentioned by Orea, *et al.* (2012).

The $\frac{T\dot{F}P}{TFP}=(\mu-1)\sum_{k=1}^{K}\eta_k\frac{\dot{x}_k}{x_k}+\varpi_t=(\varpi-1)\frac{\dot{x}}{x}+\varpi_t$ rted as:

(8)

Where μ is the scale elasticity, $\eta_k = \mu_k/\mu = \mu_k/\sum_{k=1}^{k}\mu_k$ is the input elasticity share of the *k-th* input and $\mu_k = \partial \ ln \ F(\cdot)/\partial t$ is the elasticity of output with respect to input $\mu>(<)1$. Indicates increasing (decreasing) returns to scale. It is clear from equation (8) that beside technical change (or pure productivity growth), Changes in input usage when returns to scale are not constant, can affect observed TFP. When analyzing productivity growth in a specific farm, the impact of technical change on producer welfare has to be determined. But, when decomposing the productivity of a sector, the role of scale change and risk management issues by producers is important because producers affect observed productivity or productivity growth by their choice of inputs when hedging production risk. Undoubtedly, when producers intent to change their inputs, they consider their marginal impact on the risk premium as well as the marginal effect on expected profits. The Arrow-Pratt risk premium has two main parts. Risk preferences of producers which can be estimated by simultaneous equation system introduced by Love and Buccola (1991) and the variance (or higher moments) of profits. Therefore, it makes sense that risk-averse producers choose different amount of inputs to risk-neutral producers, which will affect observed TFP.

Data and empirical models

Data

The five largest producers of date in the world, are Egypt, Iran, Saudi Arabia, Iraq and united Arab Emirates, but Egypt, China, Bahrain, Gaza strip and Qatar have the largest yield by hectare respectively, (FAO, 1992-2010). Date is kind of fruit and food that is eaten around Sistan and Baluchestan by people and also animals. Datepalms have been cultivated because they have provided almost all rural people's necessities. Now this province is the second largest producer of date in Iran because of it's weather condition (Saeedian, *et al.* (2013); 76 kinds of dates are produced and sold from 30 regions of the province, 46000 hectares of Sistan & Baluchestan agricultural lands are under datepalms with 200000 tones dates produced in 2012 (Ministry of Jihad-e- Agriculture, 2012).

We estimate TFP and its effect on welfare using a panel dataset of 340 Mazafati date farms from Suran, a southern region of Sistan and Baluchestan province of Iran and a principal producer and exporter of date. The data were collected by questionnaires over 3 agricultural years: 2009/ 2010, 2010/2011 and 2011/2012. The sample statistics for the input and output variables are reported in table 1 briefly. Seven inputs were considered in this research, i.e., irrigation, labor, fertilizer (chemical and animal), herbicide, Machinery expenses where all these inputs were measured in monetary terms (in thousands of 2010 Rial, where the Consumer Price Index was used as the deflator) and also number of palms. One output that is the physical product of date in each period of harvesting. Following Orea, *et al*.(2012), we did not use the data of inputs which were invariant overt time. As an example; land as it was almost invariant over time and does not contribute to productivity change was not used.

Underlying technology

The first step to implement the welfare change index is to estimate the underlying technology.

Table 1: Descriptive statistics of variables

Variable	Mean	SD	Min	Max
Output				
Date ('000 Kg)	9.173	907.6	120.1	160.711
Inputs				
Labor (rial)	360163.8	453615.4	19845.24	6775431
Chemical Fertilizer (rial)	63778.9	105441.3	2175.15	1775172
Animal fertilizer	202188.3	246607.2	12597.4	3546798
Herbicide (rial)	39771.19	50285.43	2229.437	744827.6
Machinery (rial)	63269.51	74904.99	4328.139	984926.1
Irrigation cost (rial)	351639.2	450678.8	18042.93	6770690
Palms	205.99	226.41	19	2501
Prices*				
Date	562.4	216.77	315.5	721.5
Labor (hour)	5945.955	1164.62	4926.10	7215
Chemical fertilizer (kg)	118.49	84.79	68.96	216.4
Animal fertilizer (kg)	9.81	1.0306	8.76	10.82
Herbicide (kg)	5627.6	1708.23	4926	7575
Machinery (hour)	6566.5	651.86	5911.33	7215.007

Source: Research findings .Note: *The price of Irrigation water is normalized to 1.

Dillon and Anderson (1971) were almost the first researchers who came up with the relation between input usage and production risk. Just and Pope (1978) attempted to quantify this relationship with a specific stochastic function which could show the increasing, decreasing or constant impact of each input on production risk. The general form of Just and Pope Production function can be written as:

$$Y=F(x, \phi, t)= g(x, t)+h(x, t)^{1/2}. \phi \quad (9)$$

Where $g(.)$, is the mean function and $h(.)$ is the variance of output or risk function. x, ϕ and t are input vector, random noise and time variable respectively. Random noise term has zero mean and, its variance, σ^2 is normalized to one. Therefore, the variance of output is $h(.)$. For estimating the technology parameters, there are some alternative ways. Studies under risk which allow input use to respond optimally to prices generally have separated technology estimation from preference estimation (Love and Buccola, 1991). Just and Pope (1979) proposed a nonlinear three-stage approach to estimate the technology parameters. They also mentioned that if the inputs are endogenous and correlated with error term, then the parameters which are derived from those estimations are inconsistent. Wiens (1976), Paris (1979), Brink and McCarl (1978) used a mathematical approach to incorporate the prior estimates of technology parameters to determine the optimal input allocations and after that by minimizing the distance between actual and optimal input use, obtained the risk-aversion levels. Antle (1987), introduced a moment-based approach to estimate the stochastic production function parameters, then he used them to measure the distribution of risk preferences. All these studies assumed exogenous input use while almost always in agriculture fields, input uses are correlated with error term. Love and Buccola (1991) suggested joint risk preference-technology estimation with a primal system in which the technology parameters and absolute risk-aversion coefficient are estimated jointly in a system of non-linear equations. Therefore, the negative exponential utility $U(\pi)=-exp(-\gamma\pi)$ is assumed where γ denotes the absolute risk-aversion coefficient and π is net profit. The practical form of Just-Pope production function which is a Cobb-Douglas form is shown at below:

$$Y=ZX_1^{a1}X_2^{a2}X_3^{a3}X_4^{a4}X_5^{a5}X_6^{a6}X_7^{a7}t_2^{a8}t_3^{a9}+wX_1^{c1}X_2^{c2}X_3^{c3}X_4^{c4}X_5^{c5}X_6^{c6}X_7^{c7}t_2^{c8}t_3^{c9}.\phi \quad (10)$$

with Z, a_i, W, c_i as parameters. Equation (10) beside usual inputs includes some time variables, t_2, t_3 which capture time effect. Moreover, it would be much better to just sum from t=2 to t=T. (t=2, 3, 4, 5,…,T or in the paper, t=2011, 2012). So the variable t_{2011} takes a value of 1 if the observation is from 2011, and takes a 0 in all other cases. Following Love and Buccola (1991), the utility function in equation (2) which is a function of net profit has to be maximized to find the optimal input levels. So, substituting (10) to (2), taking derivatives with respect to the first input to show first-order condition, and using U\`(π) as marginal utility, provides:

$$E\{U`(\pi)\}[PZa_1X_1a^{1-1}X_2^{a2}X_3^{a3}X_4^{a4}X_5^{a5}X_6^{a6}X_7^{a7}t_2^{a8}t_3^{a9}+PWc_1X_1^{c1-1}X_2^{c2}X_3^{c3}X_4^{c4}X_5^{c5}X_6^{c6}X_7^{c7}t_2^{c8}t_3^{c9}\phi-\psi_1]\}=0$$

Equation (11) has to be written with respect to all regressors. By taking expectation and dividing by $E[U`(\pi)]$, equation (11) converts to

$$PZa_1X_1a^{1-1}X_2^{a2}X_3^{a3}X_4^{a4}X_5^{a5}X_6^{a6}X_7^{a7}t_2^{a8}t_3^{a9}+PWc_1X_1^{c1-1}X_2^{c2}X_3^{c3}X_4^{c4}X_5^{c5}X_6^{c6}X_7^{c7}t_2^{c8}t_3^{c9}\Delta=\psi 1 \quad (12)$$

Where $\Delta=E[U`(\pi)\phi]/E[U`(\pi)]$ is risk preference function that indicates the risk-aversion, risk neutral and risk-loving producer when it takes values $<(=)>$ than zero. After some manipulation, Love and Buccola (1991) showed that under negative exponential utility, the risk preference function reveals as as $\Delta=-\gamma\,\sigma$ in which γ denotes the usual Arrow-pratt absolute risk aversion coefficient and σ is the profit standard deviation. The profit standard deviation also is defined as

$$\sigma=P[var(Y)]^{1/2}=PWX_1^{c1}X_2^{c2}X_3^{c3}X_4^{c4}X_5^{c5}X_6^{c6}X_7^{c7}t_2^{c8}t_3^{c9} \quad (13)$$

Substituting the latter and $\Delta=-\gamma\,\sigma$ into (12) gives

$$PZa_1X_1^{a1-1}X_2^{a2}X_3^{a3}X_4^{a4}X_5^{a5}X_6^{a6}X_7^{a7}t_2^{a8}t_3^{a9}-P^2\gamma W^2c_1X_1^{2c1-1}X_2^{2c2}X_3^{2c3}X^{42c4}X_5^{2c5}X_6^{2c6}X_7^{2c7}t_2^{2c8}t_3^{2c8}=\Psi_1 \quad (14)$$

Which is the manipulated first-order condition with respect to first input and it has to be written for other regressors to form the system of equations. The last equation which is to be incorporated in the system is the modified version of (10). As Just-Pope (1979) mentioned, the original stochastic production function error term is heteroskedastic due to production risk presence. This heteroskedasticity can be removed by dividing each term in (10) by $X_1^{c1}X_2^{c2}X_3^{c3}X_4^{c4}X_5^{c5}X_6^{c6}X_7^{c7}t_2^{c8}t_3^{c9}$. The result is

$$YX_1^{-c1}X_2^{-c2}X_3^{-c3}X_4^{-c4}X_5^{-c5}X_6^{-c6}X_7-^{c7}t_2^{-c8}t_3^{-c9}-ZX_1^{a1-c1}X_2^{a2-c2}X_4^{a4-c4}X_5^{a5-c5}X_6^{a6-c6}X_7^{a7-c7}t_2^{a8-c8}t^{3}{}^{a9-c9}=W\phi \quad (15)$$

Once equations (14) and (15) were estimated jointly by NL3SLS (which is sort of optimization, see Amemiya, (1977)) approach with Limdep Software, to calculate the parameters Z, a_i, c_i, Then these parameters are substituted into (15) to estimate the homoskedasticitic production error vector $W\phi^*$. Following Buccola and McCarl (1986), the log of absolute value of $W\phi^*$ is measured. After that, taking expectation of the vector and adding 0.6352 and exponentiating gives the best reliable and consistent estimate of W. On the other hand, for having a consistent estimate of the absolute risk-aversion coefficient γ, the parameter γW^2 derived from the system estimation is to be divided by the square of W which was estimated earlier. Results of technology estimation are reported in table 2. To show the contributions of productivity and risk premium growth on monetary welfare of producers, we follow Orea, *et al.* (2012). First off, the coefficient of variation of output is defined. The coefficient of variation of output which is called the relative production risk is defined as = $h(x, t)^{1/2}/g(x, t)$. Taking logs and differentiating with respect to time, the growth of the coefficient of variation can be derived as:

$$\frac{\dot{m}}{m}=\sum_{s=1}^{S}(\Gamma_s-\varpi_s)\frac{\dot{x}_s}{x_s}+(\Gamma_t+\varpi_t),[3] \quad (16)$$

Where $\sum_{s=1}^{S}(\Gamma_s-\varpi_s)\frac{\dot{x}_s}{x_s}$ denotes the scale effects which can be controlled by producers by using distinct combinations of inputs. And technical change is displayed by $\Gamma_t+\varpi_t$ which is called the non-controlable part of relative risk. Both scale effects and technical change have a crucial role in increasing the relative production risk. ϖ_k and ϖ_s represent the elasticities of expected output and the standard deviation of output with respect to the *s-th* input. And ϖ_t and Γ_t are two parts of technical change contribution to the mean and standard deviation

[3] $\Gamma_s=0.5\frac{\partial h(x,t)}{\partial x_s},\varpi_s=\frac{\partial g(x,t)}{\partial x_s}\Gamma_t=0.5\frac{\partial h(x,t)}{\partial t},\varpi_t=\frac{\partial g(x,t)}{\partial t}$

of output on the base of parameters estimated earlier in the simultaneous system. More importantly, input x_s will be risk-increasing (reducing) in relative terms if $\Gamma_s - \varpi_k > (<) 0$. Needless to say, the equation (16) exhibits that any variation in input usage will affect the variance of output beside the productivity so this is a good reason for producers to be prudent about using different combinations of inputs. The average elasticities of the inputs in the mean and variance functions over the two periods, calculated on the base of system estimates of mean and variance functions are reported in Table 3.

Besides, as we know from Just and Pope (1978), the risk premium can be expressed locally as

$$R \approx 0.5\gamma\sigma_\pi^2 + \varphi\,(M_i) \qquad (17)$$

Where $\sigma_\pi^2 = p^2[var(y)] = p^2 h(x,t)$ and φ_i represents the higher moments of profit distribution which are ignored to simplify the analysis. And it is assumed that risk is equated with variance of production.

Once the risk premium equation (17) is substituted into equation (2) and normalized by the output price, reveals

$$\frac{dw^*}{dt} = g(x,t).\varpi_t - \frac{1}{2}.\gamma.p.\frac{\partial h(x,t)}{\partial t} \qquad (18)$$

Where W^* is the welfare measure and $g(x,t)=E[F(x,\varphi,\ t)]$ and $h(x,\ t)$ is the variance of output corresponding to the Just-Pope production function estimated with the jointly estimated system. Differentiating with respect to time gives a somehow different index to measure the impact of productivity and risk on the monetary welfare for optimal inputs as below

$$\frac{dw^*}{dt} = g(x,t).\varpi_t - \frac{1}{2}.\gamma.p.\frac{\partial h(x,t)}{\partial t} \qquad (19)$$

As we mentioned before $\frac{\partial h(x,t)}{\partial t} = \frac{\partial \ln h(x,t)}{\partial t}.h(x,t)$ and recall from earlier that $\Gamma_t = 0.5\frac{\partial \ln h(x,t)}{\partial t}$ substituting for $\frac{\partial h(x,t)}{\partial t}$, equation (19) converts to:

$$\frac{dw^*}{dt} = g(x,t).\varpi_t - \gamma.p.\Gamma_t.h(x,t). \qquad (20)$$

To simplify, the equation (20) can be changed by dividing it by $g(x,\ t)$ and then multiplying the second term on the right hand side by $g(x,\ t)/g(x,\ t)$, which results in:

$$Dw^*/dt = \varpi_t - r_A(\pi).p.g(x,\ t).\ \Gamma_t.m^2 \qquad (21)$$

Positive technical change ($\Gamma_t > 0$) with respect to output variance, increases risk premium (In the presence of production risk ($m > 0$)) and decreases producer welfare during time. But, when $\varpi_t > (<) 0$ the producer welfare increases (decreases).

RESULTS

At first, we used Imbens and Wooldridge (2007) procedure to test whether the inputs were endogenous or exogenous. A wald test showed that almost all inputs were endogenous except machinery[4]. Therefore, the Just-Pope (1979) or Antle (1987) and even Nelson-Preckel (1989) approaches result inconsistent and inefficient parameters for mean and standard deviation functions. So, it is reasonable to use the Love and Buccola (1991) approach which estimates risk preference-technology parameters jointly in a non-linear system of simultaneous equations. Generally, the Just-pope production function parameters are used as the best (guesses) starting values for the non-linear system estimations. So, at first the physical product of date is regressed on $ZX_1^{a1}X_2^{a2}X_3^{a3}X_4^{a4}X_5^{a5}X_6^{a6}X_7^{a7}t_2^{a8}t_3^{a9}$ by applying non-linear least squares to obtain stage 1 estimates of Z and the a_i\`s. Logs of absolute values of the residuals are derived and regressed on $ln\,|W\,X_1^{c1}\,X_2^{c2}\,X_3^{c3}\,X_4^{c4}\,X_5^{c5}\,X_6^{c6}\,X_7^{c7}\,t_2^{c8}t_3^{c9}.\phi|$ to derive the first stage estimates of $W$ and $c_i$\`s. Stage 2 estimates of Z and a_i\`s the was obtained by applying non-linear least squares to the weighted regression (15) are used as

[4] *A Wald test carried out to test whether the joint set of coefficient is equal to zero. Each input was tested for exogeneity and the p-values for the test of the null for Machinery, Labor, Irrigation, Chemical and Animal fertilizer, Herbicide and Palms were 0.000, 0.254, 0.320, 0.0782, 0.0856, 0.285, 0.1147 So, the endogeneity was accepted.*

Table 2: Parameter estimates of mean and standard deviation of date production

Variable	Just-Pope Method	Primal system
	Yield mean	
Constant	20.2612*[16.6]	172.981***[10.43]
Machinery cost	3.76876***[0.24]	0.57916***[0.00625]
Labor	3.20771***[0.07]	0.70929***[0.000560]
Irrigation	-0.72727***[0.20]	-0.10680**[0.00045]
Chemical fertilizer	-0.99074*[0.77]	0.00670***[0.0052]
Animal fertilizer	-3.18625***[0.58]	-0.05065*[0.0019]
Herbicide	-2.05639***[0.46]	0.10767**[0.00510]
Palms	-1.10957***[0.14]	-0.00179***[0.1973]
t_{2011}	0.01424*[0.13]	0.00276**[0.1671]
t_{2012}	-0.3609*[0.26]	-0.002457**[0.4016]
Adjusted R-square:0.9173 F(9,1010)=1244.6 Prob=0.000		
	Yield variance	
Constant	4.68153***[0.77]	174.4307
Machinery	1.16037***[0.32]	3.08658**[1.16528]
Labor	0.57022**[2.12]	-1.19021***[0.7628]
Irrigation	2.71052**[0.64]	0.35919**[2.00514]
Chemical fertilizer	0.35969**[1.44]	-0.18183***[1.09245]
Animal fertilizer	0.30521***[0.91]	-0.10018***[0.73711]
Herbicide	0.70055***[0.039]	-0.12437**[0.49487]
Palm	-0.27824**[0.039]	0.07976**[0.13340]
t_{2011}	1.67014***[0.34]	0.03907***[0.57281]
t_{2012}	0.90272***[0.34]	-0.03424**[0.7268]
Adjusted R-square:0.58505 F(9,1010)=158.227 Prob=0.000		

Source: Research findings .Note: Asterisks *, **, *** denote on 10%, 5% and 1% of significance, respectively. Bracketed numbers are standard errors. A likelihood ratio test (LR=0.012) preferred the Cobb-Douglas functional form for mean function.

starting values for estimation of primal system of non-linear equations parameters which both are reported in table 2. After estimating the primal systems parameters, substituting into (15) consistent estimates of Z, a_i`s and $c_i$`s gives $W\phi*$ a consistent estimate of the error vector. Buccola and McCarl (1989) suggest that the expectation of log absolute value of $W\phi*$ is $E(ln|W\phi*|)=ln=W+Eln|\phi*|=lnW-0.6352$. So, we obtained the average of log absolute values of error term $W\phi*$, then by adding 0.6352 and exponentiating it we attained a consistent W estimate of 174.4307 which when is squared and divided into the consistent estimate of γW^2 generated the absolute risk-aversion (γ) consistent estimate of 2.0016 (yielding a t statistic of 3.64). Note that for obtaining a reasonable starting value of γ, at first we estimated the Just-Pope production function separately and following Orea, *et al.* (2012), formed a system of linear equations which replaced the prior estimates of marginal products of mean and variance functions by their predicted values and then only the equations of input demands (14) were used to estimate. The average elasticities of mean and variance functions are reported in table 3.

Note that if $(\Gamma_s - \varpi_s) < (>) 0$, then the x_s will be a risk-reducing (increasing) input, relatively. More importantly, It shows that Producers take into account both the impacts of input usage on expected output and output variance and how much it is to be critical for them to be cautious about using different combinations of inputs. As shown in table 3, the scale effect of mean function is 4.73 that exhibits increasing returns to scale. Machinery expenditure has a considerable positive effect on both expected output and variance of output, implying that increasing this input will tend to increase the production risk. Labor cost has a negative effect on variance and a positive effect on the mean function. But, the negative effect is bigger than that on the mean function, so increases in labor costs reduce relative risk. Increases in irrigation costs and number of palms- on the other hand would in-

Table 3: Average elasticities over period 2010-2012

	Machinery	Labor	Irrigation	Ch-Fert	A-Fert	Herb	Palms	scale effect
S. dev. Effect(Γ_s)	4.68441	-3.02603	2.53892	-1.15153	-0.59964	-0.85378	1.403574	2.510797
Mean effect(ϖ_s)	3.43012	0.370045	0.539721	0.03778	-0.26794	0.653357	-0.02784	4.735243
Overall effect (Γ_s -ϖ_s)	1.26429	-3.396075	1.514171	-1.18931	-0.3317	-1.50713	1.431315	-2.224446

Source: Research findings. Ch-Fert, A-Fert and Herb denote on Chemical fertilizer, Animal fertilizer and Herbicide, respectively. Note that the scale effects are the sum of the input elasticities.

Table 4: Growth rate of total factor productivity (TFP) and production risk

	2010/2011	2011/2012
Changes in Inputs		
Machinery	0.133869	0.107507
Labor	0.156454	0.266428
Irrigation	0.244902	0.293569
Chemical fertilizer	0.050582	2.056709
Animal fertilizer	0.005807	0.236032
Herbicide	0.074525	0.377305
Palms	0.004254	-0.00904
Productivity		
$\dot{TFP}/TFP$	2.97049	12.0175
Scale	2.5040	12.4327
Tech	0.4664	-0.4152
Production risk		
$\dot{m}/m$	2.48624	1.8959
Scale	-0.15957	4.2082
Tech	2.6458	-2.3122

Source: Research findings.

crease production risk. But both kind of fertilizers (chemical and animal) will tend to reduce the production risk and subsequently increase the welfare for risk-averse producers as they reduce relative risk. Some policy implications can be drawn from the last column of table 2. As we see, the overall average effect of a scale increase in mean function is smaller than that on variance function which interestingly means an increase in the scale of date farms will rebate the riskiness of output. Therefore it is suggested to keep the Mazafati date farms bigger (to protect farmers against production risk) with current situation of management and the impacts of different inputs which can also be a result of high-sensitivity of this kind of humid date. The TFP growth rates using equation (8) and coefficient of variation corresponding to equation (16) are reported in table 4, which includes also the changes in inputs for the two periods in order to understand the influence of these changes in productivity growth and production risk. According to table 4, farms have expanded over time and the use of all inputs has increased on average over time.

As the increasing returns to scale was experienced, the scale effects in TFP growth are considerable and significantly higher than technical change effect in TFP growth and the sum of Scale and technical change in TFP growth is positive in both periods but higher in 2011/2012 while in this period technical change is negative. As the TFP, the growth of coefficient of variation (production risk) has a scale effect and technical change. Scale effects of output risk in two periods go to opposite direction and so is for technical changes do not. As it is seen, technical change has a negative effect on production risk in 20111/2012. Finally, expanding inputs has increased both production risk and productivity over two periods.

Given the estimated Absolute risk-aversion of 2.0016, the relative risk-aversion coefficients (ς) for each famer is estimated using $\varsigma = \gamma\pi$ Where π is expected profit and γ is the estimated coefficient of absolute risk-aversion. The relative risk-aversion coefficients for each farmer are depicted in figure1. These coefficients vary from 6.69 to 17.07 with a mean estimate of 10.42.

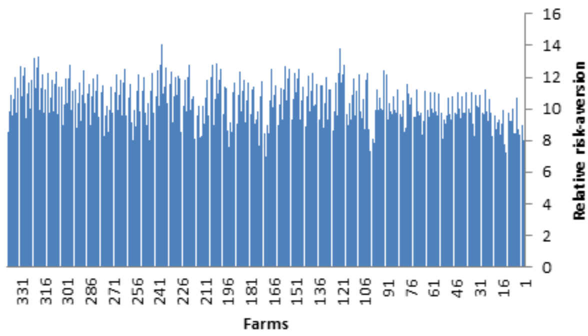

Figure1: Farms relative risk aversion coefficients

The welfare change index and its components are exhibited in table 5. A positive sign on the

Table 5: Impact of total factor productivity (TFP) and production risk on welfare

	2010/2011	2011/2012
WC*	-1041478.41	912727.21
ϖ_t	0.4664	-0.4152
Risk premium	1041478.88	-912727.62

Source: Research findings.

productivity side means that technical change has increased the productivity and hence increased the producer welfare. As such it is seen in 2010/2011 period productivity has increased but it also has increased the risk premium more stronger which has resulted in reducing monetary welfare of producers overall. More interestingly, technical change has increased both productivity and production risk in 2011/2012 but has affected production risk more than productivity which resulted in increasing welfare of producers in 2011/2012.

CONCLUSION

Agriculture is the mainstay economic sector of rural areas in Iran that has great potential for development. Mazafati Palms are cultivated in dozens southern provinces of Iran, such as Khuzestan, Kerman, Hormozgan, Fars and Sistan and Baluchestan. This study provides some interesting results on the date farms production risk, productivity and their effect on monetary welfare during 2010/2012 in the region of Suran, Sistan and Baluchestan Province, one of the leading producers of different varieties of dates in Iran. The objective of this paper was to estimate the influence of productivity growth and production risk on monetary welfare using the framework introduced by Orea, *et al.* (2012). But, since the inputs were endogenous, for estimating the stochastic production function parameters we applied the joint risk Preference-Technology system of non-linear equations to obtain consistent parameters of technology and also Arrow-Pratt absolute risk-aversion coefficient. The data were complete balanced panels including 340 farms and two periods. Cobb-Douglas functional form was preferred to translog by specification test. In addition, some policy implications were drawn from the last column of table 2. As we mentioned, the overall average effect of a scale increase in mean function was smaller than that on variance function which means an increase in the scale of date farms will increase the riskiness of output. Therefore it is suggested to keep the Mazafati date farms bigger (to protect farmers against production risk) with current situation of management and the impacts of different inputs which can also be a result of high-sensitivity of this kind of humid date. Finally, technical change has increased both productivity and production risk in 2011/2012 but has affected production risk more than productivity which resulted in increasing welfare of producers in 2011/2012. But, in 2010/2012 period risk premium overcame the productivity and producer's welfare reduced.

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