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Economic Efficiency of Smallholder in Iran: Adjusted for Market Distortion

Research Article

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ABSTRACT

To measure an unbiased farm-specific efficiency of individual dairy farmers, a shadow-price profit frontier adjusted for market distortion was applied to a sample of 860 Iranian small intensive dairy farms surveyed in 2005-2006. This measure was then compared with that of unadjusted measure that assumes undistorted market. A multiple general linear model (GLM) technique was applied to the data to examine the multiple effects of pure-bred animals, and the used farm capacity on profit efficiency indices. The mean value of adjusted profit efficiency was 0.40, significantly different from the latter measure, i.e. 0.72, revealing over-stating efficiency by ignoring imperfect structure of market. The difference between the figures is attributed to an index of market efficiency that was estimated of 46% in average. The number of pure-bred animals in the herd was found to affect the profit efficiency indices. Regardless of their characteristics, all the farms can gain from correcting the distortion in milk market, where small and average-sized farms are domain farms in the country.

KEY WORDS dairy farms, profit efficiency, shadow-price profit, smallholder.

INTRODUCTION

In dynamic and competitive environment and with the changes such as technological change and alterations in the marketing of milk, only the more efficient farmers will generate profits and survive (Tauer and Belbase, 1987). Economic efficiency includes technical efficiency, allocative (price) efficiency, and scale (size) efficiency. Economic efficiency simply implies to maximum profit or minimum cost at a given level of output. Situation where it is impossible for a firm to produce, with the given technology, maximum output from minimum inputs refers to technical efficiency. A firm is allocatively efficient when its price is equal to its marginal costs and scale efficiency means the reduction in unit cost available to a firm when producing at a higher output. A review of recent literature on economic efficiency in agricultural production is provided by Ozkan *et al.* (2009).

Broadly, three quantitative approaches are developed for measurement of production efficiency: parametric (deterministic and stochastic), non-parametric based on Data Envelopment Analysis (DEA), and productivity indices based on growth accounting and index theory principles (Coelli et al. 1998). Stochastic Frontier Analysis (SFA) and DEA are the most commonly used methods. The SFA model was simultaneously proposed by Aigner *et al.* (1977) and by Meeusen and van den Broeck (1977) and has been applied by several researchers including Battese and Coelli (1992), Battese and Coelli (1995), Ahmad and Bravo-Ureta (1996), Battese and Broca (1997), Alvarez and Gonzales (1999), Rezitis *et al.* (2002) and Cullinae and Song (2003).

A number of studies focussed on the examination of scale efficiencies while others generated efficiency results by different methods and analysed their comparability. For instance Fraser and Graham (2005) employed DEA to measure technical efficiency (TE) and scale efficiency (SE) for a sample of 1742 Australian dairy farms. Barnes and Oglethorpe (2004) considered technical and cost efficiency of 57 Scottish dairy farms over two years (2000-2002).

The two approaches are widely used in measuring technical and economic efficiencies of dairy farming all over the globe (Latruffe *et al.* 2002; Moreira *et al.* 2003; Balcombe *et al.* 2006; Ortner *et al.* 2006; Wubeneh and Ehui, 2006). Efficiency measures of individual dairy farms are sensitive to the choice of production frontier estimation method (e.g. Jaforullah and Premachandra, 2003; Johansson, 2005) but not very much to selection of functional forms (Bakhshoodeh, 2000; Mbaga *et al.* 2003).

Apart from applying frontiers in various empirical studies, several attempts have been made in developing such model. Wang *et al*. (1996), for instance, utilized a normalized shadow-price profit function that is an approach by which the price distortion may be incorporated, while the advantages of stochastic models are kept in the model.

Iranian dairy farming and milk market

Dairy farming is one of the most important branches of agriculture in Iran. The dairy sector is composed of two different types of farm. Those farmers who produce mainly crops, and keep a few locally bred cows as a supplementary enterprise, constitute the traditional dairy farm sector. These small traditional farms are based on non-intensive systems and are scattered throughout most rural areas of the country. Modern dairy farms are based on more intensive and specialized systems. There are more than 120 million livestock in Iran at present. Cow's milk constitutes the major portion of production in Iran. A total of 842000 pure-breed Holsteins are kept at intensive dairy farms which are adequately equipped for modern dairy farming. Although, the majority (almost three forth) of cow milk is produced by the traditional dairy farmers, the growing milk market in urban areas is mostly supplied by more intensive farms, many of which are small and medium sized located around the cities (Bakhshoodeh, 2000).

The majority of the total milk production in Iran (80%) belongs to thedairycattle. According toFAO (http://apps.fao.org) the average cow-milk yield in Iran is around one sixth of that in Europe and half of the world average. Whilst a little less than 15% of the traditional dairy farmers produce milk only for their household needs, almost 90% of milk produced by the rest is supplied either at the farm gate or via middlemen to the local market or to milk processing factories (Iranian Ministry of Agriculture, 1996). In some cases, farmers believe that they cannot sell more milk than the current level because of the lack of demand for milk.

There are different sources of market demand for milk such as urban milk factories, local creameries, middlemen, and local milk processors. However, despite this variety, many milk producers suffer from marketing weakness. In recent years, the government has tried to facilitate public access to milk and dairy products. During 1996-2001, milk and dairy products accounted for 2.5 percent of Iranian household's total expenditure (Iranian Dairy Industry's Web Site). The per capita consumption of dairy products stood at 95 kg in 2003, about 10 kg above that in 2002. The figure was aimed to be 163 kg by the end of 2009 almost half of which is in form of milk liquid, however, it has achieved little success in this regard as state subsidies on milk and dairy products are not enough to tide over the low purchasing power of the people.

Per capita consumption of milk is in excess of 300 kg per year in western Europe and less than 30 kg (and even sometimes as little as 10 kg) in some African and Asian countries (IFCN, 2008). Since milk consumption dependents mainly on domestic production, improving consumption exert greater pressure on the commercial dairy cattle population of Iran and encourages private sector to invest in the establishment of milk-processing factories.

The milk market seems not to be in equilibrium with regard to different places and times. Despite the lack of milk supply in some areas, many dairy farmers have no access to an adequate market for milk. The price of milk fluctuates not only because of differences in the percentage of milk fat but depends on the bargaining power of the farmers. This arises from the fact that there are not enough milk-gathering facilities and transport services to collect the milk produced by a large number of small dairy farmers scattered throughout the country. In 2004, almost half of the cow-milk production was absorbed by the milk factories and only one tenth by the milk collecting centers. Many farmers who produce milk in rural areas neither have access to a market near the farm nor have the machinery and equipment needed to keep or process the produced milk. Transport limitations and lack of roads also reduce the ability of farmers to supply milk to a higher-priced market. The government supports the farmers by a guaranteed milk price each year but farmers often sell milk at a lower price to the middlemen who typically pay farmers at a shorter time than the government does. Apart from low price of milk, dairy farmers are usually paid only after some delay. This reduces the purchasing ability of the farmers who have to pay on credit for feedstuffs, etc. While Iranian dairy farmers are faced with milk price distortion due to the market imperfection and use subsidized concentrates, there is no evidence of exploitation in the markets for other dairy inputs and outputs.

The objective of this paper is to measure an unbiased farm-specific efficiency, herewith adjusted profit efficiency, for small intensive dairy farms in Iran. Towards this aim, prices are adjusted in order to consider imperfect structure of milk market in the country. In this context, this study attempts to highlight bias in calculating profit efficiency of individual farms ignoring the imperfect structure of milk market in Iran.

The rest of this paper is organized as follows: The methodology including normalized shadow-price profit frontier and measurement of profit efficiency is presented following by data description and estimation results. The summary wraps up the paper and concludes.

MATERIALS AND METHODS

The normalized shadow-price profit model

To construct the normalized shadow-price profit function the market prices of inputs (Wi) and outputs (P_k) are first normalized with an input (or output) price to W_i^n and P_k^n. The normalized shadow-prices $\theta_k P_k^n$ of output and those of inputs, $\theta_i W_i^n$, are then derived from the normalized market prices by the use of (non-negative) output and input market efficiency parameters θ_k and θ_i. Wang *et al*. (1996), define the θs as price efficiency indices. Since market efficiency, according to Jamison and Lawrence (1982) and Bakhshoodeh (2000), denotes farm capacity to get as low (high) a price as possible for inputs (outputs), the θs are defined in this study as market efficiency indices.

The normalized shadow-price profit frontier can be shown as:

$$\pi_j^* = f(\theta_k P_k^n, \theta_i W_i^n, Z) \exp(\varepsilon_j) \qquad (1)$$

In which π_j^*; is the normalized shadow-price profit of the *j*-th farm, is unobservable and Z represents a vector of fixed factors. The error term ε_j is decomposed into the usual random term V and a non-negative profit inefficiency component U.

The relationship between the normalized shadow-price profit π_j^* and the normalized market-price profit π^n, defined as the difference between gross revenue and variable cost, is given by Wang *et al*. (1996) as equation (2) in which θ_k, θ_i, b_k and c_i are the parameters to be estimated.

$$\pi^n = \pi_j^* \{1 + \sum_k b_k[(1-\theta)/\theta_k] + \sum_{i=1}^{N-1} c_i[(1-\theta_i)/\theta_I]\} \qquad (2)$$

Substituting function (1) for π_j^* in equation (2), the farm-specific estimates of inefficiency for each observation and the population average efficiency can be determined by this approach. The output supply and input demand functions can be attained by applying Hotelling's lemma to the profit function (2), i.e. by the partial derivatives of the function with regard to the prices of outputs and inputs, respectively. Furthermore, the input profit shares, i.e. the ratio of the i^{th} variable cost to the shadow-price profit, and the output profit shares, i.e. the ratio of output value to profit, can be obtained.

Within the context of the shadow-price profit function, profit efficiency is defined as the highest profit that can be obtained by farmers, given the prices and levels of fixed inputs of the farm. Following Wang *et al*. (1996) and based on Yotopoulos and Lau (1971), the market price of milk (P_1) can be related to its shadow-price (P_s), i.e. the price without distortion, as $P_s = \theta P_1$ The non-negative parameter θ captures the milk market imperfection and is regarded here as a measure of market efficiency (ME) to be estimated as a coefficient of the shadow-price profit function (3):

$$\pi^* = (\theta P_1^n)^{b1} \prod_{K=2}^{M} (P_k^n)^{bk} \prod_{i=2}^{N} (W_i^n)^{ci} \prod_{q=1}^{Q} (Z_q)^{dq} \exp(-U+V)$$

or;

$$ln\pi^* = b_1 ln(\theta P_1^n) + \sum_{k=2}^{M} b_k ln(P_k^n) + \sum_{i=2}^{N} c_i ln(W_i^n) + \sum_{q=1}^{Q} d_q lnZ_q - U + V \qquad (3)$$

Applying Hotelling's lemma to the profit function (3), the functions of output supply Y_k and input demand X_i may be derived, along with the profit share of inputs s_i and those of outputs, such as of milk:

$$s_1 = \partial(ln\pi^*)/\partial ln(\lambda P_1^n) = Y_k (\theta P_1^n)/\pi^*$$

The market prices of variable inputs (W_i) and outputs (P_k) are normalized by the price of one input among the i (i=1,...,N) inputs, e.g. the price of fuel W_1. Thus, the normalized prices of inputs W_i^n equal W_i/W_1 and that of outputs P_k^n equal P_k/W_1. The error term in equation (3) is decomposed into components U and V to capture the effects of profit inefficiency (PE) and the usual statistical noise, respectively. The inefficiency component U is assumed to have a half-normal distribution as $U \sim |N(0,\sigma^2_U)|$, and V is supposed to be normally distributed independently from U as $V \sim N(0, \sigma^2_V)$.

The normalized frontier profit π_f^* derived from frontier function (3), where, the error component U equals zero, is shown by equation (4):

$$\pi_f^* = (\theta P_1^n)^{b1} \prod_{k=2} (P_k^n)^{bk} \prod_{i=2}^{N} (W_i^n)^{ci} \prod_{q} (Z_q)^{dq} \exp(V) \quad (4)$$

Profit efficiency is defined as the ratio of observed profit π^* to the potential profit π_f^*:

PE = observed profit / frontier profit (5)

Transforming the shadow profit frontier

The normalised market-price profit π^n in which profit is evaluated with the normalised market prices can be derived from the observed profit π. Equation (6) shows the observed gross profit, which is a market-evaluated profit, measured as total output value minus total variable costs:

$$\pi = \sum_{k=1}^{M} P_k Y_k - \sum_{i=1}^{N} W_i X_i = \sum_{k=1}^{M} P_k Y_k - W_1 X_1 - \sum_{i=2}^{N} W_i X_i \quad (6)$$

Where, P_k and Y_k (k=1,...,M) are the observed prices and quantities of outputs, W_i and X_i (i=1,...,N); show the price and quantity of other inputs, respectively. W_1 is the observed price of the input X_1 and is used in normalizing the other prices. As indicated by equation (7), the observed profit π is normalized by W_1 such that $\pi^n=\pi/W_1$:

$$\pi^n = \sum_{k=1}^{M} (P_k / W_1) Y_k - X_1 - \sum_{i=2}^{N} (W_i / W_1) X_i = \sum_{k=1}^{M} (P_k^n) Y_k - X_1 - \sum_{i=2}^{N} (W_i^n) X_i \quad (7)$$

The same process is used in normalizing the shadow-profit π_s shown in equation (8):

$$\pi_s = (\theta P_1) Y_1 + \sum_{k=2}^{M} (P_k) Y_k - W_1 X_1 - \sum_{i=2}^{N} (W_i) X_i \quad (8)$$

The shadow-profit π_s, evaluated by the shadow prices θP_1, P_k and W_i, can be normalized by W_1 as indicated in equation (9) where P_k^n is P_k/W_1 and W_i^n shows W_i/W_1:

$$\pi^* = (\theta P_1^n) Y_1 + \sum_{k=2}^{M} P_k^n Y_k - X_1 - \sum_{i=2}^{N} W_i^n X_i \quad (9)$$

Substituting X_1 from equation (7) into equation (9) results in the following:

$$\pi^* = (\theta P_1^n) Y_1 + \sum_{k=2}^{M} P_k^n Y_k - \sum_{k=1}^{M} (P_k^n) Y_k + \sum_{i=2}^{N} W_i^n X_i + \pi^n - \sum_{i=2}^{N} W_i^n X_i$$

$$\pi^* = (\theta - 1) P_1^n Y_1 + \pi^n \quad (10)$$

Equation (11) is given by substituting $(s_1\pi^*)/\theta$ for $P_1^n Y_1$ from milk output share, defined above, to equation (10):

$\pi^* = (\theta - 1)(s_1\pi^*)/\theta + \pi^n$

$$\pi^n = \pi^*(1 - s_1 + s_1/\theta) \quad (11)$$

$(1-s_1+s_1/\lambda)$ is a distortion-adjusted component in which $\theta=1$ reflects an undistorted market and satisfies $\pi^*=\pi^n$. The logarithmic form of equation (11) provides a behavioural profit function as indicated in equation (12) which relates $ln\pi^n$ to $ln\pi^*$ by the market efficiency parameter θ and the profit shares:

$$ln\pi^n = ln\,\pi^* - ln(1 - s_1 + s_1/\theta) \quad (12)$$

Lastly, this equation is rewritten as the frontier function (13) by substituting equation (3) for π^* and b_1 for s_1:

$$ln\pi^n = b_1 ln(\theta P_1^n) + \sum_{k=2}^{M} b_k ln(P_k^n) + \sum_{i=2}^{N} c_i ln(W_i^n) + \sum_{q=1}^{Q} d_q lnZ_q - ln(1 - b_1 + b_1/\theta) - U + V \quad (13)$$

The market efficiency parameter θ may be related to determinants D_j (farm age, total number of cows and sales of milk) that allow the calculation of an index for individual farms:

$$\theta = \exp(D_j, \alpha_j) \quad (14)$$

All the parameters, i.e. b_k, c_i, d_q and α_j, can be estimated by the system of equation (14) and frontier (13) in which the dependent variable as well as other variables are known and measurable and the difficulty of direct estimation of equation (3) is solved.

Imposing $\theta=1$ reduces equation (13) to a normalized market-price profit frontier where there is no distortion in the milk market, i.e. farms are 100% market-efficient.

Measuring profit efficiency

Using the seemingly unrelated regression (SUR) method, the values of the coefficients in the profit frontier (13) and the market efficiency equation (14) were estimated and used in calculating the farm-specific profit efficiency indices. The measure was evaluated first with regard to a distorted market and then compared with a situation of no distortion in the milk market, i.e. where $\theta=1$.

The profit efficiency component was estimated in both cases using the method suggested by Jondrow *et al*. (1982) as the conditional mean of U_j, given $\varepsilon_j=-U_j+V_j$ and assuming a normal distribution for V and a half-normal distribution for U:

$$E(U_j | \varepsilon_j) = \sigma_*\left[\frac{f(.)}{1 - F(.)} - \frac{\varepsilon j\lambda}{\sigma}\right] \quad (15)$$

Where, $\sigma_*^2=\sigma^2_U\sigma^2_V/\sigma^2$, $\lambda=\sigma_U/\sigma_V$, $\sigma=\sqrt{\sigma^2_U+\sigma^2_V}$ and σ, σ_U, and σ_V are the standard errors of the residuals ε, of the inefficiency term U, and of V, respectively. The standard normal density function and the cumulative distribution function evaluated at ε_j/σ are shown by f(.) and F(.), respectively.

Data

The data were taken from completed questionnaires from a sample of 860 Iranian small intensive dairy farms in 2005-2006. Although, dairying technology in its wide concept may vary among the farms with different sizes in different regions of the country, the small dairy farms are assumed to have similar technologies over the country. The distribution of these farms by provinces is indicated in Table 1.

Amongst the regions, Tehran, Khorasan, Isfahan, Mazandaran, East Azarbaijan and Khuzestan record the highest production, accounting for 50 percent of total output, however, small dairy farms are scattered throughout the country including above provinces as well as Markazi, Semnan, Yazd, etc.

Table 2 represents some basic variables in sample farms. Although, dairy farms in Iran vary in size and include large, medium and small farms, the sample farms have 25 animal on average out of which 34% are cows.

While total variable costs (TVC) constitute over 50% of value of total products (VTP), 80% of TVC is attributed to foodstuffs. Furthermore, the vast majority of workers in the farms are family labours (73%).

Apart from above variables, dependent variable in frontier function (13) is gross margin (GM) and the explanatory variables are prices of outputs (P_k) and variable inputs (W_i), normalized all with the price of fuel, and the quantity of fixed inputs (Z_q). Farm age, total number of cows, and total sales of milk are recognized as factors associated with the market efficiency index.

RESULTS AND DISCUSSION

The estimated coefficients of the shadow-price profit frontier (13) and equation (14) are given in Table 3. Out of the 11 coefficients, eight are significantly different from zero and have the expected sign. The significant coefficient for cows suggests that the bigger the number of milking cows, the less market-efficient it is. This may arise from the fact that the larger farms supply more milk to market than small farms.

Distribution of profit efficiency indices:

The distribution and frequency of unadjusted profit efficiency (PE_1), adjusted profit efficiency (PE_2), as well as the distribution of market efficiency (ME), are illustrated in Tables 4 and 5, and in Figures 1 and 3. As shown in Table 4, the mean value of PE_1 is 0.70 and that of PE_2 is 0.93.

Table 1 Distribution of sample farms by provinces in Iran

	No of farms		No of farms
Ardabil	7	Khuzestan	25
Charmahal Bakhtiari	13	Kordestan	21
Eest Azarbayjan	48	Lorestan	21
Fars	60	Markazi	64
Gilan	16	Mazandaran	65
Hamadan	19	Semnan	71
Hormozgan	10	Tehran	41
Isfahan	89	West Azarbayjan	14
Kerman	16	Yazd	66
Kermansha	11	Zanjan	15
Khorasan	159	Others	9

Table 2 Basic variables in sample farms

	Mean	Std. Deviation
Herd size	25.07	13.28
Cows in herd (%)	34.2	15.28
Daily milk (liter/day)	12.45	5.73
TVC to VTP	0.54	0.28
Value of feed to VTP	0.41	0.19
Value of feed to TVC	0.80	0.16
Ratio of family labor	0.73	0.35

Table 3 The coefficients of the profit frontier and market efficiency equation, intensive dairy farms, Iran

	Estimates	SE	P-value
Frontier function			
price of milk	1.376	0.172	0.000
manure	0.156	0.068	0.024
animals	0.279	0.076	0.000
concentrates	-0.326	0.169	0.054
forages	-0.252	0.124	0.043
hired-labor (wage)	-0.135	0.108	0.210
family labor	0.028	0.045	0.530
gross investment	0.007	0.011	0.527
total capacity	0.766	0.031	0.000
λ	0.635	0.017	0.000
σ	2.340	0.205	0.000
Market efficiency equation			
farm age	-0.002	0.002	0.278
total number of cows	-0.001	0.004	0.008
sales of milk	0.000	0.000	0.588

As can be seen, there is a wide dispersion of the indices for both PE_1 and PE_2, however, the former exhibits a wider range. There are farmers who are just 2% profit efficient due to these indices but on average, profit efficiency is 0.40 based on shadow-price profit frontier that is much less than mean index that ignores market imperfection, i.e. 0.72. In other words, the findings reveal that farmers are mistakenly recognized to have high efficiency scores if we ignore to adjust distortion in efficiency estimation. As was stated earlier, the differences between these two indices are due to market efficiency carries from 22% to 97% and 46% in average.

Moreover, comparing Figures 1 and 2, it can be seen that the PE_2 measures of profit efficiency are almost normally

Table 4 Distribution of small intensive dairy farms by unadjusted (PE_1) and adjusted (PE_2) profit efficiency and market efficiency (ME)in Iran

	Number of cases	Minimum	Maximum	Mean	SD[1]
PE_1	696	0.02	0.95	0.72	0.205
PE_2	696	0.02	0.72	0.40	0.125
ME	859	0.22	0.97	0.46	0.157

SD: standard deviation.

distributed as we assume to be so. Thus, it may be concluded that to calculate an unbiased farm-specific efficiency, prices should be adjusted in the imperfect milk market in Iran.

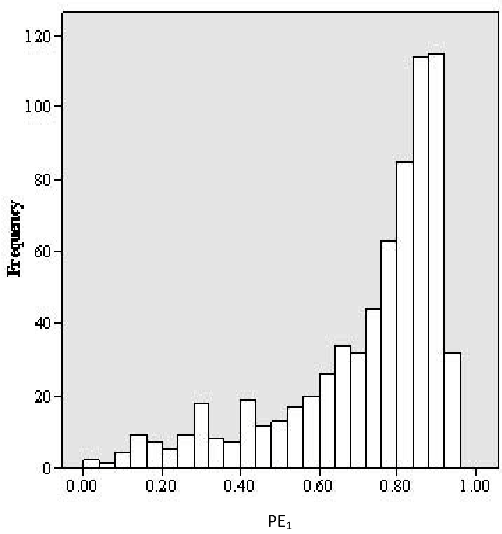

Figure 1 Distribution of small dairy farms by unadjusted profit efficiency in Iran

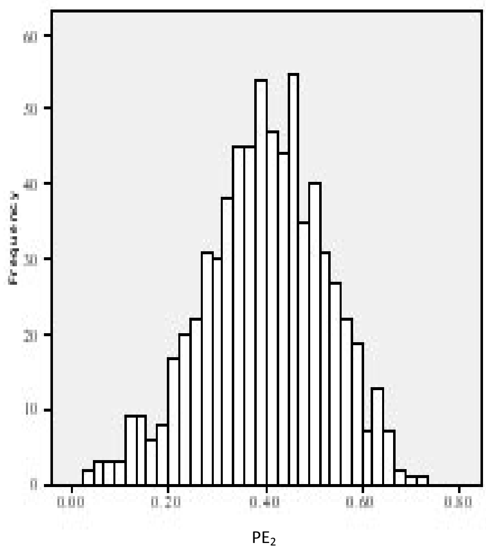

Figure 2 Distribution of small dairy farms by unadjusted profit efficiency in Iran

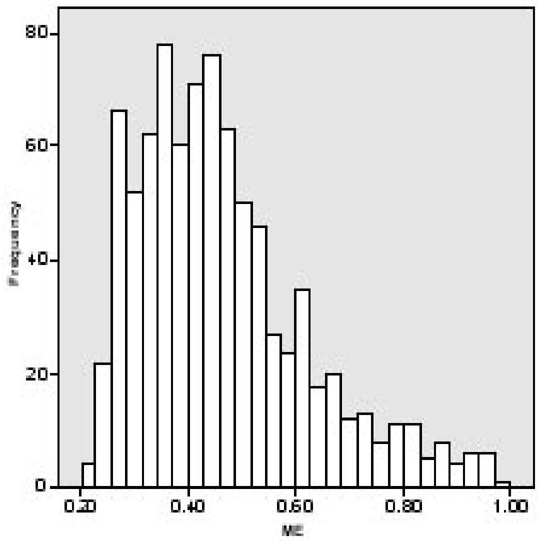

Figure 3 Distribution of small dairy farms by unadjusted profit efficiency in Iran

Breed and profit efficiency

A multiple general linear model (GLM) technique was applied to the data to examine the multiple effects of pure-bred animals and the used farm capacity on profit efficiency indices. Using GLM procedure, null hypotheses about the effects of factor variables on the means of various groups of a joint distribution of dependent variables can be tested. It also allows the investigation of interactions between factors as well as the effects of individual factors.

The level of efficiency may differ not only by the pure-bred animals in the herd, but with the used capacity of the farms (which may be over 100% on some farms: 7% of the intensive dairy farms in Iran overused their farms). So, the main and interaction effects of pure-bred animals and used capacity of farms are examined to explain the effect of breed on profit efficiency indices. The results of GLM are indicated in Table 5.

Regarding the percentage of pure-bred animals, there were no evidence of discrepancy among different groups, i.e. the farms with high (100%), average (between 50% and 100%), and low (maximum 50%) level of pure-bred animals.

The farms with a high level of capacity use (at least 75%) were found to be more profit-efficient than those with average capacity use (between 50% and 75%) and low capacity use (maximum 50%) in the imperfect milk market. The farms with over 100% capacity use were more profit-efficient than those with average and these in turn more profit-efficient than farms with low capacity use. There was no difference between the index of farms with overused and high-used capacity in the distorted market. The index had the opposite pattern in perfect milk market. The farms with over 100% capacity use, for instance, were less profit-efficient than either the farms with average and low capacity use.

Table 5 Effects used capacity and pure-bred animals on profit efficiency indices (PE_1) and (PE_2), intensive dairy farms, Iran

Dependent variable	Pure-bred animals (i)	(j)	Mean difference (i-j)	Significant level
PE_1	High	Average	0.00217	0.393
		Low	0.00102	0.376
	Average	Low	-0.00106	0.677
PE_2	High	Average	-0.00002	0.524
		Low	0.00000	0.659
	Average	Low	0.00003	0.418
Dependent variable	**Used capacity (i)**	**(j)**	**Mean difference (i-j)**	**Significant level**
PE_1	High	Over	-0.00098	0.646
		Average	0.00358	0.012
		Low	0.00649	0.000
	Average	Low	0.00291	0.028
		Over	-0.00456	0.036
	Low	Over	-0.00747	0.000
PE_2	High	Over	0.00000	0.646
		Average	-0.00007	0.000
		Low	-0.00009	0.000
	Average	Low	-0.00002	0.248
		Over	0.00008	0.012
	Low	Over	0.00009	0.001

CONCLUSION

The milk market in Iran is distorted and dairy farmers supply milk at a low price mainly to the market. To increase their revenue, some farmers have extended their farms and increased the number of animals in their herd to produce as much milk as possible, but still the majority of farms are categorized as small and average-sized. To test the main hypothesis in this study, an adjusted measure of profit efficiency was calculated based on a shadow-price profit frontier. Finding revealed a significant difference between this index and its alternative calculated from an unadjusted frontier function. The former measure also exhibited closely a normal distribution. Since the prices should be adjusted in an imperfect market, we assume that this measure is accurate and so, the efficiencies of farms are overstated, if they are calculated based on an unadjusted frontier. Moreover, small dairy farmers in Iran realized to be market inefficient much worse than their profit inefficiencies, on average. This implies that attempts should focus on the milk market rather than on encouraging dairy farmers to enlarge their farms, so that the dominant small farms in milk production can compete and survive more efficiently in a more perfect milk market.

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