DATE MARKETING EFFICIENCY ESTIMATION IN SAUDI ARABIA: A TWO-STAGE DATA ENVELOPMENT ANALYSIS APPROACH

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A two-stage data envelopment analysis (DEA) approach was applied to explore the relationship between date marketing efficiencies in Saudi Arabia and estimates of technical and cost efficiencies. Special reference was made to the objectives of date marketing traders: namely, increasing the scale and margins of date marketing and achieving the highest ratio of date marketing margin to date marketing cost, thereby enabling the impact of improved date marketing efficiency to be estimated. In addition, the research paper analyses the determinants of technical and cost efficiencies in an econometric framework using a TOBIT model to assess the impacts of the determinants on date marketing traders in Saudi Arabia. The results showed that Saudi Arabia has great potential to improve its date marketing efficiency and to achieve an additional 51% of added value annually, increasing from a current figure of about US$2.67 billion per year to about US$4.01 billion per year with improved economic efficiency. The results also showed that developing date marketing in Saudi Arabia needs policies which relate the traditional concept of market efficiency to the technical and cost efficiencies of date marketing. Such policies would help to establish the programmes and tools which are needed to achieve marketing goals.
Keywords: Added value, cost efficiency, marketing margin, marketing scale, technical efficiency, TOBIT model.

INTRODUCTION

The date sector in Saudi Arabia has acquired a considerable reputation at local and global levels. This reputation could be attributed to the premium quality of Saudi dates and to the significant investment in expanding local and worldwide demand. Saudi Arabia has the largest cultivated area for date palms in the world, with about 168.92 thousand hectares which is equivalent to about 16% of the total worldwide date palms cultivated area, and ranks third in global date production with more than one million tons which is equivalent to about 15% of the worldwide production in 2013 (FAO, 2015).

Although the date sector in Saudi Arabia has a global reputation and is recognised as one of the country's most competitive economic sectors, date marketing has not kept pace with the global standing of Saudi Arabia and with the competitiveness of the date sector in the national economy. It faces many problems and obstacles which have reflected negatively on the efficiency of the local date market and on the competitiveness of Saudi dates in the world market, including but not limited to, low quality and high costs of marketing services such as transportation, storage, sorting, grading and packaging, shortage of seasonal labourers and the emergence of a black labour market, lack of inadequate marketing information systems, and lack of coordination among market components and players. Leveraging technical and cost efficiencies is necessary to enhance date marketing efficiency in Saudi Arabia and the ability of the sector to meet local market needs and respond successfully to international market challenges.

This research paper aims to explore the relationship between date marketing efficiencies and estimated technical and cost efficiencies using a two-stage data envelopment analysis (DEA) approach. In this regard, the paper makes special reference to the objectives of date marketing traders; namely, increasing the scale and margins of date marketing, and achieving the highest ratio of date marketing margin to date marketing cost, thereby enabling the impact of improved date marketing efficiency to be estimated. In addition, the research paper analyses the determinants of technical and cost efficiencies in an econometric framework which includes personal and marketing unit characteristics and uses a TOBIT model to assess the impacts of the determinants on date marketing traders.

The literature review shows a widespread application of the two-stage DEA approach in different disciplines since it was first introduced by Charnes *et al.* (1985) to gain insights into the efficiency of marketing efforts. Since then, there have been marketing studies which have used the DEA approach as a methodology in diverse applications (Kamakura *et al.*, 1988; Mahajan, 1991; Heskett *et al.*, 1994; Kamakura *et al.*, 1996; Donthu and Yoo, 1998; Luo and Donthu, 2001; Kamakura *et al.*, 2002; Donthu *et al.*, 2005; Keh *et al.*, 2006;

Gelan and Muriithi, 2010; Minegishi, 2013; Thibbotuwawa *et al.*, 2013; O'Donnell, 2014).

At the national level, Alabdulkader *et al.* (2015) led the first scientific attempt to assess the marketing efficiency of dates in Saudi Arabia using the two-stage DEA approach. Yet, the literature showed some scientific efforts in the field of dates marketing in Saudi Arabia that tackled the marketing output transaction of dates in Saudi Arabia including marketing characteristics, volume, prices, marketing channels, and loss analysis (Alkahtani, *et al.,* 2016), evaluated the competitiveness and the demand elasticity of Saudi dates in some selected countries (Almodarra and Saghaian, 2016, Ali *et al.*, 2014a,b), analysed the determinants of competitive advantage of Saudi dates in international markets (Abdel Gawad *et al.,*2014), and evaluated the technical efficiency and performance of the date processing industry in Saudi Arabia (Alabdulkader, 2006).

MATERIAS AND METHODS

Data envelopment analysis: Basic concepts: Researchers have analysed the relationship between efficiency and performance using different techniques. One of these is a non-parametric method such as DEA, which uses a linear programming method and does not need to estimate a pre-established functional form. This follows the approach of Farrell (1957) and Charnes *et al.* (1978). DEA constructs an efficient frontier using the best performing units of a sample. The basic concepts of these efficiencies include technical and cost (or economic) efficiencies. With an input-oriented framework, technical efficiency (TE) gives the potential input reduction which a marketing unit could apply without reducing its output level. In the case of constant returns to scale, the assumption is that the marketing unit is working at its maximum scale. In the case of variable returns to scale (increasing or decreasing), an additional assumption is included which assumes that the marketing unit is working at less than its maximum scale. Cost, or economic, efficiency (CE or EE), on the other hand, is the product of technical and allocative efficiency (overall efficiency), which can be interpreted as the potential reduction in production costs (cost efficiency) at the same level of production.

Data envelopment analysis: The model: The DEA model involves optimising a scoring function (H), defined as the ratio of the weighted sum of date marketing objectives (Y1, Y2 and Y3) as output, and the weighted sum of date marketing cost functions (x1, x2, x3, x4 and x5) as inputs, subject to the constraints that the similar ratios for each date marketing unit (DMU) be less or equal to one, implying that efficient units will have a score of one. DMU outputs include the marketed date quantity in tons (Y1), the date marketing margin in Saudi Riyals (Y2) and the ratio of date marketing margin to the total cost of date marketing (Y3).

Inputs of DMUs used in date marketing are x1, x2, x3, x4 and x5, representing the cost of labour, transportation, grading, storage and other costs (including packaging, advertising and commissions), respectively.

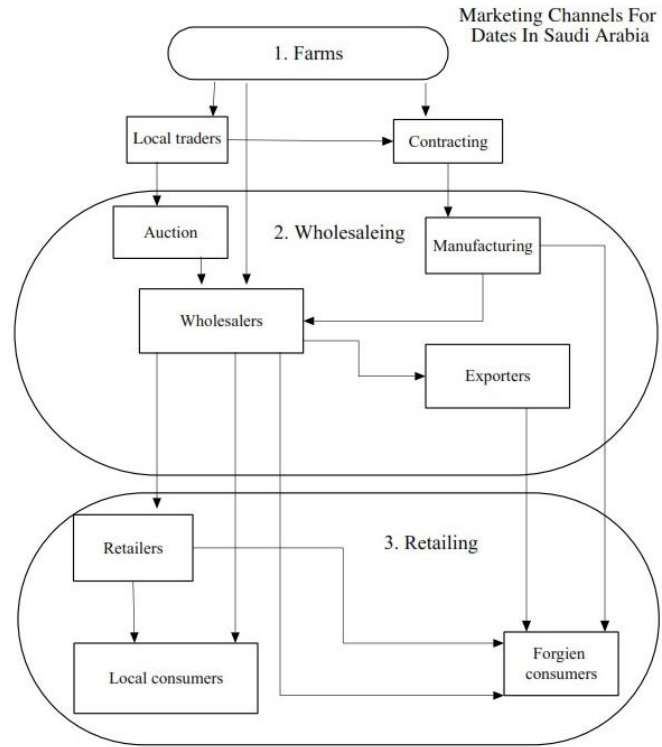Figure 1 shows in a schematic flow chart the marketing channels for dates in Saudi Arabia.

Figure 1. Marketing channels for dates in Saudi Arabia.

For each ith DMU, the linear problem is as follows:

$$\max_{u,v} H = (u'y_i/v'x_i)$$
$$st \quad (u'y_j/v'x_j) \le 1, \quad j = 1,2,...,N$$
$$u,v \ge 0$$

where $u'y_i/v'x_i$, is the scoring function (where u is an Mx1 vector of output (Y) weights and v is an Kx1 vector of input (x) weights). The goal is to find values for u and v which maximise the efficiency score of the ith DMU subject to the constraint that all the efficiency measures must be less than or equal to one. This ratio formulation ensures that 0 <Max, H <1. A unit will be efficient if and only if this ratio equals unity, otherwise it is considered as relatively inefficient. Identifying the technical efficiency of DMU would require solving the following linear programming problem:

$$\text{Max} \quad y_{y,\lambda^1,....,\lambda^k} \qquad (1)$$

Subject to:

$$\sum y^k \lambda^k \ge y \quad k =1$$

$$\sum x_n \lambda^k \leq x_n \quad k=1$$

$$\sum \lambda^k = 1 \quad k=1$$

$$\lambda^k \geq 0$$

where y is an optimal level of output or date marketing objective (Y_i), y^k denotes the output of the kth DMU, x_n^k denotes the level of the nth input used on DMU k, x_n^{0} is the nth input used on the DMU whose efficiency is being tested, and λ^k is the weight given to DMU k in forming a convex combination of the input vectors. The resulting technical efficiency index is calculated as a ratio between the observed levels of output on the DMU being tested (y^{0}) and the optimal level of output (y). Technically efficient DMUs are those with an efficiency index equal to one. Technically inefficient DMUs are those with an index strictly lower than one.

Cost-efficient DMUs (under the assumption of variable returns to scale) are identified by solving the following:

$$\text{Min} \ \Sigma^t_{n=1} w^0_n x_n \qquad (2)$$

Subject to:

$$\sum y^k \lambda^k \geq y \quad k=1$$

$$\sum x^0_n \lambda^k \leq x_n \quad \text{for } 1 \leq n \leq t, \quad k=1$$

$$\sum x^k_n \lambda^k \leq x_n \quad \text{for } n > t, \quad k=1$$

$$\sum \lambda^k = 1 \quad k=1$$

$$\lambda^k \geq 0$$

where w^0_n is the cost of the n ($n=1,\dots,t$) input faced by the DMU whose efficiency is being tested, λ^k is the weight given to DMU k in forming a convex combination of the output or input vectors, x_n denotes the optimal amount of input n ($n=1,\dots,t$), y^k denotes the output of DMU k ($k=1,..,K$), x^k_n denotes the level of input n for DMU k, and x^0_n is the amount of fixed input n on the DMU whose efficiency is being tested.

The cost efficiency index is calculated as the ratio between the optimal cost ($w_n x'_n$) and the observed cost on the kth DMU being tested ($w_n x^0_n$). Cost efficient DMUs are those with a cost efficiency index equal to one. DMUs with an index less than one are characterised as cost inefficient. Technical efficiency and cost efficiency indexes are relative measures in the sense that they are obtained by comparing each DMU to DMUs within a reference category.

In order to determine the factors contributing to technical and cost efficiencies, the study model was formulated and estimated using DEAP computer software (Coelli *et al.,* 1998).

Date marketing efficiency determinants: In the two-stage approach, a DEA problem is solved in the first stage of analysis, which involves only traditional inputs and outputs. In the second stage, the efficiency scores from the first stage are regressed upon the efficiency determinant variables (Coelli *et al.,* 1998). In this study, the two-stage approach is used to assess the influences of various factors on technical and economic efficiencies. This approach has several advantages such as not requiring prior assumptions regarding the direction of influence, and the ability to accommodate more than one variable with continuous or categorical variables. A TOBIT regression approach was used to estimate the potential determinants of DEA technical and economic efficiencies because the efficiency estimates had (1) as an upper limit and (0) as a lower limit. A number of previous studies have used the same approach with a TOBIT model (Binam *et al.,* 2004; Chavas *et al.,* 2005; Cinemre *et al.,* 2006) which is given as:

$$CE_i = \beta_0 + \sum_{j=i}^{n} \beta_j V_{ij} + u_i \ if \ \ u_i > -\beta_0 - \sum_{j=i}^{n} \beta_j V_{ij} \qquad (3)$$

$$CE_i = 0 \qquad if \ \ u_i \leq -\beta_0 - \sum_{j=i}^{n} \beta_j V_{ij} \qquad (4)$$

CEi = the measure of cost efficiency for the date marketing unit (DMU),

Vij = explanatory variables which influence the cost efficiency of the date marketing units, including personal characteristics, such as education, experience and whether date marketing was an inherited job; and marketing unit characteristics such as trade type, business start date, engagement in other activities than date marketing, and the income share of date marketing with the other activities.

N = an index of the variables,

β & u = parameters of the model and the random error term, respectively.

$$TE_i = \beta_0 + \sum_{j=i}^{n} \beta_j V_{ij} + u_i \ if \ \ u_i > -\beta_0 - \sum_{j=i}^{n} \beta_j V_{ij} \qquad (5)$$

$$TE_i = 0 \qquad if \ \ u_i \leq -\beta_0 - \Sigma_{j=i}^{n} \beta_j V_{ij} \qquad (6)$$

TEi = the measure of technical efficiency for the date marketing unit (DMU),

Vij = explanatory variables which influence the technical efficiency of the date marketing units, including personal characteristics, such as education, experience and whether date marketing was an inherited job; and marketing unit characteristics such as trade type, business start date, engagement in other activities than date marketing, and the income share of date marketing with the other activities.

N = an index of the variables,

β & = parameters of the model and the random error
u   term, respectively.

Data sources: The two-stage DEA analysis was based on collected primary and secondary data of the date marketing sector in Saudi Arabia, including a survey of about 300 traders operating in date markets in the key production regions in Saudi Arabia, namely Al-Hassa, Al-Madena, Al-Qaseem and Riyadh. Sources of collected data also include interviews with key stakeholders in the date sector and data from official national and international statistics. Table 1 presents the basic characteristics of the study sample. It shows that study areas represented in the sample were in line with the most important date marketing locations in Saudi Arabia, as 33.9% of the interviewed DMUs had done business in Al-Madena, which is considered the most important date marketing region for Saudi dates and combines all types of DMUs (retailers, wholesalers, and exporters).

Table 1. Basic characteristics of the study sample of date marketing unites (DMU) in Saudi Arabia – 2012.

Variable	Frequency	%
Study areas		
Riyadh	75	25.2
Al-Madena	101	33.9
Al-Hassa	49	16.4
Al-Qaseem	73	24.5
Marketing Channels (Types)		
Wholesaling	47	15.8
Retailing	129	43.3
Wholesaling and Retailing	106	35.6
Retailing and Exporting	3	1.0
Wholesaling, Retailing and Exporting	6	2.0
Undefined	7	2.3
Specialization in date marketing activities		
Specialised	216	72.5
Non-specialised	82	27.5
Other activities (for non-specialised)		
Agricultural marketing activity	71	86.59
Non-agricultural marketing activity	11	13.41
Trader background		
Inherited business	116	38.6
Un-inherited business	182	61.1
Trader Educational level		
Lower than hi-school	150	50.3
Hi-school	120	40.3
Higher Education	24	8.1
Undefined	4	1.3
Scale of trade (ton)		
Small scale	< 10	17.2
Medium scale	10 - < 50	41.9
Above medium scale	50 – < 100	11.0
Large scale	100 – 500	22.5

Variable	Frequency	%
X-large scale	> 500	7.4

Source: analysis of study data.

The study sample contains all trade types, where retailing represents about 43% of the total study sample. Also, Al-Madena procures dates from all varieties and locations in Saudi Arabia to supply Saudi dates for national and international date consumers. Most of the sampled DMUs were only specialised in date marketing (72.5%) while most non-specialised DMUs (about 87%) practiced other agricultural marketing activities. A very limited portion of DMUs were highly educated (about 8%) while more than 90% were secondary-educated or lower.

The first stage concerns the efficiency of the date marketing unit (DMU). Data includes dependent variables (Y_i) which are date quantity in tons (Y_1), marketing margin in amounts of 1,000 Saudi Riyals (Y_2) and the ratio of marketing margin to total marketing costs (Y_3). The independent variables (X_i) required to estimate technical efficiency (TE_i) include the costs of labour (X_1), transportation (X_2), grading (X_3), storage (X_4) and the total of packing materials, commissions and advertising (X_5). For cost efficiency (CE) estimation, the costs of the last marketing functions are estimated per ton of dates (W_i), then multiplied by the date quantity per ton which was used in each marketing function. The exception is labour (X_{11}), for which X_{22}, X_{33}, x_{44} and X_{55} are considered as marketing function share per ton respectively. Thus, the parameter's relational forms are:

$$TE_i = Y_i = f(X_1, X_2, X_3, X_4, X_5) \qquad (7)$$

$$CE_i = Y_i = f(W_1X_{11}, W_2X_{22}, W_3X_{33}, W_4X_{44}, W_5X_{55}) \quad (8)$$

Determinants of technical and cost efficiencies were estimated using a TOBIT model which included traders' personal characteristics such as education, experience and whether date marketing was an inherited job (inherited job); and marketing unit characteristics such as trade type, business start date, engagement in other activities than date marketing (marketing share) and the income share of date marketing with the other activities. It is worthwhile to indicate that in most cases a trader is working at his father store to build his experience, before he starts his own business.

RESULTS

The results of the research paper are presented under three headings. These are: 1) the technical and cost efficiency of date marketing, based on date marketing scale, date marketing margin, and ratio of marketing margin to total marketing costs. 2) the determinants of date marketing efficiency, which are determinants of cost efficiency, and determinants of technical efficiency, and 3) estimated impact of improved marketing efficiency.

Technical and cost efficiencies of date marketing:

Table 2. Technical and cost efficiencies of date marketing in Saudi Arabia based on date marketing scale (tons).

Quantity of marketed dates (tons)	Technical efficiency	# of traders (number)	# of traders (%)	Quantity of marketed dates (tons)	Cost efficiency	# of traders (number)	# of traders (%)
269	1.00	116	39	381	1.00	9	3
144	0.93	9	3	409	0.93	4	1
117	0.74	28	9	68	0.84	4	1
46	0.63	13	4	77	0.73	3	1
283	0.55	15	5	256	0.66	5	2
45	0.45	18	6	362	0.55	10	3
52	0.33	22	7	162	0.45	22	7
55	0.23	22	7	69	0.35	35	12
185	0.13	22	7	198	0.25	52	17
492	0.06	33	11	81	0.14	64	21
				222	0.03	87	29
				3,340	0.003	3	1
Average	**0.51**				**0.494**		
Total		**298**	**100**			**298**	**100**

Source: Study results analysis.

Table 3. Technical and cost efficiencies of date marketing in Saudi Arabia based on date marketing margin (US$000).

Marketing margin (US$000)	Technical efficiency	# of traders (number)	# of traders (%)	Marketing margin (US$000)	Cost efficiency	# of traders (number)	# of traders (%)
1023	1.00	121	41	275	1.00	9	3
447	0.93	9	3	936	0.93	4	1
298	0.85	13	4	71	0.84	4	1
121	0.74	14	5	394	0.73	3	1
1715	0.63	13	4	44	0.66	5	2
281	0.55	15	5	413	0.55	10	3
448	0.45	18	6	88	0.45	22	7
66	0.33	30	10	105	0.35	36	12
261	0.23	21	7	70	0.25	53	18
103	0.13	20	7	225	0.14	64	21
136	0.06	24	8	353	0.03	85	29
				275	0.003	3	1
Average	**0.54**				**0.494**		
Total		**298**	**100**			**298**	**100**

Source: Study results analysis.

Estimation based on date marketing scale (tons): The technical and cost efficiency estimations of date marketing are classified into 11 categories (Table 2) to show the relation between average efficiency and average date marketing scale. The number of date marketing units (DMU) and the relative importance (ratio) for each category are also included. With regard to the technical efficiency of date marketing, 116 DMUs (39%) have full technical efficiency and market about 269 tons/year on average, while 99 DMUs (32%) have technical efficiency ranging from 0.33-0.06. Note that with minimum technical efficiency equal to about 0.06 (11%), DMUs have an average of 492 tons/year, which is contrary to the expectation that increasing date marketing scale would increase date marketing technical efficiency. The difference in experience between small- and large-scale date traders would explain this result.

It is important for DMUs to have the right combination of marketing functions which minimise the cost of date marketing, thereby achieving higher cost efficiency. 3% of the study sample, 9 DMUs, have full cost efficiency, while 29% of DMUs have only 0.03 as their cost efficiency for date marketing.

Estimation based on date market margin (US$000s):
Table 3 shows that technical and cost efficiencies differ as the DMUs' objective changes from date marketing scale (tons) to maximising date marketing margins. 121 DMUs (41%) have full technical efficiency with an average date marketing margin of US$1023 thousands. Figure 2 shows that increasing date marketing scale would increase technical efficiency. However, the last relation is not clear with regard to cost efficiency (Fig. 3) where only 9 DMUs (3%) have full cost efficiency for date marketing, with an average marketing margin equal to US$275 thousands which implies the need to adopt marketing policies which minimise the input costs required for different date marketing functions. As shown in Table 3, 80% of DMUs have relatively lower cost efficiency, ranging from 0.35 to 0.03, which requires the adoption of market policies which minimise the cost of the inputs required for different date marketing functions.
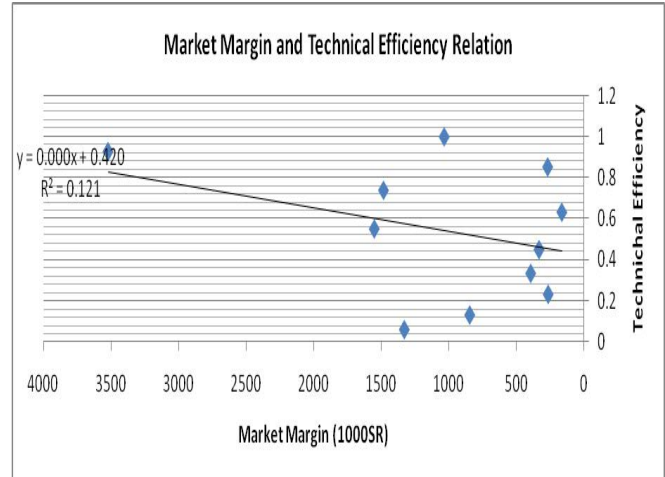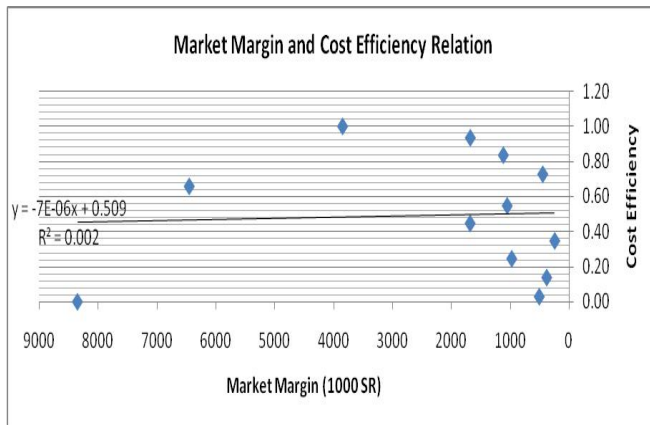

Figure 2. Relation between marketing margin and technical efficiency.

Table 4. **Technical and cost efficiencies of date marketing in Saudi Arabia based on the ratio of market margin to total date marketing costs (MM/MC).**

Technical efficiency				Cost efficiency			
MM/MC	Technical efficiency	# of traders (number)	# of traders (%)	MM/MC	Cost efficiency	# of traders (number)	# of traders (%)
41	1	121	41	146	1.00	9	3
222	0.93	9	3	39	0.93	4	1
52	0.85	13	4	289	0.84	4	1
163	0.74	14	5	22	0.73	3	1
2	0.63	13	4	519	0.66	5	2
123	0.55	15	5	93	0.55	10	3
13	0.45	18	6	84	0.45	21	7
52	0.33	30	10	22	0.35	37	12
61	0.23	21	7	57	0.25	54	18
64	0.13	21	7	31	0.14	63	21
69	0.06	23	8	47	0.03	85	29
				29	0.003	3	1
Average	0.54				0.494		
Total		298	100			298	100

Source: Study results analysis.

Figure 3. Relation between marketing margin and cost efficiency.

***Estimation based on the ratio of market margin to total marketing costs*:** When a DMU changes its objective from increasing its marketing margin to increasing its ratio to total date marketing costs (MM/MC), which is an indicator of marketing efficiency, the results of technical and cost efficiencies do not change (Table 4). However, the relation between date marketing margin and its ratio to total date marketing cost needs to be explained because a higher ratio does not mean higher technical and cost efficiencies. The highest market margin, 3,521, ensures the highest ratio, 222, with 0.93 technical efficiency for only 9 DMUs (3%); while for date marketing cost efficiency, the highest ratio was 519 with 0.66 cost efficiency achieved by 5 DMUs (2%) of the

Table 5. Cost efficiency determinants of date marketing in Saudi Arabia.

	Variable	Coefficient	SD	T	Prob.(T)
Al-Hassa Region					
	Constant	0.127235	0.109764	1.159	0.2464
Education	XA2	0.058199	0.045494	1.279	0.2008
Experience	XA51	0.003277	0.004611	0.711	0.4773
Inherited job	XA6	-0.075930	0.067515	-1.125	0.2607
	Constant	0.696593	0.164476	4.235	0.0000**
Trade type	XA1	-0.004990	0.022318	-0.224	0.8230
Date marketing %	XA4	-0.003800	0.001813	-2.094	0.0362*
Date income %	XA7	-0.001550	0.001538	-1.007	0.3138
Al-Madena Region					
	Constant	0.218231	0.049304	4.426	0.0000**
Education	XA2	-0.000890	0.031632	-0.028	0.9777
Experience	XA51	-0.003780	0.002384	-1.586	0.1128
Inherited job	XA6	0.000960	0.000179	0.536	0.5922
	Constant	0.062326	0.043280	1.440	0.1499
Trade type	XA1	0.040318	0.014842	2.717	0.0066**
Date marketing %	XA4	0.000279	0.000179	0.156	0.8759
Date income %	XA7	0.000320	0.000918	0.349	0.7272
Al-Qaseem Region					
	Constant	0.265177	0.049754	5.330	0.0000**
Education	XA2	0.000177	0.000190	0.093	0.9260
Experience	XA51	-0.006080	0.003789	-1.604	0.1087
Inherited job	XA6	-0.000400	0.000185	-2.183	0.0291*
	Constant	0.039778	0.240377	0.165	0.8686
Trade type	XA1	-0.009480	0.020710	-0.458	0.6473
Date marketing %	XA4	0.004161	0.002191	1.899	0.0575*
Date income %	XA7	-0.002570	0.001460	-1.759	0.0786
Riyadh Region					
	Constant	0.267263	0.047364	5.643	0.0000**
Education	XA2	-0.000150	0.000248	-0.610	0.5417
Experience	XA51	-0.003470	0.002922	-1.188	0.2348
Inherited job	XA6	-0.004840	0.060671	-0.080	0.9364
	Constant	0.165981	0.182028	0.912	0.3619
Trade type	XA1	0.017127	0.021665	0.791	0.4292
Date marketing %	XA4	0.000120	0.002048	0.059	0.9532
Date income %	XA7	-0.000127	0.000240	-0.053	0.9576

Source: Analysis of study data.   Note: * significant at 5%, ** significant at 1%.

study sample. Figures 4 and 5 show a positive relation between the ratio of MM/MC as a classical marketing efficiency indicator with technical and cost efficiencies of DMUs, but the significance of this relation is not clear. About 80% of DMUs, based on cost efficiency, have ratios of MM/MC ranging from 31 to 93.

Determinants of date marketing efficiency:

***Determinants of cost efficiency*:** Table 5 shows the impact of determinants on cost efficiency in the study's regions, namely Al-Hassa, Al-Madena, Al-Qaseem and Riyadh.

***Al-Hassa region*:** Table 5 shows that personal characteristics (education, experience and date marketing as an inherited job) of the trader do not affect the cost efficiency of date marketing, simply because the new traders have to fallow up

the old system of date marketing, based on their father and grandfather experiences. For DMU characteristics (trade type, date marketing share (%) and date marketing income share (%)), the only factor affecting the cost efficiency of date marketing is date marketing share. The negative impact, -0.0038, is significant at 5%. The final result indicates that increasing the share of marketing activity for other crops would increase the cost efficiency of date marketing. To explain the negative relation between the cost efficiency of marketing dates and the share with all marketed crops, the experience of marketing different crops and the availability of the areas and facilities used for them have a negative impact on date marketing cost efficiency.
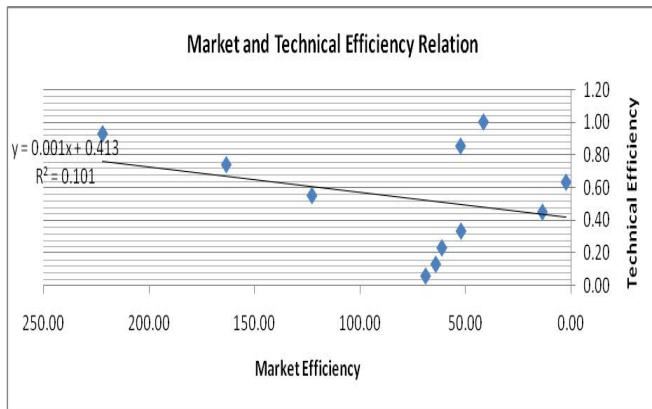
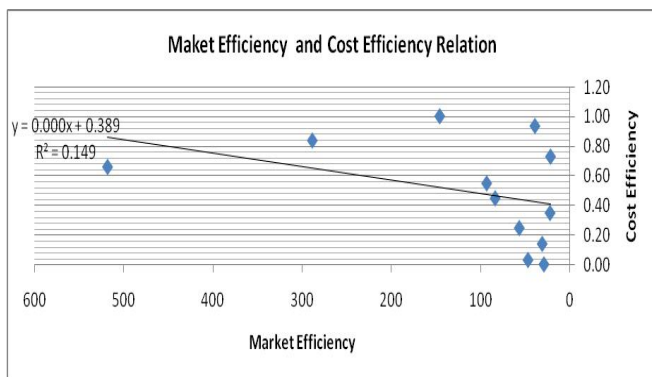**Figure 4. Relation between market efficiency (MM/MC) and technical efficiency.**

Figure 5. Relation between market efficiency (MM/MC) and cost efficiency.

Al-Madena region: The traders' personal characteristics do not affect the cost efficiency of date marketing in Al-Madena region. However, the trade type of a DMU has a significant positive impact, 0.04, on the cost efficiency of date marketing; that is, when DMUs extend their date marketing activities to include wholesale and export, they increase the cost efficiency of date marketing in the region. This result supports the recommendation to increase the scale of date marketing and extend date marketing activities to include, in addition to retail, wholesale and exports. The long experience of marketing dates is required to have three trade types of dates, such experience would explain its positive impact on date cost efficiency.

Al-Qaseem region: The results show the negative impact of experience and inherited jobs, -0.0061 and -0.0004 respectively, on the cost efficiency of date marketing. These relations were significant at levels of 10% and 5%, respectively. The DMU characteristics of date marketing share in the marketing of other crops, and date marketing income share of total marketing income have different impacts on the cost efficiency of date marketing, +0.004 and – 0.0025 respectively. In an another words, increasing the share of date marketing by 10% among the marketing of

other crops would increase the cost efficiency of date marketing by 0.04 at a significant level of 5%, which imply that date marketing is the primary activity at Al-Qaseem region and the other crops marketing are secondary. On the other hand, the negative impact of date marketing income share on the cost efficiency of date marketing is less significant (10%). Most of marketing other crops channels are using different facilities compared to that for marketing dates, so increasing date marketing income has its negative impact on cost efficiency of marketing dates as the quantities of date marketing increased, which need to apply more facilities.

Riyadh region: The results show different impacts for the traders' personal characteristics and DMU characteristics; but all such impacts were non-significant, implying a lack of consideration for these efficiency determinants for date marketing policy improvements in the Riyadh region.

Generally speaking, the minimal, unexpected impact and the insignificance of some cost efficiency determinants of date marketing imply, mainly, that following the traditional marketing system has increased the level of inefficiency of date marketing system in Saudi Arabia which in turns surpasses the impact of considered determinants on date marketing.

Determinants of technical efficiency: Table 6 shows that personal characteristics of date traders have no significant impacts on the technical efficiency of date marketing, while DMU characteristics have only two significant impacts: one for trade type in Al-Madena region and the other for the date marketing ratio (%) relative to marketing other crops in Al-Hassa region. Trade type, such as retailing, wholesaling and exporting dates, has a positive significant impact at 10% on technical efficiency in the Al-Madena region. The date marketing ratio (%) relative to marketing other crops in the Al-Hassa region has a significant positive impact at 10% level, equivalent to about 0.0773 on the technical efficiency of date marketing.

Similarly, the minimal, unexpected impact and the insignificance level of some technical efficiency determinants of date marketing imply, mainly, that following the traditional marketing system has increased the level of inefficiency of date marketing system in Saudi Arabia which in turns surpasses the impact of considered determinants on date marketing.

Estimated impact of improved date marketing efficiency: The impact of improving date marketing efficiency was estimated on the basis of calculated cost efficiency or economic efficiency (CE or EE), assuming that the objective of a DMU is to maximise the date marketing margin with an average CE or EE equivalent to about 49%. This implies that the potential reduction in marketing costs by about 49% is at the same level as value-added marketing. In another words, date dealers can achieve an additional 51% value added (marketing margin) once they reach full economic efficiency

Table 6. Technical efficiency determinants of date marketing in Saudi Arabia.

Parameters	Personal Characteristics				Date Marketing Unit (DMU) Characteristics					Model
Determents	Constant	Education	Experience	Inherited Job	Trade Type	Starting Date	Other Activity	Date Marketing (%)	Date Income (%)	Significance (F test)
Riyadh Region										
Coefficient	0.4803	0.0578	-0.0027	-0.0231	-0.0022	0.0008	-0.0285	0.0007	0.0011	0.355
T test	1.0090	0.8130	-0.5600	-0.2500	-0.0650	0.5970	-0.1470	0.1480	0.5490	9.230
Prob.	0.3131	0.4161	0.5752	0.8026	0.9484	0.5508	0.8832	0.8821	0.5832	0.000**
Al-Madena Region										
Coefficient	0.5423	-0.0823	-0.0026	0.0009	0.0516	0.0003	-0.1731	0.0023	-0.0005	0.309
T test	1.2580	-1.3810	-0.5560	0.2800	1.7910	0.1220	-0.8480	1.0060	-0.3660	11.277
Prob.	0.2083	0.1673	0.5783	0.7793	0.0732*	0.9029	0.3964	0.3145	0.7143	0.000**
Al-Qaseem										
Coefficient	23.5912	0.0006	-0.0228	-0.0013	-0.0740	-0.0164	0.0003	0.0150	-0.0028	0.393
T test	0.5980	0.1440	-0.8480	-0.3530	-1.4620	-0.5990	0.6760	1.5340	-0.6260	8.321
Prob.	0.5497	0.8851	0.3964	0.7239	0.1437	0.5495	0.4989	0.1251	0.5314	0.000**
Al-Hassa										
Coefficient	-10.491	0.0747	0.0046	-0.1474	-0.0385	0.0071	0.0722	0.0106	0.0022	0.168
T test	-0.5550	1.3060	0.3580	-1.4560	-0.9960	0.5400	0.3720	1.7660	0.8200	5.845
Prob.	0.5786	0.1915	0.7201	0.1453	0.3191	0.5890	0.7097	0.0773*	0.4120	0.000**

Note: * significant at 10%, ** significant at 1%.

Source: Data analysis of the study.

in date marketing.

As shown in Table 7, the estimated added value of Saudi dates at local and international markets is equivalent to about US$2.67 billion in 2011 and could reach US$4.01 billion per year at full economic efficiency, with additional added value equivalent to about US$1.35 billion per year.

Table 7. Estimated impact of improved date marketing efficiency in Saudi Arabia.

Item	Unit	Value
Produced quantity (2011)[a]	000 ton	1,008,105
Local consumed quantity (2011)[a]	000 ton	896,008
Exported quantity (2011)[b]	000 ton	74,797
Lost (wasted) quantity	000 ton	37,300
Retail price at local market	000 US$/ton	2,864
Export price	000 US$/ton	1,109
Lost (wasted) price	000 US$/ton	529
Estimated added value at local market	000 US$	2566.17
Estimated export added value	000 US$	82.95
Estimated lost date added value	000 US$	19.74
Estimated total added value	000 US$	2668.86
Calculated cost efficiency	%	49
Estimated added value with improved efficiency	000 US$	4019.3
Estimated impact of improved date marketing efficiency	000 US$	1350.44

Source: Data analysis of the study.

* FAO: Food and Agriculture Organization of the United Nations. www.fao.org. 2013a, b.

Conclusions: The technical and cost efficiencies of date marketing in Saudi Arabia were estimated based on three marketing objectives, namely date marketing scale, date marketing margin and the ratio of date marketing margin to the total cost of date marketing. With regard to date marketing scale, the results showed that technical efficiency and cost efficiency decreased as date marketing scale decreased; that is, a higher date marketing scale implied greater proficiency in date marketing with few exceptions. Also, economies of scale decrease input use and marketing costs per unit, which increase a unit's technical efficiency and cost efficiency. Lower efficiency for date marketing results in sharing the marketing of other crops at the same time; it is therefore hard to distinguish between the costs of marketing dates and marketing other crops. This would explain the over-estimation of date marketing costs when these are shared with other crops. For example, decreasing date marketing scale from an average 269 to 55 tons would decrease technical efficiency from 100 to 23%. Cost efficiency would decrease from 100 to 35% as marketing scale decreased from an average 381 to 69 tons.

Using date marketing margin (MM) as an objective for DMUs would produce different results compared with date marketing scale because 41% of date traders have 100% TE with an average MM of US$1,023,000, while only 3% of DMUs have 100% CE with an average MM equal to about US$275,000.

The use of date marketing margin to date marketing costs as a ratio (MM/MC) to indicate classical date marketing efficiency would provide different relations with the TE and CE of date marketing. The highest MM/MC ratio does not

mean that the highest TE and CE is achieved. For example, the MM/MC ratio of 222 has 93% as TE, while the ratio of 519 has 66% CE. These results are explained by the scale impact on both efficiency measurements, where a small date marketing scale would achieve a higher MM/MC than a larger scale, which is not the case for instances of TE and CE estimation.

Date marketing efficiency determinants are estimated based on owner (trader) and date marketing unit (DMU) characteristics, using a TOBIT Model and MLE for estimating regression parameters.

Results show few significant cost and technical determinants of date marketing with a minimal and unexpected impacts on date marketing. The significant determents of the cost efficiency are the inherited job and date marketing share in Al-Qaseem region at 5% significant level for both, trade type in Al-Madena region at 1% significant level, and date marketing share in Al-Hassa region at 5% significant level. On the Other hands, only two significant impacts of the technical efficiency determents of date marketing have been observed, one of which is the trade type in Al-Madena region at 10% significant level and the other is the date marketing share in Al-Hassa region at 10% significant level.

Most of the considered cost and technical efficiency determinates of date marketing have not proved yet its significance, because of the traditional family system of trading and marketing dates, which attract family members regardless of their education or experience level.

The long and short run policies are different, the new traders have to follow up rules of traditional date marketing based on their father experience in short run, but in long run, new trader would use new marketing rules which reflect their experience and education level. The impact of efficiency determinants would be different in short and long run as mentioned before.

Based on the estimated results, Saudi Arabia has great potential to improve its date marketing efficiency and achieve an additional 51% of added value annually. This would equate to an annual increase from a current figure of about US$2.67 billion to about US$4.01 billion with improved economic efficiency.

In conclusion, developing the date marketing sector in Saudi Arabia needs policies which relate the traditional concept of market efficiency to the technical and cost efficiency of date marketing. Such policies would help in choosing programs and tools for establishing and achieving marketing goals and would help decision makers to leverage the efficiency of the date marketing system in Saudi Arabia.

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