Does Farmer's Identity Make a Difference in Efficiency in Dairy Farms Conducting Educational Tourism? Evaluation by Slacks-based Measure DEA Models

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Whether farm management conducting tourism activity becomes more efficient or not is an important theoretical and empirical question for the promotion of tourism in agriculture. Thus, this study theoretically and empirically evaluated the efficiency of Educational Dairy Farms (EDFs) that provide educational tourism by DEA. The financial data were collected by the author's survey of these farms located around the Tokyo Metropolitan area. Based on the theoretical framework that stipulates that the efficiency of farm activity is determined by a farmer's identity, a bilateral slacks-based measure (SBM) model applied to empirically evaluate efficiency. The results revealed that those farmers that engage in processing milk products and direct selling have higher efficiency than those who do not. This is because having an enlarged identity that provides a wider perspective on farm activity enables these farmers to create demand and reduce marginal cost. This wider perspective was nurtured through the network of educational tourism activity. Thus, educational tourism activity by dairy farmers can nurture a new business opportunity and lead to efficient farm resource allocation.

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JEL Codes: O35, Q12

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Keywords: educational tourism in agriculture, educational dairy farm, DEA, slacks-based measure (SBM), managerial efficiency

JEL code: M14, O35, Q12, Q26, Z32

Introduction

Farm diversification through tourism activity has been increasingly recognized as an effective measure for rural development (Fleischer and Tchetchik, 2005; Ohe and Kurihara, 2013). Nevertheless, a general economic framework for farm diversification has not yet been fully established. Also empirical evidence on issues related to farm diversification should be accumulated further. Thus, this study tries to fill in this scarcity both conceptually and empirically. The infusion of tourism activity in the farm sector inevitably evolves into various types of tourism activity. Educational tourism in dairy farms is considered to be an example of one of such evolutions in agriculture. Particularly, the organization Educational Dairy Farms (hereafter, EDFs) in Japan has been playing a leading role in this kind of educational tourism in agriculture. This activity contributes to an understanding of dairy farming from a perspective of food education directed toward school children and consumers in general (Kobayashi, 2009;

Ohe, 2011a). The effects generated by EDFs are not limited to the consumer side. Positive effects on the farmer's side have been pointed out mainly from non-economic aspects such as self-confidence and extending human networks (Ohe, 2012b, 2015), which eventually leads to further progress in diversification. Thus, the reason why this study focusses on EFDs is that this activity enables us to gain novel insights into tourism-oriented farm diversification issues. Specifically, the relationship between farmer's identity and diversification among EDFs has been studied intensively by Ohe (2016, 2017a, 2017b), the results of which have made progress in this field conceptually and empirically.

Identity was introduced into economics by the pioneering works of Akerlof and Clanton (2000, 2002, 2010), which stimulated studies incorporating identity into diversification issues through tourism in agriculture as mentioned above. Ohe (2014, 2017b) clarified that the EDFs were more diversified in farm activity and that more females played active roles than on conventional dairy farms. Ohe (2011a, 2012a, 2012b, 2012c) focussed upon how to internalize the educational externality as multifunctionality generated by EDF activity into income sources by taking charging behaviour of the educational services as an internationalization criterion. Ohe (2011a, 2012a) presented a microeconomic framework that explained a stepwise process of the educational internalization conceptually and empirically. He (2016) extended these studies by firstly introducing identity into the issue of diversification of farm activity through tourism. Although identity is robust after once established, identity that is related to managerial identity can be transformed depending on the person's experiences in business (Ohe, 2017a). Specifically, Ohe (2017a) investigated what factors affect the identity of the successor generation on dairy farms. Ohe (2017b) revealed that those who have the enlarged identity that is more oriented toward diversification had job training experience abroad about farm management and extended the human network and female initiative in EDF activity to a greater degree than those who did not. Ohe (2016) evaluated the technical efficiency of milk production by EDFs using the Stochastic Frontier Production Function and pointed out that non-EDFs were more efficient.

However, since EDFs had diversified their activities, evaluation of efficiency should consider managerial efficiency in total including the diversified activity. To cope with this deficiency of study, Ohe (2017a) compared the managerial efficiency of two groups of EDFs by a DEA model using simulated revenue earned from the educational service. The two groups were assumed to have different identities determined by the service charging behaviour for the EDF activity. The results indicated that those who have the

enlarged identity can realize higher managerial efficiency (Ohe, 2017a). Nevertheless, the data used for Ohe (2017a) were not financial data that enables more rigid verification. Therefore, this study addresses this issue by financial data obtained from the author's survey on EDFs. If these diversified EDFs realize higher managerial efficiency than those who are not diversified, we can present empirical evidence to promote dairy farms' diversification toward tourism. That is the basic hypothesis to be investigated conceptually and empirically in this study.

Economic analyses of dairy farms have focussed upon milk-production efficiency rather than tourism-related diversification. In this context, this study will be able to contribute to deepening research on farm diversification through tourism. In the field of agritourism, although a quantitative investigation of labour productivity was conducted on rural tourism facilities (Ohe, 2011b), evaluation of managerial efficiency of farms involved in tourism-oriented diversification in terms of a monetary basis had not been performed, yet. To clarify this point is essential for the promotion of farm diversification with tourism. That is the rationale for this study.

To approach this issue, firstly the author refines the concept of dairy farmer's identity based on the criticism of previous studies and sets more objective criteria, i.e., whether processing and direct selling activities are performed or not, which demonstrates a representative identity toward tourism-oriented diversification. Secondly, the author empirically evaluates how managerial efficiency is different between the two identities of the next successor generation of EDFs who are already engaged in the operation. DEA (Data Envelopment Analysis) is employed based on the financial data derived from the author's survey of EDFs under the conceptual framework that explains why different identities generate different managerial efficiency and diversification levels. DEA has been a quite frequently applied method and still makes theoretical progress that enables more realistic assumptions. In this study, the SBM (slacks-based measure) model is employed since it is highly probable to assume the existence of underutilized farm resources in the input and output based on the reality. Employment of SBM models has been scarcely applied in agriculture and tourism research despite their suitability for these fields wherein underutilized resources are not uncommon. Finally, policy recommendations toward tourism-oriented farm diversification will be presented.

Analytical Framework

This study investigates the diversified activity by the EDFs from the perspective of farmer's identity. "Identity" is defined as a person's sense of self in the social category to which a person belongs according to Akerlof and Kranton (2010). Thus, people can

act more efficiently and satisfactorily in accordance with their own identity than those who do not have such identity. Since the works of Akerlof and Kranton (2000, 2002, 2010) were qualitative rather than quantitative and did not mention clearly how identity can be appropriately measured empirically. Further, these studies are implicitly assumed that identity was easily considered to imply observable criterion such as gender and race. Ohe (2017b) pointed out that identity matters when a farmer conducts a new activity because he/she needs a new mindset that enables him/her to envisage a new activity domain. If he/ she has a suitable identity for that domain, a new activity like tourism can be practiced more efficiently (Ohe, 2017a). In this respect, formation of identity should be paid more attention for the promotion of tourism-oriented farm diversification. Nevertheless, economic evaluations so far have been rather concentrated on technical aspects such as learning skills and obtaining necessary knowledge. That is why this study considers the matter of identity.

Empirically, Ohe (2017a) stated that there are two ways to know person's identity, i.e., subjective and objective ways, with each having advantages and disadvantages. This is because identity per se cannot be observable since it is only in the mind. This study takes the objective way since it is more operational for policy makers to identify those who have the targeted identity than the subjective way, which requires directly asking about the target person what his/her identity is. The objective way was undertaken by Ohe (2016, 2017a, 2017b). Although the criterion that Ohe (2016, 2017a, 2017b) used was charging behaviour for the educational service, our survey results showed that there were farms that charged for a service but were not always orientated toward tourism-oriented diversification. So, more representative criteria should be established. For this reason, the author used the criteria of whether a farmer performed processing and direct selling. This is because processing and direct selling are easily objectively observable behaviours that represent tourism-oriented diversification since selling processed produce to visitors indicates the aim to diversify.

Figure 1

Here, points discussed in the previous studies were summarized in relation to identity and dairy farmers' behaviour (Figure 1). Definitions of types of identity slightly differed from one study to another depending on the range of analysis, so that it is necessary to refine the definitions of the types of identity for a wider application. The first criterion that this study took was the existence of diversification, i.e., processing and direct selling. The second was whether a dairy farm was or was not an EDF. With these more easily observable criteria than those of previous studies, we set three types of identity,

including the case of conventional dairy farmers: traditional, pre-enlarged, and enlarged identity. Now let me explain each of those. The traditional identity is held by conventional dairy farmers who solely produce milk and ship it to the cooperatives or the dairy industry. This is the average image and behaviour of dairy farmers in this country. Normally, they try to maximize their milk production physically or revenue in value, which is the traditional dairy farmers' behavioural principle.

The pre-enlarged identity is held by those on EDFs who offer educational services to visitors, but engage in no processing and direct selling activity. It is supposed that those farmers with the pre-enlarged identity know of the processing and direct selling activities through the EDF network. In this sense, the pre-enlarged identity is considered as a prior step before going further to the enlarged identity. Nevertheless, most of their activities remain as they are. Those with the pre-enlarged identity seek to maximize milk production or its revenue.

The enlarged identity is held by those who operate EDFs with a sector for processing and direct selling. Those who have this identity have two sectors to maximize: milk production and diversified goods/services. Those with this type of identity have a largest domain of farm activity among the three types. From the consideration above, it is safe to say that it is necessary to form an appropriate identity for the development of farm diversification. There could be another case, which is the case wherein a conventional dairy farmer conducts processing and direct selling. This case would be included in the enlarged identity. For empirical evaluation, however, since this study focusses on EDFs, the pre-enlarged and enlarged identity cases, among EDFs are considered here but not conventional farmers who are not operating EDFs but who do processing and direct selling.

Figure 2

The above consideration of identity of dairy farmers leads to an empirical hypothesis that those farmers with the enlarged identity attain higher managerial efficiency in total than those with the pre-enlarged one. A conceptual framework that explained this hypothesis is depicted in Figure 2. This framework is based on Ohe (2017a) and revised with the two-identity case. Under the assumption of other conditions being constant, it is assumed that there are two types of curves that have different directions of slopes: right downward marginal benefit curves *SB* and right upward marginal cost curves *MC*. The optimal level of activity is determined where the two curves meet at point *e*. In the case of those farmers who have the pre-enlarged identity, the activity level is determined

at e_t where SB_0 and MC_0 meet and the optimal activity level is *oj* at this point.

On the other hand, in the case of the enlarged identity, what makes it different from the pre-enlarged case is that both supply and demand shifts occur, which are illustrated as from SB_0 to SB_1 for demand and from MC_0 to MC_1 for supply. The demand upward shift is created by the marketing effort for processed products and farm experience services. The supply side shift is recognized as marginal cost reduction due to the enhancement of managerial capability generated by the formation of an appropriate identity for diversification. This is probably because those having the wider perspective on farm-resource management stimulate the economy of scope between activities, which results in more efficient resource management of the entire farm. Consequently, the meeting point goes rightward to point e_e and the activity level results in *ok*. Thus, the activity level increases *jk* (=*ok*-*oj*) from the pre-enlarged case, which demonstrates that those with the enlarged identity practice more efficient farm management than the others.

That is the conceptual framework and empirical hypothesis. The empirical question is to investigate how managerial efficiency differs between those with different identities using DEA models.

Data

The author obtained information on the milk production of each EDF from the Kanto Dairy Cooperative and Chiba Dairy Cooperatives from 2006 to 2015, and asked their cooperation in conducting a farm survey. From the Japan Dairy Council, the number of visitors to each EDF in the same period was obtained. The author conducted a survey of EDFs from January to March in 2017 because dairy farmers are not very tied up in winter. All EDFs in Chiba and one EDF in Saitama were listed to receive this on-farm survey. Nevertheless, three farms refused to disclose their financial report and one farm provided only a partial report. As a result, 11 farms agreed to provide financial reports, and some provided reports for multiple years. In total, 27 samples were obtained as shown in Table 1.

Table 1
Table 2

Outline of dairy production in Japan and profiles of surveyed EDFs

Dairy production in Japan has been diminishing in terms of amounts shipped due to ageing of farmers and the decreasing number of dairy farms (Table 2). Region-wise, the

decrease in production in regions other than Hokkaido was covered by the increase in production in Hokkaido, the northern island where agriculture is the main industry. Production in Hokkaido exceeded that of all other regions together. Nevertheless, since production in Hokkaido became flat, the national total production continues to diminish due to the rapid decrease in the number of dairy farms in this country. Then, looking at the Kanto region, which includes Yamanashi and Shizuoka prefectures, although Table 2 shows trends of decreasing production the same as with national production, production by EDFs in this region increased. Production by surveyed EDFs also increased. Thus, we can say that EDFs are dairy farms that have higher productivity than the average.

Table 3

Turning to the surveyed EDFs, Table 3 shows the profiles of these farms. The average age of operators was 49 years, which is relatively young. The farms have 54 milk cows and 8.8 ha of land in feed production on average. The number of milk cows ranged widely from a minimum of 30 to a maximum of 100. As stated above, milk production has increased. To investigate this trend further, Figure 3 contrasts production trends between two groups: one that processes and direct sells milk and the other that does not. As shown in Figure 3, those not processing and direct selling increased production while among those processing and direct selling there was a decreasing trend in recent years.

Figure 3

Consequently, the gap between the two groups narrowed. This is farm behaviour that contrasts with what has been conventionally understood as farm-size enlargement behaviour. In the author's interview, a surveyed famer replied that he shifted from the milk production sector to put more focus on the higher value-added sector, i.e., processing and direct selling of milk and milk products. This behaviour is considered to be reflected by the trend in the processing and direct selling group in that they reduced fresh milk shipments to raise profitability by diversifying. In short, those who perform processing and direct selling are intensive oriented rather than oriented to extensively enlarge farm size.

Table 4

Further, farm activity in the two groups was statistically compared in Table 4.

Differences that were found to be statistically significant were the format of stall barns, net labour size and farm incorporation. Net labour size was calibrated by giving full-time family labour=1.0, family part-time family labour=0.5, and hired part-time labour=0.25. Specifically, a lower percentage of farms that had a stanchion stall barn were among the processing and direct selling group than the other group. More free stall barns and even milking robots were introduced into the farms belonging to the processing and direct selling group. This is because such farms need intensive labour input to perform these activities. To cope with this tight labour demand, they adopted labour saving technology in fresh milk production such as adoption of free stalls or milking robots. Attaining efficient labour input was needed more in this group.

From these differences described above, we can say that those farms with processing and direct selling activities are supposed to conduct better farm-resource management. Thus, those farms can attract more visitors to their farm yard. Actually, the average number of visitors differed between the two groups although the significance level was not high due to the large variations in visitor numbers among farms.

Table 5

The differences between the two groups in revenue and costs were examined in Table 5. First, what statistical differences were found are total revenue from diversification and total revenue. With respect to total revenue, the difference between the two groups was almost double. In comparison, the difference in revenue from fresh milk production between the two groups was 1.5 times, and the difference in the total revenue widened due to revenue from diversified activity. In fact, the share of revenue from fresh milk production in total revenue was significantly lower, about two thirds, among those processing and direct selling than among those who did not while revenue from diversification reached 20% (5% and 10% significance levels, respectively).

On the cost side, there was not a statistically significant difference in feed cost. Nevertheless, as expected, labour costs for the processing and direct selling group were significantly different from the group that did not process and directly sell; both direct labour cost and total labour cost were more than double for the group that engaged in processing and direct selling (1% and 5% significance). Further, fixed costs and the fuel/energy costs were almost double in that group (1% and 5%). These differences clearly indicate that processing and direct selling activity requires fixed investments and intensive labour input, which is consistent with that revealed in the interviews. The ratio between labour and fixed costs did not differ, which means that capital intensity of

labour did not differ between the two groups. In this sense, processing and direct selling activity is not capital intensive compared with conventional fresh milk production.

To summarize, the processing and direct selling group had twice the cost and revenue of the group without these activities. Therefore, since we cannot judge which group of farms **is** more efficient at this stage, it is necessary to employ the DEA model to empirically evaluate this issue in detail.

DEA model: Theoretical background

The DEA model is a non-parametric method that does not need any assumption of sample distribution. Therefore, it has the advantage that allows estimation with small samples not like regression analysis. For a case with tight data constraints like this study it is a good example of the application to take advantage of that strength. There are two types of basic DEA models: the CCR (Charnes-Cooper-Rhodes) model with a constant return to scale and the BCC (Banker-Charnes-Cooper) model with a variable return to scale. Although these models have been widely applied to empirical analyses, they have the drawback that the input/output ratio is assumed to be fixed, which is termed as radial models. To overcome this drawback, non-radial models were developed and one of them is the slacks-based measure (=SBM) model, which was introduced by Tone (2001). The feature of this model is to consider the slacks, i.e., unutilized resources and evaluate the efficiency of managerial behaviour. Unutilized resources can be generated in either inputs or outputs; excess inputs or shortage of outputs.

Figure 4 shows the basic idea of the SBM model. Figure 4 depicts the input slacks under the assumption of two inputs, x_1 and x_2, and one output. Efficiency frontier is SS' and decision-making unit A and unit B are located inside of the frontier, so that these units are not efficiently operated. For example, OA'/OA<1 in the unit A. On the other hand, in the radial models inefficiency is measured as AA', so that if the operator reduces input to point A' then efficiency will be attained. Nevertheless, at point A' the same input amount x_1 with excess input in x_2 exists as measured as CA'. Therefore, the excess input CA' can be removed without the output reduction by moving to point C, which means increased efficiency. In the radial model, however, since only points on the line OA are considered, the excess input CA' are not considered. The SBM model considers this point. That is, the input-oriented SBM model. Likewise, the case of output slacks with two outputs is illustrated in Figure 5, which is the output oriented SBM case. The operator can increase the production of q_1 to the amount of P'A from moving Point P' to point A while maintaining the production amount of q_2.

Figure 4
Figure 5

The above illustration is a visual explanation of the SBM model. Actually, the SBM model has an objective function that minimizes slacks. The aim of this paper is to evaluate diversification, which needs to effectively utilize farm resources, and we assume that rural tourism is a behaviour that internalize multifunctionality, which exerts positive externalities to society as a joint product of agriculture. From this nature, rural tourism at the private optimal level tends to be under-supply from a socially optimal level because of the existence of positive externality. For this reason, the SBM model is an appropriate methodology to evaluate diversification.

Figure 6

Specifically, this paper compares the efficiency of two groups, so that the Bilateral SBM model is employed, which allows comparison of the efficiency between the two groups. Let me explain the basic concept of this model graphically. The idea is, firstly, to obtain the efficiency frontier of one group and, secondly, compare the efficiency with that of another group. In Figure 6 unit *a* is located at *P'* in the outside of the frontier b_1b_4 and the efficiency score is $OQ/OP>1$, which is greater than unity. Because of the comparison between the two groups, we should keep in mind that the efficiency score can be over unity. Measured efficiency score and rank are statistically tested between the two groups to identify whether differences exist or not.

Empirical analysis with the DEA model

Bilateral SBM model

Specifically, firstly, two kinds of models were considered to compare the efficiency between the two groups; the Bilateral SBM model assumed constant return to scale (Bilateral SBM_C) and the other assumed a variable return to scale (Bilateral SBM_V). The measured efficiency score and rank were evaluated by nonparametric tests.

Table 6

The variables commonly used for the model estimation are summarized in Table 6. The input variables were labour cost, feed cost as the largest variable cost, and fixed cost, which were major basic costs for dairy farm activity. With regard to output

variables, three cases were considered to identify differences in efficiency and, if identified, where the differences come from. The first case is to use the revenue from milk production, which is the largest revenue for dairy farmers. Dairy farmers normally ship their milk to local dairy cooperatives to which they belong. This case is a one output model with no consideration of diversification. The second case is total revenue from milk and diversified activities, which is to only consider diversification to see whether there are any differences in efficiency. Total revenue sums up milk revenue and revenue from diversified activities.

The third is two output variables, i.e., the revenue from milk production and total revenue from diversification, which is the most realistic case by taking into account two kinds of revenues. Looking back to Figure 2, the researcher tried to find whether those farms with operators having the enlarged identity are located at point e_e under the different outputs in the farm. If the two outputs case indicates differences in efficiency between the two groups, the efficiency issue should be dealt with as farm management as a whole rather than as one sector of farm production.

Results of DEA model estimation

Bilateral SBM model

Table 7 shows the results of the Bilateral SBM model estimation and the efficiency scores and ranks. Firstly, there was no statistically significant difference in efficiency between the two groups in the case of one output, i.e., the milk revenue case, which means that efficiency in milk production was not related to identity. This result was different from Ohe (2016) by the estimation result of a stochastic frontier production function. It says that those who charge for educational experience services had lower efficiency in milk production than those who do not among EDFs. Nevertheless, milk production in physical terms and real labour units, feed production acreage, and the number of milk cows were used of input variables that are different from variables in strict monetary terms used in this paper. In this sense, we should be careful to compare the results with those of Ohe (2016).

Secondly, taking a look at the case of total revenue as the output. The results are clearly different from between the constant return to scale and variable return to scale models. The efficiency scores and ranks showed no statistical significance with less than the 10% level in the model of variable return to scale. In contrast, in the model of constant return to scale, significant differences were observed in both efficiency scores (10% significance) and ranks (5% significance). Thus, those who have the enlarged identity conducting processing and direct selling realized higher efficiency in their

farm-resource management. Nevertheless, this model is based on the assumption of single output although actually two outputs on farms exist, which is the third model that we are going to look at below.

Table 7

Thirdly, what was obtained from the results are common with the second one output model. No statistical significance was observed in the model of variable return to scale, which is consistent throughout the three models. Hence, we can say that it is a robust result. On the other hand, the constant return to scale model shows statistically significant differences in both the efficiency score and rank (5% level). To look at details, there was a larger difference in rank sum of the two outputs model between the two groups than that of the second one output model. This fact means that the gap in efficiency between the two groups widens in the two outputs model. With respect to the efficiency score, the t test result shows that the differences in average efficiency scores between the two groups are larger than with the second one output model. These facts indicate that two output models are effective. This result is consistent with Ohe (2017a), which evaluated managerial efficiency of EDFs by two outputs DEA SBM models with a different data set, i.e., milk production in physical terms and simulated revenue from the educational service.

Discussion

Let me discuss policy implications for diversification of dairy farms that conduct educational tourism from the results of DEA model estimation.

The significance of this study has two aspects. The two aspects are that diversified activity conducted by EDFs were investigated with the concept of identity theoretically and with the SBM model empirically.

On the theoretical contribution, this paper characterized farmers' identity into two types: the traditional identity and enlarged identity based on the critical review of previous studies. From the framework that explains the relationship between efficiency and diversification, the author can point out that those who have the enlarged identity experienced both an upward shift of demand and marginal cost reduction by realizing efficient farm resource management. These two aspects both in demand and supply sides are considered as sources of higher efficiency of farms operated by those who have the enlarged identity.

The author empirically evaluated the efficiency of farm management based on this

conceptual framework with the employment of SBM models that enable users to be realistic in taking account of underutilized farm resources. The results revealed that those who have the enlarged identity who conduct processing and direct selling realized higher efficiency with the constant return to scale than those who do not. Especially, the realistic two outputs model showed a statistically significant difference in efficiency between the two groups. From these empirical results, two derivative findings are obtained below.

First, the connection between farm size and efficiency was not confirmed. This fact indicates that the efficiency of a dairy farm and farm size are not related as far as diversification is considered.

Second, the theoretical framework and empirical results are consistent, which means that the issue of identity is an integral part of managerial behaviour that raises the efficiency of diversified farm activity. Specifically, those operators who have the enlarged identity use managerial behaviour to make efficient farm resource allocation for the main purpose of milk production and diversified activity including educational service.

So far, analyses of dairy farm management have been mainly focussed on the farm structure for milk production and its efficiency. The study result here also indicates that, when a farmer tries to launch farm diversification especially toward tourism-related activity, if the existence of a different identity is supposed, the significance and potential for demand creation and diversification can be clarified. However, this tourism oriented perspective has not been paid enough attention.

Consequently, capability building for demand creation and farm resource management become important issues for the promotion of dairy-farm diversification. For this purpose, identity formation should be included in the area of that capability building. Put differently, to realize efficient farm resource allocation, the enlargement of the perspective of their domain of farm activity is a prerequisite condition. In this respect, the EDF activity that takes advantage of the EDF network across the country nurtures the enlargement of a farmer's perspective that leads to the formation of the enlarged identity that suits and promotes diversified activity. Ohe (2015, 2017b) pointed out the function of the social learning effect through this open network among EDFs.

Since this study focused on the EDFs located around the Tokyo Metropolitan area, all of these farmers are supposed to have better managerial skills than ordinary dairy farmers. Therefore, when compared with ordinary dairy farms, the efficiency gap found in this study will be wider. As far as our findings are concerned, it should be noted that the existence of efficient diversified dairy farms conducting educational tourism

presents basic evidence for the design of support measures toward tourism-oriented diversification of dairy farms in the future.

Conclusion

This study evaluated the efficiency of diversified dairy farm activity by focussing on EDFs around the Metropolitan area in Japan from the financial data obtained by the author's survey. To this purpose, two types of SBM models that consider slacks of farm resources were employed. The significance of identity formation suitable for diversified activity to realize efficient farm-resource management was revealed theoretically and empirically. Specific findings are as follows:

First, with output-oriented bilateral SBM, those who conducted processing and direct selling of milk products, i.e., supposed to have the enlarged identity, realized higher efficiency in their farm-resource management with statistical significance than those who did not. These were robust observations by both models.

Second, it is necessary to enlarge farmer's identity for efficient farm diversification, especially tourism-related activity. Thus, it will be effective to support the smooth formation of the enlarged identity.

Third, a connection between farm size and efficiency was not observed when diversified activity was considered. In other words, diversification can be undertaken at any farm size, either small or large, because such diversity is natural for farms of any size.

Fourth, one of the causes to generate the efficiency gap is social learning opportunities through EDF activity that enables farmers to share experiences and perspectives toward the evolution of farm management as Ohe (2017b) mentioned. This wide social capital formed among EDF farmers is considered to eventually lead to demand creation and farm resource management.

To summarize, it is quite natural for EDFs to evolve toward farm diversification and efficient farm resource management. This point should be broadly recognized as an important effect of EDFs. In this respect, tourism-related diversification should be explicitly placed in dairy farm policy.

Finally, this study had limitations. The study area was EDFs around the Metropolitan area; therefore, this framework should be tested on EDFs in other areas such as Hokkaido, a northern island where large-scale dairy farms exist, to determine whether a similar result can be confirmed. Thus, empirical evidence should be further accumulated since the framework is also applicable to other parts of the world.

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Figure 1 Refined idenity definition of dairy farmers from previous studies

Previous studies	Identity	Observable behaviour	Drawback
Ohe(2015, 2016, 2017a)	Traditional	EDFs as volunteer	Not clear difference with the charging service in terms of diversification
	Enlarged	EDFs with charging service	Not always consitent with orientation toward diversification
Ohe(2017b)	Traditional	Conventional dairy farm	—
	Sub-enlarged	EDFs as volunteer	Not clear difference with the charging service in terms of diversification
	Enlarged	EDFs with charging service	Not always consitent with orientation toward diversification
⇩ Refined definition of identity			
This study	Identity	Observable behaviour	Attitude toward diversification
	Traditional	Conventional dairy farm without processing and direct selling	No orientation toward diversification
	Pre-enlarged	EDFs without processing and direct selling	No practicing diversification
	Enlarged	EDFs with processing and direct selling	Viable diversifiction oriented

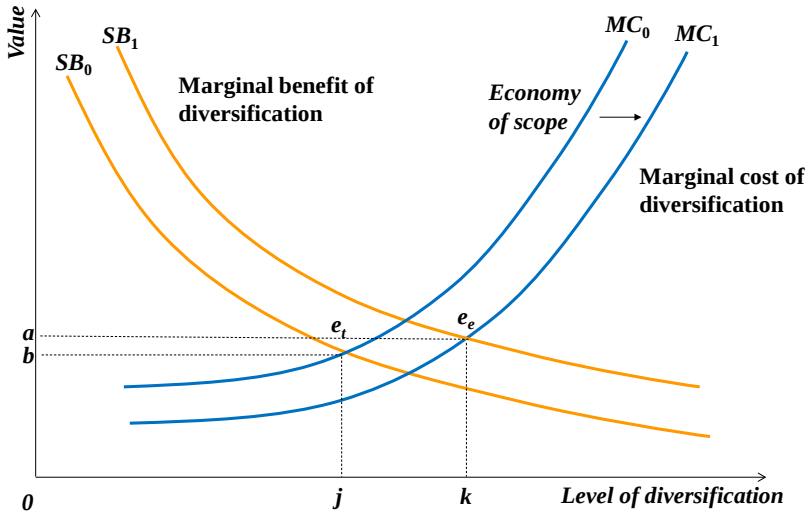


Figure 2 Identity and farm diversification

Table 1. Years of obtained finacial data among surveyed EDFs

Year of book closing	Sample size
2008	1
2010	1
2011	1
2012	1
2013	8
2014	3
2015	11
2016	1
Total	27

Source: Survey of 14 EDFs by the author from December 2016 to February 2017.

Table 2. Trends in milk production in Japan and by surveyed EDFs (2006-2015） Unit: kg

Year	National total	Hokkaido	Other regions	Kanto region	Total EDFs in Kanto region	Total Studied EDFs
2006	8,137,512	3,799,121	4,338,391	1,319,001	26,281	7,159
2012	7,630,418	3,935,224	3,695,194	1,151,889	27,871	7,636
2015	7,379,234	3,871,319	3,507,915	1,114,002	29,176	7,775
2015/2006	0.91	1.02	0.81	0.84	1.11	1.09

Source: National total, Hokkaido and other regions were from Statistics on Dairy Products by Ministry of Agriculture, Fisheries and Forestry. Other data were from Kanto Dairy Cooperatives.

Table 3. Outline of surveyed EDFs

Items	Mean	Maximum	Minimum
Age of operators	49	68	31
Year of EDF certifiation	—	2016	2001
No. milk cows	54	100	30
Acreage in feed production (ha)	8.8	23.0	2.4
No. net labour size: Dairy sector	3.8	6.5	2.0
No. labour: Processing and direct selling	0.8	3.3	0.0
Amount of milk shipped (kg in 2006)	460,404	883,540	152,829
Amount of milk shipped (kg in 2015)	523,885	1,092,034	210,730

Source: Author's survey except for milk shipment, which was provided by Kanto Dairy Cooperatives.
Note: Net labour size was calibrated as follows: full-time=1, family part-time=0.5, part-time=0.25.

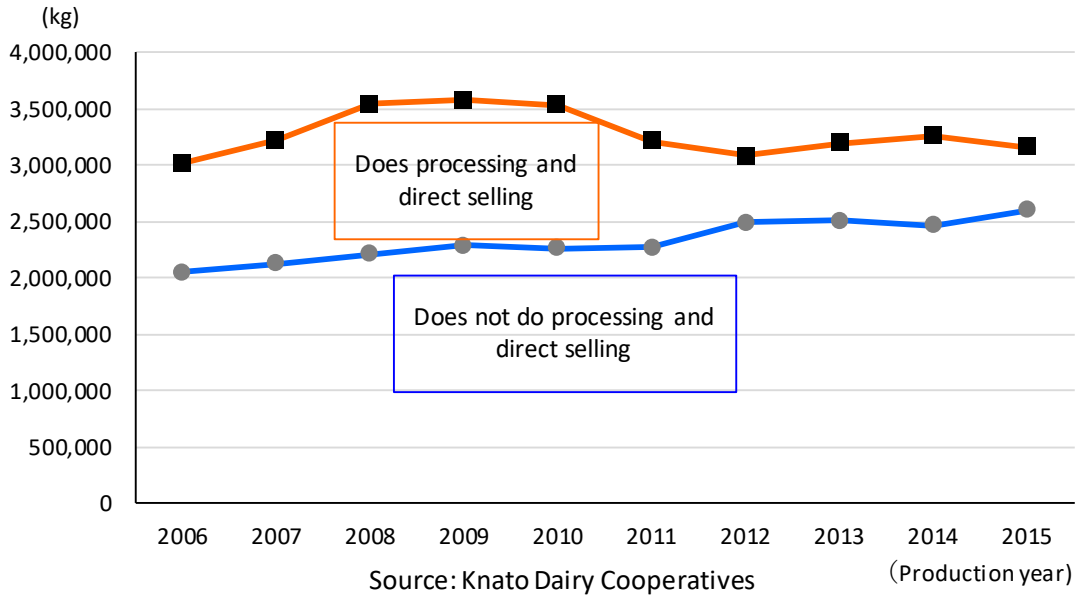


Figure 3. Changes in amount of milk shipped by study farms

Table 4. Comparison of attributes of EDFs whether or not processing and direct selling

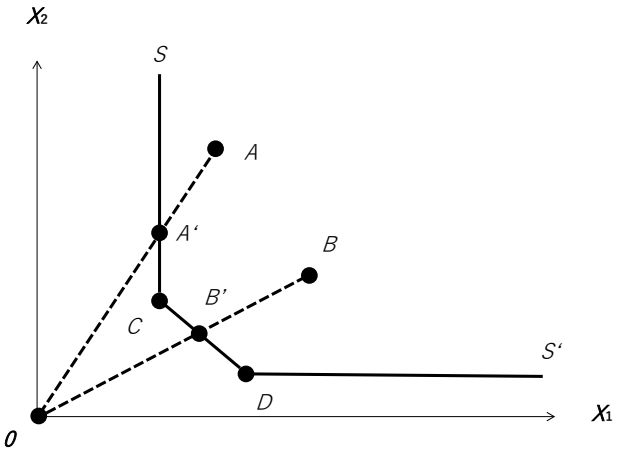
Item	Processing and direct selling		Test method	Test result
	No	Yes		
Age of respondents in 2016	44.3	53.6	t test	ns
Year of EDF cetification	2009.8	2007.0	t test	ns
Stanchion stall barn: yes=1, no=0	85.7	14.3	Chi-squared	**
Incorporated farm: yes=1, no=0	16.7	80.0	Chi-squared	*
No successor: yes=1, no=0	16.7	0.0	Chi-squared	ns
No. milk cows in 2016	47.8	61.0	t test	ns
Forage crop field (ha, 2016)	5.7	12.40	t test	+N
Net labour size in 2016	2.8	4.6	t test	**E
Milk shipment (kg, 2006)	340,988.3	603,702.2	t test	+N
Milk shipment (kg, 2007)	354,992.6	644,406.4	t test	+N
Milk shipment (kg, 2008)	368,072.9	707,403.7	t test	+N
Milk shipment (kg, 2009)	381,389.8	715,703.0	t test	+N
Milk shipment (kg, 2010)	376,712.6	706,172.1	t test	+N
Milk shipment (kg, 2011)	378,054.7	642,214.0	t test	+N
Milk shipment (kg, 2012)	414,425.4	616,380.5	t test	ns
Milk shipment (kg, 2013)	418,357.9	638,200.2	t test	ns
Milk shipment (kg, 2014)	411,120.4	651,587.9	t test	ns
Milk shipment (kg, 2015)	433,386.3	632,483.7	t test	ns
Ratio of change in milk shipment (2015/2006)	1.30	1.08	t test	ns
No. visitors in 2013	109.6	639.0	t test	+N
No. visitors in 2015	79.8	609.6	t test	*N

Source: Data were obtained from author's survey except milk production and no. of visitors, which were obtained from Kanto Region Dairy Cooperatives and Japan Diary Council, respectively.
Notes: ***, **, * and + indicate 1%, 5%, 10% and 20% (as reference), repectively, and ns means no significance. E= equal variance and N=not equal variance.

Table 5. Comparison of EDF attributes (t test)

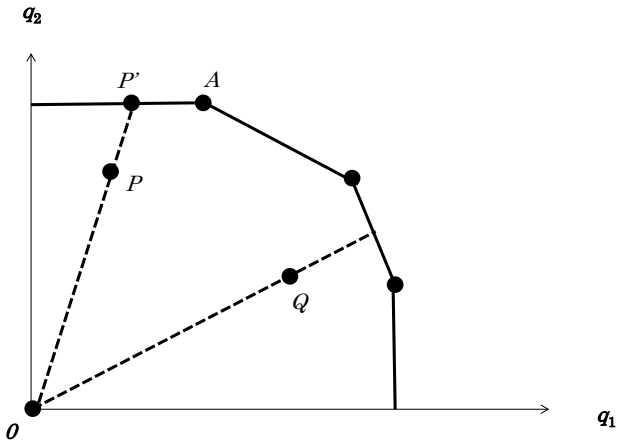
Item	Proessing and selling		Test result
	No	Yes	
Direct labour cost (Yen)	7,376,420	16,900,000	***N
Total labour cost (Yen)	7,591,188	18,900,000	***N
Feed cost (Yen)	24,100,000	33,100,000	+N
Fixed capital cost (Yen)	8,216,700	20,100,000	**N
Energy cost (Yen)	2,032,010	4,639,004	***N
Capital/labour ratio	1.3339	1.2544	ns
Milk revenue (Yen)	44,600,000	69,200,000	+N
Revenue from selling farm products (Yen)	9,213,198	15,100,000	+E
Total revenue from diversification (Yen)	9,213,198	33,000,000	***N
Total revenue (Yen)	53,800,000	102,000,000	**N
% share of milk revenue (%)	84.6	66.1	**N
% share of farm product revenue (%)	15.4	13.3	ns
% share of diversification revenue (%)	0.0	20.0	*N

Source: Financial statements obtained by author's survey on EDFs.
Notes: ***, **, * and + indicate 1%, 5%, 10% and 20%(as reference) significance, respectively, and ns means no significance. E=equal variance and N=not equal variace.



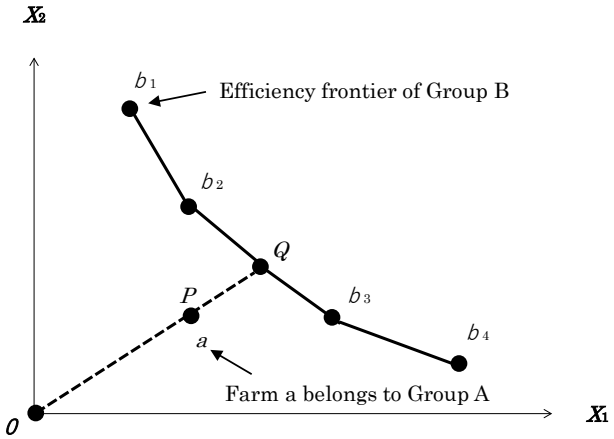
Source: Changed by the author from Coelli et al (2005) p.165.

Figure 4. Input Slacks



Source: Changed by the author from Coelli et al (2005) p.181

Figure 5. Output slack



Source: Changed by the author from Cooper et al (2007) p.237.

Figure 6. Two-group comparison DEA model

Table 6. Input and output variables used for DEA Model Unit: Yen

Item	Input			Output		
	Total labour cost	Total feed cost	Total captal cost	Revenue from milk shipments	Total revenue from diversification	Total revenue
Max. value	32,165,124	62,225,571	43,950,869	131,966,224	71,955,396	165,339,918
Min. value	3,818,690	8,048,651	3,075,449	18,792,745	3,074,678	29,909,561
Mean	11,775,219	27,424,095	12,600,419	53,694,405	18,028,686	71,723,091
SD	8,621,786	13,131,443	9,399,426	31,049,155	18,340,707	39,671,199

Source: Same as Table 5.

Table 7. Results of DEA model evaluation on the managerial efficiency of EDFs (SBM model)

DEA model	Output	Economy of scale	Evaluated item	Processing and direct selling		Test method	Test result
				Yes	No		
2-group comparison Slacks-based measure model	1 output: revenue from milk production (Yen)	Constant	Rank	158	220	Kruskal-Wallis	ns
				158	220	Wilcoxon	ns
			Score	0.6513	0.7883	t test	ns
				122	256	Kruskal-Wallis	ns
				122	256	Wilcoxon	ns
		Variable	Rank	145	233	Kruskal-Wallis	ns
				145	233	Wilcoxon	ns
			Score	1.0411	1.2062	t test	ns
				135	243	Kruskal-Wallis	ns
				135	243	Wilcoxon	ns
	1 output: total revenue (Yen)	Constant	Rank	100	278	Kruskal-Wallis	**
				100	278	Wilcoxon	**
			Score	0.9347	0.7347	t test	*N
				180	198	Kruskal-Wallis	**
				180	198	Wilcoxon	**
		Variable	Rank	112	266	Kruskal-Wallis	+
				112	266	Wilcoxon	+
			Score	1.3313	1.1636	t test	ns
				168	210	Kruskal-Wallis	+
				168	210	Wilcoxon	+
	2 outputs: Revenue from milk production (Yen) & total revenue (Yen)	Constant	Rank	89	289	Kruskal-Wallis	**
				89	289	Wilcoxon	**
			Score	1.0954	0.6696	t test	**N
				191	187	Kruskal-Wallis	**
				191	187	Wilcoxon	**
		Variable	Rank	120	258	Kruskal-Wallis	ns
				120	258	Wilcoxon	ns
			Score	1.2726	1.2254	t test	ns
				160	218	Kruskal-Wallis	ns
				160	218	Wilcoxon	ns

Source: Same as Table 5.
Notes:***, **, *, + indicate1%, 5%, 10% and 20%(as reference) signifiance, respectively, and ns means no significance. N=not equal variance between the two groups.