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The Economic Returns to Membership of a Dairy Discussion Group: Evidence from the Irish National Farm Survey

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Abstract

In December 2009 the Irish Department of Agriculture launched the Dairy Efficiency Programme. The Programme, which is operated through a series of discussion groups, is designed to promote technology transfer to dairy farmers. Drawing on National Farm Survey data from 2009, the purpose of this paper is to quantify the economic return to membership of dairy discussion groups. An endogenous switching regression model is specified for over 300 dairy farms to assess the impact of discussion group participation on farm gross margins. The results indicate self-selection into discussion groups, suggesting that 'better' farmers tend to participate. Generally, younger farmers who operate larger farms are more likely to join discussion groups. Discussion group members have higher gross margins than non-members, but non-members could increase their gross margins if they join discussion groups. Overall, the findings confirm positive returns to discussion group membership, thus supporting the Dairy Efficiency Programme.

Keywords: Endogenous switching regression model, Discussion group membership, Dairy Efficiency Programme.

1 Introduction

Agricultural extension programmes enhance productivity mainly through innovation and training. They are seen as the main link between agricultural research and farmers. By providing information, extension programmes can facilitate a shift to more efficient methods in production (Birkhaeuser et al. 1991). The objective of this paper is to examine the role of discussion groups in relation to farm profit. Drawing on National Farm Survey (NFS) data from Ireland, the economic benefits of participating in a discussion group are quantified.

The paper begins by providing some background information on the role of discussion groups in transferring technology and encouraging technology adoption. A short review of previous empirical studies is also provided. After describing the empirical approach and the data, the results of the analysis are presented and discussed. The paper ends by drawing some conclusions about the effectiveness of discussion groups as a means to increase farm profit.

2 Background

Agricultural extension programmes are targeted to improve productivity through provision of training and the promotion of new technologies (Evenson, 2001). Generally, agricultural extension is seen as the connection between research and changes in the individual farmer's field, thus it can generate more efficient production (Birkhaeuser et al., 1991). Extension programmes aim to improve farmers' skills through a variety of means, such as one-to-one consultations, demonstrations, training courses and discussion group meetings (Romani, 2003). Thus, it is not surprising that considerable amount of money is spent on agricultural extension worldwide.

In 2009, the Irish government launched the Dairy Efficiency Programme in order to prepare the dairy sector for the imminent removal of the milk quota. The programme is designed to encourage efficiency gains on dairy farms by supporting the transfer of knowledge and technology. The Department of Agriculture will make €6 million available in each of 2010, 2011 and 2012 to encourage participation in technology transfer based discussion groups. Farmers will receive a payment of approximately €1,000 for participation. While payment for participation is a new phenomenon, dairy farm discussion groups have been in operation for a number of years.

The purpose of discussion groups is to transfer knowledge about new technologies and management practices in order to promote their adoption and to increase farm efficiency. In recent years farm discussion groups have become a popular means of technology transfer.

Discussion groups, which fall into the category of knowledge exchange approaches, involve greater participation by the farmer through interaction with peers. By reviewing the advantages of the knowledge exchange approach, Morgan and Murdoch (2000) conclude that this approach allows farmers to take ownership of problems, to draw on the non-scientific knowledge of the group and thereby empower them to adopt new technologies.

The objective of this paper is to estimate the economic returns to discussion group membership, thus aiming to provide insight whether the Dairy Efficiency Programme can be useful as a means to increase farm profit.

The impact of extension programmes on farm performance has received considerable interest in the literature. Birkhaeuser et al. (1991) and Evenson (2001) provide reviews of the economic impact of agricultural extension and methodological issues that can arise. Generally, a problem of endogeneity can occur due to several reasons. First, the self-selection bias is caused by the tendency of better skilled farmers to participate in extension programmes. Here, it is likely that more productive farmers also have a stronger desire to receive information than less productive farmers (Birkhaeuser et al. 1991). Second, the endogenous placement bias, meaning that extension programmes are often provided in regions which have previously been identified as more receptive to advice provided. Third, the simultaneity bias is explained by the possibility that poorer farmers in the need for advice seek extension programmes, which would cause a negative effect of extension services (Romani, 2003). Finally, a potential bias can occur due to indirect information flows, meaning that knowledge from advisory services is passed on to other farmers (Birkhaeuser et al. 1991).

The previous discussion suggests that the effect of extension programmes is subject to selection bias, highlighting the need to account for this bias when attempting to model the effects of extension services. An important issue to consider is that participation in a discussion group is self-selecting and as such there may be some factors, observed and unobserved, that influence both the decision to participate and production costs. More specifically, it is expected that better skilled farmers are more likely to join discussion groups.

The classic example of such a problem is the analysis of the performance of private schools, as outlined by Evans and Schwab (1995). On an analysis of test scores, one could conclude that private schools deliver better results. However, such a conclusion is biased if the analysis does not account for all of the other characteristics of students attending private schools, many of which may be unobserved, for example inherent talent and ability.

This problem has often been cited in the agricultural economics literature mostly in relation to evaluating the benefit of technology adoption. Fuglie and Bosch (1995), for example, use endogenous switching regression analysis to estimate the economic and environmental implications of soil nitrogen testing in Nebraska. Their results confirm self-selection into adoption of soil testing. Further, the study showed that the value of soil testing was highest for fields that have considerable uncertainty about the quantity of soil nitrate and average nitrate fertilizer rates fell, without affecting crop yield. Similarly, Alene and Manyong (2007) apply endogenous switching regression analysis to estimate the effect of technology adoption on agricultural productivity in northern Nigeria. By focusing on education, their results show that schooling and extension contact have a different impact on traditional and improved cowpea production.

A similar approach is proposed in this paper. An endogenous switching regression model is estimated to account for self-selection bias. Thus, profit functions are estimated conditional on discussion group membership.

3 Methodology

The examination of the effect of discussion group membership on farm profit requires special econometric treatment. As explained previously, there might be a self-selection problem when analysing the effect of discussion groups. Thus, self-selection into discussion group membership causes endogeneity and ignoring this will not correctly estimate the effect of discussion groups.

In this context, a model which was initially applied in labour economics (Lee, 1978) can be used to address this problem. This endogenous switching regression model estimates the participation decision with a binary model and the equations for the outcome, i.e. the profit functions are then modelled for both groups conditional on the participation decision.

Theoretically, the farmer decides to participate in discussion groups when the expected utility received from participation is greater than the utility received from non-participation. Since expected utility is not observed but participation in discussion groups is observed, the participation decision (D) is treated as a dichotomous choice. Thus, using an underlying latent variable model, the participation decision can be modelled as:

$$
\begin{aligned}
D^* &= Z'\alpha + \varepsilon \\
D &= 1 \ if \ Z'\alpha \geq \ \varepsilon \\
D &= 0 \ if \ Z'\alpha < \varepsilon
\end{aligned}
\qquad [1]
$$

where Z represents explanatory variables, α is a vector of parameters to be estimated and ε is an error term with mean zero and variance σ_ε^2.

It is expected that the choice of the farmer to participate in discussion groups affects farm performance, such as profit. Based on this assumption, a separate equation is specified for discussion group members and non-members:

$$
\begin{aligned}
Y_1 &= X'\beta_1 + \epsilon_1 \qquad if \ D = 1 \\
Y_2 &= X'\beta_2 + \epsilon_2 \qquad if \ D = 0
\end{aligned}
\qquad [2]
$$

Y represents farm profit expressed in gross margin per hectare. Y_1 and Y_2 indicate farm profit for participants and non-participants respectively and X is a vector of explanatory variables. It is assumed that the error ε of the selection equation (equation [1]) is correlated with the errors ϵ_1 and ϵ_2 of the profit equations (equation [2]) (Maddala, 1983). The error terms ε, ϵ_1 and ϵ_2 are assumed to have a trivariate normal distribution with mean vector zero and the following covariance matrix:

$$
cov(\varepsilon, \epsilon_1, \epsilon_2) = \begin{bmatrix} \sigma_{\epsilon_2}^2 & \sigma_{\epsilon_1\epsilon_2} & \sigma_{\epsilon_2\varepsilon} \\ \cdot & \sigma_{\epsilon_1}^2 & \sigma_{\epsilon_1\varepsilon} \\ \cdot & \cdot & \sigma_\varepsilon^2 \end{bmatrix}
$$

where σ_ε^2 is the variance of the selection equation (equation [1]), which is assumed to be 1 as α is only estimable only up to a scale factor. $\sigma_{\epsilon_1}^2$ and $\sigma_{\epsilon_2}^2$ are the variances in the profit functions (equation [2]) and $\sigma_{\epsilon_1\varepsilon}$ and $\sigma_{\epsilon_2\varepsilon}$ represent the covariance of ε, ϵ_1 and ϵ_2. Note that the covariance between ϵ_1 and ϵ_2 is not observed, since the farm profit conditional on participation (Y_1) and non-participation (Y_2) are never observed simultaneously (Maddala, 1983).

Thus, the solution to the problem is to find the expression for $E(\epsilon_1|D = 1)$ and $E(\epsilon_2|D = 0)$:

$$
\begin{aligned}
E(\epsilon_1|D = 1) &= E(\epsilon_1|\alpha Z' \geq \ \varepsilon) = -\sigma_{\epsilon_1\varepsilon}\frac{\phi(Z'\alpha)}{\Phi(Z'\alpha)} = \sigma_{\epsilon_1\varepsilon}\lambda_1 \\
E(\epsilon_2|D = 0) &= E(\varepsilon_2|\alpha Z' < \varepsilon) = \sigma_{\epsilon_2\varepsilon}\frac{\phi(Z'\alpha)}{1 - \Phi(Z'\alpha)} = \sigma_{\epsilon_2\varepsilon}\lambda_2,
\end{aligned}
\qquad [3]
$$

ϕ and $\boldsymbol{\Phi}$ are the probability density and the cumulative distribution function of the standard normal distribution, respectively. $\lambda_1 = \frac{-\phi(Z\prime\alpha)}{\Phi(Z\prime\alpha)}$ and $\lambda_2 = \frac{\phi(Z\prime\alpha)}{1-\Phi(Z\prime\alpha)}$, thus the profit functions can be written as follows (Maddala, 1983):

$$Y_1 = X'\beta_1 + \sigma_{\epsilon_1\varepsilon}\lambda_1 + u_1 \; if \; D = 1$$
$$Y_2 = X'\beta_2 + \sigma_{\epsilon_2\varepsilon}\lambda_2 + u_2 \; if \; D = 0 \qquad [4]$$

Equation [4] illustrates that an OLS regression of y on x using participants or non-participants omits the term $\sigma\lambda$, thus leading to inconsistent estimates of β.

Identification of the model requires that there is at least one variable in Z' which is not included in X'. In the present model, age is included in Z' which is thought to affect discussion group participation, but not to affect gross margins directly. An efficient method to estimate the endogenous switching regression model is by full information maximum likelihood (FIML) estimation (Lokshin and Sajaha, 2004). The FIML method simultaneously estimates the selection equation and the regression equations to yield consistent estimates.

The previously explained model can be used to estimate the mean values of the dependent variables for the alternative choice. More specifically, it is possible to estimate how discussion group membership affects gross margins. Gross margins are recoverable by inserting the variable values for each farm into the corresponding equation to evaluate the predicted outcome. Here, it is possible to use the coefficients for the discussion group members' equation to predict the values for non-members were they members, and vice versa. More formally, the effects of discussion group (non-) membership are:

$$E(Y_1|D = 1) = X'\beta_1 + \sigma_{\epsilon_1\varepsilon}\lambda_1 \qquad [5]$$

$$E(Y_2|D = 0) = X'\beta_2 + \sigma_{\epsilon_2\varepsilon}\lambda_2 \qquad [6]$$

These are the expected gross-margins for discussion group members and non-members respectively. However, it is also possible to estimate the hypothetical cases that the discussion group members were not members, and that the non-members were members. The hypothetical cases can be calculated as follows (Maddala, 1983):

$$E(Y_2|D = 1) = X'\beta_2 + \sigma_{\epsilon_2\varepsilon}\lambda_1 \qquad [7]$$

$$E(Y_1|D=0) = X'\beta_1 + \sigma_{\epsilon_1\varepsilon}\lambda_2 \quad [8]$$

Based on the calculated and hypothetical gross margins the return to discussion group membership for non-members can be calculated as follows:

$$E(Y_1|D=0) - E(Y_2|D=0) = X(\beta_1 - \beta_2) + (\sigma_{\epsilon_1\varepsilon} - \sigma_{\epsilon_2\varepsilon})\lambda_2, \quad [9]$$

which estimates the expected change in gross margins for non-members, had they been members.

4 Data

The main data source employed in this analysis is Teagasc NFS data from 2009 (Connolly et al. 2010). The NFS is based on approximately 1,100 farms each year, representing a farming population of approximately 110,000 farms. The NFS is collected as part of the EU-Farm Accountancy Data Network (FADN). Farms are classified into farming systems, based on dominant enterprise which is calculated on a standard gross margin basis. The NFS distinguishes between six farming systems: dairying, dairying other, cattle rearing, cattle other, mainly sheep and tillage. Here, a sub-sample of 329 specialized dairy farms is used.

Table 1 outlines the mean values of the variables used in this analysis and their description. In 2009, 34.95% of the sample participated in discussion groups, which is the dependent variable for the selection equation. The farmers, who participated in discussion groups, have on average been members for 8 years, which assumed to be long enough to see an effect on farm performance. Gross margin per hectare, which is on average €1,079 per farm is the dependent variable for the profit function and is defined as dairy gross margins per forage area. Gross margins are defined as gross output minus direct costs.

The explanatory variables consist of farm and farmer characteristics as well as regional dummy variables. Farm characteristics include farm size, milk yield, stocking density, grazing season as well as somatic cell count. Farm size is measured in utilizable agricultural area and milk yield is measured in kg milk produced per cow. Stocking density is the number of dairy cows per hectare forage area. Grazing season is calculated as the number of days cows are grazed over the course of the year. An extended grazing season can reduce direct costs, thus it is expected to be positively correlated with gross margins. Somatic cell count is used as a measure of milk quality, therefore it is anticipated that a higher somatic cell count is negatively correlated with gross margins. In order to account for regional effects, four

regional dummy variables are included: border, midlands and western (BMW), south-west, east and south region. The BMW region is characterized by lower stocking density, while the south-west and south are mainly dairy production regions. Consequently, productivity and profitability of dairy production differ between the four regions.

Table 1: Descriptive statistics for the sample

		All farms	
Variable	**Definition**	Mean	(St. Dev.)
BMW	=1 if farm is in the BMW region	0.22	(0.42)
South-west	=1 if farm is in the south-west region	0.19	(0.39)
East	=1 if farm is in the east region	0.27	(0.44)
South	=1 if farm is in the south region	0.32	(0.46)
Member	= 1 if the farmer is a member in a discussion group	0.35	(0.46)
Length[1]	Membership in years	8.49	(6.42)
GM/ha	Gross margin per hectare in €	1,072.6	(535.50)
Farm size	UAA measured in hectares	63.44	(35.71)
Yield/cow	Milk yield per cow	4,789.25	(1,057.13)
LU/ha	Livestock density (dairy cows)	1.87	(0.47)
Grazing	Length of the grazing season in days	225.95	(25.86)
SCC	Somatic cell count in 1,000	272.70	(125.87)
Age	Age of the farmer	50.16	(10.78)

[1]This variable includes members only and is not included in the analysis

5 Results

5.1 Descriptive statistics

Before embarking on the empirical analysis, characteristics between members and non-members are compared, which are shown in Table 2. Close inspection of the characteristics reveals some notable differences between discussion group members and non-members, which are confirmed using statistical tests. The results of the statistical tests are also shown in Table 2. In the sample, the south-west and the south regions have significantly higher participation rates, while no significant differences could be found in the BMW and east regions. Overall, the two groups differ significantly in all farm and farmer characteristics.

With an average gross margin per hectare of €1,334, members have significantly higher gross margins per hectare than non-members with an average of €932. Discussion group members have also significantly larger farms, higher livestock densities as well as yields, and they were also found to be significantly younger than non-members.

Table 2: Comparison of characteristics between members and non-members

Variable	**Member**		**Non-member**		
	Mean	(St. Dev.)	Mean	(St. Dev.)	
BMW	0.21	(0.41)	0.23	(0.42)	$X^2 = 0.267$
South-west	0.10	(0.31)	0.23	(0.42)	$X^2 = 8.177$***
East	0.27	(0.44)	0.27	(0.44)	$X^2 = 0.001$
South	0.42	(0.49)	0.26	(0.44)	$X^2 = 8.389$***
GM/ha	1,334.70	(455.70)	931.76	(522.89)	t = -6.963***
UAA	73.47	(36.56)	58.06	(34.13)	t = -3.808***
Yield	5,203.10	(944.27)	4,566.85	(1,049.53)	t = -5.4265***
LU/ha	1.97	(0.43)	1.81	(0.49)	t = -2.954**
Grazing	236.54	(25.51)	220.26	(24.26)	t = -5.674***
SCC	241.74	(84.78)	289.43	(140.36)	t = 3.278***
Age	46.78	(10.62)	51.98	(10.44)	t = 4.279***

*** p<0.01; **p<0.05; *p<0.1.

5.2 Empirical Results

The results of the econometric model are presented in the following section. While the model is estimated simultaneously, participation decision and profit functions are presented consecutively.

Participation decision

The estimates of the discussion group participation decision are depicted in Table 3. The marginal effects indicate the change in probability of participation given a one unit change in the explanatory variables. The marginal effects are calculated following $\hat{\alpha} \cdot \phi(Z'\hat{\alpha})$ at the mean (median) values of Z' (Wooldridge, 2002). The model correctly predicts the participation decision of 76% of the sample.

In terms of regional effects, model results indicate that farmers in the south-west and east region have a lower probability to join discussion groups compared to farmers in the south region.

Farm size was found to be positively correlated with discussion group membership, while livestock density is not significantly related to discussion group membership. This indicates that farmers with larger holdings are more likely to participate in discussion groups. In addition, the length of the grazing season is positively correlated with participation. Somatic cell count, a measure of milk quality, is negatively correlated with participation, suggesting that farmers with poorer milk quality are less inclined to join discussion groups. In terms of farmer characteristics, age was found to be negatively correlated with participation. This suggests that younger farmers are more likely to participate in discussion groups.

Table 3: Discussion group participation

Variable	Coefficient	(z-value)	Marginal effect
BMW	0.11	0.46	0.03
South-west	-0.53**	-2.12	-0.15
East	-0.35*	-1.67	-0.10
Farm size	0.006***	2.61	0.001
LU/ha	0.27	1.38	0.08
Yield	0.0002***	2.75	0.000
Grazing	0.01***	3.79	0.003
SCC	-0.002**	-2.30	-0.0006
Age	-0.02***	-3.25	-0.006
Constant	-3.64***	-3.30	-1.05
X^2	62.14		
Correct predictions			
Members	52.29%		
Non-members	88.83%		
Overall	76.19%		

***p<0.01; **p<0.05; *p<0.1. Note this model is based on estimation results from the endogenous switching model.

Profit functions

The profit function estimates of the endogenous switching regression model are reported in Table 4. The estimated coefficient of correlation between discussion group members and gross margins is negative and significant, while the correlation coefficient between non-members and gross margins is not statistically significant. This implies that a farmer who chooses to participate in discussion groups has higher gross margins than a random farmer, while farmers who choose not to participate in discussion groups are no better or worse than a random farmer (Hartog and Oosterbeek, 1993, Maddala, 1983). The null hypothesis of independent equations can be rejected at the 10% level based on a likelihood ratio test (χ^2 =2.91 p = 0.08).

The results show that the coefficients of the variables hypothesized to influence gross margins have the expected signs. Similar to previous studies (Fuglie and Bosch, 1995; Pycroft, 2008), different variables affect farm productivity conditional on group membership, indicating that it is necessary to split the sample.

Table 4: Endogenous switching regression model

	Gross Margin per hectare			
	Member		**Non-member**	
BMW	11.10	(0.13)	-51.01	(-0.70)
South-west	71.97	(0.63)	7.97	(0.12)
East	234.81***	(3.04)	34.57	(0.54)
UAA	-1.27	(-1.36)	1.39*	(1.79)
Yield	0.18***	(5.05)	0.28***	(11.35)
LU/ha	420.19***	(5.42)	465.07***	(8.95)
Grazing	0.31	(0.18)	3.13***	(2.69)
SCC	-0.54	(-1.25)	-0.16	(-0.86)
Constant	-174.36	(-0.27)	-1,870.90***	(-6.26)
$\sigma_{\epsilon_1 \varepsilon}$	-220.51			
$\sigma_{\epsilon_1 \varepsilon}$	86.95			
$\rho_{\epsilon_1 \varepsilon}$	-0.67*			
$\rho_{\epsilon_1 \varepsilon}$	0.27			
X^2	98.30			

***p<0.01; **p<0.05;* p<0.1.

In the members group, there is a regional effect in the sense that farmers in the east have higher gross margins per hectare than farmers in the south. In contrast, there is no statistical significant regional difference for the non-members. Size of the farm, measured in utilizable agricultural area, has a significant positive effect on the gross margins of non-members, while this variable was not found to have a significant effect on gross margins for members. As expected, yield per cow and livestock density positively affect gross margins for members and non-members and there is no statistical significant difference between the coefficients. This suggests that a higher yields and stocking densities could further increase gross margins per hectare for both groups.

The estimated coefficients for the length of the grazing season were statistically different between members and non-members. This variable positively affects gross margins of non-members but not of members. For example, by lengthening the grazing season by one day, gross-margins per hectare for non-members would increase by over €3. Somatic cell count, which acts as a quality measure of milk, does not significantly affect gross-margins of either group.

5.3 The benefits of discussion group membership

In order to determine the effect of discussion group membership, gross-margins for non-members are compared to what they would be if the farmer had been a member. The differences in gross-margins conditional on membership are calculated following equation [9]. The calculated expected gross margins for a farm with mean characteristics of a non-member in the south region are reported in Table 5.

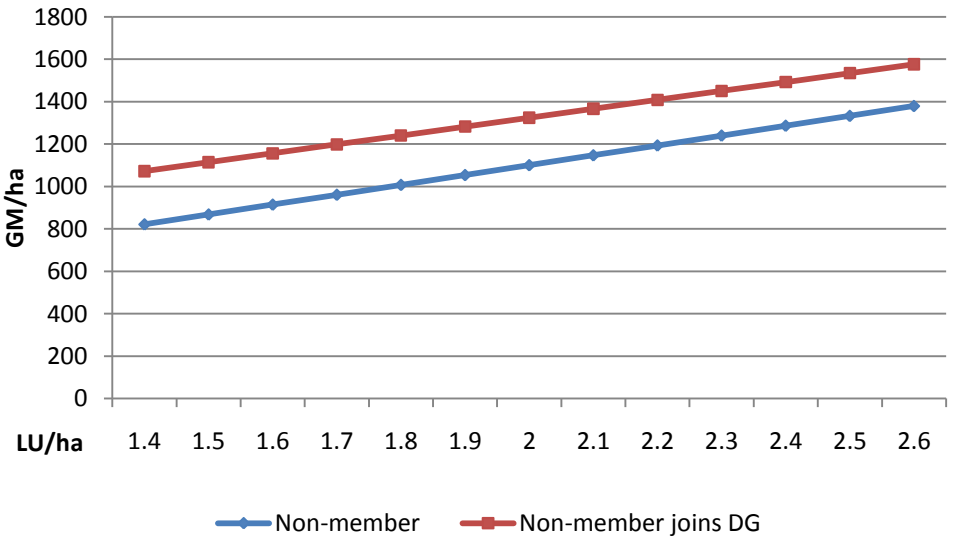
Table 5: Predicted gross margin and return to discussion group membership

Expected gross margin member	Expected gross margin non- member	Effect of membership
$Y_1(DG = 0)$	$Y_2(DG = 0)$	Δ DG
€ 1,148	€ 1,013	€135

The expected gross-margin per hectare for a non-member is €1,013, while the gross-margin of the same farm, based on the assumption that the farmer had been a member, is estimated to be €1,148. Thus, the expected return to discussion group membership for a farmer with these characteristics is €135.

The returns to discussion group membership are plotted for varying livestock densities for non-members and for the hypothetical case that this farmer had been a member. As is evident from Figure 1, gross margins per hectare increase with increasing livestock density. Further, the same farm would have benefitted from discussion group membership, although the returns to discussion group membership decrease with increasing livestock density.

Figure 1: Return to discussion group membership based on livestock density



6 Discussion and conclusion

In December 2009 the Irish Department of Agriculture launched the Dairy Efficiency Programme. The Programme, which is operated through a series of discussion groups, is designed to promote technology transfer to dairy farmers. Drawing on National Farm Survey data from 2009, the purpose of this paper is to quantify the economic return to membership of a dairy discussion group. An endogenous switching regression model is specified for Irish dairy farms and the profit equations are estimated conditional on discussion group membership.

Overall the study provides insight into what can be expected from participation in discussion groups. The results of this analysis show that to date, farmers participating in discussion groups tend to farm larger, more intensively stocked farms. However, even when the characteristics, both observed and unobserved, of discussion group farmers are controlled for, the results of the analysis show that farmers in discussion groups are more likely to have higher profit levels. The findings suggest that farmers who self-select into discussion groups have higher gross margins than a random farmer, confirming that it is necessary to account for selection bias when attempting to estimate the return to discussion group membership. In addition, the findings show that gross margins of the two groups are affected by different variables, further supporting that the two profit functions should not be pooled together.

These results support the Dairy Efficiency Programme launched by the Department of Agriculture that aims to enrol more farmers in discussion groups. The results of the analysis show that farmers of all levels of intensity, size and in all regions could gain from membership of a discussion group. However, it should be noted that those participating in discussion groups as recorded in this paper had become discussion group members of their own free will and without any financial incentive. It is possible that farmers that join under the new scheme may have different motivations, i.e. they may join for the financial reward rather than for any knowledge gained. One would expect that such farmers will not gain as much from membership as the more "traditional" members. It would be interesting to test this empirically and this may be possible in a number of years when data on new entrants under the Dairy Efficiency Programme are available.

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