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Measuring Productivity Change and Efficiency on Irish Farms

Suzanne O'Neill[1]
Anthony Leavy
Alan Matthews

Prepared for Teagasc Rural Economy Centre

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Summary

Measuring Productivity Change and Efficiency on Irish Farms

This report investigates technical change and levels of technical efficiency on Irish farms using National Farm Survey (N.F.S.) data. It also examines whether levels of technical efficiency are influenced by contact with the extension service.

The study utilises a stochastic production frontier approach to measure productivity growth and the technical efficiency of a panel of Irish farms over the period 1984 to 1998. This sample was used to calculate (a) technical change over time as measured by best practice farms and (b) technical efficiency levels of all farms over this period. It, therefore, provides disaggregated estimates of technical change by farming system as well as quantifying the average level of technical efficiency. The project also examines the factors associated with differences in technical efficiency between farms and the impact of extension service contact on farm-level technical efficiency.

Mean technical change (i.e. changes in best practice) continued, albeit at a declining rate, throughout the period studied. Significant differences were revealed in the rate of technical change on farms of different types. For example technical change on dairy and crop farms averaged nearly 2 per cent per annum while technical regress occurred on beef and sheep farms.

In addition to examining technical change, farm efficiency relative to best practice within each farming system was also measured. Results indicate that farms achieved, on average, approximately 65 per cent of the efficiency level of best practice farms. The average level of farm efficiency has been decreasing by 0.4 per cent per annum indicating that the gap between best practice farms and all farms has been increasing by this amount over time.

Thirty one percent of the most efficient farms were dairy farms while 23 per cent were arable farms. Approximately 52 per cent of the least efficient farms were cattle farms while a further 31 per cent were sheep farms. Average efficiency over the period was 34.2 per cent in the least efficient quintile of farms. This compared to almost 90 per cent for the most efficient quintile of farms.

A positive relationship between age and efficiency was found up to the age of 49 years after which the relationship between age and efficiency becomes negative. The farm debt to assets ratio was positively related to efficiency while farm size and location in the West of Ireland was negatively related to efficiency.

Farms in contact with the extension service were found to be on average 6.5 per cent more efficient than farms without contact. Contact farms with a lower than average dependency on direct payments were a further 6.6 per cent than contact farms with an average dependency on direct payments. Contact farms with a higher than average dependence on direct payments were 1.9 per cent less efficient than the same group of contact farms. However, efficiency on these farms with a high dependence on direct payments was still, on average, higher than on farms with no extension contact.

Introduction

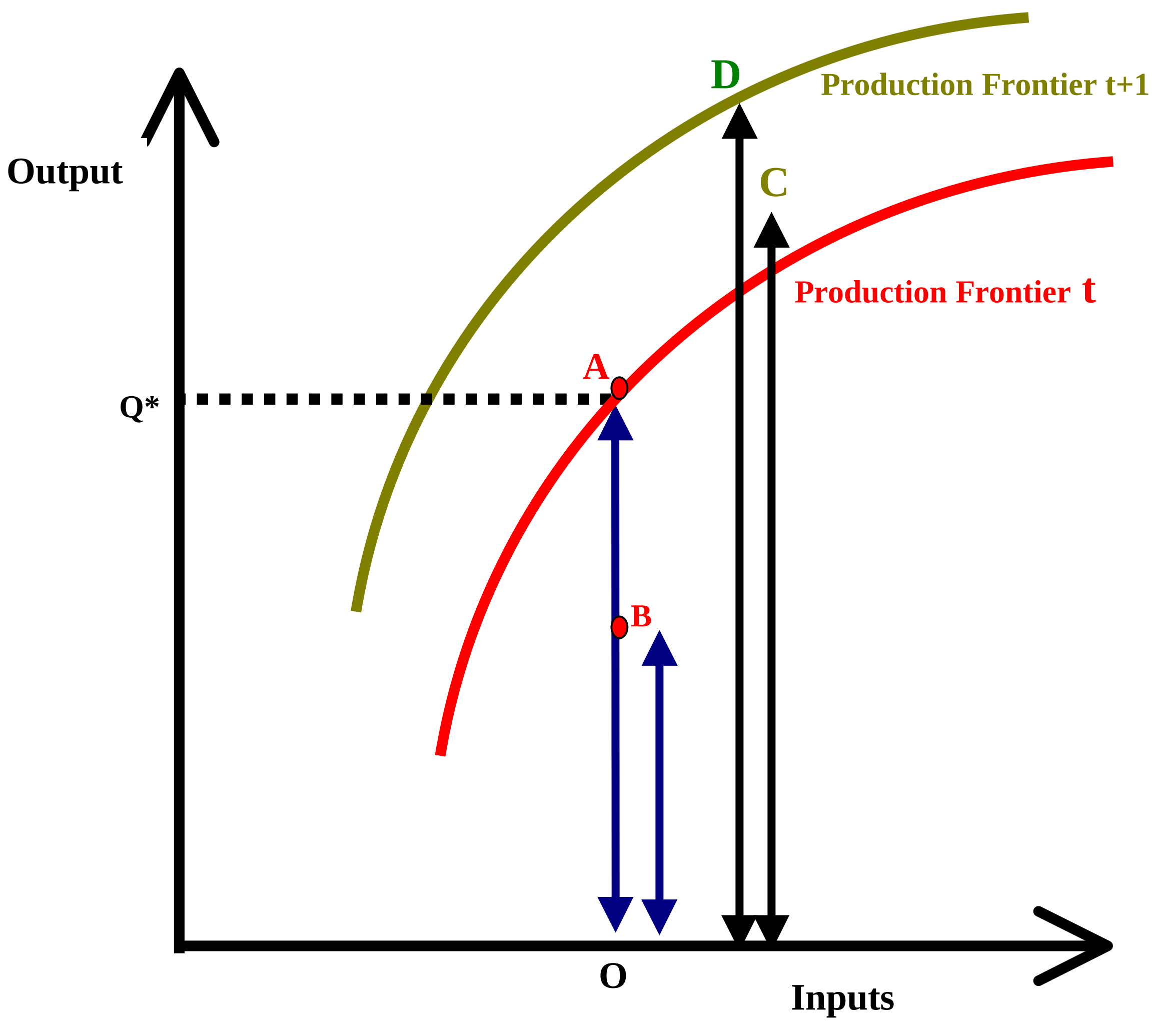
The future competitiveness of Irish agriculture depends on access to up-to-date and productive new technologies, on achieving an optimal structure of production, and on the management skills of its farmers (Matthews, 2000). This project seeks to quantify two of these competitiveness factors, namely, the rate of productivity improvement over time and the relative efficiency of individual farms compared to best practice in the industry. It provides disaggregated estimates of technical change by farming system as well as quantifying the average level of technical efficiency. The project findings also throw light on the factors associated with differences in technical efficiency across farms and on the impact of contact with the extension service on farm-level technical efficiency.

Large differences in the efficiency with which individual farms use their available resources have been a consistent feature of Irish agricultural performance. For example, in 1998, farmers in the lowest third of the population had an average gross margin of £381 and a stocking density of 1.13 livestock units per hectare (lu/ha). This compared to a gross margin of £821 and a stocking density of 1.54 lu/ha per hectare for farmers in the top third of the population. Since different farmers may use different combinations of fixed inputs partial productivity indicators of this kind can be misleading in comparing relative efficiency between farms. For example, farmers with a low level of gross margin per ha may also use relatively few capital and labour inputs. In assessing the factors associated with technical efficiency, it is important to measure efficiency differences accurately. The analysis undertaken in this project measures the relative technical efficiency of farms in a consistent way. It also examines the factors associated with these differences. Understanding the reasons why these differences occur can be a valuable aid to policy makers in designing policies to improve the overall efficiency and competitiveness of the agricultural sector.

A particular focus of the project was to assess the impact that contact with the agricultural extension service has on farm-level technical efficiency. Previous Irish studies of the impact of extension have focused on particular extension programmes, such as the Farm Improvement Programme, using a cost benefit approach (Leavy, 1991; Frawley, 1985; Leavy et al, 1997). In Ireland, the role of the extension service is changing as a result of the changed policy environment for agriculture following EU agricultural policy reforms in 1992 (the MacSharry reform) and 1999 (the Agenda 2000 reform). Over 20 per cent of revenue and over 50 per cent of income from farming is now derived from direct payment support financed by the EU’s Common Agricultural Policy. The project explored whether this increased dependence on direct payments has any implications for farm-level efficiency and for the role of the extension service.

The study utilises a stochastic production frontier approach to measure productivity growth and the technical efficiency of a panel of Irish farms over the period 1984 to 1998. A production frontier is defined in terms of the maximum output that can be achieved from a set of inputs given the technology available to the farm. Productivity growth is associated with an upward shift in the production frontier over time, implying greater output from the same set of inputs. Productivity growth derives from technical change and is identified as such in this study, although other factors such as the improved management skills of farmers can also play a role. Underlying the frontier approach is the assumption that if a farm is operating at a point inside the frontier then it is technically inefficient (Coelli et al., 1998). Once the frontier has been defined the position of any farm relative to the frontier can be identified and interpreted as a measure of its relative efficiency. Inefficiency is measured as the extent farms are using more resources to produce a given level of output relative to the best practice farms in the sample. If a farm is operating at a point such as A in Figure 1 then the farm would be on the best practice frontier with an efficiency ratio of 1. If a farm is at a point such as B then the farm is said to inefficient, that is, the efficiency ratio will be less than one. In fact, its relative efficiency can be measured as the ratio of the distance OB to OA. It should be noted that the frontier can move over time from *t* to *t+1* due to technical change. Levels of relative efficiency can also change on individual farms over time. For example a farm operating at point B in period *t* could end up at C in period *t+1*, showing an improvement in its relative efficiency over time.

Figure 1
The Production Frontier



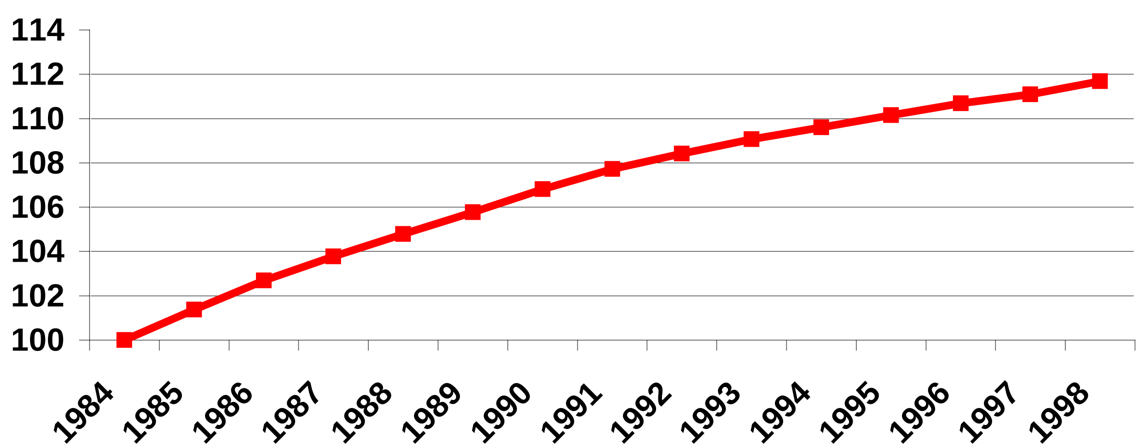
Two data sets were used in the analysis. The first data set comprised a sample of 2,603 farms in the years 1984 to 1998, representing all farms in the National Farm Survey at any time during this period. Farms remained in the sample for on average 5.9 years. This sample was used to calculate technical change over the period 1984 to 1998. For the analysis of the factors affecting farms' technical efficiency including the impact of the extension service, a subset of 530 of the above farms was used. Data were available on both the education level and extension contact of the farm operator for this smaller sample for the years 1995 to 1998. Data on farmer and family characteristics, farm size, levels of general education, contact with extension service, level of direct payments and regional location were used as explanatory factors in the latter part of the study.

Results

Technical Change

Technical change is defined as the movement of the production frontier, as measured by best practice farms within each system, over time. The results for the large data set are shown in Figure 2. There is evidence of technical change over the period but this is occurring at a decreasing rate. Between 1984 and 1989 technical change averaged 1.1 per cent annually compared to an annual average rate of 0.7 per cent between 1990 and 1998. The annual rate of technical change over the period was 0.9 per cent with a cumulative increase in total factor productivity on best practice farms of 13.9 per cent. In comparison Matthews (forthcoming), found an annual rate of total factor productivity (TFP) growth in Irish agriculture of 2.3 per cent per annum in the 1980s falling to 0.8 per cent annually in the 1990s. He used an index number methodology with aggregate data which combines the impact of technical change with changes in average efficiency levels of farms. Few other comparative estimates of TFP growth in Irish agriculture exist for this period. For the 1973-89 period, Bureau et al. (1995) found an average annual TFP growth rate in Ireland of 1.35 per cent. The apparent slow-down in technical change in Irish agriculture is clearly a cause for concern and warrants further investigation. It might be due to cutbacks in research expenditure which occurred in the 1980s, or to the greater regulation of agriculture and the impact of the shift to direct payments to support farm incomes which was introduced by the MacSharry CAP reforms in the 1990s.

Figure 2
The Rate of Technical Change



Since estimates of the rate of technical change for each farm in the sample were available the average unweighted rate of technical change for farms of different characteristics was explored. Significant differences were revealed in the rate of technical change on farms of different types. Farms located in the East had a mean annual rate of technical change of 1.35 per cent over the period compared to a mean annual rate of 0.13 per cent for farms in the

West.[2] Farms in the top size quintile (over 81 hectares of land) had an average annual rate of technical change of 2.54 per cent annually. This compared to an average annual fall in productivity (which we call technical regress)[3] of -0.8 per cent on farms in the bottom size quintile (less than 22 hectares). Thus disparities in the rate of uptake of new technologies appear to be contributing to the observed polarisation of Irish agriculture (Frawley and Commins, 1996). Dairy, dairy and other and crop farms experienced technical change over the period (at annual rates of 1.9, 1.3 and 1.75 per cent respectively) while cattle and sheep farms experienced technical regress over the same period. In the latter farm systems direct payments comprise a high proportion of total farm income and it is possible that this result is due to the conditions attached to these payments (Matthews, forthcoming).

Table 1
Average Annual Rates of Technical Change by Region, Farm Size and System

Region	**%**
West	0.13
East	1.35
System	
Dairy	1.90
Dairy and other	1.36
Cattle	-0.22
Sheep	-0.47
Crops	1.75
Size Quintiles	
less than 22 ha	-0.80
23 to 33 ha	0.17
34 to 48 ha	0.82
49 to 80 ha	1.57
80 ha and above	2.54

Technical Efficiency

The project methodology measured farm efficiency relative to best practice within each farming system in a particular year. Results indicate that farms within a farming system achieve, on average, around 65 per cent of the efficiency level of best practice farms within that system. This figure fell to approximately 60 per cent if farm efficiency was measured relative to the most efficient farms in the sample overall. This latter figure compares to an average of 58 per cent found by Boyle (1987) using a different model specification and an earlier time period (1984-86). The average level of farm efficiency has been decreasing by 0.4 per cent per annum over the period of this study. This implies that the gap between

[2] In this study the West of Ireland was defined to include the counties of Kerry, Clare, Galway, Mayo, Roscommon, Leitrim, Sligo, Donegal, Cavan and Monaghan.

[3] Recall that productivity growth on best practice farms (i.e. greater output with the same use of inputs) is defined as technical change in this study. Where productivity is falling (i.e. farmers even on best practice farms are using greater amounts of inputs to produce the same level of output) this is defined as technical regress. But for the same reasons that it is not correct to identify all productivity growth as being due to technical progress, the terminology of technical regress is not fully satisfactory either. Once a technical discovery is made, it stays made – in this sense technical regress is a contradiction. What we are observing is that best practice farms over time, for whatever reasons, are not continuing to use the most productive technologies available to them. We speculate that, in Irish circumstances, the most likely reason why we observe technical regress is because of the incentive structure created by direct payments.

productivity on best practice farms and farms in general has been growing over the period. These results suggest that there is considerable scope for either increased output or cost savings if average efficiency levels were improved.

The breakdown of the most efficient farms by system of farming shows that 31 percent are dairy farms while 23 per cent are arable farms (Table 2). Approximately 52 per cent of the least efficient farms are cattle farms while a further 31 per cent are sheep farms. These figures suggest that a much greater proportion of farms in drystock systems fall into the least efficient category. Because efficiency is measured relative to the best performing farms in each system this implies that the *variation* in efficiency levels is much greater among cattle and sheep farms than it is among dairy and arable farms.

Table 2
Percentage of Farming Systems in the Most and Least Efficient Efficiency Quintiles

System	**% Most efficient**	**% Least efficient**
Dairy	31.04	4.76
Dairy and Other	17.70	9.62
Cattle	16.93	51.17
Sheep	11.10	31.33
Crops	23.23	3.12
Total	100.0	100.0

The characteristics of the most and least efficient farms are reported in Table 3. All figures are sample mean values. The average efficiency level over the period is 34 per cent in the least efficient farms compared to almost 90 per cent for the most efficient farms. Significant differences emerge in the characteristics of farms in the two categories. Farms in the most efficient category have much higher levels of gross output and gross margin per ha. They are larger though not by that much, and the role of size is examined in more detail below. Farms in the most efficient category use more capital and have a higher average debt to assets ratio. They also have younger farm operators than farms in the least efficient category. The next part of the study describes the application of econometric methodology to quantifying the exact relationship between these variables and the level of farm efficiency.

Table 3
Characteristics of the Most and Least Efficient Farms Evaluated at the Mean Value over the Period 1984 to 1998

	Most Efficient Quintile	Least Efficient Quintile
Technical Efficiency (%)	89.1	34.2
Gross Output per ha (£)	890	210
Gross Margin per ha (£)	662	324
Family Farm Income per ha (£)	389	161
Capital per ha (£)	678	452
Variable Costs per ha (£)	488	303
Total number of Labour Units	1.6	1.2
Total number of Livestock Units	67.2	53.7
Size of farm in adjusted ha	58.3	50.0
Borrowing per ha (£)	293	122
Debt Ratio to Assets (%)	23	9
Age of Farm Operator (Years)	47	52
Household Size (Number of people)	4.4	3.5

Explaining Technical Efficiency
The first part of the study indicated that there were systematic differences in relative efficiency levels between farms and that these differences appeared to be related to particular farm and farmer characteristics. The second part of the study investigated the role of education and the farm advisory service in influencing farm efficiency using a smaller sub-set of farms covering the period 1995-98. The reason for the smaller sample and the shorter time period was that data on education and extension contact were only available for the more limited sample and period. However, the characteristics of the smaller sample and the results obtained are broadly similar to those of the full sample discussed above. The results are presented in Table 4. The coefficients are interpreted as the effect of each variable on farm efficiency, holding all other factors constant.

A positive relationship between age and efficiency was found up to the age of 49 years after which the relationship between age and efficiency became negative. The farm debt to assets ratio was positively related to efficiency while location in the West of Ireland was negatively related to efficiency. Farm size was negatively related to efficiency. There is no contradiction between this result and the findings reported in Table 3 that the more efficient farms tend to be larger farms. This latter result arises because many other factors which are positively associated with efficiency are also positively associated with farm size. The regression analysis undertaken in this section made it possible to quantify the contribution of size alone, holding all other factors constant. The result indicates that larger farms are under less pressure to optimise the use of the resources under their control.

There is a marked negative relationship between dependence on direct payments and farm efficiency. In other words, the greater a farm's dependence on direct payments, the lower its efficiency in using its resources. Surprisingly, the farmer's education does not appear to influence his level of efficiency. In addition, education does not appear to influence extension impact. The coefficient of the interaction term between education and extension contact is not significantly different from zero. An important finding in the context of the debate on multiple job holding and part-time farming is that having an off-farm job did not have any impact on farm-level technical efficiency.

Advisory contact is positively related to efficiency and is significant at a 1 per cent level. In deriving this result, account was taken in the methodology of the need to allow for selection bias in farmer-advisor contact. We are interested in determining the causal effect of extension contact on farm efficiency. But if the more (or less) efficient farmers are those that are more likely to make use of the extension service, then the coefficient measuring the relationship between efficiency and extension contact will be biased by this self-selection behaviour of farmers. Similarly, if extension workers deliberately seek to work with particular groups of farmers, there will be a selection bias at work. The analysis therefore used techniques which corrected for these potential biases by first estimating the probability of contact with the extension service. The results of this estimation are interesting in their own right. The probability of contact was negatively influenced if the farm operator had an off-farm job and was involved in low-margin cattle and sheep farming. It was positively influenced by a high dependence on direct payments in farm income. Level of education and ease of access to extension advisors also raised the probability of contact with the service.

Table 4
The Relationship Between Farm Level Factors and Efficiency

	Coefficient
Age of farm operator	0.089*
Age squared	-0.0009*
Farm is located in the West of Ireland	-0.5842*
Share of direct payments in gross margin	-3.396*
Household size	0.0340
Size of farm 25-36 ha	-1.165*
Size of farm 36-60 ha	-1.334*
Size of farm 60+ ha	-1.926*
Education to Junior Cert	-0.147
Education to Leaving Cert	0.395
Debt Ratio to assets	0.9428*
Off Farm Job	0.036
Contact with the advisory service.	5.618*
Low dependency on direct payments and contact with the advisory service.	5.705*
Interaction of education level and contact with the advisory service.	-0.6740
High dependency on direct payments and contact with the advisory service.	-1.610*

* statistically significant at 1 per cent level

The correction revealed that the extension service is more likely in practice to have contact with farmers predisposed to make relatively less efficient use of their resources than would be expected on a purely random basis. This may arise from a number of factors:

- the policy of maintaining lower charges for access to the extension service for non-commercial farmers;
- the significant resources devoted to the Farm Viability Scheme geared to these farmers;
- the fact that contact with a large number of farmers may be motivated by the participation of these farmers in REPS.

In examining the factors affecting farm efficiency, it is important to take into account the changed EU policy environment for agriculture. To capture these relationships between agricultural policy and role of the farm advisory service, a series of interaction variables was used in the efficiency model. Contact farms are defined as those in contact with the extension service. Low-payments-dependent farms are defined as those where direct payments make up less than 33 per cent of their gross margin. High-payments-dependent farms are defined as those where over 66 per cent of their gross margin coming in the form of direct payments. The efficiency of both the low-payments-dependent contact farms and the high-payments-dependent contact farms is measured relative to contact farms with an average dependence on direct payments. The level of farm efficiency is found to be higher than average on contact farms with very low dependence on direct payments. In contrast, the level of farm efficiency on contact farms with very high dependence on direct payments is lower than on contacts farms with an average dependence on these payments. The level of efficiency on the latter farms is, however, still higher than on farms with no extension contact.

Claiming eligibility for direct payments can be as important as improving production efficiency in maximising farm income. It may, therefore, be rational for a high-payments-dependent farmer to accept a higher level of technical inefficiency in order to meet the qualifying conditions for direct payments. It is likely that this group would seek advice from the advisory service mainly on the eligibility criteria for direct payments. The low-payments-dependent farmers may make more use of the farm advisory service to improve productive efficiency.

The coefficients on the explanatory variables give an indication of the direction of the effect of each variable on technical efficiency. By differencing each of the explanatory variables in the efficiency model with respect to the technical efficiency predictor it is possible to calculate the marginal effect of each of the efficiency variables. The marginal effects give an indication of the quantitative impact of each variable on efficiency and are shown in Table 5. The size of the effects is valid only for small changes. They should, therefore, not be extrapolated to large changes in the explanatory variables.

Table 5
Marginal Effect of a One Unit Change in Each Factor (%)

	Percentage change in efficiency
Age of farm operator (one year increase)	0.00004
Farm is located in the West of Ireland (relative to farms in the East)	-0.69*
Share of direct payments in gross margin (one percentage point change in the ratio)	-0.04*
Household size (one additional person)	0.04
Size of farm 25-36ha	-1.35*
Size of farm 36-60ha	-1.54*
Size of farm 60+ha	-2.22*
Debt ratio to assets (one unit change the ratio)	1.11*
Farm operator has an off farm job (relative to no job)	0.04
Education level of farm operator to Junior Cert. (relative to primary only)	-0.16
Education level of farm operator to Leaving Cert (relative to primary only)	0.52
High dependency on direct payments and contact with the advisory service (relative to the medium dependency farms)	-1.90*
Low dependency on direct payments and contact with the advisory service (relative to the medium dependency farms)	6.56*
Interaction of education level and contact with the advisory service (relative to primary education and contact)	-0.87
Contact with the farm advisory service (relative to no contact)	6.47*

*Statistically significant at 1 per cent level

Being located in the West of Ireland is associated with an average decrease in efficiency of less than 1 per cent. Larger farm size is associated with a steady decrease in efficiency. Though statistically significant the effects are not quantitatively important. Relative to farms less than 25 hectares in size, the very largest farms of 60+ ha are just 2 per cent less efficient in their use of resources. The effect of both junior and leaving certificate education level relative to primary education does not have a statistically significant impact on the efficiency level. Receiving direct payments has a negative impact on efficiency; farms with a share of direct payments 25 percentage points greater than average are, on average, 1 per cent less efficient.

Contact with the extension service increases efficiency by 6.5 per cent relative to farms with no contact. Since the extension contact variable covers contact with Teagasc advisors only, it is possible that non-contact farms may have contact with private consultants. This suggests that the impact of advisory contact per se may be greater than reported here. The interaction between the level of education and extension contact is found to be statistically insignificant. Farms in contact with the extension service and with a lower than average dependency on direct payments were on average a further 6.6 per cent more efficient. Farms that are highly dependent on direct payments and have contact with the extension service are 1.9 per cent less efficient than contact farms with an average dependence on direct payments. Nonetheless, even this group of farms are, on average, more efficient that those farms which had no extension contact whatsoever.

Policy Implications

This report summarises work using a panel data set of Irish farms to ascertain the levels of technical efficiency and technical change and to examine whether levels of technical efficiency on farms are influenced by contact with the extension service. The results suggest that, on average, farms achieve around 65 per cent of the efficiency level of best practice farms within the system they are in. Comparing farms with best practice within the agricultural sector as a whole does not radically change this result. This suggests that there is considerable scope for improvements in efficiency levels leading either to increased output or cost savings.

Measured by the shift in the frontier of best practice farms, an average annual improvement of 0.9 per cent took place in the rate of technical change over the period 1984-98. Because the average level of farm efficiency has been decreasing by 0.4 per cent per annum overall productivity growth has been slower than this. In the short-term, extension work to halt the decline in average efficiency levels could have a high pay-off. There was also evidence that the rate of technical change has been slowing down over the period. This has serious implications for the future competitiveness of Irish agriculture. It warrants further investigation into the resourcing and priorities of the research effort.

The negative relationship between a farm's dependence on direct payments and efficiency is noteworthy. Significant direct payments are made to cattle, sheep and cereal producers but support to dairy farmers continues to be provided entirely through market price support. However, because efficiency is measured relative to best practice within each system, the dependence on direct payments variable is not simply picking up the more efficient use of resources by some farming systems. Rather, it appears to reflect the fact that eligibility for payments may require a farmer deliberately to pursue technically less efficient production practices (such as is required to qualify for REPS or extensification payments). There is an evident tension between short-run income support or environmental objectives and long-run competitiveness.

The changing role of the extension service, in a situation in which direct payments now make up a high proportion of income for the majority of farmers, was also explored. Contact with the extension service is shown to increase the average level of farm technical efficiency. However, the size of this impact depends on the relative importance of direct payments to the farm. The impact of the extension service was much greater on farms with a lower than average dependence on direct payments. These low-payments-dependent farms seem to be using the extension service for productivity-oriented advice. On the other hand, contact farms with a very high dependence on direct payments were, on average, less technically efficient than other contact farms. It appears that these farms are using the extension service mainly for assistance in maximising direct payments, sometimes at the expense of technical efficiency. Even for these farms, however, efficiency was higher, on average, than on farms who had no contact at all with the extension service.

These findings have important policy implications. The positive association between dependence on direct payments and farm technical inefficiency suggests that reform of EU agricultural policy is encouraging a less competitive agricultural sector. Will the sector, therefore, find it more difficult to face up to the more market-oriented policy regime which may result from WTO negotiations on agricultural trade liberalisation? Indeed, it may be that the high dependence on direct payments not only raises inefficiency but also slows down the take-up of technical innovations and is thus responsible for the decreasing rate of technical change over time. On the other hand, there are environmental benefits arising from the more extensive farming methods encouraged by the present policy. Quantifying the negative effects on agricultural productivity and the positive effects on the environment of the direct payments regime are important issues in assessing the overall benefits to Ireland from the operation of the EU's Common Agricultural Policy. It should, however, be emphasised that neither hypothesis has been explored in this study.

The positive association between extension contact and technical efficiency suggests that there is a high pay-off to extension advice. We have not attempted to estimate a benefit-cost ratio to public extension expenditure in this project. The fact that over three-quarters of all eligible commercial farmers have signed up to participate in the Farm Tech Service offered by the extension service suggests that this advice is valued by them. On the other hand, it is clear that many farmers now rely on the extension service for advice and assistance in applying for direct payment supports. Comparing farms with extension contact, technical efficiency is lower on farms with a higher than average dependence on direct payments. Nevertheless, efficiency is higher on the former group of farms than on farms with no extension contact. This suggests that there is a positive productivity benefit from extension contact even where the primary purpose of this contact is assistance with qualification for direct payments.

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Papers and publications arising from this work.

The technical details of the methodology on which these findings are based can be found in the following publications and conference presentations.

Publications

O'Neill S., Matthews, A. and Leavy T. "Farm technical efficiency and extension" ***Trinity Economic Paper***, No.12, 1999.

Papers in Preparation

O'Neill S. and Matthews A."Farm Efficiency and Technical Change". Submitted to journal.

O'Neill S. and Matthews A. "Does Contact with the Extension Service Improve Farm Efficiency?" Submitted to journal.

Conference Papers

O'Neill S., Matthews A. and Leavy T. "Measuring the rate of return to agricultural research and extension using an unbalanced panel of Irish farms", ***North American Productivity and Efficiency Workshop***, June 2000.

O'Neill S. "Measuring the Rate of Return to Agricultural Research and Extension Farms using Farm Level Data", ***The Agricultural Economics Society Conference***, University of Manchester, April 2000.

O'Neill S. and Matthews A. **"**Measuring the Rate of Return to Agricultural Research and Extension using a Panel of Irish Dairy Farms**",** *Irish Economics Association Conference***,** March 2000.

O'Neill S. and Matthews A. "Evaluating extension impact: a stochastic production function analysis", ***European Association of Agricultural Economists Conference***, August 1999.

O'Neill S., Matthews A. and Leavy T. "Measuring the rate of return to agricultural extension expenditure", ***Irish Economics Association Conference***, April 1999.

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O'Neill S., Matthews A. and Leavy .T "Measuring the rate of return to agricultural extension expenditure: a cross sectional analysis", ***Teagasc Walsh Fellowship Day***, February 1999.

Seminar Papers

O'Neill S. and Matthews A, and Leavy, T. "Does contact with the extension service improve farm efficiency?", ***Invited paper at the Permanent Seminar of Productivity and Efficiency, Department of Economics***, University of Oviedo, Spain. November 2000.

O'Neill S. "Measuring the rate of return to agricultural extension expenditure: a stochastic frontier approach", ***Agricultural Economics Society of Ireland Young Researchers Workshop***, April 1999.

O'Neill S., Matthews A. and Leavy T. "Methodological issues when using matched samples from the National Farm Survey", ***Rural Economy Workshop, Teagasc***, February 1998.

O'Neill S., Matthews A. and Leavy T. "Farm performance over time", ***Rural Economy Workshop, Teagasc***, February 1998.