Economic performance and drivers of efficiency in the Irish crops sector (2011 – 2019)

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Abstract

Whilst extensive analyses of the performance and drives of efficiency have been conducted for the Irish dairy sector in recent years, particularly in the run up to quota abolition, analogous studies of the Irish crops sector have been lacking. The statistical analysis of farm level data and use of efficiency models, using data from the Teagasc, National Farm Survey, in this study has indicated the importance of a range of farm and farmer, socio-economic variables in the determination of farm level performance.

Key Words: Economic sustainability, farm performance, cost efficiency, crop production

Introduction

The tillage sector plays an important role in the Irish agri-food sector, by means of the economic output produced, input spend in the wider rural economy, provision of inputs for the livestock sector, and contributing to rural employment. According to Wallace (2020) the wider tillage sector contributes over €1.3 bn per annum to Irish economic output, supports 11,000 full-time equivalent jobs, spends an estimated €423m per annum on inputs and invests about €54m per annum on machinery, buildings and land improvements. In terms of land area devoted to crops in the tillage sector and the gross output in economic terms, cereals are the dominant crop over the recent past. In recent years, about three quarters of the country's area devoted to crops is accounted for by cereals (CSO, 2017-2019), with a total output value of €224 million in 2020.

Whilst partial productivity indicators for the Irish cereal sector have shown to be very high in the international context (Thorne, 2017), there is mounting evidence that the average Irish (and EU) cereal yield is expected to increase only very slowly in the medium term (Kelly, 2019) .There are various reasons cited for this apparent yield stagnation, including technological advancements which have evolved to an extent that outputs are close to the theoretical frontier achievable yields. The evolution of EU agricultural policies have also been cited as having a

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stagnating effect on attainable yields, due to the decoupling of direct payments which has a theoretical potential to lower demand for direct inputs. Furthermore, the EU stance on technologies such as GM, gene editing and the limitation of certain active ingredients used in plant protection are theoretically cited as having a potential negative impact on yield advancements (Kelly, 2019).

In the national context, competitiveness concerns for the sector are also borne out by the trend in income across sectors, with the relative income on Irish dairy farms increasing considerably in the past two decades. Total cereal area has also been decreasing, in a time when there is an increased demand for concentrate feeds, which is been met by increased cereal imports. Improving technical efficiency at farm level thus has become a matter of concern for the tillage farming sector in Ireland. The concerns regarding competitiveness (and efficiencies) in the sector have been reflected in various national policy documents such as FoodWise 2025 and Ag Climatise, with the ambition to introduce targeted support measures to '*increase the area under tillage above the current area of 300,000 ha's*.

In response to these competitiveness concerns this paper examines seeks to examine the (i) the trend in key farm performance indicators within the sector (ii) a particular focus on technical efficiency levels and (iii) determination of the factors affecting technical efficiency. The focus on technical efficiency and drivers of efficiency is considered appropriate given that technical efficiency is considered to be a principal driver of competitiveness (Latruffe, 2010). This empirical approach will help to guide policy aimed at improving the income and thus the viability of cereal farmers, since knowing the main drivers of efficiency will help decision makers to improve farmers' efficiency and ultimately economic viability.

The remainder of the paper is organized as follows. Section 2 presents the background to the Irish cereal tillage sector, for readers unfamiliar with the Irish agricultural sector, with a brief outline of sector's characteristics and notable economic trends over the last two decades, paying particular attention to the last ten years. Section 3 presents the theoretical background of efficiency analysis and its determinants, along with a review of empirical applications of stochastic frontier analysis in the cereal sector. Section 4 describes the data and the models used for our sample of Irish cereal producing farms. Section 5 presents and discusses the empirical results, and Section 6 concludes with policy implications.

2. Background to the Irish cereals sector

2.1 Structure of the Irish cereals sector

The Irish cereal sector has undergone significant change in recent years. While traditionally the cereals has always played a prominent role in terms of its contribution to the primary agricultural sector, its relative importance has declined considerably. For example, in 1980, there were 444.8 thousand hectares of cereals grown in the country, which declined to 181.1 thousand hectares in 2020, representing an annual average decline of 4,500 hectares over the forty year period (Figure 1).

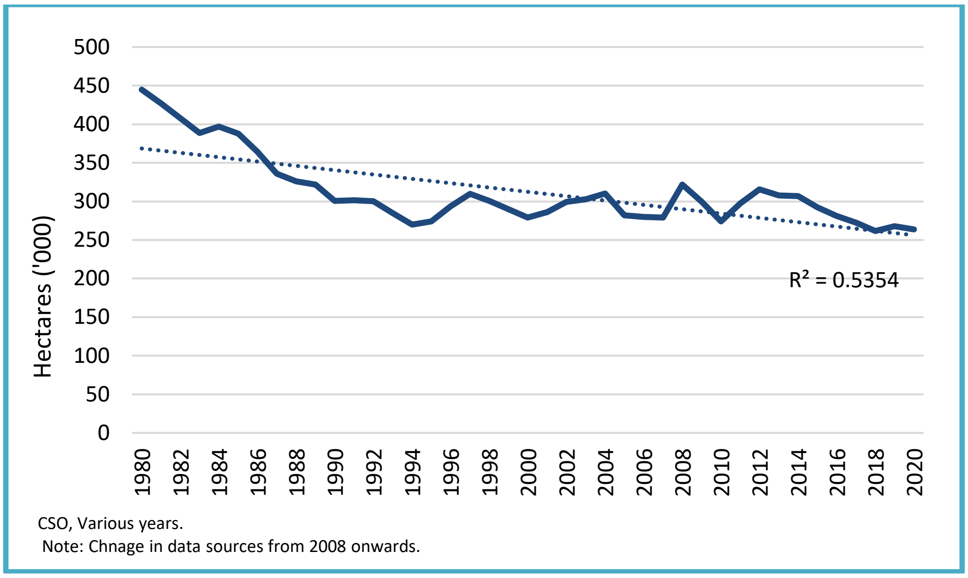

Figure 1: Total Cereal Area Farmed (hectares) 1980 – 2020

Declines are also observed in the total number of specialist tillage farms, but the level of detail on number of farms growing cereals is less extensive and detailed. Between 1991 and 2010 the number of farms growing cereals declined by over 50 percent, compared to a reduction in the area of cereal crops of 15.5 percent over the same period (Wallace, 2020). However, it is apparent that despite the decrease in cereal area and farms growing cereals the data outlined in Figure 2 shows that total cereal production volume has not declined over the recent past. Over the period 1985 to 2019, linear growth in national cereal volume was 15,000 tonnes/year.

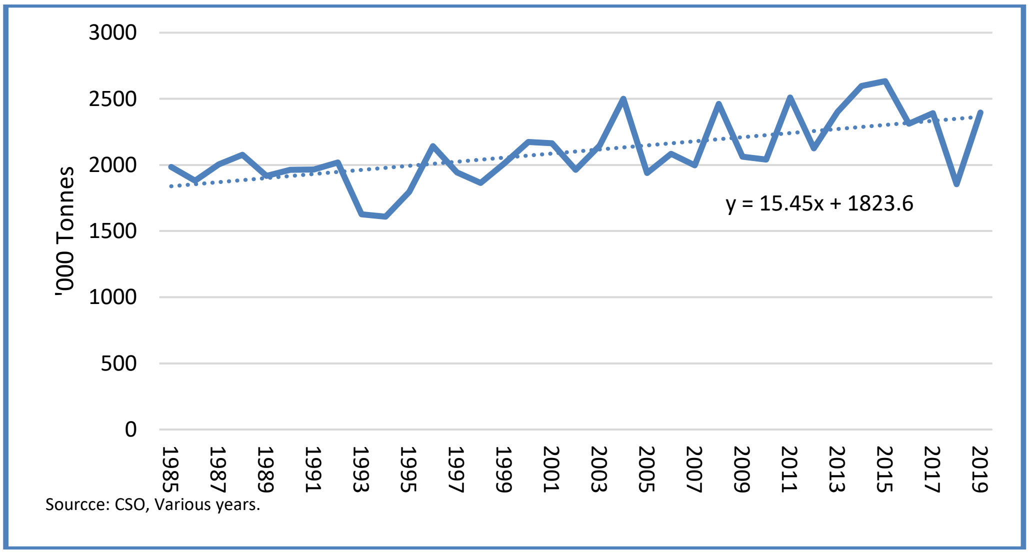

Figure 2: Total Cereal Production Volume (1985 – 2019)

This growth in cereal volume over the past two decades can be explained by the growth in winter cereal crops and yield improvements per hectare. These increases in national cereal production however did not keep pace with demand, with the shortfall in feed ingredients for livestock purposes supplemented by increases in net imports of feed cereals (Figure 3).

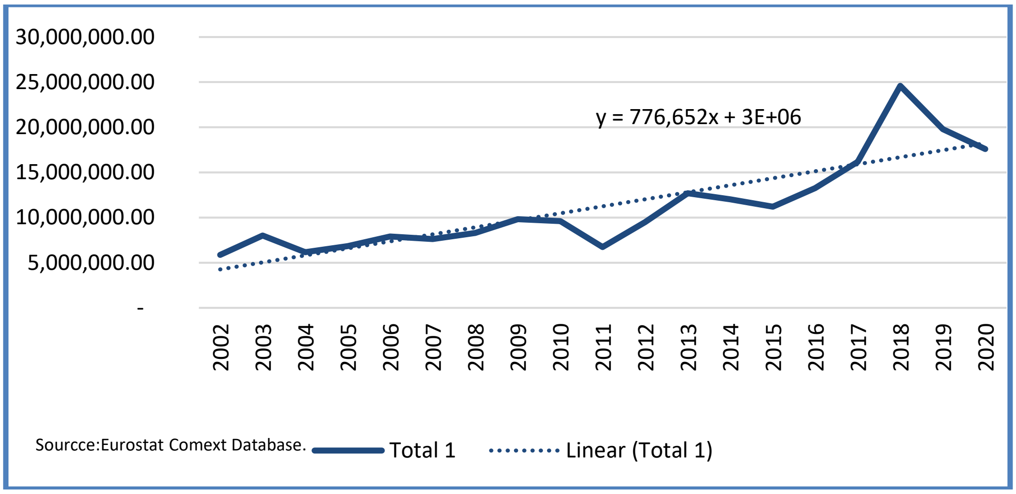

Figure 3: Total Cereal Imports (2002-2020)

2.2 Economic Performance of the Irish cereal sector

An analysis of recent data from the Teagasc, National Farm Survey (NFS) shows that specialist tillage farms[2] have outperformed the average farm, as defined by the Teagasc, NFS, but in second place to specialist dairy farms, based on family farm income indicators on a per farm and a per hectare basis. The divergence between dairy farms and all other farms in income terms has become more pronounced since quota abolition (and the preceding soft landing period where dairy farms had some opportunity to increase scale before abolition) , where the potential to increase scale (and income) has benefited dairy farms (Figure 4).

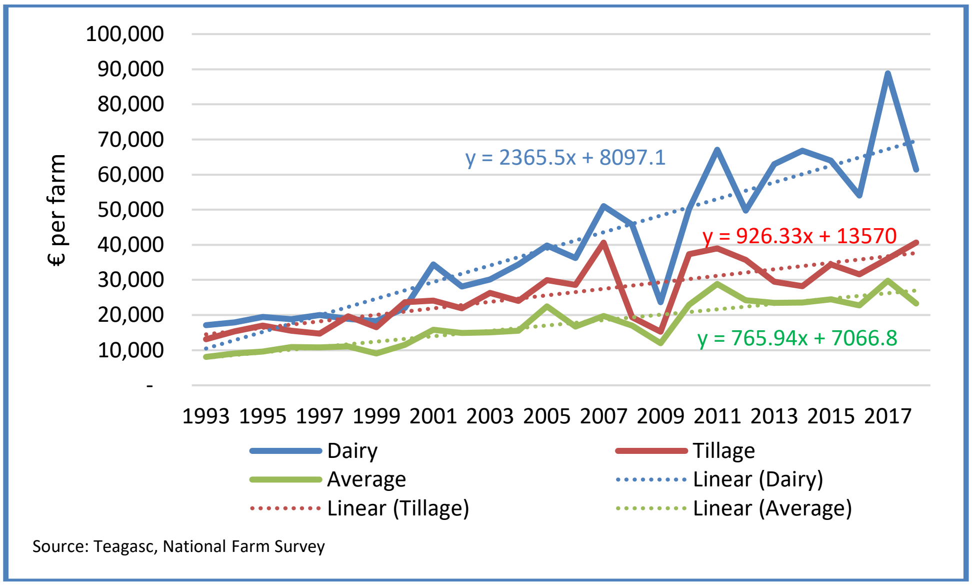

Figure 4: Family farm Income per farm (1993-2019)

The data in Figure 4 clearly shows a divergence in relative income in more recent years and highlights the competitiveness issue which affects cereal/tillage farmers in Ireland. These competitiveness issues are particularly acute for specialist tillage farms that rely on the land

[2] Specialist tillage farms are defined according to the proportion of the total standard output of the farm which comes from the main enterprises, including EU classifications: 151, 833, 834, 161 and 166.

rental market to achieve economies of scale, with increasing competition from neighbouring dairy farms, with heightened ability to pay higher land rental rates in the local market.

The ability of Irish grown cereals to compete against the increasing volume of imported feed grains is only to some extent impacted from domestic conditions affecting competitive ability, but also affected by competiveness on international markets. Hence, it is interesting to compare the ability of Irish cereals to compete with international cereal production. Here we use data from the European Commissions Farm Accountancy Data Network to examine the competitive performance of Irish cereal production against key competitors in the EU. Figure 5 shows the total costs as a percent of output for specialist cereal, oilseed and protein farms across a range of EU MS's for 2018, the latest available data, which places Ireland in the most competitive position across all EU countries, with the lowest costs as a percent of output. This finding is consistent with previous reviews of competitive performance of cereal production across EU countries, which have also found that using costs as a percent of output as an indicator of competitive performance, places Irish cereal producers in a strong position (Thorne et al., 2017; Thorne et al;., 2007).

The contradiction between the competitive performance of Irish cereal producers on the domestic landscape on one hand is increasingly at odds with the performance of the sector outside of Ireland, as witnessed from the data described so far. The intra country competitive performance of the cereals sector is lagging significantly behind the expanding dairy sector, whereas the inter country data portrays a positive story for the Irish cereal sector. Notwithstanding the positive indicators from the inter country analysis, the competitive pressures on the domestic scene are a cause for concern for the continued viability of the sector. Thus far, average figures have been used to examine the structure and relative performance of the sector, but evidence from Thorne (2020) has shown that there continues to be significant variation in the performance of the sector across farms. Further analysis of the drivers of performance is warranted if the scope for improvements in performance are to be maximized and provide improvements in efficiencies for a sector which is under significant competitive pressure on the domestic market. An outline of previous empirical studies which have examined the drivers of efficiency of the crops sector, nationally and internationally is outlined in the following section.

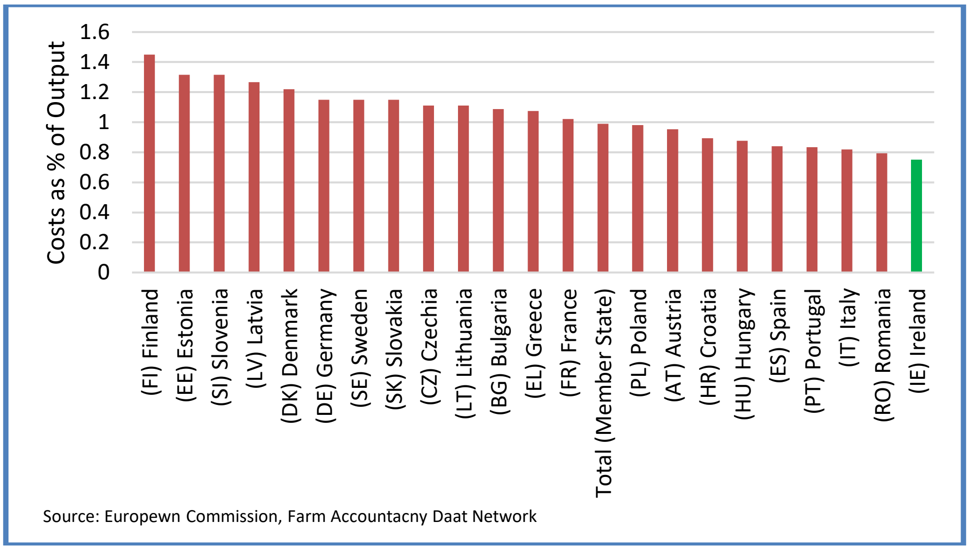

Figure 5: Costs percent of output on specialist cereal, oilseed and protein farms (2018)

3. Literature review

3.1 Technical efficiency measurement

The estimation of technical efficiency in the empirical literature follows two separate approaches– Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Both approaches follow the seminal paper by Farrell (1957) which defines a production frontier which is estimated in order to obtain a measure of firm efficiency. The production frontier represents the maximum level of output (or minimum level of input) for a group of firms and calculates inefficiency of individual firms as the potential proportional gain in output (or reduction in input) to the previously specified frontier. The DEA approach is a deterministic method which means that it does not take into account any stochastic components or statistical noise within the data. In the DEA methodology any deviation from the frontier output is assumed to represent inefficiency. This is often seen as a drawback when using farm level data given that such noise is considered to be very 'noisy' , which has the potential to bias inefficiency estimates (Irz and Thirtle, 2004; Zhu and Lansink, 2010). Hence, the SFA approach was taken for the purpose of examining technical efficiency in crop farms in Ireland.

Unlike the DEA approach, SFA accounts for statistical noise in modelling of stochastic frontier and the calculation of technical inefficiency. In the SFA approach, which follows the initial work of Aigner et al. (1977) and Meeusen and Van den Broeck (1977), the production function expresses output as a function of inputs, as in a normal production function, but also a random error component and a one sided technical inefficiency component, the latter of which captures deviations from the frontier. One potential shortcoming of the SFA approach which is often cited in the literature is that it requires the researcher to specify the functional form of the model, which has many different suggestions in the literature.

Underlying both the DEA and SFA methods is the assumption that inefficiency is due to management inadequacies, but in a production function specification if unobserved farm and/or farmer specific factors are not controlled for, the estimates could be considered biased. It is for this reason the drivers of inefficiency, apart from the traditional list of inputs, are examined in further detail in this paper.

3.2 Determinants of technical efficiency

A review of the literature provides a large number of empirical studies which have examined a range of farm and farmer factors which affect technical efficiency levels, with these range of factors in addition to the traditional agronomists view of the factors affecting efficiency limited to environmental and biophysical factors (Lobell et al., 2009; ZHOU Wen-bin et al. (2021). In terms of farm characteristics that have been employed in previous studies, the most common variables include: farm size, specialisation, location, debt level, subsidy type and reliance and organisational structure. The most common farmer variables employed in previous studies include: farmer education, off-farm employment status, household size, and contact with extension agents.

Kumbhakar, Biswas and Bailey (1989) found that farm efficiency increases with farm size and farmer education. Alvarez, Arias and Orea (2006) found that efficiency increases with higher specialisation rates. Hadley (2006) examined the effects of a large number of potential farm variables for separate farm types in the UK and found that technical efficiency levels were positively affected by low debt to asset ratios, high subsidy to gross margin ratios, high owner occupation rates and low levels of specialisation.

Ogandari (2013) also examined the impact of a range of socio-economic factors on technical efficiency levels on a sample of crop farms in Nigeria and found that crop diversification, had a positive impact on technical efficiency levels. Tipi et al., (2009) examined the determinants of technical efficiency on a sample of rice farmers in Turkey and found that number of plots, negatively influenced technical efficiency, whereas farm size and membership of a cooperative showed a positive relationship with technical efficiency.

The impact on efficiency of various subsidy types and reliance is varied within the literature (Cillero et al., 2017). Lambarra et al., (2009) found coupled payments had a negative impact on technical efficiency, which they say is compatible with reduced motivation to produce efficiently. Zhu and Lansink (2008) found that decoupled subsidies had positive impacts on the technical efficiency in a number of case study countries, whilst there was evidence in some situations that coupled subsidies had a positive impact on efficiency. Mixed results were obtained in Latruffe et al (2012) in relation to the impact of decoupled subsidies on efficiency. Cillero et al., (2017) found that decoupled payments had a positive impact on farm efficiency.

Much emphasis has also been placed on the characteristics of the 'farmer' in the empirical literature, and its impact on technical efficiency. The effect of farm operator age on efficiency has been extensively examined, with varying results (Battese & Coelli, 1995, Mathijs & Vranken, 2000, and Bozoğlu & Ceyhan, 2007), with results depending on how age was captured in the analysis, the sample used and time period examined.

Education has mostly been found to have a positive effect on technical efficiency, as evidenced by studies such as Weir (1999) and Mathijs and Vranken (2000). Whilst there appears to be a positive relationship between education and efficiency there too also tends to be a threshold that implies that a certain number of years of schooling are required to at least four years of schooling are required to lead to a significant effect on farm level technical efficiency.

Finally, off-farm employment status has been found to be significantly significant in the determination of technical efficiency at the farm level. Brummer (2001) noted that full-time farmers were more technically efficient than those involved in part-time farming.

In a more specific Irish context, O' Neill and Matthews (2001) explored the variables that affect the efficiency of Irish agriculture in aggregate and found that higher efficiency levels were associated with farms in the east of the country, larger household size and higher debt levels. O'Neill and Matthews (op cit) found that having an off-farm job and larger farm size were negatively associated with technical efficiency levels. Additional Irish based studies by Boyle (1987) and O'Neill, Matthews and Leavy (2002) found that contact with the advisory service was associated with higher levels of technical efficiency. With specific reference to the Irish crops sector the micro analysis of determinants of efficiency are limited, with Carroll et al., (2007) the only relevant study to report. In this analysis six explanatory determinant variables were examined: use of the extension service, the presence of an off-farm job, the farm size, age of the farmer, the degree of specialisation and the effect of decoupling. Of the six efficiency variables examined, only farm size and the degree of specialisation were found to be significant. The coefficient for farm size was negative and significant which implies that larger Irish crop farms are more efficient. In addition, more specialised cereal farms were also found to be more efficient.

4. Methods

4.1 Technical Efficiency estimates using Stochastic Frontier Analysis

The SFA model which was required in this analysis necessitated the incorporation of inefficiency drivers, which was an objective of the research. Wang and Schmidt (2002) highlighted the importance of selecting a model which allowed the one-step incorporation and estimation of inefficiency drivers. Kumbhakar and Knox Lovell (2000) provides a comprehensive overview of panel data models in the literature that examine how observed exogenous factors affect technical inefficiency. The selection of the appropriate model was guided by the need to select a model that identified the drivers of efficiency in a one stage process. Following Martinez Cillero (2017) the generalisation of the Battese and Coelli (1992) panel data specification was adopted.

A translog functional form was the chosen specification for the production function, since it provides a flexible representation of the production technology:

$$\ln Yit = \beta o + \sum_{k-1}^{K} \beta k \; lnXit + \frac{1}{2}\sum_{k=1}^{K}\sum_{g=1}^{G} \beta gk \; lnXik + \delta tT + vit - uit. \qquad (1)$$

In equation (1) Yit represents farm specific output from crop farms producing spring barley, Xit is a vector of k inputs and t is a time trend that accounts for technical change. Even though Irish crop farms generally produce many outputs, the use of just one output was chosen for two reasons: (i) the objective of the analysis was to focus specifically on the spring barley crop, the biggest crop in land terms in Ireland and (ii) in order to eliminate the problems caused by zero values which cannot be handled in the translog functional form. A composite error term is also included in equation (1), where vit is a producer specific error term that captures effects of random shocks and uit is the inefficiency term.

The individual specific inefficiency is calculated as the conditional expectation of uit given the estimated composed error vit- uit, according to Jondrow et al., 1982, and as shown in equation (2).

$$uit = E[uit|vit - uit] \qquad (2)$$
$$TEit = \exp(-uit).$$

As mentioned earlier the SFA method originally employed by Battese and Coelli (1992) for panel data was employed in this analysis.

$$uit = [\exp(njZjit)]*Ui \qquad ` \qquad (3)$$
$$Ui\sim(0, \delta^2{}_{u}).$$

Equation (3) shows that Ui represents a time invariant firm effect, Zit is a vector of j farm characteristics that are hypothesised to affect inefficiency plus a time trend and ηj are parameters to be estimated.

The estimation of the parameters of equations (1-3) are jointly carried out using maximum likelihood procedures in LIMDEP for the analysis.

4.2 Data

Data from the Irish Teagasc, National Farm Survey (NFS) was used in this analysis. In the survey, each animal and hectare of crop are assigned a standard gross output and farms are then grouped into systems according to the dominant enterprise. Farms are selected, according to system and size, so as to attain a representative sample of the farming population, according to size and system, in Ireland. In this paper the analysis was not confined to specialised systems of production, rather all farms producing the crop spring barley were included. Teagasc, NFS data on farms producing a crop of spring barley are employed for the 9 year period 2011 through 2019. Although only farms producing spring barley have been selected for analysis, the majority of farms are also involved in either or a number of other sectors. Where inputs are not explicitly assigned in the data (for example, capital, labour and machinery operating costs), they are allocated according to the crop enterprise according to the proportion of gross output that is attributable to spring barely (i.e. the proportion of total gross output that can be attributed to the crop enterprise), similar to Carroll et al., 2008; Kazukauskas et al., 2010 and Martinez-Cillero et al., 2017.

All monetary figures are deflated according to annual Irish agricultural price indexes which are available from the Irish Central Statistics Office. The exact calculation of inputs and outputs are outlined in Appendix A while descriptive statistics

The output variable used in the estimate of the production frontier in this analysis represents the output spring barley. Annual output therefore equals the sales from the spring barley crop. The input variables used include: direct costs of production, including seeds, fertilisers, crop protection costs, machinery hire and operating expenses. In addition to direct costs, variables relating to land, labour and capital are also included. The Teagasc, NFS, records the number of mandays expended on the farm during the year, which is then allocated to the crop enterprise, based on the proportion of crop output methodology explained previously. Total land used to grow spring barley is recorded and used as the land variable. Finally, the capital variable used is the value of machinery and buildings (as estimated by the farmer), and allocated to the crop enterprise, based on the proportion of crop output methodology.

In addition to the standard output and input variables specified for use in the production frontier, it was also necessary to identify farm and farmer variables assumed to be drivers of technical efficiency. The share of total farm receipts received as a coupled/decoupled payment is used to identify whether the reliance on direct payments is a determinant of technical efficiency. The share of crop area in total farm land area is included as a proxy for the effects of specialisation on technical efficiency. Two variables capturing the effects of farmer's characteristics on technical efficiency are also included, the age of the farm operator (and the squared term) and a dummy variable reflecting the off-farm work status of the operator are also included. In order to identify the effects on technical efficiency of farmers' management skills, two dummy variables that capture the effects of the use of different kinds of advisory services (annual advisory contracts or scheme specific assistance) are included. Descriptive statistics for all variables included in the production function and in the inefficiency effects model are provided in Table 1.

The dataset employed is quite unbalanced – in total, the final samples consist of 838 observations (representing 170 individual farms) for the nine year period. .

Table 1: Descriptive statistics

	Spring Barley farms
Crop Output (€)	11253.01 (9242.263)
Direct Costs (€)	13354.44 (10540.54)
Capital (€)	17792.6 (19040.32)
Labour (labour units)	2274429 .(1803238)
Area (hectares)	13.56929 (10.46368)
Direct payments (share of gross output)	.2153001 (.0758585)
Age (years)	57.96774 (11.44795)
Age squared	3491.158 (1338.383)
Off farm employment (D)	.1198222 (.3249475)
Advisory contact (D)	.7159379 (.4512358)
Specialisation (share)	.1689216 (.1498742)

Notes: (D)
Indicates a dummy variable. Means are provided, standard deviations are in parentheses. Monetary values (€) are expressed in 2010 prices.

5. Results

5.1 Technical Efficiency Estimates

Table 2 outlines the parameters from the production frontier, for spring barley producers, over the period 2011 to 2019. All elasticities in the main production frontier model are as expected from the literature, positive and statistically significant. Area and direct costs demonstrated the highest elasticities, meaning they have the largest contribution to output levels. In comparison, the two other inputs, labour and capital have a substantially smaller contribution to output production.

Returns to scale are calculated by summing the output elasticities. Average decreasing returns to scale (i.e. below 1) are observed for the spring barley crop. This indicates that on average farms producing spring barely over the period operate under decreasing returns to scale, implying that potential productivity gains can not be obtained by further increasing farm size (Coelli et al., 2005). Such a finding could be linked to the small scale of cereal farm operations in Ireland compared to the international context. It is interesting to note that Carroll et al., previously found increasing returns to scale for an earlier time period whilst examining efficiency and productivity on specialist tillage farms.

The time component included in frontier models measure the movement of the frontier over time. The sign on the time variable in the model indicts positive movements in the frontier over the time period, but at a decreasing rate, which is consistent with the findings from earlier in the paper, where yield improvement were shown to take place but at a decreasing rate. The coefficient of the time trend is interpreted in the literature as capturing the annual rate of linear technical change, which is indicative of the change in output due to change of time, holding all other inputs constant (Heshmati, 1996). The average annual technical change rate was 6% between 2011 and 2019 for spring barley producing farms, which indicates technical progress. Technical progress was previously found Carroll et al., (2007) for Irish specialist tillage farms.

Table 2: Production frontier parameter estimates

	Spring barley
Constant	
Area	.557798*** (.844273E-14)
Labour	.949383E-01*** (.168022E-14
Capital	.537435E-01*** (.109006E-14)
Variable costs	.204238*** (.288830E-14)
Returns to Scale	.910718 (.127752E-13)
Technical Change (full period)	1.39937 (2.57698)

Notes: Standard errors are in parentheses. *Significant at 10%; **Significant at 5%; ***Significant at 1%. (D) Indicates a dummy variable.

Following on from the elasticity data presented in Table 2, the mean technical evidence score over the time period outline din Table 3 shows that mean technical efficiency levels were . 79 over the time period. Alternatively, inputs could be reduced by 21% on average to produce the same quantity of barley output. This level of efficiency compares well with previous estimates for cereal farms in Ireland, with Carroll et al., (2007) estimating that technical efficiency was between 63 and 74 percent depending on the method employed.

Table 3: Descriptive Statistics for Technical Efficiency on Spring Barley Farms, 2011- 2019

	Mean	**Std. Dev.**	**Minimum**	**Maximum**
Technical efficiency	.785080	.138626	.247224	.979635

5.2 Drivers of technical Efficiency

A number of iterations of the model were considered, with alternative variables included as determinants of technical efficiency. However, failure of the models to converge was a big issue with a number of variants of the model. In the final specification of the model considered the variables includes as determinants of technical efficiency include: the use of the extension service, the presence of an off-farm job, age of the farmer, and the degree of specialisation. and the effect of decoupling. The results are presented in Table 4 below.

Table 4: Spring Barley Results for Battese and Coelli (1992) Maximum Likelihood Efficiency Effects Model

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Primary Index Equation for Model					
Constant	.15163873	.03458070	4.385	.0000	
Area	.55779815	.04007424	13.919	.0000	.297136D-07
Labour	.09493829	.02346923	4.045	.0001	.119332D-09
Capital	.05374352	.01408727	3.815	.0001	-.823389D-08
Direct costs	.20423772	.04387691	4.655	.0000	-.284010D-07
Area*Area	.12945843	.09529354	1.359	.1743	.34931453
Area*Labour	.19898332	.05402564	3.683	.0002	.55017897
Area*Capital	-.00273755	.03354838	-.082	.9350	.63860366
Area*Direct	-.27114436	.10490872	-2.585	.0097	.68521803
Labour*Labour	-.16944709	.03076644	-5.508	.0000	.39690496
Labour*Captial	-.02551612	.01219105	-2.093	.0363	.70598558
Labour*Direct	-.09581583	.05543810	-1.728	.0839	.57498674
Capital*Capital	.01481856	.01033851	1.433	.1518	1.16424653
Capital*Direct	.00112311	.03987103	.028	.9775	.68584710
LNDCDC	.38632748	.15543387	2.485	.0129	.36775512
Time	.05729903	.01296949	4.418	.0000	4.37470167
Time*Time	-.00989903	.00262109	-3.777	.0002	12.9534606
Variance parameters for compound error					
Lambda	1.15015404	.14817604	7.762	.0000	
Sigma(u)	.20039155	.00412844	48.539	.0000	
Coefficients in u(i,t)=[exp{eta*z(i,t)}]*|U(i)|					
AGE	01768777	.00460161	3.844	.0001	
ADV (D)	-.21872082	.11307361	-1.934	.0531	
OFF (D)	.30661946	.25000435	1.226	.2200	
SPEC1	-2.86182057	51845659	-5.520	.0000	

In terms of interpreting the results from the inefficiency effects model it is important to remember that the model captures the relationship between individual determinant variables and inefficiency. Hence a negative sign on a co-efficient is interpreted as a positive relationship with efficiency.

Of the four efficiency inputs, three of the four inputs were statistically significant, age, contact with an advisory agent and specialisation. The presence of an off-farm job was not significantly correlated with cereal farm efficiency levels.

The coefficient for farmer age size was positive and significant which implies that older farmers were more inefficient (or younger farmers were more efficient). It is interesting to note that Carroll et al., (2007) did not find a significant relationship between age and technical efficiency on crops farms. In terms of specialisation it was found that cereal farms with a higher proportion of cereal gross output to total gross output (higher degree of specialisation) were more efficient, which is line with Carroll et al., (op cit) and Iraizoz et al., (2005) but at odds with Hadley et al., (2007) where more specialised farms were found to be less efficient in England.

The dummy variable capturing the effect of contact with an extension agent was negative, implying a positive relationship with technical efficiency. Hence, those spring barely farmers that had contact with an extension agent tended to be more technically efficient. It is however important to note that no account was taken in the model for the need to allow for selection bias in extension service contact. If the more efficient farmers are those that are more likely to make contact with extension agents then the coefficient measuring the relationship between efficiency and extension contact will be biased by this self-selection behaviour.

6. Conclusions and Implications

The aim of this paper was to examine the economic performance and drivers of technical efficiency on crop farms over the past decade in Ireland. The results indicated that there was a contradiction between the competitive performance of Irish cereal producers on the domestic landscape on one hand which is increasingly at odds with the performance of the sector outside of Ireland. The intra country competitive performance of the cereals sector is lagging significantly behind the expanding dairy sector, whereas the inter country data portrays a positive story for the Irish cereal sector. Notwithstanding the positive indicators from the inter country analysis, the competitive pressures on the domestic scene are a cause for concern for the continued viability of the sector. Further analysis of the drivers of performance was considered timely if the scope for improvements in performance are to be maximized and provide improvements in efficiencies for a sector which is under significant competitive pressure on the domestic market.

The results from the technical efficiency analysis showed that resources at the farm level were used in a sub optimal manner, with opportunity for higher outputs to be gained from the same set of inputs. For the period 2011 to 2019 it was found that inputs could be reduced by 21% on average to produce the same quantity of barley output. This level of efficiency compares well with previous estimates for cereal farms in Ireland, with Carroll et al., (2007) estimating that technical efficiency was between 63 and 74 percent depending on the method employed. There was some evidence that technical efficiency levels improved slightly across the time period on average, with technical progress also increasing, with outward movements in the frontier evident. However, there was evidence that technical progress did slow down over the analysis period. Decreasing returns to scale were also observed, which could be considered a warning signal for the average size of operations on cereal farms in Ireland, with no additional gains to be made on average by increasing scale.

A range of farm and farmer factors were found to affect technical efficiency. These results call for policies aimed at providing training programs and extension services and improving input management by cereal farmers. Specifically, efforts such as agricultural investment on scale appropriate technology development and farming conditions improvement, training initiatives for improved technology adoption and extension could be considered appropriate.

Finally, it is worth noting that results from studies of this kind should be interpreted with some caution. While the promotion of some of the positive efficiency variables will likely lead to higher average efficiency, the costs for the farmer (and the State) of such initiatives are unknown, with the aggregate effect on profitability undetermined. It is evident that the degree of specialisation, the use of extension services and age of the farmer all positively affect efficiency levels and any policy aimed at increasing the extent and uptake of such would likely lead to an increase in average efficiency levels and productivity. However, the impact on producer and consumer surplus of the promotion of policies to improve efficiency should also be considered.

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