The Direct Impact of Risk Management Tools on Farm Income: The Case of Irelands Spring Barley Producers

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Contributed Paper prepared for presentation at the 89th Annual Conference of the Agricultural Economics Society, University of Warwick, United Kingdom

13 - 15 April 2015

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Abstract

Tillage farmers must manage numerous economic risks including uncertain yields and prices. Despite the presence of government subsidies, these factors can generate a relatively high variability in farm income. The improved management of farm income variability can contribute towards stability in household consumption, support for farm investments and further investment in child education. Forward contracting is the main available risk management tool for Irish tillage farmers. This paper uses a stochastic farm-level model to simulate the potential direct profit impact of this tool under alternative scenarios where 20 per cent of expected output is forward sold. Our results suggest that risk averse farmers may be willing in these scenarios, to forego approximately one to two per cent of their overall farm income to receive the protection of forward contracts. The proportion of market based income tends to be much greater as many tillage farms rely on government subsidies for a majority of their income. The overall direct profit impact also depends on the costs of production and the share of production committed to the contract.

Keywords Spring Barley, Forward Contract, Risk Management, Stochastic Model

JEL code C15, D81, Q12

Acknowledgements: The authors acknowledge the funding support of the Department of Agriculture, Food and the Marine under the project entitled 'Volatility and Risk in Irish Agriculture'.

1. INTRODUCTION

Tillage Farming has in recent decades provided, on average, the second most financially rewarding enterprise in Irish agriculture. Specialist Dairy Farming is the only enterprise that provides, on average, superior farm incomes. The economic situation on Irish Tillage farms therefore, compares favourably, to that of sheep or drystock cattle farming where economic viability is much less prevalent (Dillon et al. 2010; Hynes and Hennessy 2013). Tillage farms face however, a number of serious challenges which could threaten their economic viability into the future. These include a heavy dependence on direct payments (Hennessy et al. 2008), further risks associated with nutrient loss and the wider environment (Buckley and Carney 2013) and numerous sources of risk associated with uncertain yields and prices for individual crops.

These challenges are clearly related given that direct payments and other subsidies have in recent times, shielded Irish tillage farmers from wild fluctuations in market returns. This was evident in the demand slump of 2009 when average market returns became negative and average family farm income became entirely reliant on the support payments (Connolly et al. 2010). During the new CAP reform package, the real decline in the value of the direct payments will be accompanied by the emergence of an IST income stabilisation tool (European Commission, 2011). A few studies have sought to estimate the economic outcomes that such a tool could produce. Mary et al. (2014) have estimated that farm income volatility in France declines by more than 35 per cent with the introduction of the IST but may generate output distortions. Finger and El Benni (2014) find that the IST mechanism significantly reduces income inequality among Swiss farms.

Rather than focusing on the potential economic impact of non-established tools, this paper concentrates on the direct profit impacts from an existing risk management tool namely the forward contracting tool. Seifert et al (2004) define a forward contract simply as “an agreement to buy a commodity at a certain future time for a certain price”. In our case, the commodity in question is spring barley for animal feed usage and the forward contract is arranged between a farmer and a grain purchaser such as the local co-op. We seek to identify the direct impact on farm profit of entering into a forward contract at different prices and under a range of alternative yield and price scenarios. In addition, we estimate the degree of risk aversion that is required for a

farmer to enter into a forward contract at alternative fixed prices although these estimates are only applied to hypothetical farms.

Tillage farmers in Ireland have access to a very limited number of risk management tools to manage risk with forward contracting being the main available market risk management tool. Ryan et al. (2014) have estimated that approximately 30 per cent of Irish tillage farms availed of the forward contracting tool during 2012. The limited availability of risk management tools in Ireland contrasts with the situation in the United States where Pennings et al. (2008) report that a majority of U.S. crop producers employ more than one risk management tool. Forward contracts, basis contracts, futures contracts, catastrophic coverage and crop revenue coverage appear to be the most commonly adopted tools. In Australia, the Farm Management deposit scheme has been widely adopted as a form of risk management tool with the total number of accounts reaching almost 46,000 in June 2014 and total deposits peaking at over $4bn (Australian Government, 2014).

The widespread use of risk management tools in the United States has generated a significant literature examining the economic impact of tool adoption at the farm level. Cornaggia (2013) finds that risk management leads to greater productivity by relaxing financial constraints suggesting that producers that hedge are more likely to receive access to finance, which can then be used 'to finance productivity-enhancing investments'. Glauber (2013) concludes that crop revenue insurance coverage based on expected prices compares favourably to fixed-price supports such as counter-cyclical payments and marketing assistance loans. Goodwin and Smith (2013) argue however, that the burdens associated with the collection of tax revenues to fund the subsidized crop insurance program can generate a large number of distortions both within agriculture and the aggregate economy.

There is a clear absence of similar empirical analysis on the economic impact of risk management tools for the main grain crops in Irish agriculture. Numerous studies have provided stochastic analysis of the risk associated with uncertain yields and prices in other areas of Irish agriculture e.g. Shalloo et al. (2004), Finneran et al. (2011) and Clancy et al. (2012) but none of these dealt with the main grain crops. We provide a stochastic analysis of the risk associated with uncertain prices and yields in the production of Spring Barley, the most commonly produced crop on Irish tillage farms (Holden et al. 2003; Kennedy and Connery 2005). Our empirical analysis with

respect to the direct profit impact of risk management tool adoption is based on the forward contracting tool.

The development of the stochastic model largely follows the semi-parametric Monte Carlo simulation techniques outlined in Richardson et al. (2000) and Richardson et al. (2014) and adopted by Archer and Reicosky (2009) and Feng et al. (2014) among others. As its name implies, stochastic budgeting is carried out by attaching probabilities of occurrence to the possible values of the key variables in a budget, thereby generating the probability distribution of possible budget outcomes (Hardaker et al., 2004). Stochastic modelling has a number of advantages over the more long-standing deterministic approach where farm planning typically involves the development of forecasts for yields, prices and costs in the following year based on either personal opinion or some published data (Lien, 2003).

In our case, the simulations are based on actual farms in the Teagasc National Farm Survey. Kimura and Le Thi (2011) explain that accounting for farm level characteristics is a critical part of risk analysis and point out that "using the cross-section data or aggregated time series data does not properly measure the producer's exposure to risks". Kimura and Le Thi (2011) recommend the use of longitudinal panel data "to measure the producer's exposure to risk over time".

In the next section, we provide a description of the data sources which includes panel data. In section 3, we discuss the methodology used to develop the stochastic model. This is followed in Section 4 with summary statistics. In section 5, we discuss some results relating to the profit impacts. In section 6, we discuss the results with reference to the estimates of risk aversion for hypothetical farms and this is followed finally by the conclusion.

2. DATA

In this section, we describe the data source used to perform the analysis. This includes the Teagasc National Farm Survey, the CSO Data on crop yields, FAO data on international crop yields and a crop price database collected and maintained by the Agricultural Economics and Farm Survey department of Teagasc Rural Economy. The objectives of the National Farm Survey (NFS) are to

1. Determine the financial situation on Irish farms by measuring the level of gross output, costs, income, investment and indebtedness across the spectrum of farming systems and sizes,
2. Provide data on Irish farm incomes to the EU Commission in Brussels (FADN),
3. Measure the current levels of, and variation in, farm performance for use as standards for farm management purposes, and
4. Provide a database for economic and rural development research and policy analysis.

To achieve these objectives, a farm accounts book is recorded for each year on a random sample of farms, selected by the CSO, throughout the country. For this analysis, the Teagasc NFS micro data spans the period from 2004 to 2013. The panel is unbalanced in the sense that there is some attrition from year to year as farmers leave the sample and are replaced by other farms. The attrition rate is relatively low however and new farmers are introduced during the period to maintain a representative sample that is usually kept to between 900 and 1100 farms.

For our purposes, we concentrate on tillage farmers who produce spring barley for animal feed use. We concentrate on this subset of farmers as spring barley is the most common grain crop produced by Irish farmers. We have excluded malted spring barley due to the price differential. We have excluded some growers of spring barley (animal feed use) for a number of reasons. Firstly, it is critical that each farm in the analysis has a sufficient number of historical yields for the generation of stochastic projections. We have excluded farms with fewer than five years of historical data between 2004 and 2013. There are a total of 138 Farms meeting the above criteria and these farms are therefore available for the stochastic analysis. There is some attrition

in our data in that only 37 farms have historical data for Spring Barley in all of the previous ten years. The 138 farms represent approximately 8,700 Spring Barley growers. Our sample is therefore representative of the vast majority of spring barley growers in the country. The Census of Agriculture 2010 showed that there were 9,058 spring barley growers (inc. malted barley) in Ireland during that year (CSO, 2012). Our sample includes farms which rotate crops from time to time. This explains the relatively high number of growers being represented.

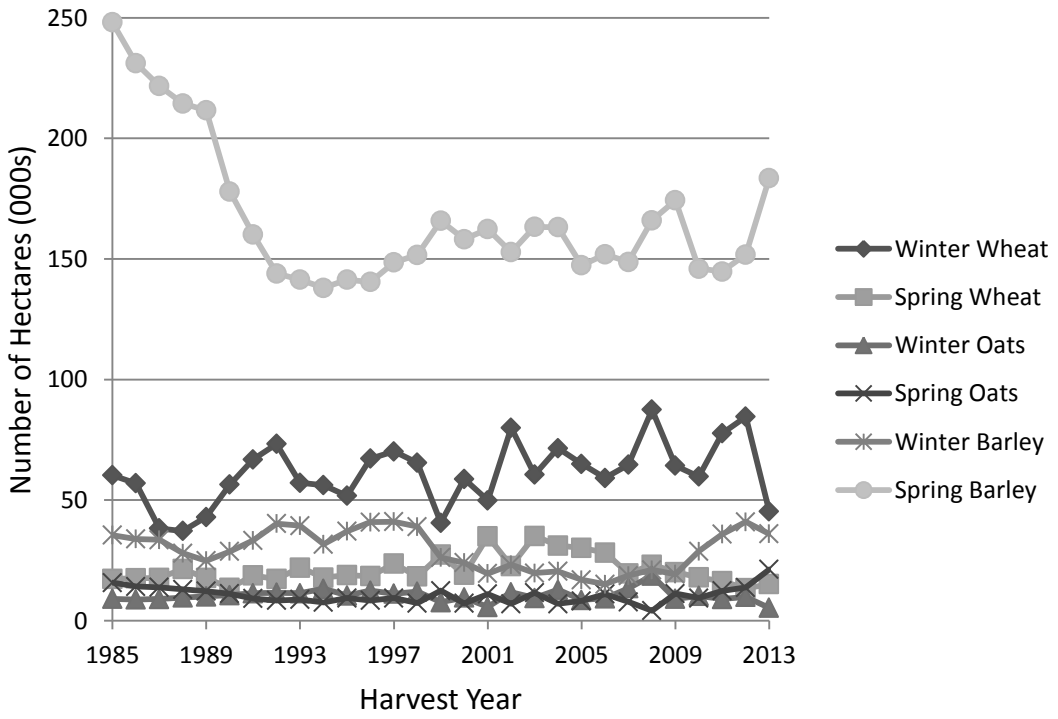
Our sample of 138 farms is almost evenly split between farms that can be classified as mainly tillage and farms with other enterprises such as Sheep, Cattle or Dairy. For risk aversion analysis, the data requirements are much more challenging where multiple enterprises exist. For the purposes of estimating risk aversion in the adoption of forward contracts, we will therefore develop some hypothetical examples of tillage farms. In addition to the farm level micro data, the analysis draws from alternative sources for price data. Kimura and Le Thi (2011) explain that output price data at the farm level can be sometimes unreliable and advise the use of another market price time series from an alternative source such as aggregated price data at regional or national level. We therefore utilise data from a Teagasc database for historical crop prices. This helps us overcome issues related to seasonality and moisture content which may not be captured by the CSO data. The FAO data on international crop yields provides us with the yields for alternative crops in the UK, USA, France and Germany (FAO, 2014).

3. SUMMARY STATISTICS

Apart from Spring and Winter Barley, the two main alternative grain crops are Wheat and Oats. As in the case of Spring Barley, these crops can be used for either animal feed use or for household and industrial consumption. We do not have access to official aggregate statistics on the harvesting area under the level of disaggregation that distinguishes between malted and other uses. We can however, illustrate in figure 1, the different scale of harvesting area for Barley, Oats and Wheat for both Spring and Winter varieties since 1985.

It is immediately apparent from figure 1 that a wide gap exists between the amount of land allocated to the production of Spring Barley and that allocated to Winter Wheat, which has been the second most harvested crop in recent times. The dominance of Spring Barley has not always been prevalent in Ireland. Oats was the main grain crop in the early part of the 20th Century. The structural shift towards a more intensive form of livestock production was considered by Walsh (1976) as being one of the main reasons for the trend towards Barley along with the higher yield and the better resistance to adverse climate when compared with Oats.

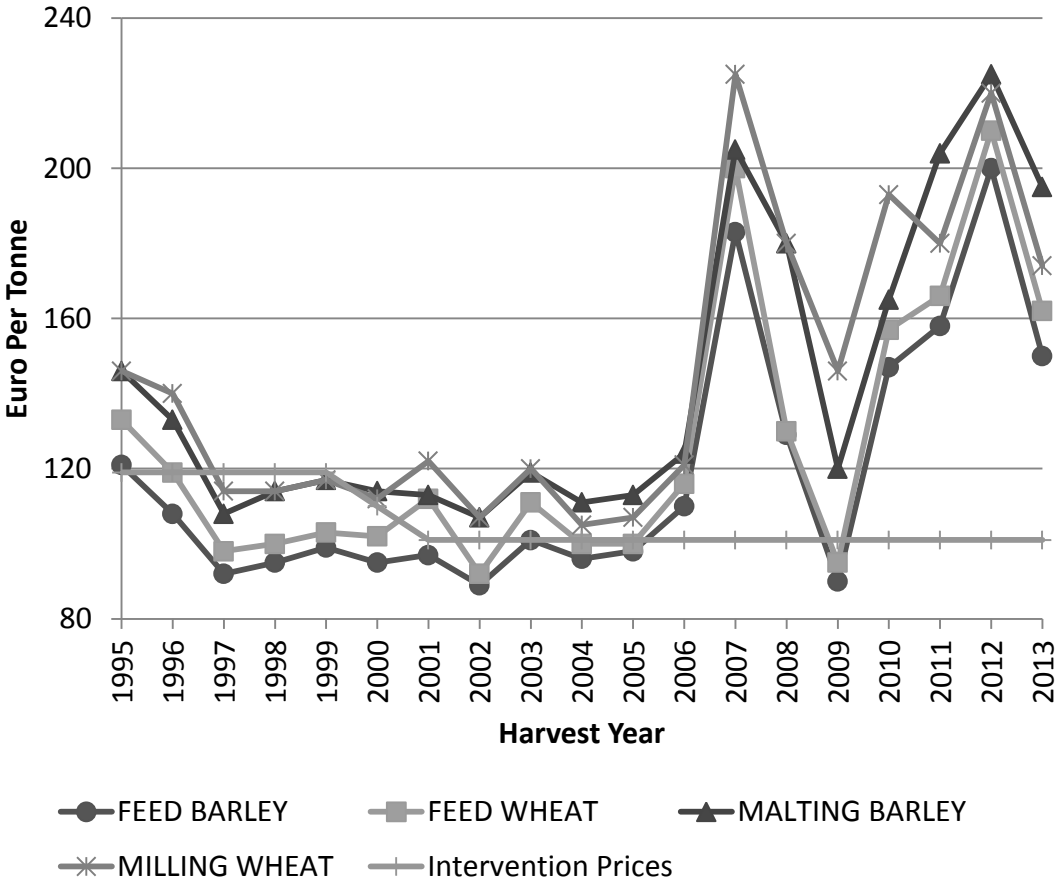
Figure 1: Historical Harvest Area for Selected Crops



Given that the total agricultural area is estimated as close to 4.5 million hectares, it is clear that tillage farming forms a relatively small share of the total agricultural area in the country. However, the higher than average output on tillage farms gives the sector a very important influence on overall agriculture (CS0, 2012). As in the case of dairy farmers, the volatility in output and input prices has increased in the past decade. This is part of a wider global trend which has received much attention in the academic literature (see for example Abbott et al. 2011). In figure 2, we present the recent output price trends for the main grain crops including Barley for animal feed usage. Historically, there have been significant differences in price between Malted Barley and Barley for animal feed use with Malted Barley commanding the higher output price.

Despite this price differential, the Barley for animal feed use is more commonly grown in Ireland. The size of the livestock sector in Ireland demands a large supply of grain crops for animal feed use. In addition, the production of Malted Barley demands that the crop meet protein and grain size standards (Gali and Brown, 2000) and usually be of a softer variety than the non-malting varieties (Allison et al. 1976). Colour is also an important attribute in that a bright, light yellow grain colour is generally preferred for malting, brewing and food purposes (Baik and Ullrich, 2008). Meeting these demands is therefore quite difficult to achieve and the majority of Barley ends up as feed for livestock.

Figure 2: Historical Price Trends for Selected Grain Crops

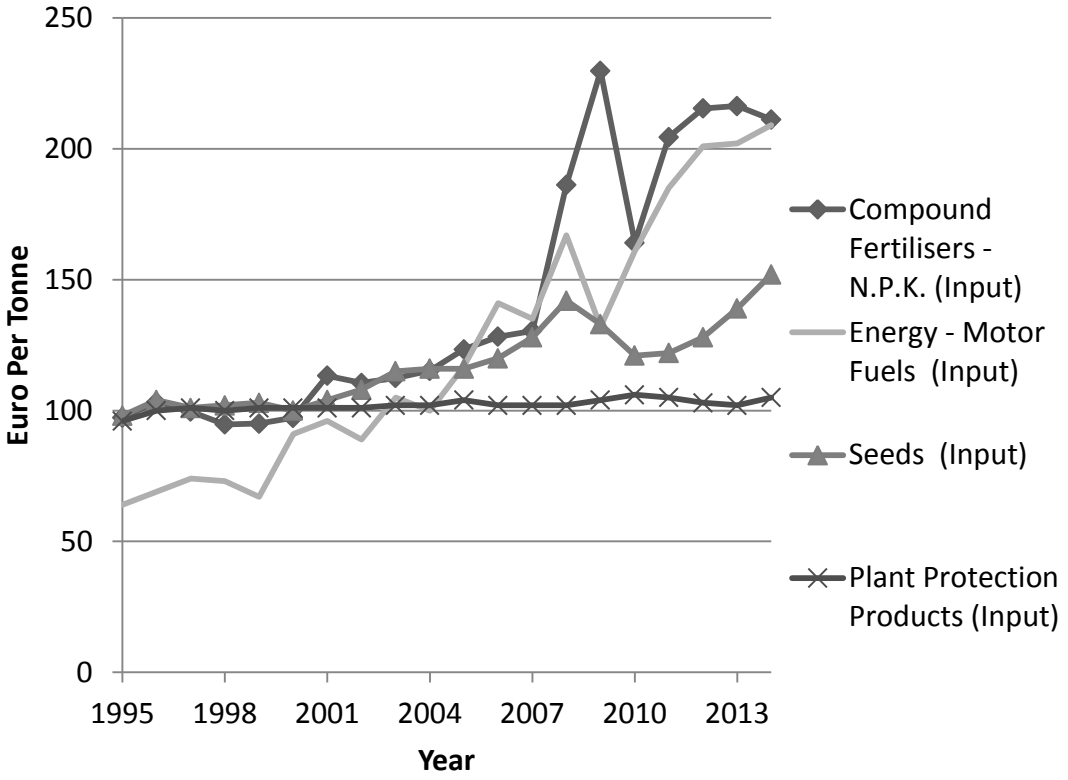


Source: Teagasc Database of Grain Crop Prices

One can see from figure 2 that the price for Feed Barley has lagged behind Malted Barley for the entire period. The price for Feed Barley has closely followed that for Feed Wheat especially since the year 2000. Perhaps, the most striking aspect of this graph is the apparent increase in the volatility of these output prices since 2006. Both Feed Barley and Feed Wheat prices hit the intervention price in the demand slump of 2009 having reached record nominal prices in 2007. It does appear however, that the intervention price is becoming less significant over time. During the 1990s and early 2000s, the market price for Barley was frequently below the intervention price.

The profitability of Barley production is dependent on both the output price and the relevant input prices. In terms of input prices, the price of Fertilizer, Machinery Hire, Crop Protection and Seeds are particularly important. In figure 3, we display the cost price indices for these four inputs. We use the index for motor fuel as a substitute for machinery hire.

Figure 3: Cost Indices for Key Inputs at Sowing Time[1] (Index 2000)



Source: Authors calculations using CSO Data on Input Costs (CSO, 2014)

Figure 3 shows that the price index for fertilizer has more than doubled since 2000 while plant protection products have barely changed in cost terms. There has been a steady increase in energy prices while seeds are approximately 50 per cent more expensive in 2014 relative to 1995 or 2000. We have chosen to base these price indices on the average price index for the first three months of each year. This coincides closely with the timing of the sowing period, which usually takes place in March.

4. METHODOLOGY

Our model provides an estimate of Market Gross Profit for the production of Spring Barley (animal feed use) for each farm under alternative output price and yield scenarios thereby accounting for the risk associated with these two random variables.

[1] Assumed that average of the first three months is the relevant price index

The returns are based on market gross profit rather than market net profit due to the difficulties associated with allocating total farm overheads to one particular crop.

The formula for the market gross profit function is the following:

$$\pi_{GROSS} = \sum p * q * HA - DC$$

p output price of Spring Barley

q yield of crop of Spring Barley

HA Land Size in Number of Hectares cultivated of Spring Barley

DC Direct Costs including Hired Machinery, Seeds, Crop Protection, Fertiliser, Transport Costs, Labour and Other Direct Costs. The Direct Costs are crop specific for Spring Barley (animal feed use).

Our data allows for the estimation of stochastic yields and prices for 138 farms in the production of spring barley for animal feed use. In the case of Direct Costs, we have made some assumptions to simplify the procedure. The cost of each direct cost item is assumed to be given at the time of sowing. It is assumed that the price of the fertiliser, crop protection and other direct costs are known by the farmer at this point in time and that no risk is attached to fluctuations in the price of direct costs.

The direct costs for each farm are based on historical farm-level direct costs per hectare for each individual cost item listed above and CSO price data for the first three months of the projection year, in this case 2014. We assume however, that there is no behavioural response to changes in fertiliser prices or other direct costs from the historical data to the projection year. This may impact on the overall results given that some farms only have historical data for the 2004-2009 period and therefore prior to the large increase in motor fuel costs. We therefore test the sensitivity of our results by excluding those farms with less than eight years of data.

Given the overall objectives of this research, our methodology must address between-farm variability in both average Spring Barley yield and the variability around that

average yield. In addition, we must account for correlations between Spring Barley yields and prices to the yields and prices of other crops both within Ireland and internationally. In our model, we include yields for Irish Spring Barley, Irish Oats, Irish Wheat, UK Barley, UK Wheat, UK Rye, UK Oats and USA Soybeans.

Our initial model included a larger range of crop yields from French, German and USA agriculture but these were excluded due to the absence of a significant correlation between these crop yields and Irish crop prices or yields. In terms of Prices, we include Irish Barley for animal feed use, Irish Oats for animal feed use, Irish Wheat for animal feed use, Irish Malted Barley, Irish Milling Wheat and Irish Milling Oats.

As in the case of the Italian analysis by Kimura and Le Thi (2011), we include all crop producers that have stayed in the sample for at least five years. Our projections are made for one year forward. The forward contracting tool is chosen as the risk management tool and these contracts are typically provided for Barley sold one year after the signing of the contract agreement. The correlations between crop yields are made at the aggregate level using data taken from the CSO rather than farm level data from the Teagasc National Farm Survey. This is a necessary step given that the vast majority of the farms in the sample do not produce all of the relevant crops in the same year i.e. Barley, Wheat and Oats. We are therefore assuming that the correlations between the yields of Barley, Wheat and Oats, as calculated using the CSO aggregate statistics are appropriate for the variety of farms in our sample.

The variety of prices and yields in the model means that we have a fourteen-variable probability distribution that must be parameterized with a maximum of ten observations. The model is simulated for one year, thus requiring the parameters for a multivariate distribution with 14 random variables. Richardson et al. (2000) advise that ten observations provide a sample size that is too small for the use of standardized probability distributions such as the weibull or beta distribution.

We therefore employ an empirical distribution. Richardson et al. (2000) conclude that an empirical distribution "avoids enforcing a specific distribution on the variables and does not limit the ability of the model to deal with correlation and heteroscedasticity".

As proposed by Richardson et al (2000), the first step in estimating the parameters for a multivariate empirical (MVE) distribution is to separate the random and non-random components for each of the stochastic variables. There are two alternative methods for the removal of the random component of a stochastic variable: (a) use regression (or

time series) analysis to identify the systematic variability, or (b) use the mean when there is no systematic variability.

We utilise a series of ordinary least squares (OLS) regressions to identify whether or not a deterministic component of yields and prices appears to exist. Where a trend is not identified, the alternative is to use the simple mean ($\bar{X}_i$) of the variable over the sample period as given in Equation 2.

$$\hat{X}_{\text{it}} = \hat{a} + \hat{b}(\text{Trend}_t,) + \hat{e} \qquad (1)$$

or

where the trend is insignificant

$$\hat{X}_{\text{it}} = \bar{X}_i \qquad (2)$$

for each random variable $\bar{X}_i$ and each year t

The random component ($\hat{e}$) is calculated by subtracting the predicted or non-random component of the variable from the observed value and these residuals will be utilitised for the simulations.

$$\hat{e}_{\text{it}} = X_{it} - \hat{X}_{it} \qquad (3)$$

These residuals are converted into fractional deviates about their respective deterministic components.

$$D_{\text{it}} = \frac{\hat{e}_{\text{it}}}{\hat{X}_{it}} \qquad (4)$$

For each farm, the relative deviates D_{it} are then sorted from the minimum deviate to the maximum deviate. In this case, the notation i represents the individual farm and n

represents the annual observation. N denotes the total number of farms in the sample, in this case 138. Prior to this sorting exercise, the creation of pseudo minimums and pseudo maximums are necessary for each random yield and price variable. This ensures that the simulated distribution returns the extreme values. As in the case of Richardson et al (2000), the pseudo-minimum and maximums are defined to be very close to the observed minimum and maximum.

The relative deviates D_{in} denote the deviates,

$$D_{i,\,\text{low\_bound}} = 1.05 * min_n D_{in} \tag{5}$$

$$D_{i,\,\text{upper bound}} = 1.05 * max_n D_{in} \tag{6}$$

The relative deviates are then sorted and probabilities are assigned to each of the sorted deviates in the following

$$\mathrm{P}\left(D_{i,\,\text{low\_bound}}\right) = 0 \tag{7}$$

$$\mathrm{P}\left(D_{i,\,(1)}\right) = \left(\frac{1}{N}\right) * 0.5 \tag{8}$$

$$\mathrm{P}\left(D_{i,\,(2)}\right) = \left(\frac{1}{N}\right) + \mathrm{P}\left(D_{i,(1)}\right) \tag{9}$$

$$\mathrm{P}\left(D_{i,\,(N)}\right) = \left(\frac{1}{N}\right) + \mathrm{P}\left(D_{i,(N-1)}\right) \tag{10}$$

$$\mathrm{P}\left(D_{i,\,\text{upper\_bound}}\right) = 1 \tag{11}$$

Having estimated the probabilities for each deviate, the next step is to calculate the

M x M intra-temporal correlation matrix for the M random variables for the aggregate level data. The intra-temporal correlation matrix is calculated using the unsorted, random components (e_{it}) from equation 3 and is demonstrated in Richardson (2000) for a 2 X 2. The results for the intra-temporal matrix are available on request. For the final steps, we refer the reader to the procedures outlined in Richardson (2000). We exclude the estimation of an inter-temporal correlation matrix. For the generation of Correlated Uniform Standard Deviates $CUSD_{i(14x1)}$ in SIMETAR, we follow the method outlined in (Richardson et al. 2008). Having followed these procedures, we produce the entire 500 simulated values in SIMETAR.

Risk Aversion

From an economic perspective, there is a sound motivation for estimating the risk aversion of tillage farmers. For a risk averse farmer, the direct profit impacts from forward contracting, should prove to be negative over time. Such farmers are willing, in the short run, to forego some of their expected revenue for the protection given by a forward contract. The entry into a forward contracting arrangement may however, not always be the product of risk aversion and can be the product of straightforward speculation whereby farmers will only enter into a contract at above normal prices (Pennings et al. 2004; Kuethe and Morehart 2012).

In the case of multiple enterprises, the estimation of risk aversion can be a demanding exercise as one must account for the level of risk associated with each of the relevant enterprises. The situation of specialist tillage farming with multiple crops is however, much easier to deal with. In our estimates for risk aversion, we keep to a hypothetical situation where the farm is devoted to the production of two grain crops and has no other enterprise.

In order to estimate risk aversion or risk attitude, we employ the constant proportional risk aversion function of Pratt (1964) where the utility function is defined as

$$U(y) = Y^{1-r} \qquad (12)$$

The parameter r refers to relative risk aversion. The parameter Y refers to the payoffs (Output Price minus the Costs per Tonne) associated with the production of Spring

Barley at each alternative Output Price. A Constant Relative Risk Aversion CRRA is assumed. Further work is being undertaken under the Expo-Power Utility (EP) function proposed by Saha (1993). Our initial analysis suggests that the EP function will make a relatively minor difference to the overall results but this is dependent on certain assumptions.

Due to the data limitations reported in the data section, we base the analysis of risk aversion on a series of hypothetical scenarios. The added value of this analysis is that we account for the importance of risk aversion in farmer decision-making albeit under particular circumstances. The analysis will serve as a guide to the levels of risk aversion that are required for farmers to enter into a forward contract at a particular price under a particular set of circumstances.

5. RESULTS 1

In this section, we present the profit impacts due to the adoption of the forward contracting tool. In figure 4, we first provide the cumulative distribution of farms according to their average gross margin per hectare, an indicator of dispersion in the long run economic performance of different farms. We follow this with the risk-related results. In figure 5, we provide the entire simulated distribution for the main output price i.e. the Price for Spring Barley for animal feed usage. This is followed by some analysis of the cumulative distribution of gross profits or payoffs attached to the production of Spring Barley. We follow this with the results detailing the profit impacts of forward contracting adoption.

Long Run Performance

The long run economic performance of Barley production can be described by the average gross margin achieved by each farm. Each farm is represented by the average gross margin across the alternative 500 simulated scenarios. In figure 4, we provide the cumulative distribution of the average gross margin per hectare from our 138 farms. To allow for the possible effect of sample attrition, we represent the graph with all 138 farms and also for the 78 farms with eight or more years of historical data.

Figure 4: Cumulative Distribution of Average Gross Margin Euro per Hectare

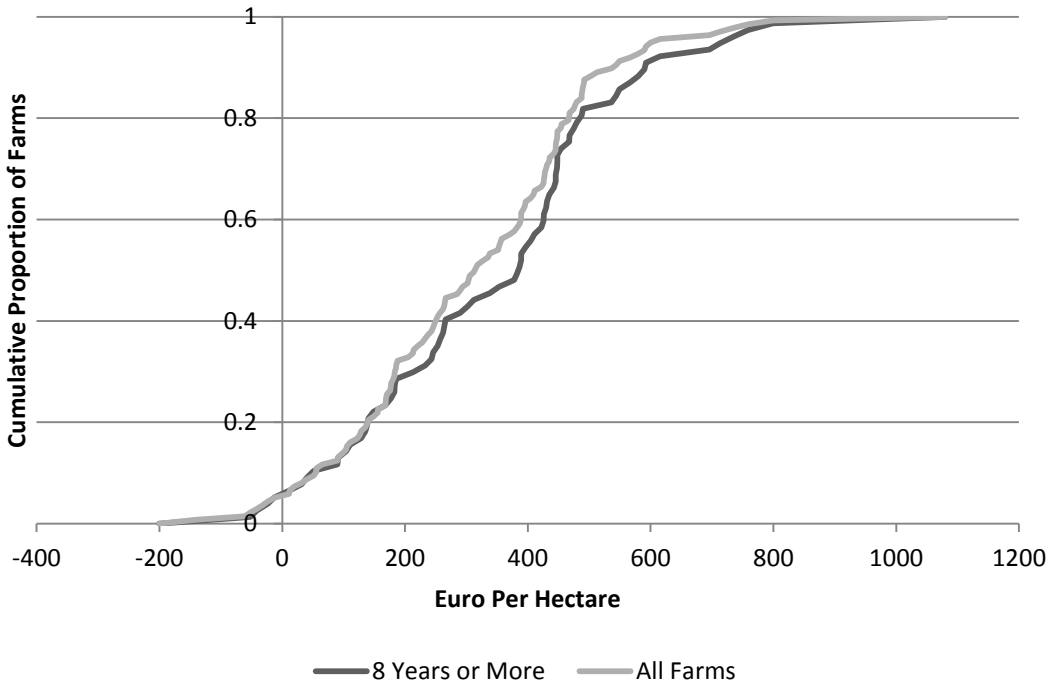
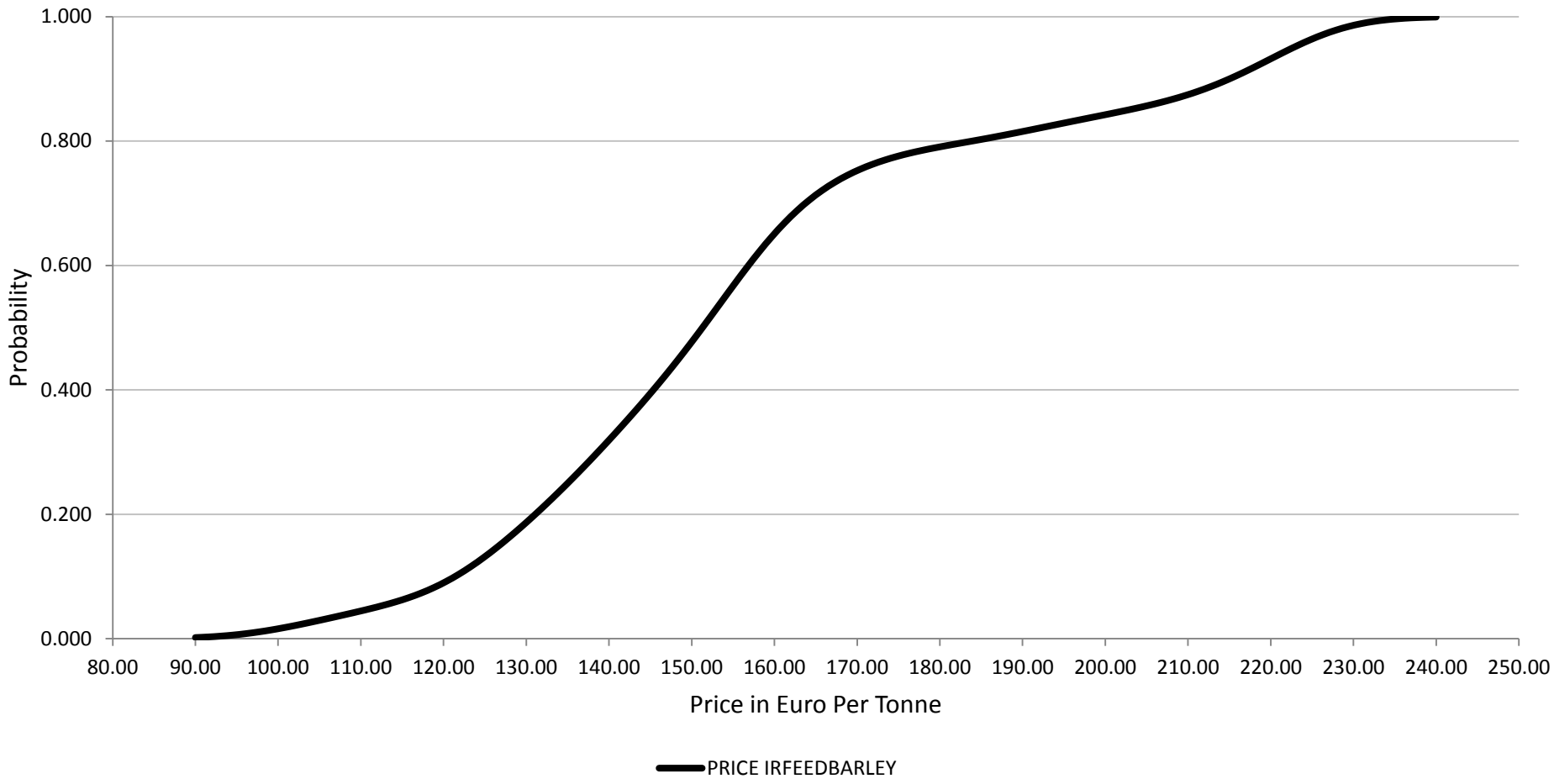


Figure 4 shows that the attrition has a relatively small impact on the distribution of gross margin for most of the distribution. There are however, noticeable differences along the middle of the distribution but these are entirely due to a small number of farms between the 40th and 45th percentiles of the full sample distribution having less than eight observations. The majority of farms achieve a gross margin per hectare in excess of 200 euro per hectare. The best performing farms have gross margins in excess of 600 euro per hectare.

Risk and Price

In figure 5, we show the entire simulated distribution for the output price. One can see that the probability of a price greater than 150 euro per tonne is estimated to be slightly greater than 50 per cent in our simulation year, in this case 2014. The average simulated price in SIMETAR is 157 euro per tonne. There is estimated to be only a ten per cent chance of the price falling below 120 euro per tonne. At the other end of the distribution, there is an estimated ten per cent chance of the price exceeding 215 euro per tonne.

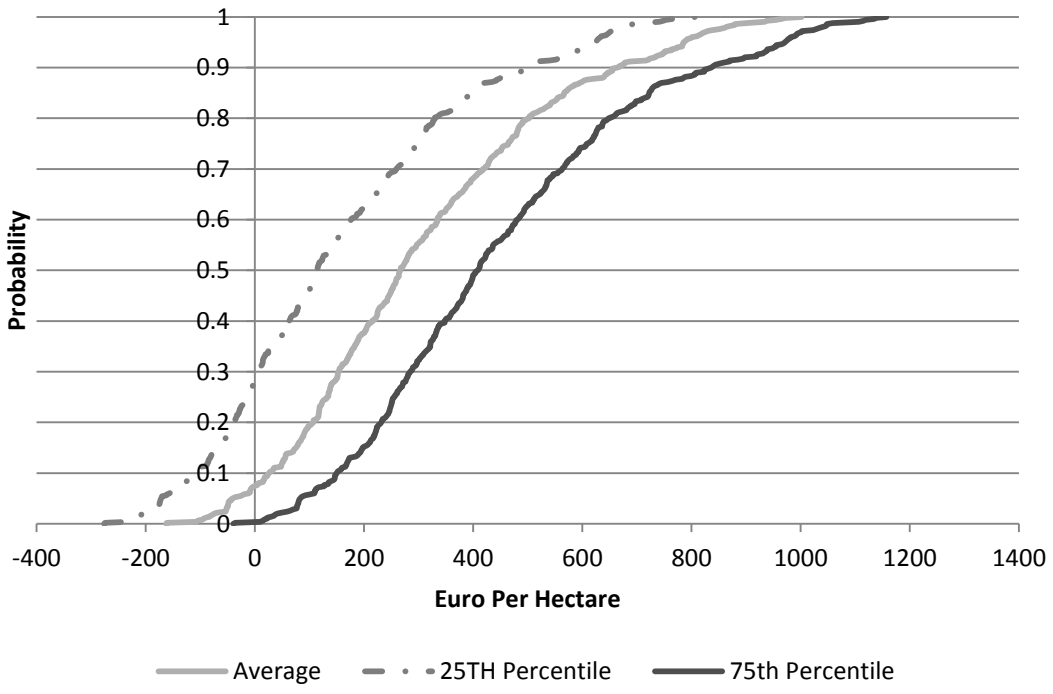
Figure 5: Cumulative Distribution Function of the Feed Barley Price in 2014



Risk and Profit

We now describe the relationship between risk and profit in spring barley production. Differences in growing conditions and numerous other factors generate inevitable differences in the gross margin earned by different farmers over time. The Teagasc Farm Management book 2013/2014 gives some indication of the average yield and gross margin expected under moderate, good and excellent production (Teagasc, 2014). These factors in combination with uncertain yields can produce wide disparities in the profitability of spring barley production in any given year. It would seem therefore, reasonable to present the risk results with respect to these diverging outcomes. In figure 6, we therefore provide the interquartile range for the gross margin at each point in the cumulative probability distribution.

Figure 6: The Interquartile Range of the Cumulative Distribution of the Simulated Gross Margin Euro per Hectare in 2014

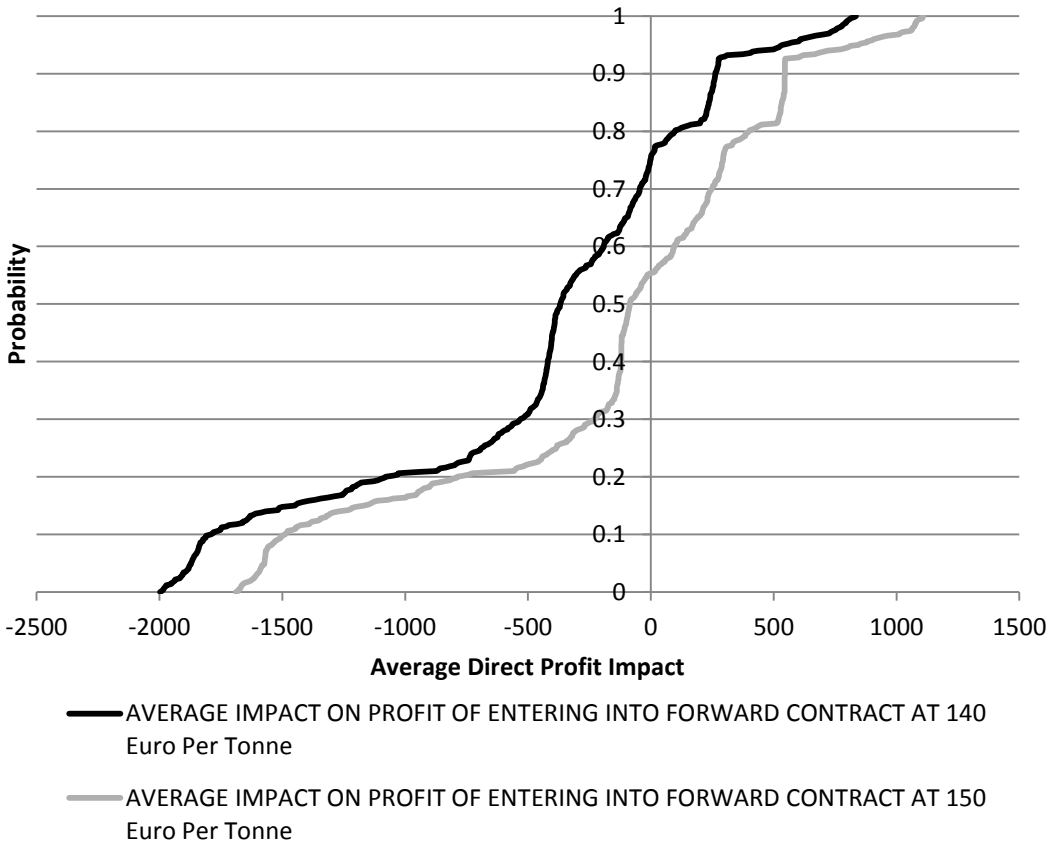


One can see that the 75th percentile enjoys a gross margin that is estimated on a majority of occasions to exceed approximately 400 euro per hectare. This contrasts with the 25th percentile where there is estimated to be a 50 per cent chance of the gross margin exceeding only 100 euro per hectare.

Profit and Forward Contracting

Figure 7 shows the cumulative distribution of the Profit Impact of Forward Contracting under two chosen forward contracting prices. We assume that all farmers choose the same forward contracting price. We base the analysis on each farm committing 20 per cent of production to a forward contract. Each of the 500 points along this curve represents the average simulated value for 138 farms. The relevant amounts therefore the average effect across all farms being represented.

Figure 7: Cumulative Distribution of the Profit Impact of Forward Contracting [20 Per Cent of Expected Production]



Entering into a forward contract at 140 euro per tonne will lead on average to losses for spring barley producers. The average producer is estimated to lose on approximately 75 per cent of occasions under a forward contract price of 140 per tonne and on approximately 55 per cent of occasions under a forward contract price of 150 per tonne. We estimate that the losses will average at approximately minus 350

euro when all farms enter into a forward contract at 140 euro per tonne for twenty per cent of production. For specialist tillage farms, the average outcomes are closer to minus 500 euro. Farmers may however, still be willing to enter into forward contracts at such prices due to risk aversion. In approximately 20 per cent of scenarios, the entry into a forward contract at 140 per tonne will lead to average losses of at least €1,000 in total with some scenarios generating an average loss of approximately €1,500. This would occur in circumstances where the actual market price reaches particular highs. While the direct profit impact may on average prove to be negative, the added protection given by a forward contract can promote better access to credit and therefore higher long run profit for the farm.

Among the sample of 138 farms, the average producer has typically earned in the region of €35,000 to €40,000 per annum in farm income so the average profit impacts of forward contract adoption are likely to be in the region of one to two per cent of total income when considered over a relatively long period.[2]

6. RESULTS 2

In this section, we provide the risk aversion results for our hypothetical farms. As in the case of experimental studies such as (Masclet et al 2009; Holt and Laury 2002), a range of values for risk aversion are given for each observation under each decision as opposed to point estimates. We assume that the farm is a producer of both Winter Wheat and Spring Barley. Winter Wheat tends to command a higher price and yield per hectare relative to Spring Barley but comes with higher costs (Teagasc, 2014). In these hypothetical examples, we assume that each farm produces 25 hectares of both crops, a situation which is about average for a specialist tillage farm with no other enterprise.

Table 1 shows that relative risk aversion has an estimated value between .23 and .39 for the high cost farm under a contract at 150 euro per tonne for Spring Barley and 160 euro per tonne for Winter Wheat for 20 per cent of production in both crops.[3] This is normally considered in the literature to be 'slightly risk averse' behaviour (Masclet et al 2009; Holt and Laury 2002). By contrast, entering into a forward

[2] This assumes that the farmer enters into a contract for a relatively small proportion of total output

[3] It is assumed that the forward price decisions are made in units of five euro per tonne. For example, if the farmer is willing to enter into a contract at a minimum of 150 euro, this implies that the farmer has rejected the possibility of entering at 145 euro per tonne.

contract at 140 euro per tonne for Barley and 150 euro per tonne for Winter Wheat would be considered ‘risk averse’. We do not describe this farm as very risk averse or extremely risk averse unless we simulate for much higher shares of production entering into a forward contract.

In the second example, the farmer has a lower cost structure and is therefore in a better position to withstand the risk associated with crop production. In this situation, it takes larger amounts of risk aversion to justify the practice of forward contracting at each alternative price. This is of course based on our expected utility model. In this scenario, the farmer has a very low probability of severely bad outcomes which might generate a gross margin of less than 40 euro per tonne for Barley. This means that the farmer would need to be ‘very risk averse’ to enter into a contract at 145 euro per tonne for Barley and 155 euro per tonne for Wheat under the given range of expected prices. This result is however predicated on the assumption that the costs of production are absolutely certain at the time of sowing. The most competitive farmers will therefore be only willing to enter into contracts at approximately 148-150 euro per tonne unless they are very risk averse. This reluctance is likely to be even more evident where the farmer has a high net wealth position.

To test the sensitivity of the results, we have also simulated these values with the exclusion of Winter Wheat and a complete reliance on Spring Barley. We find that a farmer in this situation would require lower levels of risk aversion to justify adoption of forward contracting at each price. The effect would be however, relatively small with the coefficients for risk aversion being approximately 0.05 lower at each price. This is unsurprising given that a sole reliance on Spring Barley would leave the farmer in a slightly more vulnerable position and more exposed to risk than a situation where the farmer has diversified into multiple crops (See Chavas and Di Falco 2012) for a discussion on risk management and crop diversification. From the Teagasc National Farm Survey, we find that among those tillage farms with a minimum of five years of historical data, the average number of crops per farm is approximately 1.7. It therefore appears sensible that we describe a situation with multiple crops even though most farms do not grow multiple crops in the same year.

Table 1: Range of Risk Aversion Values under Hypothetical Farms

[Twenty Per Cent of Production is Forward Contracted]

Farm Type	Choice of Forward Contract Price	Direct Cost Per Expected Tonne	Risk Preference Classification	Minimum Relative Risk Aversion CRRA	Maximum Relative Risk Aversion CRRA
High Cost	1. 155B 165W	100B 115W	Slightly Risk Averse	0.03	0.22
	2. 150B 160W		Slightly Risk Averse	0.23	0.39
	3. 145B 155W		Risk Averse	0.40	0.51
	4. 140B 150W		Risk Averse	0.52	0.61
Low Cost	1. 155B 165W	80B 95W	Slightly Risk Averse	0.08	0.42
	2. 150B 160W		Risk Averse	0.42	0.50
	3. 145B 155W		Very Risk Averse	0.77	1
	4. 140B 150W		Highly Risk Averse	1+	

Note: B represents Barley and W represents Wheat. For both farms, the estimated average expected prices are 157 euro per tonne for Barley and 165 euro per tonne for Wheat. The estimated minimum prices for Barley and Wheat are 100 euro per tonne and 105 euro per tonne respectively. The estimated maximum prices are 226 euro per tonne and 242 euro per tonne respectively.

7. CONCLUSION

In this paper, we have utilised historical farm-level data from the Teagasc National Farm Survey to develop a stochastic model for the production of Spring Barley for animal feed use among Irish farmers. This has provided us with an indication of the income risk associated with the production of this grain crop. Forward Contracting is the main available risk management tool in Irish tillage farming and we have estimated the first round direct impact on farm profits from adopting this tool. In addition, we provide examples of hypothetical specialist tillage farms to illustrate the likely extent of risk aversion required to enter into a forward contract at alternative prices.

The estimates in this paper suggest that a risk averse producer, with average production levels, may be willing to forego amounts in the region of one to two per cent of total farm income for the protection of a forward contract for twenty per cent of production. These amounts will form a much greater share of market-based income. This is due to the fact that direct payments form the majority of farm income for tillage farmers in Ireland.

The willingness of farmers to enter into a forward contract at a particular price is likely to vary according to the degree of crop diversification and particularly the degree of cost competitiveness. Our results suggest that the most cost competitive tillage farmers will demand relatively high forward contract prices in order to be incentivised into contract adoption. This tendency will, of course, be partly dependent on the degree of risk aversion. The reluctance of highly cost competitive farmers is likely to be compounded in circumstances of high net wealth.

Alternatively, the farms with low net wealth and high production costs are unlikely to be categorised as 'highly risk averse' in order to rationalise their entry into a contract at relatively low prices. Entering into forward contracts at relatively low prices essentially means that the farmer will, on average, face a higher direct negative profit impact than under more generous prices. These less competitive producers can be particularly vulnerable to an adverse shift in grain markets unless alternative and relatively stable sources of income are available. Future work will incorporate the role

of the single farm payments and off-farm work in stabilising household income particularly for these less cost competitive tillage producers.

In terms of the academic literature, this is the first real attempt to combine a stochastic profit analysis for the main grain crop in Irish tillage farming with analysis of the profit impacts of forward contracting. Although our models have some relatively strong assumptions, the work can support a better understanding about the economic risks associated with the production of grain crops in Ireland and the extent to which forward contracting can offer protection from adverse economic shocks. Farmers will need to establish their own stochastic budgets before considering the forward contracting tool. As in the case of other European farmers, the Irish tillage farmers could benefit from a wider range of available risk management tools. This may include tools capable of giving better protection from adverse changes to the gross margin than is available under a forward contract.

Further work is required to estimate the degree of risk aversion attributable to Irish tillage farmers. Our example of hypothetical farms involves the assumption of constant relative risk aversion and excludes treatment of the net wealth and the importance of direct payments. Alternative utility functions should be tested and based on some empirical data of the actual prices that farmers are entering into forward contracts.

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