Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

Research Stimulus Fund

Final Report

'Volatility and risk in Irish Agriculture'

DAFM Project Reference No: 10/S/715 (10/RD/AgRisk/TMFRC/715)

Start date: 01/11/2011

End Date: 31/08/2014

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Please place *one* "x" below in the appropriate area on the research continuum where you feel this project fits

Basic/Fundamental → Applied → Pre Commercial

1	2	3	4	5x	6	7

Please specify priority area(s) of research this project relates to from the National Prioritisation Research Exercise* (NRPE) report;

Priority Area (s)	**Sustainable Food Production and Processing**

Key words: *(max 4)*

Risk, Volatility, Prices, Income

1. Rationale for Undertaking the Research

This section should outline the rationale for carrying out the research and identify the need / problem to be addressed

The volatility of international agricultural output prices appears to be increasing. European agricultural policy reforms (reduced intervention prices, lower tariff rates and reductions in export subsidy expenditure) over time have led to an increase in the exposure of EU and Irish agricultural commodity markets to world market developments. As a consequence the prices Irish farmers and agri-businesses receive for their output and the prices that they pay for purchased inputs have become more volatile. Commodity output price, input price and yield volatility is therefore associated with increasing volatility in agricultural incomes. Increased price and income volatility and risk have negative consequences for production and economic welfare.

The growing importance of establishing a better understanding of the consequences of price and income volatility for agriculture, as well as measures which could mitigate the income risk faced by farmers is underlined by the European Commission's suggestions that a "risk management toolkit" be part of the future CAP. The Commission's communication (ref 2010) on the reform of the CAP, places this policy area under Pillar II of the CAP, thus any such measures will be co-financed and consequently Member State specific. The need for, and the success of, such a "toolkit" in an Irish context would depend on an improved understanding of the nature of the volatility faced by Irish farmers and the impact of volatility on agricultural production and incomes.

Providing agricultural stakeholders with more detailed information about price volatility allows them to plan more effectively for the future. Farmers and industry representatives can use the information on price risk generated by this research in business and investment planning.

2. Research Approach

Specify the research methodologies employed, emphasising novel techniques and also outline any modifications from the original approved project proposal

The research approach involved a review of the available tools that could be used to address the consequences of excess volatility in agricultural markets which has been an observable since the mid 2000s. Over the last 15 to 20 years a movement away from government intervention in agricultural markets, particularly in the EU, has been observable and this have increased the focus on the need for private risk management markets and business level risk management strategies.

One element of the project involved a review of the market tools and government policies that currently exist for managing agricultural risk. A multi-criteria analysis was adopted to critique the various risk management tools available. These tools were assessed according to criteria such as costs (by whom they are incurred), benefits (to whom they accrue), political and budgetary acceptability, feasibility, functionality and effectiveness in controlling risk. This allowed for all tools reviewed to be ranked according to the various criteria. It is argued that governments should support the development of private solutions to agricultural risk and that government risk-related policies should focus on "residual risk".

Second the approach involved the creation of additional capacity in the FAPRI-Ireland suite of models. These models are already successfully used to project the levels of future prices, production, trade and incomes in Irish agriculture. A stochastic projection capacity was built into these models, which allowed them to be used to make projections which take account of possible future volatility.

3. Research Achievements/Results

Outline main results achieved

TASK 2: The project produced a detailed review of the types of risk that farmers face in agriculture. The review also detailed the available tools that could be used to manage price and income risk and ranked them in terms of their suitability in an Irish context.

A review of various market tools and government policies designed for the management of agricultural risk was undertaken. Given the recent impetus for empowerment of farmers to manage risk independently and for the development of private risk management markets, particular focus in the review was placed on agricultural derivative products and insurance markets. Derivative products have the capacity to offer farmers and processors considerable protection from price volatility, but it is important that their limitations and the extra risks with which they are associated such as systemic, basis and counterparty risk are fully understood by agricultural producers who use them. There is a risk that such tools may be employed by producers without sufficient knowledge to do so optimally. This lack of knowledge about how best to employ these tools can result in extreme losses of income and impact negatively on welfare. In addition to further education of producers who may use these tools, considerable support from government at the EU level may be required to establish futures and options exchanges with sufficient liquidity to be effective. In particular there is a lack of diversity in Europe in the types of agricultural commodities for which options can be purchased.

In addition to the aforementioned risks associated with derivative products, policy makers must also consider the limitations of these tools. For marketable risks (in this case price volatility) they will be of use, but in the event of long term price trends that negatively impact farmers' incomes, such tools offer no protection. Price trends constitute residual risk, as opposed to marketable risk. Under the holistic approach to risk management, there is scope for government policy and associated tools that compensate producers for income-affecting events which intelligent on farm risk management strategies and efficiently operating risk management markets can do nothing about. Another example of residual risk is systemic production risk, such as the widespread incidence of adverse weather patterns (e.g. drought or flooding) and contagious diseases affecting livestock and crops. Because of asymmetric information, moral hazard and adverse selection, the cost of insurance policies to both insurers and farmers often lead towards market failure (lack of provision of a suitable insurance product). While examples of insurance on livestock, crops and farm property do exist, compensation is often associated with non-systemic for example in the US this might cover risks like fire, hail and personal injury. Once risks become systemic, they generally become too costly to ensure. Thus price trends and systemic production risk make up the bulk of residual risk which, under a holistic approach to agricultural risk management, governments must address.

The results of the multi-criteria analysis suggested that income stabilisation regimes, such as the Canadian AgriStability scheme, were the superior mechanism for offering farmers protection from

systemic, residual and catastrophic risks, without crowding out private market solutions to marketable and normal agricultural risk. This is achieved by staggering/increasing compensatory payments to farmers as the scale of income declines increase. However, given findings in the literature that many risk-related government payments to producers end up taking the form of support payments, it is vital that any such income stabilisation regimes are implemented with a holistic approach in mind. This means that farmers should not be compensated for small losses, should be only partially compensated for losses from risks that are marketable (to ensure demand available market tools is supported) and are more fully compensated for residual risks for which there exist no market or on-farm solutions and where therefore, there can be no crowding out effect. In the future, many issues will have to be addressed if risk is to be managed across the three institutions (farm, market and government) in a holistic sense. One such issue will be diagnosing what can be considered to represent a "catastrophic risk". Ambiguity in this regard, combined with political pressure to provide support payments to producers (though risk-related channels) will undermine the ability of such instruments to peg payments to residual risks (instead becoming support payments).

Future work in this area could attempt to quantify the impact of government risk-related policies on the development of private risk-management markets and on farm risk management strategies. Discrete choice methods analysing the characteristics of producers that avail of market tools for price risk management may also be of interest to policy makers.

TASK 3: The project developed a capacity within the FAPRI Ireland model to produce stochastic projections of prices and output volumes. This allows confidence intervals to be placed around a central projection for specific variables.

The stochastic projections developed using the FAPRI-Ireland Stochastic model capture uncertainties from several key sources, namely variable crop yields, meat demand, macro-economic conditions and world prices. This represents the first comprehensive assessment of uncertainties within the FAPRI-Ireland modelling system.

The stochastic modelling system that has been developed provides a means to understand how agricultural markets behave under different assumptions. In addition, the stochastic modelling system will provide a more complete understanding of the impact of policy decisions, particularly policies that have asymmetric consequences; or when there is intrinsic policy interest in the tails of distributions, e.g. provision of payments under extreme adverse conditions. In turn this provides a benchmark against which to measure the cost and efficacy of a range of risk management tools and other policy measures.

Importantly, the magnitude of future uncertainties revealed is limited by the set of sources of uncertainty incorporated in the analysis. The stochastic projections should not be considered in an unconditional probabilistic sense, rather they should be understood as conditional on the sources and the magnitude of uncertainty introduced. All future oriented models will be wrong to some degree and therefore it should be understood that stochastic projections, just like deterministic projections, will be shown, ex post, by the passage of events, to be wrong to some degree. Users must therefore, understand that the value of both the deterministic and the stochastic projections is not as "predictors" of the future, but rather as tools with which to consider changes that could be made now so as to change or alter the future that we are likely to experience.
The motivation behind the original development of the FAPRI-Ireland model was the development of an analysis tool that could provide timely and relevant analysis to policy makers of the impact of potential agricultural and other policy changes. The development of the stochastic Baseline provides

an additional dimension of information to policy makers concerning the future evolution of Irish agriculture. The development of the Stochastic FAPRI-Ireland model will allow for this type of policy question to be considered in the future.

TASK 4: A paper was published that utilised econometric techniques to examine the demand for the forward contracting risk management tool among Irish dairy farmers. The findings suggest that the demand for forward contracts is significantly related to the recent price history and that 'Within the farm-gate diversification' and the 'number of children' in the 16-19 year old age category both have a positive and significant association with the adoption of forward contracting.

This task provided insights into the volatility of incomes in Irish agriculture, with a particular focus on the dairy sector. The findings of this research have shown that commodity price and Irish farm gate price volatility has increased dramatically since 2005 due in part to policy changes and has become an inherent part of the dairy industry as prices become more aligned with world market levels. In addition the range with which the prices fall has widened considerably and the dynamics at farm gate has changed with a strong cyclical component now evident in some EU countries farm gate prices. The findings have also shown that commodity price volatility has translated along the supply chain to farm gate prices, farm input prices and farm income.

These developments make it more difficult to plan and budget, reduces investment and R&D spend and make less volatile substitutes more attractive. In order to manage the increased risk which has resulted from this policy reform, the EU has extended its risk management toolbox and implemented the milk package of 2012. The latter involved a series of measures aimed at boosting the position of dairy producers in the dairy supply chain. However there is a sense that these measures may not be adequate in times of market stress and are of limited use to others in the supply chain.

In such an environment it is understandable that the provision of private risk management tools such as insurance and futures markets should gain prominence. However the provision of these latter tools is not straightforward. The dairy supply chain can be regarded as long, making risk sharing problematic. Dairy farmers and even the raw milk they supply is not homogeneous. Raw milk prices and farm incomes and profitability vary considerably across the EU. This fact, coupled with delayed and in some cases incomplete data, mitigates against the introduction of insurance type products, in particular in the short to medium term.

The development of EU dairy futures markets has been steady but slow. There appears to be a demand for these markets on the buy side in particular. The slow adoption may in part be explained by the fact that these tools are new and there is an education gap. However it may also indicate that cross hedging milk with dairy commodities is not ideal at present.

TASK 5: A paper was published quantifying how risk management tools impact on farm income. A microsimulation model was used to estimate the impact of forward contracting on farm income and the riskiness of the farm income. The results showed that forward contracting can reduce farm income risk significantly, but that other stable sources of income are probably necessary to contain the exposure to the income risk attached to cereal production.

A stochastic farm level model was developed in order to assess the income risk associated with spring barley production. This model is based largely on the methodologies of the FLIPSIM model developed at Texas A & M University. Due to the development of this model, it became possible to estimate the direct impact of forward contracts on farm profit and income variability. In addition,

the research has produced a paper on the factors driving the adoption of forward contracts in dairy farming. A related conference paper includes analysis with respect to the risk perceptions of Irish dairy farmers.

This research has addressed some knowledge gaps with regard to the risk associated with dairy and tillage farming in Ireland. The farm level model will inform end users about the degree of income risk associated with tillage farming and the potential role of forward contracts in addressing this problem. The model is developed at the farm-level and is therefore capable of addressing the heterogeneity of different farms in a manner that is not possible with aggregate models. The research can therefore contribute to future policy development in a more flexible way. The research has uncovered some interesting findings with respect to the factors driving forward contract adoption in the dairy sector and this is likely to inform a variety of end users and assist in the development of alternative risk management tools.

The development of the farm level model expands the capacity for future research on income risk in the tillage sector. This research has focused on one particular risk management tool i.e. forward contracts. The development of this model may allow us to assess the impact of alternative risk management tools. There remains further scope for the application of analysis with respect to the risk aversion of farmers and how this relates to risk management tool adoption.

A paper was published which examined the potential relationship between farm income variability and off-farm employment decisions in the short and medium term for the case of Irish farm operators. The analysis identified a positive association between farm income variability and off-farm employment over a nine year period, but no significant relationship in the short-term. The findings suggest that off-farm employment is part of a wider portfolio decision, but is not considered by Irish farmers to be a strong immediate solution to short-term farm income shocks.

4(a) Summary of Research Outcomes

(i) Collaborative links developed during this research

The project increased the collaborative links between members of the project team drawn from Teagasc and CIT. It also increased the collaborative links between the project team and the agri-food industry in the area of price risk management, particularly in the dairy sector. Links were also developed between the project team and a financial institution providing services in the area of price risk management in commodity markets (FC Stone).

(ii) Outcomes where new products, technologies and processes were developed and/or adopted

A review of the market tools and government policies that currently exist for managing agricultural risk was produced. A multi-criteria analysis was adopted to critique the various risk management tools available. Tools were assessed according to criteria such as costs (by whom they are incurred), benefits (to whom they accrue), political and budgetary acceptability, feasibility, functionality and effectiveness in controlling risk. This allows for all tools reviewed to be ranked according to the various criteria.

Stochastic analysis undertaken as part of the further development of the FAPRI-Ireland agricultural commodity model, provided confidence intervals for medium term price projections based on a limited number of sources of uncertainty. These confidence intervals supplement the deterministic projections of the future level of prices and output quantities. Limiting the sources of uncertainty to those judged to be the most important makes it easier to interpret the results of the stochastic model simulations.

A stochastic farm level model was developed in order to assess the income risk associated with spring barley production.

(iii) Outcomes with economic potential

A greater appreciation and use of risk management tools should secure a greater level of stability in agricultural incomes, making for more resilient farm businesses better capable of coping with fluctuations in commodity prices and production related shocks such as adverse weather events.

(iv) Outcomes with national/ policy/social/environmental potential

Recognising that any deterministic projection of the future is likely to be incorrect, the research undertaken provides policy makers with a range of future price and quantity possible outcomes. In turn this could be used to ascertain possible ranges of outcome for important policy related variables such as agricultural income or the level of greenhouse gas emissions produced by the sector.

An example of where the stochastic baseline projections could be used in the future arises in the intersection of ambitions for growth in the Irish agricultural sector and the parallel ambitions to decarbonise the Irish economy so as to mitigate the impact of global climate change. The Baseline stochastic projections on average are very close to the deterministic FAPRI-Ireland model projections and in aggregate provide some comfort in that while aggregate greenhouse gas emissions from Irish agriculture do not decline over the projection period they at least do not increase dramatically. What the stochastic baseline illustrates is that there exist possible future states of the world where growth in the Irish dairy herd is such that Irish greenhouse gas emissions are likely to grow and possibly grow dramatically. Have Irish agricultural and environmental policy makers as well as agricultural industry stakeholder considered whether national climate change strategies are flexible enough to accommodate such possible developments? If a commitment under future climate change policy is to allow the Irish agricultural sector to grow in response to market demand and where the State pays for the purchase of the carbon credits required to allow Ireland to meet its international GHG reductions commitments –what potential level of future budgetary expenditure risk is the Irish state exposed to?

4 (b) Summary of Research Outputs

(i) Peer-reviewed publications, International Journal/Book chapters.

Kelly, E., O'Connor D. & Keane, M. (2013) Measurement of the effect of policy changes on volatility in dairy markets. Irish Business Journal Vol 8, Number 1.pp 26-42

Bergmann D., O'Connor, D., Thümmel A. (2014) Seasonal and cyclical behaviour of farm gate milk prices British Food Journal Vol. 117 Issue 12 (pages numbers unavailable)

Kelly E and O'Connor D. (2014) An analysis of price and volatility transmission in butter, palm oil and crude oil markets Agribusiness: an International Journal Vol 8, Number 1.pp 26-42

Loughrey J., Thorne F., Kinsella A., Hennessy T., O'Donoghue C. and Vollenweider X., (2015), Market risk management and the demand for forward contracts among Irish dairy farmers, International Journal of Agricultural Management

Loughrey J. and Hennessy T., (2016), Farm Income Variability and Off-Farm Employment in Ireland, Agricultural Finance Review

Loughrey J., Thorne F. and Hennessy T., (2016), A Microsimulation Model for Risk in Irish Tillage Farming, International Journal of Microsimulation

(ii) Scientific publications and abstracts including those presented at conferences

Bergman D., and O' Connor D. A time series decomposition analysis of EU farm gate milk prices Presentation at AES Conference, Warwick, UK April, 2012

Kelly, E., O'Connor, D., Keane, M. The effect of policy changes on volatility in dairy markets Proceedings AESI Annual Conference Dublin November 19th 2012

Kelly, E., O'Connor, D., Keane, M., Policy changes and volatility in dairy markets. Proceedings International Farm Management Congress, 19th congress 21st-26th July, Warsaw Poland 2013

Kelly, E., O'Connor, D., Keane, M., Breen, B. & Hennessy, T. Sectorial analysis of income volatility in Irish agriculture.Proceedings AES Annual Conference Warwick, England April 8th-10th 2013

Breen B., Hennessy T., Donnellan T and Hanrahan K. A review of the risk management tools available for the CAP 2013 reform. Proceedings AES Annual Conference Warwick, England April 8th-10th 2013

Keane, M., and O Connor D. Dairying in the EU - A New Paradigm? International Dairy Federation World Dairy Situation, 2013

Loughrey J, Thorne F, Kinsella A, Hennessy T, O'Donoghue C. The market risk perceptions of Irish dairy farmers 88th Annual Conference of the Agricultural Economics Society, Paris 2014

Thorne F. and Loughrey J. The Direct Impact of Risk Management Tools on Farm Income: The Case of Irelands Spring Barley Producers 89th AES Conference Warwick, April 14th 2015

O Connor D, Bergmann B and Kean M. The challenges posed by price volatility in the EU dairy sector Invited Pleanary Paper at the Agrarian Perspectives XXIV Conference, Prague, September 2015.

Donnellan T and Keane M. The EU Dairy Sector in a New Era. Invited Pleanary Paper at the Agrarian Perspectives XXIV Conference, Prague, September 2015.

(iii) National Report

Not applicable

(iv) Workshops/seminars at which results were presented

O' Connor D., and Keane M. Price volatility: Risk management – the role of futures markets. Presentation to European Dairy Association March 1st 2013

O' Connor D., and Keane M. Price volatility and the role of futures markets as a risk management tool. Presentation to Irish Dairy Industries Association, January 24th 2013

O' Connor D. Dairy Sector Risk and Risk Management in Europe. Presentation at 20th Annual National Workshop for Dairy Economists and Policy Analysts May 13th 2013

Donnellan T. Risk and uncertainty relating to Agricultural Production and future Ag GHG emissions. Presentation to Institute of Engineers. May 14th 2013

Loughrey J. Identifying and Managing Risks. National Dairy Conference, November 12th 2013

Loughrey J. Ten Year Baseline Projection and Policy Scenario for the Barley Sector in Ireland. FAPRI Missuouri Workshop, July 11th 2014

O'Connor, D and Keane M. Analysis of the Crisis Dairy Supply Management Proposal in CAP Reform 2012/2013. European Dairy Association, Brussels, July 5th 2015

O'Connor D. An Introduction to Milk Price Volatility and Risk Management. Irish Farmers Association Workshop, July 23rd 2014

O'Connor D. The Economic and Policy Dynamics of the European Dairy Market. Dairy Market Risk Management Workshop, London, September 2nd 2015

Keane M & Donnellan T. Dairy Market Prospects and Mgt of Risk Presented at DAFM High Level Group Meeting, Dublin,September 30th 2015

(v) Intellectual Property applications/licences/patents

Not applicable

(vi) Other (Popular publications)

Keane, M., and D. O Connor. Analysis of the Crisis Dairy Supply Management Proposal. Report of the Committee on Agriculture and Rural Development (COMAGRI) on CAP Reform 2013, International Dairy Magazine, pp 18-20, April 2013.

Donnellan T, Hanrahan K, Hennessy T, O Connor D and Kelly E Risk Management in Dairy Irish Food Magazine Issue 07 2012

Donnellan T, Hanrahan K, Hennessy T, O Connor D and Kelly E Risk Management in Dairy Tresearch Winter 2012

5. Scientists trained by Project

Total Number of PhD theses: _0___

There was no PhD student in the proposal.

Total Number of Masters theses: _0___

There was no Masters student in the proposal.

6. Permanent Researchers

Institution Name	Number of Permanent staff contributing to project	Total Time contribution (person years)
Teagasc	4	0.31
CIT	1	2.68
UCC	1	0.22
Total	**6**	**3.21**

7. Researchers Funded by DAFM

Type of Researcher	Number	Total Time contribution (person years)
Post Doctorates/Contract Researchers	3	3.1
PhD students	0	0
Masters students	0	0
Temporary researchers	0	0
Other	0	0
Total	**3**	**3.1**

8. Involvement in Agri Food Graduate Development Programme

Name of Postgraduate / contract researcher	Names and Dates of modules attended
Not Applicable	

9. Project Expenditure

Total expenditure of the project: € 183,348.80

Total Award by DAFM: € 199,385.94

Other sources of funding including benefit in kind and/or cash contribution(specify): € 0

Breakdown of Total Expenditure

Category	Teagasc	CIT	UCC	Total
Contract staff	79,510.59	50,795.16		130,305.75
Temporary staff				
Post doctorates				
Post graduates				
Consumables		484.78		484.78
Travel and subsistence	7,765.30	5,414.97	2378.64	15,558.91
Sub total				146,349.44
Durable equipment		412.00		412.00
Other				
Overheads	21,818.97	14,173.73	594.66	36,587.36
Total	**109,094.86**	**71,280.64**	**2973.30**	**183,348.80**

10. Leveraging

Summarise any additional resources'/funding leveraged by this award from other sources e.g. Additional Staff, National/EU funding secured, EI Commercialisation Fund, etc.

Not Applicable

11. Future Strategies

Outline development plans for the results of the research.

The Permanent staff who worked on the project will continue to liaise with relevant stakeholders, providing an understanding of the usefulness and limitations of tools that address price risk in agriculture. It is intended to continue to develop and use the stochastic modelling capacity that has

been developed. This will supplement the deterministic model projections that are already produced.