THE IMPACT OF FARMER AGE ON INDICATORS OF AGRICULTURAL SUSTAINABILITY

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ABOUT THE FLINT PROJECT

FLINT will provide an updated data-infrastructure needed by the agro-food sector and policy makers to provide up to date information on farm level indicators on sustainability and other new relevant issues. Better decision making will be facilitated by taking into account the sustainability performance of farms on a wide range of relevant topics, such as (1) market stabilisation; (2) income support; (3) environmental sustainability; (4) climate change adaptation and mitigation; (5) innovation; and (6) resource efficiency. The approach will explicitly consider the heterogeneity of the farming sector in the EU and its member states. Together with the farming and agro-food sector the feasibility of these indicators will be determined.

FLINT will take into account the increasing needs for sustainability information by national and international retail and agro-food sectors. The FLINT approach is supported by the Sustainable Agriculture Initiative Platform and the Sustainability Consortium in which the agro-food sector actively participates. FLINT will establish a pilot network of at least 1000 farms (representative of farm diversity at EU level, including the different administrative environments in the different MS) that is well suited for the gathering of these data.

The lessons learned and recommendations from the empirical research conducted in 9 purposefully chosen MS will be used for estimating and discussing effects in all 28 MS. This will be very useful if the European Commission should decide to upgrade the pilot network to an operational EU-wide system.

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LIST OF ACRONYMS

CAP	Common Agricultural Policy
CO_2	carbon dioxide
EU	European Union
FADN	Farm Accountancy Data Network
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
LFA	Less Favoured Areas
NFS	National Farm Survey
OLS	Ordinary Least Squares

EXECUTIVE SUMMARY

The farming age profile for many European countries is rapidly rising and European Union's (EU) programmes like the Young Farmer Scheme aim to redress this balance. This paper aims to analyse the impact of farmer age on economic, environmental and social indicators of sustainability in the EU, incorporating new data from the FLINT project on the age at which a farmer becomes a decision maker.

Descriptive results confirm the issue of an aging farming population in the eight EU countries considered, with mean farmer's ages of between 43 and 55, and highlight that 96% of farmers sampled would not qualify for the Young Farmers Scheme. Econometric results on the Irish sample suggest a significant relationship between indicators of economic, environmental and social sustainability and the age of the farmer. The Irish combined FLINT-Farm Accountancy Data Network (FADN) data suggest that the older the farmer is when they establish themselves as a decision maker, the less likely the farm is to be sustainable and the more likely the farmer is to reside in a vulnerable household.

The preliminary results from the FLINT-FADN data in this paper suggest that if programmes like the Young Farmers Schemes are successful in incentivising younger entrants, positive impacts on the sustainability of farming in Europe could be achieved.

1 INTRODUCTION

The global demand for food is increasing rapidly, resulting in agricultural expansion and a growth in associated environmental degradation. It has been projected that by 2050 the demand for crops will be 100-110% higher than 2005 levels. If current trends in agricultural production in developed and developing nations continue, then 1 billion hectares of land will be cleared globally by 2050, resulting in vast increases in carbon dioxide (CO_2) emissions and nitrogen use (Tilman et al., 2011). As the global population edges towards 9 billion, the required increase in food production must become more sustainable, socially, environmentally and economically. In this regard, it is expected that younger farmers are more likely than their older counterparts to develop more efficient, competitive and sustainable methods of production (DAFM, 2014a).

Sustainability is becoming increasingly important for policy makers. Within agriculture sustainable intensification is emerging as a major priority, allowing for more production from the same area of land while reducing negative impacts. Transition towards sustainability requires the support of young farmers and new entrants who will be the future of farming in the European Union (EU). Thus the current sustainability of farms headed by young farmers is of great importance to the future of farming.

Only 7 percent of farmers in the EU 27 are under the age of 35 and one third of farmers are aged 65 years or more (EC, 2011). The high cost and scarcity of land for farming along with limited and costly access to credit create high barriers to entry to young farmers. Entry is often only possible through inheritance or succession. Table 1.1 highlights the change in total utilised agricultural area (UAA) given in hectares, managed by those aged 35 and under for the years 1990-2007 for the FLINT project's partner countries.

Table 1.1: Total utilised agricultural area (UAA) in hectares managed by under 35's in FLINT member states: 1990-2007

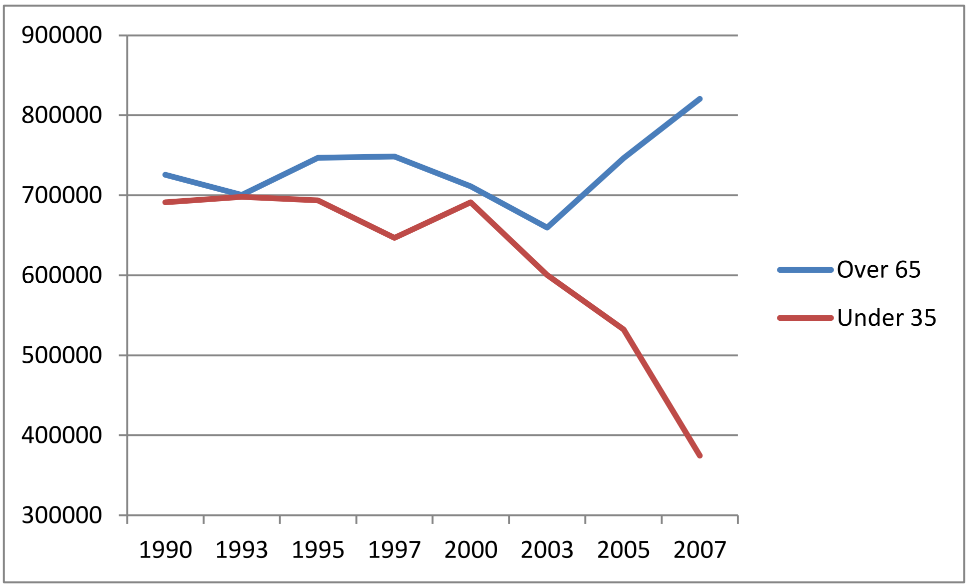
	Germany	Ireland	Greece	Spain	France	Hungary	Netherlands	Poland	Finland
1990	:	691,130	376,560	2,379,320	:	:	189,390	:	:
1993	:	698,190	331,130	2,816,580	:	:	159,160	:	:
1995	:	693,680	298,210	2,875,190	:	:	214,780	:	410,540
1997	:	646,770	270,490	2,750,580	:	:	107,930	:	370,970
2000	2,275,280	691,420	475,290	3,106,230	:	377,930	111,460	:	286,690
2003	1,760,490	600,470	519,050	2,398,980	4,294,470	294,010	154,320	:	267,670
2005	1,358,500	532,250	483,430	2,014,990	3,610,890	334,290	110,260	2,436,320	260,940
2007	1,151,250	374,500	472,700	1,876,000	3,200,890	316,540	75,250	2,551,040	264,220

Source: Eurostat

While Greece and Poland saw a slight increase in the UAA managed by those under 35 during this time period, the others experienced a steep decline. In just 7 years, the UAA in Germany managed by younger farmers declined by over a million acres and in France similar results can be seen for just four years.

Figure 1.1 highlights the sharp decline in the number of hectares under management of farmers aged below 35 years old in Ireland, particularly since 2000. The number of hectares under control of those aged 35 and under more than halved by 2007. In the same period, land under the control of those aged over 65 rose by over 100,000 hectares.

Figure 1.1: Total utilised agricultural area (UAA) in hectares managed by over 65's and under 35's in Ireland: 1990-2007



Source: Eurostat

Young farmers receive assistance under the Common Agricultural Policy (CAP) of the EU through both Pillar I and Pillar II. These supports were introduced in response to well documented demographic challenges facing European agriculture. Under Pillar I, the Young Farmers Scheme provides annual top ups to their Basic Payment for farmers aged 40 years or less who have set up their farm within the past five years. EU member states are obliged to use up to two percent of their national envelope to fund a 25 percent top-up on the Basic Payment made to young farmers for a maximum period of five years. This is intended to aid young farmers financially through the early years of their business when debt is likely to be high. Pillar II contains a combination of measures that aid young farmers starting in the industry. This includes business start-up grants (up to €70,000), general investment in physical assets, training and advisory services. To qualify young farmers must submit a business plan and implement it before the final payment is received.

Studies analysing farming sustainability have found that farmer age may be an influencing factor. Tauer (1995) found that farmer efficiency rose on average by 5%-10% every 10 years up to a middle age of 35-44 years and then declined at the same rate. Comer et al. (1999) found that sustainable farmers were younger than conventional farmers. Vanslembrouck et al. (2002) conducted a study on Belgian farmers and discovered that younger, more educated farmers were more likely to participate in voluntary agri-environmental policies. An attempt at measuring sustainable efficiency was made by van Passel et al. (2007) who found that increasing age led to lower sustainable efficiency. Zagata and Sutherland (2015) suggest that there is a difference between young farmers and new entrants and the two can often be conflated in EU policy. This study also found that young farmers managed larger farms, use more labour and generate higher value.

For the purposes of this study young farmers are defined as those aged 40 years or less. This is the age used in the CAP to identify those eligible for young farmer benefits. As CAP is extremely important to farming in the EU, and given the amount of help provided to set up young farmers this seems like the most appropriate definition to consider.

An important obstacle in investigating farmers' sustainability has up to now been the lack of data. The analysis here will rely on the data collected via the FLINT project. These are farm-level data for a sample of farmers of the FADN in several EU countries (The Netherlands, Hungary, Finland, Poland, Spain, Ireland, Greece, France and Germany). The data include accountancy data from FADN (here after: 'FADN data'), as well as additional data on economic, environmental and social sustainability of farms. These additional data, the 'FLINT data', were collected via face-to-face survey or merging of existing data,

depending on the country. The FADN and FLINT data relate to accountancy year 2015, except for France and Germany for which it is 2014.

This case study aims to understand whether age is currently a factor in the sustainability of Irish farms using sustainability indicators as a measure under the three pillars of sustainability: economic, environmental and social. This analysis will utilise both Irish FADN data and additional information from the FLINT project to establish the influence of farmer age on sustainability indicators. This will examine the value of additional data on farmer age and the age of establishment as a decision maker, on sustainability outcomes. This case study continues as follows. Firstly, the methods and data used are outlined, followed by the descriptive and econometric results, and finally key conclusions and policy implications are highlighted.

2 METHODOLOGY AND DATA

The following section outlines the concept of economic, environmental and social sustainability. It then outlines the data used in this analysis, namely the Irish FADN, collected through the Teagasc National Farm Survey (NFS) and the FLINT data, collected from eight countries in Europe (the ones listed in Table 1.1 except for France).

The FADN data are used to indicate the impact of farmer age on sustainable farm outcomes in Ireland. Although the Irish FADN data provide a range of information on economic, environmental and social outcomes, they are limited in terms of detail on the age at which the farmer became a decision maker and the years of experience as a decision maker. More detail provided by the FLINT data is presented and the impact of decision maker start age for Ireland is also presented.

2.1 Methodology

2.1.1 Sustainability indicators

'Sustainable development' as a concept has existed since the late 1980's, introduced by the 'Brundtland report' (WCED, 1987). Although no operational meaning of sustainable development has been agreed upon, from an economic point of view it aims to preserve or enlarge our capital stock including economic, social and natural capital (Pingault, 2007). The principle of sustainability has been injected into the CAP in recent years (Dillon et al., 2010). Within agriculture the concept of sustainable development has been related to both the sustainability of the agricultural system itself and its contribution to sustainable development (Bockstaller et al., 2009). This has led to the view that the farm contribution to sustainable agriculture includes an economic function (the production of goods and services, an ecological function (the management of natural resources), and a social function (the contribution to rural dynamics) (Diazabakana et al., 2014). These functions are interconnected and to move towards sustainability it is necessary to progress simultaneously.

In order to compare the sustainability of young and old farmers we need to be able to measure it. This is done through the use of sustainability indicators. Indicators are defined by the OECD (2001) as 'a representative measure involving raw data on a phenomenon that is important for policy makers'. Sustainability indicators are often split into three categories based on the sustainability pillars: economic, environmental and social.

Sustainability indicators are the dependent variables in this study. These provide an indicator of the sustainability of each of the farms in the areas of economic, environmental and social sustainability. These indicators and how they are measured is listed in

Table 2.1.

Table 2.1: Sustainability indicators

Indicator		Measure	Unit
Economic	Productivity of land	Gross output per hectare (ha)	€/hectare
	Profitability	Market based gross margin per ha	€/hectare
	Productivity of labour	Income per unpaid labour unit	€/labour unit
	Viability of investment	Farm is economically viable*	1= viable, 0= not viable
	Market orientation	Output derived from market	%
Environmental	Greenhouse gases (GHG) per ha	GHG per ha using IPCC estimates[1]	Kg CO_2 equivalent/hectare
	Nitrogen per ha	Risk to water quality	Kg nitrogen surplus/hectare
Social	Household vulnerability	Farm is not viable and no off farm employment	1= vulnerable, 0= not vulnerable
	Education	Agricultural education attainment	1= educated, 0= not educated
	Isolation risk	Live alone	1= yes, 0= no
	Work life balance	Number of hours worked	Hours worked on the farm

*Farm is viable if the farm could pay family farm labour at the minimum agricultural wage plus a 5% return on non-land assets.

A wide range of indicators can be used to represent sustainability in each of the three pillars. This is especially true for the environment as sustainability can relate to many different parts of the environment, each needing to be separately measured. The choice of indicators used is limited by the data available and whether there are comparable data across all farm systems.

2.1.2 Method

In order to assess if there are statistically significant differences due to farmer age, the differences in means of young and old farmers for each of the 11 sustainability indicators outlined previously will be tested using either a t-test or chi square test using the Irish FADN data. Following this, ordinary least squares (OLS) regressions will be conducted using this Irish FADN data. Eleven OLS regressions will be conducted, one for each of the sustainability indicators. These sustainability indicators will be the dependant variable. Each regression will include the same independent variables, outlined in the following section. These will include information on farm system, soil type etc. The independent variable of interest for this part of the study will be “age”, indicating the current farmer age.

Using the new information provided by the FLINT data, the age upon which the farmer began as a decision maker on the farm will be identified. With this information, the difference in means of those who begin as decision maker at a younger age and those who begin at an older age will be tested using either a t-test or chi square test. As above, several OLS regressions will be conducted, one for each of the sustainability indicators. The independent variable of interest for the combined FADN and FLINT data will be “start age”, indicating the age upon which the farmer became a decision maker.

[1] The methodology utilises a combination of Tier 1 and Tier 2 approaches to estimate GHG emissions per farm (tonnes of carbon dioxide equivalent (t CO_2 eq) by applying relevant coefficients from the Intergovernmental Panel on Climate Change (IPCC) to animal numbers (on the basis of age category). IPCC Tier 1 utilises simple methods with default values. Tier 2 methods include country-specific emission factors. Tier 3 includes more complex approaches, possibly models.

THE RESULTS FOR THE PRESENTED IN THE RESULTS SECTION, WITH FULL RESULTS FOR ALL OF THE OTHER INDEPENDENT VARIABLES OUTLINED IN APPENDIX A

Table 0.1: Results of each regression on sustainability indicators: Irish FADN sample

Variables	(1) Output per ha	(2) Gross margin per ha	(3) Farmily farm income per labour unit	(4) Viability	(5) Market orientation	(6) GHG per ha	(7) Nitrogen per ha	(8) Household vulnerability	(9) Education	(10) Isolation	(11) Hours worked
Age	-5.003***	-2.918***	-363.7***	-0.00590***	-0.000160	-0.0147***	-0.375***	0.0114***	-0.0133***	0.00199*	3.619
	(2.331)	(1.443)	(90.81)	(0.00143)	(0.000318)	(0.00608)	(0.168)	(0.00141)	(0.00131)	(0.00102)	(2.231)
Cattle rearing	-1,926***	-1,068***	-29,261***	-0.432***	-0.181***	-4.009***	-102.3***	0.184***	-0.233***	0.111***	-678.2***
	(80.71)	(47.86)	(2,914)	(0.0467)	(0.0102)	(0.194)	(5.009)	(0.0492)	(0.0481)	(0.0386)	(69.04)
Cattle other	-1,840***	-1,094***	-26,771***	-0.347***	-0.193***	-3.875***	-90.78***	0.166***	-0.164***	0.118***	-534.0***
	(78.67)	(44.64)	(2,856)	(0.0440)	(0.00879)	(0.183)	(5.185)	(0.0421)	(0.0440)	(0.0342)	(66.00)
Sheep	-1,834***	-1,052***	-26,548***	-0.337***	-0.236***	-4.337***	-100.7***	0.183***	-0.0886*	-0.00535	-415.5***
	(86.22)	(48.92)	(3,039)	(0.0555)	(0.0144)	(0.227)	(6.035)	(0.0560)	(0.0532)	(0.0376)	(73.64)
Tillage	-1,680***	-1,007***	-11,087**	-0.110*	-0.149***	-6.506***	-133.4***	0.0230	0.0189	0.0948*	-588.7***
	(96.15)	(57.58)	(5,523)	(0.0627)	(0.00854)	(0.230)	(6.618)	(0.0588)	(0.0557)	(0.0515)	(99.72)

Other	-1,039***	-695.3***	-5,341	-0.192**	-0.0878***	-3.087***	-66.92***	0.190**	0.0938	0.0360	-104.9
	(315.4)	(116.6)	(9,646)	(0.0942)	(0.0221)	(0.423)	(11.78)	(0.0963)	(0.0887)	(0.0756)	(145.9)
Soil class 2	-235.7***	-120.6***	-4,532**	-0.0640*	-0.0165**	-0.606***	-9.717**	0.0298	-0.0214	0.0326	-95.44*
	(57.03)	(33.86)	(2,210)	(0.0341)	(0.00692)	(0.135)	(3.992)	(0.0344)	(0.0338)	(0.0257)	(48.90)
Soil class 3	-524.6***	-271.4***	-3,013	-0.0330	-0.102***	-1.514***	-20.58***	0.0259	-0.113**	0.0698	-127.9
	(77.01)	(44.89)	(2,867)	(0.0595)	(0.0182)	(0.231)	(5.112)	(0.0619)	(0.0572)	(0.0480)	(85.41)
Number of residents in household	37.21*	39.18***	1,818**	0.0262**	0.00705***	0.0861*	0.435	-0.0266**	0.0254**		41.94***
	(20.45)	(11.63)	(770.7)	(0.0108)	(0.00207)	(0.0458)	(1.162)	(0.0110)	(0.0109)		(15.49)
Region 1,	135.8	13.23	1,977	-0.105*	0.0478***	0.0925	-4.349	0.0595	0.0281	0.0224	-327.3***
	(97.89)	(60.10)	(3,565)	(0.0612)	(0.0140)	(0.231)	(7.071)	(0.0601)	(0.0571)	(0.0441)	(87.83)
Region 3	213.3*	68.29	11,204***	0.123**	0.0492***	0.479*	0.379	-0.104*	0.00537	-0.000622	-298.2***
	(119.6)	(61.72)	(3,606)	(0.0586)	(0.0121)	(0.267)	(7.539)	(0.0568)	(0.0573)	(0.0446)	(86.32)
Region 4	218.5**	120.7**	15,414***	0.111*	0.0462***	0.390	-3.089	-0.114*	0.0472	0.00248	-201.2**
	(109.2)	(59.42)	(4,522)	(0.0584)	(0.0132)	(0.241)	(6.711)	(0.0580)	(0.0544)	(0.0438)	(86.60)
Region 5	153.1	171.3**	11,852***	0.0995	0.0459***	0.257	-6.957	-0.0944	0.112*	0.00715	-58.55
	(117.2)	(73.14)	(3,554)	(0.0650)	(0.0136)	(0.292)	(7.413)	(0.0641)	(0.0623)	(0.0477)	(81.58)
Region 6	190.7**	105.2*	14,634***	0.125***	0.0304***	0.398*	0.432	-0.0915**	0.0533	-0.00509	-293.5***
	(94.88)	(61.10)	(3,337)	(0.0455)	(0.0104)	(0.215)	(6.142)	(0.0452)	(0.0450)	(0.0349)	(74.25)
Region 8	141.1	82.94	5,598*	0.0366	0.0144	0.262	-8.185	-0.135**	-0.163***	0.0497	-261.2***
	(93.74)	(58.13)	(2,908)	(0.0659)	(0.0166)	(0.251)	(6.729)	(0.0642)	(0.0610)	(0.0494)	(88.42)
Less severly disadvantaged area	-275.7***	-186.9***	-1,370	0.0103	-0.0420***	-0.545***	-7.387	-0.00125	0.00920	-0.0171	85.29
	(73.32)	(44.00)	(2,845)	(0.0380)	(0.00712)	(0.174)	(4.909)	(0.0375)	(0.0394)	(0.0302)	(58.64)
Severely disadvantaged area	-399.2***	-295.3***	-8,580***	-0.0916*	-0.0641***	-0.827***	-10.72*	0.0685	-0.124**	-0.0548	7.083
	(80.97)	(48.11)	(3,177)	(0.0504)	(0.0111)	(0.200)	(5.786)	(0.0498)	(0.0501)	(0.0399)	(71.05)
Constant	3,537***	1,810***	59,934***	0.965***	0.879***	9.113***	184.3***	-0.250***	1.342***	-0.0239	2,258***
	(178.0)	(104.8)	(6,343)	(0.0975)	(0.0199)	(0.454)	(12.18)	(0.0967)	(0.0896)	(0.0611)	(145.2)
Number of	872	872	872	872	872	872	872	872	872	872	871

observations											
R-squared	0.634	0.649	0.301	0.281	0.606	0.652	0.554	0.199	0.263	0.041	0.228

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 0.2: Results of each regression on sustainability indicators: Irish FLINT sample

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2.2 Data

2.2.1 FADN data

Irish FADN data for 2015 are used for this analysis. This is collected through the Teagasc NFS, which surveys a statistically representative random sample of farms. A series of face-to-face interviews are conducted by a professional data collection team on an annual basis. The NFS also provides more detailed information used to supplement the FADN data in this study. This analysis looks at all the farm systems for which data are collected namely dairy, cattle rearing, cattle other, sheep, tillage and other. These are classified on a standard gross margin basis.

The FADN data are used in this analysis to examine the impact of farmer age on each sustainability indicator in Table 2.1. The sustainability indicators are the dependent variables of interest, and the independent variable of interest is a variable indicating the age of the farmer.

Other variables included in this analysis are a range of farm characteristics including the farm system, (detailed above) and soil type. This variable is comprised of 3 classifications: class 1 indicating soil with little or minor limitations in terms of agricultural use; class 2 comprising of soils with more limitations, poorer drainage and those that are generally unsuitable for tillage; and class 3, consisting of soils that are greatly limited in terms of agricultural use, primarily found in the West of Ireland and mountainous areas.

A variable is also included to classify those areas designated as "less favoured" (Less Favoured Areas – LFA)[2]. This variable consists of three categories: the first consisting of those regions not classed as disadvantaged; the second comprising of less severely disadvantaged areas and the third, indicating regions regarded as severely disadvantaged. The number of people in the household is also included. Region variables are also included, however the Dublin region is excluded from the analysis due to the small sample size. The final Irish FADN data set consists of 877 observations.

2.2.2 FLINT data

The FLINT survey included information on the age at which the farmer became a decision maker and the years of experience as a decision maker. This data is not available from the FADN data and so this new information is subsequently incorporated with the FADN data in OLS regressions, outlined in the results section. Following the methodology established in the previous section, the sustainability indicators are the dependent variables of interest. The FLINT data can then provide an important independent variable: the age upon which the farmer took over the farm. As above, the FADN and NFS data will provide the other explanatory variables such as farm system, soil type etc.

The full FLINT sample in this report includes data from 822 farms for eight European countries, as represented in Table 2.2. Although France is a project partner, the results for this country were not available at the time of this analysis. The FLINT sample is not nationally or geographically representative; however it provides useful pilot information on the age upon which the farmer became the decision maker and the experience of the farmer. The partner countries adopted different strategies for

[2] The Disadvantaged Area Scheme, introduced under EEC Council Directive 268/753 sought to "ensure the continued conservation of the countryside in mountain areas and in certain other less-favoured areas". It established that farmers in these areas were disadvantaged due to permanent natural handicaps and as a result were prevented from receiving a "level of income similar to that enjoyed by farms of a comparable type in other regions." (DAFM, 2014b).

collecting this data, with some using agricultural researchers and others availing of students. In Ireland, these data were collected in conjunction with the annual NFS survey by Teagasc surveyors. The data relate to 2015 accountancy year (2014 for Germany).

Table 2.2: FLINT national farm samples

	Number of farms sampled
Ireland (IE)	65
Germany (DE)	52
Netherlands (NL)	155
Greece (EL)	124
Spain (ES)	128
Finland (FI)	50
Hungary (HU)	102
Poland (PL)	146
Total	822

Nineteen observations were dropped as they indicated a decision maker start age of below 15, leaving 803 observations in total. There were a further 220 missing observations to this variable, as for only 583 farmers the question relating to start age as decision maker was available.

3 RESULTS

3.1 Summary statistics using the FLINT data

Figure 3.1 outlines the mean age at which farmers in each of the FLINT pilot sample countries became a decision maker on the farm along with the mean years of experience (calculated as the difference between the start year and current age). This information indicates that although there are slight differences amongst countries, farmers establish themselves as decision makers generally between the age of 24 and 34. Farmers in the Finnish sample represent the youngest starting cohort, with a mean decision maker age of 24 and the oldest are found in the Hungarian sample. Due to having the oldest mean farmer age, Irish farmers have more years of experience as the decision maker. Even though the Finnish farmers start younger as decision makers, this sample has the joint least experience with Denmark, due to the lower mean current age for the sampled farmers in this country.

It is not fully clear from these results if the farmer was the primary decision maker when he/she began as a decision maker. In Ireland, for example, the mean age for a farmer now is 55. When these farmers became decision makers they were, on average, 30 years old. This could represent general aging rural populations or it could mean that when these farmers became decision makers it was under the supervision or alongside others on the farm e.g. a parent or other manager.

Figure 3.1: Mean starting age as decision maker, years of experience as decision maker and current age: FLINT samples

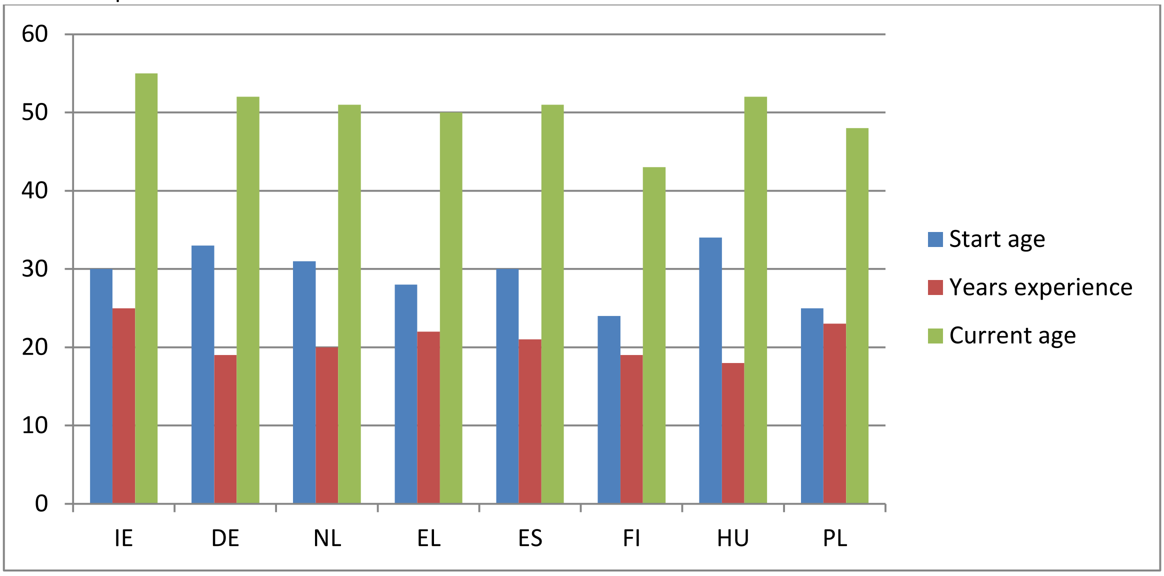

Table 3.1: Farmers qualifying for Young Farming Scheme: FLINT samples

	Number of qualifying farmers	% of national sample
Ireland (IE)	0	0%
Germany (DE)	1	2%
Netherlands (NL)	5	3%
Greece (EL)	3	3%
Spain (ES)	7	6%
Finland (FI)	5	10%
Hungary (HU)	2	2%
Poland (PL)	8	5%
Total	31	

Table 3.1 outlines the number of farmers in the FLINT sample per country that would qualify for the Young Farmers Scheme: that is, they are aged 40 or under in 2015 and have less than five year's experience in farming. Thirty-one farmers out of the sample of 803 would qualify, approximately 4% of the sample. Ireland had no farmers in the sample which would qualify for this scheme, reflecting the older farming population and high experience (Fig. 3.1). Finland has the highest proportion of farmers which would qualify, again due to their lower mean age and experience. This table emphasises the need for incentives for young farmers in agriculture, highlighting the lack of new, younger entrants.

3.2 Irish FADN results

In order to further investigate the impact of farmer age, Irish FADN and Teagasc NFS data is analysed. Table 3.2 presents the average values of the sustainability indicators in the three categories (economic, environmental and social) for Irish farmers over 40 years and those at or below 40 years of age. All the economic variables are significantly different for the two groups. Young farmers obtained over €550 more per hectare in gross output. When costs are accounted for, the difference in gross margin per hectare was over €300. There were also significant differences in the environmental indicators with young farmers faring worse on average than their older counterparts. Social indicators showed that on average young farmers were more likely to have a positive rating i.e. they are less likely to live in a vulnerable household, they are more likely to have agricultural education and are less isolated (less likely to live alone). The number of hours worked showed no significant difference with only 6.5 hours separating the two groups.

Table 3.4: Average of sustainability indicators for old and young farmers and the significance of the difference in means: full FLINT sample

	Old farmers		Young farmers		Difference	
	mean	sd	mean	sd	value	t
Output per ha	1924.03	1199.95	2476.95	1308.22	-552.92	4.46***
Gross margin per ha	893.50	705.60	1207.08	793.83	-313.58	4.18***
Family farm income per labour unit	31676.40	32387.42	45386.29	38377.88	-13709.89	3.80***
Viability	0.49	0.50	0.67	0.47	-0.18	13.47*** (χ^2)
Market orientation	0.75	0.15	0.78	0.14	-0.04	2.71**
GHG per ha	5.05	2.87	6.35	3.31	-1.30	4.16***
Nitrogen per ha	82.38	68.89	111.67	84.31	-29.30	3.71***
Household vulnerability	0.38	0.49	0.15	0.36	0.23	-26.23*** (χ^2)
Education	0.55	0.50	0.84	0.37	-0.29	-38.33*** (χ^2)
Isolation	0.15	0.36	0.07	0.26	0.08	-5.929** (χ^2)
Hours worked	2012.97	710.98	2019.46	765.05	-6.49	-0.09
Number of observations	750		127		877	

*** p<0.01, ** p<0.05, * p<0.1
Chi square (χ^2) results reported for binary variables

There are notable differences between young and old farmers in Table 3.2 in terms of their characteristics that must be accounted for when looking at the above variables. One of these is the type of farming undertaken by young farmers. Over 50% of farmers aged 40 or under are dairy farmers compared to 33% of the older farmers. As dairy farming can have high levels of investment in infrastructure and is generally the most time-consuming farming sector, it is important to control for sectoral differences when analysing the data.

THESE FACTORS ARE CONTROLLED FOR IN THE REGRESSIONS, OUTLINED IN TABLE 3.3, WHICH INCLUDE VARIABLES RELATING TO FARMING SECTOR, LFA ETC. THE RESULTS OF THE REGRESSIONS ON THE SUSTAINABILITY INDICATORS USING THE FADN AND TEAGASC NFS DATA ARE OUTLINED IN THIS TABLE. THE COEFFICIENTS OF THE AGE VARIABLE ARE

PRESENTED FOR EACH OF THE REGRESSIONS. FULL REGRESSION RESULTS, THAT IS TO SAY FOR ALL EXPLANATORY VARIABLES, CAN BE FOUND IN APPENDIX A

Table 0.1: Results of each regression on sustainability indicators: Irish FADN sample

Variables	(1) Output per ha	(2) Gross margin per ha	(3) Farmily farm income per labour unit	(4) Viability	(5) Market orientation	(6) GHG per ha	(7) Nitrogen per ha	(8) Household vulnerability	(9) Education	(10) Isolation	(11) Hours worked
Age	-5.003**	-2.918**	-363.7***	-0.00590***	-0.000160	-0.0147**	-0.375**	0.0114***	-0.0133***	0.00199*	3.619
	(2.331)	(1.443)	(90.81)	(0.00143)	(0.000318)	(0.00608)	(0.168)	(0.00141)	(0.00131)	(0.00102)	(2.231)
Cattle rearing	-1,926***	-1,068***	-29,261***	-0.432***	-0.181***	-4.009***	-102.3***	0.184***	-0.233***	0.111***	-678.2***
	(80.71)	(47.86)	(2,914)	(0.0467)	(0.0102)	(0.194)	(5.009)	(0.0492)	(0.0481)	(0.0386)	(69.04)
Cattle other	-1,840***	-1,094***	-26,771***	-0.347***	-0.193***	-3.875***	-90.78***	0.166***	-0.164***	0.118***	-534.0***
	(78.67)	(44.64)	(2,856)	(0.0440)	(0.00879)	(0.183)	(5.185)	(0.0421)	(0.0440)	(0.0342)	(66.00)
Sheep	-1,834***	-1,052***	-26,548***	-0.337***	-0.236***	-4.337***	-100.7***	0.183***	-0.0886*	-0.00535	-415.5***
	(86.22)	(48.92)	(3,039)	(0.0555)	(0.0144)	(0.227)	(6.035)	(0.0560)	(0.0532)	(0.0376)	(73.64)
Tillage	-1,680*	-1,007*	-11,087*	-0.110*	-0.149***	-6.506*	-133.4*	0.0230	0.0189	0.0948*	-588.7*

	**	**	*			**	**				**
	(96.15)	(57.58)	(5,523)	(0.0627)	(0.00854)	(0.230)	(6.618)	(0.0588)	(0.0557)	(0.0515)	(99.72)
Other	-1,039***	-695.3***	-5,341	-0.192**	-0.0878***	-3.087***	-66.92***	0.190**	0.0938	0.0360	-104.9
	(315.4)	(116.6)	(9,646)	(0.0942)	(0.0221)	(0.423)	(11.78)	(0.0963)	(0.0887)	(0.0756)	(145.9)
Soil class 2	-235.7***	-120.6***	-4,532**	-0.0640*	-0.0165**	-0.606***	-9.717**	0.0298	-0.0214	0.0326	-95.44*
	(57.03)	(33.86)	(2,210)	(0.0341)	(0.00692)	(0.135)	(3.992)	(0.0344)	(0.0338)	(0.0257)	(48.90)
Soil class 3	-524.6***	-271.4***	-3,013	-0.0330	-0.102***	-1.514***	-20.58***	0.0259	-0.113**	0.0698	-127.9
	(77.01)	(44.89)	(2,867)	(0.0595)	(0.0182)	(0.231)	(5.112)	(0.0619)	(0.0572)	(0.0480)	(85.41)
Number of residents in household	37.21*	39.18***	1,818**	0.0262**	0.00705***	0.0861*	0.435	-0.0266**	0.0254**		41.94***
	(20.45)	(11.63)	(770.7)	(0.0108)	(0.00207)	(0.0458)	(1.162)	(0.0110)	(0.0109)		(15.49)
Region 1,	135.8	13.23	1,977	-0.105*	0.0478***	0.0925	-4.349	0.0595	0.0281	0.0224	-327.3***
	(97.89)	(60.10)	(3,565)	(0.0612)	(0.0140)	(0.231)	(7.071)	(0.0601)	(0.0571)	(0.0441)	(87.83)
Region 3	213.3*	68.29	11,204***	0.123**	0.0492***	0.479*	0.379	-0.104*	0.00537	-0.000622	-298.2***
	(119.6)	(61.72)	(3,606)	(0.0586)	(0.0121)	(0.267)	(7.539)	(0.0568)	(0.0573)	(0.0446)	(86.32)
Region 4	218.5**	120.7**	15,414***	0.111*	0.0462***	0.390	-3.089	-0.114*	0.0472	0.00248	-201.2**
	(109.2)	(59.42)	(4,522)	(0.0584)	(0.0132)	(0.241)	(6.711)	(0.0580)	(0.0544)	(0.0438)	(86.60)
Region 5	153.1	171.3**	11,852***	0.0995	0.0459***	0.257	-6.957	-0.0944	0.112*	0.00715	-58.55
	(117.2)	(73.14)	(3,554)	(0.0650)	(0.0136)	(0.292)	(7.413)	(0.0641)	(0.0623)	(0.0477)	(81.58)
Region 6	190.7**	105.2*	14,634***	0.125***	0.0304***	0.398*	0.432	-0.0915**	0.0533	-0.00509	-293.5***
	(94.88)	(61.10)	(3,337)	(0.0455)	(0.0104)	(0.215)	(6.142)	(0.0452)	(0.0450)	(0.0349)	(74.25)
Region 8	141.1	82.94	5,598*	0.0366	0.0144	0.262	-8.185	-0.135**	-0.163***	0.0497	-261.2***
	(93.74)	(58.13)	(2,908)	(0.0659)	(0.0166)	(0.251)	(6.729)	(0.0642)	(0.0610)	(0.0494)	(88.42)
Less severly disadvantaged area	-275.7***	-186.9***	-1,370	0.0103	-0.0420***	-0.545***	-7.387	-0.00125	0.00920	-0.0171	85.29
	(73.32)	(44.00)	(2,845)	(0.0380)	(0.00712)	(0.174)	(4.909)	(0.0375)	(0.0394)	(0.0302)	(58.64)
Severely disadvantaged area	-399.2***	-295.3***	-8,580***	-0.0916*	-0.0641***	-0.827***	-10.72*	0.0685	-0.124**	-0.0548	7.083
	(80.97)	(48.11)	(3,177)	(0.0504)	(0.0111)	(0.200)	(5.786)	(0.0498)	(0.0501)	(0.0399)	(71.05)
Constant	3,537***	1,810***	59,934***	0.965***	0.879***	9.113***	184.3***	-0.250***	1.342***	-0.0239	2,258***

	(178.0)	(104.8)	(6,343)	(0.0975)	(0.0199)	(0.454)	(12.18)	(0.0967)	(0.0896)	(0.0611)	(145.2)
Number of observations	872	872	872	872	872	872	872	872	872	872	871
R-squared	0.634	0.649	0.301	0.281	0.606	0.652	0.554	0.199	0.263	0.041	0.228

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 0.2: Results of each regression on sustainability indicators: Irish FLINT sample

.

Table 0.3: Results for each regression with sustainability indicator as dependent variable: Irish FADN sample

Indicators	Age coefficients	Stanard error	R-squared	Number of observations
Economic				
Output per ha	-5.003**	2.331	0.634	872
Gross margin per ha	-2.918**	1.443	0.649	872
Family farm income per labour unit	-363.7***	90.81	0.301	872
Viability	-0.006***	0.001426	0.280	872
Market orientation	-0.00016	0.000318	0.606	872
Environmental				
GHG per ha	-0.0147**	0.00608	0.652	872
Nitrogen per ha	-0.375**	0.168	0.554	872
Social				
Household vulnerability	0.01141***	0.0014	0.199	872
Education	-0.01331***	0.00130	0.220	872
Isolation	0.00199*	0.0010	0.040	872
Hours worked	3.619	2.231	0.228	871

Robust standard errors reported
*** p<0.01, ** p<0.05, * p<0.1

These results show a significant relationship between the majority of the sustainability indicators used and the age of the head farmer. The effect of the age variable on the economic sustainability indicators is significant except in the case of market orientation. Output per hectare was estimated to decrease by €5 per increase in one year of age of the farmer at the 5% significance level. The decrease in the gross margin per year of age within the sample was smaller on average, by €2.9 for every year of age at a 5% significance level. Family farm income per unpaid labour unit declines significantly on average for each additional year of age of the head farmer by €364 at a 1% significance level. The relationship between age and the viability of the farm, which is equal to one when the farm provides a minimum agricultural wage and has a 5% return on investment, is also significant, declining with every year of age. Age in the regression of market orientation (the proportion of income from output rather than subsidies) was insignificant. Age is significant in both the environmental indicators regressions at the 5% level. Both indicators are decreasing with age. This suggests that younger farmers are less environmentally sustainable than older farmers (all else held constant). This, along with the higher levels of output and gross margin, suggests that young farmers are likely to farm more intensively. The social indicators of household vulnerability, education and isolation show that younger farmers are more socially sustainable. Every year of age of the farmer increases the odds of living in a vulnerable household. Younger farmers are also more likely to have agricultural education. At the 10% level of significance older farmers are also more likely to live in isolation. There was found to be no significant relationship between age and the number of hours worked on the farm.

3.3 Irish FLINT + FADN results

The results above indicated the importance of farmer age in terms of sustainability indicators. The FLINT data provide additional information on the age upon which the farmer becomes a decision maker. As the mean age of establishment as a decision maker in Ireland was 30, a variable indicating a "young" start age was created. This is a binary variable which takes a value of 1 if the farmer is aged 25 and under when they become a decision maker.

Table 3.4 presents the difference in means for the Irish FLINT sample of those who took over the farm aged 25 and under and those who were older, incorporating the sustainability indicators from the Irish FADN database. The significance of these differences was tested using either a t-test or chi square test.

Although this sample was small, consisting of 62 respondents, this preliminary analysis indicated that there were significant differences between the two groups for several of the indicators. Farms with younger starters had a higher output per hectare on average by approximately €592 in comparison to their older counterparts. Farms with younger decision makers also had a higher gross margin per hectare, by approximately €362 per hectare. The younger sample is also more likely to be market oriented. As with the FADN difference in means outlined earlier, the environmental indicators showed the opposite with younger starters faring worse in both the GHG per hectare measure and nitrogen surplus per hectare. Though farmers who took over at a younger age appear to fare better in terms of the social indicators, these results are not significant.

Table 3.4: Average of sustainability indicators for Irish farmers who started aged 25 and under, those who started older and the significance of the difference in means: Irish FLINT sample

	Young start age		Older start age		Difference	
	mean	sd	mean	sd	value	t
Output per ha	2795.84	261.67	2203.45	1406.58	592.39	1.67*
Gross margin per ha	1386.31	805.82	1023.83	854.06	362.49	1.69*
Family farm income per labour unit	41927.59	29760.45	35588.06	35552.81	6339.523	0.74
Viability	0.65	0.49	0.50	0.51	0.15	1.45(χ^2)
Market orientation	0.83	0.10	0.76	0.14	0.06	2.07**
GHG per ha	7.51	3.25	5.87	3.15	1.64	1.99**
Nitrogen per ha	149.86	93.93	108.44	79.80	41.41	1.87**
Household vulnerability	0.27	0.45	0.39	0.49	-0.11	-2.92(χ^2)
Education	0.65	0.49	0.58	0.50	0.07	0.32(χ^2)
Isolation	0.08	0.27	0.17	0.38	-0.09	-1.08(χ^2)
Hours worked	2181.35	566.02	2106.39	570.92	74.96	0.51
Number of observations	26		36		62	

*** p<0.01, ** p<0.05, * p<0.1
Chi square (χ^2) results reported for binary variables

AS ABOVE, REGRESSIONS ARE USED IN ORDER TO FURTHER ANALYSE THE INFLUENCE OF THE AGE UPON WHICH A FARMER BECOMES A DECISION SUSTAINABILITY INDICATORS 3.5. THE COEFFICIENTS OF RESULTS, THAT IS TO SAY ON ALL EXPLANATORY

Table 0.1: Results of each regression on sustainability indicators: Irish FADN sample

Variables	(1) Output per ha	(2) Gross margin per ha	(3) Farmily farm income per labour unit	(4) Viability	(5) Market orientation	(6) GHG per ha	(7) Nitrogen per ha	(8) Household vulnerability	(9) Education	(10) Isolation	(11) Hours worked
Age	-5.003***	-2.918***	-363.7***	-0.00590***	-0.000160	-0.0147***	-0.375**	0.0114***	-0.0133***	0.00199*	3.619
	(2.331)	(1.443)	(90.81)	(0.00143)	(0.000318)	(0.00608)	(0.168)	(0.00141)	(0.00131)	(0.00102)	(2.231)
Cattle rearing	-1,926***	-1,068***	-29,261***	-0.432***	-0.181***	-4.009***	-102.3***	0.184***	-0.233***	0.111***	-678.2***
	(80.71)	(47.86)	(2,914)	(0.0467)	(0.0102)	(0.194)	(5.009)	(0.0492)	(0.0481)	(0.0386)	(69.04)

Cattle other	-1,840***	-1,094***	-26,771***	-0.347***	-0.193***	-3.875***	-90.78***	0.166***	-0.164***	0.118***	-534.0***
	(78.67)	(44.64)	(2,856)	(0.0440)	(0.00879)	(0.183)	(5.185)	(0.0421)	(0.0440)	(0.0342)	(66.00)
Sheep	-1,834***	-1,052***	-26,548***	-0.337***	-0.236***	-4.337***	-100.7***	0.183***	-0.0886*	-0.00535	-415.5***
	(86.22)	(48.92)	(3,039)	(0.0555)	(0.0144)	(0.227)	(6.035)	(0.0560)	(0.0532)	(0.0376)	(73.64)
Tillage	-1,680***	-1,007***	-11,087**	-0.110*	-0.149***	-6.506***	-133.4***	0.0230	0.0189	0.0948*	-588.7***
	(96.15)	(57.58)	(5,523)	(0.0627)	(0.00854)	(0.230)	(6.618)	(0.0588)	(0.0557)	(0.0515)	(99.72)
Other	-1,039***	-695.3***	-5,341	-0.192**	-0.0878***	-3.087***	-66.92***	0.190**	0.0938	0.0360	-104.9
	(315.4)	(116.6)	(9,646)	(0.0942)	(0.0221)	(0.423)	(11.78)	(0.0963)	(0.0887)	(0.0756)	(145.9)
Soil class 2	-235.7***	-120.6***	-4,532**	-0.0640*	-0.0165**	-0.606***	-9.717**	0.0298	-0.0214	0.0326	-95.44*
	(57.03)	(33.86)	(2,210)	(0.0341)	(0.00692)	(0.135)	(3.992)	(0.0344)	(0.0338)	(0.0257)	(48.90)
Soil class 3	-524.6***	-271.4***	-3,013	-0.0330	-0.102***	-1.514***	-20.58***	0.0259	-0.113**	0.0698	-127.9
	(77.01)	(44.89)	(2,867)	(0.0595)	(0.0182)	(0.231)	(5.112)	(0.0619)	(0.0572)	(0.0480)	(85.41)
Number of residents in household	37.21*	39.18***	1,818**	0.0262**	0.00705***	0.0861*	0.435	-0.0266**	0.0254**		41.94***
	(20.45)	(11.63)	(770.7)	(0.0108)	(0.00207)	(0.0458)	(1.162)	(0.0110)	(0.0109)		(15.49)
Region 1,	135.8	13.23	1,977	-0.105*	0.0478***	0.0925	-4.349	0.0595	0.0281	0.0224	-327.3***
	(97.89)	(60.10)	(3,565)	(0.0612)	(0.0140)	(0.231)	(7.071)	(0.0601)	(0.0571)	(0.0441)	(87.83)
Region 3	213.3*	68.29	11,204***	0.123**	0.0492***	0.479*	0.379	-0.104*	0.00537	-0.000622	-298.2***
	(119.6)	(61.72)	(3,606)	(0.0586)	(0.0121)	(0.267)	(7.539)	(0.0568)	(0.0573)	(0.0446)	(86.32)
Region 4	218.5**	120.7**	15,414***	0.111*	0.0462***	0.390	-3.089	-0.114*	0.0472	0.00248	-201.2**
	(109.2)	(59.42)	(4,522)	(0.0584)	(0.0132)	(0.241)	(6.711)	(0.0580)	(0.0544)	(0.0438)	(86.60)
Region 5	153.1	171.3**	11,852***	0.0995	0.0459***	0.257	-6.957	-0.0944	0.112*	0.00715	-58.55
	(117.2)	(73.14)	(3,554)	(0.0650)	(0.0136)	(0.292)	(7.413)	(0.0641)	(0.0623)	(0.0477)	(81.58)
Region 6	190.7**	105.2*	14,634***	0.125***	0.0304***	0.398*	0.432	-0.0915**	0.0533	-0.00509	-293.5***
	(94.88)	(61.10)	(3,337)	(0.0455)	(0.0104)	(0.215)	(6.142)	(0.0452)	(0.0450)	(0.0349)	(74.25)
Region 8	141.1	82.94	5,598*	0.0366	0.0144	0.262	-8.185	-0.135**	-0.163***	0.0497	-261.2***
	(93.74)	(58.13)	(2,908)	(0.0659)	(0.0166)	(0.251)	(6.729)	(0.0642)	(0.0610)	(0.0494)	(88.42)

Less severely disadvantaged area	-275.7***	-186.9***	-1,370	0.0103	-0.0420***	-0.545***	-7.387	-0.00125	0.00920	-0.0171	85.29
	(73.32)	(44.00)	(2,845)	(0.0380)	(0.00712)	(0.174)	(4.909)	(0.0375)	(0.0394)	(0.0302)	(58.64)
Severely disadvantaged area	-399.2***	-295.3***	-8,580***	-0.0916*	-0.0641***	-0.827***	-10.72*	0.0685	-0.124**	-0.0548	7.083
	(80.97)	(48.11)	(3,177)	(0.0504)	(0.0111)	(0.200)	(5.786)	(0.0498)	(0.0501)	(0.0399)	(71.05)
Constant	3,537***	1,810***	59,934***	0.965***	0.879***	9.113***	184.3***	-0.250***	1.342***	-0.0239	2,258***
	(178.0)	(104.8)	(6,343)	(0.0975)	(0.0199)	(0.454)	(12.18)	(0.0967)	(0.0896)	(0.0611)	(145.2)
Number of observations	872	872	872	872	872	872	872	872	872	872	871
R-squared	0.634	0.649	0.301	0.281	0.606	0.652	0.554	0.199	0.263	0.041	0.228

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 0.2: Results of each regression on sustainability indicators: Irish FLINT sample

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Table 0.5: Results for each regression with sustainability indicator as dependent variable: Irish FLINT sample

Indicators	Start age coefficient	Standard error	R-squared	Number of observations
Economic				
Output per ha	-3.427	7.222	0.738	61
Gross margin per ha	-2.736	4.174	0.744	61
Family farm income per labour unit	-200.5	223.3	0.579	61
Viability	-0.00945***	0.00329	0.528	61
Market orientation	-0.000947	0.000785	0.885	61
Environmental				61
GHG per ha	-0.0089	0.0205	0.703	61
Nitrogen per ha	-0.486	0.593	0.67	61
Social				61
Household vulnerability	0.0117***	0.00363	0.439	61
Education	-0.00183	0.00492	0.312	61
Isolation	0.00491	0.00534	0.268	61
Hours worked	-8.237	5.745	0.409	61

Robust standard errors reported
*** p<0.01, ** p<0.05, * p<0.1

Due to the small sample size, these results are not significant for many of the sustainability indicators. However, the significant results suggest that the older the farmer is when he/she becomes a decision maker, the less viable the farm becomes and the more likely it is that the farmer will reside in a vulnerable household. Although the majority of the effects are not significant, all of the economic indicators are decreasing with increasing start age. The environmental sustainability indicators are also decreasing. This is likely to be related to the reduced farm output, although again, this is insignificant. The results for the social sustainability indicators suggest that a higher start age may also reduce the likelihood that the farmers will receive agricultural education, increases the likelihood of isolation and implies that these farmers work less hours, but again these results are not statistically significant.

4 CONCLUSION

4.1 Conclusions on the analysis

The literature on farmer age indicates that the presence of younger farmers can have a positive impact on economic (Zagata and Sutherland, 2015), environmental (Vanslembrouck et al., 2002) and social (Comer et al., 1999) indicators of sustainability. The aim of this case study was to analyse the impact of farmer age on these indicators, utilising new data incorporating the age at which the farmer became a decision maker, along with years of experience. The results from this paper highlight the issue of an ageing farming population, with mean farmers' ages of between 43 and 55. This could have a negative impact on farming efficiency in the future as studies have shown that farming efficiency can decline by 5%-10% on average every 10 years after a middle age of between 35-44 years (Tauer, 1995).

The Irish FADN results suggest a significant relationship between indicators of economic, environmental and social sustainability, and the age of the farmer. For each additional year of farmer age, declines can be seen in output per hectare, gross margin per hectare, family farm income and farm viability. As the farmer ages, declines can be seen in environmental impacts. This is likely to be due to the fact that younger farmers are more intensive, and as a result they have a greater GHG output per hectare than their less intensive counterparts and it is probable that due to increased efficiencies their GHG emission per kg of output is lower than older farmers. Intensive farmers are also more likely to have a greater nitrogen surplus per hectare. This is consistent with the 2016 Teagasc NFS Sustainability Report (Lynch et al., 2015). Younger farmers appear to be more socially sustainable. Older farmers are more likely to live in a vulnerable household and in isolation and are less likely to have attained agricultural education.

The Irish combined FLINT + FADN data suggests that the age at which the farmer becomes the decision maker matters in terms of viability and household sustainability. The older the farmer is when they establish themselves as a decision maker, it is less likely that the farm will be sustainable and the more likely they are to live in a vulnerable household.

These results highlight the importance of programmes such as the Young Farmer Scheme. The majority of EU farmers are over 55 years old and one-third are above the standard retirement age of 65. In Ireland, currently less than 6% of farmers are under the age of 35. Young farmers (under 40) receive assistance under the CAP of the EU through both Pillar I and Pillar II. Studies have shown that incentives for young farmers can have positive results. Davis et al. (2013) found significant positive impacts from a New Entrants Scheme in Northern Ireland, particularly in comparison to an Early Retirement Scheme. They found that younger farmers had a longer planning horizon and were more likely to invest in business growth than their older counterparts. McDonald et al. (2013) found that a scheme to incentivise new entrants to the dairy industry resulted in a young, highly educated and highly resourced group of new farmers. The preliminary results from the FADN and FLINT data in this paper echo this, and suggest that if programmes like the Young Farmers Schemes are successful in incentivising younger entrants, then this could have a positive impact on the longer term sustainability of farming in Europe.

4.2 Conclusions on the data

There are limitations to this work. The European FLINT and Irish FLINT samples are small and are not geographically or nationally representative. Inconsistencies in the data may be present due to the various data collection methods used in the partner countries and due to the pilot nature of the study, which collected new and different types of data.

The results for the FLINT mean age data as represented in Figure 3.1 are unclear. It may be the case that becoming a decision maker does not mean taking over the farm but instead working alongside or under a parent or other decision maker. This could explain why the mean age in Ireland for example was 30 for

becoming a decision maker while 55 was the current farmer mean age. Or it may represent ageing farming populations and general rising mean ages. It is not possible to disaggregate this result.

The OLS regressions could potentially be improved with the use of logit regressions for the binary variables, however, particularly in the case of the FLINT data the sample size was too small for this to be undertaken.

There were issues with the data collection. Nineteen farmers appeared to become a decision maker below the age of 15, two of which provided negative ages and eight were aged 10 or under. These appear to be data entry errors and on this basis these observations were excluded in this analysis.

There were a further 220 missing observations for decision maker start age, where presumably the farmer did not know the answer, refused to answer or was not asked.

Despite these limitations, as this work was undertaken as a pilot test study it provides a considerable level of groundwork and valuable learnings from which a full scale project could be established.

4.3 Conclusions on the usefulness of FLINT data

The FLINT descriptive data highlight the difference between the mean age at which the sample farmers become decision makers in the FLINT EU countries and the current mean age of farmers. These data underline the ageing population of farmers but also provide valuable information on the age at which new entrants become farmers or become decision makers on the farm. As Zagata and Sutherland (2015) suggest, it makes the distinction between new entrants (by providing the age at which they became a decision maker) and current farmer age.

Irish FADN data provides information on the importance of farmer age in terms of sustainability indicators. These results show that the rising mean farmer age alluded to in the FLINT descriptive statistics could be detrimental to the industry, particularly for economic and social sustainability.

Although this analysis was conducted with a limited data set, the combined FLINT + FADN results provide information that is not available from FADN data alone. The combined results indicate that the age at which a farmer becomes a decision maker matters also in terms of social sustainability, particularly for viability and household vulnerability. These results indicate that there may be a wider issue to be analysed in terms of encouraging new, younger entrants into the farming industry. It is possible that a larger sample could find that the age 40 cut-off for the Young Farmer Scheme may be too high in terms of attracting young and dynamic entrants (Tauer, 1995).

4.4 Recommendations

Generally, a larger sample size would have improved the accuracy of the econometric analysis. A greater sample size per country would also allow for detailed descriptive statistics and specific country-by-country comparisons on economic, environmental and social outcomes. Analysis could have also been conducted with the full FLINT sample and not just one nation, as in this paper, which could provide a broader European perspective.

Due to the small sample size, logit regressions were not conducted for the binary variables (i.e. viability, household vulnerability, education, and isolation). This type of regression could improve the accuracy and statistical significance of the variables. A larger sample size would allow for this without the necessity of dropping observations.

It is also recommended that data collectors are more precise in the way in which they provide responses. The FLINT pilot survey marked a divergence from the standard FADN invoice-based questions to qualitative questions. It is possible that surveyors did not have experience in this area and additional training may be required.

The question on year of establishment as decision maker resulted in 220 missing observations across the eight countries. One reason could be due to the farmer having difficulty recalling such information; if so, perhaps an instrumental measure can be established e.g. the first year in which they completed a farm survey.

If this pilot is extended to a larger study, it is recommended that the term “decision maker” be clarified. Instead, the main farmer could be asked the age upon which he/she took over the farm/ became the owner or became the *primary* decision maker. Alternatively, another question could be added to clarify if the respondent was the sole decision maker or one of a number of decision makers.

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APPENDIX A

Table 0.1: Results of each regression on sustainability indicators: Irish FADN sample

Variables	(1) Output per ha	(2) Gross margin per ha	(3) Farmily farm income per labour unit	(4) Viability	(5) Market orientation	(6) GHG per ha	(7) Nitrogen per ha	(8) Household vulnerability	(9) Education	(10) Isolation	(11) Hours worked
Age	-5.003**	-2.918**	-363.7***	-0.00590***	-0.000160	-0.0147**	-0.375**	0.0114***	-0.0133***	0.00199*	3.619
	(2.331)	(1.443)	(90.81)	(0.00143)	(0.000318)	(0.00608)	(0.168)	(0.00141)	(0.00131)	(0.00102)	(2.231)
Cattle rearing[3]	-1,926***	-1,068***	-29,261***	-0.432***	-0.181***	-4.009***	-102.3***	0.184***	-0.233***	0.111***	-678.2***
	(80.71)	(47.86)	(2,914)	(0.0467)	(0.0102)	(0.194)	(5.009)	(0.0492)	(0.0481)	(0.0386)	(69.04)
Cattle other	-1,840***	-1,094***	-26,771***	-0.347***	-0.193***	-3.875***	-90.78***	0.166***	-0.164***	0.118***	-534.0***
	(78.67)	(44.64)	(2,856)	(0.0440)	(0.00879)	(0.183)	(5.185)	(0.0421)	(0.0440)	(0.0342)	(66.00)
Sheep	-1,834***	-1,052***	-26,548***	-0.337***	-0.236***	-4.337***	-100.7***	0.183***	-0.0886*	-0.00535	-415.5***
	(86.22)	(48.92)	(3,039)	(0.0555)	(0.0144)	(0.227)	(6.035)	(0.0560)	(0.0532)	(0.0376)	(73.64)
Tillage	-1,680***	-1,007***	-11,087**	-0.110*	-0.149***	-6.506***	-133.4***	0.0230	0.0189	0.0948*	-588.7***
	(96.15)	(57.58)	(5,523)	(0.0627)	(0.00854)	(0.230)	(6.618)	(0.0588)	(0.0557)	(0.0515)	(99.72)
Other	-1,039***	-695.3***	-5,341	-0.192**	-0.0878***	-3.087***	-66.92***	0.190**	0.0938	0.0360	-104.9
	(315.4)	(116.6)	(9,646)	(0.0942)	(0.0221)	(0.423)	(11.78)	(0.0963)	(0.0887)	(0.0756)	(145.9)
Soil class 2[4]	-235.7***	-120.6***	-4,532**	-0.0640*	-0.0165**	-0.606***	-9.717**	0.0298	-0.0214	0.0326	-95.44*
	(57.03)	(33.86)	(2,210)	(0.0341)	(0.00692)	(0.135)	(3.992)	(0.0344)	(0.0338)	(0.0257)	(48.90)
Soil class 3	-524.6***	-271.4***	-3,013	-0.0330	-0.102***	-1.514***	-20.58***	0.0259	-0.113**	0.0698	-127.9
	(77.01)	(44.89)	(2,867)	(0.0595)	(0.0182)	(0.231)	(5.112)	(0.0619)	(0.0572)	(0.0480)	(85.41)
Number of residents in household	37.21*	39.18***	1,818**	0.0262**	0.00705***	0.0861*	0.435	-0.0266**	0.0254**		41.94***
	(20.45)	(11.63)	(770.7)	(0.0108)	(0.00207)	(0.0458)	(1.162)	(0.0110)	(0.0109)		(15.49)
Region 1[5],[6]	135.8	13.23	1,977	-0.105*	0.0478***	0.0925	-4.349	0.0595	0.0281	0.0224	-327.3***

[3] Dairy farming dropped as base category
[4] Soil class 1 dropped as base category
[5] Region 7 dropped as base category: includes counties Cork and Kerry
[6] Region 1: includes counties: Louth, Leitrim, Sligo, Cavan, Donegal, Monaghan

	(97.89)	(60.10)	(3,565)	(0.0612)	(0.0140)	(0.231)	(7.071)	(0.0601)	(0.0571)	(0.0441)	(87.83)
Region 3[7]	213.3*	68.29	11,204***	0.123**	0.0492***	0.479*	0.379	-0.104*	0.00537	-0.000622	-298.2***
	(119.6)	(61.72)	(3,606)	(0.0586)	(0.0121)	(0.267)	(7.539)	(0.0568)	(0.0573)	(0.0446)	(86.32)
Region 4[8]	218.5**	120.7**	15,414***	0.111*	0.0462***	0.390	-3.089	-0.114*	0.0472	0.00248	-201.2**
	(109.2)	(59.42)	(4,522)	(0.0584)	(0.0132)	(0.241)	(6.711)	(0.0580)	(0.0544)	(0.0438)	(86.60)
Region 5[9]	153.1	171.3**	11,852***	0.0995	0.0459***	0.257	-6.957	-0.0944	0.112*	0.00715	-58.55
	(117.2)	(73.14)	(3,554)	(0.0650)	(0.0136)	(0.292)	(7.413)	(0.0641)	(0.0623)	(0.0477)	(81.58)
Region 6[10]	190.7**	105.2*	14,634***	0.125***	0.0304***	0.398*	0.432	-0.0915**	0.0533	-0.00509	-293.5***
	(94.88)	(61.10)	(3,337)	(0.0455)	(0.0104)	(0.215)	(6.142)	(0.0452)	(0.0450)	(0.0349)	(74.25)
Region 8[11]	141.1	82.94	5,598*	0.0366	0.0144	0.262	-8.185	-0.135**	-0.163***	0.0497	-261.2***
	(93.74)	(58.13)	(2,908)	(0.0659)	(0.0166)	(0.251)	(6.729)	(0.0642)	(0.0610)	(0.0494)	(88.42)
Less severly disadvantaged area	-275.7***	-186.9***	-1,370	0.0103	-0.0420***	-0.545***	-7.387	-0.00125	0.00920	-0.0171	85.29
	(73.32)	(44.00)	(2,845)	(0.0380)	(0.00712)	(0.174)	(4.909)	(0.0375)	(0.0394)	(0.0302)	(58.64)
Severely disadvantaged area	-399.2***	-295.3***	-8,580***	-0.0916*	-0.0641***	-0.827***	-10.72*	0.0685	-0.124**	-0.0548	7.083
	(80.97)	(48.11)	(3,177)	(0.0504)	(0.0111)	(0.200)	(5.786)	(0.0498)	(0.0501)	(0.0399)	(71.05)
Constant	3,537***	1,810***	59,934***	0.965***	0.879***	9.113***	184.3***	-0.250***	1.342***	-0.0239	2,258***
	(178.0)	(104.8)	(6,343)	(0.0975)	(0.0199)	(0.454)	(12.18)	(0.0967)	(0.0896)	(0.0611)	(145.2)
Number of observations	872	872	872	872	872	872	872	872	872	872	871
R-squared	0.634	0.649	0.301	0.281	0.606	0.652	0.554	0.199	0.263	0.041	0.228

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[7] Region 3: includes counties: Kildare, Meath, Wicklow
[8] Region 4: includes counties: Laois, Longford, Offaly, Westmeath
[9] Region 5: includes counties: Clare, Limerick, Tipperary North
[10] Region 6: includes counties: Carlow, Kilkenny, Wexford, Tipperary South, Waterford
[11] Region 8: includes counties: Galway, Mayo, Roscommon

Table 0.2: Results of each regression on sustainability indicators: Irish FLINT sample

Variables	(1) Output per ha	(2) Gross margin per ha	(3) Farmily farm income per labour unit	(4) Viability	(5) Market orientation	(6) GHG per ha	(7) Nitrogen per ha	(8) Household vulnerability	(9) Education	(10) Isolation	(11) Hours worked
Start age	-3.427	-2.736	-200.5	-0.00945***	-0.000947	-0.00890	-0.486	0.0117***	-0.00183	0.00491	-8.237
	(7.222)	(4.174)	(223.3)	(0.00329)	(0.000785)	(0.0205)	(0.593)	(0.00363)	(0.00492)	(0.00534)	(5.745)
Cattle rearing [12]	-1,938***	-1,140***	-15,295*	-0.225	-0.197***	-4.692***	-130.1***	-0.139	-0.177	0.178	-740.4***
	(335.9)	(202.0)	(9,066)	(0.165)	(0.0256)	(0.841)	(22.54)	(0.162)	(0.202)	(0.154)	(204.2)
Cattle other	-2,255***	-1,340***	-25,405***	-0.238	-0.210***	-5.066***	-135.7***	0.160	-0.250	0.291**	-220.8
	(270.7)	(172.8)	(8,823)	(0.165)	(0.0208)	(0.659)	(21.70)	(0.164)	(0.159)	(0.135)	(171.9)
Sheep	-2,542***	-1,430***	-20,507**	-0.346**	-0.309***	-6.904***	-154.8***	0.0619	-0.216	-0.113	-360.3
	(400.0)	(262.3)	(8,122)	(0.157)	(0.0425)	(0.916)	(22.95)	(0.352)	(0.445)	(0.121)	(249.9)
Other	1,192***	643.7***	23,160*	0.739***	0.0586***	-1.287	-86.84**	-0.760***	0.339*	-0.147	-477.9*
	(321.9)	(176.6)	(12,168)	(0.227)	(0.0186)	(0.833)	(40.04)	(0.210)	(0.178)	(0.0963)	(240.3)
Soil class 2	-522.6**	-219.3	-1,709	0.0446	-0.00869	-1.274**	-27.49*	-0.0951	-0.345***	-0.0760	-235.2
	(232.9)	(132.4)	(7,491)	(0.129)	(0.0168)	(0.539)	(15.06)	(0.131)	(0.123)	(0.113)	(142.3)
Soil class 3	-309.6	-141.6	-541.6	0.0322	-0.0251	-0.900	-44.37	0.0115	-0.319	-0.187	-406.7*
	(464.2)	(332.6)	(11,134)	(0.216)	(0.0318)	(1.008)	(26.86)	(0.257)	(0.246)	(0.125)	(208.4)
Number of residents in household	-92.31	-27.69	3,094	-0.0179	0.000253	-0.186	-10.32	0.00240	0.0647		-10.56
	(76.63)	(39.63)	(2,523)	(0.0388)	(0.00491)	(0.205)	(6.800)	(0.0408)	(0.0518)		(56.12)
Region 1	153.2	-32.96	-16,431	-0.448	0.0271	0.830	-14.70	0.373	0.198	0.408*	-589.6
	(490.7)	(231.2)	(14,686)	(0.319)	(0.0321)	(1.260)	(49.13)	(0.323)	(0.243)	(0.222)	(355.6)
Region 3	984.0**	623.7***	27,845*	0.175	0.0483*	2.160**	6.502	-0.319	-0.170	0.166	-1,078***
	(404.6)	(181.6)	(14,617)	(0.309)	(0.0254)	(1.065)	(42.41)	(0.282)	(0.213)	(0.182)	(350.1)
Region 4	419.7	356.6	19,080	0.408	0.0899**	0.970	-6.241	-0.422	0.449**	0.146	-266.2
	(493.0)	(239.8)	(13,753)	(0.282)	(0.0363)	(1.083)	(42.36)	(0.294)	(0.171)	(0.210)	(321.5)
Region 5	-3.422	139.6	1,595	-0.0246	0.0741**	1.078	-44.42	0.111	0.293	0.316	-437.1
	(502.9)	(255.3)	(15,942)	(0.378)	(0.0338)	(1.239)	(46.91)	(0.364)	(0.242)	(0.229)	(357.7)
Region 6	188.2	25.65	2,496	0.257	0.0398	0.671	-49.50	-0.236	-0.0318	0.361	-632.5*
	(483.5)	(221.3)	(15,258)	(0.268)	(0.0275)	(1.368)	(48.86)	(0.281)	(0.267)	(0.258)	(333.3)

[12] Tillage farms were not surveyed as part of the FLINT study, so this variable was omitted.

FLINT

Region 8	457.7	302.0	-5,201	-0.203	0.0371	1.666	-29.09	0.363	0.221	0.374	-557.7
	(574.6)	(314.0)	(15,441)	(0.343)	(0.0343)	(1.472)	(49.71)	(0.354)	(0.283)	(0.256)	(399.8)
Less severly disadvantaged area	-512.6	-280.1	-1,441	0.148	-0.0227	-1.596	-14.82	-0.0846	0.0266	-0.119	234.8
	(361.4)	(185.3)	(13,119)	(0.169)	(0.0141)	(0.995)	(24.29)	(0.147)	(0.197)	(0.135)	(162.0)
Severely disadvantaged area	-492.3	-289.1	-8,062	0.0952	-0.0449**	-1.162	-28.52	-0.224	-0.187	-0.0971	30.03
	(459.4)	(243.2)	(14,347)	(0.205)	(0.0217)	(1.188)	(27.93)	(0.172)	(0.205)	(0.138)	(165.0)
Constant	4,130***	2,054***	47,837***	0.967***	0.904***	10.31***	289.3***	0.0696	0.665**	-0.272	3,246***
	(496.1)	(271.5)	(13,795)	(0.323)	(0.0372)	(1.268)	(52.50)	(0.331)	(0.302)	(0.217)	(426.6)
Number of observations	61	61	61	61	61	61	61	61	61	61	61
R-squared	0.738	0.744	0.579	0.528	0.885	0.703	0.670	0.439	0.312	0.268	0.409

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1