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Is off-farm income driving on-farm investment?

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1

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Abstract

National Farm Survey data for Ireland shows that in the ten year period from 1995 to 2005 average farm incomes declined by almost 17 percent while net new investment increased by almost 30 percent in real terms. This paper explores the factors affecting farmers' decisions to invest in farming. In particular, the role of non-farm income in the farm investment decision is explored. The theory that farmers may be investing non-farm income in the farm business is tested empirically. Economic theory suggests that it may be rational for part-time farmers to substitute capital for labour, thereby releasing labour for off-farm work while still maintaining farm output. The results of the econometric models estimated in this paper lead us to reject this hypothesis. The results indicate that, when farm size, system and income are controlled for, the presence of off-farm income earned by the farmer decreases the probability of farm investment and has no significant effect on the level of farm investment. The effect of off-farm income earned by the farmer's spouse is less clear. The presence and level of the spouse's off-farm income increases the probability of farm investment, although it has no significant impact on the level of investment.

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2

Is off-farm income driving on-farm investment?

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Introduction

Despite the ever growing divergence between farm and non-farm incomes, farmers continue to invest in agriculture. Data for Ireland shows that in the ten year period from 1995 to 2005 average farm incomes declined by almost 17 percent while net new investment increased by almost 30 percent in real terms over the same period (Connolly et al. 2005). Moreover, anecdotal evidence drawn from advertisements in the farming print media suggests that the market for agricultural farm machinery remains buoyant. Data on agricultural equipment shows that in 2005 over 4,000 new tractors were sold, the highest level observed for 20 years (FTMTA, 2005). Given that agriculture is a sector in relative decline, with farm numbers in decline and farm and non-farm incomes continuing to diverge, it is surprising then that new investment in farming has remained so positive, especially when one considers the alternative investment opportunities available, in a buoyant economy like Ireland. Furthermore, the 2003 reform of the CAP led to the decoupling of direct payments from production and a consequent decline in the coupled returns to agriculture, which one would expect to lead to a decline in agricultural activity. It is, therefore, somewhat counter-intuitive that given the apparent disincentives to invest in farming that agricultural investment levels remained positive.

This paper explores the factors affecting farm investment decisions with a view to identifying why farm investment has increased despite the apparent poor returns to farming. In particular, the focus of this paper is on the role of off-farm income. While farm incomes have been declining in real terms over the last number of years, the number of farm households supplementing the family farm income with earnings from other sources has increased. In this paper the hypothesis that farm families are using income earned outside the agricultural sector to re-invest in farming is tested empirically. The paper begins by providing a clear definition of farm investment and some background information on investment trends in farming in Ireland. Following this a

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3

theoretical model is developed which is used to explain why farmers invest in agriculture. This theoretical model forms the basis of the hypothesis that is empirically tested in the following section. The paper concludes with a discussion of the factors affecting farm investment in Ireland.

Defining Investment

The Irish National Farm Survey (NFS), which is a member of the Farm Accountancy Data Network of Europe, collects data from a random sample of approximately 1,200 farms each year and records both family farm income and investment levels, (Connolly et al, 2005). The NFS records both gross and net new investment. Net new investment is defined as investment (including both purchase and repair) in buildings, land improvements, machinery, and production quotas, less all sales, grants and subsidies. The net new investment measure does not include land purchases. It is a very apt definition of farm investment as it excludes all grants and subsidies and therefore accounts for only "actual" investment. Furthermore, the exclusion of investment in land purchases means that it does not include any potentially speculative investment, such as farmers buying land with the intention of re-selling for a profit.

NFS data show that over the period 1995 to 2004, average family farm income declined by 17 percent in real terms, while net new investment increased by almost 30 percent. Figure 1 shows net new investment as a percentage of income for the various farm systems that are defined in the NFS.

Figure 1: Net New Investment as a Percentage of Farm Income
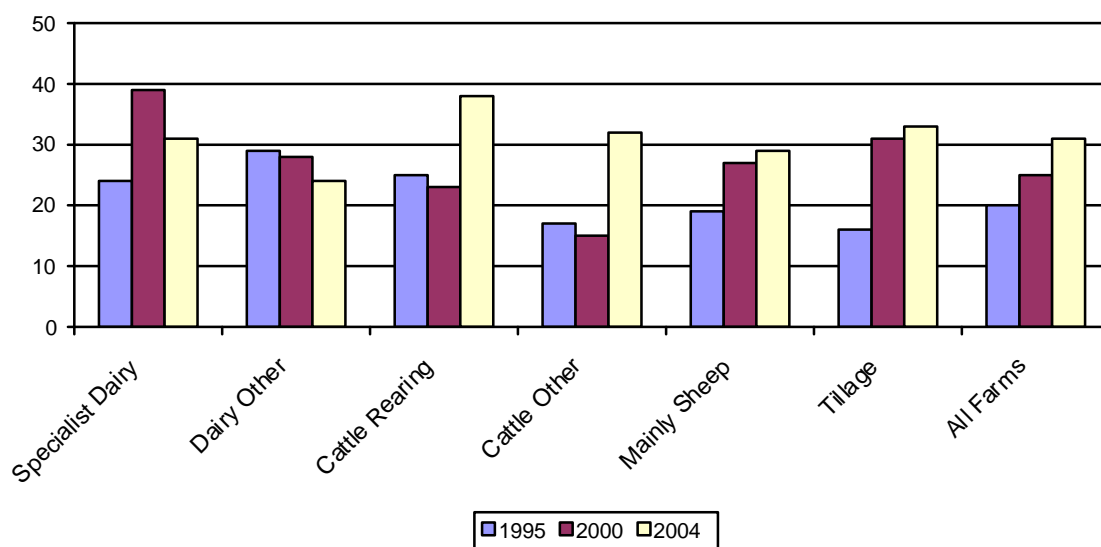
Source: NFS

The data in Figure 1 show that while investment levels are volatile across the period, there is a consistent trend of increasing investment levels across all farm systems over time, with the exception of the dairy and other system.[1] When all farm systems are combined, the percentage of farm income being re-invested in farming grew from 20 percent in 1995 to just over 30 percent in 2004.

Figure 2: Investment Type – 2004 National Farm Survey Data
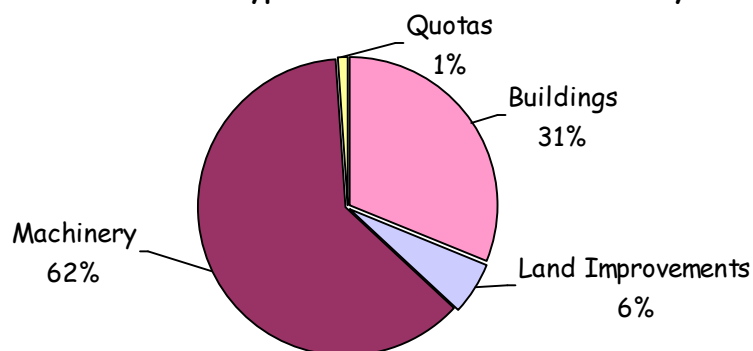
Source: NFS

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[1] A full description of farm systems is available from the National Farm Survey, see www.teagasc.ie

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5

It is also interesting to consider the types of farm investment. Figure 2 decomposes the net new investment data into the different types of investment. Machinery is the most common source of investment, accounting for over 60 percent of net new investment. About 31 percent of investment relates to new buildings or repair to existing ones while investment in production quotas accounts for just 1 percent of net new investment across all farms in 2004.

Why Farmers Invest – Previous Findings

It seems counter-intuitive that investment in farming would remain buoyant despite falling real farm incomes. One possibility is that although farm incomes are declining, total farm household income may be increasing, as farmers and their spouses supplement declining farm profits with non-farm earnings. In Ireland, the number of farm households where the farmer and/or spouse were participating in the off-farm labour market has increased from 36.5 per cent in 1995 to over 50 per cent in 2004. Similar trends have been recorded across the EU; in Austria more than 50 percent of farms have off-farm income (Weiss 1999), 61% of Norwegian farm families have off-farm employment (Lien et al 2006) while Phimister and Roberts (2002) found that around 10 percent of all Scottish farmers and nearly 30 percent of farmers' spouses have off-farm employment. This paper empirically tests the theory that the growth in the non-farm earnings of farm households is affecting farm investment levels. Previous studies have examined the relationship between these two phenomena but the conclusions have been mixed.

Previous empirical studies of farm investment have found statistically significant relationships between farm investment and off-farm employment, albeit there is no consistency in the direction of the relationship. Rosenzweig and Wolpin (1993) found a positive relationship between off-farm income and farm investment, as farmers with stable off-farm incomes were more likely to invest in farm capital. Ahituv and Kimhi (2000) came to a more mixed conclusion. They concluded that on the one hand a substitution effect exists between farm labour and capital, where farmers working off-farm substitute capital for labour as capital deepening releases labour from farm production. On the other hand, however, they also refer to an expansion effect; whereby investment in farming increases the marginal productivity of family labour on

the farm thus making farm work more productive than non-farm work. Upton and Haworth (1987) and Weiss (1999) found evidence to support the substitution effect, as both found significant positive relationships between farm growth and off-farm income, thereby suggesting that farms with higher levels of off-farm income were more likely to grow their farms through investment. Anderson et al. (2005), using a larger database through which farm and non-farm investments were recorded, found that investment in farm assets falls relative to non-farm assets as off-farm income increases. In this paper we adopt a cross-sectional approach and examine the relationship between farm investment and off-farm income.

Why Farmers Invest – A Theoretical Model

The agricultural household model offers insights into why one would expect the time spent working off-farm and the level of off-farm income earned to affect farm investment. The agricultural household model developed by Singh, Squire and Strauss (1986) can be used to explain many aspects of farmers' behaviour. The model is based on the premise that farmers behave to maximise utility, which is assumed to be a function of consumption C and leisure time L, as expressed by equation 1.

$$\text{Maximise } U = f(C, L) \tag{1}$$

subject to the following constraints

$$T = L + O + F \qquad O \geq 0 \tag{2}$$

$$C = w\,O + w_f\,F + V \tag{3}$$

$$w_f\,F = (P_f\,Q_f - I_f\,X_f) \tag{4}$$

$$Q_f = f(F, X, H, R) \tag{5}$$

$$w = w(H, Z) \tag{6}$$

Leisure time is constrained by the time constraint (2), which shows that time is finite and is allocated between leisure, farm work (F) and off-farm work (O). Consumption is constrained by budget (3). The household budget is derived from off-farm wages ($w\,O$) and the return to farm labour ($w_f\,F$) and non-labour income (V) which may include, among

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7

other things, returns to non-agricultural investments. The return to farm labour is a function of farm profit and time. Farm profit is derived from the quantity of products produced Q_f times a vector of the prices received P_f, less variable costs of production, $I_f X_f$, where I is the input price vector and X is the quantity of inputs used. The technology constraint (equation 5) represents what can be produced on the farm. Total farm output Q_f is a function of the time allocated to farm work F, the quantity of inputs used X, the human capital H and finally R which is a vector of exogenous factors that determine the production function, these include variables such as capital stock, machinery and other technologies. Finally the off-farm wage is also affected by human capital and local labour market conditions, Z.

It follows then that farmers will allocate their time between farm and non-farm work in such a way that maximises their leisure time and consumption. If farmers can improve technology (R) so that the same output can be produced (Q) without increasing the allocation of farm time (F), then other things being equal, farmers can choose to work less, maintain consumption and have more leisure time (a wealth effect), spend more time working off-farm thereby relaxing the budget constraint and increasing consumption (a substitution effect), or maintain the farm labour allocation, increase farm output and relax the budget constraint (an expansion effect).

Using Irish National Farm Survey data it is possible to test for the presence of a substitution or expansion effect, but not for the wealth effect as data on leisure time is not available. By examining the investment decisions of farmers, it is possible to test the relationship between farm investment and off-farm income. If there is a positive relationship between off-farm income and farm investment, we can conclude that a substitution effect is present, i.e. farmers are investing in labour-saving devices so as to increase the amount of time available for working off-farm. If there is no positive relationship between off-farm work and on-farm investment, and if there is a positive relationship between farm output and investment, then we can conclude that an expansion effect is present. The ensuing section of the paper explains the empirical models that allow us to test these hypotheses.

Modelling the Investment Decision – The Empirical Model

Two related decisions are under analysis, the first is the decision to invest in farming activities and the second is the level of investment. Therefore, two empirical models are necessary; a participation model and a level of investment model. In this article, we use a two-step econometric model. The first step is a binary probit model that captures the characteristics influencing the decision to invest. Following this, a conditional truncated submodel is specified that models the factors affecting the level of investment conditional on the decision to invest. Modelling the level of investment decision conditional on, rather than jointly with, the decision to invest overcomes the major shortcoming of the Tobit, Poisson, and Multinomial logit models used in previous studies. These models impose the assumption that personal and farm characteristics influence the adoption decision and the quantity of investment decision in the same way (Lin and Schmidt year?). In general, the two-step model approach allows the same (or different) variables to affect the adoption and the quantity of investment decisions in different ways via different coefficients (Katchova and Miranda, 2004).

The investment decision model used is binary, and estimates the probability of each farmer investing in farming activities given the farm and demographic characteristics. It is a binary choice model where the dependent variable investment is equal to one if the farmer invests in farming activities and equals zero otherwise. We assume;

$$Prob\ (O_i=1 \mid x_i) = F\ (x_i\beta) \tag{7}$$

where F is some normal distribution function bound by the [0,1] interval, i.e. $0 \leq F(x_i\beta) \leq 1$ to satisfy the probability properties. If we assume F to be a probability distribution then equation 1 can be estimated using a probit model. The probit model is estimated using the maximum likelihood procedure. Where the effect (β) of a vector of explanatory variables, x, on the probability of investment (p_i) is estimated. The estimated coefficient corresponding to an explanatory variable measures its influence on the probability of investment. Thus the effect of non-farm income on the probability of investing in farming can be tested.

Using the estimates of the probit model, the probability of investing in farming activities can be estimated. Thus, for a particular farm when the values of the independent variables are known, it is possible to estimate the probability of that farmer investing in farming activities. Additionally, if a policy change such as decoupling of direct payments is expected to change farm wages and household wealth, it is possible, with the probit model, to estimate the effect of such changes on the probability of investment.

The dependent variable in the level of investment model is the total amount invested by farm households in farming activities and it is incidentally truncated, that is for some observations, those who do not invest, the level of investment recorded is zero. As this data is censored it may give rise to sample selection bias. Verbeek (2000) notes that sample selection bias may occur if some of the unobserved factors in the first stage model, that is in the selection process, also enter the second stage model. If this is the case, they are both being captured by the error terms and therefore we cannot conclude that the error terms are independent, and consequently it cannot be concluded that the estimates yielded from the models are unbiased.

The decision to invest in farming activities is;

$$p_i * = x_{i2}\beta + e_{i2} \tag{8}$$

where $p_i *$ measures the probability of the farmer investing in farming activities. The selection rule is that $y_i = y_i *$ if, $p_i * = 1$ in other words the dependent variable in the level of investment model is only observed for observations with a positive probability of investing in farming activities. The level of investment submodel is structured as follows;

$$y_i * = x_{i1}\gamma + e_{i1} \tag{9}$$

$y_i *$ measures the level of investment in farming activities as a function of a vector of independent variables, x_{i1}, and unobservable factors. The two error terms are distributed

$$\begin{pmatrix} \varepsilon_{i1} \\ \varepsilon_{i2} \end{pmatrix} \approx \text{NID} \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \begin{pmatrix} \sigma 2_1 \\ \sigma 12 \end{pmatrix} \end{pmatrix} \qquad (10)$$

If the correlation coefficient suggests that the error terms in these two models e_{i1} e_{i2} are uncorrelated, then the level of investment equation can be estimated consistently by ordinary least squares. However, if the error terms are significantly correlated, then it can be concluded that some unobserved variable is significantly influencing both decisions, the decision to invest and the level of investment decision. In other words, there is a problem of sample selection bias and the estimates from the level of investment model must be corrected.

Heckman (1979) proposed a two-stage estimation method to test and correct for sample selection bias. In this case, the first stage is the decision to invest in farming activities, while the second stage is the level of investment in farming activities. The first stage model must contain at least one explanatory variable that is not included in the second stage level of investment model, which is known as the identification restriction; therefore, a variable must be found which affects the decision to invest in on-farm activities but does not affect the level of investment. The estimated parameters from the first stage participation model are used to estimate the Inverse Mills Ratio, ($\widehat{\lambda}_i$) by dividing the probability density function by the cumulative density function as follows

$$\widehat{\lambda}_i = \frac{\phi(x_{i2}\beta)}{\Phi(x_{i2}\beta)} \qquad (11)$$

Next the Inverse Mills Ratio $\widehat{\lambda}_i$ is used as an additional regressor in the second stage level of investment model which is only run for those observations that invest in farming activities. The significance of the Inverse Mills ratio in the investment model is the test for sample selection bias. The null hypothesis is that there is no sample selection bias, i.e. $\widehat{\lambda}_i$ =0. If a simple t-test suggests that $\widehat{\lambda}_i$ is not statistically significantly different from zero, then we can conclude that sample selection bias is not a problem and the co-efficients of a straightforward OLS model can be used.

Data – National Farm Survey Data

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11

NFS data for 2004, consisting of 1226 observations, are used to estimate the model described above. As outlined in previous sections there has been an increasing trend (in the number) of farm households participating in the off-farm labour market. This source of income plays a vital role in ensuring the sustainability of farm households. The National Farm Survey (NFS), produced annually by Teagasc, provides estimates of family farm income for different categories of farms. Despite the wealth of data created by the NFS, it provides only limited information regarding off-farm occupations of farm operators/spouses. The off-farm income earned by operators and spouses are allocated to income ranges only, and there is no information relating to income earned or the labour force participation of any other household members.

Table 1 describes the investment activities of farms included in the 2004 NFS. We can see from Table 1 that two-thirds of all farmers in the sample invested in farming activities in 2004, with the average investment being approximately €12,500. To assess the contribution of off-farm income, the sample has been divided on the basis of off-farm labour market participation. On farms where there was no off-farm income present, the average family farm income in the 2004 sample was €27,300 compared to €24,900 for the full sample or €22,500 for sample farms where off-farm income was present. The frequency of investment is similar for both groups, with 65% of farmers having no off-farm income investing compared to 66% for farmers with off-farm income. The level of investment, however, was slightly larger on farms where no off-farm income was present, €13,398, compared to €11,827 for farms with off-farm income.

A sub-group of the off-farm income group of farms is presented separately in Table 1. This sub group is comprised of farms where the farm operator does not work off the farm and the off-farm income is earned only by the spouse. There are 266 observations in this group. This is the most profitable group of farms with an average family farm income of €35,247. It is also the group with the highest frequency of investment with 83% of observations having investment, compared to 66% of the full sample. The data presented in Table 1 suggests that the presence of off-farm income in general may not affect the probability of investment, but the source of the off-farm income may be significant. In other words, farms that are operated on a full-time capacity but where

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12

the spouse works off-farm are the most likely to invest. This hypothesis will be tested empirically.

Table 1: Sample Statistics for Farms with and without investment

	All Farmers	No off-farm Income	Off-farm Income	Spouse only off-farm income
No. of Farms (%)	1226 (100%)	611 (49%)	615 (51%)	266 (21%)
Average FFI	24,910	27,336	22,500	35,247
%. with Off-farm income	50	none	All	All
% Investing	66	65	66	83
Average Investment	12,599	13,398	11,827	15,477

Source: NFS 2004?

The variables included in the models are outlined in Table 2. To explore the effect of off-farm income on the decision to invest in farming activities, we have included both the presence of off-farm income earned by farmer or spouse as well as the level of income as categorical variables.[2] Both sets of variables are presented in the table for information purposes, but due to multicollinearity, indicators of the presence of off-farm income as well as the level cannot both be included. Table 2 also contains the other explanatory variables that are hypothesised to affect the investment decision, such as farm size and system among others.

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[2] The level of off-farm earnings is not reported for all farms that indicate that off-farm income is present.

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13

Table 2: Definitions and Summary Statistics of Variables used in the Investment Decision Models

Variable	Definition	Sample Mean (N= 1226)
Dependent Variables	
Invested	Dummy (=1) if farm invests in farming activities	0.66
TotInv	Total Amount Invested in farming activities €000	8.334
Independent Variables	
System	Dummy variable = 1 if farm is in dairy production	0.4
Size	Total Agricultural Area in hectares	52.5
Size2	Total Agricultural Area in hectares squared	4790
Fjob	Dummy variable = 1 if farm operator has off-farm employment	0.28
sjob	Dummy variable = 1 if spouse has off-farm employment	0.33
FFI	Family Farm Income €000	24.91
FFI2	Family Farm Income €000 squares	1375
Age	Farmer's age in years	52.11
Age^2	Farmer's age squared	2863.37
No	Number living in farm household	3.69
Fless12	Farmer earns less than €12,000 off –farm	0.058
F12to20	Farmer earns between €12,000 and €20,000 off-farm	0.062
F20more	Farmer earns more than €20,000 off-farm	0.111
Sless12	Spouse earns less than €12,000 off –farm	0.09
S12to20	Spouse earns between €12,000 and €20,000 off-farm	0.062
S20more	Spouse earns more than €20,000 off-farm	0.14

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14

Results

The results from the investment decision model are presented in Table 3 showing the estimated coefficients, the marginal effect (the effect of a unit change in each independent variable on the probability of participation) and some goodness of fit measures for the model. The likelihood ratio statistic suggests the model is significant ($p < 0.01$), correctly predicting participation in 71 percent of the cases. All the variables affecting the investment decision were included in the initial run of the model. Initial estimates of the participation model showed multicollinearity between the presence of off-farm income and the level of off-farm earnings. In one run of the model the level of earnings data was excluded and the results showed that the presence of off-farm income earned by the farmer reduced the probability of investment, while that earned by the spouse increased the probability. The results presented in Table 3 are for the model which includes the earnings data.

It is interesting that the age of the farm operator does not significantly affect the decision to invest in farming. Previous studies on investment decisions cite a life-cycle effect, whereby the probability of investment initially grows with age as young farmers prepare for retirement. The significance and direction of this life-cycle effect can be affected by the presence of a successor.

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15

Table 3: Results of the Probit Model of the Decision to Invest

Variable	Coefficient (Z Values)	Marginal Effects
Intercept	-.7842	
Size***	.01389 (6.05)	.00483
Size2***	.24644 (-5.21)	-.00001
FFI**	.00560 (2.39)	.00195
No***	.09067 (3.71)	.03157
System***	.67169 (6.95)	.22261
Fless12*	-.279243 (-1.72)	-.10262
Sless12*	.2464 (1.65)	.08085
Pseudo R^2 = 0.164 Correct Predictions = 71%		
Likelihood Ratio Statistic χ^2_7= 257.81***		

N = 1226; *(p < 0.1) **(p < 0.05) *** (p < 0 .01)

The results show that farm size, the number of people living in the farm household and the system of farming are the most significant (p<0.01) variables affecting the decision to invest in farming. The effects of farm size are positive but non-linear, meaning that as farm size increases the probability of investment increases but at a declining rate. The effect of the number of people living in the farm household also increases the probability of investment. A larger household size increases the probability of a farm successor being present and the farms being continued by the next generation (Hennessy and Rehman 2007). It may be inferred that the presence of a successor increases the probability of investment. The effect of system is also positive. This suggests that, other things being equal, if a farmer is involved in dairy production the probability of investment is 0.236 higher than if there is no dairy enterprise on the farm. The effect of farm income is also significant (p<0.05) and positive. The squared term of income was not significantly different from zero indicating that the effect of income is linear. A one unit increase in farm income, i.e. €1,000, increases the probability by 0.0019. However it should be noted that there may be an endogeneity problem between farm income and farm investment. In summary, larger, more profitable dairy farms with a successor present have a higher probability of investment.

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16

The main hypothesis under examination in this paper is whether the presence of off-farm income increases the probability of farm investment. Three off-farm income ranges for both farmer and spouse were included in the initial run of the model. However, as is evident from the results, only the first income range is significant. The effect of off-farm income earned by the farmer is negative. The results show that, other things being equal, when the farmer earns €12,000 or less off the farm the probability of investing in the farm is 0.102 lower than if the farmer had no off-farm income. The presence of off-farm income earned by the spouse is significant and positive but also in just one income range. If the farmer's spouse earns €12,000 or less off the farm the probability of investing in the farm is 0.08 higher than if the spouse has no off-farm income. The model was also run with simple binary dummies for the presence of off-farm income without specifying the income levels. The results of this model suggested that the presence of off-farm income if earned by the farmer reduced the probability of investment but if it is earned by the spouse it increases the probability of investment. This also supports the findings presented in Table 3.

The level of investment model is first estimated using the Heckman two stage procedure, to test for the sample selection bias. All the variables that are hypothesised to affect the level of investment are included in the model and all those variables found to be significant in the investment model are used in the selection equation. It is difficult to find a variable that can be assumed to affect the decision to invest but not the level of investment decision. The number of people living in the farm household is chosen as the identification restriction, since the number in the household, or the presence of a successor, if that is the inference, may affect the decision to invest but not the level of the investment. The results of the model are presented in Table A1 in the appendix. The results show that the lambda is not significantly different from zero and therefore sample selection bias is not present. The model therefore can be re-estimated using ordinary least squares. All of the explanatory variables presented in Table 2 above are included in the OLS model. A stepwise approach is used where only the variables that significantly affect ($p < 0.1$) the level of investment decision are retained. The results are presented in Table 4.

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17

Table 4: Results of the Ordinary Least Squares Model of Investment Levels

Variable	Coefficient
	(T-Values)
Intercept	-1213.85
Size***	273.42
	(6.67)
Size2***	-.48550
	(-3.20)
System**	3077.45
	(1.97)
R^2= 0.112	F= 32.54***

N = 775; *(p < 0.1);** (p < 0.05);*** (p < 0.01)

Following a stepwise approach only three variables significantly affect the level of investment. Farm size is again positive but nonlinear while the farm system is also positive. Other things being equal, if a farm is engaged in dairy production then investment levels are likely to be €3,077 higher than a non-dairy farm. None of the variables indicating the presence or the level of off-farm income were significantly different from zero.

The results from the two models are mixed. On the one hand it seems that the presence of off-farm income earned by the farmer significantly negatively affects the probability of that farmer investing in farming but has no effect on the actual level of investment. The level of the farmer's off-farm earnings is only significant at lower levels. In relation to the spouse, the presence of off-farm income increases the probability of investment but has no significant effect on the level of investment. Similar to the farmer, the level of off-farm earnings is only significant at lower levels. It seems then that the hypothesis that off-farm income is driving farm investment can be rejected for the farmer, but the conclusion is more mixed for the spouse. The

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18

results also seem to suggest that farmers that work off the farm do not necessarily substitute capital for labour.

The investment data used in the models above included net new investment in machinery, buildings, land improvements and quota. To investigate further the hypothesis that part-time farmers may invest in machinery in order to substitute capital for labour the investment decision model was run for investment in machinery only. The results are presented in Table A2 in the Appendix. The presence of the off-farm income earned by the farmer significantly negatively affects the decision to invest in machinery, while the spouse's off-farm income is not significant.

Conclusions

The objective of the paper is to explore the factors affecting farm investment decisions with a view to identifying why farm investment has increased despite the apparent poor returns, in particular focusing on the role of off-farm income. A two-step econometric technique is used first to assess the effect of off-farm income on the decision to invest and second to assess the effect on the level of investments made.

The econometric results illustrate the importance of farm characteristics such as system, size and family farm income. Interestingly, the age variables are not significantly different from zero suggesting there are no life cycle effects present. The role of off-farm income is less clear. In summary the results suggest that off-farm income earned by the farmer reduces the probability of farm investment in general and investment in machinery, while the presence of off-farm income earned by the spouse increases the probability of investment in general with no influence over the probability of investment in machinery. There is no significant relationship between off-farm income and the level of farm investment.

We therefore reject the initial theory that off-farm income is driving farm investment which makes it difficult to explain why farm investment continues to increase despite the declining profitability of farming. One possible explanation may be the restructuring that is taking place in the dairy sector. The results show that dairy farmers are more likely to engage in investment than non-dairy farmers and in fact dairy farmers account

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19

for half of all farm investment in 2004 even though they comprise just 26 percent of the weighted population of farms. Significant restructuring has occurred within the dairy industry with the number of milk quota holders falling from 31,000 producers in 2000 to just 22,000 in 2005. In an industry constrained by milk quota, the exit of some producers increases the average size of the remaining producers thereby increasing the need for farm investment.

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20

APPENDIX

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21

Table A1: Heckman Two-step Procedure for the Level of Investment Decision

Heckman selection model -- two-step estimates

Number of obs	=	1226
Censored obs	=	451
Uncensored obs	=	775
Wald chi2(15)	=	203.77
Prob > chi2	=	0.0000

	Coef.	Std. Err.	z	P>|z|
TotInv				
uaa	147.9948	23.73466	6.24	0.000
ffi000	44.82983	42.86231	1.05	0.296
dairy	4194.589	3548.279	1.18	0.237
fless12	-1047.131	3841.606	-0.27	0.785
f12to20	-3344.041	3565.834	-0.94	0.348
fgreat20	-759.6968	3004.801	-0.25	0.800
s12to20	2717.444	3117.681	0.87	0.383
sgreat20	1121.812	2129.729	0.53	0.598
sless12	-167.0043	2842.278	-0.06	0.953
Intercept	-348.7826	7761.001	-0.04	0.964
Select				
uaa	.0025866	.0010574	2.45	0.014
ffi000	.0078136	.0021455	3.64	0.000
nohm	.1030194	.0241156	4.27	0.000
dairy	.6577261	.0935619	7.03	0.000
fless12	-.2460981	.1623043	-1.52	0.129
fgreat20	-.1572192	.1229937	-1.28	0.201
sless12	.1992065	.1427443	1.40	0.163
Intercept	-.5490683	.0980756	-5.60	0.000
mills lambda	2874.766	8167.349	0.35	0.725

rho	0.13412
sigma	21433.597
lambda	2874.7658 8167.349

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22

Table A2: Probit model of the decision to invest in machinery

stepwise, pr(.15): probit invmac uaa ffi000 nohm dairy fless12 f12to20 fgreat20 s12to20 sgreat20 sless12 size2 fojb sjob

begin with full model

p = 0.9174 >= 0.1500 removing fojb

p = 0.4332 >= 0.1500 removing f12to20

p = 0.3201 >= 0.1500 removing sjob

p = 0.3011 >= 0.1500 removing fless12

p = 0.2758 >= 0.1500 removing s12to20

p = 0.2510 >= 0.1500 removing sless12

p = 0.1549 >= 0.1500 removing sgreat20

Probit regression

Log likelihood = -771.52283

Number of obs	=		1226
LR chi2(6)	=		156.43
Prob > chi2	=		0.0000
Pseudo R2	=		0.0920

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invmac	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
uaa	.0133599	.0021797	6.13	0.000	.0090877	.0176322
ffi000	.0033638	.0019478	1.73	0.084	-.0004539	.0071815
nohm	.0674313	.022276	3.03	0.002	.0237711	.1110915
dairy	.2600357	.0880901	2.95	0.003	.0873824	.4326891
fgreat20	-.2115559	.1255801	-1.68	0.092	-.4576884	.0345765
size2	-.0000336	6.99e-06	-4.81	0.000	-.0000473	-.0000199
Intercept	-.9375827	.1080237	-8.68	0.000	-1.149305	-.7258601

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23

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26