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REFEREED PAPER

IS OFF-FARM INCOME DRIVING ON-FARM INVESTMENT?

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Farm investment in Ireland is increasing despite falling farm incomes. Some suggest that this phenomenon is due to farmers using off-farm income to invest in farming. This paper explores the farm investment decision, in particular focussing on the role of off-farm income. The results indicate that, when farm size, system and profit are controlled for, the presence of off-farm income earned by the farmer decreases the probability of investment. The effect of income earned by the farmer's spouse, however, is less clear.

Keywords: Farm Investment, off-farm income, probit modelling

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 period from 1995 to 2006 average farm incomes declined by almost 17 percent in real terms while net new investment increased by almost 20 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. Given that agriculture is a sector in relative decline, with farm numbers decreasing 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. It is, therefore, somewhat counter-intuitive that given the apparent disincentives to invest in farming that agricultural investment levels remain positive.

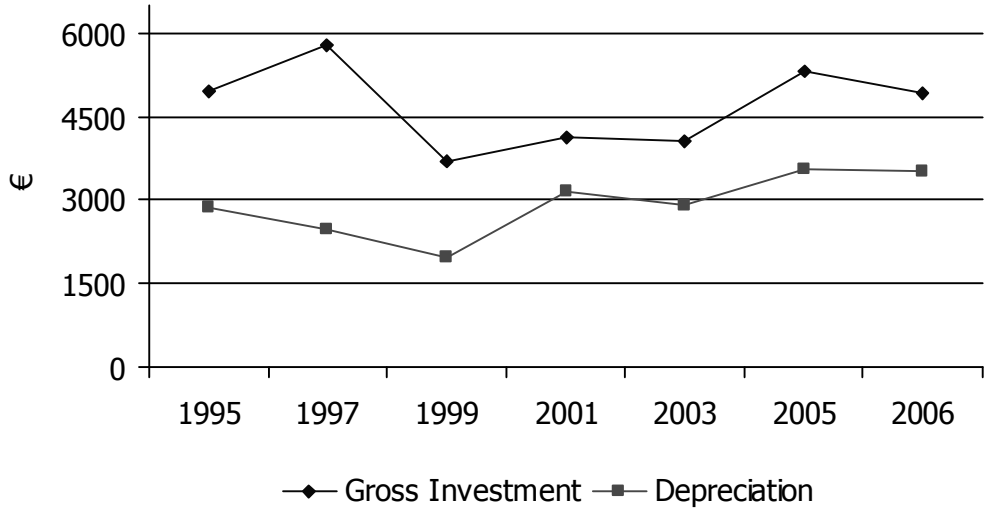
This paper explores the factors affecting farm investment decisions. In particular, the focus of this paper is on the role of off-farm income. While farm incomes have been declining in real terms over the last decade, the number of farm households supplementing the family farm income with earnings from other sources has increased. In this paper the hypothesis that farm families are using income earned outside the agricultural sector to reinvest in farming is tested empirically. The paper begins by providing a clear definition of farm investment and some background information on farm investment trends in Ireland. Following this a number of theories are developed that may explain the relationship between farm investment and off-farm income. These theories are investigated using farm survey data from Ireland. The paper concludes with a discussion of the results of the analysis.

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 gross new investment and depreciation for each farm in the survey. Gross new investment is the absolute level of investment made by a farmer in a particular year, i.e. before any grants or subsidies. Depreciation is estimated using the replacement value technique, meaning that the depreciation estimate for each farm represents the cost of maintaining the current capital stock. It is interesting to compare gross new investment (GNI) and depreciation as the difference between the two can be considered an estimate of the extent to which individual farmers are increasing their capital stock. Figure 1 presents GNI and depreciation figures for the full sample of farms in the NFS from 1995 to 2006, the figures presented are in real terms.

Figure 1: Average Gross New Investment and Depreciation per Farm 1995 to 2006



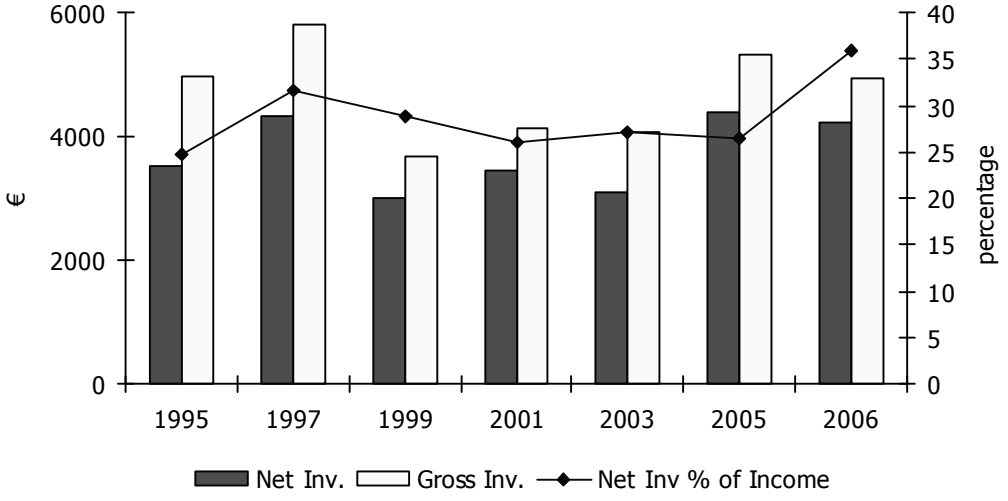
Source National Farm Survey Data.

From 1995 to 2000, GNI was almost twice the value of depreciation, suggesting that half of all investment was to fund new capital. From 2000 to 2006 the gap between GNI and depreciation narrowed; during this period between 67 and 75 percent of all investment was to replace existing capital stock. While investment in new capital stock has diminished somewhat over the decade, the data still shows that between a quarter and a third of all new investment is to expand the capital stock of the farm.

Ireland, like many other EU Member States, offers considerable grants to farmers to improve farm facilities. It is important when examining investment figures in agriculture to take cognisance of this incentive effect. The Irish NFS estimates net new investment (NNI) per farm; this is defined as investment (including both purchase and repair) in buildings, land improvements, machinery, and production quotas, less all sales, grants and subsidies. The NNI 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. Figure 2 presents data on average GNI and NNI per farm from 1995 to 2006 and also shows NNI as a percentage of family farm income

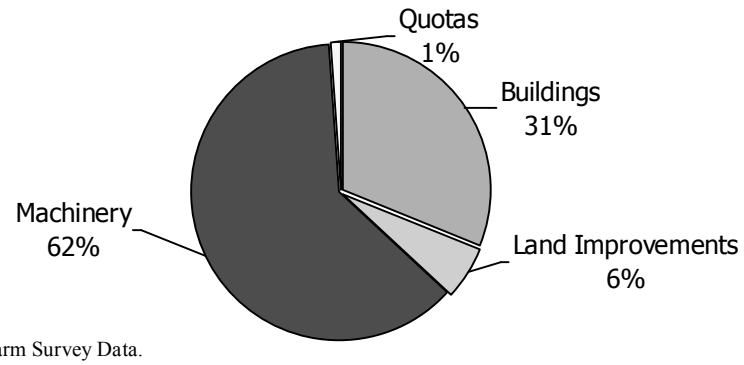
Figure 2: Net New Investment as a Percentage of Farm Income 1995 to 2006



Source National Farm Survey Data.

The data in Figure 2 show that while investment levels are volatile across the period, there is a consistent trend of increasing investment. The data also shows that NNI is typically between 15 and 25 percent lower than GNI. Net new investment has been increasing in real terms over the period; from €3,500 in 1995 to €4,230 in 2006, an increase of almost 21 percent. Furthermore, NNI as a percentage of income has also been increasing; from 24 percent in 1995 to 35 percent in 2006. Investment data is also available on a farm system basis. The data shows that year on year, dairy farmers are consistently the most

Figure 3: Investment Type – 2004 National Farm Survey Data



Source National Farm Survey Data.

significant investors. In 2006, dairy farms contributed 44 percent of the total new investment although they only represented 23 percent of the population.

It is also interesting to consider the types of farm investment. Figure 3 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.

The relationship between off-farm income and farm investment

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 are employed off the farm increased from 36.5 per cent in 1995 to over 50 per cent in 2004. This is not a trend unique to Ireland, Phimister et al (2002) found that around 10 percent of all Scottish farmers and nearly 30 percent of farmers' spouses have off-farm employment.

There are a number of economic theories as to why off-farm income may affect farm investment. These theories can be developed within the agricultural household model first developed by Singh, Squire and Strauss in 1986. This model has been extended over the years and has been applied in many studies investigating investment decisions. Some of these studies are briefly summarised and simplified here, for a more detailed explanation of the model and its application to labour and investment decisions see O' Brien and Hennessy (2007). The agricultural household model refers to the substitution effect. This theory suggests that it is economically rational for farmers that work off the farm to invest in farming, if the farm investment allows them to maintain or increase farm output with less farm labour and thereby increase total household income. In effect, farmers who work off the farm may maximise their total income by using some of their off-farm income to invest in labour-saving devices, if the opportunity cost of their labour exceeds the required investment. The presence of off-farm income may also relax the budget constraints in the farm household. Farm households that depend only on farm income have to use a larger proportion of farm profit to satisfy the consumption demands of the household. In households where additional income is present, the budgetary constraints are relaxed thereby making more of the farm profit available for reinvestment. The importance of the budgetary constraint is somewhat diminished in the Irish situation where farmers have access to borrowed capital.

A number of previous studies have investigated these theories. Rosenzweig and Wolpin (1993) and Ahituv and Kimhi (2000) found that 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. Upton and Haworth (1987) examined the growth of farms in the UK using Farm Business Survey data. They found evidence to support a positive relationship between farm growth and off-farm income,

thereby suggesting that farmers with higher levels of off-farm income were more likely to grow their farms through investment. These studies suggest that there may be a positive relationship between farm investment and off-farm income. However, a number of studies have found conflicting evidence to suggest that the presence of off-farm income in the farm household may in fact reduce the probability of investment.

The transition from full-time to part-time farming can often be perceived as a first step out of farming and therefore farmers that work off the farm might not be expected to reinvest in farming. A number of studies, as reviewed by Hennessy and Rehman (2008), show that farmers that work off the farm typically operate more extensive and less profitable farms. Glauben et al (2003) conducted a review of studies that investigated these issues. They cite a number of studies that presented empirical evidence that farmers that work off the farm have lower expectations of continuing the farm business, are less likely to have a successor and as a consequence are less likely to invest in their farms. Furthermore, a study conducted by Anderson et al (2005) using farm data from the US shows that an increase in off-farm income increases the investment in non-farm assets relative to farm assets.

It seems that there are conflicting theories about the relationship between off-farm income and farm investment. On the one hand, farmers that work off the farm may choose to substitute capital for labour thus increasing farm investment. Furthermore, the presence of off-farm income in the household, earned by either farmer or spouse, may release more capital for reinvestment in the business. On the other hand however, farmers that work off the farm seem typically to operate less profitable, less intensive farms and therefore may be less likely to reinvest in a business that may provide a poor return. In this paper we explore these theories by testing the hypothesis that off-farm income is driving farm investment. Using Irish NFS data to estimate an econometric model of farm investment, the effect of off-farm income on the probability of investment is quantified. The following sections describe the model developed and data used.

Modelling the Investment Decision

Wooldridge (2006) defines data as being censored if it is roughly continuously distributed over positive values but is zero for a nontrivial fraction of the population. In the sample under analysis here approximately 34 percent of farmers have zero investment while the other 66 percent have varying levels, thus the data is censored. A standard ordinary least squares model with a continuous dependent variable is not appropriate when the dependent variable is censored. With censored data two separate phenomena can be examined. In this case the first stage of the decision is whether to invest or not, while the second stage is the amount to invest, with the second stage decision being conditional on the outcome of the first. It can be useful to model the two decisions separately as the differences in behaviour at both stages of the investment decision can be captured. In this paper the two decisions are modelled using a sample selection corrected two-stage model. The paper focuses on the first stage of the analysis, i.e. the decision to invest

or not.[1]

The investment decision is a binary one, i.e. to invest or not, and thus can be analysed using a dichotomous choice probit model. The probit model, which is described in more depth in Appendix 1, can be used to identify and quantify the factors that have a statistically significant effect on the probability of investment. All variables that are hypothesised to affect the investment decision can be included in the model as independent variables. Variables with a positive coefficient increase the probability of investment while those with a negative coefficient decrease the probability.

While the NFS collects very detailed information on farming activities, the data on non-farm activities such as off-farm employment is more limited. The off-farm income earned by farmers and their spouses is collected as a categorical variable only, and there is no information relating to income earned or the labour force participation of any other household members or information relating to other sources of non-farm income such as returns on non-farm investments.

Table 1 describes the investment activities of farms included in the 2004 NFS. The table shows that approximately two-thirds of all farmers in the sample invested in farming activities, 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; this suggests that the spouses of more profitable farmers are more likely to work off-farm. 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 the spouse works off-farm are the most likely to invest. This hypothesis will be tested empirically.

The variables included in the model 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

1. For more detail on the model selection and specification and the results of the second stage of the model consult O' Brien and Hennessy (2007).

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%)
Family Farm Income €	24,910	27,336	22,500	35,247
Percentage with Off-farm income	50	0	100	100
% Investing	66	65	66	83
Average Investment	12,599	13,398	11,827	15,477

Source:NFS 2004

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

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

Variable	**Definition**	**Sample Mean (N= 1226)**
	Dependent Variable	
Invested	Dummy (=1) if farm invests in farming activities	0.66
	Independent Variables	
System	Dummy variable = 1 if farm is in dairy production	0.4
Size	Total Agricultural Area in hectares	52.5
$Size^2$	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	Farmers' age in years	52.11
Age^2	Farmers' 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

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

variables that are hypothesised to affect the investment decision, such as farm size and system among others.

Results

The results of the investment decision model are presented in Table 3 showing the estimated coefficients, the marginal effect (the effect of a unit change in each explanatory variable on the probability of investment) and some goodness of fit measures for the model. The likelihood ratio statistic suggests that the model is significant ($p<0.01$), correctly predicting investment 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. A stepwise regression approach was adopted meaning that Table 3 presents the results of the parsimonious model which only includes the statistically significant variables.

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 grow their businesses but it then eventually declines with age as older farmers prepare for retirement.

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 $\chi^2_7 = 257.81$***		

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 previous study has found that larger farm households are more likely to have a successor present, i.e. living with the farmer (Hennessy and Rehman 2007). In the absence of any verifiable empirical data on the presence

of a successor, it may be inferred from the results here that the larger household size is a proxy for succession and thus the potential 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. A one unit increase in farm income, i.e. an increase of €1,000, increases the probability by 0.0019. It should be noted that there may be an endogeneity problem between farm income and farm investment, in other words there may be a problem of two-way causality. Investment may be higher because income is higher and there are more funds to invest. Alternatively, income may be higher because investment is high and the productive capacity of the farm has been increased. In other words there may be a two-way relationship between the two variables. This is difficult to account for in the model and the coefficient on the income variable should be interpreted with caution.

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. It is interesting and somewhat unexpected that low off-farm earnings have a negative impact on the probability of investment and higher earnings have no effect at all on the probability of investment. 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.

Further Analysis

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

Discussion

Farm investment remains buoyant. Some have suggested that this may be due to farmers using income earned outside the sector to invest in farming. Both anecdotal evidence and economic theories support the possibility of a positive relationship between off-farm earnings and farm investment. This paper uses farm survey data from Ireland to test this theory empirically.

The results illustrate the importance of farm characteristics such as system, size and profitability but the conclusions in relation to off-farm income are mixed. When farm size, system and profit are controlled for, the presence of off-farm income earned by the farmer reduces the probability of farm investment. Other things being equal, the presence of off-farm income earned by the spouse increases the probability of investment. When the actual levels of off-farm income are examined the results are less clear. Farmers earning €12,000 or less off the farm are less likely to invest in farming compared to those with no off-farm employment. However larger off-farm earnings have no effect on the investment decision.

It is possible that the source of off-farm income may affect the results. If the off-farm income is earned from another business, then it is likely that this other non-farm business would have to compete with on-farm investment, thus reducing the probability of investment relative to a situation where the off-farm income is earned in paid employment. It would be interesting to test the significance of the source of off-farm income but due to data constraints it is not possible to distinguish between off-farm income arising from paid employment and income earned from self-employment in this study.

If we conclude that off-farm income is not driving farm investment then it is 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 farming sector. Taking the dairy sector as an example, the number of farmers engaged in milk production in Ireland has fallen 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. The results show that dairy farmers are more likely to engage in investment than non-dairy farmers. So while it might seem counterintuitive that an industry with a high exit rate such as farming still has strong investment levels, it may be the case that the restructuring induced by a high exit rate increases the need for investment.

The introduction of environmental and cross compliance legislation may also partially explain why farm investment has increased. In Ireland the introduction of the Nitrates Directive means that farmers must have greater slurry storage capacity and the rules governing cross-compliance are likely to increase the need for investment in land improvements. It would be interesting to explore these issues further by reviewing the investment data from the NFS over the last ten years in conjunction with a review of environmental legislation.

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Appendix 1

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;

$$Prob\ (Oi=1|xi) = F\ (xi\beta)$$

where F is some normal distribution function bound by the [0,1] interval, i.e. $0 \leq F(xi\beta) \leq 1$ 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 (pi) 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.