Hidden Underemployment Among Irish Farm Holders 1996-2011

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Abstract

This paper examines the factors driving hidden underemployment on Irish farms during the course of the economic boom in Ireland and the subsequent economic decline post 2008. This measure of hidden underemployment is due to differences between the farmer's reported amount of labour and the standard labour requirement estimated in the Teagasc National Farm Survey. Hidden underemployment can be attributed to a number of factors relating to inadequate employment situations as described at the 16th International Conference of Labour Statisticians (16th ICLS) such as low productivity, casual work practices and the poor utilisation of skills and other factors specific to agriculture and/or self employment. We place particular attention upon the potential role of off-farm labour supply in solving the underemployment problem. We use a two-stage residual inclusion model and a random effects probit model to examine the forces behind farm underemployment. This paper provides an interesting set of results given that the end of the economic boom phase co-incided closely but not precisely with the decoupling of farm-level subsidies in 2006.

Keywords: Hidden Underemployment, Inadequate Employment Situations, Probit Model, Labour Supply, Off Farm Employment

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I. INTRODUCTION

The economic crisis in Ireland has provoked a renewed focus on the problem of unemployment in both rural and urban areas. This is understandable given that the seasonally adjusted unemployment rate increased from just 4.4 per cent in the fourth quarter of 2006 to 15 per cent in the first quarter of 2012. This devastating change involves the male unemployment rate increasing by 13.4 per cent with the female unemployment rate increasing by 7.3 per cent (CSO, 2013a). While these unemployment statistics give a useful indication about the state of the overall economy, the related problem of underemployment is given much less attention. Underemployment can come in many forms but is most commonly recognised as a problem of lack of working hours. In this paper, we examine the factors driving underemployment on Irish farms during the economic boom and the subsequent decline using a definition of underemployment that emphasises the quality of labour supply thereby shining some light on aspects of hidden underemployment.

Underemployment is arguably of greater relevance to farmers than unemployment given that livestock and crop production will always demand some amount of labour regardless of the size of the farming operation. Farmers are therefore unlikely to report their principle economic status as unemployed in socio-economic surveys. This is in common with many other self-employed occupations. The full extent of the underemployment problem is therefore liable to remain undetected for both groups. The economic boom guaranteed that very few farmers or self-employed people would suffer from a shortage of working hours relative to their desired levels but the onset of the economic recession means that time-underemployment has re-emerged among both groups in a widespread manner.

In the case of farmers, the growth in underemployment is likely to be driven in many instances by the loss of off-farm employment. During the economic boom, many farmers took up an off-farm job. O'Brien and Hennessy (2006) showed that that the farmer held an off-farm job in approximately 41 per cent of sampled farms in 2006 in comparison to just 26 per cent in 1995 as recorded on a nationally representative dataset by the Teagasc National Farm Survey (NFS) in both years. This changed in 2008 with the arrival of the economic recession. By 2011, the NFS recorded that the

share engaged in off farm employment declined to just below 32 per cent and therefore returning close to the levels of 1999.

In addition to macro-economic changes, we should also consider major agricultural policy changes. No previous econometric studies have explicitly dealt with the impact of agricultural policies on underemployment but there exists a good deal of research about the impact on the closely related issues of productivity and off-farm employment. For instance, Newman and Matthews (2007) found that productivity growth in the sheep sector flatlined in the aftermath of the introduction of the MacSharry reforms in 1992 and the associated growth in extensification payments and agri-environmental payments. Both schemes acted as incentives towards a less efficient use of resources. At this stage, there is limited literature examining the impact of the recent decoupling of direct payments on productivity.

The absence of econometric studies on farm underemployment means that there is the potential to gather useful insights with respect to the under-utilization of labour on Irish farms. In order to establish the extent of underemployment, we must define underemployment according to some internationally recognisable criteria. The International Labour Organisation (ILO) in this area. At the sixteenth international conference of labour statisticians (16th ICLS) in 1998, the ILO stipulated that a person can be considered underemployed if that person has a willingness and availability to work additional hours within a subsequent period and has a recorded number of working hours that lies below a threshold deemed to be a "sufficient" number of hours i.e. the amount generally considered to be sufficient for full-time work.

A paper by Bell and Blanchflower (2011) is perhaps the best recent example of an econometric study on underemployment. This paper examined the individual characteristics associated with underemployment during the recession in the United Kingdom. The results pointed to significant levels of underemployment among younger age groups (employees and self-employed) and a concentration of underemployment in the retail trade, education and employment activities which includes temporary agencies. The authors noted that the young are more likely to give up searching for work and that this exit is most likely among those with lower education.

In this paper, we are concerned with the quality of labour supply as well as the quantity. The inclusion of quality in the measurement of underemployment has been an issue of serious discussion for some time. At the 16th ICLS, the ILO expressed 'the need to revise the existing standards on the measurement of underemployment and to broaden the scope to cover also inadequate employment situations'. These inadequate employment situations form an important component of hidden underemployment i.e. underemployment that is not described merely by a lack of hours. This ILO resolution outlined three particular types of inadequate employment situations as the following:

I.   Skill-related inadequate employment - Refers primarily to workers who would like to change their work situation in order to better utilise their skills. It describes over-education and/or over-qualification among other situations.

II.   Income-related inadequate employment – Refers to workers who wished to change their work situation and thereby achieve higher income but found themselves limited by factors such as low levels of organization of work or productivity, insufficient tools and equipment and training or deficient infrastructure.

III. Inadequate employment related to excessive hours - Refers to workers in overemployed situations where the person concerned "wanted or sought to work less hours than they did during the reference period, either in the same job or in another job, with a corresponding reduction of income."

In this study, we are primarily interested with the second category but we allow for situations relevant to the first. We therefore completely omit issues relating to overemployment as described in the third category. In the case of farmers, we should perhaps expect that many dairy farmers are overemployed. O'Donnell et al (2008) emphasised the importance of hired labour on dairy farms and the inadequacy of family labour in most cases. While the scarcity of hired labour is much less of an issue in Ireland today than during the time of that study, it remains the case that many dairy farmers must still choose between hiring labour within or outside of the family or otherwise push their own labour supply towards unusually long hours. Choosing the latter option may be a reflection of low productivity in some cases.

The ILO concluded at the 16th ICLS that the statistical concepts surrounding inadequate employment situations have not been sufficiently developed. We seek to address some of this void for the case of farm holders.[1] At a national level in Ireland, it appears that the quantitative measurement of underemployment is gaining some priority. Since the 3rd of quarter of 2008, the Central Statistics Office in Ireland has published the number of part-time workers classified as underemployed as distinct from just publishing the pooled number of part-time workers. This is in addition to the already available statistics about the 'Potential Additional Labour Force' which is more commonly referred to as 'discouraged workers'.[2]

Table 1: The Economic Status of the Male Labour Force from 1998 to 2012 (000's)

	In employment full-time	In employment part-time	In employment part-time - not underemployed	In employment part-time - underemployed	Unemployed	Potential additional labour force	Others not in labour force	Unemployment Rate
1998	842	69	..	..	79	18	405	8.0
1999	893	68	..	..	63	17	394	6.1
2000	931	68	..	..	48	14	399	4.6
2001	961	67	..	..	42	13	409	3.9
2002	966	66	..	..	51	15	426	4.7
2003	977	69	..	..	55	16	435	5.0
2004	1010	65	..	..	57	14	437	5.0
2005	1048	72	..	..	60	14	434	5.1
2006	1095	80	..	..	58	14	432	4.7
2007	1133	87	..	..	63	14	444	4.9
2008	1114	95	..	..	87	14	463	6.7
2009	959	113	65	48	194	29	485	15.3
2010	894	121	70	51	208	35	514	17.0
2011	864	129	69	60	214	37	528	17.7
2012	840	137	68	69	216	32	536	18.1

Source: CSO (2013)

[1] More recently at the 18th ICLS in 2008, the special situation of self-employed workers gained more prominence in discussions (inc. agriculture) as low working hours may not be a clear indicator of full employment. This discussion included the observation that farm operators or the self employed may not reduce their working hours during slack periods and at the same time remain vigilant in seeking employment elsewhere in the economy. In such circumstances, the farmer may report hours of a full working week but is actually operating at an underemployed level.

[2] De La Fuente (2011) defines the Potential Additional Labour Force as "jobless persons who want to work and are either available to work or are searching for work but not both at the same time. This group includes, among others, discouraged job seekers and persons prevented from job seeking due to personal or family circumstances." These statistics are presented in table 1 below for the case of males along with the established statistics on numbers of full-time employed and the unemployment rate.

Table 1 shows that the number of males in full-time employment in 2012 is close to that in 1998 at approximately 840,000. The number of males in full-time employment reached a peak of 1.114 million in 2008 meaning that almost 300,000 full-time jobs have been lost during the recession in the case of males. We should expect that farm holders have not escaped the immediate impact of this decline. We can see that the unemployment rate at 18.1 per cent is much higher in 2012 than at the beginning of the period and that the number of discouraged male workers more than doubled between 2008 and 2011. It is therefore clear that the unemployment rate statistics underestimate the extent of the work shortage problem for males.

In the next section, we discuss the data sources used to perform the analysis. This is followed by a discussion of the underemployment definition and we provide associated trends in underemployment. This is followed by the methodology section where we discuss the application of the econometric models. In section 5, we discuss some results and this is followed finally by the conclusion.

II. DATA

In this section, we describe the data sources used to perform the analysis in this paper. In addition, we provide some useful trends with respect to on-farm workloads and off-farm employment. The main data source for this work is the Teagasc National Farm Survey. O'Brien and Hennessy (2006) described the objectives of the National Farm Survey (NFS) as being to

1. Determine the financial situation on Irish farms by measuring the level of gross output, costs, income, investment and indebtedness across the spectrum of farming systems and sizes,

2. Provide data on Irish farm incomes to the EU Commission in Brussels (FADN),

3. Measure the current levels of, and variation in, farm performance for use as standards for farm management purposes, and

4. Provide a database for economic and rural development research and policy analysis.

To achieve these objectives, a farm accounts book is recorded for each year on a random sample of farms, selected by the CSO, throughout the country. The National Farm Survey is designed to collect and analyse information relating to farming activities as its primary objective. Information and data relating to other activities by the household are considered secondary and as such where this information is presented it should be interpreted with caution. For 2011, there are 1,022 farms included in the analysis, representing 105,535 farms nationally.

The Teagasc NFS micro data spans the period from 1996 to 2011. The NFS represents panel data of the form xit, where xit is a vector of observations for farmer i in year t. As pointed out by O'Brien and Hennessy (2006), the panel is unbalanced in the sense that there is some attrition from year to year as farmers leave the sample and are replaced by other farms. The attrition rate is relatively low however and a sizeable proportion of the farms are contained in the dataset for all of the years concerned. New farmers are introduced during the period to maintain a representative sample and the sample size is usually kept to between 1000 and 1100 farms.

The NFS data provides vital information on the reported number of hours devoted to labour on each farm and the estimated amount of labour required to produce the recorded level of farm output. This required amount of labour is summarised in one variable known as standard man days (SMD). In the Teagasc NFS, the total labour requirement for each farm is estimated on the basis of a number of factors. Each SMD comprises of eight hours of work supplied by a person over 18 years of age.

This SMD variable accounts for a range of factors mainly including the following:

a. The size, age profile and stage of production of the livestock herd
b. Number of days grazing and hand feeding
c. The degree of modernisation in buildings, roadway and paddocks
d. The existence of self-feeding for silage as facilitated generally by creep feeders, feeding racks and similar products
e. The efficiency of buildings and farm layout
f. Whether or not farmer makes silage with his own machinery or hires a contractor

g. In the case of tillage, whether or not machinery is hired, owned or done using traditional means

Farm Labour Statistics

The extent of underemployment on Irish farms is dependent in part by the workload that is demanded on each farm. It is likely that the farmers with a relatively light workload are among the farmers most likely to be classified as underemployed. The number of SMD required per hectare for the different crops and per head for various categories of livestock, is used to calculate the total number of SMD required to operate the farm. In figure 1, we present the recent trends in the SMD for different farm systems.

Figure 1: Average Labour Requirement (SMD) by Farm System 1996-2011
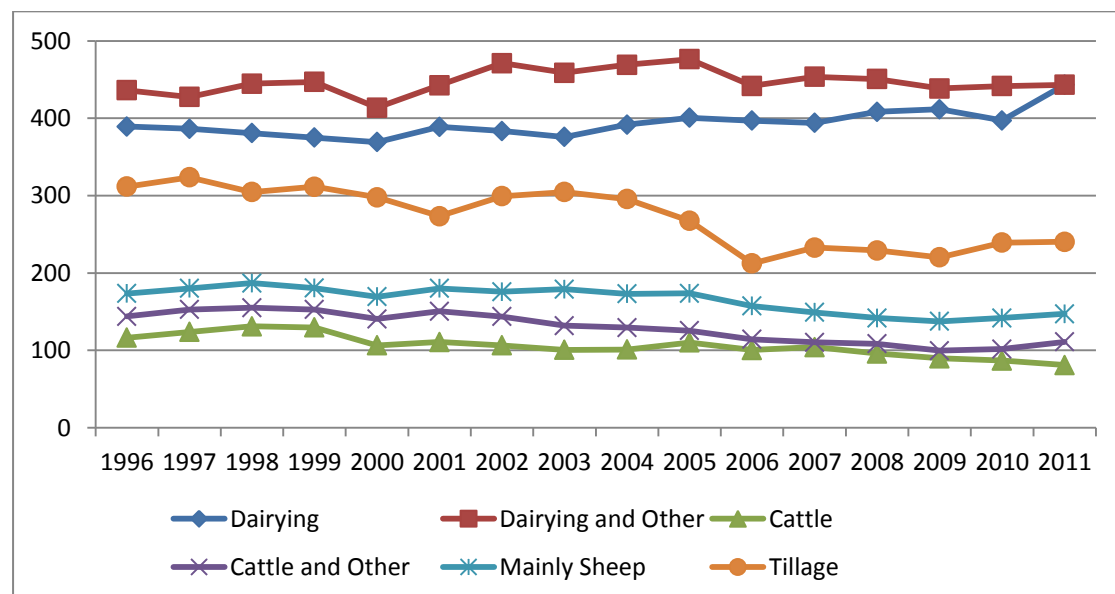
Source: Authors own calculations using Teagasc National Farm Survey data (2013)

It is immediately apparent from this graph that the average labour requirement for dairy farming is well above that for other systems and that dairy farms demand a level of labour input well above the levels considered normal for one individual worker in other industries. The average labour requirement is above 400 standard man days for

the Dairying and Other category in all years and for the specialist dairy farms in more recent years.

The results over time show that the labour requirement has changed differently according to the system of farming. It appears that the gap between dairy farms and non-dairy farms has grown over the course of the period. The labour requirement on tillage farms fell substantially around the timing of the decoupling of subsidies between 2004 and 2006. It has since recovered some lost ground but remains well below the level of close to 300 man days that persisted up to 2004. The labour requirement on cattle and sheep farms has also declined. Most of this decline is confined to the post decoupling period.

The overall trends suggest that decoupling has played some role in reducing the workload on Irish farms. An interesting development has occurred however, in the past three years as the labour requirement for most systems has risen to varying degrees. The one exception appears to be those farms exclusively devoted to cattle farming and this may be related in some respects to the age profile of farmers in this group.

Off-Farm Labour Statistics

In this section, we address the trends in the farm holder's participation in the off-farm labour market and the trends in wage rates in different sectors of the economy. From figure 2, we can see that 28 per cent of farm operators engaged in off-farm employment in 1996. This increased to a peak of 41 per cent in 2006 and declined subsequently to 32 per cent in 2011. The growth in off-farm employment among spouses has been more persistent rising from 20 per cent in 1996 to 35 per cent in 2006 followed by a three per cent decline in the subsequent four years. It is now the case that the rates of off-farm employment participation are almost equal for the farmer and the spouse.

Figure 2: Off Farm Employment Participation Rates 1996-2011
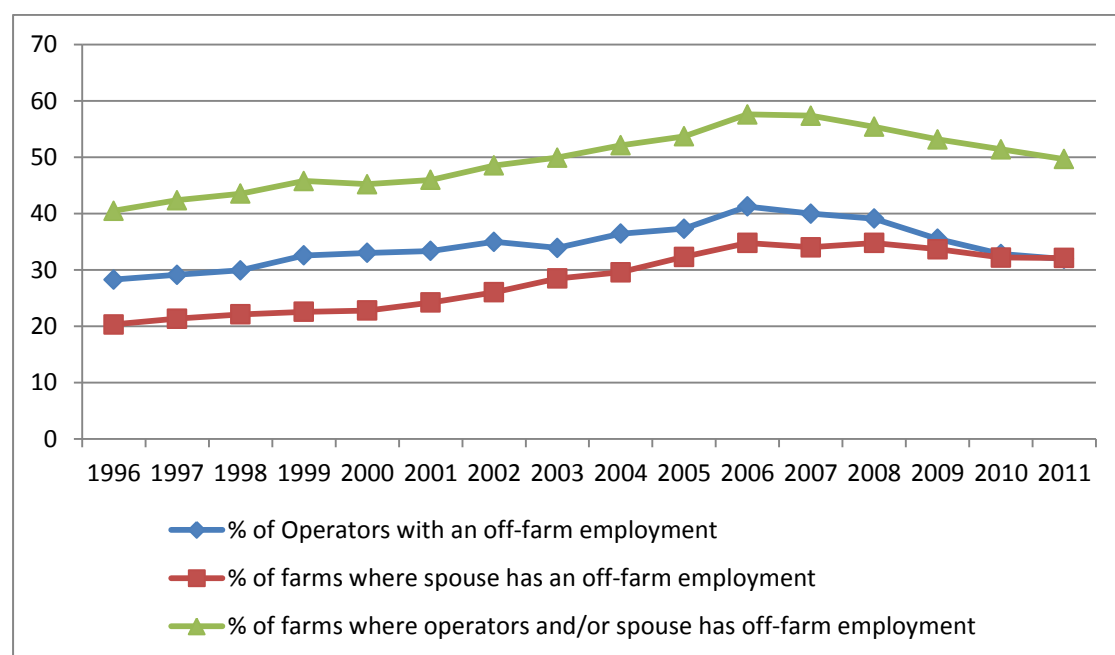
In figure 3, we examine recent trends in wage rates for coupled farm income and the construction sector which happened to be one of the main destinations for farmers seeking off-farm employment during the boom. Coupled farm income refers to the income of the farm minus decoupled subsidies i.e. the disadvantaged area scheme payments and the single farm payment, the latter applying for 2005 onwards.

Figure 3: On Farm and Coupled Off Farm Wage Rates 1996-2011
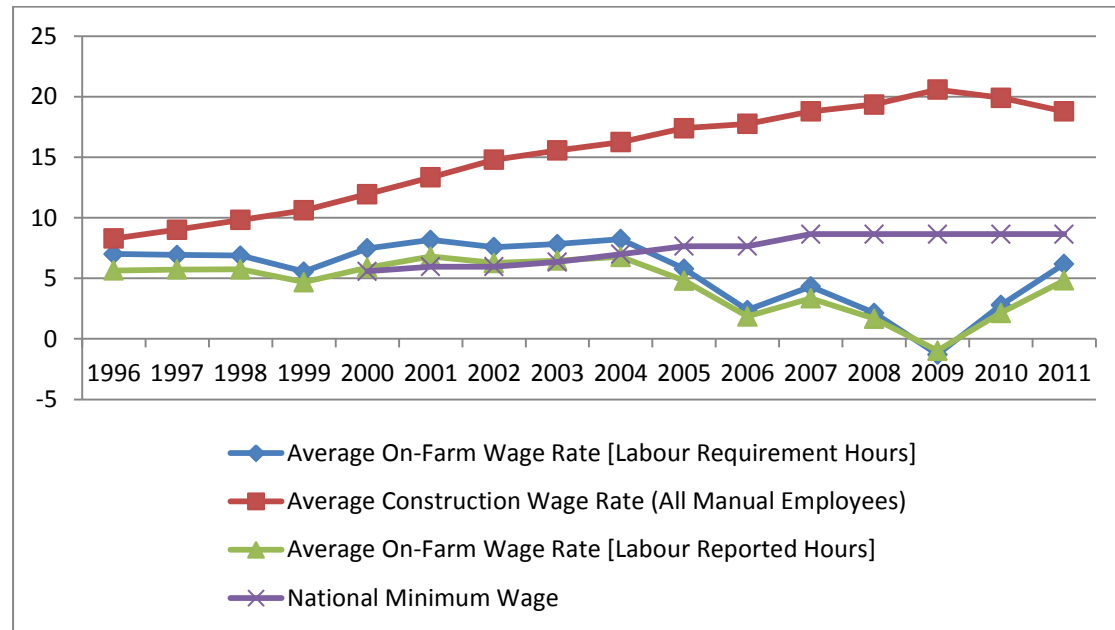
Source: Author own calculations using CSO Data (2013b) and Teagasc NFS Data (2013)

From figure 3, we can see that the wage rate gap between coupled farm income and construction grew significantly over the course of the period. On purely marginal economic grounds, the relative attractiveness of farm work declined rapidly during the course of the economic boom and this accelerated in the aftermath of decoupling of the single farm payment in 2005. We may expect that this explains some of the increase in off-farm employment among farm holders as shown by figure 2. The average coupled farm wage tracked the minimum wage up to 2004 but the decoupling of subsidies ended this pattern.

III. UNDEREMPLOYMENT – DEFINITIONS AND TRENDS

This paper is concerned with identifying the factors driving the extent of hidden underemployment. We therefore consider three different indicators for the measurement of underemployment. Each of these has particular strengths and weaknesses. The choice of the most appropriate method is influenced by our efforts to incorporate 'inadequate employment situations' into the measurement of underemployment as described in the introduction. These three alternative definitions of underemployment are outlined in the following:

I. The first option is based on the hours of labour reported by the farmer in the National Farm Survey. We first sum the total reported on-farm and off-farm labour hours where relevant and arrive with a total labour supply for each farm holder. The measure of underemployment is then calculated by measuring the distance of the reported total labour supply from the number of hours required to produce one labour unit i.e. 1800 hours per annum or 34.5 hours per week for all 52 weeks of the year. Under this first definition, a farm is deemed underemployed if the reported amount of total labour falls short of 1800 hours for a given year. This definition addresses the problem of low working hours. It does not however account for situations whereby the farmer is below this threshold and is either unwilling or unavailable to work additional hours off-farm. In the event of the farmer being unwilling or unable to increase hours, this measure of underemployment will overestimate the problem. In addition, this measure of underemployment will not address the hidden underemployment problems of inadequate employment situations due to low productivity and closely related issues.

II. The second option is based upon the amount of labour required to produce the reported level of output on each farm. Under this definition, a farmer is deemed underemployed if the SMD plus off farm hours fall short of one labour unit i.e. 1800 hours per annum or 34.5 hours per week for all 52 weeks of the year. We should expect that some farmers will report a number of hours that differs from the standard labour requirement (SMD) estimated in the Teagasc NFS. We may therefore expect some difference in the statistics for

the first definition and this particular definition. This definition is also limited by the fact that it fails to account for situations whereby the farmer is either unwilling or unable to increase their off-farm labour supply. In such situations, this measure of underemployment will overestimate the problem. It does not suffer however from the problem of over-reporting labour hours given that we can rely upon other variables in estimating the labour requirement variable.

III. The third and final definition of underemployment is essentially a measurement of hidden underemployment as distinct from the crude measures of time-related underemployment described in the first two definitions. Both of those definitions relied upon estimates of reported or required labour. While this gives us some picture about the inadequacy of available working hours, it does not give us a clear indication about the quality of hours worked. A sole concentration on time-related underemployment means that we can overlook important problems regarding the inadequacy of employment situations.

We stipulate that hidden underemployment can only occur on farms where the sum of the labour requirement (SMD) and the reported off-farm labour is less than one labour unit i.e. 1800 hours per annum or 34.5 hours per week for all 52 weeks of the year. This satisfies many of the conditions set out by the ILO at the 16th ICLS. Hidden underemployment is then calculated by subtracting the SMD from the reported on-farm labour supply where the reported on-farm labour supply exceeds the SMD.

This measure of hidden underemployment is chosen as the main dependent variable in our analysis for a number of reasons. Firstly, it does not suffer from the main limitation of the first two methods namely it does not classify farmers as underemployed in situations where the farmer is either unwilling or unable to increase working hours. It doesn't cover however, all situations where the farmer is willing to work additional hours up to the point of the threshold but this is not considered to be an important limitation.

In figure 4, we present the share of farmers classified as underemployed under the three alternative options recalling from above that we have chosen the measure of hidden underemployment as our most appropriate measure of underemployment.

Figure 4: Share of Farmers classified as Underemployed 1996-2011
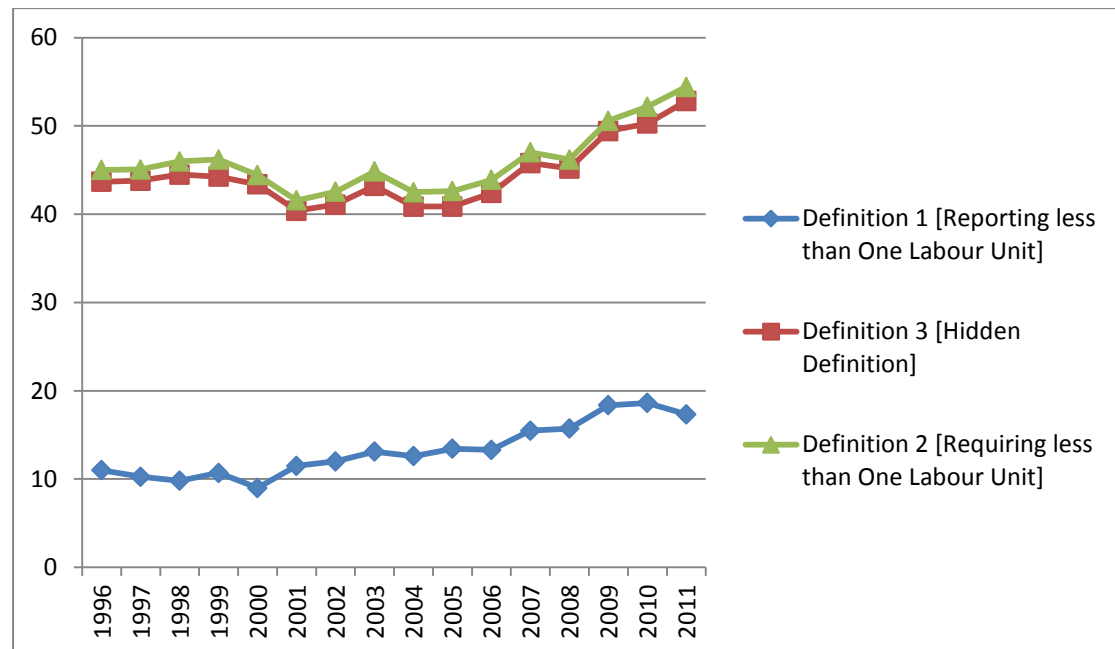
Figure 4 shows that under the third definition of hidden underemployment, the share of farm holders classified as underemployed is higher in 2011 than for any of the previous fifteen years. This is a worrying statistic and suggests that the decline in off-farm employment participation (post 2007) may have contributed to more hidden underemployment on Irish farms. Essentially, farmers who have lost their off-farm jobs have returned to solely working on the farm. The problem is that they are in many instances devoting an amount of labour time towards the farm which is above and beyond the required level as indicated by our SMD variable.

While the recent trends point to increasing underemployment, we can see that the share of farmers classified as underemployed actually changed very little during the economic boom phase regardless of the method chosen. This is despite the large increases in off-farm employment participation during the boom. This suggests that the farm workload declined in many instances as represented by the SMD variable and that increases in off-farm employment just offset those on-farm trends. We also

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find that the share of farmers reporting less than one labour unit grew by approximately five per cent between 2006 and 2009 but has since plateaued. This appears to reflect some increase in the reported on-farm activity but this is not reflected by the trends in the standard labour requirement (SMD). This suggests that some farmers are reporting longer hours on-farm but this is not necessarily reflected by their labour requirement. It is clear that there is little difference between the statistic for the second and third definitions. This is due to the fact that the vast majority of farm holders report an amount of labour on or above one labour unit for their farm.[3]

It must be pointed out however that a large proportion of this hidden underemployment problem is likely to be age-determined. Farmers older than the normally accepted retirement age, are more likely to be undertaking a workload less than one labour unit in the first instance. Furthermore as farmers reach a certain age, it takes longer to perform a given task thereby increasing the chances of hidden underemployment.

To illustrate this point, we first categorise farms into four categories where RL_{it} represents the farmers reported labour for farm i at time t and SMD_{it} represents the standard labour requirement for farm i at time t.

$$Group_{jt} \begin{cases} Sufficient\ Employment\ if\ (RL_{it} \leq SMD_{it}) \\ Mild\ Hidden\ Underemployment\ if\ 0 < (RL_{it} - SMD_{it}) \leq 52.14 \\ High\ Hidden\ Underemployment\ if\ 52.14 < (RL_{it} - SMD_{it}) \leq 100.28 \\ Severe\ Hidden\ Underemployment\ if\ (RL_{it} - SMD_{it}) > 100.28 \end{cases} \quad (1)$$

The first category incorporates those farmers with sufficient employment i.e. where the reported labour RL_{it} is less than or equal to the standard labour requirement SMD_{it}. The second category involves those farms where the reported annual labour exceeds the SMD but by less than one day per week or alternatively 52.14 days per annum. We consider this to be mild hidden underemployment. The third category of high hidden underemployment consists of those farm holders where the reported

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[3] The total labour recorded for each farmer is capped at one labour unit. Therefore, the distance between the reported labour and the standard labour requirement (SMD) is usually one labour unit subtracted by the SMD.

labour exceeds the SMD by between one and two days per week. The final category of severe hidden underemployment involves the cases where the reported labour exceeds the SMD by more than two days per week or 100.28 days per annum. We add a further condition that one can be considered sufficiently employed where the SMD plus off-farm hours exceed that required to meet one labour unit i.e. where

$$Group_{jt} = Sufficient\ Employment\ if\ (SMD_{it} + OFFHRS_{it} \geq One\ Labour\ Unit) \qquad (2)$$

This ensures that we do not classify farms as being underemployed where the workload both on-farm SMD_{it} and off-farm hours $OFFHRS_{it}$ exceeds the threshold of one labour unit. Some farmers may have a combined on-farm and off-farm workload well in excess of one labour unit and report longer on-farm working hours than the SMD amount. While there may well be inadequate employment situations in these cases, we cannot classify them as having hidden underemployment. Such farmers are clearly not underemployed in the first place as total required hours exceed a commonly used threshold.

In figure 5, we present the proportion of farmers in each age category that fall into each of the four underemployment categories.

Figure 5: Category of Hidden Underemployment by Age Bracket in 2011

It appears from this graph that hidden underemployment is highly age correlated. The proportion of farmers falling into the high or severe underemployment categories is

about twenty per cent for the youngest three age groups. This is far higher among the older age groups at close to seventy per cent for those aged between 60 and 64 and close to 90 per cent for those aged 70 or older. In reality, we should not be overly concerned about the number of farmers aged above 60 with hidden underemployment. We do not expect a high fraction of people in other industries to carry on working past 64 years old. The opportunity exists for farmers in the older age categories to carry on pursuing farming but perhaps with less intensity than in earlier years. It does remain concerning however that many farmers in younger age groups have some form of hidden underemployment.

In terms of the extent of the problem, it appears from table 2 that there has been little change in the severity of underemployment over the course of the period. The numbers in table 2 show that the average underemployed farm is reporting between 13 and 15 hours of labour per week above that of the standard labour requirement (SMD). This means that potentially an average of a day and a half per week of labour is being lost per annum on underemployed farms through hidden underemployment or what could be otherwise termed as inadequate employment situations. There does not appear to have been any great change in the average severity of hidden underemployment during the period.

Table 2: Hidden Underemployment in Hours Per Week

Year	Hours	Year	Hours
1996	14.7	2004	15.1
1997	14.3	2005	14.9
1998	13.9	2006	14.8
1999	14.4	2007	15.3
2000	15.0	2008	14.8
2001	14.7	2009	15.1
2002	15.2	2010	15.3
2003	14.8	2011	14.9

**Underemployed Hours are divided among all 52.14 Weeks of the Year

As suggested earlier, we should probably concern ourselves most with cases of underemployment where the farm holder is aged less than 60 years old. We estimate based upon the Teagasc NFS that there are approximately 26,400 farm holders younger than 60 years old with hidden underemployment in 2011. In table 3, we show the percentage of farmers in underemployment according to the system of farming in four selected years and impose the restriction that only farmers aged less than 60 years old can be classified as underemployed.

Table 3: Share of Farmers Underemployed by System 1996-2011**

Year	1996	2001	2006	2011
Dairying	16.8	13.5	11.8	12.6
Dairying and Other	16.6	14.1	12.6	18.1
Cattle – Specialist Beef	50.9	35.3	36.2	45.5
Cattle and Other	35.1	24.3	31.1	40.0
Mainly Sheep	40.7	29.8	20.6	29.0
Tillage	24.8	19.7	16.5	18.5
All Farm Holders Aged Less than 60	31.3	25.0	25.1	33.6

**Restriction - only farm holders less than 60 years old can be classified as underemployed

The results from table 3 show that underemployment declined between 1996 and 2001 plateaued until 2006 and subsequently increased between 2006 and 2011. This initial decline in underemployment from 1996 to 2001 is perhaps less evident from figure 4. This is partially due to the restriction imposed here i.e. we do not classify farm holders aged 60 and above as underemployed for the purposes of table 3.

In terms of the variations between systems, the underemployment problem has generally been more prevalent among non-dairy cattle and sheep farmers and less prevalent among dairy and tillage farms. This changed little over the course of the period. Approximately half of all specialist beef farms were underemployed in 1996. This declined in subsequent years as the on-farm workloads increased as well as the number of hours worked off-farm.

A similar improvement is found among the sheep farms and the cattle and other farms. We find that underemployment rates changed by relatively small amounts on dairy farms while there was a sustained decline in underemployment on tillage farms up to 2006. It appears that the underemployment problem has increased most among

non-dairy cattle and sheep farms during the economic recession. The rate of underemployment is now close to exceeding that of 1996 in the case of non-dairy non-dairy cattle farms.

IV. METHODOLOGY

As can be seen from figure 4, approximately half of the weighted sample has some form of hidden underemployment. We know from figure 5 that there is a good deal of variation in the severity of this underemployment between farmers and that this severity appears to be highly correlated with age. The first task in this methodology is to put forward an appropriate econometric technique that can be used to model the factors driving the existence of underemployment. We recall that we are particularly interested in examining the impact that changes in off-farm employment status may have upon underemployment. We consider that endogeneity may well be an issue in that there may be unobserved factors driving both off-farm employment and the presence of hidden underemployment.

These unobserved factors may include health status and ability related variables among others. We therefore use a two stage residual inclusion model (2SRI) to address the potential endogeneity of off-farm employment towards underemployment. This method was first suggested by Hausman (1978) and has later been used by Burnett (1997), Petrin and Train (2006) and Terza et al (2008) among others. The 2SRI model is preferred to the two stage least squares (2SLS) model and the two-stage predictor substitution (2SPS) on the basis of its consistency in non-linear models.

In the first stage of the model, we model the off-farm employment decision as the following:

$$Prob\ (O_{it} = 1) = F(\beta' X_{it}) \tag{3}$$

where F is the normal probability distribution function over the closed interval, [0,1], or $0 \leq F(\beta X'_{it}) \geq 1$ to satisfy the probability properties. Equation 3 can be estimated using a probit model, and from the estimated coefficients, the probability of participation in off-farm work can be calculated. If, for a particular farm holder, the values of the independent variables are known, it is possible to estimate the probability of that particular farmer participating in off-farm employment. If the exogenous variables are expected to vary, such as the post-decoupling variation in the on-farm income and net worth, it is possible to estimate the effect of those changes on the probability of participation as well.

The probability of the farm holder being employed off-farm is estimated as

$$P_{it}^* = \exp(\beta_0 + \beta' X_{it}) \tag{4}$$

Where P_{it}^* measures the probability of participation. We find the residuals v_{it} by subtracting the predicted value $p^*{}_{it}$ from the reported off-farm participation p_{it}

$$X_{ui}^* = p_{it} - p_{it}^* = v_{it} \tag{5}$$

In the second stage, we model the condition of underemployment as a binary outcome. We include the residual from the first stage (v) as an explanatory variable in order to address potential endogeneity of off-farm employment towards underemployment.

The Underemployment status equation is the following:

$$U_{it}^* = \exp(\beta_0 + \beta'_e X_{it} + \beta'_u X_{ui}^*) + \varepsilon_{it}^{2SRI} \tag{6}$$

Where ε_{it}^{2SRI} is the regression error term for this stage and X_{ui}^* represents the residuals from the first stage regression. The term β'_u represents the coefficient parameter for the first stage residual while the term β'_e represents the coefficient parameter for the other independent variables which includes the off farm employment status variable.

$$UDAYS_{it}^* = \exp(\beta_0 + \beta'_e X_{it}) + \varepsilon_{it} \tag{7}$$

We model the severity of hidden underemployment in equation 7, using the log of hidden underemployment (days per annum) as the dependent variable and apply this to the subsample of underemployed farm holders.

V. RESULTS

In this section, we discuss the results of our econometric analysis. We first take a look at the results for the underemployment status model. The results for the off-farm participation model are included in the Appendix rather than here. We present the results in three columns. The first regression includes all of the independent variables except the lagged underemployment term and the initial condition i.e. whether or not the farmer entered the sample as underemployed in their first year. The lagged underemployment term is included in the second regression and both are included in the third regression. We find that the estimated impact of age upon underemployment is significantly positive and increasing as we move up the age distribution. The baseline category being those farmers aged less than 40 years old. It appears that being a specialist dairy farmer has a significantly negative association with underemployment i.e. specialist dairy farmers are much less likely than other farmers to have hidden underemployment.

The size of the farm is also significant and negatively associated with underemployment. The off-farm employment variable is as expected negative. The potentially interesting aspect of this is that the residual from the first stage is significantly positive at the one per cent level. This suggests there are unobserved factors driving farmers into off-farm employment and driving an increased likelihood of hidden underemployment. The number of livestock units and the yield per hectare are both significantly negative. The lagged term is significantly positive as well as the initial condition. This suggests that there unobserved variables which have a stubborn influence upon instances of hidden underemployment. The introduction of the decoupled single farm payment in 2005 does not appear to have made any statistically

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significant impact upon the presence of hidden underemployment. The size of the household (number of members) is also insignificant.

Table 4A: Results from the Probit Regression of Underemployment Status

Dependent Variable	Underemployed	Underemployed	Underemployed
Age 40-44	0.0973	0.0628	0.0523
	(0.10)	(0.11)	(0.11)
Age 45-49	0.209**	0.202*	0.187
	(0.11)	(0.12)	(0.12)
Age 50-54	0.340***	0.351***	0.343***
	(0.11)	(0.12)	(0.12)
Age 55-59	0.0231	-0.00562	-0.00610
	(0.11)	(0.13)	(0.13)
Age 60-64	0.148	0.164	0.168
	(0.11)	(0.13)	(0.13)
Age 65-69	0.338**	0.355**	0.393**
	(0.13)	(0.15)	(0.15)
Age 70+	0.350**	0.351**	0.418**
	(0.14)	(0.17)	(0.17)
System (Dairy Only = 1)	-0.962***	-1.040***	-1.024***
	(0.12)	(0.14)	(0.14)
Size	-0.0265***	-0.0245***	-0.0272***
	(0.00)	(0.00)	(0.00)
Single Farm Payment	-0.00234		0.000105
	(0.00)		(0.00)
Off Farm Job (No = 0, Yes = 1)	-3.658***	-4.105***	-3.985***
	(0.34)	(0.38)	(0.39)
Yield (Gross Output per Hectare)	-0.000618***	-0.000392***	-0.000591***
	(0.00)	(0.00)	(0.00)
Size	-0.0265***	-0.0245***	-0.0272***
	(0.00)	(0.00)	(0.00)
Size Squared	0.0000473***	0.0000483***	0.0000484***
	(0.00)	(0.00)	(0.00)
No. of Household Members	0.00256	0.0274	0.0169
	(0.02)	(0.03)	(0.03)
Number of Livestock Units	-0.0159***	-0.0232***	-0.0203***
	(0.00)	(0.01)	(0.01)
Less Favoured Area (No= 0, Yes= 1)	0.446***	0.322***	0.396***
	(0.08)	(0.10)	(0.10)
No. of Livestock Units Squared	-0.0000748**	-0.0000506	-0.0000658*
	(0.00)	(0.00)	(0.00)
Residual from First Stage	1.590***	1.793***	1.668***
	(0.32)	(0.36)	(0.37)
Underemployed in Previous Year (No = 0, Yes = 1)	1.944***	1.412***	1.399***
	(0.06)	(0.07)	(0.07)
Initial Condition		1.715***	1.757***
		(0.14)	(0.15)
Couple Farm Income		-0.0162***	
		(0.00)	
		-0.0162***	

_cons	1.299***	1.000***	0.956***
	(0.22)	(0.24)	(0.24)
N	15200	15200	15200

Table 4B: Results for Time Dummies in the Probit Regression of Underemployment

Dependent Variable	Underemployed	Underemployed	Underemployed
1998	0.178	0.239*	0.234*
	(0.12)	(0.14)	(0.14)
1999	0.136	0.208	0.229*
	(0.12)	(0.14)	(0.14)
2000	0.343***	0.479***	0.467***
	(0.12)	(0.14)	(0.14)
2001	0.0828	0.227	0.219
	(0.13)	(0.15)	(0.15)
2002	0.378***	0.515***	0.513***
	(0.13)	(0.14)	(0.14)
2003	0.149	0.281*	0.279*
	(0.13)	(0.14)	(0.14)
2004	0.332**	0.465***	0.462***
	(0.13)	(0.15)	(0.15)
2005	0.590***	0.675***	0.721***
	(0.15)	(0.15)	(0.16)
2006	0.563***	0.624***	0.729***
	(0.15)	(0.16)	(0.17)
2007	0.891***	1.024***	1.103***
	(0.16)	(0.17)	(0.18)
2008	0.535***	0.603***	0.750***
	(0.15)	(0.16)	(0.17)
2009	0.715***	0.748***	0.946***
	(0.15)	(0.15)	(0.17)
2010	0.629***	0.742***	0.889***
	(0.15)	(0.16)	(0.17)
2011	0.887***	1.084***	1.175***
	(0.15)	(0.16)	(0.17)

Table 5A: Results for Severity Analysis

Model	Fixed Effects	Random Effects	Random Effects
Dependent Variable	Log of Underemployment (Days Per Annum)	Log of Underemployment (Days Per Annum)	Log of Underemployment (Days Per Annum)
Age 40-44	0.00876	0.0114	0.0130
	(0.06)	-0.05	(0.05)
Age 45-49	0.157**	0.138***	0.140***
	(0.06)	-0.05	(0.05)
Age 50-54	0.211***	0.153***	0.144***
	(0.07)	-0.05	(0.05)
Age 55-59	0.156**	0.118**	0.107**
	(0.07)	-0.05	(0.05)
Age 60-64	0.217***	0.154***	0.147***
	(0.08)	-0.06	(0.05)
Age 65-69	0.237***	0.176***	0.165***
	(0.08)	-0.06	(0.06)
Age 70+	0.298***	0.222***	0.204***
	(0.09)	-0.06	(0.06)
System (Dairy Only = 1)	-0.632***	-0.739***	-0.728***
	(0.07)	-0.06	(0.06)
Size (No. of Hectares)	-0.00811***	-0.00652***	-0.00465***
	(0.00)	0	(0.00)
Size Squared	0.0000166***	0.0000124***	0.00000930***
	(0.00)	0	(0.00)
Household Size (Number of Members)	-0.00803	-0.0127	-0.00909
	(0.01)	-0.01	(0.01)
Number of Livestock Units	-0.0237***	-0.0212***	-0.0210***
	(0.00)	0	(0.00)
Less favoured Area (No=0, Yes =1)	-0.0264	0.144***	0.104**
	(0.07)	-0.04	(0.04)
Single Farm Payment	0.00903***	0.00796***	
	(0.00)	0	
Off Farm Job (No=0,Yes =1)	-0.852***	-0.814***	-0.796***
	-0.04	-0.04	-0.04
Yield (Gross Output Per Hectare)	-0.000331***	-0.000271***	-0.000180***
	(0.00)	(0.00)	(0.00)
Number of Livestock Units Squared	-0.0000044	0.0000126	0.0000174
	(0.00)	(0.00)	(0.00)
Coupled Farm Income			-0.00568***

			0
Initial Condition			0.324***
			(0.05)
_cons	5.390***	5.051***	4.729***
	-0.13	-0.09	-0.1
N	5804		5804

The results for the severity of underemployment are quite similar under both random effects and fixed effects which gives us some confidence. Age appears to be positively associated with the severity of underemployment as indicated by the earlier summary statistics. Being a specialist dairy farm and the size of the farm also have a significantly negative association. The less favoured area variable is insignificant in fixed effects while it is significant and negative in random effects. This is perhaps due to the removal of time invariant information in the case of fixed effects.

Interestingly, the single farm payment is significant and positively associated with hidden underemployment although it is not a significant factor in determining whether or not one is underemployed in the first place. The introduction of the single farm payment did not lead to significant entry into situations of hidden underemployment. It did however push already underemployed farmers into even greater levels of underemployment. These farmers essentially reduced their farm workload in response to the decoupling of direct payments. This led to an increased gap between reported hours and the required number of hours.

Having an off-farm job reduces the severity of hidden underemployment and so does higher yield per hectare. The initial condition is positively related to underemployment in the random effects model. It is excluded from the fixed effects due to its time invariance. We report the results for the time dummies in the appendix as there are very few significant time dummies.

VI. CONCLUSION

This paper has examined hidden underemployment among Irish farm holders between 1996 and 2011. Our measure of hidden underemployment is due to differences between the farmer's reported labour supply and the standard labour requirement estimated by the Teagasc National Farm Survey. We have applied a random effects probit model to examine the factors driving instances of underemployment. A two-stage residual inclusion method is included to account for the potential endogeneity of off-farm labour supply towards our dependent variable. We utilise both fixed and random effects OLS and the sub-sample of underemployed farms to examine the severity of hidden underemployment.

Our findings indicate that hidden forms of underemployment are of greater relevance to Irish farming than the more established time-related underemployment, the latter essentially capturing instances whereby the farmer's labour hours are below their desired level. This is due to the finding that the vast majority of Irish farmers are reporting a combined number of hours (on-farm and off-farm) that is generally considered to be sufficient for full time employment. There appears however to be substantial gaps between the reported labour supply and the standard labour requirement thereby indicating instances of hidden underemployment.

In terms of the patterns over time, it appears that the early stages of the economic boom involved some reduction in the instances of hidden underemployment but there appeared to be little or no improvement over the latter stages of the boom from 2001 onwards. We find that the proportion of farm holders with hidden underemployment in 2011 is close to the levels of 1996. Our probit analysis suggests that the introduction of the decoupled single farm payment in 2005 did not significantly increase the number of underemployed farmers. We can therefore most likely attribute a large fraction of the dis-improvement to the decline in the wider economy and the related decline in off-farm employment.

It appears from our results that the severity of hidden underemployment among underemployed farms did not change significantly over the entire period. It appears that the problem is highly age correlated and this is supported by our econometric

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results. The single farm payment is found to have significantly increased the severity of hidden underemployment among underemployed farm holders even though it does not significantly affect the proportion with underemployment. This suggests that the single farm payment affected workloads on a particular subset of underemployed farms.

We may expect that an improvement in the general economy can remove some of the underemployment problem via higher off-farm employment participation. The response of off-farm participation to such an improvement however, may not be immediate. Employers may increase the hours of their existing workers rather than make new hires as pointed out by Bell and Blanchflower (2011). Our results suggest that some on-farm variables can be important in bringing about a reduction in hidden underemployment. It appears that spatial and unobserved factors are inhibiting the situation. Farmers classified as underemployed at the beginning of the period are significantly more likely to be underemployed in 2011 and this does point towards stubborn factors being influential.

Finally, the measurement of hidden underemployment is being discussed at length by the International Labour Organisation (ILO) and other relevant institutions but there does not appear to be agreement on the best measurement approaches. This paper has offered a method to estimate the level of hidden underemployment in the case of farming in Ireland. In an ideal world, this method could be applied to other sectors of the economy but it remains open to debate as to whether or not similar methods can prove as useful in the case of other sectors.

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Appendix 1: Results for Probit Regression of Off Farm Employment Participation

Dependent Variable	Off Farm Employment	Off Farm Employment	Off Farm Employment
Age 40-44	0.00412	0.00587	0.0108
	(0.10)	(0.10)	(0.10)
Age 45-49	0.144	0.147	0.148
	(0.11)	(0.11)	(0.11)
Age 50-54	-0.0741	-0.0690	-0.0664
	(0.12)	(0.12)	(0.12)
Age 55-59	-0.489***	-0.483***	-0.482***
	(0.12)	(0.12)	(0.12)
Age 60-64	-1.122***	-1.115***	-1.108***
	(0.14)	(0.14)	(0.14)
Age 65-69	-2.923***	-2.912***	-2.903***
	(0.18)	(0.18)	(0.18)
Age 70+	-3.487***	-3.473***	-3.464***
	(0.21)	(0.21)	(0.21)
Sex (male = 0, female = 1)	-0.636***	-0.637***	-0.634***
	(0.21)	(0.21)	(0.21)
System (Dairy Only = 1)	-0.969***	-0.973***	-0.920***
	(0.11)	(0.11)	(0.11)
Spouse Work (No= 0, Yes = 1)	0.0112	0.0110	0.0130
	(0.08)	(0.08)	(0.08)
Size (Number of Hectares)	-0.0189***	-0.0191***	-0.0182***
	(0.00)	(0.00)	(0.00)
Size Squared	0.0000439***	0.0000441***	0.0000440***
	(0.00)	(0.00)	(0.00)
Married (No = 0, Yes = 1)	0.187	0.187	0.200*
	(0.11)	(0.11)	(0.11)
No. of Children Aged 0 to 4	-0.0843	-0.0825	-0.0837
	(0.06)	(0.06)	(0.06)
No. of Household Members	0.181***	0.180***	0.183***
	(0.03)	(0.03)	(0.03)
Hired Labour (No=0, Yes = 1)	-0.0504	-0.0492	-0.0512
	(0.07)	(0.07)	(0.07)
Number of Livestock Units	-0.0185***	-0.0185***	-0.0179***
	(0.00)	(0.00)	(0.00)
Net Worth (Value of Land and Buildings)	-0.000146	-0.000379	-0.000242
	(0.00)	(0.00)	(0.00)
Less Favoured Area (No = 0, Yes = 1)	0.358***	0.356***	0.333***
	(0.11)	(0.11)	(0.11)
Single Farm Payment		0.00307	
		(0.00)	
Coupled Family Farm Income			-0.00527***
			(0.00)
_cons	-1.721***	-1.706***	-1.680***
	(0.22)	(0.22)	(0.22)
N	18245	18245	18245

Appendix 2: Time Dummies in Probit Regression of Off Farm Employment

Dependent Variable	Off Farm Employment	Off Farm Employment	Off Farm Employment
1997	0.274**	0.275**	0.265**
	(0.13)	(0.13)	(0.13)
1998	0.369***	0.370***	0.358***
	(0.13)	(0.13)	(0.13)
1999	0.569***	0.571***	0.546***
	(0.13)	(0.13)	(0.13)
2000	0.548***	0.551***	0.544***
	(0.13)	(0.13)	(0.13)
2001	0.631***	0.634***	0.630***
	(0.13)	(0.13)	(0.13)
2002	0.813***	0.817***	0.807***
	(0.13)	(0.13)	(0.13)
2003	0.832***	0.836***	0.829***
2004	1.080***	1.086***	1.075***
	(0.13)	(0.13)	(0.13)
2005	1.307***	1.276***	1.272***
	(0.14)	(0.14)	(0.14)
2006	1.548***	1.517***	1.478***
	(0.14)	(0.15)	(0.14)
2007	1.783***	1.755***	1.745***
	(0.15)	(0.15)	(0.15)
2008	1.571***	1.538***	1.501***
	(0.15)	(0.15)	(0.15)
2009	1.268***	1.232***	1.153***
	(0.14)	(0.15)	(0.15)
2010	1.039***	1.003***	0.973***
	(0.15)	(0.15)	(0.15)
2011	1.108***	1.072***	1.075***
	(0.15)	(0.15)	(0.15)

Appendix 3: Results for Time Dummies in Severity Analysis

Model	Fixed Effects	Random Effects	Random Effects
Dependent Variable	Log of Underemployment (Days Per Annum)	Log of Underemployment (Days Per Annum)	Log of Underemployment (Days Per Annum)
	Fixed Effects	Random Effects	Random Effects
1998	-0.0122	-0.00958	-0.00008
	-0.04	-0.04	-0.04
1999	-0.0195	-0.0173	-0.00881
	-0.04	-0.04	-0.04
2000	0.0181	0.0191	0.0355
	-0.04	-0.04	-0.04
2001	0.0396	0.0425	0.0603
	-0.04	-0.04	-0.04
2002	0.0146	0.0292	0.0481
	-0.04	-0.04	-0.04
2003	0.0658	0.0749*	0.0941**
	-0.04	-0.04	-0.04
2004	-0.0271	-0.00927	0.0165
	-0.04	-0.04	-0.04
2005	-0.0749	-0.0535	0.0283
	-0.05	-0.04	-0.04
2006	-0.0838	-0.0668	0.00809
	-0.05	-0.05	-0.04
2007	-0.023	0.000584	0.0791*
	-0.05	-0.05	-0.04
2008	-0.0461	-0.0175	0.0511
	-0.06	-0.05	-0.04
2009	0.00154	0.0328	0.103**
	-0.06	-0.05	-0.04
2010	0.0787	0.0979**	0.174***
	-0.06	-0.05	-0.04
2011	0.0875	0.100**	0.186***
	-0.06	-0.05	-0.04
N	5804	5804	5804