



Modelling the Effect of Policy Reform on Structural Change in Irish Farming

Thia C. Hennessy

Teagasc, Rural Economy Research Centre, Athenry, Co Galway, Ireland.

Email: thennessy@rerc.teagasc.ie

	
Irish Agriculture and Food Development Authority	Rural Economy Research Centre Ionad Taighde Eacnamaíochta Tuatha

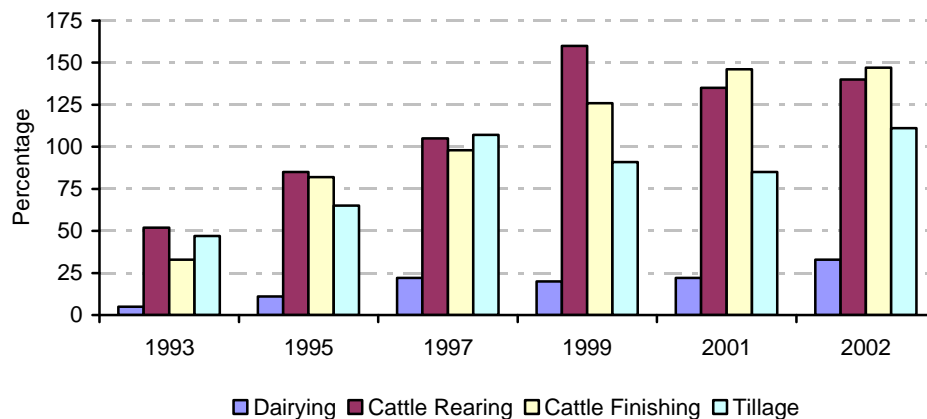
Executive Summary

- The objective of these research projects was to build an economic modelling system to show the effect of policy reform on the viability and changing structure of the Irish farming sector.
- The modelling system once developed was used to analyse the implications of the 2003 Mid Term Review of the CAP, particularly the decoupling of direct payments from production.
- The methodology involved applying FAPRI-Ireland price and cost projections to Irish National Farm Survey data and integrating optimisation and econometric estimation to simulate farmers' behaviour under different policy scenarios.
- Linear programming models were used to simulate farmers' production decisions while exogenously estimated models were used to simulate other behaviour. Three econometric models were developed a multinomial logit model of farm entry and exit, a two step econometric model of farmers' labour supply decisions and milk quota market model. The linear programming and econometric models are linked and solved iteratively for a five year period.
- The results of the research show that farm numbers will decline over the next five years and, the rate of decline will accelerate further after decoupling relative to a continuation of Agenda 2000 policies. Furthermore, decoupling is likely to result in a more positive economic outlook for beef farming with an increase in the number of economically viable beef farms. The number of beef farmers relying on income from outside the farming sector will however increase. Dairy farmers will face a price cost squeeze and that the pace of structural change in this sector of farming will accelerate due to decoupling. Despite an increased availability of milk quota for farmers remaining in business, the number of economically viable dairy farming businesses is set to decline.

Introduction

The Mid Term Review (MTR) of the Common Agricultural Policy (CAP) has allowed for the decoupling of all direct payments from production from 2005 onwards; until then, most direct payments were coupled to production, requiring farmers to produce specific products in order to claim support. After decoupling, farmers will receive a payment regardless of production as long as their farm land is maintained in accordance with good agricultural practices. Direct payments to farmers have been an integral part of the CAP since the 1992 Mac Sharry reforms. Throughout the 1990s, market prices for farm produce have declined generally in line with policy while costs of production have continued to increase. Meanwhile, direct payments increased in value, increasing farmers' reliance on this source of income. Furthermore, farmers adapted farming practices to maximise their receipt of direct payments, leading to the culture of 'farming the subsidy'. By 1997, on cattle and tillage farms in Ireland 100 per cent of family farm income was derived from direct payments, meaning that on average the market-based revenue was insufficient to cover total costs. Farmers engaged in production only to receive the payments, see Figure 1.

Figure 1: Direct Payments as a Percentage of Family Farm Income on Irish farms



Source: Irish National Farm Survey, Teagasc.

The decoupling of direct payments is expected to have major ramifications for aggregate agricultural production, farm practices and the structure of farming in Ireland. It will significantly reduce the actual 'coupled' return to production; and, in some cases, the return to coupled production will be negative. The purpose of these two research projects was to develop a modelling approach to assess the changes that are likely to be engendered by decoupling, in terms of the implications for the economic viability and the structure of farming in Ireland. This end of project report begins by providing some background to the economics of decoupled payments and the challenges of modelling such policy instruments. Following on from this, the methodology adopted in these projects is outlined and described. The results of the projects are presented and the report concludes with some recommendations for future research.

The Challenge of Modelling Decoupling and its Relationship with Structural Change

The difficulties of expanding the EU within the constraints of a limited agricultural budget, the desire to make agriculture more market oriented and, the perceived need to formulate policies that are defensible within the current WTO processes which have lead to pressure for reform of the direct payment system in place for the EU farmers. It was in response to these pressures that the Luxembourg Agreement was ratified in June 2003, making it possible to decouple all (or some) direct payments from production.¹ In Ireland, all payments are decoupled from production from January 2005. A decoupled payment is based on the number of premiums received in a historical reference period, paid in the form of a per hectare Single Farm Payment (SFP) the land under farming during the reference period.

Economic theory suggests that if coupled subsidies are replaced with decoupled payments, then production falls to a level that would exist without any subsidies. If such a situation transpires, then production on farms making a market-based loss should fall substantially post decoupling unless

¹ For further details on the partial decoupling options included in the Luxembourg Agreement see European Commission (2003).

significant cost management or efficiency gains can be achieved. The production effects of decoupled payments however are still somewhat of an enigma. Burfisher and Hopkins (2003) have reviewed research on the topic to show that even fully decoupled payments have a 'production inducing effect' as they affect farmers' exposure to economic risk, their access to capital and their future expectations. Whilst direct payments may be decoupled from production there may still be an 'incentive effect', which can occur if some residual production or resource use is still required to qualify for the decoupled payment (Swinbank 2004). Although production is not necessary after the MTR, the direct payment remains tied to land. Even if payments were not to be linked to production at all, supply will not be so price sensitive so as to immediately fall to the free trade levels, which is especially the case for multi-period activities such as livestock.

With or without a link to production, payment is a source of revenue for the farm household and thus it may indirectly affect production decisions through what is referred to as a 'wealth effect'. Hennessy (1998) and Sckokai & Moro (2002) have explored the interaction between decoupled payments, farmers' risk preferences and production decisions. They conclude that if farmers' aversion to risk declines as income increases, then an increase in wealth can induce them to take riskier production decisions; thus, output increases compared to the situation when no decoupled payment is made. Decoupled payments also relax the household's capital constraint, lowering the cost of capital to the household. According to Andersson (2004) the resulting effect is that farm investment is likely to be greater after decoupling than in the absence of such payments. Revell and Oglethorpe (2003) have recently explored the expectations effect, claiming that producers may adopt a 'safety first' strategy and make only minimal changes to production plans in case future payments are reassessed and again related to production or an agricultural activity. It is clear then that even decoupled payments can influence production decisions. This paper explores some of these issues empirically. Whilst farmers' risk preferences or investment plans are not modelled explicitly, the effect of decoupling on production decisions, entry and exit decisions and the pace of structural change in farming is explored.

Despite the long-standing interest in structural change in farming, modelling such change still remains notoriously difficult (Garvey and Steele 1999). The processes of structural change play a powerful role in the analysis of competitive industries in standard microeconomic text books, but as noted by Gale (2002), there has been relatively little empirical study of the process in farming. The available empirical models of structural change in agriculture mostly focus on the aggregate by examining changes in the total number of farms using time-series econometric models or changes in the numbers in various sub-sections of the population using, for example, Markov Chain models. Such aggregate modelling approaches are often criticised for overlooking the micro dynamics of change (Jackson-Smith 1999). Furthermore, such models do not lend themselves conveniently to policy analysis as it is difficult to quantify the relationship between policy instruments and changes in farm numbers.

The Markov Chain is probably the most frequently used model for analysing structural change. Recently, non-stationary Markov Chain models have been used to project changes in the structure of farming in response to exogenous shocks, see (Zepeda 1995; Karantininis 2001; and Jongeneel 2002). Theoretically, the non-stationary Markov Chain model would analyse the effect of a policy reform and likewise, regression techniques could be used to estimate the effect of the new policy on the probability of farms moving from one structural state to another. There are however two main reasons why a Markov Chain model is not appropriate for the research questions addressed in this paper. First, the limited details available in the Irish macro data it is not possible to develop a model that allows movement between all states of structural change; that is, a matrix of transition probabilities for all $n \times n$ cells cannot be estimated. It is therefore necessary to use a Krenz-modified Markov Chain, which assumes that an identifiable pattern of structural change is evident; for example, farms getting bigger, only small farms exiting and entry only through one size class. This assumption is not tenable for Ireland, as exits from farming occur from all sizes and systems and farms of all sizes and systems choose to transfer into part-time farming. Furthermore, given the

major policy reform under investigation, new structural states may evolve, for example the existence of the "sofa farmer", and the Krenz-modified Markov Chain model cannot predict unprecedented structural states.²

The second problem in using non-stationary Markov Chains is the estimation of the transition probabilities; the model assumes that the historical relationships between the various exogenous variables and the transition probabilities remain constant into the future. This assumption is not sustainable in analysing the effect of a change in intervention prices or export subsidies, that is the policy instruments are the same and there is simply a marginal adjustment to their value. Decoupling is an unprecedented change to policy and hence the coefficients estimated from regression analysis on data from an Agenda 2000 type policy regime would not be appropriate for decoupling.³ Furthermore, with decoupling new policy instruments emerge, most notably the SFP. To analyse the effect of the SFP in a non-stationary model, it is necessary to identify a proxy for the SFP. Identification of a suitable proxy variable, that is a source of revenue to the household that is linked to land but not to production, is problematic. Given these difficulties, it was decided to move away from a Markov Chain type methodology and instead to develop a farm level model of structural change.

Methodology

In this paper the FAPRI-Ireland model is adapted to estimate the effect of decoupling on the pace of structural change in Irish farming. The FAPRI-Ireland Partnership consists of a partial equilibrium model of Irish agriculture, which is linked to the FAPRI EU GOLD model, and a set of farm level models. At the aggregate level, a set of individual econometrically estimated commodity models are linked and solve simultaneously under different policy scenarios. The farm level modelling system is

² A sofa farmer is one who uses the farm land only to claim the decoupled payment but not to produce any tangible agricultural output.

³ This criticism is due to Lucas (1976) who, in his seminal paper, argued that empirical models estimated under a specific policy regime are not applicable for economic analysis under another policy regime because the parameters of an estimated model embody the policy under which the data were generated.

comprised of a number of representative farms that are modelled using multi-period profit maximising linear programming (LP) models. This modelling system however, does not account for how policy may affect the pace of structural change in farming or the reallocation of resources that may occur as a result of a policy change. In this paper the FAPRI-Ireland farm level models are adapted to estimate the effect of decoupling on structural change in farming.

The proposed methodology involves integrating econometric and optimisation models. A profit maximising LP framework is retained to simulate production decisions. The advantage of LP is it does not rely on time-series data and it does not extrapolate future relationships from historical ones, and therefore it can go beyond the realm of past observations and analyse unprecedented changes. The disadvantages of using LP however are its normative nature and its limited scope to project population change. To overcome these weaknesses, the LP model is supplemented with a number of exogenously estimated models of farmer behaviour that can quantify the effects of non-pecuniary factors on farmers' decision-making. Three exogenous models were estimated: first, entry to and exit from farming; second, labour allocation; and third, land and milk quota distribution. The first model simulates the Irish farming population. The second model estimates the number of part-time farmers and the amount of farm labour to provide the right hand side parameters for the labour constraint in the LP models. The third model simulated the allocation of land and milk quota; again, to provide the right hand side parameters for the land and quota constraints in the LP models.

Modelling Entry and Exit Decisions

Many studies of entry and exit in the farming sector have concluded that age related variables are the most significant factors (Gale 1999 and Glauben et al 2003). Gale noted that there is a common perception that farm numbers are in decline due to accelerated exits. His research on farm numbers in the US in the 1950s and 1960s, however, shows the decline is mostly due to a substantial drop in new entrants concurrent with a steady rate of retirement. An age cohort analysis of the Irish data reveals that farm numbers in Ireland are in net decline as older farmers leaving the sector exceed the

young new entrants. Hence entry and exit from farming are modelled in the context of succession and retirement decisions. Several empirical models of retirement were developed, including early retirement scheme and heir identification models. Due to the lack of verifiable empirical data and in the absence of a statistically significant model, it was necessary to assume that the retirement process is independent of the agricultural policy environment and that retirement occurs on average at 70 years of age, as suggested by previous qualitative research (Gasson, Errington and Trantrer 1998). Better empirical data are available on the succession decisions and it is therefore possible to quantify the factors affecting a young person's decision to enter farming.

The decision to enter farming is modelled in the context of the nominated farm heir's occupational choice between farm and non-farm work (Hennessy and Rehman 2006). Drawing on the seminal contribution by Schmidt and Strauss (1975), a model of occupational choice is developed. Theoretically, an individual chooses his/her eventual occupation by comparing the discounted utilities derived from all alternative occupations over the entire expected life-span of a career and, then chooses the occupation that maximises life-time utility (Barkley 1990). The individual i is assumed to have a subjective evaluation of each occupation type and to choose the occupation with the highest utility index. Thus for the individual i faced with j choices, the utility of choice j is

$$U_{ij} = \alpha + \beta' x_{ij} + \varepsilon_{ij} \quad (1)$$

where $\beta' x_{ij}$ is a function of the observed attributes of the alternative, the occupational choice and the observed characteristics of the decision-maker and ε_{ij} , the random component, represents the unobserved attributes of the occupations and the decision-maker. If the individual makes the choice $j = 1$ then U_{ij} is maximised from among the j utilities. The empirical model is driven by the probability that choice j is made, that is:

$$\text{Prob}(U_{ij} > U_{ik}) \quad \forall k \neq j \quad (2)$$

The above probability is estimated using the multinomial logit model (MNL). In the MNL x_{ij} denotes the vector of variables that influence the utility associated with each occupational choice j as perceived by each individual heir i . The probability that individual i will choose occupation j is

$$\text{Prob}(i \text{ chooses } j) = \frac{\exp(\beta' x_{ij})}{\sum_{k=1}^m \exp(\beta' x_{ik})} \quad (3)$$

where m equals the number of occupations in the choice set. It is assumed that the nominated farm heir is faced with three choices; full-time farming, a non-farming occupation and part-time farming; that is, combining both farm and non-farm work.⁴

Using data collected by the Irish National Farm Survey (NFS) on farmers' succession plans and their heirs' occupational choices the above MNL model can be estimated. Farmers participating in the survey were questioned about their succession plans and their nominated farm heirs' future plans. Farmers were asked first if they had nominated an heir and subsequently about what they expected their heir to do in future, i.e. continue the farm or not.⁵ The nominated heirs' occupational choice is represented by the categorical variable CHOICE. The empirical data suggest that part-time farming is the most common occupational choice as reported by 48 per cent of respondents, whereas just 21 percent of farms are likely to continue on a full-time basis. Using the MNL framework, the farm and personal characteristics that are hypothesised to affect the succession can be tested empirically. Table 1 presents the variables included in the MNL model.

The results of the MNL model show that an heir's educational achievements influence all occupational choices significantly (appendix 1). Interpreting the effect of education on the

⁴ Whilst there may be many non-farming occupations, they have been combined to one occupational category here as our interest is specifically in the probability of entering farming.

⁵ The data on the nominated farm heirs' occupational choices suffers from generational bias in that it reflects the current generations' opinions of what their heirs will do rather than the heirs' actions or plans. However, it is the only such data available for this study.

occupational choice is problematic. The third level education is a self-selecting process and thus participation in education may not vary autonomously from other factors that influence the occupational decision; that is, the occupational and educational decisions are joint decisions and should be modelled thus by using a bivariate probit specification. This specification is a simultaneous equation model which tests and controls for the endogeneity of the two choices that are related. The results of this bivariate probit model (appendix 1) suggest that the educational and succession decisions are indeed determined jointly, showing that heirs with third level education are significantly less likely to enter full-time farming and that education participation is negatively influenced by farm income. Thus, if decoupling results in a decrease in farm incomes then the probability of farm heirs entering third level education will increase, thereby reducing the probability of their participation in full-time farming.

Table 1: Independent variables for the occupational choice model

Variable	Description	Unit	Mean	Std Dev
FFI	Family Farm Income	€'000	22.876	22.8
FFI2	Family Farm Income Squared	€0'000	1.04e+09	1.95e+09
UAA	Utilised Agricultural Area	Acres*	53.3	54.9
UAA2	Area Squared	Acres	5844	27157
LUS	Livestock Units	Unit	73.8	60.3
LUS2	Livestock Units Squared	Unit	9081.1	17416.76
FJOB	Dummy=1 if current farm operator has an off farm job	Yes/No	0.23	0.42
SJOB	Dummy=1 if operator's spouse has an off farm job	Yes/No	0.30	0.46
DAIRY	Dairy=1 if farm is in dairying	Yes/No	0.42	0.49
HED3	Dummy=1 if heir has third level education	Yes/No	0.22	0.41

*N=514, * An acre equals 0.404 of a hectare.*

Modelling Labour Allocation Decisions

It is hypothesised that decoupling will lead to a significant decline in the return to farm labour resulting in a shift of labour out of agriculture. The allocation of labour cannot be modelled effectively in a profit maximising LP model as the model will reallocate labour to the most profitable activity regardless of preferences, the stickiness of labour and the hidden costs associated with reallocating labour. The allocation of labour is modelled exogenously so as to quantify the effect of decoupling on (i) the number of part-time farmers and (ii) the amount of labour available for farm work.

Theoretically, farmers' labour allocation can be explained using the agricultural household model (Singh, Squire and Strauss 1986). The essence of the model is that farmers maximise a utility function which is a function of consumption and leisure, subject to time and budget constraints. An individual optimises his/her utility by choosing those levels of hours of farm labour, off-farm labour and leisure so as to equate the respective marginal utilities of time spent on each alternative use. Consumption and leisure are restricted by a budget constraint. Income is derived from farm profit depending upon the amount of labour allocated to farm work, from off-farm wages obtained from the amount of labour allocated to such work and also, from non-labour income, that is, income generated without any labour input, for example, investments. The shift from coupled to decoupled subsidies is likely to affect labour allocation within the household too. Coupled subsidies are attached to production and are, therefore, equivalent to an increase in the marginal value product of farm labour. The decoupled subsidy is not attached to production but it is nonetheless a source of revenue for the household and is thus 'non-labour' income. It follows then that decoupling is likely to affect the relative return to farm work in two conflicting ways. First, the return to farm labour will decline significantly and, other things being equal, farmers will substitute off-farm employment for farm labour; that is the substitution effect. An increase in

non-labour income however relaxes the budget constraint, allowing the farmer to work less and maintain consumption; the so called wealth effect.

The above theoretical analysis can be tested empirically using econometric labour participation and labour supply models (Hennessy and Rehman 2005). The participation model is a binary probit which estimates the effect of a vector of exogenous variables on the farmers' probability of participation in the off-farm labour market. The labour supply model is an OLS (ordinary least squares) model where the dependent variable is the number of hours a farmer devotes to off-farm employment. The dependent variable is incidentally truncated, as for some farmers who do not work off-farm the number of hours recorded is zero; thus raising the possible problem of sample selection bias as some of the unobserved factors affecting the participation decision may also affect the supply decision. The Heckman two-step procedure is used to test for sample selection bias in the labour supply model (Heckman 1979).⁶ The results show that no sample selection bias is present, and therefore the OLS model of labour supply is an appropriate one to estimate.

The Irish National Farm Survey (NFS) data for 2002, consisting of 937 observations, are used to estimate these models. Most of the factors that were identified as affecting labour allocation decisions significantly in previous studies are recorded by the NFS. The system and size of farm as well as the number of livestock units are included as explanatory variables. Demographics of the farm household are also included in the model. To explore the effect of decoupling, the substitution and wealth effects have to be measured and therefore variables representing the return to farm labour and total household wealth are specified in the model. Returns to on-farm labour are estimated by dividing total farm income by total labour employed on the farm.⁷ To

⁶ For further details see Hennessy and Rehman (2005)

⁷ In some cases the return was negative due to negative farm income; to avoid negative farm wages the variable was constrained to a lower limit of zero.

explore the effect of wealth, a variable representing non-labour income should be included in the model. The identification of such a variable is however problematic as the NFS does not collect any non-farm data; therefore in common with Mishra & Goodwin (1997) and Ahituv & Kimhi (2002) a farmer's net worth is used as a proxy for household wealth.⁸ The variables used in the model are presented in Table 2.

Table 2: Data for Labour Allocation Models

Variable	Definition	Sample Mean (N=937)	Standard Deviation (N=937)
Dependent Variables			
WORK	Dummy variable=1 if operator engages in off-farm employment	0.26	0.44
HOURS*	Number of hours supplied off-farm	1481	678
Independent Variables			
SYSTEM	Dummy variable=1 if farm is in dairy production	0.52	0.49
SIZE	Total agricultural area in hectares	46	39
SIZE2	Agricultural Area Squared in hectares	3571	17938
FFI	Family Farm Income €000	22.8	22.05
FWAGE	Family farm income per hour of total labour €	11.38	10
FWAGE 2	Family farm income per hour of total labour squared €	231	438
LUS	Number of livestock units	70	55
LUS2	Number of livestock units squared	7928	14302
AGE	Farmer's age in years	55	12
AGE2	Farmer's age squared	3148	1243
SPJ	Dummy variable=1 if spouse engages in off-farm employment	0.30	.45
NO	Number living in farm household	3.9	1.8
LAB	Number of unpaid labour units on the farm	1.09	0.43
UNEMP	Local unemployment rate in percentage	4.6	0.86
OWAGE*	Estimated Off-farm work wage per hour €	14.34	11.89
NW	Net Worth €000	434.25	348
NW2	Net Worth Squared €000	309564	872610

* Sample mean and standard deviation provided only for sample of 247, i.e. where HOURS>0

⁸ Some have argued that this is not an appropriate measure of wealth as many farmers tend to be asset rich but income poor; however, in the absence of any more appropriate verifiable data, there is no realistic alternative to using net worth.

The results of the labour participation and supply models are presented in Appendix 2. The effect of on-farm wage is as expected, negative but non-linear, suggesting that as the farm wage increases the probability of working off-farm declines but at a declining rate. The effect of farm size is also negative suggesting that operators of larger farms are less likely to participate in the off-farm labour market. The effect of the farming system is significant and negative suggesting that the presence of a dairy enterprise reduces the probability of working off farm by 0.31. Again, this is as expected as dairy farming is very labour intensive and is one of the more profitable farm enterprises in Ireland. The effect of the age variable is counter-intuitive in that as farmers get older the probability of off-farm employment increases, albeit at a declining rate. The effect of the labour variable is negative indicating that farms with more unpaid family labour units have a lower probability of the farmer engaging in off-farm employment. Finally, the non-labour income variable, net worth, is significant at the 1 percent level and is negative as expected, suggesting that an increase in non-labour income reduces the probability of off-farm employment.

The results of this labour supply model show that the on-farm wage, the farmers' net worth, the amount of unpaid labour on the farm and the number living in the farm household all affect the number of hours supplied to off-farm employment significantly. The effect of the farm wage and wealth variables are both negative as expected. It follows, therefore, that other things being equal, a decline in the on-farm wage - as is likely to occur following decoupling - increases the numbers working off-farm and the amount of time allocated to off-farm employment. Any increase in non-labour income, which is likely to occur, decreases the number of part-time farmers and hence the amount of time spent working off-farm. The effect of decoupling, therefore, depends on the extent of the decline in the on-farm wage and the increase in non-labour income. The initial estimates suggest that the probability of labour participation increases for 58 percent of the observations, while at the same time the number of hours spent on off-farm

employment also increase for the majority of part-time farmers, with the average number of hours increasing from 1481 hours in the baseline situation to 1550 hours for a decoupled scenario.

Modelling the Distribution of Milk Quotas

The allocation of milk quota as distributed amongst different types of farms is modelled outside the LP framework because of the existence of institutional barriers as well as non-profit related factors influencing production decisions. Modelling the reallocation of milk quota is particularly important, as milk quota is one of the few factors over which the Irish government has complete control. The milk quota market is managed as the price at which quota is traded is set administratively and the redistribution of the existing quota is also state managed through spatial ring-fencing. Milk quota therefore, is of great interest to policy makers in Ireland as they can manipulate this policy instrument to achieve desired economic, social and political goals.

The farm level milk price will decline by approximately 10 percent from 2005 to 2012 as a result of the agreed reductions in the intervention prices for dairy products (Binfield et al 2003). The associated compensation will be decoupled from production meaning that producers giving up milk production in 2005 will still receive €0.04 per litre compensation in 2006 and onwards. Furthermore, producers remaining in production should no longer factor the €0.04/litre into the returns to their output as this payment is received regardless of production. The effect of the policy reform, therefore, is the erosion of the actual (coupled) returns to production and to milk quota. This erosion of the returns to production is likely to render dairy production unprofitable on many farms and, as a result, will have negative consequences for the number of producers. Previous studies of decoupling in the dairy sector suggest that the implications for farm numbers would be negative. Harvey and Colman (2003) concluded that milk producer numbers in the UK would fall by 21 percent in the period from 2002 to 2010 as a result of decoupling.

A model of dairy farmers' production decisions was estimated where farmers could make one of a discrete number of production decisions, maintain, increase, contract or cease milk production. Historical data from a panel of farms was used with the objective of estimating the types of farms that are most likely to change their production decisions. The objective was to simulate the demand for and supply of milk quota in the various regional quota markets. The lack of historical data that exist on farm however posed some problems; so, some additional data on farmers' future plans were collected. Again, problems were encountered as it was not possible to identify any factors that would affect farmers' future production plans significantly. The data collected could not be used to project what may happen in the future. Instead, it was necessary to resort to a farm profitability analysis to extrapolate future production decisions.

The number of farms exiting milk production was estimated as the numbers retiring without a successor and as well as those operating below the critical level of profitability below which exits from farming have occurred in the past. From these estimates the regional supply of milk quota was estimated. It was assumed that farmers with a marginal revenue exceeding marginal cost would demand additional milk quota. From these estimates the milk quota market was simulated and new quantities of milk quota per farm were projected. These milk quota estimates provide the right hand side parameters for the milk quota constraint in the LP models.

Modelling the Reallocation of Land

Structural change may result in the re-allocation of land as the resources of exiting farmers are redistributed among those who remain in farming. The retirement and succession models produce annual estimates of the number of farmers exiting production each year. The estimates of exiting farmers are used to develop regional land banks. The land left by each departing farmer enters a regional land bank and that land is then redistributed amongst expanding farms within the same region. The redistribution of such land banks is achieved by the LP models,

which reallocate newly available land on a rental basis to the farms with the highest shadow values for land; that is, to those farms that can afford to pay the most. This transfer of land is a rental, rather than a permanent, transfer because of the complexities of annualising the cost of a permanent acquisition of land within a multi-period model.

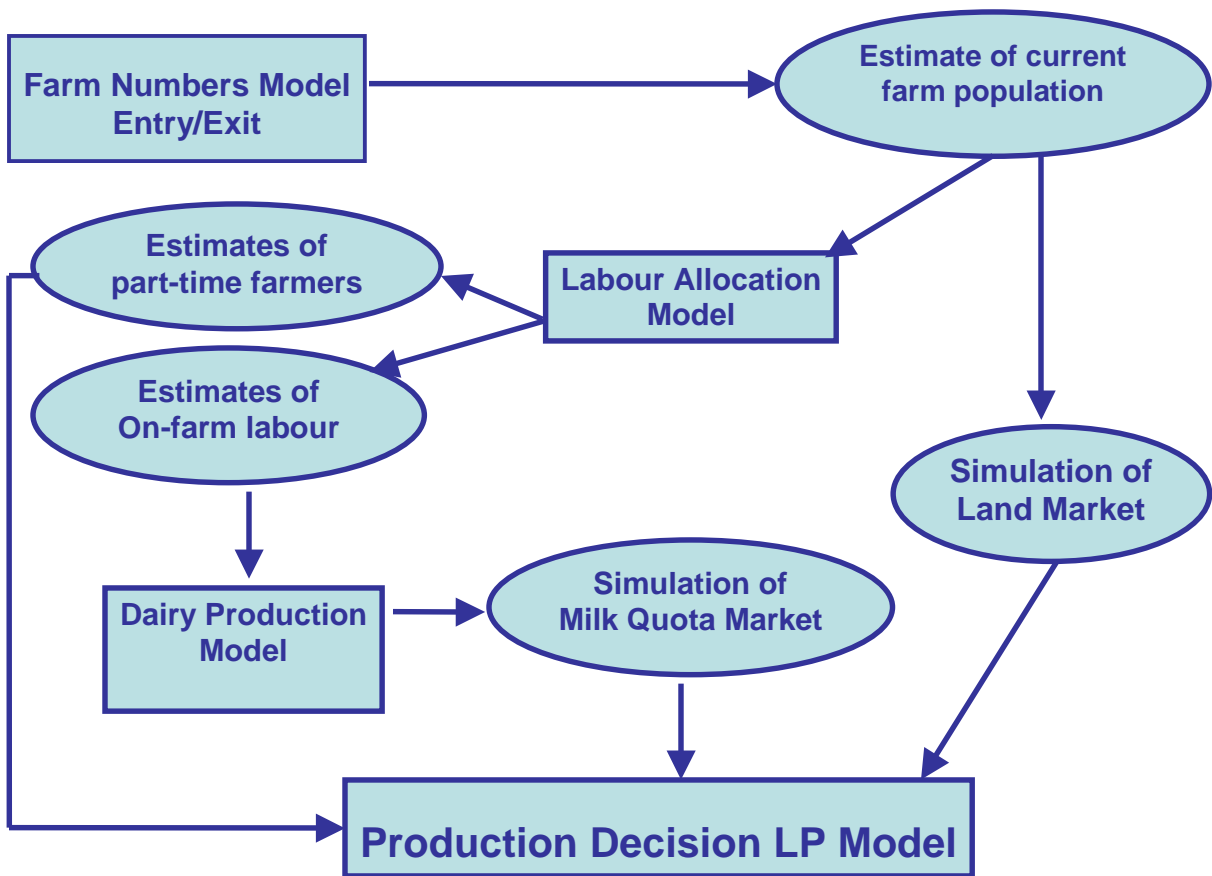
It is assumed that land is reallocated only when a farm ceases production; further, all active farmers continue to farm the same land area as in the base period, with the exception of those acquiring the land that becomes available. It is a tenuous assumption, which may limit the final findings of this modelling exercise. It can however be argued that there may not be any significant change in the allocation of land as after decoupling. Under the MTR the decoupled payment is still linked to the land and, therefore, the farmer must keep 'farming' the land to qualify for the payment. Even the most inefficient farmer would have to be offered, at the minimum, the value of the decoupled payment less the compliance costs to induce him to lease out their land. The land rental prices in a decoupled scenario are therefore likely to reflect the value of the associated decoupled payment rather than the productive capacity of land. Farmers wishing to expand production beyond what they produced in the reference period will have to do so without any direct payments or financial support; therefore, the market based margins, after excluding the decoupled payment, that may be earned on rental land, in many cases may not be worthwhile.

The Integrated Modelling Approach

To recapitulate: in order to assess the impact of the MTR reform of the CAP, the above econometric models are integrated with individual farm level optimisation models. Figure 2 presents a schematic outline of how these models link together to form the integrated modelling system. The 'entry and exit' model estimates the number of active farms in any one year. The lands of farms that are estimated to exit production during the year enter the land simulation model and are reallocated to exiting farms wishing to expand. Following on from this, the

econometric labour model is run in order to estimate the number of part-time farms and the amount of labour available on each farm. When labour estimates are available, the milk production decision model, this model, as explained above, is used to estimate the number of farmers exiting milk production and the amount of milk quota being reallocated to existing farms. In the final stage of the integrated modelling system, a generic multi-period LP model is specified for each farm in the dataset and production plans and farm incomes are simulated for each year covering a period over 2005 to 2010 for two scenarios: a baseline situation, which is the continuation of the Agenda 2000 reform, and the MTR scenario. Projections of prices and costs for the baseline and the decoupling scenarios are taken from the FAPRI-Ireland model (Binfield et al 2003). The input-output coefficients in the LP model are 'mean values' for the base year and remain constant throughout the projection period. In the MTR scenario direct payments are removed from the objective function and the Single Farm Payment (SFP) is the new source of revenue, due to decoupling, which is attached to land use. The choice set for this scenario includes the option of entitlement farming, which is the activity of using land to claim the SFP but not to produce any tangible products (Breen et al 2005).

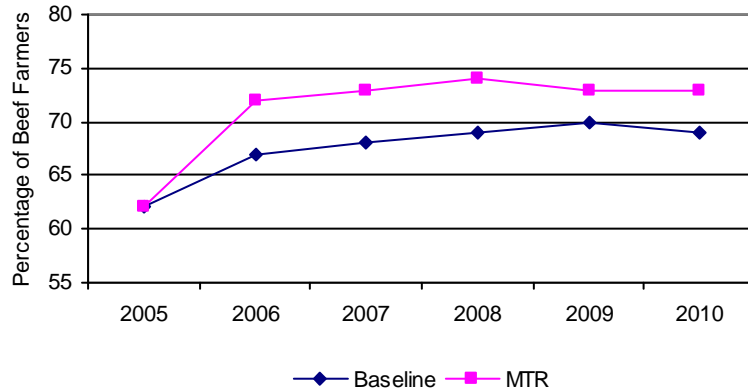
Figure 2: Schematic Outline of Integrated Modelling System



Results of the Two Scenario Runs

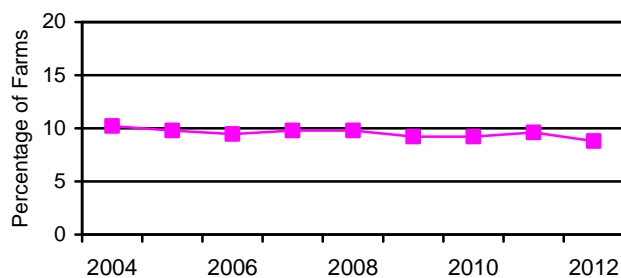
Figure 2 shows the proportion of beef farmers participating in the off-farm labour market. Given inter-generational changes and a positive macroeconomic outlook, the number of farmers participating in off-farm employment will increase in both scenarios. The pace of structural change, however, is faster under the MTR scenario as the substitution effect dominates the wealth effect for the majority of farmers and therefore the numbers participating in off-farm employment increases when the payments are decoupled from production.

Figure 2: Projections of the Proportion of Beef Farmers with Off-farm Employment in Ireland



A mass de-stocking of animals and a proliferation of entitlement farming is predicted after decoupling. A closer analysis however suggests that such a change is not likely transpire. A large number of Irish beef farmers have been farming at a market loss and it was thought that they could maximise profits by de-stocking. But if overhead costs are still incurred, then most of such farmers would be acting rationally by continuing with some level of farm activity. A vast majority of them can obtain a gross profit from at least one enterprise and, post-coupling they would specialise in their most profitable enterprise. Figure 3 presents the projected number of entitlement farmers who would let their land go fallow and choose not produce any tangible agricultural output.

Figure 3: Projections of Entitlement Beef Farmers in Ireland



The impact of the MTR is likely to be inequitable and differentiated with some farmers benefiting and others losing, by adapting stratagems such as off-farm employment, enterprise substitution and/or specialisation, for example. It is important, therefore, to consider the full impact of decoupling on both the viability of the farm business and the sustainability of the household. Such effects are assessed using a framework developed by Hennessy (2004), where an economically viable farm business is classified as one having (a) the capacity to remunerate family labour at the average agricultural wage, and (b) the capacity to provide an additional 5 per cent return on non-land assets (Frawley and Commins 1996). Farms that are not economically viable but where the farmer participates in off-farm employment are classified as nonviable but sustainable, as off-farm income contributes to the long-term sustainability of the household. Farmers that do not work off-farm and operate an economically nonviable business are considered vulnerable.

Table 3 shows the 2002 population of Irish beef farmers as projected population for 2010 for a baseline (continuation of Agenda 2000) and the MTR scenario. In 2002 just 17 percent of beef farms were economically viable; this number is projected to grow after decoupling as farmers benefit from higher beef prices and less market distortion. The number of viable farmers relying on outside income is also projected to increase. The number of nonviable but sustainable farms will almost double after decoupling, due to the declining importance of farm income to many farm households. Finally, the number of vulnerable farms would decline faster under decoupling than the baseline scenario because of the improved economic outlook for beef and the increased attraction of off-farm employment.

Table 3: Viability of Beef Farming in Ireland

Farm Group	2002	Baseline 2010	MTR 2010
All Viable Farms (percentage)	10,363 (17)	7,265 (12)	11,500 (20)
<i>Of which are part-time (percentage)</i>	<i>5,104 (8)</i>	<i>2,700 (5)</i>	<i>7,152 (12)</i>
Non-Viable Sustainable (percentage)	22,635 (38)	38,355 (64)	35,500 (61)
Vulnerable (percentage)	25,829 (43)	12,920 (23)	11,500 (19)
All Farms	58,828	58,600	58,002

Table 4 presents similar results for the dairy farming sector, where the effect of the MTR is less positive. The reduction in the intervention prices for dairy products means a considerable price/cost squeeze, accelerating the rate of exit from this sector after the MTR relative to the baseline situation. The average level of milk production on dairy farms in 2002 was 230,000 litres, increasing to 34,000 litres by 2010 under the MTR scenario. Despite these increases in output, the number of economically viable dairy farmers will decline.

Table 4: Viability of Dairy Farming in Ireland

Farm Group	2002	Baseline 2010	MTR 2010
Viable Farms (percentage)	16,110 (57)	15,200 (66)	12,250 (66)
Viable Part-time (percentage)	700 (2)	500 (2)	-
Non-Viable Sustainable (percentage)	2,000 (6)	1,500 (7)	-
Transitional (percentage)	10,700 (37)	6,300 (27)	6,500 (34)
All Farms	28,800	23,000	18,750

Conclusion

The objective of the research presented in this paper was to model the effects of decoupling on structural change in Irish farming. Undertaking this research has proved challenging from a number of perspectives. First, modelling the effect of policy change on structural change in farming remains difficult methodologically. Aggregate models based on trend analysis provide little information about the interaction between policy instruments and structural change, while the more advanced econometrically estimated Markov Chain models are data intensive and are based on some very restrictive assumptions. Apart from the methodological difficulties associated with capturing the essence of structural change, modelling decoupling is problematic because of it being an unprecedented policy instrument and evidently it is too early to expect any empirical evidence on supply inducing effects of its implementation. The traditional partial equilibrium models based on historically estimated supply elasticities are of limited value in analysing the effects of decoupling. This paper has addressed the research questions posed at the beginning of the paper by using a farm level modelling approach. Linear programming is used as the analytical technique because of its ability to analyse unprecedented changes; but it is of little use in projecting structural changes, unless it is supplemented with a number of exogenously estimated models. The integrated modelling approach, using optimisation and econometric estimation, allows us to simulate changes in the farming population, the proportion of full and part-time farms, the number of dairy farms and the number of economically viable farm businesses under different policy scenarios. The approach developed shows the effect of decoupling on the number of economically viable businesses, on the sustainability of farm households and on the number of vulnerable households. Undoubtedly, there is still considerable scope for improvement within the modelling approach and capacity for future research: in particular, the lack of verifiable empirical data on the number of farmers who leave farming mid-career, that is, for reasons other than retirement, makes it difficult to simulate exits from farming other than those that are caused by retirement and non-succession. Further, data on factors that influence dairy farmers' decisions to exit the industry are scarce, rendering the simulation of the milk quota market a very difficult task.

References

- Ahituv, A. and Kimhi, A. (2002). Off-farm work and capital accumulation decisions of farmers over the life-cycle: the role of heterogeneity and state dependence. *Journal of Development Economics*. 68:329-353.
- Andersson, F. (2004). Decoupling: The concept and past experiences. SLI Working Paper 2004:1, Swedish Institute for Food and Agricultural Economics.
- Barkley, A. (1990). The determinants of the migration of labour out of agriculture in the US, 1940-1985. *American Journal of Agricultural Economics*. 72: 567-574.
- Binfield, J., Donnellan, T., Hanrahan, K. and Westhoff, P. (2003). The Luxembourg CAP Reform Agreement: Implications for EU and Irish Agriculture. The Luxembourg CAP Reform Agreement: Analysis of the Impact on EU and Irish Agriculture, pp.1-69, Teagasc, Dublin.
- Breen, J., Hennessy, T. and Thorne, F. (2005). The effect of Decoupling on the Decision to Produce: An Irish Case Study. *Food Policy*. 30: 129-144
- Burfisher, M. and Hopkins, J. (2003). Decoupled Payments: Household Income Transfers in Contemporary U.S. Agriculture, Agricultural Economic Report No. 822, USDA: Washington D.C.
- Frawley, J.P. and Commins, P. (1996). The Changing Structure of Irish Farming, Trends and Prospects, Rural Economy Research Series No. 1, Dublin, Teagasc
- Gale, F.H. (1993). Why did the number of young farmers decline? *American Journal of Agricultural Economics*. 75:138-146
- Gale, F.H. (2002). Age specific patterns of exit and entry in US Farming 1978-1997. *Review of Agricultural Economics*. 25:168-186.
- Garvey, E. and Steele, S. (2000). Modelling Farm Structure: Accounting for Tradition and Other Distortions, Proceedings of the Agricultural Economics Society of Ireland. Teagasc, Dublin.
- Gasson, R., Errington, A. and Tranter, R. (1998). Carry on Farming? Wye: Wye College, University of London

Glauben, T., Tietje, H. and Weiss, C. (2002). Inter-generational succession on family farms: evidence from survey data. Paper Presented at the Xth Congress of the European Association of Agricultural Economists, Zaragoza, Spain

Harvey, D.R. and Colman, D. (2003). The Future of UK Dairy Farming, commissioned jointly by the MDC, DIAL, and DEFRA, with project advice from the NFU, on behalf of the Dairy Supply Chain Forum, <<http://www.dia-ltd.org.uk/pdf/Colman%20Report.pdf>>

Heckman, J. (1979). Sample selection bias as a specification error, *Econometrica*. 47: 153-162

Hennessy, D. A. (1998). The Production Effects of Agricultural Income Support Policies Under Uncertainty. *American Journal of Agricultural Economics*. 80:346-57.

Hennessy, T.C. (2004) Projecting Farm Numbers. Paper Prepared for 2015 Agri-Vision Committee and included as appendix 4 in the 2015 Agri-Vision Report. Irish Department of Agriculture and Food.

Hennessy, T.C. and Rehman, T. (2005). Explaining the Labour Allocation of Irish Farmers in the Context of Decoupling. Paper presented at the EAAE Seminar on Policy Modelling. Parma, Italy.

Hennessy, T.C. and Rehman, T. (2006). An Investigation into the Factors Affecting the Occupational Choices of Nominated Farm Heirs. Accepted for publication by the Journal of Agricultural Economics.

Jackson-Smith, D. (1999). Understanding the Microdynamics of Farm Structural Change: Entry, Exit and Restructuring. *Rural Sociology*. 64:66-90

Jongeneel, R (2002). An analysis of the Impact of Alternative EU Dairy Policies on the Size Distribution of Dutch Dairy Farms: an information based approach to the non-stationary Markov Chain Model. Paper presented at the 2002 Congress of the EAAE, Zaragoza, Spain.

Karantininis, K. (2001). Information Based Estimators for the Non-stationary Transition Probability Matrix: An Application to the Danish Pork Industry. Copenhagen: Department of Economics and Natural Resources, Royal Agricultural University of Copenhagen.

Lucas, R.E. (1976). Econometric policy evaluation: a critique. In: Brunner K. and Meltzer, A.H. (Eds), *The Phillips Curve and Labor Markets*. Vol.1. Carnegie-Rochester Conference Series on Public Policy, Amsterdam, North-Holland.

Mishra, A. and Goodwin, B. (1997). Farm Income Variability and the Supply of Off-farm Income. *American Journal of Agricultural Economics*. 79:880-887

Revell, B. and Oglethorpe, D. (2003). Decoupling and UK agriculture: a whole farm approach. Study Commissioned by DEFRA, London.

Schmidt, P. and Strauss, R. (1975). The prediction of occupation using multiple logit models. *International Economic Review*. 16:471-486.

Sckokaj, P. and Moro, D. (2002). Modelling the CAP Arable Crop Regime Under Uncertainty. AAEA Annual Meeting, California, July 2002.

Swinbank, A. (2004). An examination of various theoretical concepts behind decoupling and review of hypothetical and actual de-coupled support schemes in some OECD countries. Unpublished Report Prepared for Sixth Framework Project - GENEDEC

Zepeda, L., (1995b) Technical change and the structure of production: A non-stationary Markov analysis. *European Review of Agricultural Economics*. 22:41-60.

Output from these Research Projects 2002-2005

Breen J, Hennessy T and Thorne F (2005) *The Impact of Decoupling on the Decision to Produce: An Irish Case Study*. Food Policy. Vol 30. No. 2.

Hennessy T, Shalloo L and Dillon P (2005) *The Economic Implications of Complying with a Limit on Organic Nitrogen in a Decoupled Policy Environment – An Irish Case Study*. The Journal of Farm Management. Vol. 12 No.6

Hennessy T and Thorne F (2005) *How Decoupled are Decoupled Payments?* Eurochoices. Volume 4. No.1

Hennessy, T and Rehman T (2005). An Investigation into the Factors Affecting the Occupational Choices of Farm Heirs. *Under Review at Journal of Agricultural Economics*

Hennessy, T and Rehman T (2005). Assessing the Impact of the Decoupling Reform on Irish Farmers' off-farm Labour Market Participation Decisions. *Under Review at Journal of Agricultural Economics*

Hennessy T (2005) *Examining the Labour Allocation Decisions of Irish Farmers in the Context of decoupling*. Proceeding of the EAAE Seminar on Policy Modelling in the University of Parma, Italy.

Hennessy T (2004) *Farm Level Adjustment in Ireland Following Decoupling* Proceedings of the Annual Meeting of the British Agricultural Economics Society, Imperial College, London.

Hennessy T and Kelly P (2003) *Modelling Farm Level Adjustment Following Decoupling: An Irish Example*. Proceedings of the International Workshop on Modelling Farm Level Adjustment, Imperial College Wye, UK.

Hennessy T (2003) *An Examination of European Agricultural Policy and the Effects at the Farm Level*. Proceedings of the Australian Agricultural and Resource Economics Society, Perth, Australia.

Hennessy T and Kelly P (2002) *Modelling Succession on Irish Dairy Farms*. Proceedings of the European Association of Agricultural Economists, Zaragoza, Spain.

Hennessy T (2002) *The Future of Irish Dairy Farming: The Implications of Agenda 2000 and a Booming Economy*. Proceedings of the International Farm Management Association, Wageningen, The Netherlands.

Hennessy T (2004) *Projecting Farm Numbers*. Paper Prepared for 2015 Agrivision Committee and included as appendix 4 in the 2015 Agri-Vision Report. Irish Department of Agriculture and Food.

Hennessy T, Shalloo L and Dillon P (2004) *The Economic Implications of a Limit on Organic Nitrogen*. Chapter included in Application for Derogation on the Nitrates Directive. Irish Department of Agriculture and Food.

Hennessy T (2005) *Projecting Farm Numbers to 2015*. Invited Paper to the Agricultural Economics Society of Ireland, University College Dublin February 2005.

Hennessy T (2003) *Farming After Fischler*. IFA Regional Meetings on CAP Reform, Roscommon, Cavan, Carlow and Cork.

Breen J, Donnellan T and Hennessy T (2003) *A Future for Dairy Farmers After Fischler*. Proceedings of the Teagasc National Dairy Conference, Cork

Donnellan T and Hennessy T (2003). *WTO and MTR – The Possible Impact for the Dairy Sector*. Proceedings of the IFA National Dairy Conference, Cahir.

Donnellan T, Dillon P, Shalloo L, Hennessy T and Breen J (2002) *A Dairy Farming Road Map: Where now for Dairy Farmers*. Proceedings of the Teagasc National Dairy Conference, Killarney

Donnellan T and Hennessy T (2002). *Dairy Policy in the EU – Time to Broaden the Debate*. Proceedings of the Irish Farmers' Journal Conference, Reforming the Milk Quota –The Road Ahead, Cork

Hennessy T. (2002). *Farm Incomes With and Without Quotas*. Proceedings of the Teagasc Northwest Dairy Conference, Loughrea.

Hennessy T (2002). *Reforming Milk Quota Policy - Implications for Farm Income*. Proceedings of the IFA National Dairy Conference, Cahir.

Hennessy T (2004) *An Analysis of the Impact of Decoupling in Ireland*. Invited Paper to OECD Conference on Household Income Issues, OECD, Paris.

Hennessy T (2004) *The Impact of Decoupling: An Irish Case Study*. Proceedings of the Annual Meeting of the British Farm Management Association, Bedford, England

Hennessy T (2003) *Farming in the EU – A Look at Your Competitors*. FAPRI Farm–Level Baseline Conference, Missouri, USA.

Behan J, Binfield J, Breen J, Donnellan T, Hanrahan K, Hennessy T, McQuinn K and Westhoff P. (2003) *An Analysis of the effects of Decoupling Direct Payments from Production in the Beef, Sheep and Cereals sector*. Report prepared for the Department of Agriculture and Food.

Breen J and Hennessy T (2003) *The Impact of the MTR and WTO Reforms on Irish Farms*. Proceedings of the FAPRI-Ireland Outlook 2003 Conference, Dublin.

Breen J and Hennessy T (2003) *The Impact of the Luxembourg Agreement on Irish Farms*. FAPRI-Ireland, The Luxembourg CAP Reform: Analysis of the Impact on EU and Irish Agriculture, Teagasc, Dublin.

Donnellan, T and Hennessy, T (2002). *Implications of EU Milk Quota Abolition - with special emphasis on Ireland*. Proceedings of the Centre for European Policy Studies, Conference on future of milk quotas, Brussels, Belgium

Binfield J, Donnellan T, Hanrahan K, Hennessy T, McQuinn K and Westhoff P. (2002) *Mid-Term Review: An Analysis of a Beef Sector Policy Scenario*. Proceedings of the FAPRI-Ireland Outlook 2002 Conference, Dublin.

Hennessy T (2002) *The Outlook for Farm Incomes in Ireland*. Proceedings of the FAPRI-Ireland Outlook 2002 Conference, Dublin.

Appendix 1

Results of the Multinomial Logit Model of Occupational Choice

Independent Variables	Part-time CHOICE=2		Non Farming CHOICE = 3		Don't Know CHOICE = 4	
	Param.	z ratios	Param.	z ratios	Param.	z ratios
Intercept	2.23**	7.29	-.668	-1.15	.7790*	2.49
UAA	-.0056	-1.57	-.0027	-0.32	-0.006*	-1.79
LUS	-.0178**	-4.64	-.0215**	-2.66	-0.0015	-0.53
FJOB	1.399**	2.88	.5718	0.77	.9002	1.70
SJOB	.9046**	.9046	1.616**	3.30	0.389	1.24
DAIRY	-.9913**	-3.17	.3430	0.63	-0.4616	1.51
HED3	1.163**	2.91	1.561**	2.81	0.7733*	1.90

* Significant at 5%; ** Significant at 1% N= 514 Pseudo R2 =0.178
 Log Likelihood =-499.19 Unrestricted Log Likelihood = -607.7
 Correct predictions:
 CHOICE=1 (65%) CHOICE=2 (89%) CHOICE=3 (0) CHOICE=4 (31%)
 Total Correct Predictions (65%)

Marginal effects of Selected Explanatory Variables

Independent Variables	Full-time CHOICE=1	Part-time CHOICE=2	Non-Farming CHOICE=3	Don't Know CHOICE=4
UAA	.0007	-.0003	.00009	-.00049
LUS	.0016	-.0037	-.00052	.0026
FJOB	-.133	.1904	-.0182	-.0387
SJOB	-.0962	.1212	.0534	-.0784
DAIRY	.1010	-.1850	.0459	.0380
HED3	-.1194	.1257	.03532	-.0416

Results of the reduced bivariate probit model

Independent Variables	FULLTIME		HED3	
	Parameter	(t ratios)	Parameter	(t ratios)
Intercept	-.2333**	-4.09	-.4464**	-5.02
SJOB	-	-	.1947*	2.19
FFI	-	-	-.0177**	-6.68
HED3	-1.809**	-13.70		

Rho (ρ) 0.99** * ($p \leq 0.05$) ** ($p \leq 0.01$)

Number of Observations = 514 Log Likelihood = -484.80

Appendix 2

Results of the Probit Model of Labour Participation

Variable	Coefficient (Z-Values)	Marginal Effect
Intercept	-1.136783 (-1.11)	
FWAGE***	-.0284262 (-2.57)	-.007
FWAGE2*	.0003971 (1.63)	.0001
SIZE**	-.0060623 (-2.15)	-.0015
SYSTEM***	-1.210383 (-9.03)	-.3158
AGE***	.1234819 (3.08)	.0318
AGE2***	-.001633 (-4.26)	-.0004
NO***	.0849544 (2.78)	.0219
NW***	-.0008696 (-2.62)	-.00022
NW2***	3.95e-07 (3.11)	1.02e-07
LAB**	-.3207875 (-1.92)	-.0828
Pseudo R ² = 0.324		Correct Predictions = 80%
Likelihood Ratio Statistic $\chi^2_{10} = 349.40$ ***		

N = 937; * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

Results of the Ordinary Least Squares Model of Labour Supply

Variable	Coefficient (T-Values)
Intercept***	2169.69 (19.86)
FWAGE**	-12.3749 (-2.02)
NW***	-.6025994 (-2.53)
LAB***	434.0715 (-3.68)
R ² = 0.199	F = 15.61***

N = 247; *(p < 0.1); ** (p < 0.05); *** (p < 0.01)