AN EXPLORATION OF THE IMPACT OF 'DECOUPLING' OF AGRICULTURAL SUPPORT PAYMENTS ON LAND MARKET PARTICIPATION DECISIONS OF IRISH FARMERS

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ABSTRACT:

This paper analyses the impact of the recent decision by the EU to `decouple' agricultural support payments from agricultural production on Irish farmer's land market decisions. Farmer's land market partcipation decisions are modelled using a dynamic probit model while the extent of particiaption decisions are modelled using a dynamic tobit model. Allowance is made for differences between farms engaged in different enterprise types. `Decoupling' does not appear to have significantly altered farmer's land market decisions. One likely explanations for this is the requirement to maintain land in a state fit for agricultural production in order to receive payments.

KEYWORDS: land, decoupling, participation, dynamic, econometric

1 INTRODUCTION

As of 1st January 2005, European Union agricultural support payments were 'decoupled' from agricultural production, in part due to the over-production which had become a feature of the existing system of 'coupled' payments. Under the new Single Payment Scheme (SPS), farmers are required to maintain a certain level of land in a state fit for agricultural production - although actual production is not required. The amount of land to be maintained is equal to the average number of hectares declared during the reference period (2000 to 2002 inclusive). If there were no requirements attached to the payment, production and hence input demand may have been anticipated to fall - impacting negatively on the demand for land. However, due to the land-maintenance requirement, any fall in demand for land may be negligible.

Since it was felt that placing the land requirement on farmers whose rental agreements had expired was perhaps unfair, these farmers were given the option of ‘consolidating’ their entitlements. These farmers would then be required to maintain an area equal to the portion of their declared land for which the rental agreements had not expired. While in many of the EU countries this was unlikely to affect many farms, in Ireland the vast majority of land rental agreements are for a period of less than one year’s duration (usually 11 months). As a result, most Irish farmers had the option of consolidating their entitlements - although to-date there has not been a full uptake of this option.

The farmers that have exercised this option may effectively no longer have a requirement to rent-in land to satisfy the SPS land requirement. Thus we may anticipate an overall reduction in renting-in of land amongst Irish farmers. However decisions taken in the past to expand capacity may have increased the optimal cultivated area for many farmers, negating this argument. Thus the impact of ’decoupling’ on farm rental decisions is essentially an empirical matter.

In this paper we examine the impact which the ’decoupling’ of support payments from production has had on Irish farmers’ land market decisions. For this study, data from Teagascs’ National Farm Survey is used to form a nine-year panel spanning both the announcement, in 2003, and introduction, in 2005, of ‘decoupling’. An attractive feature of such a panel, extending from 2000 to 2008, is that we may adequately take account of the ‘initial conditions’ problem associated with estimating dynamic models where there is unobserved heterogeneity. In this paper we estimate dynamic probit and tobit models while taking account of the ‘initial conditions’ problem by using the Wooldridge estimator (Wooldridge, 2005).

Within the NFS dataset, farms are categorized as being engaged in one of six systems: dairying, dairying and other activities, cattle-rearing, cattle-rearing and other activities, mainly sheep and tillage. It is reasonable to suppose that there may be differences in the importance of the factors influencing land market decisions across the systems. We allow all coefficients to differ across the six farm systems and briefly discuss some issues that arise when making comparisons between groups.

The remainder of the paper is organised as follows: Sections 2 & 3 discusses the implementation of ‘decoupling’ in Ireland and its implications for land markets, Section 4 introduces the dataset used, Section 5 considers the econometric methodology employed and Section 6 discusses the results of the analysis.

2 DECOUPLING IN IRELAND

Following the Mid-Term Review (MTR) of the European Union's Common Agricultural Policy (CAP) [1] in June 2003, the decision to 'decouple' agricultural support payments from production was taken. The previous system of production-based payments was replaced with the Single Payment Scheme (SPS), under which support payments were instead 'coupled' to the possession of land with a requirement that the land be maintained in a state suitable for agricultural production. However there was no requirement to actually produce on this land with the intended result that farmers should make production decisions independently of the support payments, thus avoiding the 'payment farming' which led to overproduction in the previous system.

The MTR permitted some flexibility to the member states in terms of the particular form that decoupling would take and the time-frame in which it was to be implemented. Additionally, the agreement allowed each country to partially re-couple some payments. Member States were also permitted to choose the basis upon which the level of payments for individual farmers would be calculated. Three broad systems can be identified: historic, regional and hybrid. Under the historic system, payments to individual farmers would be directly linked to the level of payments received by them during the reference period (2000-2002). The regional system, in its simplest form, allowed payments to be aggregated for a region and then divided equally among recipients in that region. More complicated aggregations were permitted, for example arable payments could be aggregated and then divided amongst recipients with arable farms. The hybrid system combined elements of the regional and the historic systems. A still more complicated system, known as a dynamic hybrid, involved the components of the system changing over time. The distinction between the various systems is elaborated on by Swinbank *et al.* (2004). Ireland opted to base payments to farmers on the historic system[2].

We now briefly focus on the Single Payment Scheme as implemented in Ireland. A more comprehensive guide to the implementation of the SFP in Ireland is given in DAF (2004).

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[1] The review was conducted by the Luxembourg Council of Agricultural Ministers.
[2] E.C. (2007) shows each member states' choice of implementation.

2.1 The single payment scheme as implemented in Ireland

On the 19th October 2003, the Irish Minister for Agriculture and Food announced that all direct payments for Cattle, Sheep and Arable Crops would be fully decoupled from production as of the 1st January 2005. Under the Single Payment Scheme, each farm now receives a single support payment known as the Single Farm Payment (SFP). In Ireland, payments are decided based on the historic system. 'The gross Single Payment is based on the average number of animals, and/or the average number of hectares in the case of Arable Aid, on which payments were made in the three reference years 2000, 2001 and 2002. The average is multiplied by the 2002 payment rate for those schemes' (DAF, 2004). The payment the farmer is eligible to receive is thus:

$$SFP_{Eligible} = \sum_{i=1} \bar{H}_i \times P_i + \sum_{j=1} \bar{N}_j \times P_j \qquad (1)$$

where $H, \square_i$ is the average number of hectares on which payments were made under arable aid scheme *i* during the reference period(2000-2002), $N, \square_i$ is the average number of animals on which payments were made under livestock scheme *j* during the reference period (2000-2002) and P_i and P_j are the 2002 payment rates for the relevant schemes.

The SFP is coupled to the possession, as opposed to ownership, of agricultural land through the establishment of 'entitlements'. For most farmers, the number of entitlements received is based on the average number of eligible hectares declared on the Area Aid application forms during the reference period (2000-2002). The value of each entitlement is then calculated by dividing the SFP by the number of entitlements. In order to receive the full SFP the farmer must possess an eligible hectare for each entitlement they have. The farmer loses the value of any entitlement that is not matched with an eligible hectare. Therefore the farms realised support payment is:

$$SFP_{received} = \begin{cases} V \times H & \text{if H} < \text{E} \\ V \times E & \text{if H} \geq \text{E} \end{cases} \qquad (2)$$

where V is value of entitlement, H is number of eligible hectares and E is number of entitlements.

2.1.1 Consolidation of entitlements

The requirement to possess an eligible hectare of land for each entitlement would have a serious detrimental effect on farmers who have reduced their eligible hectares since the reference period. For this reason, the agreement allowed farmers to consolidate or 'stack' their entitlements provided their inability to satisfy the eligble hectares requirement is due to one of the following reasons:

- Afforestation of land since the beginning of the reference period
- Disposal of land to a Public Authority for non-agricultural use
- The expiry of rental agreements relating to land declared during the reference period
- Land declared during the reference period being situated in Northern Ireland

Consolidation involves surrendering the existing entitlements which are then replaced with a smaller number of higher valued entitlements. Thus the farmer is able to claim their full SFP even though their number of eligible acres has decreased since the reference period. While in many EU countries, rental agreements tend to be for a fairly long period, in Ireland most renting is carried out under the 'conacre' system where land is rented for a period less than 12 months. Thus consolidation is likely to be an option for many farmers. Between the years 2005 and 2007 approximately 25,500 applications to consolidate were made to the Department of Agriculture. In Ireland there are approximately 127,000 farmers, meaning over twenty percent of farmers consolidated their entitlements during this period[3]. It is also important to note that it is not possible to consolidate entitlements if the inability to satisfy the requirement is due to the sale or leasing out of land. Thus consolidation is likely to lead to some renters, for whom production was only economically beneficial due to the 'coupled' support payment, reducing the area that they rent or possibly exiting the land market completely.

3 IMPLICATIONS OF DECOUPLING FOR LAND MARKETS

We begin by considering the impact which a 'decoupled' support payment, *SFP*, would have if introduced into a market free of other supports and distortions.

[3] Source: E-mail correspondence with Declan Donovan at Department of Agriculture and Food.

Suppose that in order to receive the payment in full, the area possessed[4] by the farmer, denoted *A*, must at least be equal to the farmer's entitlement requirement, *E*. If the farmer is unable to satisfy this requirement, then the payment received is decreased by **Fehler!**. We consider firstly the case where the entitlement constraint is not binding before turning to the case where it is.

The entitlement constraint is not binding if the farmer's optimal cultivated area would have been greater than *E* even in the absence of the payment. In this case, the farmer will receive the full decoupled payment even without altering his input decisions, thus the constraint has little direct effect on the farmer's input use. The payment may however influence his input decisions in a manner akin to a lump-sum payment to the farmer, for example through relaxing credit constraints (Rude, 2000) or through changing the farmer's labour supply (Guyomard et al., 2004). Farmers may alter their production decisions in the hope that at some point in the future the reference period will be revised to include the current period[5] Westcott and Young (2002); Revell and Oglethorpe (2003). Also, a payment which increases the farmer's wealth may alter his tolerance for risk which in turn may influence his production and input-use (Hennessy, 1998)[6]. Since some of these considerations drive the farmer to increase his cultivated area while others operate in the opposite direction the overall effect on the farmer's demand for land is somewhat ambiguous.

If, on the other hand, the entitlement requirement is binding then the payment which the farmer receives will be affected by the area rented in/out since failure to satisfy the requirement leads to a lower SFP. The decoupled payment is therefore likely to directly influence the farmer's marginal decision regarding the area cultivated in addition to having the indirect effects outlined above. We may observe transfers of land from farmers that have satisfied the entitlement constraint towards those that have not (or alternatively we may observe transfers of entitlements (Kilian and Salhofer, 2007)). However, where farmers have the option to consolidate

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[4] Agricultural production is not required

[5] Through the use of a survey administered by the National Agricultural Statistics Service(NASS) in Mississippi and Iowa in 2005, Coble et al. (2008) find that 40% of U.S. farmers believe that updating may occur in the next farm bill - though only 17% adjust their acreage accordingly.

[6] The decoupled payment may also influence the choice of production since areas used for certain outputs may not be used to satisfy the entitlement constraint

entitlements, this need not be the case - after consolidation, the SFP may have effects similar to the non-binding case above. Bhaskar and Beghin (2007) review the literature regarding the mechanisms by which a decoupled payment may still influence farm decisions.

It must be remembered however that the 'decoupled' payment was not introduced into a support-free environment. Rather, the 'decoupled' payment is replacing a system of payments which were 'coupled' to agricultural production. As such the observed impact of 'decoupling' will be inextricably linked with the previously existing distortions in the input and output markets.

A support payment which is coupled to production such as an output price support is likely to lead to greater production than would otherwise occur. This in turn will lead to greater demand for land and non-land inputs. Floyd (1965) shows that price support influences input prices and that this effect depends on the elasticity of supply of inputs. For an input which is relatively inelastic, such as land, the change in price is likely to be more dramatic than the change in quantity utilised.

However, while the aggregate supply of land to agriculture is likely to be inelastic, the quantity of land supplied for a particular type of agricultural production is likely to be more elastic. Thus if different outputs receive differing levels of support, land and non-land inputs may be transferred towards the more heavily supported product. This creates distortion in input markets. To the extent that 'decoupling' allows farmers greater flexibility in their choice of production (though some restrictions remain e.g. areas used for fruit and vegetables are excluded when calculating the farmer's eligible acres) these distortions may be removed following the introduction of the SFP.

A considerable number of studies (Weersink et al., 1999; Roberts et al., 2003; Kirwan, 2009) have considered the extent to which government support payments are capitalised into land values or rents. Few studies have focussed on the effects of support payments upon farmers' land market participation decisions. Coupled support payments are likely to have increased farmers' demand for land with the result that land-use during the reference period is likely to be above that which would be observed in the absence of support payments. Since this period provides the basis for deciding how much land is required by each farmer in order for them to meet the entitlement requirement, less adjustment may be anticipated in the land market than in other input markets.

However, since many farmer's in Ireland who rented under the 'conacre' system are likely to be in a position to consolidate their entitlements, the constraint may not be binding and farmers may be more inclined to respond to market forces. The effects of consolidation may be somewhat offset by the fact that farms that have undertaken investments to increase their capacity in the years prior to 'decoupling' may find it economically efficient to continue to operate on a larger scale than would be warranted in the absence of such investments. This would mute the response of land demand even in the presence of consolidation.

Since the current CAP agreement will expire in 2012, some farmers may be reluctant to reduce their cultivated area in case the next agreement involves a move towards a regional system where payments may be based on the area operated during an updated reference period. Thus there may be an incentive to farm *more* land than during the reference period. There is also evidence that some farmers view the 'decoupled' payment as still coupled to production. When surveyed prior to the introduction of decoupling, a majority of Irish farmers indicated that they intended to continue with their current production patterns post-decoupling (Breen et al., 2005). However since at the time these farmers would have been somewhat unfamiliar with 'decoupling', this may not correspond to their actual actions post-decoupling.

Thus the impact of 'decoupling' on farmers' land market participation decisions is unclear from a theoretical perspective. We empirically explore whether 'decoupling' has altered farmers' decisions regarding firstly whether to rent-in land and secondly how much land to rent-in.

4 DATA

Each year the Irish National Farm Survey (NFS) of approximately 1,200 Irish farmers is conducted by Teagasc[7]. The survey data is nationally representative of Irish dairy, cattle and sheep farmers. In this paper we construct a panel of Irish farmers using NFS data for the years

[7] The NFS is part of the Farm Accountancy Data Network (FADN) of the European Union (FADN).

from 2000 to 2008 inclusive. In total there are 10,513 observations relating to 2,129 different farms, with approximately 1/4 of farms being present for all nine years[8].

We focus on the impact of 'decoupling' on two decisions facing Irish farmers; firstly whether to participate in the land rental market and secondly, how much land, if any, to rent-in. The dependent variable for land market participation, *Renting*, is a binary variable equal to one if the farmer rents-in land in the current year and zero otherwise. When considering the extent of participation, the dependent variable, *Conacre rented*, equals the area of land rented-in under the 'conacre' system in the current year[9]. The dependent variable for conacre rented is censored from below at zero. The same explanatory variables are used for both models. We next briefly discuss the rationale for including them.

Older farmers may not wish to farm as actively as younger farmers and hence may rent-in less land than younger farmers (Teklu and Lemi, 2004; Holden and Ghebru, 2005; Noev, 2008). To capture this effect we include the age of the head of household in quadratic form, (*Age* and Age^2). Farmers that have an off-farm job may have less time to devote to agriculture and so may also rent-in less land than those without off-farm jobs (Kung, 2002; Holden and Ghebru, 2005). On the other hand, income from off-farm jobs may serve to relax credit constraints so the effect is somewhat ambiguous. We include a dummy variable which equals one if the head of household[10] has an off-farm job and zero otherwise (*Job*).

The farmer's endowment of land will influence whether the farmer participates in the land market. Farmers with large initial land endowments, (*Area owned*), are expected to rent-in less land than those with small endowments (Deininger and Jin., 2002; Jin and Deininger, 2009; Vranken and Swinnen, 2006; Ballesteros and Bresciani, 2008), though ownership of land may also relax credit constraints through the greater collateral it represents.

Use of other inputs is also likely to influence the extent to which the farmer rents-in land. Farmers who hav access to a large number of units of paid labour, (*Paid labour*) and unpaid labour, (*Unpaid labour*) may be anticipated to rent-in more land if land and labour are

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[8] After removing missing values, 10,156 observations remain.

[9] The vast majority of renting in Ireland is carried out under the 'conacre' system

[10] Unfortunately data for spouses working off-farm jobs is not available for some years, although it appears to be insignificant in the years for which it is present - so the spouses job is not included here.

complements or less if they are substitutes. The log of machinery operating costs is included to capture the use of machinery on the farm, (*Machinery*). A farmer with a large number of livestock is likely to need more land for grazing etc. so a variable representing the number of livestock units is also included, (*No. livestock units*). Finally since farmers with poor land quality may compensate for this by renting-in extra land, a series of dummy variables are included to capture soil quality, (*Soil class 1=best to Soil class 5=worst*). Table 1 displays summary statistics for binary and scale variables respectively.

The impact of 'decoupling' is captured by the inclusion of a dummy variable which equals zero prior to the introduction of 'decoupling' and is equal to one from the year 2005 onwards, (*Dummy decoupling*). Thus there are 5 years in the pre-'decoupling' period and 4 years in the post-'decoupling' period. If 'decoupling' has had an impact on farmers' land market decisions we would anticipate a significant coefficient for this variable.

[Table 1 about here]

5 ECONOMETRIC METHODOLOGY

In much of the literature dealing with land market participation, the decision whether to rent-in land is modelled as a binary choice, with farms choosing between participation and non-participation. The extent of participation is then usually modelled using a censored model such as tobit. We can think of the decision to participate in the land market as depending on an unobserved latent variable, $Y^{*,it}$, which is a function of individual characteristics, X_{it}, and a random component, ε_{it}. The latent model can be written as:

$$Y^{*,it}=X_{it}\gamma+\varepsilon_{it} \tag{3}$$

and the observed binary participation decision, Y_{it}, is[11]:

$$Y_{it} = \begin{cases} 1, & if\ Y^*_{it} > 0; \\ 0, & if\ Y^*_{it} \le 0. \end{cases} \tag{4}$$

[11] Where Y_{it}=1 represents a choice to participate in the market by renting in land

A similar latent variable framework can be seen to underlie the tobit model with Y_{it} representing the area transacted. In this case, Equation 4 becomes Equation 5 below[12]:

$$Y_{it} = \begin{cases} Y_{it}^{*}, & if\ Y_{it}^{*} > 0; \\ 0, & if\ Y_{it}^{*} \leq 0. \end{cases} \quad (5)$$

5.1 Unobserved heterogeneity

In addition to being influenced by observable factors such as the use of non-land inputs, a farmer's land market participation decisions may depend on a plethora of unobservable (to the econometrician at least) factors such as the farmers ability, the existence of contiguous plots of land and the farmers attitude towards land market participation. These factors, grouped together are referred to as unobserved heterogeneity. Through the use of panel data methods, we can deal with time-invariant unobserved heterogeneity

In order to take account of unobserved heterogeneity, we can decompose the error term, ε_{it} into two components; an unobserved individual specific effect[13], μ_i, and a component, ν_{it} which is assumed to be independently and identically distributed (iid) over time and individuals. So that Equation 3 becomes:

$$Y^{*,it} = X_{it}\beta + \mu_i + \nu_{it} \quad (6)$$

If we believe that the unobserved factors captured by μ_i are correlated with our explanatory variables then we should use a fixed effects estimator[14]. If on the other hand, we do not believe that μ_i is correlated with our explanatory variables, then we may use a random effects estimator. However, the assumption that individual unobserved heterogeneity is uncorrelated with all of the explanatory variables is quite strong. Mundlak (1978) and Chamberlain(1984) relax this assumption, allowing for a correlated random effect. This involves specifying that the unobserved effect for individual *i* is partially dependent on a function of X_{it} such as the average for the

[12] The values of the parameters may differ from those in the binary model
[13] This parameter captures unobserved heterogeneity
[14] It is not possible to use fixed effects with a probit model as it is not possibly to find a sufficient statistic to condition on to remove μ_i from the likelihood.

individual, X_i, □ ($\mu_i = X_i$, □$\alpha + \varsigma_i$). Since the Mundlak approach allows us to take account of correlation between unobserved farm heterogeneity and farm characteristics, this approach is used throughout the paper.

5.2 State dependence

Past participation in the land rental market may influence the decision to participate in the current period for a number of reasons, such as reduced search and contracting costs. If, for example, the farmer participates in a given year and as a result has identified landowners to rent from and has drafted contracts, then the farmer's transaction costs in future periods should be lower and as a result the farmer may be more likely to rent-in land again. We refer to this as state-dependence. If there were no unobserved individual heterogeneity we could include a lagged dependent variable to capture the effect of state-dependence. However in the presence of heterogeneity an issue known as the 'initial conditions problem' arises. The problem is caused by correlation between the unobserved heterogeneity and the lagged dependent variable. This violates the strict exogeneity assumption and so results in endogeneity.

Approaches to deal with this problem have been suggested by Heckman (1981a, 1981b); Orme (1997, 2001) and Wooldridge (2005) in a random effects framework. Simulation results suggest that the Wooldridge estimator is superior for samples longer then 5-8 periods and shorter than 10-15 periods (Akay, 2009). Akay also shows that the Wooldridge estimator performs well even on extremely unbalanced data. In this paper we apply the Wooldridge estimator to our unbalanced dataset.

5.2.1 Wooldridge Estimator

Whereas Heckman's approach includes an approximation for the probability of renting in the first period in order to overcome the initial conditions problem, Wooldridge assumes that the distribution of the unobserved component, μ, is conditional on the initial condition, Y_{i0}, and the exogenous explanatory variables. While previously we decomposed the error term, ε into two components, μ_i and ν_{it}, Wooldridge suggests that we additionally specify μ_i as:

$$\mu_i = \alpha_0 + \alpha_1 y_{i0} + z_i \alpha_2 + a_i \qquad (7)$$

Thus Wooldridge specifies the latent variable model as:

Fehler! (8)

The contribution of individual *i* to the likelihood function would then be:

Fehler! (9)

An attractive feature of this approach is that the model above may be estimated using a standard random effects probit where the regressors are **Fehler!**.

5.2.2 Farm systems

In the National Farm Survey, farms are categorised according to their activities into one of six 'systems'; dairying, dairying and other activities, cattle rearing, cattle and other activities, mainly sheep and finally, tillage. To assume that the influences exerted by the explanatory variables are the same across systems would appear to be a very restrictive assumption. One approach to dealing with differences across farm systems would be to interact dummies representing each system with the explanatory variable.

Ai and Norton (2003) show that the coefficients for interaction terms, their signs and their significance levels may all be incorrect when using non-linear models. Ai and Norton suggest a method to overcome this. However, for binary models such as probit, the scale of the error variance is unidentified. Therefore the estimated coefficients, γ are confounded with the variance of the error term σ_{ε}.

Whilst this generally is of little consequence, in order for comparisons of coefficients across groups (farm systems) to be valid, it is necessary that the scale of the error variance is the same for all groups (Allison, 1999; Hoetker, 2004, 2007). Whilst to some degree this problem can be overcome by estimating heteroskedastic models, Keele and Park (2006) suggest that if the variance equation is mis-specified then estimates may be even more biased. Dynamic probit and tobit models are estimated separately for each system[15]. Fortunately, the scale of the error term *is* identified in the tobit model and so comparison of coefficients across farm systems are valid for the tobit results.

[15] A likelihood ratio test confirms that coefficients differ across systems.

5.2.3 Average partial effects

While in a linear model, the marginal effect of X_i on Y is given by the coefficient, β, in a non-linear model such as Probit, the marginal effect of X_i, **Fehler!**, depends on the value of Xβ at which it is evaluated. However, when using non-linear models with panel data, the marginal effect also depends on the value of the unobserved heterogeneity, μ_i. Wooldridge suggests using the Average Partial Effect, which consists of averaging the partial effect across the distribution of μ_i. A consistent estimator of which is:

$$APE = \sum_{j=1}^{j=N} N^{-1}\phi\frac{X\beta + \mu_j}{1+\sigma_\mu^2}\beta_i \qquad (10)$$

6 RESULTS

It is clear from Table 2, that farmers engaged in the two Dairying systems are most likely to rent-in land with close to two-thirds of these farmers doing so. However from Table 3 we can see that farms which specialise in dairying rent-in much less land than dairy farmers who also engage in other activities. Farms engaged in the two systems relating to cattle tend to rent-in a similar area to specialist dairying farms. Renters engaged in the Tillage system tend to rent-in a much larger area on average than farmers engaged in any of the other system which is not surprising.

[Table 2 about here]

[Table 3 about here]

Tables 4 and 5 report the coefficients from the dynamic probit and tobit models respectively while Tables 6 and 7 contain the associated Average Partial Effects[16]. The dummy variable representing the years following ‘decoupling’ is insignificant in both the probit and tobit models for all systems. This suggests that ‘decoupling’ has had little or no impact on farmer’s land market decisions. This is somewhat surprising given the large number of farmers who have availed of the option to consolidate their entitlements.

[16] The APEs were bootstrapped 300 times. Some of the bootstraps failed so the number of successes is reported in the last row of the tables.

A possible explanation is that farmers may still be treating the ‘decoupled’ payment as ‘coupled’ to production. Breen et al. (2005) contains the results of a survey of Irish farmers in which a majority of the farmers indicated that they intend to continue with the same production patterns post decoupling, supporting this view. Also, farmers may have undertaken investments to expand their capacity prior to the ‘decoupling’ of support payments with the result that it is optimal to continue using a large area of land. For example, it may be optimal for livestock farmers who have built large slatted sheds prior to decoupling to maintain a larger herd size than would otherwise bne the case. If land is scarce, farmers may continue to rent-in land in the belief that it preserves the option to rent-in land in future periods since often rental agreements are renewed in subsequent years. The expectation of future rebasing may also play a role.

From Tables 6 and 7, we can see that there is significant evidence of state-dependence in farmers’ land market decisions which to some degree may contribute to the lack of impact which ‘decoupling’ appears to have had on land market decisions. Farmers’ previous land market decisions positively effect their current decisions - though the affect seems to be stronger for participation than for the extent of participation. To some degree this may reflect barriers to entering the land market such as transaction costs - a large proportion of which may be relatively fixed and so would exert less influence on how much land is rented-in. State-dependence may delay the impact of ‘decoupling’ and this may be a contributing factor to the lack of impact observed. The influence of past participation is much lower for Tillage farmers than for farmers engaged in other farm systems. In Ireland, tillage farmers are likely to be amongst the most market-oriented producers and may be altering the crop produced annually so it is unsurprising that these farmers decisions are influenced less by their previous actions.

Surprisingly, older farmers are generally not less likely to rent-in land than younger farmers - surprisingly, older farmers engaged in dairying and other activities are more likely to participate in the land rental market[17]. Perhaps this is a testament to the increasing mechanisation of agriculture in Ireland. Alternatively, aging farmers increasing experience may offset the decrease in their physical attributes.

[17] The bootstrapped APE’s tell a slightly different story to the unbootstrapped coefficients. We treat the APE’s as being a better representation of the true effects of the explanatory variables.

Having an off-farm job decreases the probability of specialist dairy farmers renting-in land while it increases the probability of non-specialist dairy farms renting-in. While the former can be explained by the considerable time-commitment which large scale dairying involves, the latter is somewhat puzzling. It is possible that these farms face credit constraints which are relaxed through labour market participation. While having an off-farm job doesn't influence land market-participation decisions for farmers engaged in other system, farmers who are engaged in the 'cattle and other activities' system and those in the 'mainly sheep' system rent-in less land on average if they have an off-farm job.

With the exception of farmer's engaged in the 'mainly sheep' and tillage systems[18], larger land endowments tend to be associated with lower probabilities of participation in the land market and with less renting-in of land. In Ireland, the land which is used by sheep farmers tends to be of a lower quality than that used by other farmers. Often sheep farmers have large areas of mountainous terrain, so that while their land endowment is large, perhaps in productivity terms it is similar to a smaller though better quality plot used by other sheep farmers. This would obscure the impact which the area owned has on land market decisions. For tillage farmers, the efficient scale is likely to be quite large with the result that these farmers may always wish to rent-in more land regardless of land endowment to benefit from returns to scale.

On the whole, Irish farmers' use of non-land inputs (paid labour, unpaid labour and machinery) exert less influence on their land market decisions than may have been anticipated. Farmers use of machinery (as proxied by their machinery operating costs), is unimportant in determining how much land to rent-in for all farmers except those engaged in tillage. In this system, farmers that use more machinery tend to rent-in more land - again suggesting these farmers may be benefiting from increasing returns to scale.

Farmers' use of labour, both paid and unpaid, has no significant impact on farmers' land market decisions for farmers classified as being involved in specialist dairying or the three livestock systems. For farmers engaged in dairying and other activities labour appears to be a complement for land as greater use of paid or unpaid labour increases renting-in. A possible explanation for the negative coefficient of paid labour for how much land tillage farmers choose to rent-in is that farms renting-in land may be in a position to substitute machinery for labour.

[18] The negative coefficient for area owned in the Tillage system is significant at the 13% level

Having more livestock increases renting-in of land for almost all farm systems - the exception being tillage farms. This is not surprising since farms which rely on livestock will require areas for grazing etc. Soil quality does not appear to influence farmer rental decisions[19], which is somewhat surprising as we may have expected farmers with poorer quality land to rent-in land to compensate for their land's lower productivity.

7 CONCLUSIONS

One would anticipate that the impact of decoupling on land markets would be most evident in a country like Ireland where all payments were decoupled at the earliest possible date and where rental agreements generally last for less than one year, allowing most farmers the option of consolidating their entitlements. 'Decoupling' should allow farmers to respond to market forces while still providing income support and so might be expected to have implications for land use.

However results contained in this paper suggest that the move to 'decoupled' payments has not greatly impacted on farmer's land market decisions. Whilst to some extent this may be attributed to the requirement to maintain land in a state fit for agricultural production, in light of the large number of farmer's who availed of the option to consolidate their entitlements, this does not appear to be the full story. Farmers who have undertaken investments to increase capacity may find it optimal to produce at a higher level than might otherwise be the case in the absence of such investments - with the result that land use may also not differ substantially from the pre-'decoupling' scenario. Since the current agreement expires in 2013, farmers may be loath to reduce the area that they farm - lest it should provide the basis for payments in any new scheme at that time. Alternatively, farmers may actually still view the 'decoupled' payment as being 'coupled' to production. Further work is warranted to explore the impact on the use of non-land inputs.

Were it possible to identify farmer's who have consolidated their entitlements, it is possible that we may observe some effect of 'decoupling' for these farmer's, however the existing dataset does not allow this although these farms are identified

[19] Although soil quality appears to have an effect on dairying farmers' participation decisions, in the original regression reported in Table 4,**Fehler! Verweisquelle konnte nicht gefunden werden.** the soil dummies are jointly insignificant in all cases

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Table 1: Summary statistics for dependent and independent variables

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Binary variables	No. of obs.	Percentage of 1's	
Renting	10437	51.32	
Job	10437	28.26	
Soil class 1 (best)	10437	32.71	
Soil class 2	10437	18.01	
Soil class 3	10437	18.27	
Soil class 4	10437	21.23	
Soil class 5 (worst)	10437	9.77	
Scale variables	**No. non-zero obs.**	**Mean**	**Std. dev.**
Conacre rented	5356	49.16	70.79
Age	10437	52.04	12.17
Area owned	10388	114.24	91.92
Unpaid labour	10414	1.20	0.49
Paid labour	3990	0.37	0.57
Machinery	10156	7.92	1.19
No. Livestock	10201	71.69	57.56

Table 2: Renting by system

Renting	Dairying	Dairying and other activities	Cattle-rearing	Cattle and other activities	Mainly sheep	Tillage	Total
Not renting	39.69	35.66	57.08	56.88	55.91	48.69	48.69
Renting	60.31	64.34	42.92	43.12	44.09	51.56	51.39
Total	100	100	100	100	100	100	100

Table 3: Average conacre rented by system

System	No.	Mean	Std.dev.
Dairying	1770	39.99	36.83
Dairying and other activities	830	61.58	65.17
Cattle-rearing	939	36.17	42.63
Cattle and other activities	868	35.25	34.12
Mainly sheep	522	51.07	75.14
Tillage	462	115.56	169.58

Table 4: Coefficients for dynamic probit by farm system

Variable	Dairying	Dairying and other activities	Cattle-rearing	Cattle and other activities	Mainly sheep	Tillage
Lagged renting	2.3848***	2.5722***	2.6639***	2.6255***	2.5540***	1.4508***
Initially renting	1.5222***	0.7535***	1.1763***	1.2852***	1.7824	1.9493**
Age	0.0151	0.0247	-0.0201	0.1198**	0.0591	0.0128
Age-squared	-0.0002	0.0006	0.0003	-0.0010**	-0.0003	-0.0001
Job	-0.4104**	0.6262**	0.2457	-0.2655	-0.2043	-0.1185
Area owned	-0.0106	-0.0283***	-0.0602***	-0.0428***	-0.0117	-0.0149
Unpaid labour	-0.0724	1.1647**	0.0883	-0.4560	0.6787	-0.7554
Paid labour	-0.5559	0.5762	-0.6030	-1.1721	0.6052	-0.9104*
Machinery	0.0254	-0.0795	0.1112	0.0493	-0.1566	0.2425
Number of livestock Units	0.0350***	0.0147*	0.0316***	0.0233**	0.0132	-0.0016
Soil class 2	0.3976	-0.1167	-0.3676	-0.0990	-0.1531	0.6103**
Soil class 3	-0.0518	0.0510	0.0373	-0.0067	-0.4829	-0.5963
Soil class 4	0.3509*	0.0612	0.3006	0.1343	0.2492	-0.3759
Soil class 5	0.7034**	0.4486	0.2372	-0.2036	-0.0370	-4.1164
Dummy decoupling	0.0952	-0.1954	-0.0093	0.2188	-0.0148	-0.2912
Mean age	0.0103	-0.0933***	-0.0141	-0.0315	-0.0590*	-0.0153
Mean area owned	0.0035	0.0162	0.0530***	0.0313***	0.0081	0.0118
Mean unpaid labour	0.0253	-1.1323**	-0.1430	0.7809	-0.6387	1.1726
Mean paid labour	0.4032	0.0868	0.3006	0.9979	-1.7023	1.6016**
Mean machinery	0.2759	0.5078*	0.0314	0.0727	0.4980	0.1401
Mean number of livestock units	-0.0279***	-0.0054	-0.0148	-0.0105	-0.0083	0.0053
Constant	-4.8614***	-2.5998	-2.2696	-4.4860***	-3.5595	-5.1929**
σ_μ	0.8244	0.0022	0.5739	0.6609	0.8051	0.4060
Statistics						
N	2374	983	1648	1514	869	618
Log likelihood	-460.1591	-161.0247	-293.9060	-238.9092	-126.6832	-115.6123
$\ln(\sigma_\mu)$	-0.3862	-12.1976	-1.1106*	-0.8284	-0.4336	-1.8029
ρ	0.4046	5.04E-06	0.2478	0.3040	0.3933	0.1415

legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 5: Coefficients for dynamic tobit by farm system

Variable	Dairying	Dairying and other activities	Cattle-rearing	Cattle and other activities	Mainly sheep	Tillage
Lagged conacre rented	0.7280***	0.7684***	0.6472***	0.5994***	0.7643***	0.7317***
Initial conacre rented	0.2026***	0.1916***	0.3602***	0.3256***	0.3378***	0.3648***
Age	0.1869	-0.4011	-0.4145	0.1842	0.8243	1.0502
Age-squared	-0.0025	0.0049	0.0038	-0.0009	-0.0080	-0.0071
Job	-0.9766	-0.0519	1.1090	-3.3515*	-7.0207**	-6.3322
Area owned	-0.2165***	-0.3188***	-0.3376***	-0.5084***	-0.0535	-0.3475
Unpaid labour	-1.2873	13.4500***	0.6210	2.8178	10.7026	-11.8100
Paid labour	-2.0137	12.1085***	19.4028***	-5.1253	-5.5052	1.5440
Machinery	1.1698	-1.1441	-1.0154	0.6249	-1.5828	16.3918**
Number of livestock units	0.5148***	0.1402***	0.4830***	0.4082***	0.2333***	-0.5072***
Soil class 2	4.0418	-0.7211	-2.4056	-2.5092	-1.0837	12.3585
Soil class 3	2.1617	3.4389	1.4446	3.4039	-0.2029	1.1241
Soil class 4	3.0240	-1.2842	4.0153	1.8657	8.2115	9.3355
Soil class 5	5.7117*	6.0635	0.7478	0.9282	-5.2722	-272.8908
Dummy decoupling	0.4477	-1.5960	-1.4840	0.8305	1.2939	-6.3590
Mean age	-0.0967	-0.3563	-0.1884	-0.3567**	-0.4308	-1.2055*
Mean area owned	0.1149***	0.1813*	0.2626***	0.3121***	0.0016	0.2466
Mean unpaid labour	0.1041	-13.453***	-0.8576	0.5210	-10.9202	22.9350
Mean paid labour	0.8323	-4.4451	-31.3047***	11.0584	-2.9337	18.2431*
Mean machinery	-0.0967	5.4693*	3.7189**	1.1360	3.0612	-6.4507
Mean number of livestock units	-0.3399***	0.0117	-0.3567***	-0.1302**	-0.1721***	0.6311***
Constant	-18.8156	-16.9151	-11.5666	-14.5859	-21.6854	-104.9324*
σ_μ	13.7760***	14.2213***	13.5062***	13.9984***	13.8367***	29.4116***
σ_ϵ	14.5326***	16.4255***	11.7421***	12.9178***	18.0339***	41.2984***
Statistics						
N	2381	984	1663	1523	885	621
Log likelihood	-6487.6780	-2900.7355	-3208.2775	-3093.3098	-1903.3274	-1657.2881
ρ	0.4733	0.4285	0.5695	0.5401	0.3705	0.3365

legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 6: Bootstrapped average partial effects for dynamic probit by farm system

Variable	Dairying	Dairying and other activities	Cattle-rearing	Cattle and other activities	Mainly sheep	Tillage
Lagged renting	0.5051***	0.6209***	0.6332***	0.5574***	0.4708**	0.2513***
Initially renting	0.2651***	0.0964	0.1834**	0.1841*	0.2639	0.3702***
Age	-0.0010	0.0072***	0.0010	0.0006	0.0028	0.0006
Job	-0.0446*	0.0541***	0.0236	-0.0228	-0.0157	-0.0116
Area owned	-0.0015	-0.0025**	-0.0066***	-0.0043**	-0.0011	-0.0016
Unpaid labour	-0.0094	0.1012*	0.0097	-0.0461	0.0665	-0.0796
Paid labour	-0.0766	0.0501	-0.0664	-0.1185	0.0593	-0.0959*
Machinery	0.0032	-0.0069	0.0122	0.0050	-0.0153	0.0255
Number of livestock units	0.0048***	0.0013*	0.0035**	0.0024**	0.0013	-0.0002
Soil class 2	0.0422*	-0.0103	-0.0359	-0.0083	-0.0120	0.0591*
Soil class 3	-0.0054	0.0044	0.0036	-0.0006	-0.0377	-0.0625
Soil class 4	0.0375*	0.0053	0.0292	0.0115	0.0200	-0.0381
Soil class 5	0.0748**	0.0387	0.0229	-0.0171	-0.0029	-0.4653***
Dummy decoupling	0.0101	-0.0172	-0.0009	0.0183	-0.0011	-0.0285
No. successful bootstraps	300	259	300	300	291	181

legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 7: Bootstrapped average partial effects for dynamic tobit by farm system

Variable	Dairying	Dairying and other activities	Cattle-rearing	Cattle and other activities	Mainly sheep	Tillage
Lagged conacre rented	0.1598***	0.1318***	0.1397***	0.1108***	0.1100***	0.1128***
Initially conacre rented	0.0445***	0.0329	0.0778***	0.0602***	0.0496*	0.0560*
Age	-0.0133	0.0176	-0.0035	0.0162	-0.0039	0.0547
Job	-0.0155	-0.0006	0.0177	-0.0441*	-0.0708***	-0.0327
Area owned	-0.0475*	-0.0547***	-0.0729***	-0.0940***	-0.0076	-0.0537
Unpaid labour	-0.2825	2.3138**	0.1341	0.5209	1.5387	-1.8136
Paid labour	-0.4419	2.0769*	4.1889	-0.9474	-0.8052	0.2353
Machinery	0.2567	-0.1962	-0.2192	0.1155	-0.2303	2.5208**
Number of livestock units	0.1130***	0.0241*	0.1043***	0.0754***	0.0336**	-0.0781
Soil class 2	0.0645	-0.0085	-0.0347	-0.0319	-0.0102	0.0683
Soil class 3	0.0342	0.0416	0.0224	0.0470	-0.0013	0.0058
Soil class 4	0.0481	-0.0150	0.0650	0.0252	0.0982*	0.0498
Soil class 5	0.0915*	0.0744	0.0115	0.0124	-0.0520	-0.3408***
Dummy decoupling	0.0071	-0.0192	-0.0237	0.0109	0.0135	-0.0332
No. successful bootstraps	300	300	300	300	300	188

legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$