Behavioural Drivers of Stocking Rate Decisions in Less Favoured Areas

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Abstract

In this paper we use a natural experiment to investigate the behavioural response of Irish Cattle farmers to historical policy incentives. In particular we are interested in the period 2001 – 2005 when Less Favoured Area payments were decoupled from production and other subsidy payments available to all farmers remained coupled. The decoupling of the Less Favoured Areas payment provides an exogenous source of variation that gives us unique opportunity for policy evaluation. Researchers rarely observe the effects of a policy change on those affected and those not affected since in almost all cases a policy change affects all. We adopt an ordinal Utility maximization consumer choice framework where individuals make decisions in relation to consumption and leisure. Under our model of utility maximization the expected market gross margin is positively associated with livestock intensity. We identify a non-linear relationship between direct coupled payments and livestock intensity which suggests that high payments incentivise farmers towards extensification. Using a Difference in Difference with propensity score matching we find that there were substantial differences in the behavioural responses of both groups. Farms where payments remained fully coupled adapted their stocking rate decisions in a way that reflects both learning and rationality more significantly than farms where part of their payment was decoupled.

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1. Introduction

Irish cattle farmers have provided a number of puzzling questions for researchers over the previous two decades. There is no doubt as to the significance of the sector in terms of size and contribution to the wider agri-food processing sector, but profitability issues at farm level continue to plague the sector. In particular, the decision of farmers with negative market returns from cattle production, to continue to produce in a decoupled policy era has posed the most puzzling question to date. Cattle farmers continue to grapple with high levels of risk, volatility in the market (beef crisis 2015), a beef value chain with low levels of transparency (Renwick 2015), and adverse weather conditions (fodder crisis 2012/13). Despite these difficulties farmers continue to produce quality livestock when the decoupled Single Farm Payment, introduced in 2005, gave farmers a choice. Under this policy scenario, farmers could in fact receive a payment, keep their land to a certain standard required by the terms of the payment and either do nothing at all or diversify into other agricultural enterprises. Prior to the introduction of decoupled farm payments analysts predicted a significant restructuring at farm level (Breen et al., 2005). However the changes have been slower than predicted.

In the coming decades Livestock farmers must adapt to significant problems and uncertainties surrounding climate change and global food security. As a net exporter of beef, Irish farmers face both possibilities and challenges in both of these areas. From a climate change perspective, Ireland has committed to reduce GHGs of which livestock production is a major contributor. On the other hand we have a climate and soil conditions ideal for low cost grass production and are in a position to supply the global beef market with additional beef products. These conflicting objectives need careful planning and management at a policy level. As CAP policy moves further towards flat rate payments it is important to analyse how farmers have reacted to historical policy incentives, and investigate if cattle farmers reacted to behavioural pressures as theory suggest they should.

To do this we adopt a novel approach of analysing farmer responses. This approach is frequently used in Public and Labour Economics, where the design of a tax schedule to optimise tax revenue for the Government is a significant area of research. When the objective of a policy is to promote or discourage a certain type of behaviour, financial incentives occur when that behaviour is adhered to. This involves introducing some limit on the incentive, above which the financial reward decreases or disappears altogether. The introduction of this limit or cut-off point results in a Non-Linear Budget Constraint for individual consumers. Two distinct forms of non-linearities exist, Notches which create a break and Kinks which change the slope. One of the objectives of historical coupled subsidy was to combat overproduction by promoting extensive farming practices. Higher payments were paid to farmers who operated below a certain stocking rate on their farm. Above this stocking rate payment ceased, this created a Notch in individual budget constraints of Irish cattle farmers. Notches create regions of strictly dominated choice above cut-offs and provide strong incentives for bunching below cut-offs. Notches impose a large loss on individuals operating in the dominated region while leaving those on the lower side of the cut-off point unaffected. The behavioural pressures on the effected individuals is therefore stronger and it is this group that we focus on since by decreasing stocking rates they can increase subsidy income. However optimization frictions in the system may prevent farmers from making such a move. These frictions include things such low levels of subsidy literacy, a biological lag and switching costs.

In this paper we use the distinction of Less Favoured Areas and Non Less Favoured Areas to carry out a natural experiment of the response of Irish Cattle Farmers to Notches in the Potential Subsidy Budget Constraint. Prior to 2001 all payments were coupled and after 2005 all payments were decoupled. For a four year period (2001-2005) farmers in Less Favoured Areas received both per hectare Disadvantaged Area Scheme decoupled payment[2] and CAP reform coupled payments (MacSharry Reform Payments). Farmers in non-disadvantaged areas only received a coupled payment. As part of the CAP reform coupled payments, farmers in receipt of either a Suckler Cow payment or a Special Beef Payment received an Extensification payment to remain below a certain stocking rate. Above this cut-off point farmers received no Extensification payment this essentially introduces a Notch in the Potential Subsidy Budget Constraint. Both groups were subject to the behavioural pressures associated with these policy instruments. However the flat per hectare LFA payment available to farmers in Disadvantaged crated no such behavioural incentives since an increase or decrease in the stocking rate has no effect of the level of payment received and the marginal effect of these payments is essentially zero. Notches, associated with the cut-off point for extensification payments create a region of strictly dominated choice above the cut-off. In the literature this dominated region is referred to as A Hole. In a frictionless world with perfect information we would not expect farmers to be operating at a stocking rate which placed them in A Hole since lowering their stocking rate would increase income. The economic importance of *Notches* is that they create an incentive for individuals to *Bunch* at of just before the cut-off point. We use Teagasc National Farm Survey (TNFS) data from 1984 - 2012

2. Theoretical Framework

This section outlines the theoretical framework associated with nonlinear budget constraints. From a theoretical perspective, Non linearities in the potential budget constraint of individual agents provide both opportunities and complications for empirical research. Opportunities in the sense that these non linearities allow us to compare what theory predicts individual agents will do with their actual behaviour. Complications in the sense that non linearities create difficulties empirical methodology. Linear budget constraints imply linear demand curves; however non-linear budget constraints lead to non-linear utility functions and in turn non-linear demand curves. Demand functions where constraints are non-linear, increase the difficulty in estimating the function. (Moffitt, 1990)

In this paper we are interested in whether cattle farmers adjusted their behaviour in response to the behavioural pressures associated with non-linearities in the budget constraint. We adopt an ordinal Utility maximization consumer choice framework where individuals make decisions in relation to consumption and leisure. Under our model of utility maximization the expected market gross margin is positively associated with livestock intensity.

Tax literature develops a method to estimate the elasticity of taxable income using the variation created by discontinuities in *marginal* tax rates (kinks)(Saez, 2010), and discontinuities in *average* tax rates (Notches)(Kleven and Waseem, 2013). Tax responsiveness literature specifies taxpayer utility as $U = (z - T(z), z, n)$ where z is before tax income, $T(z)$ is tax liability, $z - T(z)$ is consumption and n is earnings capacity which may be interpreted as an ability parameter.

[2] In this paper the Disadvantaged Areas Scheme payment is referred to as LFA payment

In an agricultural setting where direct subsidy payments are available we adapt the utility function to reflect a subsidy recipient's utility, therefore subsidy responsiveness is captured as $u = (M(sr) + S(sr), sr, n)$ where sr is the stocking rate of the farm M is income from the market S is the subsidy rate and n is once again an ability parameter capturing the potential earnings of the farm. This ability parameter in an agricultural setting is a function of land type, farm size, credit constraints (since a change in stocking rates involves a cost to the farmer if stocking rates are to increase) and farmer ability.

The utility function of a subsidy receiving farmer is thus

Utility = (Market Income + Subsidy Income, Stocking Rate, Ability)

Subsidy receiving farmers choose a stocking rate to maximize utility given a subsidy schedule.

Unlike a tax schedule where all individuals face the same tax rate the subsidy rate is not fixed and is different for different farms, subsequently farms operating at similar stocking rates can face subsidy rates. To see this consider the stocking rate as a measure of the intensity of the farm, the stocking rate is calculated as

$$[(Number\ of\ Animals)(stocking\ rate\ equivalance)/(farm\ size\ (hectates)]$$

However subsidies are paid on a per head basis, which means that larger farms can avail of higher total payments at lower stocking rates. For example if a farmer receives a financial incentive (an Extensification payment), for remaining below a certain stocking rate level, (above which the farmer receives no payment), and all farms face the same upper limit condition, smaller farms will reach the target stocking rate level with less animals than large farms. Hence, the two farms will receive very different payment levels although operating at the same stocking rate. However if we construct a potential budget constraint for each farm based on the particular conditions of the farm (number of animals and farm size) and the per head subsidy payment, and allow for the number of animals to vary incrementally, the individual subsidy rate of each farm is observed as the marginal effect on income of an increase in the stocking rate. Essentially the subsidy rate (similar to a tax rate) is observed as the slope of their individual budget constraint at the actual stocking rate operational on the farm.

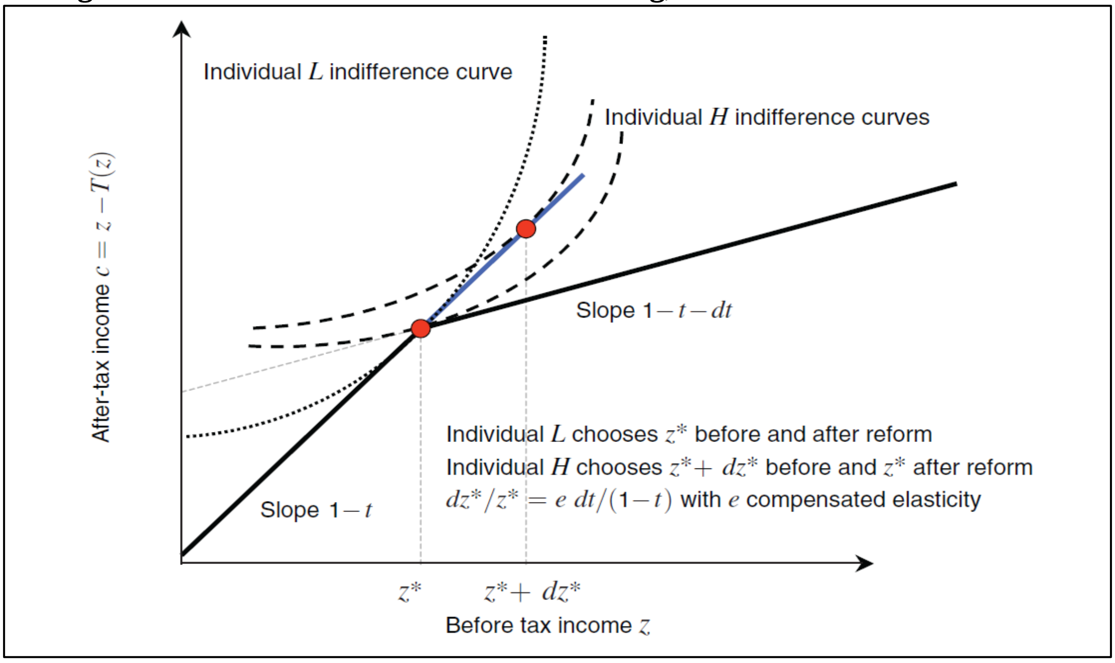
Recall; Subsidy receiving farmers choose a stocking rate to maximize utility given a subsidy schedule. The subsidy schedule for each farm is different depending on the particularities of the farm. We can think of the stocking rate as a function of underlying farm level conditions and farmer ability. Therefore the overall responsiveness of stocking rates captures the sum total of these differences. It is this subsidy schedule that determines potential budget constraint of individual farmers and imposes non linearities at upper stocking rate limits of individual policy instruments (suckler cow, Special beef and extensification premia payments)

Non-linear Budget Sets fall into two categories *Kinks* or *Notches.* A *kink* is a change in the *marginal rate* of taxation or transfer payments, this leads to a *change in the slope* of the constraint. A *Notch* is a change in the *average rate* of taxation or transfer payments, this leads to a discontinuity or a break in the constraint. In particular we investigate the behavioural responses of farmers to the *Notched* budget constraint of The MacSharry era. We are interested in the response of farmers who because of policy changes find themselves operating at a sub optimal stocking rate level in terms of maximizing subsidy payments. To do this we have adapted *bunching theory* frequently applied in labour and public policy economics to uncover the behavioural responses of labour supply to changes in the tax schedule.(Hausman, 1985, Moffitt, 1990, Saez, 2010).

Bunching Theory has its roots in individual preference and indifference theory. If individual preferences are convex and smoothly distributed in the population, workers will choose to supply hours of work up to a point where marginal utility from income equals the marginal disutility of labour. *Utility maximizing agents must be on a linear part of the budget set or at a convex kink point.*

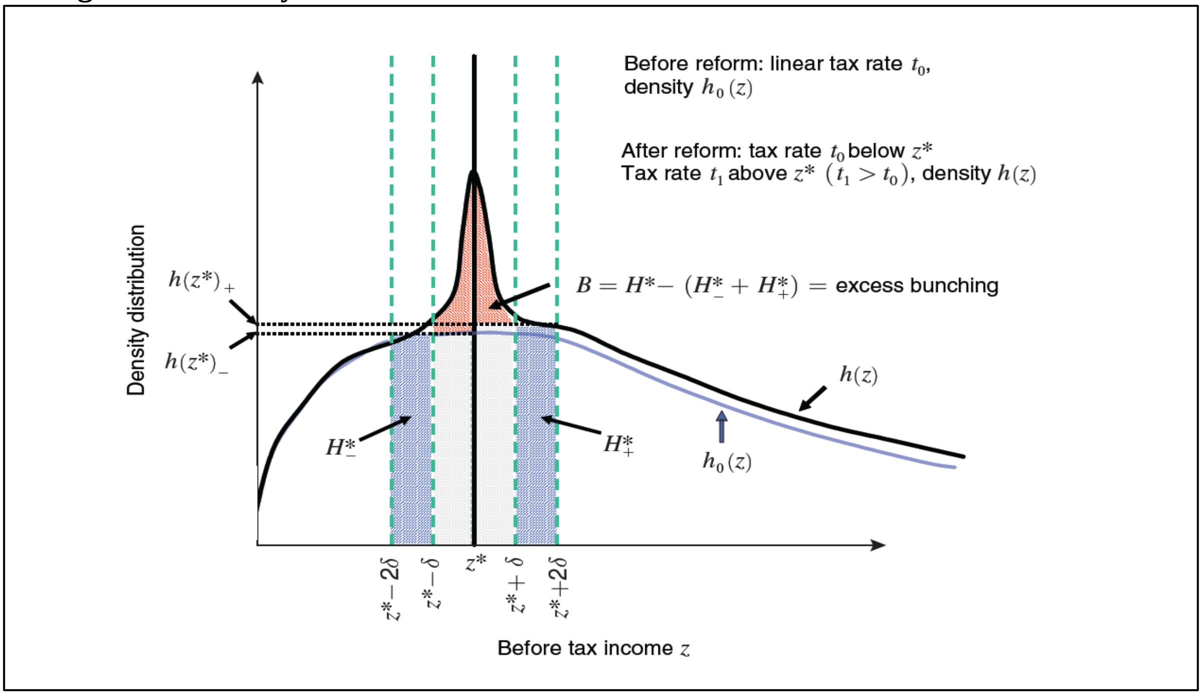
In 1978 Burtless and Hausmann developed a non-parametric method to study the Negative Income Tax experiment in the US. (Burtless and Hausman, 1978). Essentially this method consists of constructing histograms of the income distribution to see if in fact bunching 2004 and find clear evidence of bunching at the first kink point where tax liability begins but no evidence of bunching at any other kink point. (Chetty et al., 2009) Uses tax return data from Denmark and uncovers substantial bunching at a large kink point where the top rate starts to apply. All of these studies examine behavioural responses to *Kinks* defined as discontinuities in the slope of the choice set, when the *marginal* tax rate jumps at bracket cut-off points in graduated income tax schedules. Figure 1 and Figure 2

Figure 1 Indifference Curves and Bunching, Kinks Scenario



Source: Saez 2010

Figure 2 Density distribution with a Kink



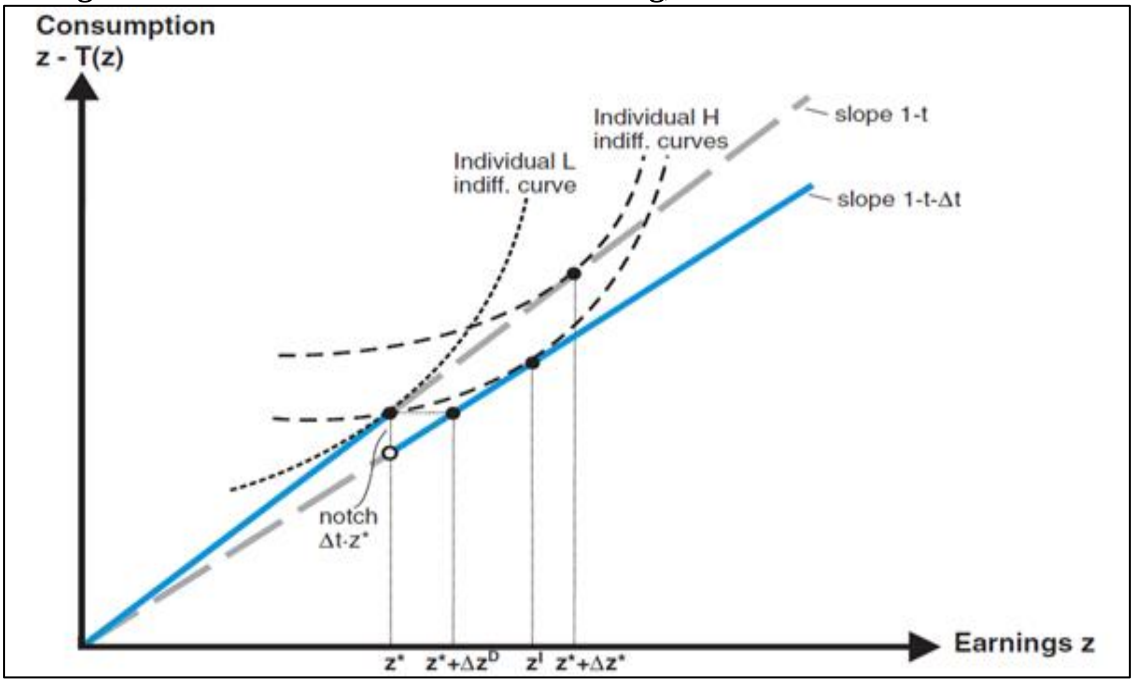
Source: Saez 2010

Evidence of bunching causes a number of difficulties for empirical research, mainly in relation to the appropriate methods of estimation. The economic importance of bunching evidence is that it points to preference heterogeneity, which has in turn implications for the error term in econometric models. Typically the error term is assumed to be randomly distributed in the population, but where bunching occurs preference heterogeneity needs to be accounted for and hence the error term needs to be split in two, a random component and a component to capture the non-random nature of individual preferences.

Notches are conceptually different from *kinks* and cause a break in the budget set as opposed to a change in the slope. In our study this occurs because an incremental change in stocking rates results in a discrete change in the level of subsidy income. Such a *notch* introduces an incentive for moving from a region above the cut-off to a point just below the cut-off, thereby creating a hole in the earnings distribution on the higher stocking rate side and excess bunching in the earnings distribution on the lower stocking rate side of the *Notch* point

Kleven ET. al. extend the *kink* framework to study tax notches in Pakistan.(Kleven and Waseem, 2013) and point out that the region of strictly dominated choice created by a notch is particularly useful in empirical research, since agents can increase both consumption and leisure by moving down below the cut-off point. They also point out that the dominated region should be completely empty in a frictionless world under any preferences. However observed density mass in this region is clear evidence that frictions exist. Their research into the behavioural responses to tax notches in Pakistan find that while bunching is large and sharp optimization frictions are also very large as the majority of taxpayers in dominated regions are unresponsive to tax incentives. Figure 3

Figure 3 Indifference Curves and Bunching, Notched Scenario



Source: Kleven (2013)

In this paper we are particularly interested in the behavioural response of farmers operating in this notched region for a number of reasons. Firstly, the notch has a large effect only on those individuals who are operating in a strictly dominated area directly after the notch point. For these individuals there is effectively a marginal change of 100%

3. Methodology

This section describes the Natural Experiment used in this study and the Difference in Difference analysis applied.

A natural experiment may be used where there is an obvious exogenous source of variation in the explanatory variables that determine the treatment assignment. In this study the obvious exogenous source of variation occurs where changes in the LFA policy only affected farmers in these areas while leaving farmers in Non LFA unaffected. We distinguish the treatment group as farms in Less Favoured Areas where the exogenous source of variation is the decoupled LFA payment.

Farmers in less favoured areas face significant handicaps deriving from factors such as remoteness, difficult topography and poor soil conditions. In 1975 the EEC, as it was then known, introduced a scheme of income support for farmers in the disadvantaged regions of the community. The Disadvantaged Areas Scheme (DAS)[3] was introduced under EEC Council Directive 268/753 of 28 April 1975 on mountain and hill farming and farming in certain less favoured areas. The Directive expressly stated that steps should be taken to "ensure the continued conservation of the countryside in mountain areas and in certain other less-favoured areas". The rationale behind the scheme was twofold, firstly "to ensure the continuation of farming, thereby maintaining a minimum population level or conserving the countryside in certain less-favoured areas" and secondly "to encourage farming and to raise

[3] We refer to this as LFA payment

farm incomes in these areas". It was stated that in areas of disadvantage farmers were prevented from achieving a "level of income similar to that enjoyed by farms of a comparable type in other regions" the decline in agricultural incomes compared with other regions and the poor working conditions would lead to land abandonment and would "jeopardize the viability and continued habitation" of the areas.

Coupled LFA payments

From the beginning LFA payments were coupled to production and paid on a livestock unit basis as in Table 1. Upper limits were placed on the number of livestock units eligible and a minimum land requirement of 3 hectares. Additional conditions were added over time which included a maximum payment per farm and a maximum payment per hectare.

Table 1. Livestock Unit Equivalence for LFA

Eligible Stock	
Each Adult Bovine over 2 years	1.0 L.U.
Other Bovines (6-24 mts)	0.6 L.U.
Reg Connemara Mare	1.0 L.U.

In addition to coupled LFA payments farmers were also eligible for CAP reform coupled payments introduce in 1993 as part of the MacSharry Reforms, which replaced market support policies of the previous era.

Partial Decoupling of LFA payments

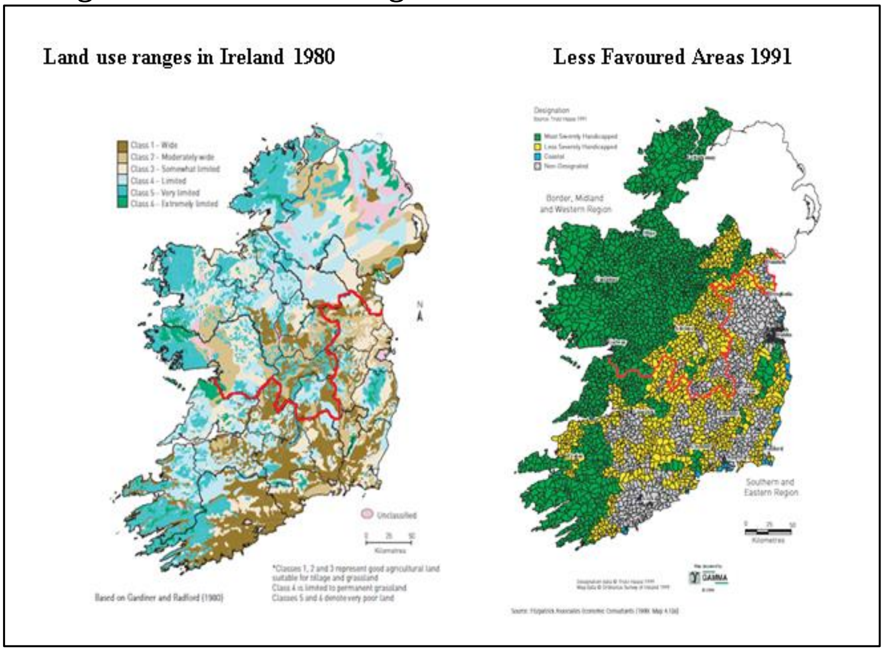
In 2001 LFA payments were decoupled from production. Article 14 of Council Regulation (EC) No 1257/99 provided that "compensatory allowances shall be granted per hectare of areas used for agriculture to farmers". This new regulation led to the replacement of Ireland's Cattle, Sheep, Goat and Equine Headage schemes and thus shifted our LFA payments to an area-based system. For a period of time between 2001 and 2005 when LFA payments were decoupled from production, CAP reform payments remained coupled until they were replaced by the Single Farm Payment Scheme in 2005. Farmers in Less Favoured Areas received payments which were both coupled (CAP Reform) and decoupled (LFA Payment). Farmers in Non-Less Favoured Areas only received coupled payments (CAP Reform). We call this a period of *partial decoupling* in Less Favoured Areas

The *Partial Decoupling* of direct payments to farmers in these areas is an obvious source of variation. Farmers in Less Favoured Areas received two payments between 1993-2001, A LFA headage payment and a CAP reform premia payment. Both payments were coupled to production and paid on a per animal basis. In 2001 the LFA payment was decoupled from production and instead farmers received a per hectare payment up to a hectare limit. At the same time CAP premia payments remained coupled to production. We refer to the period from 2001-2005 as a period of *Partial Decoupling*. This source of variation allows us define the treatment group as farms in Less Favoured Areas.

The change in policy allows us to define the treatment group but this difference alone is not enough, we also need to identify farms in both the treatment group and the control group that are similar in other aspects. The first comparison we make is in relation to soil quality. In Figure 4 we compare two maps, one showing the land use ranges and the second showing the areas designated less favoured. During the time period we are interested in the data does not make a distinction between More Severely Handicapped (Green) and Less Severely Handicapped (Yellow) therefore our definition of Less Favoured Areas includes both (Green

& Yellow). For this experiment we are interested in Class 1 and Class 2 Soil types from the first map. We equate these soil classes with soil type data available in the TNFS as Soil 1, widest use range. Good or bad soil types are not exclusive to either group, while it is fair to say that the majority of land in Non-Less Favoured Areas is good there also exists pockets of poor land. The opposite may be observed in Less Favoured Areas however since over 70% of the utilized agricultural area of Ireland is deemed to be Less Favoured the allocation of good soils (light & dark brown) is split almost evenly between the two groups. That is approx. 50% of good soil is in Less Favoured Areas and 50% is in Non-Less Favoured Areas. This is the basis for our Natural Experiment.

Figure 4 Land Use Ranges and Less Favoured Areas



The Border, Midland and Western (B.M.W.) Region – Cavan, Donegal, Galway, Laois, Leitrim, Longford, Louth, Mayo, Monaghan, Offaly, Roscommon, Sligo and Westmeath.

In Table2 we present the descriptive statistics of farms in Less Favoured Areas and Non-Less Favoured Areas with good soil in two time periods 1995 and 2004. Of interest is the large uptake of environmental schemes in 2004 when compared to 1995. There is a higher dairy share in Non-Less Favoured Ares. And family farm income is consistently higher in Non-Less Favoured Areas.

Table 2. Farm Demographics of farms in Less Favoured Areas and Non Less Favoured Areas with Good Soil (Soil Type 1)

	1995		**2004**	
	NON LFA	LFA	NON LFA	LFA
Farm Size(Ha)	26.82	23.36	33.36	31.12
Cattle Share	74%	69%	64%	75%
Dairy Share	13%	10%	20%	11%
Sheep Share	13%	20%	15%	14%
Off Farm Job	32%	35%	37%	40%
Teagasc Advice	26%	16%	37%	35%
Environmental Scheme	4%	3%	20%	35%
Farmer Age	53	56	54	55
Family Farm Income	€14056	€8579	€19432	13768

In Table 3 we highlight the different level of payments available for a number of different schemes. These payments have all been converted to euro payments but have not been index linked.

Table 3. Euro Per Head Payments for Suckler Cows and Special Beef

	Suckler Cow Premium	**Beef Cow LFA**	**SBP10**	**SBP22**	**Extensification Normal**	**Extensification High**	**Compensatory Allowance in LFA**
1995	173.61	106.68	111.61	111.61	37.19	-	
1996	178.09	106.68	114.52	114.52	38.18	-	
1997	178.09	106.68	114.52	114.52	38.18	-	
1998	178.09	106.68	114.52	114.52	38.18	54.61	
1999	178.09	106.68	108.72	108.72	36.00	52.01	
2000	187.19	106.68	122.00	122.00	33.01	66.01	
2001	206.15	-	136.00	136.00	41.91	66.00	€45 / Ha
2002	224.19	-	150.00	150.00	40.00	80.00	€45 / Ha
2003	224.19	-	150.00	150.00	40.00	80.00	€45 / Ha
2004	224.19	-	150.00	150.00	40.00	80.00	€45 / Ha

Difference in Difference Analysis

To compare the two groups we use Difference in Difference with Propensity score matching. Difference in difference requires observable date in two time periods, before and after a policy change. Policy evaluation seeks to determine the effectiveness of a particular intervention. In economic data, we observe whether subjects were treated or not, but in the absence of random assignment, must be concerned with differences between the treated and non-treated. The key concern is that of similarity. The method of propensity score matching

(PSM) allows this matching problem to be reduced to a single dimension: that of the propensity score. That score is defined as the probability that a unit in the full sample receives the treatment, given a set of observed variables. Thus, rather than matching on all values of the variables, individual units can be compared on the basis of their propensity scores alone. Two key assumptions underlie the use of matching methods, and PSM in particular: 1. **Conditional independence:** there exists a set X of observable covariates such that after controlling for these covariates, the potential outcomes are independent of treatment status: $(Y1, Y0) \perp D|X$

2 **Common support:** for each value of X, there is a positive probability of being both treated and untreated: $0 < P(D = 1|X) < 1$.

The first step is therefore to investigate if a set of observable covariates are available in the data such that there are sufficient similarities between the two groups. Since we are interested in the stocking rate decision of farmers we construct a set of covariates that are considered relevant to the decision and also similar between the treatment and control groups. We then test these covariates using a two sample T Test. The set of X observable covariates used for this analysis are presented in

Table 4. Covariates

Covariates	Rational
Advisory Contact	The extremely complicated nature of these historic coupled payments would suggest that some professional advice would have been necessary for farmers to understand the policy terms
Size of Farm	Since larger farms have more to gain from the overall level of payments we consider farm size to be a contributor to the stocking rate decision
Of Farm Employment	Off farm employment adds to the workload of a farmer and may contribute to a decision in relation to the workload of the farm
Farmer Age	We consider farmer age to be significant as farmer age on cattle farms is higher than in other farming enterprises

A propensity score is then estimated for each group based on this set of covariates and a Difference in Difference analysis is carried out on the basis of the propensity score. This reduces the dimensionality to one single measure and hence eliminates the “curse of dimensionality” that may arise since every additional variable increases the number of possible combinations exponentially by 2^n where n is the number of variables.

4. Results

In this section we present the results of the analysis of cattle farmer behaviour in relation to a stocking rate decision when policy incentives created a number of particular pressure points, observable as Notches in the budget constraint. Firstly we use a nonparametric method to investigate if bunching occurred, and secondly we use Difference in Difference with Propensity Score Matching to uncover the effect of a policy change on the treatment group.

Results 1. Bunching Evidence

First we present histograms and kernel density distributions of observed stocking rates using a weighted sample of farms in Less Favoured Areas (treatment) and Non Less Favoured

Areas (control) where both groups have similar soil type (Soil1) Figure 5 Less Favoured Areas with Soil Type 1 & Figure 6 Non-Less Favoured Areas with Soil Type 1. Kernel density estimations are applied to smooth the distribution and highlight the bunching locations. For kernel density estimation we are interested in observations in close proximity to the kink or notch point as in many cases it might be difficult for individuals to operate exactly at the cut-off point. Vertical reference lines are located at cut-off points where notches are located. These are at the upper stocking rate limits for extensification premia payments, and as can be seen in Table 5 these were not stable across the entire period. The reference line at 2 livestock units per hectare is upper limit for Suckler Cow and Special Beef Premia payments which introduced a kink at this point. Animals above 2 Livestock Units per hectare receive no premia payment and as such we would not expect farmers to be operating at this stocking rate if cattle production is the only enterprise on the farm. However the mixed enterprise nature of many Irish farms may explain observations in this region.

We present three different kernel density distributions based on three different stocking density distribution calculations. The subsidy stocking rate density distribution is based on calculations specific to the payment schemes (Suckler, Special Beef) and it is this distribution that is of interest in this study. Two additional densities based on cattle and sheep livestock units only and a stocking density based on total livestock units which includes dairy livestock units are included for reference and for a clearer picture of actual farm level stocking rate densities.

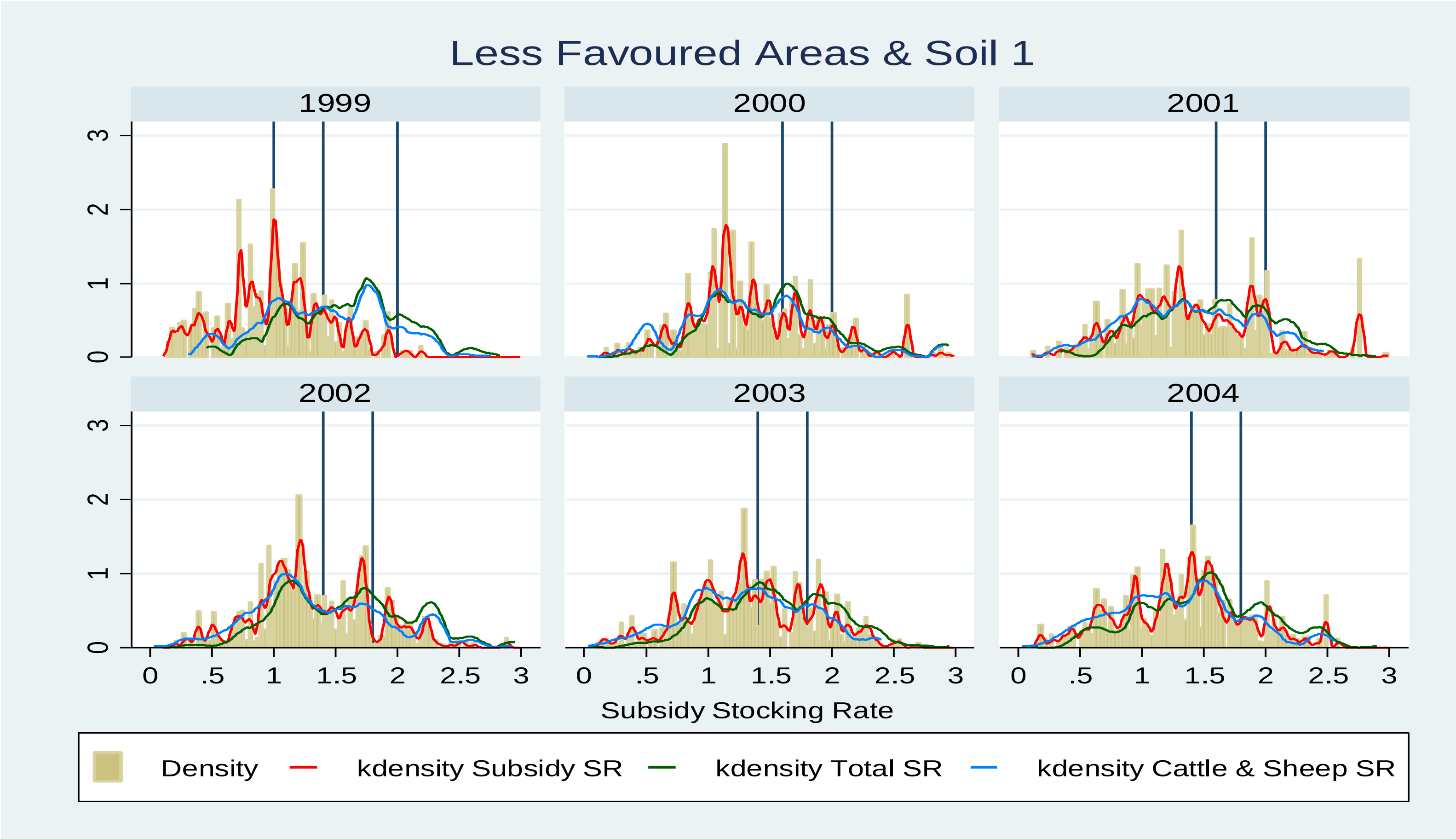
The first two cut-off points in 1999 represent the extensification stocking rate cut off point, the third vertical reference line is at the upper cut off point of 2 LU per Hectare. There is clear evidence of bunching at 1 LU per hectare in Figure 5 and evidence of bunching before 1.4 LU per hectare in Figure 6. Significantly there is almost no density after the upper limit of 2 LU per hectare in either group. Significant changes occurred in 2000 which increased the stocking rate limits but also involved changes to the method of calculating the stocking density. However bunching is still visible in Figure 5 at the same level as in the previous year, even though this limit no longer exists. This is clear evidence of lags in the system which may be biological lags or information lags or both.

We also find that evidence of bunching is very much year specific and is particularly obvious in years where policy conditions remain stable for a number of previous years (1999, 2004).

Table 5. Stocking Rate Limits and location of Notches in Bold

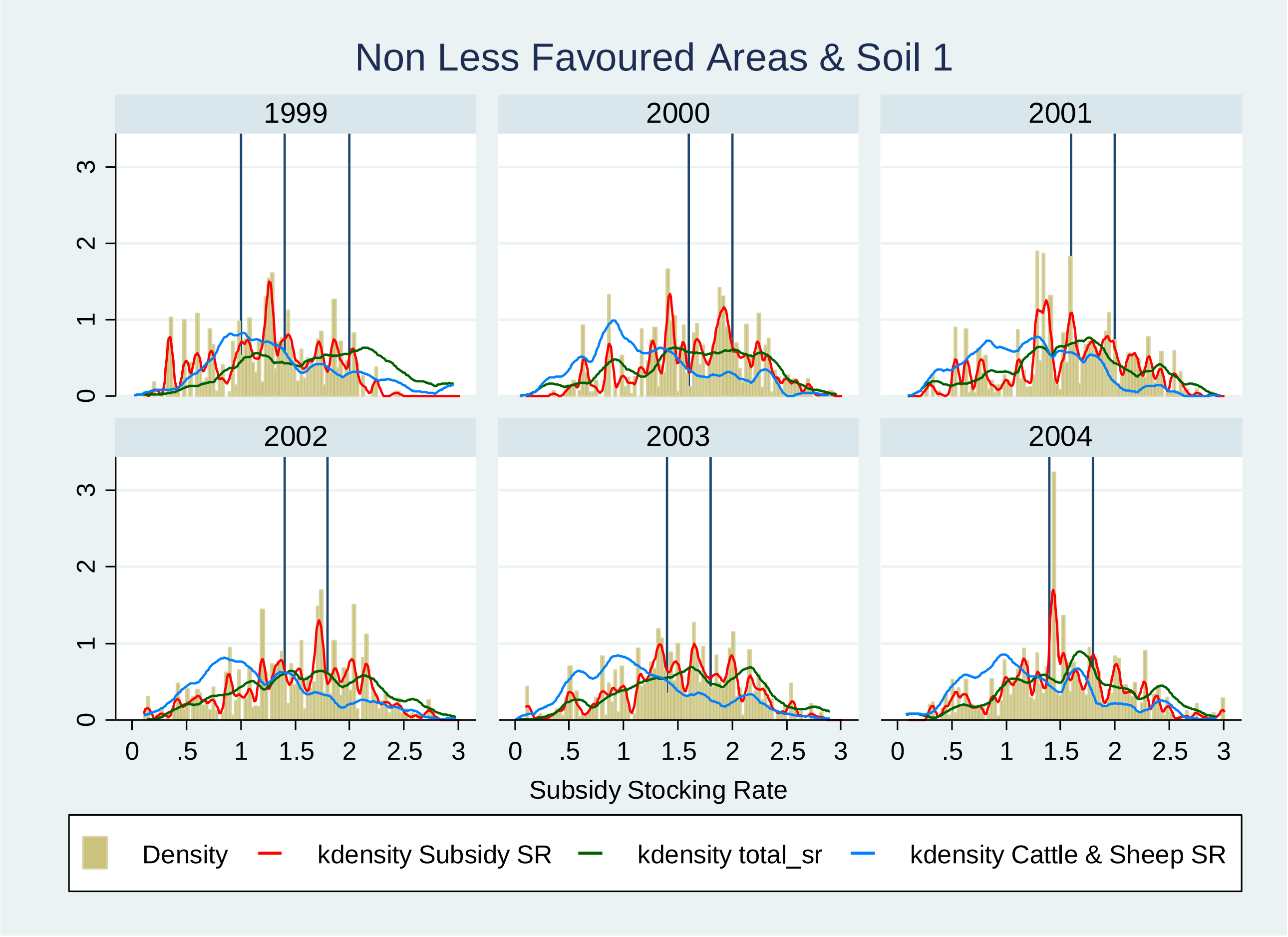
Subsidy	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Suckler Cow	3.5	3	2.5	2	2	2	2	2	2	1.9	1.8	1.8
Special Beef	3.5	3	2.5	2	2	2	2	2	2	1.9	1.8	1.8
Extensification Normal	***1.4***	***1.4***	***1.4***	***1.4***	***1.4***	***1.4***	***1.4***	***2***	***2***	***1.8***	***1.8***	***1.8***
Extensification High	-	-	-	-	***1***	***1***	***1***	***1.6***	***1.6***	***1.4***	***1.4***	***1.4***
Slaughter	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8*	*1.8.*	*1.8*	*1.8*

Figure 5 Histogram and Kernel Density Distribution Less Favoured Areas 1999- 2004 with Soil Type 1



Note: the figure shows the density distribution of Subsidy specific stocking rate for farms in Less Favoured Areas with soil type 1 which has the widest use range (best soil). Vertical reference lines represent the upper cut-off stocking rate limits for extensification payments and the maximum upper limit for all subsidy schemes. These limits change a number of times the most significant changes occur in 2000 when both the limits and the stocking rate calculation method changes. We include two other kernel distributions based on stocking rate calculations for total livestock units (incl. dairy) and cattle and sheep livestock units only.

Figure 6 Histogram and Kernel Density Distribution Non Less Favoured Areas 1999- 2004 with Soil Type 1



Note: the figure shows the density distribution of Subsidy specific stocking rate for farms in Non Less Favoured Areas with soil type 1 which has the widest use range (best soil). Vertical reference lines represent the upper cut-off stocking rate limits for extensification payments and the maximum upper limit for all subsidy schemes. These limits change a number of times the most significant changes occur in 2000 when both the limits and the stocking rate calculation method changes. We include two other kernel distributions based on stocking rate calculations for total livestock units (incl. dairy) and cattle and sheep livestock units only

Results 2. Difference in Difference with Propensity Score Matching Analysis

As previously discussed the key to this analysis is in finding a set of covariates that are similar in both the control and treatment groups. To ensure that a comparison is valid we first apply a Two Sample T Test on the covariates. Table 6 presents the results of this test. The outcome variable is **Stocking Rate** and the table presents the mean values of both the outcome variable and the covariates of interest at the baseline period 1999. There is no significant difference in the covariates used to construct the propensity score, which indicates that there are enough similarities between the groups to carry out our analysis

Table 6. TWO-SAMPLE T TEST of Covariates

Weighted Variable(s)	Mean Control	Mean Treated	Diff.	t	Pr(T>t)
Stocking Rate	1.741	1.390	-0.351	6.81	0.0000***
Teagasc Advisory	0.448	0.428	-0.020	0.40	0.6914
Farm Size	47.597	45.163	-2.434	0.78	0.4331
Off-Farm Employment	0.263	0.241	-0.022	0.49	0.6222
Farmer Age	51.334	50.151	-1.184	0.94	0.3453

*** p<0.01; ** p<0.05; * p<0.1
Attention: option kernel weighs variables in cov(varlist)
Means and t-test are estimated by linear regression
Note:

Table 7. Difference in difference Estimation Results for Marginal Payments

DIFFERENCE-IN-DIFFERENCES ESTIMATION RESULTS

Number of observations in the DIFF-IN-DIFF: 711

	Baseline	Follow-up
Control:	**214**	**157**
Treated:	**162**	**178**

Outcome var.	Marginal Payments	S.Err.	t	P>t
Baseline				
Control	2.212			
Treated	5.521			
Diff (T-C)	3.309	1.126	2.94	0.003***
Follow-up				
Control	1.499			
Treated	5.221			
Diff (T-C)	3.722	1.190	3.13	0.002***
Diff-in-Diff	0.413	1.638	0.25	0.801

*** p<0.01; ** p<0.05; * p<0.1
Attention: option kernel weighs variables in cov(varlist)
Means and t-test are estimated by linear regression
Note: Marginal Payments are calculated at the actual stocking rate of the farm and represent the change in income associated with a 0.1 increase in stocking rate. The baseline period is 2000 (before the policy change) and the follow up period is 2003 (after the policy change). The control group are farms in Non Less favoured Areas with Soil Type 1 (best soil). The treatment group are farms in less favoured Areas with similar soil type.

Table 7 presents the results of the first Difference in Difference estimation of marginal payments. There is a significant difference between the control and treatment group in both the base line period and the follow up period. However it is the change in each group that is of interest here. While both groups undergo a decline in the marginal payments received the decline is larger for the control group. The difference in the treatment includes the policy change where the flat per hectare payment has zero marginal effect. However the drop in overall marginal payments is less in the treatment group which reflects the relatively small impact of the coupled LFA payment in comparison to the other payments prior to the policy change.

Based on these results, (a decrease in marginal payments) we would expect farmers to adjust stocking rates accordingly.

The second stage of the Difference in Difference Analysis is to estimate the stocking rate decisions in both the baseline and the follow up periods between the two groups. Table 8 presents the Difference in Difference Estimation results for the stocking rate decision. We find that stocking rates did in fact decline in both the treatment and the control groups and the difference in difference between the baseline period and the follow up period in significant.

Farms in the control group reduced their stocking rates from 1.7 in the base line scenario to 1.5 in the follow up period whereas the treatment group there is almost no change. The results from these two estimations may however be subject to a simultaneity bias, that is did the marginal payments drop because the stocking rate fell or the other way around? To investigate how the behaviour of the two groups changed in the two time periods we carry out a difference in difference estimation of farmers who were operating in a strictly dominated region before and after the policy change. We identify these farmers as those who could increase subsidy income by decreasing their stocking rate. These farms operate in a range above the cut-off limit for an extensification payment the results of this estimation are presented in Table 9.

Table 8. Difference in difference Estimation Results for Stocking Rates

DIFFERENCE-IN-DIFFERENCES ESTIMATION RESULTS

Number of observations in the DIFF-IN-DIFF: 721

	Baseline	Follow-up
Control:	**217**	**160**
Treated:	**166**	**178**

Outcome var.	Stocking Rate	S.Err.	t	P>t
Baseline				
Control	1.734			
Treated	1.390			
Diff (T-C)	-0.345	0.055	-6.24	0.000***
Follow-up				
Control	1.560			
Treated	1.366			
Diff (T-C)	-0.194	0.059	-3.31	0.001***
Diff-in-Diff	0.150	0.081	1.86	0.063*

R-square: 0.08

* Means and Standard Errors are estimated by linear regression

**Inference: *** p<0.01; ** p<0.05; * p<0.1

Note. The stocking rate is calculated as per the specific guidelines attached to the subsidy schemes. The baseline period is 2000 (before the policy change) and the follow up period is 2003 (after the policy change). The control group are farms in Non Less favoured Areas with Soil Type 1 (best soil). The treatment group are farms in less favoured Areas with similar soil type.

Table 9. Difference in difference Estimation Results for Dominated Choice

DIFFERENCE-IN-DIFFERENCES ESTIMATION RESULTS

Number of observations in the DIFF-IN-DIFF: 488

	Baseline	**Follow-up**
Control:	**129**	**92**
Treated:	**129**	**138**

Outcome var.	**Strictly Dominated Region**	**S. Err.**	**t**	**P>t**
Baseline				
Control	0.444			
Treated	0.240			
Diff (T-C)	-0.204	0.057	-3.60	0.000***
Follow-up				
Control	0.295			
Treated	0.239			
Diff (T-C)	-0.056	0.061	-0.92	0.360
Diff-in-Diff	0.148	0.083	1.78	0.076*

R-square: 0.04

* Means and Standard Errors are estimated by linear regression

**Inference: *** p<0.01; ** p<0.05; * p<0.1

Note. The strictly dominated region is defined at a stocking rate where the payment received is less than the previous maximum payment. In this region farmers could increase income by reducing their stocking rate. This region is directly after the cut-off limit for extensification payments. Farms in this region operate a a higher than average stocking rate and as such would be considered progressive farmers. The baseline period is 2000 (before the policy change) and the follow up period is 2003 (after the policy change). The control group are farms in Non Less favoured Areas with Soil Type 1 (best soil). The treatment group are farms in less favoured Areas with similar soil type.

The results of the difference in difference estimation of farms in the control and treatment groups who were operating in a strictly dominated region show that in the baseline period 44% of the control group and 24% of the treatment group were operating in this suboptimal region. In the follow up period there is a 15% drop in the number of farms in the control group while there is no change in the treatment group. The decoupling of the LFA payments to farms in Less Favoured Areas has the effect of lessening the strong behavioural pressures associated with the non-linear nature of the coupled payments schemes. Table 10 presents the share of income on LFA farms with soil type 1 in both time periods (before and after a policy change) While the share of payments farmers receive changes little, approx. 1/3 of subsidy income on these farms originated through the LFA payments, the behavioural pressures which originate through coupled payments falls from 100% pre policy reform to approx. 70% after the decoupling of the LFA payments. Another way of looking at this might be that 30% of the income of farmers in LFA's is "safe" and this insurance effect insulated these farmers.

Table 10. Share of Total Direct Payments Coupled/Decoupled of Farms in Less Favoured Areas with Soil Type 1

year	**LFA Share**	**Coupled Payments Share**
1997	28%	72%
1998	23%	77%
1999	30%	70%
2000	27%	73%
2001	32%	68%

2002	30%	70%
2003	30%	70%
2004	34%	66%

Note: Farms in less favoured areas receive payments from two streams, a CAP reform payment coupled to production and a Disadvantaged Area Scheme (DAS) which became decoupled from production and paid on a per hectare basis with upper limit on the number of hectares. Table 10 shows the share of each payment in the overall subsidy income received.

The final analysis in this study is to investigate the determinants of operating in a strictly dominated region. Theory would suggest that there are three reasons for this type of behaviour. Firstly, the structural elasticities, both compensated and uncompensated elasticities, of stocking densities may be too low for farms to adapt to policy changes in a timely manner. Secondly, there may be optimization frictions in the system. These frictions may include such things as switching costs, information lags, and lack of policy literacy or natural biological lags at farm level. And thirdly, the decision may require an extensive response, which we do not address in this paper.

Table 8 presents the results of a logit regression where the dependent variable is "in a strictly dominated region". Results are presented for both the control group and the treatment group both before and after the policy change. Dominated Choice Previous year, Off Farm Employment and Teagasc Advisor are all dummy variables (1 = yes, 0 = no). The results show that being in a dominated region the previous year has a significant and positive effect on operating in a region of dominated choice in the current. This is clear evidence of frictions. Farm Size is significant in both groups but changes sign for farms in the control group. Larger farms were less likely to be in a region of strictly dominated choice in the second period which reflects a learning effect. Older farmers were less likely to be in the dominated choice region if they were in Non LFA and these farmers were less likely to have off farm employment.

Table 11. Determinants of Strictly Dominated Choice

Determinants of Strictly Dominated Choice				
	Non LFA (CONTROL)		LFA (TREATMENT)	
	1999	2004	1999	2004
	Dominated Choice	Dominated Choice	Dominated Choice	Dominated Choice
Dominated Choice Previous Year	1.268***	2.521***	0.237***	2.571***
	(0.04)	(0.05)	(0.06)	(0.05)
Farm Size	0.00389***	-0.00936***	0.00194*	0.00586***
	(0.00)	(0.00)	(0.00)	(0.00)
Off Farm Employment	-0.961***	-0.926***	1.082***	-0.397***
	(0.06)	(0.06)	(0.05)	(0.05)
Farmer Age	-0.0379***	-0.0195***	0.00147	0.0252***
	(0.00)	(0.00)	(0.00)	(0.00)
Teagasc Advisor	0.304***	0.0206	-0.415***	0.483***
	(0.04)	(0.05)	(0.05)	(0.05)
_cons	-0.0407	-0.0134	-2.097***	-3.892***
	(0.10)	(0.12)	(0.12)	(0.15)
N	19690	13399	19325	17934
R-sq				
pseudo R-sq	0.148	0.225	0.046	0.200
Standard errors in parentheses				
* p<0.10	** p<0.05	*** p<0.01		

Note: The table reports coefficients of Logit regression of a dummy for locating in a region above a notch (strictly dominated choice). This region is defined at a stocking rate where income is less than the previous maximum payment; hence farmers in this region could increase their subsidy income by lowering the stocking rate of the farm. The covariates are (i) dummy for strictly dominated choice the previous year (ii) Farm size Utilized Agricultural Area UAA in hectares. (iii) Dummy for off farm employment (iv) Farmer age in years (v) Dummy for availing of farm advisory services from Teagasc. Bottom rows show the number of observations and pseudo R-squared. Standard errors are shown in parenthesis and level of significance by stars.

5. Conclusions

The economic rationality of cattle farmers who continue to produce at a market loss in an era of decoupled payments has been called into question by many. The terms “non-profit maximisers” and “non-pecuniary benefits” oversimplify the problem. Farmers are not strictly business men with clear focus on profits or strictly consumers with a focus on utility. The question of what is rational is a combination of these two sometimes conflicting objectives. In this paper we have used a novel approach in which we can clearly identify behaviour which is neither profit nor utility maximizing by where a farm operated along a potential subsidy income non lineal budget constraint. The significance on the non linearities, which are policy induced, allows us to clearly identify this sub optimal behaviour.

The panel nature of the data further allows us to observe how this behaviour changes over time. The particular time period examined also allows for a unique opportunity to carry out a natural experiment where a partial decoupling of payments occurred for one group and not for the other.

Our hypothesis is that the decoupled LFA payments reduced the strong behavioural pressures associated with the CAP reform coupled payments. Farmers in Less Favoured Areas were somewhat insulated from the full effects of the income loss associated with non-maximization of the coupled subsidy payments. We find clear evidence to support this hypothesis. Where the full pressures associated with operating above the cut-off stocking rate for extensification payments remains intact more farmers adjusted their stocking rate decisions in a rational manner than farmers where payments consisted of both coupled and decoupled payments.

Focusing our attention on farms in the region of strictly dominated choice greatly reduces the overall problem since the full effect of the non-linear policy conditions only effect these farms. In general these farms operate at a higher than average stocking rate and as such might be considered better farms. The decisions they make in particular the different choices farmers make when a decoupled payment is introduced is similar to the decisions all farmers made when direct payments were fully decoupled in 2005. That is the reduction of stocking rates is less than expected.

With complicated policy measures and changing rules in a period when payments were coupled to production but where quota restrictions and upper payment limits restricted farmers, we find that farmers adapted and reacted to these behavioural pressures in a more rational manner than with decoupled payments.

The next stage in this research is to use evidence of bunching to uncover the structural elasticities on cattle farms which are an important factor associated with suboptimal decision making.

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