Modelling Inter-temporal Differential Returns to Agricultural and Forestry Land Use using the Forest Investment and Valuation Estimator (FIVE)

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Abstract

In this paper we examine the economics of the relative return to land use in Ireland when changing from an agricultural system to forestry. To do this we have developed a cost-benefit framework to model the inter-temporal costs and benefits of forestry planting decisions relative to alternative agricultural uses for different environmental and soil conditions. We equate forest productivity to agricultural soil categories and then generate agricultural gross margins for six farm enterprises on six soil types. Using a forest valuation estimator developed for this purpose, the gross margins are included as an opportunity cost in forestry income streams on comparable sites. The results show that forestry does not compete economically with dairy enterprises on any soil type, but that forestry is more profitable than cattle and sheep across all soil types, and particularly on less productive agricultural soils.

Keywords Forestry, Cost Benefit Analysis, Opportunity Cost, Soil Productivity

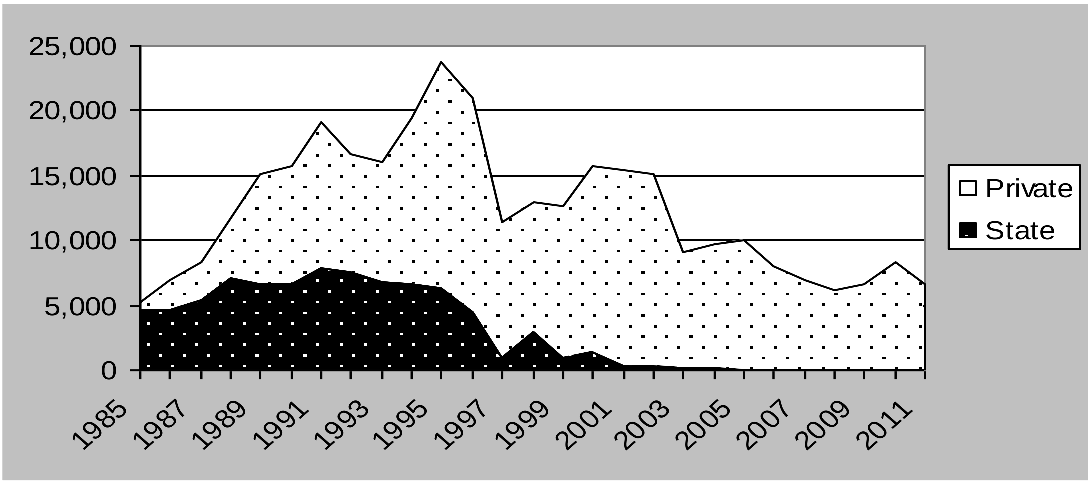
JEL code Q00 Agricultural and Natural Resource Economics

Background

The Strategic Plan for the Development of the Forestry Sector in Ireland (DAFF, 1996) set a target afforestation rate of 20,000 hectares per year from 2000 to 2030. This target was set in order to achieve a critical mass of timber production which would allow the developing forest sector to grow. Achieving this target would deliver an annual timber output of 10 million m3 and a total forest cover of 17% by 2030. However, since 2005, there has been a downward trend in the annual rate of afforestation. This has consequences for downstream timber processing and for the increasing demand for wood fibre for the renewable energy sector. It also has consequences for the level of carbon sequestered from Irish forests in the medium to long-term and the consequent potential to mitigate greenhouse gases generated by other sectors.

Afforestation in Ireland has been undertaken primarily by farmers since the early 1990's, which has resulted in over 53% of the current forest estate being privately owned. This figure is likely to increase in the future as state bodies are unlikely to engage in afforestation, so it is primarily the private estate which presents opportunities for expansion. Until the introduction of EU funded incentive schemes in 1989, virtually all afforestation was carried out by the Coillte, the state forestry board. By 2000, Coillte had virtually ceased afforestation. The impact of subsidies in the increasing rate of farmer afforestation is immediately apparent in Figure 1 as farmers became the dominant force in afforestation. From 5,242 hectares in 1985, afforestation reached a high of 23,710 ha in 1995 (Forest Service, 2012). However, it is also evident that the rate of farm afforestation changes significantly over time, as farmers respond to a variety of incentives and disincentives to afforest, including agricultural commodity prices, changes in the value of the forest premium payments, agricultural policy reforms and developments in land markets. Despite strong financial incentives in recent years, annual afforestation has been below 7,000 ha per year since 2006.

Figure 1: State and Private afforestation (ha) from 1985 to 2011



Source: Forest Service, DAFM

The reluctance of Irish farmers to afforest has been the focus of a number of published works, with Frawley and Leavy (2001) and McDonagh et al. (2010) both using farm surveys to identify farmers' primary motivations for not planting. Frawley and Leavy (2001) found that 88% of the farmers surveyed were not considering afforestation. McDonagh et al. (2010) found that for 48% of the farmers who stated that they would not plant, the most important barrier to planting land was that they needed all of their land for agriculture. Similar studies conducted by Watkins et al. (1996) in the UK also found that new policy instruments such as special farm woodland planting grants and regional forestry initiatives did not bring about any significant change in the general opposition of farmers to the conversion of agricultural land to woodland.

The recent "Food Harvest 2020" strategy published by the Department of Agriculture, Fisheries and Food (DAFF, 2010) has set dramatic growth targets for the agriculture, fisheries and forestry sectors. The strategy will present opportunities for many farmers who have the infrastructure and scope to increase productivity while maintaining efficient cost structures. However, the recent uncertainty surrounding CAP Reform and the Single Farm Payment (SFP) and the ongoing volatility in the prices of agricultural outputs and inputs, all suggest that Irish farmers are heading into a period of greater uncertainty and possibly more fluctuating farm incomes. Over the past 15 years, the incomes of many farmers were buoyed by off-farm employment and the one-off sale of land for development. However, the decline in the construction sector has reduced both of these sources of income for farm households (Hennessy et al. 2011). It remains to be seen whether or not the decline in the wider economy, and in particular the decline in the construction industry, will lead to a long-term reversal of current trends and an increase in the rate of farm afforestation. However, it is likely that given the increased uncertainty regarding the returns to traditional agriculture, changes in land use will receive greater consideration amongst Irish farmers. In this context, there is a need to assess the implications of converting land from agricultural to forestry production in the current economic climate.

Literature Review

Recent studies have added considerably to the literature on the economics of forestry in Ireland, however, there has been little work conducted to date on the subject of assessing the economic cost to farmers of deciding on a land use change from agriculture to forestry. The most comprehensive economic analysis of forestry in Ireland was undertaken by Clinch (1999) who carried out a Cost Benefit Analysis (CBA) to assess the magnitude of both timber and non-timber costs and benefits of afforestation in Ireland. Clinch did not take into account the opportunity cost involved in converting land from agricultural enterprises to forestry but he did state the need to address the question of whether forestry is a more viable prospect for farmers than an alternative land use.

In 2004, The Irish government commissioned a policy and strategy review for Irish forestry which was conducted by Peter Bacon and Associates (Bacon, 2004). The analysis was comprehensive and addressed the question of how best to incentivise farmers to undertake afforestation. The report cited a study which was subsequently published by Behan and McQuinn (2005). This study found that forestry returns would not be competitive with dairy enterprises and would only be marginally greater than tillage, but would be competitive with cattle and suckler enterprises in all regions of the country except in the south east, where they were similar. While the study did not consider the opportunity cost faced by farmers in forgoing income from existing farm enterprises when considering the decision to plant, it did however, include an estimate for the opportunity cost of labour which would have been necessary for agricultural production but is freed up as a result of planting. The most recent CBA of Forestry in

Ireland Barwise, (2009) considered an assessment of government support for afforestation. This study focused on the timber, carbon and recreation values of forests but did not address the land use change and opportunity cost issues. As part of a wider economic analysis of forestry, a study conducted by Bateman et al. (2005) was one of the first to examine a case study concerning woodland, agriculture and a CBA comparison of land use change between the two in Wales. Bateman's GIS approach was novel in that it allowed for the incorporation of biophysical data within the economic modelling of output values.

A survey of farmers in the west of Ireland analysed by Ní Dhubháin and Gardiner (1994) raised the issue of land quality as a factor in farmers' decisions on planting land. 39% of surveyed farmers said they would not plant as they felt their land was "too good for forestry". More recent studies of farmers who have already planted (Howley et al. 2012 and Upton et al. 2012) have shown that soil type is an important factor in land use decisions. This study adds to previous studies by creating a model which generates a cost benefit analysis of a land use change from agriculture to forestry which takes into account the current enterprise returns and the environmental conditions of farms.

Methodology

For the purpose of the analysis we assume that landowners make rational decisions when allocating their resources of land, labour and capital, to achieve the highest financial returns. In the case of making the decision to plant some of their agricultural land, we assume that farmers are unlikely to plant land which gives a higher return in another farm enterprise. The length of the forestry rotation must also be taken into consideration as farmers who plant are essentially making an inter-temporal choice by electing to have their land and capital tied up for perhaps a forty year period, versus achieving an agricultural return on an annual basis. This paper employs a cost benefit analysis (CBA) to generate cost and revenue streams for six agricultural systems on six soil types and for four conifer forest productivity options, for the period 1995 to 2009. There are a number of components of income that must be considered in the analysis. The FIVE is used to generate forestry income streams on the basis of planting 80% Sitka spruce (Picea sitchensis (Bong.) Carr.) and 20% Japanese larch (Larix kaempferi

(Lamb.) Carr.) on comparable soil types to the existing farm systems. Agricultural income streams are generated from a panel dataset of Teagasc National Farm Survey data, collected between 1995 and 2009. The income streams consist of market gross margins from the different agricultural systems practiced in Ireland based on farm soil type. These income streams are used to generate an opportunity cost for loss of agricultural income when deciding to plant. The agricultural gross margins foregone as opportunity costs are then incorporated into FIVE as a cost. The net present value (NPV) of the land use change is generated using FIVE to allow for the comparison of net revenue streams in today's money, assuming the same or broadly similar investment periods (Varian, 2010). The income streams with higher net present values give the best financial return.

Estimating the returns to forestry

Economic models or forest investment calculators are used by forest extension and investment professionals in many countries (Australia, New Zealand, US, UK,) to assess the rate of return on different species and management options. Most models focus specifically on forestry rates of return. In countries such as Australia and New Zealand where there is a large percentage of the forest cover in farm ownership, some of the economic models include an opportunity cost for the income foregone on the planted land. However, the growth rate of Irish forests and the opportunity cost of farm income foregone are different in Ireland, thus necessitating different modelling approaches to those employed in other countries.

FIVE (Forest Investment Valuation Estimator)

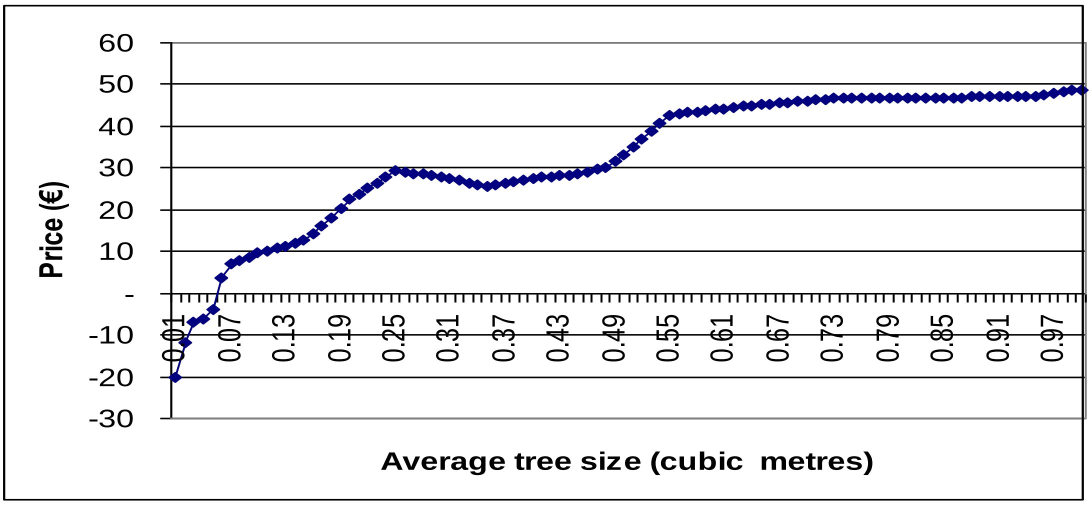
In order to provide a sound framework within which the farm forestry decision can be analysed, there was a need to develop an economic model which would reflect the costs, revenues and growth rates specific to Irish farm afforestation conditions. To this end, the FIVE (Forestry Investment and Valuation Estimator) has been developed incrementally on an Excel platform over a number of years. Up until recently, the FIVE has been used to generate forestry revenue and cost streams only. The developments described in this paper bring new flexibility to the model as it allows us to include agricultural incomes on typical farm enterprises and on typical soil types, in the model as an opportunity cost for undertaking afforestation. The FIVE is essentially used to generate a cost benefit analysis (CBA) albeit of a limited scope of the planting decision for farmers in six different farm systems and on six different soil types. Future cost and revenue streams are generated and discounted back to present day values and presented as net present values (NPV's).

The growth rate or productivity of forest crops is a function primarily of soil type, age and species and is measured as Yield Class (YC) i.e. a stand of YC 18 is capable of producing an average of 18 m3 timber volume ha-1 year-1 over a rotation length of maximum mean annual increment (MMAI). The higher the yield class, the higher the volume production per hectare of the forest. Afforestation in Ireland is only granted aided on sites which are capable of producing yield class 14 Sitka spruce and above. A spatial model developed by Farrelly et al. (2011) predicted that 73% or 5.103 million ha of the total land area in Ireland was capable of producing Sitka spruce growth of yield class 14 or greater. Furthermore, 62% of the total land area could potentially result in GYC 20 or higher. The results of the analysis indicated that significant potential exists for forestry development on land which is marginal for agriculture.

Since its inception in 1919, the Forestry Commission in Britain has collected data quantifying the characteristics of plantations growing in different yield classes. These 'yield models' are based on actual stand growth data from British forests and have been collated across varying species and management regimes (Edwards and Christie, 1981). The models show, for each species and yield class, how tree volume increases over time. These yield models are widely used in Ireland, however, they may not fully predict the higher than expected growth rates in farm forests on productive soils as suggested by Farrelly et al. (2011). In order to accommodate the higher productivity of some forest sites, higher Yield Classes (24 to 30) have been imputed using the Matthews et al. (2009) growth models and are included in the FIVE. It must be noted however, that the higher Yield Classes should be used with caution as the growth data have not yet been verified using field data.

In order to forecast volume production, the following information must be inputted into FIVE for each forest: species, age, yield class, stocking and proposed rotation length and thinning treatments. The volume estimates are for one hectare. The expected volume at each thinning and at clearfell can be read from the yield model. Models have also been developed for un-thinned stands. The predicted thinning and felling volumes can be apportioned into volumes of large timber to stated top diameters, and volumes of smaller timber by using the stand assortment tables provided by Matthews and Mackie (2006). The FIVE calculates the economic value of the timber produced by plotting timber price (€/m3) against tree size (volume of mean tree in m3) to construct a price-size curve which gives the value per cubic metre expressed in euro of standing timber of a stated mean tree diameter or mean volume.

Figure 2: 10 year conifer average price size curve



Since the 1990's, Coillte (Irish State Forestry Board) has published conifer standing prices in a range of size categories on a regular basis. FIVE presents historic averaged prices for 10, 5 and 3 years. The historic prices are deflated to the relevant year using the Consumer Price Index (CPI) (CSO, 2012) before being averaged. The revenue stream for each harvesting operation is simply the timber volume, once appropriate deductions for harvest loss and stocking have been made, multiplied by the price. The yield models (Edwards & Christie, 1981 and Matthews et al 2009) provide the volume of timber removed in the thinning and harvesting operations and the value of the mean tree is provided by the price-size curve. These revenue streams are then discounted to give their present value.

Key outputs from FIVE include Net Present Value (NPV), Total Revenue and Total Costs. Discussions with extension staff and previous experience with farmers interested in forestry indicate that many farmers are more comfortable when costs and returns are presented in the timeframe in which they occur as opposed to the standard forestry financial measures such as NPV which discount the costs and revenues that occur during the rotation to present day value. For this reason, the model generates an Annual Equivalent value and a graphic display of cash-flow estimates.

Testing of the model was undertaken in consultation with colleagues involved in both forestry research and forestry extension. The model was presented at a number of in-service training sessions with forestry extension specialists and is used extensively in farm forestry investment clinics with farmers interested in planting forests. The model is also used by researchers working in the area of forest economics.

Generation of Forestry Income Stream

The FIVE can generate income streams for forests ranging from YC 14 to YC 30. Coillte report the average YC for Sitka spruce in their forests as 17 but Farrelly, (2010) reports the average YC for Sitka spruce 0n farm forests, planted on better quality soils, to be 22. Income streams are generated for Sitka spruce for the four yield classes, 14, 18, 20 and 22. "Normal" thinning i.e. thinning at marginal thinning age and to marginal thinning intensity according to Edwards and Christie (1981) is assumed. The discount rate employed is 5%, which is the standard rate applied to forest investments in Ireland (Clinch, 1999). This analysis calculates the returns for one forest rotation only. The cost of replanting the forest after clear-fell is included in the calculations as replanting is a legal obligation to replant (Forestry Act, 1946). A number of other cost and revenue assumptions are included in FIVE. These are listed below and were arrived at in consultation with forestry extension colleagues.

Table 1: Key FIVE input parameters

Costs	Assumptions
Forest Establishment	costs fully covered by Afforestation Grant
Forest management costs	as advised by Teagasc forestry advisers allocated to a particular year or recurring for a number of years includes brash paths, annual management costs, insurance management costs held constant over time for each income stream

Harvesting losses	% timber revenue loss included for thinning and clearfell
Revenues	
Forest premium	historical farmer rate premium – (equivalent to Grant and Premium Class (GPC) 3) from 1995 to 2009
Timber volume	volume for Sitka spruce, - dependent on yield class and rotation length (financially optimum rotations for each YC assumed - from 38 to 44 years)
Timber prices	10 year Coillte average timber prices from standing sales – deflated using CPI

Generation of Agricultural Income Stream

Teagasc's National Farm Survey (NFS) collects detailed information from a sample of approximately 1,200 farms in Ireland annually. These data form part of the EU Farm Accountancy Data Network (FADN). The surveyed farms are nationally representative of the size and systems of the national farm population. Data are collected on six farm systems: dairy; dairy other; tillage; cattle; cattle other and sheep. We utilise a Teagasc NFS panel dataset from 1995 to 2009 to calculate market gross margin per hectare. Market gross margin is defined as gross output minus direct costs. The measures are reported at the farm level as opposed to the enterprise level. The assumption therefore is that a farmer entering forestry would reduce average land use equally across all their enterprises, rather than selecting their lowest gross margin enterprise. In order to capture the inter-temporal nature of the decision to change from an agricultural system with annual returns to a 40 year forestry crop, farm gross margins are inputted as an annual cost in FIVE and are included for each year of the relevant forest rotation.

The farm gross margin excludes subsidies, even prior to decoupling when subsidies were coupled to production. In general terms, agricultural subsidies were historically paid on the basis of livestock numbers or on the area farmed, and were not paid on afforested land. For the purpose of this analysis it is presumed that a farmer entering forestry prior to the introduction of Single Farm Payment (SFP) in 2005 would only have considered forestry if he was farming extensively and had scope to carry existing livestock numbers on less land, thereby not suffering a significant loss in subsidies which were based on animal numbers. Farmers planting since 2000 were able to consolidate their single farm payment entitlements and since 2008 forest crops are eligible for SFP, so farmers who planted didn't lose out on SFP. The Disadvantaged Area Scheme (DAS) was based on the area of land farmed up to a maximum threshold. Once farmers didn't drop below the area threshold, planting some land would not have negatively affected their payment. However, farmers in REPS (Rural Environment Protection Scheme) who planted some of their land would have lost REPS payments on that land. Larger REPS farmers would have been more likely to plant as the REPS payment decreased as agricultural area increased, so larger farmers would stand to lose a smaller proportion of the REPS payment. The possible loss of REPS however, was considered to be a factor in the reluctance of many farmers to plant (Breen et al. 2010). It is recognised that the exclusion of subsidies and direct payments is a limitation of this study, but their inclusion is beyond the scope of this paper.

Relative productivity of agricultural and forest enterprises

Soil type is a determining factor for both agricultural and forest productivity. The Teagasc NFS also collects data on farm soil type which essentially describes the range of use or limitations of one of six soil types. These soil types are based on the General Soil Map of Ireland which classified soils into the 41 soil associations described by Gardiner and Radford (1980). Using the General Soil Map classification, Farrelly (2011) generated forest productivity (yield class) estimates for Sitka spruce in Ireland across a range of soil types. A spatial model was used to map the potential productivity of Sitka spruce throughout Ireland in a Geographical Information System (GIS). This model predicted that 73% or 5.103 million ha of the total land area in Ireland was capable of producing Sitka spruce growth of yield class 14 or greater. Furthermore, 62% of the total land area could potentially result in GYC 20 or higher yields. The results of the analysis indicated that significant potential exists for forestry development on marginal agricultural land. These estimates were then assigned to each farm soil category as detailed in Table 2. This information enabled us to use FIVE to calculate net present values for the afforestation of previous agricultural land, while taking into account both the financial and physical productivity of the former land use as an opportunity cost. In financial terms, a project is deemed to be worthwhile if it generates a positive NPV at the proposed hurdle discount rate.

Table 2: Forest yield class estimates for NFS soil types

Soil Class		Soil type	SS Yield class
1	Wide	No limitations	24
2	Moderately wide	Minor limitations	24
3	Somewhat limited	Higher elevations, heavier, poorer structure	20
4	Limited	Poor drainage	20
5	Very limited	Agricultural potential greatly restricted	18
6	Extremely limited	Mountainous, steep slopes, shallow soil	14

Results

The average NPV's per hectare from 1995 to 2009 (adjusted using the CPI) are presented by system and soil category in Table 3. It must be borne in mind that while the NFS is nationally representative by farm system, the sample is not representative in terms of soil type. The figures are also limited by the smaller NFS sample sizes in the more limited soil categories – hence the missing values.

Table 3: Average NPV's by farm system and soil category 1995 to 2009

System	**SC1/ YC24**	**SC2/ YC24**	**SC3/ YC20**	**SC4/ YC20**	**SC5/ YC18**	**SC6/ YC14**
Dairy	-19603.1	-27229.6	-18380.6	-14572.3	-9189.15	-9167.08
Dairy other	-8005.36	-4723.01	-4302.55	-4198.11	1155.87	5573.65
Tillage	-1951.58	-5392.43	-5211.61	554.49	2322.32	-
Cattle	2244.23	3134.88	3117.51	4206.74	4410.44	3688.2
Cattle other	2248.18	3190.45	3038.65	4170.8	3140.55	4192.14
Sheep	1052.99	2244.17	2880.49	3405.87	5426.76	3765.59

As these figures represent averages, we should focus on the underlying trends rather than the absolute values. It is clear that for all soil categories, the NPV of changing from dairy to forestry is negative and that the magnitude of the negative NPV increases as soil type improves. The NPV of a change in land use from dairy other and tillage is also negative for the better soil categories, but becomes positive at yield class 18 for dairy other farm systems and yield class 20 for tillage. The largest returns arise where forestry replaces cattle systems on land that is limited for agriculture due to poor drainage and where sheep systems are replaced on land that is very limited from an agricultural perspective but is productive under forestry. These figures are not surprising in that they concur with previous studies by Breen et al. (2010), Howley et al. (2012) and Upton et al. (2012).

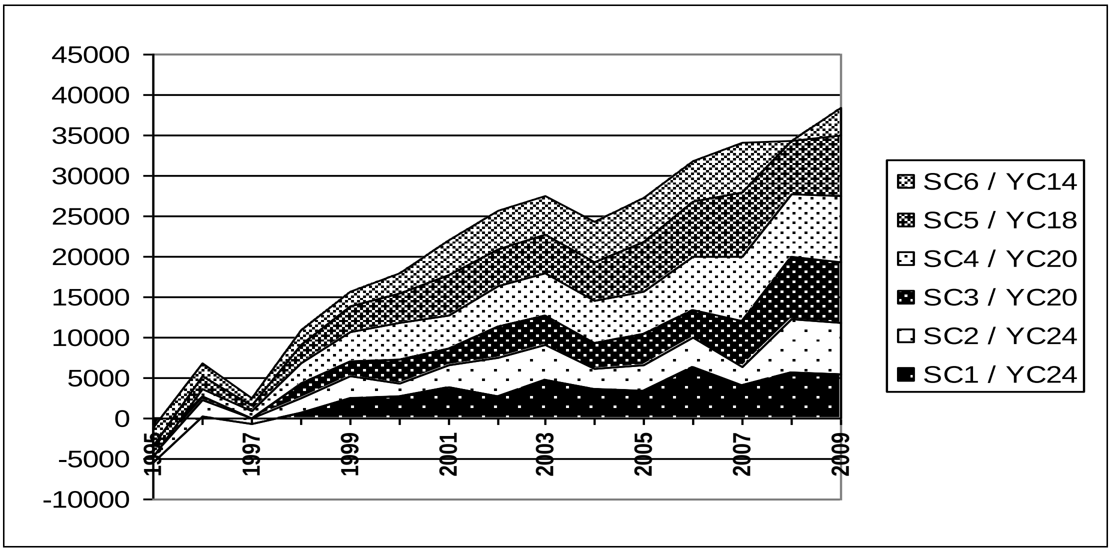
The figures presented in Table 3 refer to average NPV's across the time period 1995 to 2009 and as such, do not give any insight into inter-temporal trends. Table 4 presents the NPV's of changing from a cattle system to forestry for each year of the period 1995 to 2009 and shows definite upward trends in NPV across all soil categories, which suggests that forestry has become more competitive with cattle over time. The prices included in the NPV calculations above are expressed in terms of the relevant year. In order to correct for the effects of inflation, the prices are adjusted using the CPI and presented in graphic format in Figure 3.

Table 4: Cattle to Forestry NPV's over time

Year	SC1 / YC24	SC2 / YC24	SC3 / YC20	SC4 / YC20	SC5 / YC18	SC6 / YC14
1995	*-5951.88*	823.77	1746.78	*-1913.8*	1583.42	2428.4
1996	224.25	2151.98	434.9	1190.33	1544.14	1696.4
1997	*-824.47*	905.09	*-166.52*	1036.44	636.01	1020.69
1998	687.5	2008.75	1747.57	2690.44	2396.22	1880.59
1999	2505.9	2731.59	1877.5	3635.38	3381.65	1775.26
2000	2668.12	1596.37	3078.99	4386.08	3627.97	2706.78
2001	3645.31	2689.74	1984.75	3820.18	4789.08	4058.81
2002	2493.59	4378.82	3476.24	4523.75	4217.37	4365.89
2003	4165.34	3829.17	3199.59	4701.24	4101.66	4144.82
2004	3111.04	2262.78	2645.98	4465.28	4106.42	4286.62
2005	2806.9	2823.6	3149.88	4397.68	5253.35	4455.92
2006	5118.56	3060.4	2585.88	5382.86	5519.99	4026.66
2007	3226.53	1679.1	4389.42	6144.92	6061.81	
2008	4204.46	4965.94	5730.24	5594.57	4983.56	4763.73
2009	4223.49	4941.95	5860.09	6289.7	5869.36	2563.77

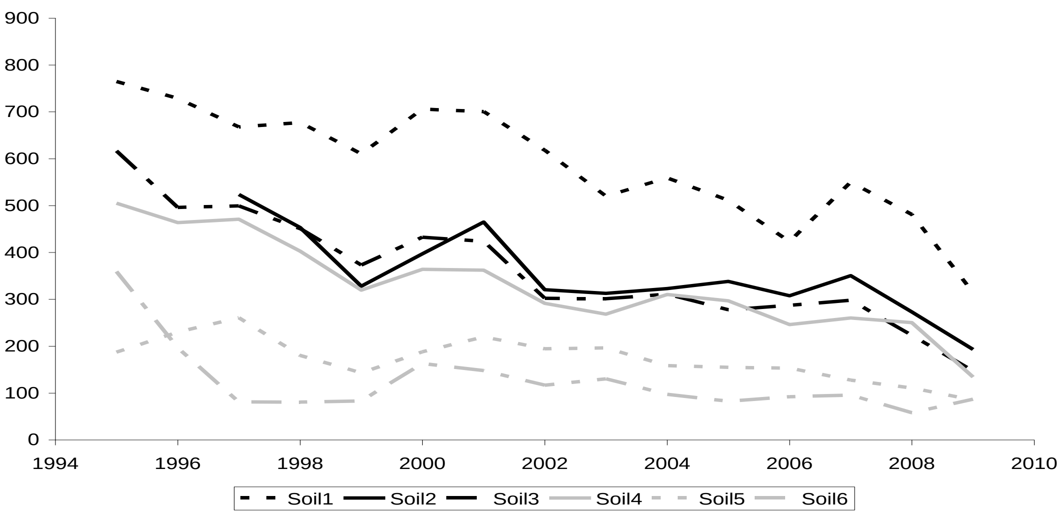
While there is some fluctuation when the figures are presented in real terms, there is still a strong upward trend in the forestry to cattle NPV's. This seems counter-intuitive in light of the declining afforestation rates, particularly in the latter part of the period.

Figure 3: Trends in Cattle to Forestry NPV's over time[1]



The methodology employed in this paper also allows us to dig deeper to look at real trends over time in the various components that make up the agricultural and forestry incomes; namely, agricultural gross margins, timber prices and forest premium payments. When the agricultural gross margins across all farm enterprises are expressed in real terms[1] (Figure 4), there is a strong downward trend over the period 1995 to 2009.

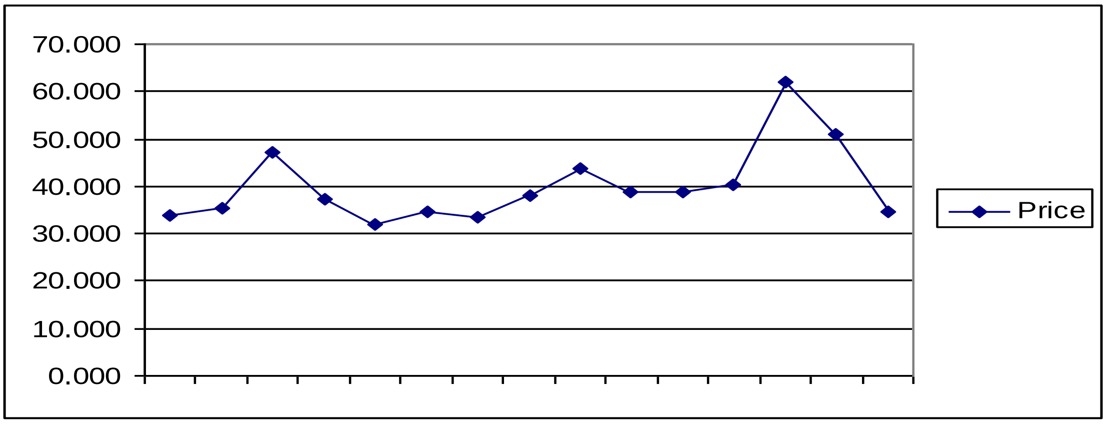
Figure 4: Trends in real agricultural gross margins over time



[1] adjusted to 2000 using CPI

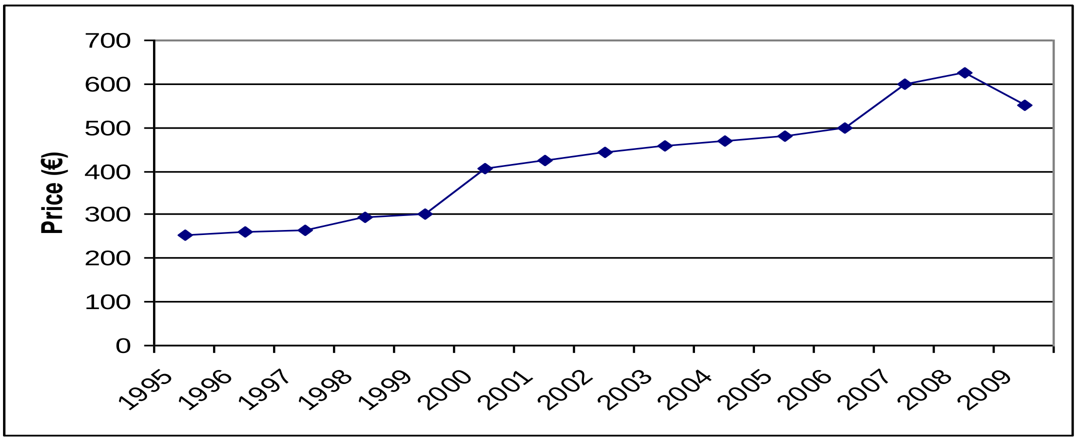
Timber prices, on the other hand appear to reflect the economic situation as prices increased dramatically at the height of the construction boom and dropped back equally dramatically once the country went into recession (Figure 5).

Figure 5: Real average timber prices 1995 to 2009[2]



Conversely, when the annual forest premiums for the period are expressed in real terms (Figure 6), there is a strong upward trend until the premium was reduced in an annual [2]budget in 2009. The results give us an insight as to the relative returns involved in a land use change from agricultural land uses to forestry, taking farm system and soil type into account. In assessing the individual components of the NPV's, the only component which has risen over time is the rate of forest premium payment, whereas agricultural gross margins having been falling and average timber prices have remained steady over the period. The results also indicate that forestry is an attractive option for cattle and sheep farmers, which has become more attractive year on year.

Figure 6: Forest premium payments expressed in real terms 1995 to 2009[2]



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[2] adjusted to 2000 using CPI

The Teagasc NFS data are not representative of farms when looking at the soil type of the systems, therefore it is not possible to identify the proportion of the farming population or the land area of land in Ireland that would financially benefit from converting to forestry from these results. However the results demonstrate the importance of soil type and agricultural system in understanding the financial outcome of land conversion.

Conclusion

In Ireland, the agricultural and forestry sectors have ambitious policy driven targets. In terms of achieving the forestry targets, this study shows that most cattle and sheep farmers on marginal soils would stand to gain financially by planting land. Within the Food Harvest 2020 framework, the targeted increase in dairy production will necessitate expansion by many farmers. However, targets set for other agricultural sectors are value rather than volume targets and may not require farmers to expand their land base. This paper confirms that a change in land use to forestry is not a financially beneficial option for dairy farmers or for tillage and dairy other farmers on better soils. Given the high potential productivity of marginal land for forestry, it is likely that the Food Harvest 2020 growth targets could be met without conflicting with the growth targets for the Irish forestry sector.

The results of this study pose a conundrum: why is the afforestation rate declining if forestry is a more financially attractive option for many farmers? In theory, we expect farmers to behave rationally by maximising their profits, however, this does not appear to be the case here. The results of this study are based on average NPV's across all farms in the NFS, however there is considerable variation between farms and between farm owners. In order to understand the economic motivations fully, further investigation at farm level is required to analyse the environmental and economic characteristics of individual farms. The reluctance of some farmers to plant also needs to be addressed. Ideally, further studies are needed to analyse the motivation to plant from the perspective of the financial and environmental characteristics of the individual farm interacted with the behavioural characteristics of the farm owner.

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