# The potential impact of differential taxation and social protection measures on farm afforestation decisions

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**Abstract**

The question of what motivates decisions to change land use or farm management practices has recently received much attention in the context of designing policies to incentivise change. This paper critically analyses aspects of the prevailing incentive policies for farm afforestation, with a view to identifying how different components of income influence the uptake of afforestation. Previous analyses have focused on the role of market income and subsidies in farm income. This paper additionally examines the impact of fiscal instruments on disposable income. The analysis finds that from a household welfare perspective, the inclusion of benefits and taxation in calculating relative life-cycle incomes from forestry and agriculture, provides additional information relevant to the farm afforestation decision. From the policy makers perspective, this analysis illustrates the re-distributive nature of the Irish tax/benefits system as benefits can be very significant at the bottom of the income distribution whereas taxation narrows the gap at the top of the distribution. The analysis shows that even if the level of disposable income is higher for agriculture on more intensive farms, the use of a disposable income measure in analysing the returns from farm afforestation, provides valuable insights in relation to how financial policy levers impact on different farm systems with different levels of farming intensity. At the lower end of the distribution, the analysis shows that low-income farms could acually be slightly worse-off as a result of planting. Further research is required to estimate "cut" points at which changes in taxation or benefit thresholds and increased level of uptake of benefits, could bring about a gain from the inclusion of forestry in overall farm income.

**Keywords:** *Farm afforestation, disposable income, market, subsidy income.*

## Introduction

The question of what motivates decisions to change land use or farm management practices is a complex one which has recently received much attention in the context of designing policies to incentivise change. Examples of recent policy objectives include the protection of water quality and biodiversity, while the issue of climate change is particularly topical in relation to the mitigation of agricultural greenhouse gas (GHG) emissions through the introduction of new technologies and changes

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in land use and farmer behaviour (UN 2016). With ambitious targets to increase agricultural production in Ireland (DAFM 2015a), the GHG mitigation potential of afforestation and forest products is an important component of the climate change mitigation tool-box.

However, afforestation targets across Europe are not being met (EC 2013[1]). Despite a number of increases in the level of forest subsidies over the last 20 years, annual afforestation in Ireland is failing to reach government targets. In the context of changing land use from agriculture to forest (afforestation), this paper uses Ireland as a case study to critically analyse aspects of the prevailing policies which attempt to incentivise farm afforestation, with a view to identifying how different financial instruments influence the uptake of afforestation. There is already extensive literature on farm-level modelling which focuses on farm subsidies (see Ahearn et al. 1985, Keeney 2000, Bhaskar and Beghin 2009). Other quantitative studies in the literature focus only on gross income, which is a combination of market income and subsidies. However, net income should also be considered as tax incentives can be quite important in relation to the determination of disposable income in farm-level decision making (Andersen et al. 2002, Hill and Cahill 2007).

In reality, when an incentive is offered, for example as a subsidy for afforestation, the wider household is affected and other income-related instruments may have implications for the farm family. For instance, in Ireland there are means-tested financial instruments for working-age farm families (Farm Assist) and (non-contributory) pensions for retirement-age farmers. In most European countries the family-farm model is the predominant form of ownership, therefore in looking at the overall incentives available to a farm family considering afforestation, the decision is in fact more complex than has been previously considered in the literature, as the fiscal measures (taxation and social welfare benefits) apply differentially to forestry and agriculture.

In this study, these wider agricultural and forestry income sources are incorporated at micro (farm) level, drawing primarily on research in middle income countries (Xu et al. 2012, Zhong et al. 2012, Lewis et al. 1988). The study focusses on the farm afforestation decision and does not consider institutional or non-farmer afforestation. However, as most of the land suitable for afforestation is in agricultural use, the same opportunity costs and constraints in relation to access to land for planting are likely to apply to non-farmers.

As in the case of other small or medium-sized enterprises, modelling farm taxation poses a challenge in relation to the data necessary for the calculation (Buslei et al.

[1] European Commission. 2013. Forest Europe. Ministerial Conferences. Available at https://www.google.ie/search?hl=en&q=European+Commission+2013.+Ministerial+Confererences+www_foresteurope_org+2011&meta=&gws_rd=ssl [Accessed July 2017].

2014). Household surveys typically only incorporate aggregated self-employment income, while farm surveys incorporate detailed farm expenditure but do not include taxation. To understand the impact of tax incentives on farmer behavour, a hypothetical microsimulation model of agricultural and forestry taxation was developed, utilising a framework similar to that used in benchmarking studies such as the International Farm Comparison Network (IFCN) (Hemme et al. 2000).

To date the role of fiscal incentives/disincentives in the farm afforestation decision has not been examined in any great detail. The theoretical framework section examines the elements of disposable income that could have a financial impact on the land-use change from agriculture to forestry. The methodological section develops a microsimulation framework to model the differential tax regimes of agriculture and forestry on stylised, hypothetical farms, while the data section describes the farm and forest datasets and the relevant tax schedules required for the modelling process.

*Theoretical framework*

A range of studies (McKillop and Kula 1988, duQuesne 1993, Collier et al. 2002, Behan 2002, McCarthy et al. 2003, Breen et al. 2010, Upton et al. 2013, Ryan et al. 2014a) has found that the rate of afforestation in Ireland is sensitive to both agricultural and forest incomes. From an economic perspective, farmers are assumed to be utility-maximisers and while the permanent nature of the afforestation land-use change (and other associated lifestyle or cultural factors) may pose barriers to the uptake of afforestation, previous research has shown that financial drivers are significant in the planting decision (Ryan and O'Donoghue 2016a). In addition, soil type is one of the primary determinants of both agricultural and forest market incomes. In the case of the farm afforestation decision, where planted land is no longer available for agriculture, it is important to take both market and subsidy returns from both land uses into account. However, previous studies consider only gross income from market transactions and/or subsidies. This paper suggests that analysis of total net income, i.e. disposable income (available to farmers at a given point in time), could provide better information to individuals (farmers) considering a land use change from agriculture to forestry. Otherwise it is suggested that comparing agricultural and forest incomes without including such relevant information is akin to "comparing apples and oranges". The range of parameters affecting farm disposable income is shown in Equation 1.

$$Disposable\ income = \big((market\ income + subsidies + benefits) - (taxation + charges)\big) \qquad [1]$$

Thus in order to examine the financial implications for a farm owner considering afforestation, the individual components that make up farm disposable income need to be examined in more detail. These include:

- agricultural subsidies and market income;
- forest subsidies and long-term market income;
- taxation and social welfare provisions in relation to both agriculture and forestry.

Agricultural market income and subsidies

In planting some of their land, farmers forego the agricultural income they would have received from that land if it remained in agriculture. In a recent study, Ryan and O'Donoghue (2016b) show that the highest opportunity costs were incurred by farmers using intensive farm systems, with higher gross incomes on good soils (for example dairy and tillage farms). However, farmers engaged in livestock enterprises benefited most from converting land use forestry. The analysis also showed that larger farms were more likely to afforest land. While the dominant enterprise or system on a farm can have a large effect on market income, the primary physical factor that determines the per-ha market income on farms is soil quality, which affects productivity and livestock carrying capacity[2]. Cattle farms were focussed on primarily in this analysis, as based on the work of Ryan and O'Donoghue (op. cit.) they are the most likely to afforest their land. However, the effect of taxation on higher-earning dairy farms was also examined in the context of afforestation.

Soil type affects stocking rate on farms and thus indirectly affects the level of animal-based subsidies. However, since the decoupling of payments from production in 2004, subsidies are now paid on a per-ha basis, regardless of production. Of the limited studies that include agricultural opportunity costs in the calculation of the economic return from planting land, the majority of calculations are undertaken on a per-ha basis (see Herbohn et al. 2009, Bateman et al. 2005), facilitating comparison between agricultural and forest incomes. Agricultural economic studies use different methodologies to calculate farm returns, depending on the objectives. For the analysis in this study both market and subsidy components of farm income needed to be included. As afforestation generally only occurs on up to 10% of farm land area (Ryan 2016), it was assumed that farms only planted a portion of their land and continued in their main farming enterprise. Thus they continue to incur costs such as overheads (e.g. building repayments) which should be taken into account in calculating returns over a long time period.

Family Farm Income (FFI) is the principal measure derived using Teagasc National Farm Survey (NFS) data to reflect farm income. FFI represents the return from farming to the owners from labour, land and capital. It does not include non-agricultural income

[2] Elevation, slope, access and farmer characteristics (ability and education) also impact on output, but were beyond the scope of this study.

but takes subsidies (Less Favoured Areas (LFA) payments and Basic Payment Scheme (BPS[3])) and overhead costs into account. For clarity, this analysis did not include agri-environment payments which are difficult to model as they are based on environmental actions undertaken and therefore include compliance costs.

$$FFI = (gross\ output + subsidies) - (total\ costs) \qquad [2]$$

where total costs include direct costs (DC) and overhead costs (OC).

Forest market income and subsidies

The international literature concerning forest economics focuses largely on deforestation or management decisions in pre-existing forests, but to a much smaller degree on the calculation or forecasting of the economic return from young or unplanted forest. The factors that need to be taken into account in estimating forest market income include soil type (which is a strong determinant of productivity and is often expressed as yield class[4] (YC) in Ireland and the UK), species, costs incurred in establishing and maintaining forests, timber prices and costs associated with thinning and final harvesting. Growth and YCs for different tree species are determined by factors such as genetic material, soil type, elevation, drainage and vegetation. Forest market return is calculated as the timber volume (in cubic metres ($m^3$) per ha) by timber assortment, multiplied by the timber assortment price (€ $m^{-3}$). Forest growth and yield models in combination with average timber prices can thus provide aggregate forecasts of timber yield and value by species, spacing and thinning regime.

There are two main subsidies available for forestry. Afforestation grants cover the cost of new forest establishment on previously agricultural land, and annual subsidy (forest premium) payments compensate for agricultural income foregone until forests can provide income in the form of thinnings[5]. Forest market and subsidy returns can be expressed as:

$$I_{for} = S_{for} - (C_{mgt} + C_{mtc}) + (V_{tim} \times P_{tim}) \qquad [3]$$

where $I_{for}$ is forestry income, $S_{for}$ is annual forestry subsidies, $C_{mgt}$ and $C_{mtc}$ are forest management and maintenance costs, $V_{tim}$ is timber volume ($m^3$ $ha^{-1}$) and $P_{tim}$ is timber price (€ $m^{-3}$).

Farm household income

The NFS does not contain data on the level of off-farm income for a farm family but

[3] BPS is payable on eligible agricultural and forest areas and is liable for income tax.

[4] Yield class (YC) is an estimate of the potential productivity of forest sites (maxium mean average annual volume production per ha). Typically, YC of Irish Sitka spruce plantations ranges from 14-24 $m^3$ $ha^{-1}$ $y^{-1}$.

[5] Harvesting of smaller trees to allow remaining trees to reach larger sizes. The timing of first thinning is determined by productivity, but generally occurs between years 15-20.

houshehold income is an important aspect of this analysis, thus a measure of typical off-farm/part-time income needs to be included in the analysis.

Taxation incentives

Ireland's system of taxation is progressive, and aims to be re-distributive. This means that as an individual's income rises above certain thresholds, the average tax rate increases, so that changes in income taxation generally have a greater impact on those individuals with higher incomes. Thus in theory, when changes are introduced that increase farm income, for example, the relative benefit for wealthier farms is smaller. Conversely, if farm income decreases, taxation should reduce more for less wealthy farms. It is quite important therefore from a social perspective, to understand the distributional impacts of taxation changes.

In general, there are two types of taxes or charges – income taxation and capital charges/taxation. In this paper only income taxation instruments that affect agriculture and forestry were focussed on, namely:

- Income Tax;
- Pay Related Social Insurance (PRSI);
- Universal Social Charge (USC), which is an income levy payable on gross income.

Agricultural income is liable for all of the above taxes. Income tax is payable on net income while PRSI and USC are payable on gross income. In order to model the impact of benefits and charges on disposable income at farm level, a number of transfer instruments were incorporated, including:

- Farm Assist - means-tested benefit;
- State Pensions - non-contributory means-tested old-age pension.

Means testing

Agricultural and forest income sources are treated differently in relation to means-tested Farm Assist (a payment available to low income farmers) and old-age pensions. The Farm Assist means-test takes account of virtually every form of income but assesses it in different ways and disregards various amounts. Until recently, 100% of forest premium income was liable for Farm Assist, however, payments for agri-environment schemes have historically enjoyed disregards of up to 50%[6]. In March 2017, a 30% disregard for income from agricultural husbandry (including forestry) was introduced (DESPa[7]). In relation to eligibility for non-contributory old-age pensions, net income

[6] First €2,540 of Agri-Environment Payments and 50% of the balance is disregarded. DESP (Department of Employment Affairs and Social Protection). See Farm Assist: Part 2 Entitlement (REPS, SACs and GLAS). Available at http://www.welfare.ie/en/Pages/Farm-Assist.aspx [Accessed April 2017].

[7] DESP (Department of Employment Affairs and Social Protection). See Farm Assist: Part 2 – Farm Inocme or other employment. Available at http://www.welfare.ie/en/Pages/Farm-Assist.aspx [Accessed April 2017].

from farming or leasing is fully assessed with no disregards (DESPb[8]). Net income is calculated by deducting expenses incurred from gross income. Payments under the Farm Retirement Scheme are not taken into account. However, the full value of forest premium payments is taken into account in the means calculation so the pension amount could potentially be reduced or a farmer could be rendered ineligible for a non-contributory pension.

Differential income tax treatment of forest profits

Profits from forests were historically not liable for income tax as the occupation of woodlands for commercial purposes was exempt from income tax. Within the sector this is considered a necessary incentive to overcome the long period of time before significant monetary returns are achieved from forests. However in 2007, Section 17 of the Finance Act (2006) introduced a limit on "specified reliefs" by "high income earners". These specified reliefs included previously exempt income from the occupation of woodlands. Initially, the provision applied to total income in excess of €250,000 in the tax years 2007 to 2010, (whereby the specified relief was limited to 50% of "adjusted income"), before being reduced to €110,000 for tax years 2011 to 2015, and abolished from 2016 onwards. While restricted reliefs could be carried forward (i.e. harvesting could take place over a number of years so that the threshold was not reached), the change in the previously "income tax free" status of forestry was considered to be detrimental to confidence in the sector and was seen as a contributing factor in declining afforestation and lower-than-anticipated timber harvesting. Following representations from the sector, the restriction was removed in the 2016 tax year (Byrne 2016).

Life-cycle framework

From a temporal perspective, a change of land use from agriculture to forest is essentially a permanent land-use change as the legal permission to clearfell and harvest a forest is accompanied by a requirement to replant the harvested area (Forestry Act 2014[9]). The decision also involves moving from an annual agricultural income to a long-term forest investment with delayed revenue. Thus the afforestation decision needs to be modelled within a life-cycle framework to take account of the inter-temporal nature of the land-use change.

*Study objectives*

In summary, this paper aims to analyse the impact of the inclusion of taxation, charges

[8] DESP (Department of Employment Affairs and Social Protection). See State Pension (non-contributory): Rules-cash income. Available at http://www.welfare.ie/en/Pages/248_State-Pension-Non-Contributory.aspx [Accessed April 2017].
[9] Available at http://www.irishstatutebook.ie/eli/2014/act/31/enacted/en/ [Accessed November 2017].

and benefits in calculating the disposable income arising from the afforestation of a portion of a farm, over the life-cycle of the forest. Results will be generated for typical cattle and dairy farms of varying intensity, reflecting the soil conditions on the farms, while forest income will be generated for a range of forest YCs, also reflecting different productivity contexts.

**Methodology**

Due to the heterogeneous nature of farm households, the lack of real data in relation to net farm income and the complexity of the policy instruments involved, it is difficult to understand the direct impact of tax, benefit and subsidy policy on farmer income and behaviour. Therefore, in order to assess these policy pressures and impacts directly, a model that simulates policy at the farm level but that can also deal with the complexity of the policy instruments, is required.

*Microsimulation: modelling impacts on hypothetical farms*

Microsimulation modelling is a micro-scale simulation methodology (see O'Donoghue 2014) that will be used in this context to compare farm incomes for hypothetical farms in order to simulate the effect of alternative tax policies on farm-level outcomes. Hypothetical microsimulation models usually focus on a particular scenario under certain predefined assumptions, allowing an examination of the practical significance of policy reforms.

According to Ciaian et al. (2012), there is a greater need for detailed descriptions of the economic and environmental impact of policies at a disaggregated level (such as the farm), as agricultural policies continue to be increasingly targeted and more farm type-specific. Thus the use of microsimulation models has grown in recent years in agriculture and natural resource policy and many ex-ante assessments of European Commission proposals are undertaken using microsimulation models (Richardson et al. 2014). Burlacu et al. (2014) list the contexts in which hypothetical models are used i.e. for illustrative purposes, validation, cross-national comparisons, replacement of individual farm (micro-scale) data and communication with the public.

O'Donoghue (2014) describes different types of microsimulation models, depending on the analytical dimensions and level of complexity considered.

- Hypothetical models abstract from population and behavioural complexity, focusing on the impact of a policy (or policy change) for stylised units such as representative farms. They are useful for describing the functioning of a policy and are used extensively in international comparisons such as the Agri-Benchmark (Deblitz and Zimmer 2005) or OECD analyses (Martin 1996).
- Static models add population complexity, but ignore behavioural changes that arise as a result of policy changes by looking at 'the day after' impact of policy

reforms (Li et al. 2014). They require representative samples of the relevant population to examine the functioning of policy across the population, without taking into consideration behavioural impacts.

- Behavioural models (Aaberge and Colombino 2014) incorporate behavioural responses across a population following a policy change.

Given the lack of suitable population data on which taxation can be modelled, the analysis was limited to hypothetical farms with particular systems, stocking rates, agricultural soil types and forest productivity (yield) classes. Utilising stylised characteristics, the impact of non-farming and forest policy instruments that are relevant for decision making can be modelled, such as income taxation and means-tested social welfare benefits such as Farm Assist and the old age non-contributory pension. The use of stylised or typical farms has the advantage of highlighting the workings of these policy instruments but the disadvantge of not capturing the full distributional incidence of these instruments. Thus this approach is a net income version of previous gross income analyses of income drivers for planting decisions undertaken by Upton et al. (2013) and Ryan et al. (2014a). While extensively used in other policy realms, the methodology is relatively recent in agricultural and forest economics (O'Donoghue 2014).

The model can be used to consider both budget-constraint and inter-temporal analyses. The microsimulation choices identified by Burlacu et al. (2014) were adapted to specify a stand-alone model using a farm unit basis for analysis. This allowed land-use change from agriculture to forestry to be simulated on a unit area basis, for a variety of farm systems and over the period of a forest rotation. In terms of the budget constraint, as the primary agricultural systems considered were animal-based, the stocking rate (number and type of animals per ha) was considered as the farm unit of variation. The analytical measure used was net farm income.

There is significant micro-unit variability as farms can vary by soil type and agronomic characteristics (which influence both agricultural and forest yield), farm systems (which result in different incomes and costs) and farm level behavioural and skills characteristics (which influence efficiency and farm intensity (stocking rate) considerations). Thus the drivers of the decision to plant can vary considerably across farm types. Therefore in order to understand the economic relative drivers of forestry behaviour, one needs to understand how all of these factors influence the opportunity cost of planting agricultural land, which in turn influences the afforestation decision.

For the purpose of this analysis, it was presumed that afforested areas comprised a relatively minor component of the overall farm operation and to reduce complexity, the initial analysis was undertaken on the basis of the land-use choice on one hectare, in one year (2015). The model choices are summarised in Table 1.

Employing this model, annual forest and livestock subsidies and market incomes before taxation, charges and benefits were applied. Next the model compared net

**Table 1:** *Model choices for farm afforestation hypothetical model.*

| Model parameter | Model choices |
|---|---|
| Modelling period | 2015 |
| Interaction with another model | None – bespoke model used |
| The unit of analysis | Farm unit |
| Measurement unit | Ha |
| Period of analysis | Long-term (5-50 years) |
| Unit of variation | Stocking rate |
| Analytical measures | Relative net farm income (agriculture and forestry) |

agricultural and forest income, utilising a hypothetical farm framework. In order to account for variability due to soil type and environmental conditions, the model included a sensitivity analysis of changes in stocking rate, disadvantaged area status and forest YC. To estimate the impact on household income, the model also examined the impact of the inclusion of off-farm income on the comparisons.

*Lifecycle framework*

In order to capture the inter-temporal income from afforestation, it was necessary to utilise a life-cycle framework such as Discounted Cash Flow (DCF). The DCF methodology involves the calculation of the net present value[10] (NPV) to generate the future value of the forest and involved the projection of costs and incomes to the end of the rotation, before discounting them to the present day at a target interest rate (Hiley 1954, 1956), thus Equation 4 defines:

$$NPV = \frac{I}{(1+r)^n} \tag{4}$$

where $n$ is the number of years into the future that the income amount ($I$) will be received, or spent if the income amount is negative and $r$ is the discount rate.

In order to examine multi-annual forest life-cycle incomes, a discount factor must be employed. The discount rate chosen for NPV calculations can significantly increase or decrease the NPV of a project. The analysis includes afforestation grant and forest premium subsidies. For an afforestation investment where most costs are incurred during and in the years immediately following establishment (apart from roading costs), and where income only begins from the age of first thinning, a higher discount rate will reduce NPV. The convention is to ignore inflation, as this cannot be predicted. Therefore, the return is regarded as a "real" rate of return. Although the convention for valuation is to generate pre-tax values as per the International

[10] NPV (Net Present Value) is the sum of the present values of incoming and outgoing cash flows over a period of time. Incoming and outgoing cash flows can also be described as income and cost cash flows.

Accounting Standard (IAS 41 – Agriculture[11]), this study goes further to calculate returns, with and without taxation and charges.

In the case of a forest, income and costs can accrue unevenly over the rotation, thus the net present value (NPV) of the whole income stream is the sum of the present values of the annual amounts in the income stream, as presented in Equation 5 (assuming a constant discount rate):

$$NPV = \frac{I_0}{(1+r)^0} + \frac{I_1}{(1+r)^1} + \cdots + \frac{I_n}{(1+r)^n} + \cdots = \sum_{i=1}^{\infty} \frac{I_i}{(1+r)^i} \qquad [5]$$

*Relative productivity of agriculture and forestry*

In simulating agricultural and forest incomes, it is necessary to utilise methodologies that take the biophysical, as well as the financial and temporal components of the land use change decision into account. Soil productivity as represented by agricultural soil classes and forest YC is an important driver of income for both land uses, thus we follow earlier research by Farrelly et al. (2011) who assigned forest YCs for Sitka spruce to Teagasc NFS soil classes. In addition, the impact of soil on productivity is included in the analysis by modelling a range of stocking rates[12] (livestock densities) and forest YCs.

*Generation of agricultural income using farm survey data*

The Teagasc NFS undertakes an annual nationally representative farm survey to fulfil Ireland's statutory obligation to provide data on farm output, costs and income to the farm Accountancy Data Network (FADN) of the European Commission. The survey assigns farms to one of six farm systems on the basis of farm gross output from the dominant enterprise[13], as calculated on a standard output basis i.e. specialised dairy, dairy other, tillage, cattle rearing, cattle other and sheep. Using 2015 NFS data (Hennessy and Moran 2016), agricultural incomes were calculated for each farm system and associated NFS soil class on a per-ha basis. This provided the agricultural opportunity cost of afforestation in that year, taking into account the farm system and soil productivity.

*Generation of forest income using the ForBES model*

The Teagasc ForBES model (Ryan et al. 2016) employs the UK Forestry Commission yield models (Edwards and Christie 1981) to predict future timber outputs based on

[11] European Commission. 2009. International Accounting Standard IAS 41 (Agriculture). Available at http://ec.europa.eu/internal_market/accounting/docs/consolidated/ias41_en.pdf [Accessed July 2017].

[12] Measured as Livestock Units (LU $ha^{-1}$).

[13] Note that farms may have multiple enterprises, but are categorised on the basis of the dominant enterprise.

species, YC, rotation and thinning regime on a per ha basis. For the purpose of this analysis, the ForBes model simulated forest incomes for Sitka spruce over a range of YCs and generated timber volume outputs from thinnings and clearfells, assuming marginal thinning intensity. The ages of thinning and clearfell were modelled based on current practice where Sitka spruce is grown on a rotation that is less than the age of maximum mean annual increment (mMAI) (as defined by Husch et al. (1982)). The model assumed rotation length to be 80% of mMAI which closely corresponds with financially optimum rotations (Phillips 1998, 2004). In relation to forest costs and revenues, annual maintenance and insurance charges (Teagasc 2015) were included. The costs of harvesting and timber sales were deducted to give net revenue. Financially optimum rotations were used for each YC, varying from 38 to 46 years. Market income was then calculated by applying Coillte (State Forestry Board) conifer roundwood prices.

It is only possible to make direct comparisons between the NPV return on two investments (in this case, land uses) if both investments have the same life spans (Boardman et al. 2011). Thus the NPV needed to be annualised so that it could be expressed on the same basis as annual agricultural returns. The annual equivalised (AE) value was calculated as follows:

$$AE = \frac{r \times NPV}{1-(1+r)^{-n}} \quad [6]$$

In summary, the model simulation process was as follows: the 2015 agricultural (market and subsidy) income was derived for cattle rearing and dairy farms, for a range of livestock densities. Next, the forest market and subsidy income was simulated for hypothetical forests planted in 2015 for a range of YCs. The ForBES model then simulated total farm (agriculture plus forest) income, incorporating the annual agricultural income (per ha) foregone for the hypothetical farms, as an opportunity cost for each year of a given forest rotation. The discounted cash flow (DCF) methodology was used to calculate the NPV of the ensuing incomes for a range of discount rates.

*Agri-Tax model*

Finally, once the market plus subsidy incomes for both agriculture and forestry had been generated from the NFS data and the ForBES model respectively, the final analytical step involved modelling these inputs within the Agri-Tax microsimulation framework developed by O'Donoghue (2017). The Agri-Tax model applied the relevant taxation and benefit parameters to generate "disposable" incomes for the hypothetical farms for both agriculture alone and for a combination of agricultural and forest incomes. The Agri-Tax model was further utilised to examine how the individual components of the taxation and benefit measures could affect overall farm income. Scenario analysis was undertaken to examine the differential incomes generated using the market plus subsidy measure and the disposable income measure. The impact of farm system, soil productivity and discount rate were also examined.

Combining the different model components allowed for the calculation of Household Disposable Income (HDI) as follows;

(a) Without income from forestry:

$$HDI = I_{mkt-farm} + S_{farm} + I_{emp} + SW - I_{Tax} - PRSI - USC \quad [7]$$

where $I_{mkt-farm}$ is farm market income, $S_{farm}$ is farm subsidies, $I_{emp}$ is employment income, SW is social welfare and $I_{Tax}$ is income taxation.

(b) With income from forestry:

$$HDI = I_{mkt-for} + S_{for} + I_{mkt-farm} + S_{farm} + I_{emp}E + SW - I_{Tax} - PRSI - USC \quad [8]$$

where $I_{mkt-for}$ is forest market income, $S_{for}$ is forest subsidies, $I_{mkt-farm}$ is farm market income, $S_{farm}$ is farm subsidies, $I_{emp}$ is employment income, SW is social welfare and $I_{Tax}$ is income taxation.

**Data and model assumptions**

For this analysis, market and subsidy data concerning cattle, dairy and forest enterprises were needed for 2015. Teagasc NFS data (Hennessy and Moran 2016) were used to build a range of hypothetical farms which allowed identification of the particular factors that may impact on income, rather than generating farms to be representative of a particular characteristic. As many Irish farm families are dependent on other income sources, a provision of €25,000[14] gross income to represent a typical annual off-farm/part-time income of either the farmer or the spouse was included.

The annual forest subsidy for Sitka spruce (GPC3[15]) was used. There are limited timber price data for privately-owned forests, therefore price data for Coillte forests as published annually by the Irish Timber Growers Asociation (ITGA 2015) were used[16]. These data represent a large proportion of Irish timber sales and ten-year averages were used to account for annual price fluctuations. As approval to harvest a forest incurs an obligation to replant, replanting costs were also included.

[14] Based on nominal median annual part-time income. Data sourced from SILC (2015). SILC (Survey on Income and Living Conditions). Central Statistics Office. Available at http://www.cso.ie/en/releasesandpublications/er/silc/surveyonincomeandlivingconditions2015/ [Accessed October 2017].

[15] General Planting Category 3: Sitka spruce with 10% diverse conifer: €510 ha$^{-1}$ for 15 years.

[16] Note that these data may not accurately represent the sale of small diameter timber (pulpwood) as much of this assortment is retained for processing by Coillte.

*Taxation*

The tax rates used in the Agri-Tax model are from 2015 and are listed in Table 2. Since only farm forestry was of interest, charges for PRSI and USC were applied at rates relevant to farmers. As the vast majority of farmers are self-employed, PRSI was paid at a rate of 4% on gross income. USC started at 1.5% on the first €12,012 of income, 3.5% on the next €5,564, 7% on the next €52,468 and 8% on the balance of income. It was assumed that the farmer was married (without children) and that tax/exemption rates remained the same from 2015 onwards.

The position in relation to income taxation for agriculture and forestry is quite different. As a financial incentive for greater afforestation and for better utilisation of existing forests, this land use has historically enjoyed a preferential position in relation to taxation. While income from forests must be declared in tax returns and is liable for PRSI and USC, profits from the "occupation of woodlands" were not liable for income tax until 2007 when a restriction on untaxable income was imposed. This restriction was removed for the 2016 tax year, but it's potential financial impact over the lifetime of a forest crop was examined.

## Results

Initially, descriptive statistics were generated which illustrate (in general terms) how the components of the tax and transfers system in Ireland operate in relation to agricultural and forest income. Following this, the hypothetical farms were used to assess how these financial instruments impact of such typical farms, before extending the analysis to examine the impacts over a forest rotation.

*General impact of fiscal instruments*

Figure 1 describes the general direct taxation and contribution schedule for a single cattle farmer with average income, aged 62. Given an allowance of €5,000, the farmer pays more self-employed PRSI initially at a flat rate of 4%. The USC increments in bands up to €100,000. Direct income tax has two bands (20% and 41%) and has an optional joint system, but with less than full sharing of the standard rate band plus a number of tax credits. The combination of the allowances and variable rates, gives the non-linear shape observed here. As forest income, (subsidies and market) was not

**Table 2:** *Key income-tax parameters (correct for 2015) used in the modelling process.*

| Year | 2015 |
|---|---|
| Income tax (low rate) | 20% |
| Income tax (high rate) | 41% |
| PRSI | 4% |
| Universal Social Charge (USC) | 1.5 – 8% |
| Married income tax credit | €3,300 |

taxable (in general), there was potentially a generous financial incentive for planting a portion of the farm.

In 2007, the High Income Individuals Restriction introduced a complex process to limit allowable tax relief on forest incomes that exceeded a certain limit. The threshold amount of €125,000 was the limit of adjusted income (taxable income plus income at which the relief applied) over which the tax-payer could claim all reliefs. Once the threshold income exceeded this limit, or if the value of the reliefs exceeded 20% of the adjusted income, the limit was imposed. In this case income that exceeded a threshold of €80,000 was added to the tax base.

The dotted line in Figure 2 describes the operation of the restriction in relation to the income taxation of a dairy farmer with a farm forest (YC 24), who has varying hectares of land in the year of harvest. Initially as the forest income is not taxable, the level of income taxation does not increase. Thus the continuous line, which describes the income taxation rate as a share of total farm income (agriculture plus forestry) decreases, as forestry harvest income increases. Once the restriction was applied however, forest taxation rises, causing the income taxation rate to rise.

Farms on low income are entitled to Farm Assist. Figure 3 illustrates the operation of Farm Assist which shows that as income increases, the Farm Assist payment decreases. Unlike other means-tests, the Farm Assist assessment is not based on total net income. While PRSI is deducted for employment income, it is not deducted from

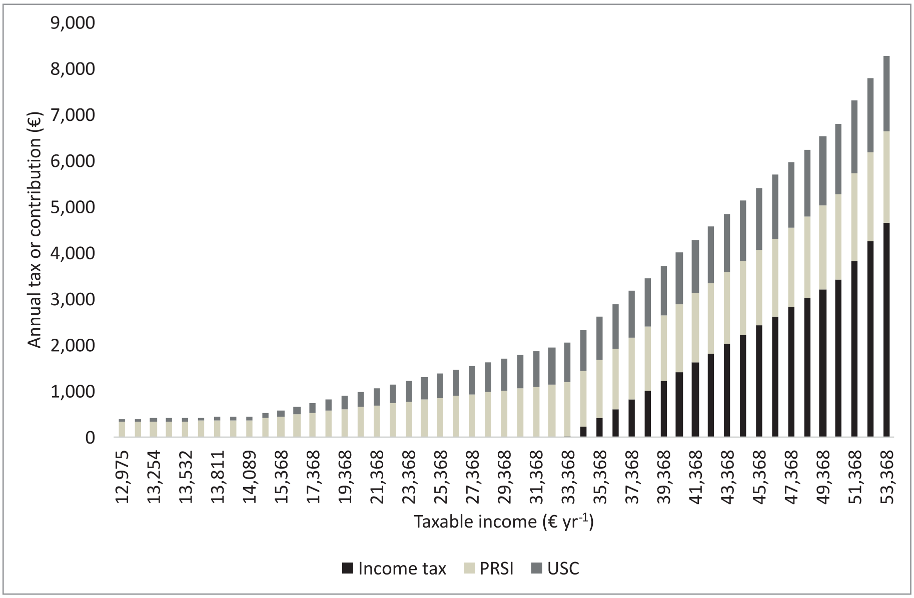


**Figure 1:** *Direct taxation and contribution schedule for a single cattle farmer with average income, aged 62 .*

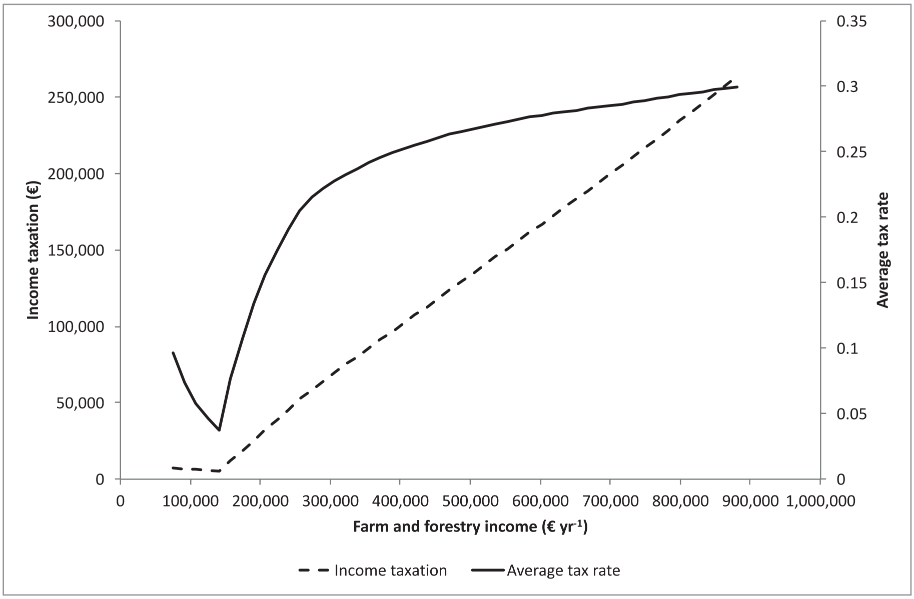


**Figure 2:** *Impact of high earners restriction (2015) on the income taxation of a dairy farmer with a farm forest (YC 24), who has varying hectares of land in the year of harvest.*

farm income, and USC and income taxation are also not deducted.

*Impact of fiscal instruments on hypothetical farms in one year (2015)*

Combining the different types of income and policy rules that apply to farmers who plant land, the analysis next reports the budget constraints generated by the model for a typical (hypothetical) cattle farm, which result from the changing components of disposable income. The complexity of the operation of the fiscal policies in relation to land use is illustrated in Figures 4 (for a working age farmer) and Figure 6 (retirement age farmer). Here the effect of adding hectares of forestry and adding income from off-farm employment are examined but the first 10 bars of both charts represent the addition of one to ten hectares of forestry. In the remaining bars of the chart, the planted area is held constant at ten hectares, while off-farm income is increased in increments of €1,000.

The typical farm examined is a cattle farm with a stocking rate of 0.7 LU ha$^{-1}$ with YC 14 land. At this low stocking rate, a farming couple can receive Farm Assist of up to €16,309 and a single farmer can get €9,802 (less means). Figure 4 illustrates that for this typical farm, as forest income increased, gross income increased since forest income was higher than agricultural income per ha at this stocking rate. However, in 2015, the withdrawal rate for Farm Assist was 100%, so a euro-for-euro reduction in Farm Assist can be seen for every extra euro of forest income. At this point PRSI and USC were being subtracted from disposable income and income taxation was

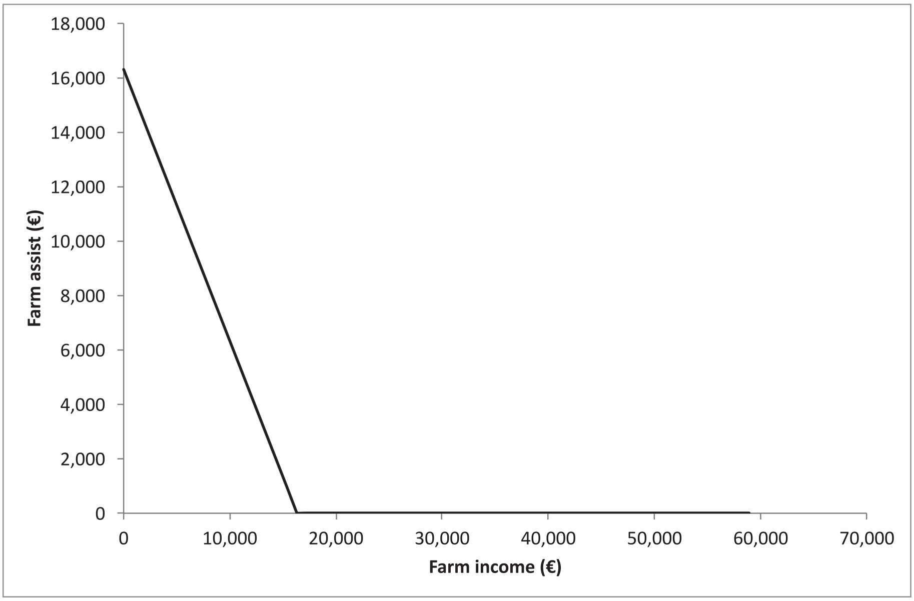


**Figure 3:** *Reduction in level of Farm Assist payment as farm income increases (2015).*

subtracted later, so that the top line of the graph represents the combined total, i.e. disposable income. The presence of off-farm income at this level largely eliminated the entitlement to Farm Assist means-tested income. Without off-farm income, additional income from forestry was lost through a reduction in Farm Assist. However if Farm Assist had already been reduced through the presence of off-farm income, then the gains from foresty would be additional.

In addition, as the means-test depends on gross income (not including taxation, PRSI and USC), and because PRSI and USC are charged on forest income, the effects of adding forest income and off-farm income are examined at both ends of the income distribution. This shows the financial effect of replacing agriculture with forestry as agricultural income falls while forest (premium) income rises and Farm Assist falls off slightly, reducing the financial incentive. This is illustrated further in Figure 5 which zooms in on the loss of Farm Assist at the lower end of the income distribution. In 2015 the withdrawal rate for employment income is 60% and so disposable income increased as employment income increased.

From 2017, the withdrawal rate for farm (and forest) income has been reduced to 70%. While this means that in future disposable income will rise with forest income, 74.5% of extra forest income will be lost through the Farm Assist means-test, PRSI and USC. Thus, for farmers whose (low) agricultural income should make planting worthwhile, because they are likely to be in receipt of Farm Assist (unless they have an off-farm job), the addition of forest income actually reduces their Farm Assist

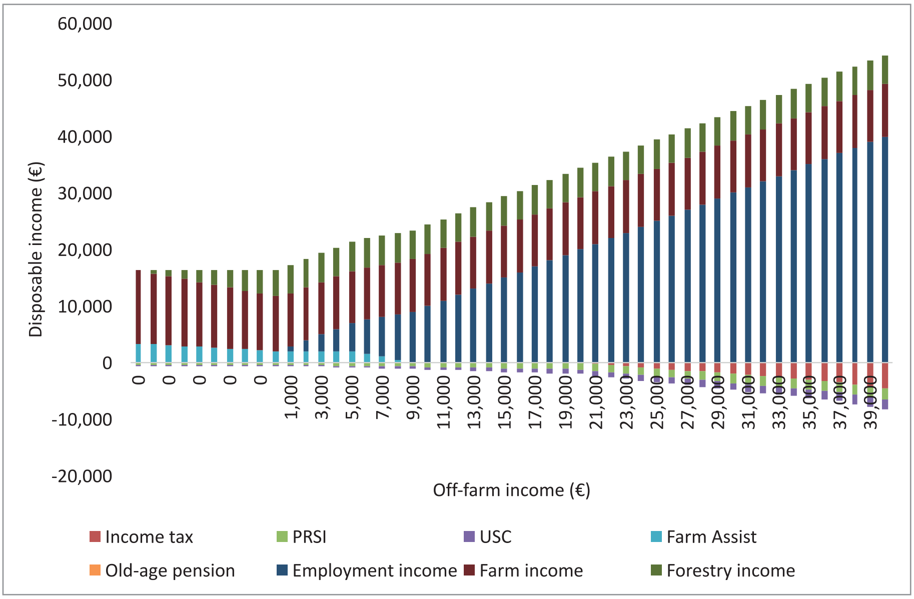


**Figure 4:** *Effect of changing forest area and off-farm income on disposable income for a cattle farm with stocking rate of 0.7 LU ha$^{-1}$ and YC 14 land (assumig owners of working age).*

payment. While the reduction in Farm Assist is small, it may still be perceived negatively by farmers.

Figure 6 presents the modelled budget constraint diagram for retirement-age farmers, replacing Farm Assist with a means-tested State pension. If a farmer was in receipt of a contributory pension, then the pension payment would be at a flat rate, regardless of income. It should be pointed out however, that older farmers who plant land could potentially suffer a reduction in old-age pension, due to the inclusion of forest income in the means assessment for a non-contributory pension, which is why the flat segment occurs in Figure 6. While PRSI is not paid by individuals of pension age, USC is, so a slight fall can be seen in disposable income at low levels of income after planting.

*Impact of fiscal instruments on life-cycle returns for a hypothetical farm*

The analysis has so far considered the general impact of policy in relation to income. Next the life-cycle impact of fiscal policies on agricultural and forest income is incorporated. In order to examine a range of productivity classes, a range of agricultural livestock densities and forest YCs were used. Cattle rearing farms of 35 ha and dairy farms of 50 ha with low, medium and high stocking rates were examined, reflecting varying intensities of production. In relation to farm systems, while the cattle farms had higher subsidies (particularly at higher stocking densities) dairy farms across all stocking densities had considerably higher outputs,

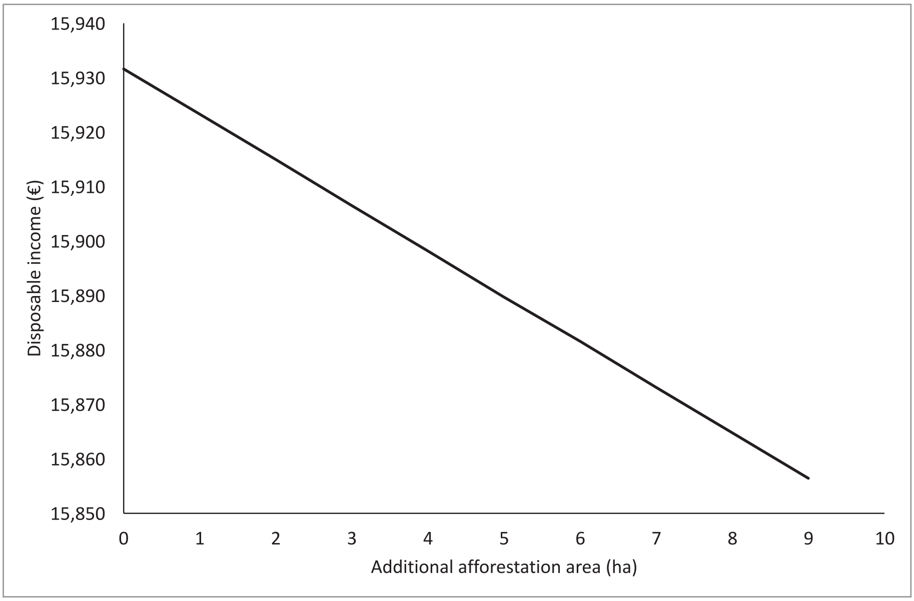


**Figure 5:** *Modelled annual disposable (€) income for a couple of working age, related to level of afforestation.*

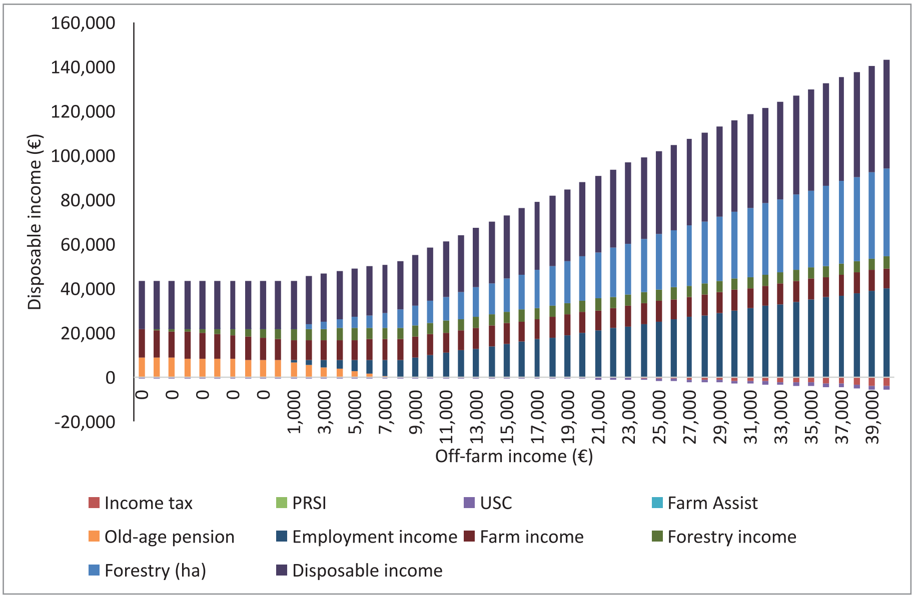


**Figure 6:** *Effect of changing forest area and off-farm income on disposable income for a cattle farm with stocking rate of 0.7 LU ha$^{-1}$ and YC 14 land (pension age). The first 10 columns represent an increase in forest area from 0 to 10 ha, required to show the impact of a land use change from agriculture to forestry. The remaining columns represent an increase in off-farm income, necessary to highlight the functioning of the wider tax-transfer system.*

were more profitable and thus had a higher opportunity cost of planting than cattle farms.

The forest market income from planting 10 ha for a range of YCs was also examined. Higher YC sites generated greater annual income as they produced greater volumes of timber over shorter rotations. Although an explicit spatial analysis was not undertaken in this paper, different soil codes or YCs were examined, which have spatial patterns as seen in Table 1 in the Appendix.

In order to incorporate the inter-temporal dimension of farm afforestation, the components of the life-cycle return from forestry were investigated. Figure 7 shows a comparison between three income measures, namely market income, gross income (market plus subsidies) and disposable income. This analysis specifically considers a 35-ha cattle farmer with a stocking rate of 0.7 LU $ha^{-1}$ who has an off-farm job (with a typical part-time wage), who plants a 10-ha YC 20 forest in 2015.

The model assumes the farmer to be 45 in the year of planting so that he/she can conceivably benefit from life-cycle market income. While the typical age at which farmers plant varies and can be substantially higher, modelling planting at an older age in a hypothetical farm simulation model is challenging as it would require a weight to be placed on the welfare of future generations, in relation to the value of a bequest. It is generally accepted that the loss of flexibility of land use after planting can be a negative consequence of the afforestation decision (Ryan et al. 2014b) even if farmers would gain personally, however the inter-generational transmission of wealth

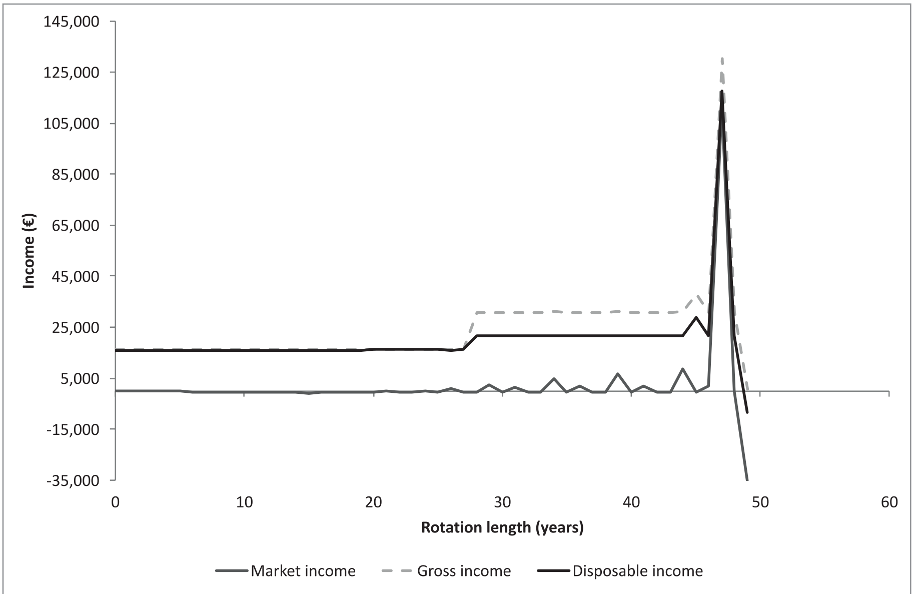


**Figure 7:** *Life-cycle comparison of income measures over time: market income, gross income and disposable income.*

is beyond the scope of this study which focused on understanding how policy drivers such as tax, PRSI and social welfare influenced the financial incentives to plant.

As such, the choice of age is unimportant as the main farm and forest policies (the factors that influence change in the numerator and denominator) are not age-dependent. The policies that depend on age, namely Farm Assist, old-age pension, the age cut-off in PRSI and age-related tax credits/tax exemptions, apply to both the numerator and denominator. The same rules are applied to both income net of agricultural farming and net of farming with agriculture and forestry income and as such, the impact of modelling different ages will not substantially alter the relative income differential between choices, other than at the margin through the progressivity of the system. Therefore this study focused on a single age.

The life-cycle considered incorporated non-contributory means-tested old-age pension as all farms were modelled without pension contributions. The income spike at year 41 represents the forest harvest income, while the dip in year 43 is the cost of replanting. The blips in the earlier years represent thinning revenues. In general it was found that the market income was only marginally negative, due to annual maintenance costs. Gross income was positive due to forest premium payments, farm direct payments and Farm Assist. In Table 3 this analysis was extended to different types of farms, combining the different incomes over the life-cycle of the forest and considering both cattle rearing and dairy farms. AE was reported for farms with different stocking rates and for different discount rates (3, 4 and 5%) keeping forest YC constant at YC 20.

The effect of the choice of discount rate used is immediately evident as the lower discount rate results in the highest life-cycle incomes. In examining the differences in farm intensity as represented by varying the livestock density, a number of trends are evident:

- For cattle farms with low stocking (0.7 LU $ha^{-1}$), the income from farms with forests is higher than the income from farming alone, regardless of the income measure used.
- Here the importance of Farm Assist is evident as it compensates for the low market plus subsidies income, thus the disposable income is higher on these farms.
- As stocking rate on the cattle farms increases to 1.3 LU $ha^{-1}$, the conclusions differ depending on whether the disposable income or market income plus subsidies measures are utilised. For cattle farms of medium intensity, the agricultural income is highest at the 3% discount rate, except in the final harvest year. Harvest income alone does not compensate for the long-term difference between forest income and agricultural income, however a combination of Farm Assist and the old age means-tested pension, compensate for the loss of income during the years of lower agricultural income. Thus, the harvest

***Table 3:** Comparison of annual equivalised (AE) NPV[a] of disposable income and market plus subsidies for farming alone and farming plus 10 ha of forest for a range of discount rates (3%, 4%, 5%).*

| **System** | **Cattle rearing** | | | **Dairy** | | |
|---|---|---|---|---|---|---|
| Stocking rate | 0.7 | 1.3 | 1.7 | 1.7 | 1.9 | 2.1 |
| Yield Class | 20 | 20 | 20 | 20 | 20 | 20 |
| **Disposable income (€)** | | | | | | |
| Forestry | | | | | | |
| 0.03 | 22,114 | 27,558 | 35,145 | 49,281 | 56,601 | 64,067 |
| 0.04 | 21,253 | 26,084 | 33,390 | 47,941 | 55,084 | 62,371 |
| 0.05 | 20,523 | 24,817 | 31,878 | 46,811 | 53,801 | 60,934 |
| Farming | | | | | | |
| 0.03 | 20,848 | 27,394 | 37,475 | 51,990 | 60,631 | 69,420 |
| 0.04 | 20,270 | 26,266 | 36,036 | 50,834 | 59,287 | 67,886 |
| 0.05 | 19,773 | 25,286 | 34,788 | 49,845 | 58,138 | 66,573 |
| **Difference**[b] | | | | | | |
| 0.03 | 1,266 | 164 | -2,330 | -2,708 | -4,030 | -5,352 |
| 0.04 | 983 | -182 | -2,646 | -2,893 | -4,203 | -5,515 |
| 0.05 | 750 | -469 | -2,909 | -3,035 | -4,336 | -5,639 |
| **Market income + subsidies (€)** | | | | | | |
| Forestry | | | | | | |
| 0.03 | 11,378 | 22,266 | 29,524 | 52,236 | 60,356 | 68,477 |
| 0.04 | 11,033 | 21,684 | 28,784 | 51,003 | 58,947 | 66,891 |
| 0.05 | 10,754 | 21,202 | 28,168 | 49,965 | 57,758 | 65,551 |
| Farming | | | | | | |
| 0.03 | 9,111 | 24,354 | 34,516 | 58,788 | 68,938 | 79,088 |
| 0.04 | 8,913 | 23,825 | 33,766 | 57,510 | 67,440 | 77,370 |
| 0.05 | 8,744 | 23,372 | 33,124 | 56,418 | 66,159 | 75,901 |
| **Difference**[b] | | | | | | |
| 0.03 | 2,267 | -2,088 | -4,991 | -6,551 | -8,582 | -10,612 |
| 0.04 | 2,119 | -2,141 | -4,981 | -6,507 | -8,493 | -10,479 |
| 0.05 | 2,010 | -2,170 | -4,956 | -6,453 | -8,402 | -10,350 |

[a] The AE value presents the life-cycle Net Present Value as an annual equivalent, thus making it comparable with annual agricultural incomes.
[b] A negative difference indicates that the income from farming alone is higher than when 10 ha of forest is substituted for 10 ha of farm income.

income is higher than the disposable income losses, particularly as this income stream is tax free.

- Conversely for cattle farms with a high stocking rate of 1.7, the AE for farming alone is higher than for farming plus forestry. This is also the case with dairy farms, irrespective of stocking rate, income measure or the discount rate applied. This reflects the greater opportunity cost that more intensive farmers incur in foregoing the annual income from 10 ha of an intensive cattle rearing or dairy enterprise.

In relation to the magnitude of the difference between the income measures when forest income is included, the story is very different for cattle rearing and dairy farms. On less intensive cattle farms with low stocking density, the difference is positive (indicating that farm plus forest income is higher), however the difference between the measures is relatively small. As the level of farming intensity increases, so too does the gap between the measures. As stocking rate increases for both cattle and dairy farms, the negative difference between the disposable income and market and subsidies measures increases monotonically. There are essentially two factors driving this trend. As intensity increases, so does agricultural income foregone, i.e. the opportunity cost is largely driving the market and subsidies measure. However, in relation to the disposable income measure, the gap between the farm and forest incomes is much smaller. This is because the tax-free nature of the forest income means that the reduction in income tax mitigates the high agricultural opportunity cost to a large extent, indicating the importance of the income tax measures at the higher end of the income distribution.

The impact of a range of forest yield classes on disposable and market plus subsidy incomes is further illustrated in Table 4. For all dairy scenarios, both disposable income and market plus subsidies measures are negative, regardless of agricultural stocking rate or forest YC at a discount rate of 4%.

Across the cattle rearing scenarios the results show consistent trends. At lower stocking rates, the inclusion of 10 ha of forest is increasingly positive as YC increases, for both income measures. However at the higher stocking rate, agricultural income is higher for both measures. As with the dairy scenarios, the scale of the negative income (from the inclusion of 10 ha of forest), decreases for the highest forest YC.

This is consistent with previous distributional analysis (Ryan and O'Donoghue 2016) which shows that forestry is not financially competitive with dairy farming (even on poorer soils) due to the high level of opportunity cost that would be incurred in a land use change to forestry. It is interesting though that the scale of the negative incomes related to the inclusion of forestry reduces for YC 24, reflecting the greater forest productivity at higher YCs. It should be noted that in reality, farmers may choose to harvest timber earlier to avail of higher timber prices and shorter rotation lengths, thereby increasing forest income, however this analysis is based on standardised forest yield models and average timber prices. While we emphasise that these calculations are for hypothetical stylized farms of different types and stocking rates, it does highlight the important point that the financial impact of planting varies when overall farm disposable income is taken into consideration, rather than just examining the traditional market plus subsidies measure.

**Table 4:** *Annual equivalised NPV[a] of the difference in disposable income and market plus subsidies, between Farm Income and Farm plus Forest Income for a range of Yield Classes (discount rate = 4%).*

| **System** | **Cattle Rearing** | | | **Dairy** | | |
|---|---|---|---|---|---|---|
| Stocking Rate | 0.7 | 1.3 | 1.7 | 1.7 | 1.9 | 2.1 |
| **Yield Class** | **14** | **14** | **14** | **14** | **14** | **14** |
| Disposable income (€) | 324 | -2,205 | -4,257 | -2,613 | -3,819 | -4,962 |
| Market plus subsidies (€) | 154 | -4,830 | -8,152 | -5,919 | -7,684 | -9,449 |
| **Yield Class** | **18** | **18** | **18** | **18** | **18** | **18** |
| Disposable income (€) | 473 | -316 | -3,177 | -2,259 | -3,483 | -4,651 |
| Market plus subsidies (€) | 2,080 | -1,717 | -4,248 | -5,627 | -7,429 | -9,232 |
| **Yield Class** | **20** | **20** | **20** | **20** | **20** | **20** |
| Disposable Income (€) | 750 | -469 | -2,909 | -3,035 | -4,336 | -5,639 |
| Market plus subsidies (€) | 2,010 | -2,170 | -4,956 | -6,453 | -8,402 | -10,350 |
| **Yield Class** | **24** | **24** | **24** | **24** | **24** | **24** |
| Disposable income (€) | 1,044 | -153 | -2,688 | -2,991 | -4,358 | -5,725 |
| Market plus subsidies (€) | 2,519 | -1,717 | -4,542 | -6,654 | -8,699 | -10,744 |

[a] Negative values indicate that farm income was greater than farm plus forest income.

The difference in the period of analysis of the annual equivalised NPV and the period of analysis of a means-tested social protection instrument or benefit is also worth noting. Means-tested benefits are paid when incomes are low in a particular year. They are not based on life-cycle total earnings. Thus a farmer with low stocking rate and income over a long period (due to forest subsidies being lower than agricultural income), may be compensated if their income is low enough. Yet when they make a major financial gain on harvesting, although it is likely to reduce or eliminate the benefit in that year, it does not impact the benefits from other years. This is one of the main reasons why disposable income is higher sometimes for forestry, while agricultural market and subsidy incomes are higher when taxation and benefits are not taken into consideration.

## Conclusions

This paper examines the potential impact of taxation and benefits on disposable income for a farm family considering planting some of their agricultural land. The methodology and model adapted for this analysis extend the literature on the economic returns from farm afforestation to incorporate the impact of fiscal measures such as farm taxation and benefits. The analysis builds on previous work by McCormack et al. (2014) who used a hypothetical model to examine how subsidy policy created behavioural pressures amongst Irish beef farmers, and Ryan et al.

(2014a) who developed a hypothetical forest subsidies microsimulation model. This model is a single country microsimulation model taking hypothetical farm units as the unit of analysis, with a policy scope of the impact of taxation/transfers on agricultural and forest incomes. The framework is similar to other models used for comparative purposes such as the OECD "Making Work Pay" type analyses (Martin 1996).

While forest YC (and prevailing market prices) largely determine the profitability of forest enterprises, in the context of a land use change from agriculture, the net benefit/deficit of farm afforestation is determined by a combination of the soil productivity for agriculture and forestry, the magnitude of the opportunity cost, the presence of off-farm income in the household and the consequent tax and benefit treatment of the overall farm household income. While much of the recent literature agrees that there are cultural, attitudinal and lifestyle barriers to the uptake of farm forestry (Frawley 1998, Duesberg et al. 2013), which are exacerbated by the loss of flexibility of land use as a result of the permanent nature of afforestation in Ireland, the financial return is also important as evidenced in previous analysis (Ryan and O'Donoghue 2016) and by O'Connor and Kearney (1993) who conclude that farmers will not undertake afforestation unless it is more lucrative than farming.

Essentially, governments use financial incentives to encourage individuals to undertake measures that achieve strategic aims (for example Food Harvest 2020 targets). The main policy instruments available to governments are financial e.g. subsidy-based incentives or taxes and benefits. Entering financially incentivised schemes reduces uncertainty around income for farmers, thus reducing their perceived economic risks (Koundouri et al. 2009). However, in a recent survey of farmers who had not planted, Duesberg et al. (2013) conclude that the reason why forestry was not an option is that it was not regarded as farming.

The desire to continue farming is not unique to Ireland. Gorton et al. (2008) examined farmer attitudes in EU countries and concluded that even after payments were decoupled from production with the consequence that farmers who were making a loss from the market could reduce their stocking rate (without losing payments), most farmers maintained their productivist objectives and preferred to maintain their farming lifestyle, even when this resulted in a financial loss. Borrowing from behavioural economics theory, this introduces the concept that a "compensating differential" (Carpenter et al. 2015) is necessary to provide a "nudge" for farmers to undertake the change from farming to forestry with which they have less familiarity and which may not coincide with their lifestyle (Ryan and O'Donoghue 2016b).

This is consistent with a study of NFS farms that planted forests over a 30-year period (Ryan and O'Donoghue 2016a), whose analysis suggested that planting land matched different lifestyle objectives for different types of farmers. For example, younger intensive farmers maintained stocking rates after planting, indicating that they optimised land use by planting their marginal land; part-time farmers reduced their agricltural area and increased stocking rates on the remaining land, optimising their time; while the largest cohort of (older) farmers reduced their stocking rate after planting. This study also showed that financial drivers are not significant at the margins but are significant when there is a large qualitative difference between agricultural and forest incomes. This arises at the extremes of the distribution as those with the highest gains (and large farm areas with access to spare land) are most likely to plant, while farms with the lowest gains are least likely to plant.

Building on these previous analyses, this study illustrates the importance of the benefits and income-tax components of disposable income in the relative returns from planting 10 ha of forest on hypothetical extensive and intensive cattle and dairy farms. From a household welfare perspective, the inclusion of benefits and taxation in the calculation of life-cycle farm and forest income can impact on the long-term financial welfare of the household, particularly at the extremes of the income distribution.

For low income farms, if income from forestry is less than agricultural income in the early stage of the forest life cycle, social protection instruments such as Farm Assist can mitigate the short-term income reduction. However, for those farms that are most likely to benefit from planting i.e. where forest income is higher than agricultural income, then the means test for social protection instruments can reduce the incentive to plant. While this may not directly affect the planting rate, it has an effect on income; i.e. why would farmers choose to plant land and forego agricultural income and lifestyle flexibility for only a marginal financial gain?

It should be noted here that the change in the Farm Assist withdrawal rate for 2017 will alleviate this, however, this change also means that the income range over which Farm Assist is paid, increases from €16,309 for a couple to €23,299. As the average weighted income for cattle systems in 2015 was just over €15,000, this income range accounts for over three quarters of NFS cattle farmers without off-farm income (Hennessy and Moran 2016). This essentially gives rise to an increase in the marginal effective tax rate for low income farms, without other (non-means tested) income sources such as off-farm income or contributory pensions.

More generally for higher income farms, the favourable tax treatment of forestry income reduces the gap between the higher income from agriculture and the lower forestry income. However, this gain may be marginal unless these farms are large with spare livestock carrying capacity. In such cases, high-income farmers benefit from a win-win situation of being able to increase stocking rates (and income), while also benefiting from the tax-free forest income.

From a policy perspective, this analysis supports the recommendations of the

Forest Land Availability Implementation Group which recognises the potential importance of taxation and benefits in relation to their impact on disposable income when making the decision to plant. The results illustrate the re-distributive nature of the Irish tax/benefits system, as benefits can be very significant at the bottom of the income distribution whereas taxation narrows the gap at the top of the distribution. The analysis also shows that even if the level of disposable income is higher for agriculture on more intensive farms, the use of a disposable income measure in analysing the returns from farm afforestation, provides valuable insights in relation to how financial policy affects different farm systems with varying levels of farming intensity. Further research is required to estimate "cut'' points at which changes in taxation or benefit thresholds and increased level of uptake of benefits, could bring about a gain at farm level from the inclusion of forestry in overall farm income.

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## Appendix

The distribution of National Farm Survey (NFS) soil codes by region is shown in Table 1. These codes reflect the potential range of uses or limitations, ranging between soil code 1 which is suitable for a wide range of agricultural uses and soil code 6 which is extrememly limited for agricultural use. Spatial patterns are evident particularly in relation to the extremes. Soil code 6 (poorest soils) areas are located primarily in the mid-west and west, while the greater proportion of soil code 1 occurs in the south, south east and midlands. These soil codes also approximate to forest yield classes for Sitka spruce with soil code 1 approximating to YC 24 and soil code 6 approximating to YC 14.

**Table 1:** *Distribution of soils by region according to data collected by the Teagasc National Farm Survey (2015).*

| Region | Soil code | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| Louth, Leitrim, Sligo, Cavan, Donegal, Monaghan | 5.2 | 22.4 | 29.9 | 28.0 | 20.2 | 0.0 |
| Dublin | 1.1 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| Kildare, Meath, Wicklow | 9.6 | 22.7 | 15.7 | 4.4 | 4.3 | 0.0 |
| Laois, Longford, Offaly, Westmeath | 25.9 | 13.6 | 8.6 | 18.3 | 9.3 | 0.0 |
| Clare, Limerick, Tipperary N.R. | 7.6 | 2.1 | 14.5 | 4.2 | 4.1 | 49.6 |
| Carlow, Kilkenny, Wexford, Tipperary S.R., Waterford | 20.3 | 14.3 | 8.0 | 8.0 | 4.0 | 0.0 |
| Cork, Kerry | 27.9 | 2.2 | 3.8 | 18.1 | 36.6 | 14.1 |
| Galway, Mayo, Roscommon | 2.3 | 21.0 | 19.5 | 18.9 | 21.4 | 36.3 |
| | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |