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Three Essays on Renewable Natural Resources (Forestry & Fisheries) Management Problems in the Republic of Ireland

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By

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Declaration of Originality

I hereby certify that this dissertation is entirely my own work. Neither the work nor the parts thereof have been published elsewhere in either paper or electronic form unless indicated otherwise through references

Signature

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(H.M. Vidyaratne Herath)

Summary of Contents

The objective of this thesis is to answer two problems related to the provisioning of forest ecosystem services and one problem related to the provisioning of aquatic ecosystem services in Ireland through three empirical papers analysing primary data collected by two different questionnaire surveys. Chapter 1 offers background information on various types of forest and aquatic ecosystem services, the concepts of natural resources (forestry and fisheries) management, thesis objectives and structure and outputs of the thesis. Chapter 2 examines the socio-economic and property specific determinants of private landowners' firstly in deciding to plant at least some area of land ownership and secondly those determinants for deciding the percentage of land area they have planted or would plant. I found that non-pecuniary aspects, socio-economic and property specific variables of the landowner are significant in planting decisions as well as planting percentages of landownership. Next in Chapter 3, I examine NIPFs' risk attitudes to insuring forest lands against risk hazards and profile the socio-economic and property specific variables of those NIPFs who believe in insuring forests and those NIPFs who do not believe in insuring forests employing a Probit model. In addition, I profile those NIPFs who believe in insuring forests and those NIPFs who don't believe in insuring forests. Only off-farm household income and landownership of NIPFs are significant in believing in insuring forests. In Chapter 4, I estimate non-market values of recreational fishing of the general public including recreational fishing households through a face-to-face, nation-wide household survey in order to answer the current problems of recreational fishing. I found that key socio-economic variables affect the non-market value of recreational fishing of both recreational fishers and general public. The individual household welfare contribution from recreational fishing as well as total welfare in Ireland from recreational fishing was estimated. Finally in chapter 5, I explain the main findings and limitations of each chapter and suggest some high priority future directions for research.

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Abbreviations

BOD	Biological Oxygen Demand
CB	Contingent Behaviour
CDM	Clean Development Mechanism
CS	Consumer Surplus
CVM	Contingent Valuation Method
DCF	Discounted Cash Flow
DAFF	Department of Agriculture, Food and Forestry
ECBA	Extended Cost Benefit Analysis
EFFIS	European Forest Fire Information System
GHGs	Green House Gases
IHS	Inverse Hyperbolic Sine
IRR	Internal Rate of Return
LEV	Land Expectation Value
LULUCF	Land use and, land-use change and forestry
MA	Millennium Ecosystem Assessment.
NFS	National farm Survey
NIPF	Non-industrial Private Forest Owners
NJFF	Norwegian Fishing and Hunting Association
NOAA	National Oceanic and Atmospheric Administration
NPV	Net Present Value
OLS	Ordinary Least Square
REPS	Rural environmental Payment Scheme
SFP	Single Farm Payment
TCM	Travel Cost Method
TEAGASC	Irish Agriculture and Food Development Authority
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
TEEB	The Economics of Ecosystem and Biodiversity
VAT	Value Added Tax
WTP	Willingness To Pay

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Chapter 1 Introduction

Introduction

The primary objective of this thesis is to investigate the factors that would encourage landowners to increase the supply of certain ecosystem services by converting their land from less environmentally productive farm enterprises to forestry and to analyze their attitudes to associated risks. The thesis is also concerned with the supply of ecosystems services and in particular what the public are willing to pay to ensure the continued supply of natural resources – in this case the preservation of Ireland's natural fish stocks and the quality of recreational fishing opportunities. Beyond establishing a context for this thesis and detailing the types of services that forestry and inland water ecosystems provide society, this chapter also provides justification for the overall research questions of the thesis. Section 1.1 provides a description of what is meant by ecosystems services. Section 1.2 compares the contrasting styles of ecosystem management for forestry and fisheries management. Section 1.3 provides an overview of the research objectives and how these objectives have been achieved through three separate empirical papers. Section 1.4 outlines the structure of the thesis. Thesis outputs such as papers and public presentations are provided in section 1.5.

1.1 Ecosystem Services

Braat and Groot (2012) define ecosystem services as the direct and indirect flux of benefits of ecosystems to human beings. The ecosystem service flux that human society receives from a forest ecosystem include direct benefits such as timber, firewood, poles, fodder, fruits, berries, nuts, mushrooms, and herbal medicines. Forests also generate indirect benefits such as carbon sequestration, climate regulation, soil erosion prevention, flood control, biodiversity conservation, and nutrient circulation. In the same manner marine and fresh water ecosystems provide direct benefits such as fish production, recreational fishing, ornamental fish and shells, conservation of biodiversity, water for other recreational activities such as boating, swimming, and kayaking. Economic policy and analyses often focus on services for which there is an immediately apparent economic market; for example food provisioning, fossil fuel production, and timber harvesting. However the flow of

benefits provided to society by natural capital extends far beyond ecosystem outputs intended for economic markets.

As demands on the environment and associated ecosystem services increase, the need for a more integrated approach to managing the exploitation of these natural resources also increases. This is particularly true for forestry and fresh water natural resources. From a policy making perspective, decisions that could affect the quality of ecosystems such as forestry or fresh water habitats are routinely made without taking into account the non-market benefits that would be foregone (or gained) if the environmental quality of these ecosystems deteriorated (improved). Decision making could be enhanced if both the level and accuracy of information on the non-market benefits of maintaining environmental quality or information on how to encourage stakeholders to provide higher levels of ecosystem provision through perhaps land use change from a grass based farm system to forestry were improved. At present, there are few decision making frameworks that facilitate integrated ecosystem service evaluation and comprehensive planning in relation to all activities taking place in any given ecosystem. According to Douvere (2008), the lack of such a framework can translate into spatial and temporal conflicts (user–user and user–environment conflicts) in the natural environment.

The Millennium Ecosystem Assessment (MA, 2005) involved the work of 1300 scientists around the world to define what is now one of the most widely used classifications of ecosystem services. Within this classification there exist four categories of ecosystem service: provisioning services, regulating services, cultural services and supporting services, each of which is broken down into further subsets of services shown in Table 1.1.

Provision services account for physical products obtained from ecosystems like fish, fresh water and fuel-wood, while regulating services play a climatic and environmental regulatory role and cultural services provide a host of non-material benefits. In turn, all three of these categories are reliant on supporting services, which differ from provision, regulating and cultural services in that their impacts on people are either indirect (and operate through their effect on regulating services) or occur over a very long period. For example, while humans do not directly use soil formation services, changes to this service would indirectly affect society through an

impact on the provisioning service of food.

Table 1.1. Classification of Ecosystem Services

Provision Services	**Regulating Services**	**Cultural Services**
Products obtained from ecosystems	***Benefits obtained from regulation of ecosystem services***	***Nonmaterial benefits obtained from ecosystems***
> Food	> Climate regulation	> Aesthetic
> Fresh water	>Disease regulation	> Recreation and ecotourism
> Fuelwood	> Water regulation	> Aesthetic
> Fiber	>Water purification	> Inspirational
> Biochemicals	>Pollination	> Educational
> Genetic resources		> Sense of place
		> Cultural heritage
Supporting Services		
Services necessary for the production of all other ecosystem services		
> Soil formation	> Nutrient cycling	> Primary production

Source: Millennium Ecosystem Assessment (2005)

Generally speaking, the provision services of ecosystems are those that are more immediately profitable and demanded by society (MA, 2005). This becomes problematic when less immediately apparent ecosystem services like regulating and support services are consistently ignored in human interactions with the natural environment. In economics, such a scenario is referred to as a negative externality, i.e. where a market activity produces economically valuable output and this process has a negative environmental impact for the rest of society (Mankiw, 2001). Viewed from this perspective, human intervention in the natural environment since the industrial revolution, and more particularly since the mid-twentieth century, has resulted in unprecedented increases in the level of negative ecosystem externalities.

In this thesis Chapter 2 focuses on analysis of the forestry 'provisioning' ecosystem services of timber production. The chapter focuses on newly planted forest area which can also contribute to the supporting, cultural and regulating services of recreation, sequestration of carbon, flood regulation, water quality, soil conservation and conservation of biodiversity. In this chapter I analyse socio-economic and property specific factors of Irish landowners that influence their decision to convert their land to forestry in planting trees in their private lands. I also use the same farm

and farm operator characteristics to explain the decision related as to the percentage of land holdings are allocated to forestry. Both of these decisions are critical in maintaining a sustained level of ecosystem service provision in Irish forestry.

Chapter 3 examines the attitudes of private forestry landowners to insurance of their forestry holdings. After planting trees in private land, landowners often acquire insurance to cover themselves against fire and other potential hazards. Whether they acquire insurance or not can have an impact on the efforts they might undertake to help avoid any potential damage to their forests, which in turn will determine the level of continuous ecosystem service flux since hazards could damage and in most cases reduce the level of ecosystem service flow. For example, forest fire reduces the values of carbon and timber stock, the level of biodiversity, and also increases surface water runoff. Though insuring forestry plantations pays back the investment lost, the occurrence of any forest fire event will affects ecosystem service flow. On the other hand, if landowners develop attitudes towards management of forests that attempt to minimize the risks of damage this can have positive impacts on the flow of ecosystem services. For example planting mixed species of trees in a stand could reduce the risks of forest fire, storm and wind damages, and pathogen and insect attacks but at the same time it can increase ecosystem service flow and the levels of biodiversity.

Chapter 4 examines the valuation of an ecosystem service benefits but in this case it relates to the water based ecosystem service of recreational fishing. The recreational anglers enjoy the ecosystem service flow provided through access to a healthy fish stock. They use their catch for consumption but occasionally they sell the extra amount of catch. Recreational fishing has cultural value-use for both recreational fishers and the general public. The general public, even though they may never fish themselves, may also hold existence values and/or bequest values for a healthy aquatic environment and a sustainable fish stock that ensures that recreational fishing remains a possible pursuit in the future.

1.2 Natural Resource Management Concepts

According to Slocombe (1993), ecosystem based management is managing whole ecological or landscape units. In an ecosystem, there are infinite numbers of complex interactions among different living beings and the physical environment all of which

contribute to sustaining of the system. Therefore, one best way to manage forest and aquatic ecosystem is ecosystem based management. However, Lackey (1998) explains the definition of ecosystem based management as vague and proceeds to articulate seven principles that make definition more meaningful. These principles are: 1. Ecosystem based management system should help continuation of evolution of social values and priorities, 2. Ecosystem based management is a location based one and therefore, location should be clearly defined, 3. Ecosystem based management should help to achieve desired social benefits, 4. Ecosystem based management should be managed in such a way that ecosystems maintain the ability to respond to a variety of stressors, 5. Ecosystem based management may or may not emphasise the maintenance of biological diversity, 6. If an ecosystem is managed under the 'sustainability principle', sustainability should be clearly defined. 7. Scientific information is required to manage the ecosystem properly. Levin *et al* (2008) stress the need for assessing ecosystem status, developing indicators and targets, and also developing a management and monitoring system to achieve ecosystem based management goals.

Braat & Groot (2012) point out that the current major debate between neo-classical economists and ecological economists relates to the concept of sustainability. Braat & Groot (2012) and Farley (2012) define and explain both the weak and strong approaches to sustainability. The weak sustainability approach assumes natural capital can be substituted for using manufactured capital. The strong sustainability approach assumes natural capital and manufactured capitals are complementary but can't be substituted for each other. Farley (2012) defines the natural capital stocks (ecosystems) that generate essential ecosystem services as critical natural capital (CNC) under the strong sustainability principle. According to Farley (2012), the strong sustainability approach is governed by two basic rules. The first rule is that humans can't deplete any element or structure of ecosystems (in my case forestry and fisheries) faster than its natural restoration rate without crossing some thresholds beyond which the whole ecosystem would be endangered. Therefore, enough structure of ecosystems should be maintained below these threshold levels. The second rule is that humans can't emit or dispose of wastes into any ecosystem at rates greater than its natural decomposing rate. If it happens, wastes and pollutants would accumulate and concentrate at harmful levels to humans and the ecosystem.

The trade-off between ecosystem services, particularly provision services and the regulating, cultural and support services, is at the heart of the issue of unsustainable use of ecosystems. As previously mentioned, the neoclassical idea is that natural resources and human-made capital are substitutable for one another; as the resource is depleted so the physical capital stock can be accumulated so as to substitute the resource in the production process in such a way that there is always enough output to hold consumption constant (Perman *et al.*, 2003). However, as argued by Villamanga *et al.* (2013), 'the flow of an ecosystem service is not sustainable when demand cannot be met by current capacity or when meeting demand causes undesirable declines in other services or in the future provision of the same service'. Neoclassical economic theory refers to such unsustainability as an inefficient or sub-optimal allocation of resources (Perman *et al.,* 2003). Within this ideology, renewable resources like forestry and fisheries are only managed optimally if there is no waste, in the sense that extraction of the resource in one period cannot be increased without it being decreased in another (essentially an optimal trajectory over time of resource extraction). The complexity of the ecological (and the economic) systems makes the impact of human activities on ecosystems and the changes to services that will arise, very difficult to predict. Nevertheless those interactions raise important questions related to efficient use of scare resources that economists need to research.

Another important concept in ecosystem management under the assumption of strong sustainability is the precautionary principle. Cameron & Abourchar (1991) explain that the precautionary principle could be applied in both environmental management and law for preventing any environmental damage. They define the precautionary principle as taking any action against a threat to an ecosystem or human being from adverse effects even if there is no scientific proof for future occurrence of damage. Cameron & Abourchar (1991) see the precautionary principle as a guiding principle for decision makers to prevent expected damages with low level of probability of occurrence. The FAO (1996) established some of the key elements of the precautionary approach:

It involves the application of prudent foresight, taking account of the uncertainties in fisheries systems and the need to take action with incomplete knowledge;

It considers the needs of future generations and the avoidance of changes that are not

potentially reversible;

It requires prior identification of undesirable outcomes and of measures that will avoid them or correct them promptly;

It requires that any necessary corrective measures are initiated without delay, and that they should achieve their purpose promptly, on a timescale not exceeding two or three decades;

It requires that where the likely impact of resource use is uncertain, priority should be given to conserving the productive capacity of the resource;

It requires that harvesting and processing capacity should be commensurate with estimated sustainable levels of resource, and that increases in capacity should be further contained when resource productivity is highly uncertain.

Cameron & Abourchar (1991) further elaborate on the precautionary principle that focuses on the philosophical and spiritual relationship between the environment and humankind which sustains physical existence. The precautionary principle is a re-evaluation of the economic path since industrialization, a path that led to many environmental issues. Therefore, it is advisable that Irish decision makers take into account the precautionary approach specifically in the case of fisheries resources management.

Next I discuss briefly how to apply the ecosystem based approach for forestry and fishery resources. Both forest (whether natural or planted) and fresh water bodies are ecosystems with many animal and plant species maintaining different interactions between each other and with the physical environment itself. Therefore both forest and aquatic ecosystems could be managed under an ecosystem based approach to achieve a set of conservation and development objectives. Forest ecosystems provide a series of ecosystem services, and forest could be planted and managed to maximize their delivery. However, Bengston (1994) explains that the main challenge of forest management is to meet the changing values of the society. Bengston (1994) further explain that professional forestry in USA accepted a new resources management paradigm that is 'multiple-use sustained yield' forest management which takes into account benefits such as timber, recreation, wildlife, water and other non-timber

forest products.

In relation to freshwater ecosystems, there are two problems in implementing the ecosystem based approach, firstly it is difficult to predict fish populations and second our understanding of the more complex dynamics at play in aquatic ecosystems is much more limited. Link (2002) explains that the term 'ecosystem' means a multi-species approach to marine biologists. It is obvious that each species has its own natural growth rate and therefore under an ecosystem based approach, the harvest of each fish species should be equal or closer to that specie's natural breeding and growth rate. Levin *et al.* (2009) stress the need for developing an information base to manage fishery resources under the ecosystem based approach. Information on the welfare implications of changes in the resource, as is looked at in chapter 4 is also essential for an ecosystem approach to the management of our fishing resources.

1.3 Overview of Research Objectives

Incorporation of natural resource and ecosystem service management into policy and development is a relatively recent occurrence and due to the complexity of natural ecosystem and human-behavioural dynamics there is as of yet no real consensus on what form it should take. The challenges in this regard are very evident in forestry and fisheries management where the ecosystems in each case exhibit greater spatial and temporal habitat and species diversity and ecosystem diversity than many other ecosystem types. This creates great demand for increased scientific understanding of these systems, but also for research into the dynamics of human interaction and willingness to pay to preserve such natural resources. Thus, the overarching objective of this thesis is to scrutinize human behaviour related to decisions, attitudes, and non-market values associated with flows of ecosystem services at different scales whether private or public.

To that end, the research has three main goals, which are addressed in three separate empirical papers. Specifically, the research aims to:

examine the forestry planting behaviour of Irish landowners. Moreover, the objective of this chapter is to estimate the size and direction of socio-economic and property specific variables which influence planting decisions;

examine the risk attitudes of Non-industrial Private Forest Owners (NIPFs) in Ireland and to estimate the impact of socio-economic and property specific variables of NIPFs on their attitude as to whether forestry should be insured or not;

examine and estimate the non-market value of recreational fishing in Ireland and in particular the public's willingness to pay for the preservation of the current quality of recreational fishing and current stock of fishing.

To achieve these objectives, my research applies econometric techniques based on microeconomic theory. These research objectives are achieved by analysing primary data collected especially in order to achieve these objectives

1.4 Structure of thesis

The main objective of this thesis is to examine the human behaviour associated with renewable natural resources, namely forestry and fisheries ecosystems management in Ireland, and to identify policy recommendations that could be applied to enhance the management of these resources in sustainable ways to maintain the continuous flow of ecosystem services for the country. The main body of the thesis consists of three separate empirical papers.

Chapter 2 examines the intention of agricultural land owners to convert at least a portion of their land area to forestry and secondly to analyze what percentage of land they are willing to convert to forestry using a double hurdle model. After explaining the status of private afforestation along with public policies for promoting such afforestation and current problems for reducing private planting, the chapter stresses the need of this research and explains data collection methods, justifies the methodology and econometric approach used by surveying the relevant literature. A theoretical framework is presented that explains the selection and use of the double hurdle model. Finally I discuss our results comparing the other results in the international literature.

Chapter 3 analyses the risk attitudes of NIPFs in relation to insuring forestry using a probit model and also profiles attitudes using a Wilcoxon rank-sum and Chi-square tests. This chapter begins by explaining the importance of understanding NIPFs risk attitudes in promoting private planting. Then the paper explains the different potential

risks for private forests in Ireland followed by a short literature review of potential risk mitigation methods. After reviewing the relevant literature on risk research in forestry, the paper moves on to justifying the econometric approach used in the paper followed by the presentation and discussion of results.

Chapter 4 estimates the non-market value of preserving natural fish stocks and for maintaining the current quality of recreational fishing in Ireland for recreational fishers and the general public using a generalized Tobit model (interval regression). The paper presents the survey instruments. Next the paper provides justification of the methodology for the model used to analyse the data set. Then summary statistics are presented as well as model results. This is followed by a discussion of results and a comparison to similar studies of non-market recreational fishing values in the literature.

Chapter 5 presents an overview of the main findings of the thesis and the key issues that emerged from each of the three empirical papers. The limitations of the research and potential future research required to overcome these limitations are discussed. Finally, I discuss how to use my results to formulate new polices for Ireland to cope with current afforestation and recreation fishery problems based on the research of this thesis.

1.4.1 Thesis Outputs

The research carried out in this thesis has led to a number of outputs to date. These include three working papers and a number of presentations at reviewed symposia. The more important research outputs are listed below.

(a) Publications

Vidyaratne, Herath, Ryan, M, Raghavendra, Srinivas, Nuala Ni Fhlatharatha (2012), 'Economic & behavioral factors motivating private afforestation decisions in Ireland', in *Conference Proceedings* of the International Union for Forest Research Organization (IUFRO) Small-Scale Forestry: University of Massachusetts, 2012, pp.189-195.

(b) Presentations

(i) Vidyaratne, Herath, Ryan, M, Raghavendra, Srinivas, Nuala Ni Fhlatharatha (2012), 'Economic & behavioral factors motivating private afforestation decisions in Ireland', Paper presented at Annual Conference of the International Union for Forest Research Organization (IUFRO), University of Massachusetts, Sep-2012.

(ii) Vidyaratne, Herath, Ryan, M, Raghavendra, Srinivas, Nuala Ni Fhlatharatha (2012), 'Economic & behavioral factors motivating private afforestation decisions in Ireland', Paper presented to the Annual Conference of the Agricultural Economics Society of Ireland, at The Royal Dublin Society, October 2012.

(iii) Herath Vidyaratne (2012), ' Multiple risk perceptions of agriculture and forest landowners of the Republic of Ireland on forest benefits, paper presented to the International Conference on Applied Microeconometrics and Public Policy, J.E. Cairnes School of Business & Economics, National University of Ireland, Galway, 2010.

Chapter 2 Economic and Behavioural Factors Motivating Private Afforestation Decisions in Ireland

2.1 Introduction

In Ireland, forestry is an expanding and developing activity in the rural economy, with forests covering over 750,000 hectares (ha), 11% of the total land area in 2012, from a low base of one per cent in 1920 (Forest Service, 2012). However, while Ireland has a low forest cover, it has some of the fastest growth rates in Europe for conifers in particular (Farrelly, 2010). The increase in forest cover is the direct result of a variety of government policies and incentive programmes to promote afforestation from the early 1920s to the present day. Prior to the 1980's, virtually all planting was carried out by the State. Since the mid 1980s, through the introduction of a variety of support packages aimed largely at farmers, the government has sought to significantly increase the rate of private planting in order to increase the proportion of land in forestry use (Kearney, 2001). The result has been a dramatic reversal in the balance of afforestation between the State and private (farm) forestry sectors. Since 2001, private ownership of forests has increased from 24% of the total forest area in 1980 to 47% (358,652 ha) in 2012 (Forest Service, 2013).

The publication in 1996 of Ireland's strategic forest policy document, 'Growing for the Future' (DAFF, 1996) focused on the expansion of the sector and envisaged an increase in the area under forestry to 17% by 2030. A review of this strategic plan for forestry (Peter Bacon & Associates, 2004) recommended that a national planting target of 20,000 ha per year was critical to secure a sustainable timber processing sector in Ireland. Despite the presence of financial incentives, there has been a downward trend in the annual rate of afforestation since 2006. In recent years, annual afforestation has dropped to 6,653 hectares (ha) in 2011 and 6,652 in 2012, well short of the government target of 14,700 ha (Forest Service, 2013). This level of uptake lags far behind what would be expected from an analysis of the economic returns to forestry (Behan, 2002). This is a cause of concern to both policy makers and to the forest sector in general.

There are unexpected and less understood causes for less planting apart from reasons of financial incentives and other support programs. One reason which has been less

examined and has been paid less attention by policy makers is stock effect, which means that the available total extent of land for planting is reducing gradually as famers have been planting every year. In addition, not every farmer is affected by financial incentives and other subsidy programs and therefore as Wiemers & Behan (2004) explain they are reluctant to plant. I visited some farms and had discussions with farmers. They have some uncertainty with respect to future benefits (Wiemers & Behan, 2004) in spite of many incentives. The other incentives offered for agriculture also would play a negative role for planting. Therefore, there is a need to understand the pattern of thinking among farmers about tree planting behaviour based on individual factors which I attempt in this chapter.

The conditions attached to current incentives regarding land use may serve to disincentivise farmers-they may resent the loss of autonomy over land. Offering higher subsidies may address this but equally increasing the degree of autonomy-reducing the lock-in period or staggering this may address concerns on the part of landowners.

When deciding between alternative land uses, farmers must consider the economic outcome of each alternative land use, taking account of potential differences in risk and uncertainty. However, rational agents make decisions based on their expected utility in each scenario rather than solely the financial outcomes associated with them. Thus it is important to include relevant non-pecuniary factors such as the influence of age, education, knowledge or peer's attitudes in any analysis. Behaviour which may initially appear irrational could in fact reflect the importance of non-pecuniary concerns in farmer's utility functions and hence may be in keeping with rational utility maximizing behaviour.

It is well known that neoclassical economic analysis focuses on individual utility maximization subject to budget constraints in the current period. However, Strotz (1955) expands the utility maximization framework to an inter-temporal context in which individuals choose for future periods of time in order to maximize utility in the current period. Further, Strotz (1955) explains that the general problem of inter-temporal utility maximization is that the decision-maker chooses various activities relating to original decision in the course of time. Meanwhile Davis *et al* (2006) explain that the value of a site (private land in this case) depends on the resource

quality, threats to resources and costs. These two explanations are in line with utility maximization by deciding to plant trees in private lands. As Strotz(1955) explains that in the current period both financial and non-pecuniary variables of landowners effects the decision-making to planting and the area to be planted. Therefore, financial variables of land owners such as household income, off-farm income, expected income from thinning, expected profits from final-felling as well as non-pecuniary variables which effects utility maximizing in the current period such as inheritance and irreversibility are included in my utility maximization model along with socio-economic variables of landowner's education, age and gender.

In his analysis of the afforestation subsidy program on private lands in Denmark, Madsen (2003) found that individual farms should be considered as rational economic units in the implementation of subsidy programs but the study found that farmers take a wide range of factors including non-pecuniary considerations into account in decision making, which I attempt. In an Irish context while the financial motivation behind the decision to plant land has been examined in a number of valuation studies, many of these studies have either ignored or placed less importance on other non-pecuniary factors (O'Leary *et al*., 2000: Behan, 2002; McCarthy *et al*., 2003; Wiemers & Behan, 2004 and Breen *et al*., 2010).

McCarthy *et al.* (2003) assessed the economic determinants of private afforestation using county level panel data. They found that the forestry planting grant, forestry subsidies, area under Rural Environment Protection Scheme (REPS), agricultural income, and net revenue from forestry are all significant determinants of private afforestation. The effect of the financial returns from timber sales, while statistically significant, was relatively low. One possible explanation for this may be that the economic benefits from forests are only realized in the long-run, (final-felling of conifers and broadleaves may not occur for 40 and 60 years after planting respectively), whereas farmers operate their farm enterprises on an annual cycle.

Behan (2002) showed that in 2001, the net present value (NPV) of forestry returns in Ireland exceeded that of beef and sheep enterprises in all regions, particularly in the western regions of Ireland. This finding coincides with recent work conducted by Breen *et al.* (2010), which analysed the NPV of a change in land use from each of the main agricultural systems in Ireland (dairy, dairy other, cattle rearing, cattle other,

sheep and tillage) to largely conifer and largely broadleaf forests. The analysis generated the opportunity cost of afforestation by calculating the gross margin foregone and working capital released for each superseded agricultural enterprise, when a portion of the land is afforested. The analysis shows that the NPV of a land use change to conifer forest is significantly higher than that of any of the superseded farm enterprises, with the largest NPV arising from a land use change from cattle farming to conifer forestry. As the majority of Irish farmers are in the cattle rearing and cattle other systems, this analysis would suggest that from a purely financial perspective, there should have been a much greater uptake of farm forestry than that which occurred.

In reality, there are probably many factors at play in the lower than expected uptake of farm forestry. Wiemers & Behan (2004) report that Irish farmers have a strong link with their existing agricultural land use and therefore are reluctant to convert agriculture to forestry in spite of higher returns (higher net present values) accruing from afforestation. This finding is consistent with earlier work conducted by Ni Dhubhain & Gardiner (1994) and O'Leary *et al.* (2000) that reported reluctance among Irish farmers to plant forests. The main reason behind farmers' negative attitudes towards forestry was not dissatisfaction with the financial rewards, but rather a negative cultural bias towards forestry (O'Leary *et al*., 2000). Forestry has traditionally not been seen as an integral part of agriculture and most farmers consider forestry only as an alternative land-use for their worst land. Ryan *et al*. (2008) found that farmers who have more land are (a) more likely to plant and (b) likely to plant more land.

McDonagh *et al*. (2011) in Ireland involved a field survey of 1,016 farmers as part of the 2006 Teagasc National Farm Survey (NFS). For 48% of the farmers who stated that they would not plant, the most important barrier to planting land was that they "needed their land for agriculture". This was despite the introduction of the single farm payment (SFP), which had allowed farmers to plant a large proportion of their land without losing any payments. Frawley & Leavy (2001) found that Irish farmers perceived the main reason for not converting land to forestry was that their farm was "too small/need the land". This reluctance to plant is not unique to Ireland as Watkins *et al*. (1996) found that most UK farmers did not want woodland on their farmland, as

they saw their land as being exclusively a preserve for agricultural production.

Land quality is an important determinant of land use (Stavins & Jaffe, 1990). Ni Dhubhain & Gardiner (1994) report that of those farmers who stated an intention to plant land in the future, 58% said that their land was good for nothing else. Farmers who felt their land was of high quality were reluctant to plant, with 39% of those who said they would not plant believing that their land was "too good for forestry".

In the NFS survey discussed by McDonagh *et al*. (2011), farmers felt that the most important barrier to afforestation was that they needed all their land for agriculture. The irreversibility of the planting decision was ranked as the second greatest barrier to afforestation. Once land has been afforested, it cannot generally revert to any other land use (Forestry Act (1946)). McDonagh *et al.* (2011) argue that the permanent nature of the afforestation decision seems to force some farmers into a more cautionary approach lest they find that having made such decisions the economic and/or political landscape subsequently changes. Allied to this is the preference of farmers to have farmland to bequeath to their son/daughter. This succession in terms of farming practice seems to favour lands on which traditional agricultural practices can continue as opposed to lands under forestry. McDonagh *et al.* (2011) also report that discussions with farmers have revealed concerns that their decision to plant trees would restrict decision making for future generations in terms of the type of farming they could conduct. Farmers were particularly concerned that making such a decision now could ultimately lead to their successor opting out of farming altogether.

Ross-Davis *et al*. (2005) examine private hardwood planting behaviour in Indiana, USA, and find that 72% of respondents were motivated by a desire to provide trees for future generations, 59% by a desire for providing habitat and food for wildlife and 54% to conserve the natural environment. Amacher *et al.* (2003) reviewed the literature examining the substitution effect between agriculture and forestry behaviour and highlighted the importance of analyzing bequests (inheritance of property by descendants) of forest owners in policy design.

Carter (1992) examined private tree planting behaviour in hill areas of Nepal. The study found that landownership is a critical factor in influencing tree planting and that wealthier farmers plant more trees than poorer farmers. Secure property rights play an

important role in determining land use and have been linked in the literature to deforestation (Alston *et al.,* 2000; Bandiera 2007; Araujo *et al*., 2009; Liscow, 2013 inter alia). Liscow (2013) uses an instrumental variable based on Nicaragua's agrarian reform to identify an increase in deforestation associated with property rights and argues that this occurs due to investment increasing returns to other land uses by improving agricultural productivity. On the other hand Araujo *et al.* (2009) fail to reject the hypothesis that insecure property rights increase deforestation in Brazil.

These two positions may be reconciled by considering that forestry returns are heavily concentrated in the distant future and hence risk leads to these returns being more heavily discounted when property rights are insecure. Thus more secure property rights decrease the discount rate and hence make forestry more attractive. On the other hand increased returns from agricultural production due to investment will accrue in the short-medium term so that more secure property rights lead to increased deforestation which of the two scenarios manifest in a given context when property rights become more secure depends on the relative magnitude of the medium term agricultural return and the delayed returns from forestry as well as on the initial level of threats to property rights.

Within the context of the foregoing literature, the objective of this paper is to critically examine and better understand the determinants of farmers' afforestation decisions. These determinants are the socio-economic attributes of the landowners, traditional land uses, land and soil attributes, the regulatory environment, farmer's perceptions of market trends (prices and subsidies) and the irreversibility of converting agricultural land to forestry, inheritance. Many of the previous studies in this area have tended to evaluate the planting decision on the basis of either financial gains or in terms of motivational factors. This study aims to provide more comprehensive results by encompassing the analysis of both economic and behavioural factors affecting the afforestation decision making process.

2.2 Theoretical Framework

An investor such as tree planter can think in line with capital budgeting lines to select a project. Capital budgeting deals with ranking of alternative projects in order to find investment alternatives for the same asset for maximizing its returns. Six criteria are

mainly used for ranking projects: Net Present Value (NPV), Land Expectation Value, Benefit Cost Ratio, Payback Period, and Internal Rate of Return (IRR) and Extended Cost Benefit Analysis (ECBA).

Fautsmann formula is based on Land Expectation Value (LEV). The formula (Fautsmann, 1849) is still widely acknowledged as the first scientific approach for assessing willingness to pay behaviour of purchasing a bare land and then using for tree planting (Pertz, 1983). Moreover, the formula provides a basis for optimum thinning and rotation of a forest stand under the constant timber prices, harvesting costs and interest factor during a given infinite period of time called perpetuity. This formula is also called Land Expectation Value (LEV) because it estimates expected net benefits from the bare land by planting trees. However, Fautsmann formula does not capture non-market values as well as compare alternatives of land uses but Extended Cost-Benefit Analysis (ECBA) would discount future returns including non-market values and compare the alternatives. The formula only takes into account timber benefits of final clear felling, thinning incomes from a few thinning in perpetuity and different administration and management costs during the perpetuity and one spot cost of replanting after clear cutting. All these costs and benefits occurring in different times of the project are discounted to the present period using the interest factor of the investor, not the market one. But Conifer trees in Ireland in general takes over 40 years for clear felling and broadleaves trees take over 60 years for clear felling. Therefore, market interest factor is not constant during such lengthy periods in Ireland. There are the other benefits of forests. According to Adger *et al.* (1995) forests have economic, ecological, cultural and aesthetic values but decisions on logging, management and conversion of land always depend on economic criteria. Also in the same way Fautsmann formula captures only a part of economic values. The other factors landowners consider when they make a decision to plant trees in land are option value (irreversibility), existence value, and bequest value (inheritance of property to children). However, other benefits in addition to benefits estimated through Fautsmann formula are collection of mushroom, berries, firewood collection, using the forest for family recreation.

However, one weakness of the formula is that it only takes into account profits from timber ignoring all the other economic benefits, and issues which are assumed to be

harder to estimate but considered by landowner in planting decision. The next weakness is that forest growth, prices of timber, costs and interest factor are considered as constants (Samuelson, 1976 and Pertz, 1983). Such factors, which are not taken into account in Fuatmsann formnaula (formula 1 below) are land quality, irreversibility of planting, inheritance of forest stands (bequeathing).

$$B_0 = \frac{A_u + \sum_{a=1}^{u} D_a . i^{u-a} - C.i^u}{i^u - 1} - V \qquad (1)$$

Where B_0 =land expectation value (present value of discounts timber benefits and costs) , A_u =harvesting yield at the end of rotation period, u =length of rotation period, D_a =thinning yields at age a , i =interest factor, C=costs for replanting, V =capital for administration. Land Expectation Values (also called soil expectation value) is a standard Discounted Cash Flow (DCF) technique applied to timber land situations to derive Net present Values of revenues and costs. In this formula, all revenue (income –costs) are in annuity wise (annually) discounted to present year for during all the forest investment period called perpetuity period.

People make investment decisions under utility maximization under which they consider both financial returns as well as non-pecuniary aspects. According to Beach *et al.* (2005), investment behaviour of private tree planter could be explained by two theories: firstly profit and utility maximization, which is maximizing discounted profits over time without consideration of benefits associated with non-market goods produced by their forests and secondly utility maximization under which forest owners may gain non-pecuniary benefits such as aesthetics, recreation, wildlife habitat from forest stand in addition to timber benefits.

Therefore I adjust the following utility function for private tree planting.

$$U = (B_0, B_1, N_P) \qquad (2)$$

Where U= utility of planting trees, B_0 =land expectation value, B_1 =benefits which are not capture by B_0 such aesthatic and recreational values, N_P =impact of Non-pecuniary aspects.

Some of these non-pecuniary aspects are land irreversibility of planting, inheritance of property to children, which I attempt to capture here and which are not well developed in the literature. I attempt to estimate the impacts of irreversibility and inheritance in first time in literature along with other socio-economic and property specific factors. Therefore I apply this utility function to capture both financial returns and non-pecuniary aspects.

As a means for conceptualising the landowner's decision whether to plant or not, one could consider a Belmann equation whereby landowners choose between a variety of land uses so as to maximise the sum of current and discounted expected future rewards (Frey *et al*., 2013):

$$V_t(s) = \max_{x \in X(s)} \{ f(s,x) + \delta E_t [V_{t+1}(g(s,x,\varepsilon))] \}$$

where $s \in S$ and t =1,2,…,T.

where $V_t(s)$ is the value of the land use in state *s* and *f(s,x)* is the reward from choosing action *x* in state *s*, δ is a discount factor and *g(s,x, ε)* is a transition function from state *s*, actions *x* and shocks *ε* (e.g. variability/risk). Frey *et al.* (2013) state that *f(s,x)* represents financial returns from an action, which is logically similar if instead this function represents utility. In such a case, the function *f* may incorporate non-financial considerations which may impact on the desirability of a particular course of action from the perspective of the landowner. McFadden (1974) observed that choices of individuals can be understood through a random utility framework and hence these choices may be analyzed using discrete choice models. Such an approach has been extensively employed previously in examining land owner decision making (Horne *et al.*, 2005, Mäntymaa *et al*., 2009). Similar arguments may be used to justify individual's choices in the context of the framework outlined above. Factors such as increased returns to forestry would serve to increase *f(s,x)* while increases in farm returns would decrease it. However, non-pecuniary considerations may also be represented within *f(x,s)*, for example disutility associated with negative reactions of peers when engaging in non-traditional farm practices.

2.3 Econometric Approach

While the variable of interest, area planted, is a continuous and non-negative variable, many farmers will choose not to plant any land. Thus estimation with OLS will be biased unless this structure of the data is accounted for. A common approach to dealing with censored data is the Tobit model. However, this model assumes that a common set of explanatory variables determine the decision whether to plant and the extent of planting, restricts the coefficients of the explanatory variables to be the identified as the same for both decisions. A more flexible approach would be the double hurdle model, which was first introduced by Cragg (1971). In the current context, the double hurdle model allows a set of explanatory variables to explain the landowner's decision whether to plant and then allows another set of variables to explain the extent of planting. The second set of explanatory variables may be the same as the first set in which case the model is more flexible than Tobit as coefficients are not restricted to be identical across the two steps of the planting decision. The double hurdle model uses a Probit model to analyse the first decision whether to plant and a truncated regression to analyse the second decision as to the area to be planted.

These models have been widely applied in the literature (Burton *et al*., 1996; Newman *et al*., 2001 and Newman *et al*., 2009 inter alia) and were used by Dhakal *et al.* (2008) to analyse small landholder planting behaviour in New Zealand. In the first stage a Probit model is used to explain the decisions whether to plant (P) is given by,

$$P_i^* = X_i\beta + \varepsilon_i \quad \text{where} \quad \varepsilon_i \sim N(0,1)$$

$$P = 1 \quad if\ P_i^* > \tau$$
$$P = 0 \quad if\ P_i^* \leq \tau$$

where P_i^* is a latent variable ($-\infty < P_i^* < +\infty$) determining the observed decision to plant of the ith household ($P_i=1$ if a farmer decides to plant, $P_i = 0$ if farmer decides not to plant). X_i is a vector of explanatory variables influencing the decision whether to plant, β the vector of coefficients and τ is a cut-off point whereby if the propensity to plant exceeds this value, planting occurs. In the second stage, I use a truncated regression to analyse the financial and socio-economic factors which influence the

area planted for landowners that choose to plant (A) in the first stage,

$$A_i = Z_i\alpha + \mu_i \text{ where } \mu_i \sim N(0, \sigma^2)$$

where A_i is the area of planted land (ha), Z_i a vector of explanatory variables determining the area planted, α is a vector of coefficients and e_i and u_i are normally distributed error terms. Since this model only applies to landowners that decide to plant in the first stage, A_i is truncated at 0. The models are estimated using Maximum Likelihood Estimation (MLE). However, if the normality assumption is violated, estimators can be biased. As a means to test the sensitivity of results to the normality assumption, I re-estimate the models using an inverse hyperbolic sine (IHS) transformation and hurdle version of the zero-truncated negative binomial models. The pattern of significance of estimates was almost identical across the models. However since the coefficients in the second stages of the transformed models are not readily interpretable as marginal effects – unlike those in the Cragg's model, I focus on the simpler Cragg's model here.

2.4 Data collection and analysis

A number of informal interviews were held with individual farmers and groups of farmers in order to gather baseline knowledge about the variables influencing planting. This provided valuable information for the design of a subsequent survey questionnaire and also informed the assumptions made in analysing farmers' decisions to convert land to forestry.

A postal survey of a) farmers in general and b) forest owners was carried out during March and April of 2011. The survey sample for farmers was drawn from an agricultural advisory database for counties Galway, Clare, Kilkenny, and West Cork. From my discussions with farmers, I believe these four counties represent climatic conditions, soil fertility and farming systems in areas where the planting of forests is more likely. These farmers may or may not already have forests. Two hundred farmers were selected (every 10th name on county database) from each county giving a total of 800 farmers.

From the Forest Service database of forest owners, 800 forest owners were randomly

selected countrywide. I received 225 responses from farmers in general and 250 responses from forest owners, giving an overall response rate of 29% (475/1600*100). However, some questionnaires lacked information on key variables and hence were excluded from the analysis, leaving a total of 345 questionnaires that were analysed. The questionnaire was divided into two parts. Section one was to be completed by all farmers irrespective of whether they had forestry or not and included land use information such as the extent of the farm, soil types and attitudinal questions regarding the various benefits of forests as well as the irreversibility of conversion to forest, and inheritance (bequeathing) concerns. This section also included questions on the reasons for planting; factors limiting planting, measures of forest premium and timber price uncertainty, as well as socio-economic variables. Only forest owners were requested to answer section two which included forestry related questions such as the extent of forest cover and species, age and soil type of afforested land, along with questions regarding respondents' access to information and expectations of the benefit streams from forestry.

Table 2.1. Variables, their names and units used in models

Variables	Units
Planted or would like to plant (dependent variable)	yes 1, no 0
Total landownership	hectares
Age	Years 40-49
	Years 50-59
	Years 60-69
	>70 years
Education (Degree/Diploma)	1, 0
Gender	Male (1), Female (0)
Land Irreversibility (Forestry)	Likert-scale
Forest premium	Likert-scale
Inheritance	Likert-scale
Using forest for tourism	Likert-scale
Knowledge on benefits of forests	Likert-scale
Income expected from thinning	Monetary values
Income expected from final felling	Monetary values

The summary statistics of the variables in Table 2.1 above reveals the total extent of land owned was used as a variable to test the hypothesis that the greater the extent of land owned, the higher the probability of planting some land. The average land ownership was 58 hectares. Off-farm income was included to capture the importance of farm income to the household (farmers with high off-farm income may view planting as more attractive than farming). The average off-farm income was €18750.3

across all farm households with only approximately 20% of the sample reporting no income from off-farm work. Thirty percent of the surveyed farmers report having a third level education. An average forest premium of €430 is paid annually to farmers who plant land as a compensation for loss of agricultural income (Breen *et al*., 2010). There was moderate agreement among farmers that this represented a 'good' income from the land. Irreversibility may be expected to influence the planting decision but the average level of agreement (on a 5 point Likert scale) with the statement "Planting land could be a bad decision as you can't change the land back to other uses" suggests this may not be the overriding barrier to planting in Ireland.

Here, the variables included to capture the expected income from thinning and clear felling of forest substantiates what several studies (Askari & Cummings, 1976; Godoy, 1992; Warford, 1989 and Démurger & Yang, 2006) confirms as a major result that policy changes can influence the behaviour of landowners as they respond to price changes. This study also attempts to understand the importance of landowners' expectations of future timber prices in influencing their decision to plant. In general farmers disagreed with the statement "You could get an income using a forest as a tourist site" suggesting that timber production is a more important motivation for planting.

2.5 Results and Discussion

The results of both models are presented in Table 2.2. The variable representing extent of land is highly significant in both models. Only those in the age group 'greater than 70 years' are more likely to have forests. However amongst those that have planted, older farmers are likely to have planted larger areas. Education (having third level educational qualifications) appears to significantly influence landowners who would plant and also how much they plant. The reason could be educated farmers would be more aware of the future forest benefits to descendents and as a whole to the society.

As expected, irreversibility is a significant negative influence on the decision whether to plant, however once a decision to plant is taken irreversibility seems not to influence the extent of planting. The desire to leave a bequest (inheritance) appears to be a strong motivator of planting decisions since farmers that agreed that a forest

could be a good inheritance but it is not significant for planting higher extent of lands. Farmers that felt the current level of premium represented a good income were more likely to plant although surprisingly this did not lead to increases in the area planted. In the questionnaire, many forest owners recorded that they planted land to increase the income from their marginal land. Thus farmers may have felt it was a good income for their marginal land rather than all of their land.

Table 2.2. Results of Probit and Truncated models

Variable Name	Probit Model (deciding to plant)	Truncated Regression (extent planted)
Extent of landownership	0.0051* (0.003)	0.646*** (0.034)
Age40-49	0.380(Not significant) (0.284)	7.694 (Not significant) (8.646)
Age50-59	0.380(Not significant) (0.285)	22** (9.0)
Age60-69	0.322(Not significant) (0.311)	23.384** (9.673)
Age greater than 70 years	0.699** (0.356)	24.724** (10.734)
Education (third level, Diploma/Degree)	0.407** (0.06)	3.486* (5.203)
Importance of irreversibility of planting	-0.09*** (0.024)	-2.788* (1.704)
Importance of Inheritance	0.278*** (0.068)	1.20 (Not significant) (2.487)
Importance of Forest premium as a good income	0.111* (0.066)	0.651(Not significant) (2.397)
Using forest for tourisms	-0.047(Not significant) (0.063)	3.056(Not significant) (1.993)
Land users' knowledge on forest benefits	0.196** (0.064)	-3.154(Not significant) (2.811)
Expected income from thinning	-0.038(Not significant) (0.101)	Not significant (3.102)
Expected income of clear felling	0.147 (Not significant (0.099)	Not significant (2.416)
Household income	-0.07(Not significant (0.052)	-3.18(Not significant) (1.384)
Off-farm income	0.102* (0.054)	2.803** ((1.398)

Note: *** means probability P< 0.01, **means probability 0.01>P>0.05 and * means 0.1>P>0.05.

The potential use of forest for tourism to generate income appears to operate in two directions; on the one hand it acts as a disincentive for planting perhaps other considerations are more important here. Therefore, using potential for tourism is

insignificant. However after deciding to plant, farmers may be increasing their planting in recognition of the fact that a larger forest will draw in more tourists, although in fact this may also be an indicator of reverse causality, with larger planted areas leading to a greater appreciation of potential tourism revenues. One may anticipate that since income from thinning is an early stream of income from forestry that it may be an important driver of planting decisions. However, the expected incomes from thinning are insignificant in this analysis. Out of the 345 questionnaires analysed, 185 landowners (52%) answered that they didn't know the value of thinning which may explain this result. I would anticipate that expected income from clear felling would be the major income source from forestry. The clear felling significantly does not influence both the decision to plant and the area planted. This may reflect the effects of discounting this income stream since final felling of conifers and broadleaves may not occur for 40 to 60 years after planting and hence these returns may be heavily discounted when making planting decisions. The landowner's knowledge on forest benefits plays a significant role only in deciding to plant.

2.6 Conclusion

To date a number of studies have examined planting behaviour in Ireland. This study analyses how key determinants contribute to the dual decisions to plant and to the extent of planting. The landowner's satisfaction around the level of the forest premium payment is significant in positively influencing the decision to plant, but not for planting higher extent of land**.** Off-farm income increases the probability of planting but not the extent of planting.

The other financial variables analysed were the expected incomes from both thinning and clear-felling. Surprisingly, the analysis shows that these have relatively little impact on planting indicating that the long-term value of the timber is perhaps not a central factor in the decision making process. This finding has also been recorded in other countries. In their 2003 study, McCarthy et al. also found that the effect of financial returns from selling timber was significant but only at a low level. In a study carried out by Démurger & Yang (2006), profit seeking behaviour in making the decision to plant in China was found to be weak in comparison to profit seeking behaviour in making agricultural decisions. Godoy (1992) observed a similar

phenomenon; while timber prices played a role in the decision to plant, they were insufficient to induce landowners to undertake planting on a commercial scale.

Age appears to play a much stronger role. The effect of landowners' knowledge of the benefits of forestry also plays a large role in influencing the decision whether to plant, whereas it does not significantly influence the area to be planted. It is perhaps surprising that only the age group greater than 70 years is significant in affecting the decision to plant, indicating that older farmers are more likely to have a forest. It may be the case that older landowners can no longer work their land and are therefore more likely to have planted. Overall the study concludes that a myriad of factors, behavioural as well as economic, play a role in the decision making process involved in converting land from agricultural use to forestry. These factors need to be taken into account in formulating policy to incentivise the continued afforestation of agricultural land in Ireland.

However, there are serious challenges in promoting forestry in private lands mainly in order to generate more social benefits at both national and global levels for a number of reasons. One main reason is that most benefits generated by forests are social, and are therefore not the ones not restricted to private values only. For example, the value of climate regulation in absorbing carbon, value of biodiversity, rain water purification benefits, the value of recreation, soil conservation benefits and nutrient cycling benefits are all social benefits. Therefore, private land owners have only their individual share of benefits. These benefits are not currently either fully or adequately internalized so that only these which are adequately internalized provide the tree planters with more benefits. The other challenge is that governments have financial constraints to fund planters based on total social benefits of their forests. However, under these circumstances non-market valuation of these social benefits play a vital role as they give rough estimates of their financial values. Finally, there is the challenge for society and the government which needs to maintain food security by leaving substantial optimal land areas for agriculture practices. A key difficulty in internalizing such effects is first obtaining credible valuations for them and second agreeing who should pay.

Chapter 3: Risk Attitudes of Non-industrial Private Forest (NIPF) owners in Ireland for Insuring Forests

3.1 Introduction

Non-industrial private forest owners' (NIPFs) risk attitudes on different risk aversion (mitigation) methods are very useful for policy makers for planning and management of private forestry in Ireland. Therefore, this chapter attempts to estimate risk attitudes of NIPFs in Ireland in believing insuring their private forests. According to the Forest Service (2013), NIPFs in Ireland own 358,652 ha in 2012, which is about 47 per cent of the total land area in the country. Therefore, NIPFs have a great share of forest ownership in the country and provide timber, wood products, and non-wood forest products for industries. They also support carbon sequestration and conservation of biodiversity, protecting genetic diversity, recreational and aesthetic values, as well as functional values such as watershed protection, nutrient cycling etc. Acknowledging the key importance of the private sector contribution in this sphere, Irish government plans to increase the current forest cover of 11 per cent to 17 per cent of the total land area in Ireland by 2030 (DAFF, 1996). The government plans to achieve 6 per cent increase by private planting in the coming years according to Clinch (1999), whereas most of the government lands have already been planted. The trends of both private planting and public planting, since 1922, can be seen in Figure 3.1. It is worth mentioning that forest cover in the country at the time of independence was 1% and since then every government has attempted to increase the forest cover both in private and public lands through various means.

However, according to Figure 3.1, the rate of afforestation has been reducing at a constant rate. Wiemer & Behan (2004) emphasize that risks associated with the potential forest benefits perceived by NIPFs as major reason for the reduction in tree planting in private lands. Therefore, examining and understanding NIPF's risk attitudes, risk propensity and perception, risk mitigation behaviour hold a key importance in promoting, managing and administrating private tree planting in Ireland. Given the complexity arising from multiple dimensions of risk and their interaction, the analysis here considers only the risk attitudes of NIPFs reflected in insuring their private forest, which is an outcome of their risk perception and

propensity.

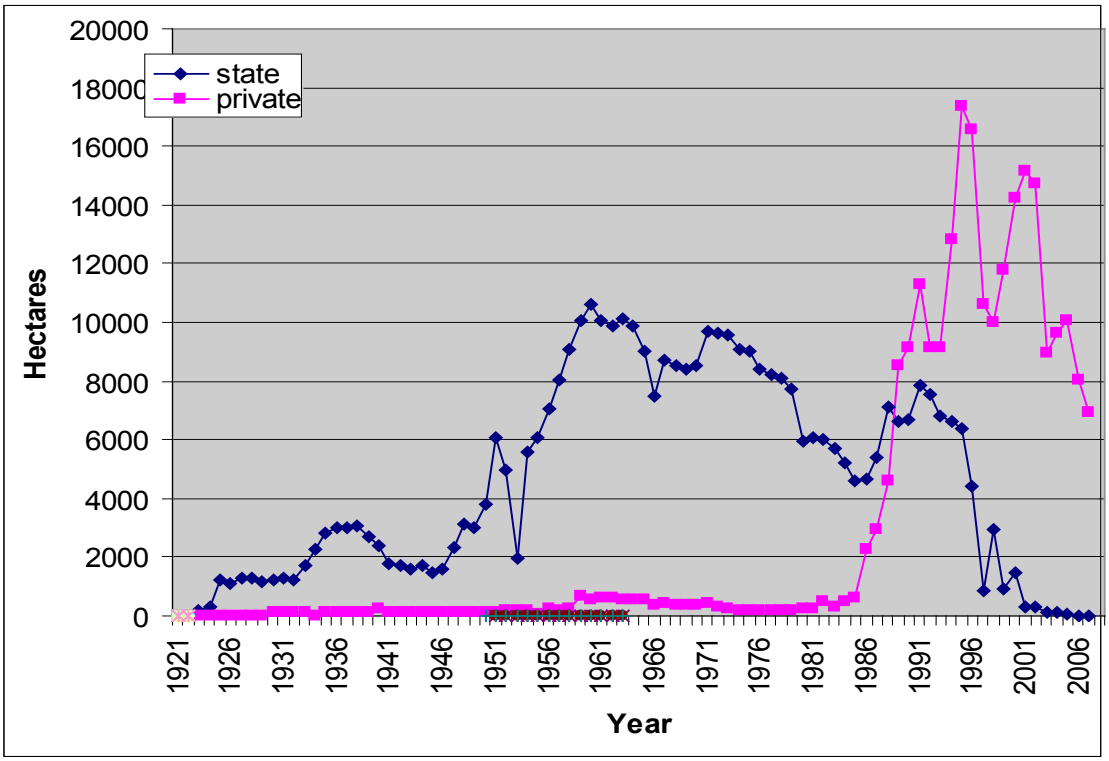

Figure 3.1. Afforestation in Private and Public Lands in Ireland from 1921 to 2008. (Source: Forest Service Data, 2009)

Private tree planting is a long term investment and hence it inherits unprecedented multiple risks associated with different time scale. Forestry can be described as a high risk activity and various forms of risk arise from natural or man-made forest fires, wind and storm damage, beetle and insect damage, forest pathogens, browsing by animals, damages to property etc. Forest fires also cause damages to private property and lives of people in addition to those of NIPFs, which is deemed to be public liability in the terminology used by the insurance companies.

There are many forest risk aversion (mitigation) methods. NIPFs can follow a single or a combination of risk aversion methods out of methods available. However, the main risk aversion (mitigation) methods followed by NIPFs are insuring forests against different kinds of risks, improving management of forests, regular monitoring of the forest stand and the diversification of total land area for different land uses. In this chapter, the analysis is conducted for three major risks; forest fire, storms and wind damages, and beetle and insect attacks that can damage forests.

3.1.2 Forest Fire Risk in Ireland

Forest fires are common hazards in every part of the world. They cause damage to timber stock, loss of lives, loss of biodiversity habitat, aesthetic values, different ecosystem functions and carbon stock. According to Irish Agriculture and Food Development Authority (TEAGASC) the most serious risk in Ireland arises from forest fires. They have destroyed 16,000 hectares of forest in the last 15 years at a cost of €20 million. In 2010 and 2011 alone, 3,000 ha of productive forests were destroyed by forest fire. According to the private forestry business company Woodland, at least 500 ha of private forestry were destroyed by fires in 2010 and costs have been estimated at €1.75 million for replanting, €1.5 million for loss of growth and €200,000 for fire fighting costs, not including the time and costs incurred by owners. However, there have been provisions in the Wildlife Act (Amended 2000), regarding forest fires. Section 39 of the Wildlife Act, 1976 (amended in 2000), provides guidelines to prevent forest fires and penalties for activities that lead to forest fires. Ireland is also a member state (among 37 members) of the European forest fire information system (EFFIS) established in 1998 which is tasked with exchanging information among EU member countries for preventing forest fires (European Commission, 2012).

The Irish Forest Service requires NIPFs to insure their forests as an obligation since they get planting grants and premiums as a promise of maintaining forest for the period of 20 years. As insurance covers the cost of replanting since June 2009, NIPFs can reconstitute the forest in the case of fire damage on average, the coverage is €3,000 per ha though this is subject to changes in the value of timber and the age of the forests (The Irish Agriculture and food Development Authority, www.teagasc.ie accessed 25th April 2014).

3.1.3 Storms and Wind Damage

Ireland is a country at the edge of Atlantic Ocean. Most of the time, wind and storms cause damage to trees by breaking stems and/or branches and in some cases destabilise to cause the uprooting of the trees. Nieuwenhuis & O'Connor (2001) estimate the costs to two forests in Ireland from storm damage in 1997. The total cost of forest in Middelton being IR£163,252 which was 28 per cent of the average annual

stumpage value of the forest. The total cost for the forest in Skibbereen was IR£641,900 which was 126% of the average annual stumpage value. The costs of storm Darwin on February 12th in 2014 were estimated to be €7.5 million. The storm blew through 5000-7000 hectares of forests (http://www.forestryservices.ie, accessed on June 26, 2014). Peterson (2000) explains that projected climate change might influence the frequency and intensity of wind storms. The interview discussions with NIPFs suggest a rough estimate that Ireland lost 7000 ha from storm damage in 2014, which is about 1 per cent of Irish total timber stock and 2 per cent of NIPFs standing forest.

3.1.4 Beetle and Insect Attacks, Pathogens

Rouault *et al.* (2006) propose that long droughts (as result of warming climates) may impact forest ecosystems by interacting natural distributions of insect pests, pathogens and fire. Increasing temperatures would increase the egg and larvae developments and increase survival rates from predators by reducing time spent in the development stages of larva. Insect and beetle attacks to forests are also a very serious problem such that it could destroy entire forests within a year. The insect populations increase exponentially in short favourable periods of time. For example, Christiansen *et al.* (1987) say that bark beetle can kill large numbers of conifer trees in a single year. Alexander & Anderson (2012) confirm that there are 208 wood decaying insects and beetles in Ireland. On the other hand, there are some invasive beetles attacking and destroying forests in the USA and Canada. There is a risk of these species coming to Ireland (via international trade) and spreading. For example, Therese & Deborah (2006) note that *emerald ash borer*, a native beetle to Asia, killed 15 million trees in Michigan in the USA and in Canada in 2002. The other dangerous invasive beetle destroying forests are the Asian *long horned borer*, which are also native to the USA.

In concluding, Schelhaas *et al.* (2003) estimate the loss of 35 million cubic meters of wood between 1950 and 2000 in Europe. Of these damages, 53 per cent were caused by storms, 16 per cent by fire, 3 per cent by snow, 5 per cent by abiotic causes and 16 per cent by biotic causes. The average annual area destroyed by forest fire between 1961 and 2000 was 213,000 ha which is about 0.15 per cent of the total forest area of Europe.

3.2 Forest Risk Mitigation (Aversion) Methods

There are many methods to averse various kinds of forest risks. These main methods are integrating risk in planning stage of planting, diversification of land use, proper forest management, insuring forest against risks such as forest fire and wind damages, and regular monitoring forests specially in summer seasons for risks such as forest fire etc. Pukkala (1998) explains how to integrate multiple risks mitigations in the planning process. Parks (1995) explains that dynamic marginal agriculture land conversion to maximise profits as a risk aversion method, which is cost-sharing among land uses. The study explains that diversity of land uses (land diversification) is a method of risk aversion. Some risks such as fire and wind damages could be mitigated through proper forest management. Agee & Skinner (2005) explain how to reduce forest fire risk through proper forest management. The reduction of surface fuel, decreasing crown density, retaining forest fire resistant large tree species and proper thinning of tree could be reducing the forest fire risks. Peterson (2000) notes that damage to forests by storms and winds might depend on soil depth and soil type, tree size and species composition etc. Therefore the farmers might take these aspects into consideration in planting in deep soils and management aspects. Blennow & Olofsson (2008) discuss the impact of increased wind speed under climate change (increased global temperature) on damages to forests in Sweden and how the impact would be different depending on the geographical area. Thus, the wind damage prevention methods should be based on geography of soil type, soil depth and location of the forest etc. These results were discussed with respect to spatial planning in forestry under a changing wind climate. According to Haas *et al.* (2011), maintaining high species diversity in forest stand reduces the risks of forest diseases.

3.3 Insuring Forests as a Mitigation Method

Notwithstanding the adoption of various risk mitigation methods discussed above, insuring forest could provide a better method of risk mitigation mainly because it pays back the price lost due to a hazard or damage. Secondly, other mitigation methods do not cover the cost of damage. In addition insuring forests gives peace of mind over the period of rotation until harvesting to the forest owner (NIPF) as the investment is secure. Insuring forest is not a new phenomenon in that it was available in Japan in 1920's (Yatagai, 1933). The research on insuring forest against fire risk

started in the USA in the1930s (Shepherd, 1937). An initial work by Yatagai (1933) suggested the need for government insurance institutes to insure forest as a small number of insurances had been sold at the time. Forest fire insurance started in the USA in 1921 (Shepherd, 1937). Shepherd (1937) also explains that forest owners need to have a sustained yield but fear of forest fire tends to constrain that. The availability of effective and economic fire insurance for forest would abolish this fear but insuring forests did not have a reputation in overall insurance circles at the time. The study stresses the need for organized protection of forest to increase private ownership estimating loss rates and relevant insurance premium which was suggested to be financed jointly by federal government, by state and by the forest owner. Cottle (2007)'s study on Indonesia explains that commercial forest fire (fire in commercial forests) losses are unacceptably high in many countries and an inability of insurers to estimate rate of fire losses leads to low insurance participation in forestry. Only 0.5 per cent of commercial forest is insured around the world. The insurance takers are individual forest owners, forestry companies, public authorities and banks. Moreover, Cottle (2007) stresses that insurance is a tool to mitigate a risk, which could not be mitigated in another way. Opdam *et al.* (2009) provides evidence why forest insurance is better than other risk aversion options explaining that Science cannot rule out all kinds of uncertainty, because scientific information poses varying degrees of uncertainty due to limitations in data or knowledge because natural systems are inherently stochastic. But Science can aid policy to find a way to deal with uncertainty in a probabilistic sense, although it will never be able to eliminate all kinds of uncertainty. Thus, scientific probabilistic risk calculations that form the basis of pricing insurance could provide a strong justification for coping with uncertainty. Even within the precautionary principle, policy measures don't have to aim at zero risk and the determination of what is acceptable level of risk for society is eminently a political responsibility.

In terms of forest fires, there can be no guarantee for fire prevention by any mitigation method and therefore purchasing insurance is an economic way of saving potential loss. Lynch (2004) denotes that catastrophic fires generate indirect costs such as rehabilitation costs, impact costs and special value losses. There are wildfire events that threaten public health, safety, or welfare and result significant degradation of the environment, loss of property, and causes even injuries and death of people. In

Ireland insurance agencies and the government do not have the appropriate research literature and knowledge required to design optimal insurance policies. Most of the literature relating to forest insurance markets has addressed the supply side issues but not the demand side aspects. Therefore, this paper aims to plug the gap in the literature by analysing the demand side aspects such as the socio-economic determinants of forest owners' attitudes in insuring their forests. A brief review of literature on the demand side aspects and determinants of NIPFs risk attitudes with a view to inform further analysis is discussed below.

3.4 Literature Review

The literature on the determinants of risk attitudes of NIPFs is always a useful starting point to conceptualize the analysis and also to clarify the analytical and methodological issues in estimating risk and uncertainty arising from future forest benefits.

In the literature, the terms uncertainty and risk are closely associated with risk attitudes. Therefore, some discussion on uncertainty and risk would be helpful in conceptualizing and understanding the determinants of risk attitudes. Many studies have defined uncertainty and risk with more or less with similar meanings. According to Kangas & Kangas (2004), there are similar words or synonyms used in the literature for the word 'uncertainty'. They are 'unpredictability', 'unsureness', 'randomness', 'haphazardness', 'variability', 'changeability' and 'irregularity'. Further, they explain that the sources of uncertainty are the lack of information, conflicting evidence, subjective belief, and ambiguity. Lutz & Munasinghe (1994) define risk in terms of probability distribution of any future event (hazard).

Most of NIPF as investors have no accurate information about their future forest benefits, or else they have conflicting information, and thus do not explicitly articulate their perceived risks or future benefits, which is one of the main limitations in the analysis of risk attitudes of NIPFs. Thus, what is attempted here is the mediating model of risk decision-making behaviour along the lines of Sitkin & Weingart (1995). The risk attitudes, *per se*, are not included in the model. The analysis attempts to explain the general risk decision-making behaviour using the socio-economic variables in the context of forestry. When NIPFs learn and analyze

the outcome history of hazards, and other information such as previous forest hazard experience, hazards data and observations of risk events (see Figure 3.2), they develop risk attitudes, which are determined by various socio-economic and property specific variables of NIPF. Once the risk attitudes are formed, they lead to risk propensity and risk perception. Therefore, risk attitudes arise from analysing outcome history and happen before developing a risk propensity or risk perception in mind. NIPFs also analyse data and information they have and know about their forest (problem framing in figure 3.2. Then they develop risk attitudes such as believing insuring forests, managing forest to adverse risk hazards or else land use diversification etc. In addition to the outcome history, risk attitudes can also arise from problem framing and lead to risk perception in shown in Figure 3.2. Finally risk propensity and risk perception together determine the risky decision making behaviour. Thus, according to Sitkin and Weingart (1995), risk perception and risk propensity are mediating variables in risky decision making behaviour (Figure 3.2).

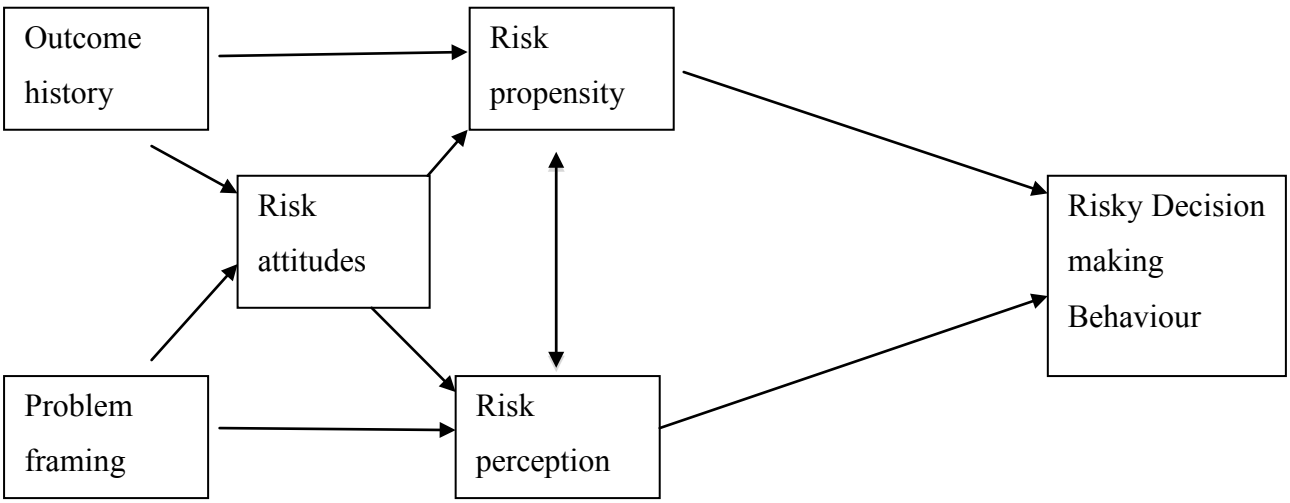

Figure 3.2. Mediating model of risky decision-making behaviour (Source: Sitkin & Weingart, 1995)

In the literature there are studies which examined the risk perception of NIFPs. Anderson (2012) examines the financial risk taking behaviour of NIPFs and argues that willingness to pay for reduction of risk is unobservable. However, Anderson (2012) estimates risk as a function of attitudes and found that longer landownership of NIPFs makes the risk-averse, female NIPFs are more risk-seeking than males, and longer the time NIPFs spend in forest for silvicultural work makes them more risk-seeking. Brunette *et al.* (2011) examine determinants of insurance decision against forest fire and found that expected income loss has a significant positive effect on

insuring forest, fixed public help has negative impact on insuring forest and also higher the commercial value of forest, higher the motive (positively significant) for insuring the forest as well. Being a farmer also has positively significant effect on insuring, as the farmer has to spend time in farm more than in forest as he/she needs to have a guarantee on property (less monitoring risks). Brunette *et al*. (2011) explain that in the literature it has also been found that high ambiguity (uncertainty) on the occurrence of risks tend to increase insurance demand. Brunette *et al.* (2011) points of the lacuna in the literature on this issue and suggest that there is no research on the effect of NIPFs characteristics on insurance demand. Thus, examining and quantifying the impact of determinants for risk attitudes on insuring forest would provide some information on insurance demand and therefore this paper attempts to estimate the determinants of attitudes for insuring forests by NIPFs.

Moreover, Pukkala (1998) argues that uncertainty and risk should be incorporated into the planning process (in forestry), because the ranking of alternative plans may change once uncertainty and risks are taken in the consideration. Furthermore, Pukkala stresses that planning is conducted under risk with the probability distributions of the source of risk are known. Thus, the determinants of risk attitudes of the NIPFs could be generalized and used in the planning of forestry and associated in insurance schemes in future.

With the review of literature setting up the context and formulation of the problem, the following analysis aim to study the impact of socio-economic and forest stand specific characteristics on farmers' attitudes in terms of insuring forests. It aims to provide an analysis of the socio-economic determinants of farmers' perception towards various forest risks and their attitudes towards mitigating those risks, i.e. in particular, the socio-economic determinants that drive NIPFs to insure their forests. In the literature, except for two studies (Brunette *et al.,* 2011, Anderson, 2012), there is no systematic study in Ireland on this aspect. Moreover, there exists paucity of publically available data on farmers' risk perception and consequent analysis on the risk premiums that they would be willing to pay to mitigate those perceived risks. Even the insurance companies seem to have no refined information about insurance demand by forest owners in Ireland. For example, insurance companies have little information on the socio-economic and property specific determinants of NIPFs risk

profiles and also the extent level of forest stand are likely to insure and at what price. *ForestRe* is one of few companies that does research on understanding the nature of risks to forest and its severity/frequency. Thus, the contribution of this paper would fill the gap from this perspective also, but within the limitations of the responses to the primary survey developed for this purpose. The analysis intends to document the socio-economic and property specific determinants of NIPFs' risk perception and their attitudes towards to insuring for those perceived risks. The results might provide a useful starting point for forest planers, environmental policy makers particularly on issues such as carbon sequestration and the forest insurance companies for designing insurance schemes for NIPFs.

3.5 Econometric Approach and Analysis

The dependent binary variable is whether NIPFs believe that his/her forest should be insured or not. In the postal questionnaire survey, the farmer (NIPF) was asked ' Do you believe that the forest should be insured or not?' with the possible responses of 'yes' and 'no'. The response 'yes' is taken as 1 and the response of 'no' taken as 0 in the probit model, discussed below. The explanatory variables are socio-economic and property-specific variables for the NIPFs. With the exception of gender, which is binary, the variables included are continuous variables. Since the decision to insure is binary, the Probit model is used to analyse the NIPFs' behaviour, and the model is specified as:

$$P_i^* = X_i\beta + \varepsilon_i \qquad \text{where } \varepsilon_i \sim N(0,1)$$

where P_i^* is a latent variable ($-\infty < P_i^* < +\infty$) determining the observed belief of insuring forest of the ith NIPF (with P_i=1 if NIPF believes insuring forest , P_i = 0 if NIPF does not believe insuring forest). X_i is a vector of explanatory variables influencing the belief in insuring the forest and β is a vector of coefficients. As an initial means of exploring whether farmers who believe in insuring their forest are similar to those that do not believe in insuring their forests, statistical tests are conducted to test whether the distributions differ between these two groups. The Wilcoxon rank-sum test (Man-Whitney U test) is used for continuous variables, while the Chi square test is used for the categorical variables.

The Wilcoxon rank-sum test is based on the formula (1) below with the requirement that the variable of interest be at least ordinal and that the two groups are independent. Group 1 represents those NIPFs who believe insuring their forest and group 2 comprise of those who do not believe in insuring their forest.

$$U_1 = R_1 - \frac{n_1(n_1+1)}{2} \qquad [1]$$

Where n_1 is the number of observations, and R_1 is total of ranks of observations in group 1, and U_1 is the corresponding theoretical U value. In ranking observations, value 1 is given for the lowest observation out of two groups, then value 2 for the next highest value and so on from lowest value to the highest value to all the observations in both the groups. All these observations are also positive continuous values. The value of U_2 for group 2 (those who do not believe insuring forest) is estimated as,

$$U_2 = R_2 - \frac{n_2(n_2+1)}{2} \qquad [2]$$

The lower U value is used as the test statistic and if this is greater than the critical value, the null hypothesis is rejected, which implies that there is a significant difference between the values of the two groups.

For the categorical variables gender (variable female), the Pearson's Chi square test given in Eq. 3 below is used to test whether the distribution of any explanatory variable differs between those who believe insuring forest and those who don't.

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} \qquad [3]$$

where χ^2 is Pearson's cumulative test statistics, O_i is observed number of observations in particular group and E_i is the expected number of observations.

3.6 Results and Discussion

3.6.1 .Results of Profiling

First, the profile the socio-economic and property specific variables of those who believe that forest should be insured or not, based on the question in the questionnaire survey whether the NIPFs believe that forest should be insured with the possible binary answer of yes or no. The result of profiling exercise is given below in Table 3.1.

Table 3.1. Results of Profiling

Variable	Mean of believing in insuring forests	Mean of not believing insuring forests	Probability
Age 20-39	7.34%	12%	0.822
Age 40-59	55.93%	68%	0.654
Age over 60	36.72%	20%	0.304
Primary education	19.2%	12%	0.383
Secondary education	47.46%	52%	0.670
Tertiary education(degree/Diploma)	27.12%	24%	0.741
Tertiary education (postgraduate)	5.65%	12%.	0.226
Gender(female)	13.41%	11%	0.585
Household income	€42,212	€35,000	0.179
Off-farm income as a % from household income	50.7%	35.27%	0.037**
Forested area	23.08 ha	25.84 ha	0.960
Total area	58.08 ha	78.89 ha	0.033**
Expected thinning income	€458	€564	0.789
Expected profits from final felling	€9,765	€9,750	0.983
Impact of inheritance(Likert-scale)	3.91	4.11	0.816
Impact of knowledge of forest benefits (Likert-scale)	3.64	3.73	0.480

Note: *** means probability P< 0.01, **means probability 0.01>P>0.05

The exercise found that the age groups 20-39, 40-59, over 60 are not significant. In general from the coefficients it can be seen that young people are taking more risk

than old people in every aspect. However, none of the age groups are statically significant in terms of those who believe insuring forest and those who do not. The education levels primary education, secondary education and tertiary education levels are also not significant between those who believing insuring and those who are not believing insuring forests. Next being NIPF a male or female is not significant between these two groups. There is no significant difference between those who believe insuring and those who are not in terms of their household income levels, but the probability is close to the 10 per cent significance level (0.179) suggest that higher the household income might influence NIPFs to believe in insuring. However, there is a significant difference in the percentage of household income of those who believe insuring forest and those who don't, which could be because of high off-farm income. The variable forested area is not significantly different between the two groups. But the total landownership seems to be significantly different between the two groups. High landownership people are likely not to believing insuring forest, because they do they could easily diversify the land to different land use to mitigate the risk. However, expected thinning income and expected profits from final felling are not significantly different between those who believe insuring and those who don't. Finally NIPFs knowledge on forest benefits and the influence of the act of bequeathing forest property to their descendants are not significantly different between two groups.

3.6.2 Results of the Probit Model

The probit model is used to study the socio-economic determinants of risk attitudes of the NIPFs. The dependent variable of the model is the response to the question "Do you believe that forest should be insured?" from 206 NIPFs. About 86.89 per cent (179) of NIPFs said yes and 13.11 per cent (27) of NIPFs answered no. Table 3.2 provides the results of the probit model for the determinants of risk attitudes (risk belief) for insuring forest.

The results suggest that age (any age group) is not at all influencing beliefs in insuring forests or not. Although the age variable is not significant, the negative sign for the coefficient of the age group 40-59 seem to suggest a decline in their belief in insuring the forest. The NIPFs with tertiary education (degree/diploma), secondary education and primary education have greater belief in insuring forests relative to

households with tertiary education (postgraduate education) as base group. This may reflect NIPFs with higher education level, having access to more information about forest risks. Interestingly, the variable female is not significant in contrast to Anderson (2012) who finds that female NIPFs are more risk seeking than male NIPFs.

Table 3.2. Results of probit model on NIPFs' determinants of believing insuring forests.

Variable	Coefficient (Standard Deviation)
Age 20-39	0.524(0.063)
Age 40-59	-0.042(0.057)
Age over 60	0.013(0.073)
Tertiary education (Degree/Diploma)	0.157(0.52)***
Secondary school	0.232(0.101)***
Primary school	0.144(0.041)***
Female	0.014(0.58)
Household Income	0.039(0.011)***
Forest area	0.001(0.0007)**
Total land area	-0.001(0.0005)**
Expected thinning income	-0.027(0.030)
Expected profits from final felling	0.019(0.024)
Knowledge on forest benefits	0.007(0.018)
Impact of inheritance	-0.009(0.020)

Note: *** means probability P< 0.01, **means probability 0.01>P>0.05

NIPFs are more likely to believe in insuring forests when their household income is higher, which may be explained by their improved ability to afford annual insurance premiums. The forested area of NIPFs is also a significant contributor to belief in insuring forest. The total landownership is also negatively significant in determining belief in insuring forest. When total land area is higher, NIPFs could mitigate the risk by diversifying their land area to different land uses since, as Parks (1995) explained, diversification may act as a risk mitigation method. The analysis also reveals that expected thinning income does not make significantly impact on the belief in insuring forest in contrast to Brunette et al. (2011) who find that higher the expected loss of forestry income higher the likelihood of insuring forest. This could be because they estimate total expected loss of income whereas expected thinning income estimated separately here in this model. This could explain why the variable loss of total income of Brunnette et al. (2011) and the variable expected thinning income used in

the Probit model in this analysis are in opposite directions (as negative and positive) and sizes (different coefficients). Finally, the other variables such as the expected income from final felling, NIPFs' knowledge on forest benefits and their act of bequeathing forest property to their decedents is insignificant in believing in insuring the forests.

3.7 Concluding Remarks

The main objective in this article was to examine the impact of the NIPFs socio-economic and their land property specific variables on their attitudes towards insuring forests. In particular, the analysis examines the determinants of believing in insuring forests and documents the variables that are significantly different between these two groups, who believe and those who do not believe, through the socio-economic profiling exercise and the Probit model. Opdam et al (2009) notes that science cannot rule out and eliminate all kinds of uncertainty and risk, but can help mitigate the effects of uncertainty through various ways. The classic example of the challenge of uncertainty in the understanding the global climate change and increasing temperature has implications increases the potential risks for forests through forest fires, insect attacks and also storms and wind damages in future. It is documented that the average global temperature has increased by around 0.6 degrees celsius during last 100 years (Root et al (2003)) and continues to rise rapidly, which again increases the risk to forests. Under these circumstances, designing a proper insurance scheme for NIPF to insure forest against risks would help the individual farmers as well as the society. Thus, it is imperative to understand the demand-side determinants of insuring forests from potential risks, which would also enhance carbon sequestration and conserve and promote the larger ecosystem.

In terms of the socio-economic determinants of NIPFs, the analysis reveals that those who have primary, secondary and tertiary education levels are likely to insure forest. This is because, it can be safely assumed, that highly educated NIPFs have access to information on risks, making landowners more aware on forest risks would motivate them to insure their forests. Alternatively making landowners aware of the risks and designing proper insurance schemes could be promote more planting of forests and their belief in insuring forests. One of the reasons for not believing in insuring forest is affordability of insurance premium because high household income (also high off-

farm income) NIPFs are likely to believing insuring. Also, the public good nature of the benefits of the forests owned by NIPFs seems to disincentivise owners from taking private insurance. Therefore, from a policy point of view, there is a need to design public insurance schemes jointly contributed by NIPFs and the local bodies/national governments that would incentivize forest owners to buy insurance covers.

Given the forest fires diminishes the carbon stock, the international interventions and mechanisms encouraging carbon reductions can partially contribute to this insurance scheme by paying a share of insurance premiums. The Republic of Ireland (total number of countries in annex 1 is 43) is in annex 1 list of the Kyoto protocol. Therefore, Ireland can jointly initiate emission reduction projects (private tree planting) for which international agencies could contribute to insure the forests for sustained carbon stock. There are examples of countries with active forest insurance schemes such as Portugal, Cataluña in Spain, New Zealand (covering more than 50 per cent of plantations), Indonesia since 1999, and Australia (Subak 2003)). Thus, the necessity of insuring carbon stock in forests (from forest fire and other risks) is one way to articulate the need for insuring forest in Ireland.

Chapter 4: Estimating the Non-market Value of Preserving Natural Fish Stocks and the Current Quality of Recreational Fishing in Ireland

4.1 Introduction

Recent literature has examined the non-market recreational values of fishing and preserving and maintaining fish stock in different parts of the world (Shrestha *et al.,* 2002; Toivonen *et al*., 2004; and Prayaga, 2007). These studies employed contingent valuation method (CVM) and travel cost method (TCM) interviewing both fishing people and general public. Almost all of these studies are site specific ones selecting a bay, impoundment or a river. The generic purpose of these studies was to estimate the aggregate welfare derived from non-market values and compare them with those of commercial fishing or over exploitation of the fish stock, and also to identify the directions and sizes of socio-economic determinants of the non-market recreational values of fishing. The results of these studies could then be used for designing optimal management and resource allocation policies.

Ireland is one of the world's premier sea angling destinations with a large and varied coastline 3000 Km in length, it is made up of hundreds of shallow bays and backwaters providing niches for about 80 sport fish species. Ireland also has 70000 Km of rivers and streams, and in extent 144000 hectares of rivers and lakes (Inland Fisheries Ireland, 2013). Coastal waters around Ireland consist of a large shallow continental shelf below 200 meters resulting diverse marine ecosystems with high biological productivity (Fisheries Science Service, 2009).

Recreational angling is a major component of the Irish fishing sector. According to Tourism Development International (2013), 406000 individuals have participated in recreational angling in 2012 and 252000 out of them are Irish adults. Domestic anglers account for 62% of the total anglers surveyed whereas 28% are from abroad with the remaining 10% arising out of Northern Ireland. As a result, the overall impact of angling to the Irish economy annually is €755 million. The aggregate non-market value of fishing on avoiding the deterioration in natural quality of fish stock in Ireland is €58 million per annum.

However, problems such as a flawed permit system, falling water quality, illegal drift netting, and angler dissatisfaction about tackle products and shops; declining fish stock, commercial fishing, and invasive species have created a bad environment for anglers. Therefore anglers need increased conservation efforts to be directed toward target species, increased protection as well as increased bank side management and better overall management of fisheries in the country. The general public also places a non-market value for continuing recreational fishing and maintaining sustainable fish stock. Becker (1993) offers reasons why the nature of the general public enjoying any good placing a value may involve their being selfish, altruistic, loyal or spiteful. Moreover, Flores (2003) explains that an individual may desire to protect fisheries resources for personal use, for bequest value (for future generations) and for existence of resources (existence value). European Directive (Directive 2006/44/EC) also stresses the need of maintaining quality of fresh water bodies in order to support fish life, which requires programs with expenditure. One such program is that a member state of European Union should check regularly water quality of designated water bodies for pollutants and parameters such as PH value, Biological Oxygen Demand (BOD), nitrates, non-ionized ammonia, total ammonium, total residual chlorine, total zinc, and dissolved copper. These pollutants could be affecting fish life and next quality of recreational fishing in Ireland. Under these circumstances, there is a need to examine the social welfare derived from non-market values for maintaining a healthy fish stock for continuation of recreational fishing in order to make policy decisions and individual socio-economic determinants of these non-market values.

There is adequate evidence that during the past few decades there is decline in participation in recreational angling. Also there has been no research on recreational angling in Ireland so far except the study of Curtis (2002) on recreational salmon angling employing TCM in Donegal area. Shrestha *et al.* (2002) carried out a study examining recreational fishing value in Brazilian Pantanal employing TCM. Then Rolfe & Prayaga (2007) carried out a study to examine the recreational value of fishing using both TCM and CVM in Australia while Toivonen *et al.* (2004) carried out a study to estimate the willingness to pay (WTP) of participants in recreational fishing for preservation of water quality and stock of fish in five countries including Denmark, Finland, Iceland, Norway and Sweden employing CVM.

To the best of my knowledge, there has not been carried out any national wide survey in any country of the world to estimate public (non-recreational fishing households) willingness to pay (WTP) for recreational fishing. Therefore, a nationwide survey, based on contingent valuation method (stated preference method) was carried out in May and October 2012 interviewing 2011 households to estimate willingness to pay for the preservation of Ireland's natural fish stocks and the current quality of recreational fishing in Ireland. A dummy variable was used to distinguish whether the household is a recreational fishing one asking whether they fished at least once during previous 12 months.

This data was used to estimate total welfare of non-market value of recreational fishing as well as to identify the socio-economic determinants of recreational fishing of households (general public) using a payment card type questionnaire survey.

I outline the chapter in the following manner. Next under the background I discuss relevant literature, then under the survey instruments I discuss how the survey was carried out followed by the methodology under which I discuss analysis. Finally under the results I discuss my results followed by a summary of my results in the conclusion.

4.2 Background Literature on Valuation of Non–market Fishing Activity

During the last four decades, literature on non-market valuation of recreational fishing grew greatly. According to Prayaga et al. (2010) 129 non-market valuation studies were carried out to estimate recreational fishing values in the world between 1967 and 2003, out of which 45 were from the USA, Canada and Europe. Most of these studies used either the travel cost method (TCM) for a particular site for recreational fishing or the contingent valuation method (CVM) studies for willingness to pay (or willingness to accept) to measure either public or recreational fishers' hypothetical non-market value of recreational fishing from the same site. Some studies used both (public and recreational fishers) to estimate recreational values of a site. Sometimes theoretical development studies for non-market valuation of recreational fishing activity (for example McConnel & Stunin, 1979; Anderson, 1983; Cameron & Huppert 1989 and Englin et al., 1997) and studies for methodological development (E.Roth et al., 2001) and also benefit transfer (Jeon & Haab, 2004) were

carried out. However, most of these valuation studies are site specific ones (eg. Mike & Cowe 1996; Baker & Pierce, 1997; Provencher & Bishop, 1997).

A large number of studies estimate the non-market value of recreational fishing or angling. The key importance of these valuation studies is the support of policy-decisions of regulation and management of fishery resources with respect to optimization and allocation issues between recreational fishing and commercial fishing to maximize social welfare by local or national authorities (see for example Navrud, 2001 and Rolfe & Prayaga, 2007).

The European Directive (2006/44/EC) suggests designing and implementing national programs for member states that aim to combat the threat to the health; quality and quantity of fish stocks as discussed in the introduction. For example the Directive stresses a need of member states to regularly check the water quality for pollutants such as PH values, biological oxygen demand (BOD), nitrites, non-ionized ammonia, total ammonium, total residual chlorine, total zinc and dissolved copper in designated fresh water bodies. These programs need revenue from the beneficiaries of fresh water fish such as recreational fishers as well as general public who place a non-market value for recreational fishing. Thus I focus mainly on the empirical literature associated with public and recreational fishers' non-market valuation of the preservation of natural fish stocks and the quality of recreational fishing in Ireland.

Nuvrud (2001) carried out a CVM and TCM study to estimate the value of recreational fishing in Norway with the aim of increasing the recreational benefits of liming program (lime is used to dilute acid pollution in rivers). The study found that the benefit-cost (B/C) ratio for two Atlantic salmon species trout, *Salmo trutta* L., is 12 and 4.4 for Atlantic salmon, *S.Salar L*. The study confirms that the results were used by environmental authorities and Norwegian fishing and hunting associations (NJFF) to increase funds for liming by 300% between 1993 and 1995. This study also estimated that €40 million would require for neutralizing acid depositions in rivers in Norway.

Rolfe & Prayaga (2007) estimate the non-market values of recreational fishing in three major impoundments in Queensland, Australia using both TCM and CVM. They found that recreational fishing values vary among different sub-groups of

fishers. This study estimated consumer surplus (CS) from TCM and marginal values for recreational fishing from CVM for major three impoundments. Their study found that CS for frequent anglers (angling more than once a year) for impoundment Bjelke-petersen was $ 95,088(Australian dollars), and $170,578 for impoundment Boondooma and $ 124,341 for impoundment Fairbairn. Prayaga *et al.* (2010) use TCM and Contingent behaviour (CB) models to estimate the values of recreational fishing in the Capricorn coast of Central Queensland, Australia. CB models ask whether respondents (consumers) would be willing to change their behaviour with response to changes in their environment (eg. increasing fish stock) instead of their reactions to the changes in costs. They found that high recreational values are insensitive and inelastic with catch and found that CS per trip is $38,534 annually per group and the total CS of annual recreational fishing in Capricorn coast is approximately $ 5.53 million.

Wheeler & Damania (2001) conduct a CVM study to estimate marginal WTP values for recreational fishing for a few fish species in New Zealand. Their objective was to collect policy-making supportive information for allocating resources between recreational fishing and commercial fishing. They found that the marginal values of fish caught for eating closely related to the market price and there was no evidence for strategic bias or on embedding effect (bias). Yamasaki *et al.* (2013) say that there is no any significant difference between WTP values for day fishing between those who catch small numbers of fish and those who catch a large number of fish. They used double bounded dichotomous format to collect data in Tasmania. They report that day value depends on factors such as motivation, quality of fishing experience and demographic characteristics of fishers. They estimated marginal WTP for saltwater fishing to be Australian $120.97 and Australian $168.98 for rock lobster fishing.

Turning out attention to more recent studies, Pascoe *et al.* (2014) estimate that the annual recreational fishing value in Moreton bay in Australia is Aus $ 20 million per year. The objective of all these site specific case studies is to estimate recreational fishing value of some site for a group (fishing community). Also there is a need to estimate the non-market value of recreational fishing of both fishing community and general public for Ireland in order to develop national polices. The non-market value

of general public is more important. Lynch & Taylor (2013) stress that policy makers should understand that fish has a value locally, regionally, nationally and internationally. Understanding value in such a way is appropriate in decision making.

Curtis (2002) estimates recreational salmon angling in Ireland. The data (on-site in person survey) was collected in Donegal area employing TCM to estimate number of trips made by a fisher. The study found that mean travel cost was IR£68 per day but it was for German and European anglers was IR£56/day and it was IR£18 for Northern Ireland anglers (in 1992 prices). The study also estimated that mean WTP (CS + travel cost expenditure) was IR£206/day meaning that anglers would get net benefits from angling.

To the best of our knowledge, there has not been a national wide study to estimate public household WTP for preserving natural fish stock and the current quality of recreational fishing in any country in the world. Therefore, the contribution of this paper to the literature is that I report first time the results of national wide public (household) WTP survey for preserving natural fish stock and current quality of fishing in a country and impacts of national wide household socio-economic and other determinants to the WTP values and subsequently aggregate social welfare. This study also estimates recreational values of recreational fishers as some members of households who were interviewed were recreational fishers. The second contribution is that the results of this study is the first national wide empirical survey conducted in Ireland which could be used to formulate resource allocation policies in an efficient manner as I discuss in detail in the conclusion of this chapter.

4.3 Survey Instrument

As a researcher, I need to provide valid, reliable, sensitive, unbiased and complete results with much certainty. Therefore, it is necessary to ensure that questions measure the concepts and behaviours of respondents I want to measure. I am concerned that my survey questions would be enough sensitive to measure the real differences and changes in values. Survey questionnaire was employed as a measuring instrument in collection of household data with face-to-face interviews. This methodology is referred to as contingent valuation method as it measures the value of respondents at the time of interview. As a standardization of data collection

procedure (see Collins, 2003) and wording in survey design, the initial questionnaire was used for focus groups to develop the questionnaire for the main survey. Because I wanted to check whether the respondents would clearly understand my wording, phrases and meanings. The focus group also was very useful in order to design willingness to pay bid values in the main survey in form of payment cards and deciding number of values from €0 to €200 that is 19 bid offers.

As a standard procedure, the objective of the survey was explained to the respondents at the beginning before the interview. In the designing of questionnaire, first questions are warm up questions so that respondents would start thinking logically about the research idea. I followed the very latest guidelines of Fredrik (2010) in designing contingent valuation questionnaires. Therefore, first questions are about general recreational activities expected to be participated by respondents including recreational fishing. Then questionnaire gradually moves to recreational fishing, household socio-economic characters and finally to the willingness to pay question payment card. Because according to Fredrik (2010), respondents give very rational answers to the latest questions during the questionnaire survey interview.

In the payment card question, preliminary information about the current problems and issues in recreational fishing in Ireland as well as information on recreational fishing in Ireland was explained. The respondents were asked the maximum willingness to pay to generate a fund to assist prevention of negative aspects of recreational fishing towards complete protection at current level of recreational fishing. The unobservable willingness to pay is falling between the value the respondents mention and next higher value. The willingness to pay bid values, €0, €1 ,€2 ,€3 ,€5, €8, €10, €15, €20, €25, €30, €35, €45, €60, €80, €100, €12 , €150, €200 and more than €200.

4.4 Methodology

In this household survey, contingent valuation method was employed to estimate the value of the general public (dummy variable for fishing households) for preserving Ireland's natural fish stocks and the current quality of recreational fishing in Ireland. The contingent valuation method (CVM) is a survey based stated preference technique which asks respondents directly to express their maximum willingness to pay (WTP) (or willingness to accept) for a hypothetical change to a non-market good

such as the quality of fish stocks and the fishing experience. CVM was incorporated into survey instrument by asking additional questions in terms of individuals' willingness to pay towards the preserving Ireland's natural fish stocks and the current quality of recreational fishing in Ireland. A focus group was used to inform the CVM question design and to gauge the likely range of individuals' willingness to pay in order to inform the bid design of the questionnaire survey.

In carrying out the surveys each interviewee was told about the current state of the fish stocks. The respondents were informed that …"*natural fish stocks in Ireland are threatened in several ways e.g. reduced water quality, barriers to fish and other fauna migration, industry and household sewage. European Directives and national programs to combat the threats on the health of our fish stocks have been put in place. These programs will cost money*". The respondents were then informed that ...*"The costs are uncertain but part of the costs will have to be paid by the taxpayer. Any payment would involve an increase in your annual income tax or VAT, for the next 10 years. All money raised would be used for the preservation of the fish stocks. Think what it is worth to you to preserve the natural fish stocks and the current quality of recreational fishing in Ireland. Note that these costs are in addition to any charges you may already pay for any fishing experiences".*

The individuals interviewed were then asked if they were willing to pay something towards preserving Ireland's natural fish stocks and the current quality of recreational fishing in Ireland, respondents were instructed to bear in mind their total annual budget and how much of this they could afford to spend on this program. Those who answered the question in the affirmative were then presented with a payment card showing 20 bid amounts ranging from €0 to €200 and were asked: "How much would you be willing to pay each year, through general taxation, for the next 10 years, to preserve the current fish stocks and current quality of recreational fishing in Ireland". Respondents answering that they were not willing to pay any amount were then asked which of several statements best described why their willing to pay was €0 (Table 4.5 in the Appendix to this chapter).

A total of 935 individuals in the household survey (47%) responded that they would be willing to pay a positive figure towards the preservation of the current fish stocks and current quality of recreational fishing in Ireland. A number of €0 WTP responses

were treated as legitimate bids depending on the response to the follow-on question asking why the individual was willing to pay €0 if that was the bid amount chosen. Respondents indicating that they choose the €0 because they objected to paying taxes, or that they perceived that the Government/Council/other body should pay, or that they did not believe the stocks would be preserved or who stated that they could not give a legitimate reason why they were willing to pay €0 were excluded from the analysis. The reasons given for choosing the €0 bid value are summarized in Table 4.5 in appendix of this chapter. The total final number of usable responses for estimating the value of preserving Ireland's fish stock in the household survey was 1684 individuals.

After understanding the basic problem of recreational fishing in Ireland, my first step was to examine the reports prepared by Inland Fisheries Ireland and other institutions to properly understand the recreational fishing problem in Ireland. Following this I had some informal discussions with officials of those institutions to further explore the problems of recreational fishing. The careful examination of literature, the previous questionnaires and models used in estimating of WTP for recreational fishing questionnaire were useful in elicitation of my questionnaire.

Then I used data collectors to use focus groups to collect basic data. Here a number of discussions with groups of recreational anglers were carried out to understand the issues in designing the questionnaire. I understand from this that WTP of most respondents are positive and less than €200. Based on the logic of the WTP value of the general public could be less than that of recreational anglers; I designed the payment card values between €0 and €200. I included the option of €0 WTP as I received zero responses in focus groups. However, Freeman (2003) explains that sometimes respondents refuse to pay a certain amount or else they refuse to place monetary values for non-marketable goods.

These discussions also helped to understand motivational questions. These motivational questions encouraged respondents to continue answering the questionnaire until the end and a brain storming process enabled them to assign a value for WTP. These questions are also named as warm up questions as they lead and encourage the respondents to continue answering and start thinking logically.

Motivating questions asked from recreational anglers were on the most appealing aspects of recreational fishing in Ireland. Thirty three percent said they like quality of fishing, scenery 29%, natural environment 15%, variety of fish 15%, variety of angling location 15%, not over-crowded locations 11% and friendliness of people in Ireland 28 % for overseas anglers. I understood that they used magazine, television, radio, friends, and word of mouth, to come to Ireland as sources of information. Then all these sources of information as well as appealing aspects of recreational fishing in Ireland were included in formal questionnaire.

In the formal questionnaire the first step were good wishes such as good morning/evening etc followed self introduction of data collector and the objectives of the interview, time taken for the interview etc. It is expected that at the end of 15 minutes, respondent should have earned some logical reasoning on values of recreational fishing and therefore they were asked to select WTP pay value showing the payment card below. If they select the value €0, then reasons were asked for in question Q8b for selecting that value contained in table 4.5 in the annex.

Q8a is WTP question

Payment card			
€0 go to Q8b question	€8	€30	€100
€1	€10	€35	€125
€2	€15	€45	€150
€3	€20	€60	€200
€5	€25	€80	More than €200

However, there could be potential problems naturally creating the controversial issues in developing new resources management policy instruments from the questionnaire. Some of who supposed to pay high value could see low values among choice in the payment card and therefore there is a possibility and probability of selecting a low value in the payment card. Someone who is supposed to pay a low value could see high values in the payment card and select a rather high value from the payment card. Respondents in the country have different levels of information on market mechanisms (recreational values of fishing), and they could have contradictory information so that they make objections especially not to pay. The WTP payment explained to be charged in form a tax and therefore those who have objections for paying high taxes are likely to make objections.

However, reasons asked for giving €0 values followed by the WTP question could be an instrument to validate the results to a higher degree. Only 935 (47%) of respondents out of my sample of 2011 said that they would like to pay a positive WTP value and 1076 (53%) said that they would like to pay 0 value. The respondents who have low income in deed can't afford to pay but still their WTP value is not zero. Therefore, those respondents who said that they would like to pay 0 as they can't afford to pay are included in the analysis. This figure is 38.85% (419 respondents) from total number of zero responses. Those who said the quality of fish stock in Ireland is not important to them (331 respondents, 30.76%) were also considered as legitimate responses because which statement does not still mean there are no values of recreational fishing to the society. The generalized Tobit model converts these values to values between €0 and €1. All the rest of respondents with other reasons were excluded from the analysis to validate the results. The final number of valid responses was by this means 1684.

The WTP responses were treated in a parametric model, where the WTP value chosen by each householder was estimated as a function of the respondents' socio-economic characteristics. A generalized Tobit model was employed and was estimated via maximum likelihood procedures. This model is also sometimes referred to as an Interval regression model as the WTP response is interpreted in the model not as an exact statement of willingness to pay but rather as an indication that the WTP lies somewhere between the chosen value and the next larger value above it on the payment card. The parametric regression results of the generalized Tobit model are presented in the results section (Table 4.4 in the Appendix to this chapter).

In the household questionnaire the price range used in the payment card was based on the responses to the pilot study which utilized the open-ended elicitation format (see Haab & McConnell, 2002). This should minimize any potential bias accruing from the bid amounts used on the payment card.

Following Hynes & Hanley (2009) the WTP responses to the CVM question was treated in a parametric model, where the WTP value chosen by each respondent was specified as: $WTP_i = \mu_i + \varepsilon_i$. where μ_i is the deterministic component and ε is the error term. It is assumed that $\varepsilon \sim N(0, \sigma^2 I)$. The chosen Generalized Tobit Interval

model employs a log-likelihood function adjusted to make provision for point, left-censored, right-censored (top WTP category with only a lower bound) and interval data. For individuals $i \in C$, I observe WTP_i, i.e. point data and for respondents $i \in L$, WTP_i are left censored. Individuals $i \in R$ are right censored; I know only that the unobserved WTP_i is greater than or equal to WTP_{Ri}. Finally respondents $i \in I$ are intervals; I know only that the unobserved WTP_i is in the interval $[WTP_{1i}, WTP_{2i}]$. The log likelihood is given by:

$$\ln L = -\frac{1}{2}\sum_{i\in C} w_j \left\{ \left(\frac{WTP_i - x\beta}{\sigma} \right) + \log 2\pi\sigma^2 \right\} + \sum_{i\in L} w_i \log \Phi \left\{ \left(\frac{WTP_{Li} - x\beta}{\sigma} \right) \right\}$$
$$+ \sum_{i\in R} w_i \log \left\{ 1 - \Phi \left(\frac{WTP_{Ri} - x\beta}{\sigma} \right) \right\} + \sum_{i\in I} w_j \log \left\{ \Phi \left(\frac{WTP_{2i} - x\beta}{\sigma} \right) - \Phi \left(\frac{WTP_{1i} - x\beta}{\sigma} \right) \right.$$

where Φ is the standard cumulative normal and w_i is the weight of the i th individual.

4.5 Variables and Summary Statistics

I used 18 socio-economic variables of households as independent variables of which summary statistics are as in appendix (Table 4.2 in the Appendix to this chapter provides the Summary Statistics of general public). The names of these variables are 'Payment bid value', Male, Age, Retired, 'Part-time employed', Unemployed, 'Fished in last 12 months', 'Third level education', Polish, Irish, 'Affiliated to a fishing club', 'Rural Dweller', 'Resides in Munster', 'Number in Household', 'Social class C1', 'Social class C2', 'Social class DE' and 'Social class F'. The all variables are binary dummy variables except three. These three variables are 'Payment bid value', Age and 'Number in household'. The variable 'Payment bid value' is the bid value I offered in the questionnaire to ask maximum willingness to pay the respondent would like to pay to preserve current fish stock and quality of fishing and these values are €0, €1, €2 ,€3 ,€5, €8, €10, €15, €20, €25, €30, €35, €45, €60, €80, €100, €120 , €150, €200 and more than €200. The mean of this variable is 12.042, standard deviation 26.269, minimum zero and maximum 200. Next I have variable age starting from 15 with every consecutive number until 99, which means how is

the respondent old. The mean of the variable is 43.292 and standard deviation is 16.575. The variable 'Number in Household' is between one and eight that is the number of members in the household of the respondent. The mean is 3.052 and standard deviation is 1.395. All the other variables are binary dummy variables with minimum zero and maximum one. Therefore as in table 4.2 (See Appendix to this chapter), means and standard deviations of all these variables are greater than zero and less than one.

Next I define these variables. The variable 'Retired' means whether the respondent is a retired person from a service. Those respondents who were employed as part-time basis are captured from the variable 'Part-time employed'. The variable 'Fished in the last 12 months' captures whether the respondent had fished at least once during last 12 months. I measure the respondent's level of education from variable 'Third level education'. The Polish population in Ireland is high. Therefore, I included a dummy variable for Polish nationality. The variable 'Affiliated to a fishing club' measures whether the respondent is a member of fishing club. The variable 'Rural Dweller' captures whether the respondent lives in rural area. Munster province in Ireland is the southern part of the country where people are supposed to practice more recreational fishing due lengthy coastal area surrounded the inland. Therefore I included a dummy variable for residents of that province. My variable Social Class C1 means social status of the respondent that is junior management, owners of junior establishments, and non-managerial positions. Social class C2 is all skilled manual workers and manual workers with responsibility for other people. Social Class DE means semi-skilled, unskilled individuals. Social Class F is farmers and farm managers.

4.6 Results and Discussion

In my chosen household model, WTP = f (Male, Age, Retired, Part-time employed, Unemployed, Fished in the last 12 months, Third level education, Polish, Irish, Affiliated to a fishing Club, Rural Dweller, Resides in Munster, Number in Household, Social class C1, Social class C2, Social class DE, Social class F). The Log Likelihood $\chi 2$ statistic shows that, taken jointly, the coefficients in the Generalized Tobit Interval models are significant at the 1% level. My result is in Table 4.4 in the Appendix to this chapter.

Men are more willing to pay for preserving recreational fishing compared with women (percentage of men in sample is 51.37%). Then becoming older would be increasing willingness to pay (WTP) significantly. As expected individuals from the general public who had fished in the last year or who were member of a fishing club are willing to pay significantly more on average for preserving Ireland's fish stock. Also having a third level education, being resident in Munster or being Polish also meant that you are significantly more likely to have a higher WTP on average. However, being from a rural area decreases your WTP as does being from any of the social classes other than the upper middle and middle social classes (A and B). Being retired would not appear to have a significant impact on WTP which was somewhat surprising as fishing is a sport you might get into and appreciate more upon retirement but the associated coefficient for being retired was found to be negative and insignificant.

Using the model results I am able to predict the average WTP in both the general public and the population of fishers of preserving Ireland's natural fish stocks and the current quality of recreational fishing in Ireland. The mean predicted WTP for the general population is estimated to be €15.97 per person per year. The mean predicted WTP for the fisher population is estimated to be a much higher €66.52 per person per year. Interestingly, the predicted mean WTP for the subset of 138 fishers (those who declared they had fished in the previous 12 months or who were members of a fishing club) in the general public household survey was significantly less than in the on-site survey and was estimated at €36.99.

In analysing aggregate WTP for preserving Ireland's natural fish stocks and the current quality of recreational fishing, I calculate the aggregate welfare value using the results of the CVM interval regression model outlined above where the estimated average value of WTP in both samples is multiplied by the respective general and fisher populations ($\sum_{i=1}^{n} \overline{WT\hat{P}}_{pop}$). Therefore, the aggregate non-market value of the recreational fishing to the Irish public (where there are 3,608,000 individuals above the age of 15) is €57,619,760 per annum. Prayaga *et al.* (2010) found that consumer surplus (CS) per trip is Aus. $ 38,534 annually per group of recreational fishers and the total CS (total welfare) of annual recreational fishing in Capricorn coast in

Australia is approximately Aus.$ 5.53 million per year. Pascoe *et al.* (2014) found annual recreational fishing value in Moreton bay in Australia being Aus $ 20 million per year. Curtis (2002) estimates recreational salmon angling in Ireland. Curtis (2002) uses the data (on-site in person survey) collected in Donegal area in Ireland and TCM was employed for the number of trips made by a fisher. The study found that mean travel cost was IR£68 per day (in 1992 prices) but it was for German and European anglers was IR£56/day and it was IR£18 for Northern Ireland anglers. The study also estimated that mean WTP was IR£206/day meaning that anglers would get net benefits from angling. Taking into account all these estimates, I find that my estimate (the total welfare from recreational fishing in Ireland) is rather higher than above recent estimates and consistent with them.

4.7 Conclusions

The objective of this article was to estimate the socio-economic determinants of recreational fishing in Ireland and also estimating total welfare from recreational fishing in Ireland. The results of such studies are expected to be used by regulatory agencies to formulate more comprehensive and resource allocation policies (eg. Navrud, 2001). It is expected that the results would also be used to formulate more efficient resource allocation policies. As expected those who have previous experience (variables Fished in last 12 months and 'Affiliated to a fishing club') keep high WTP values for continuing current fish stock and current quality of fishing more than average individuals WTP value. But surprisingly, it is not expected results that those who have more free time (variables Retired, 'Part-time employed' and Unemployed) are insignificant. When people have free-time, it is expected that they could use this free time for leisure such as recreational fishing. The next results are that all the social classes show decreasing WTP which is not expected because different social classes have obviously different income levels. Interestingly Polish nationals and residents in Munster province have high WTP values compared with average Irish individuals.

The mean predicted WTP for the general population is estimated to be €15.97 per person per year. The mean predicted WTP for the fisher population is estimated to be a much higher €66.52 per person per year. I believe my estimate of total welfare from recreational fishing in Ireland €57.619 million per annum could be higher than

two estimates of Prayaga *et al.* (2010) and Pascoe *et al.* (2014) which are Aus $ 20 million per year and $ 5.53 million per year respectively.

There are high values for maintaining current quality of recreational fishing for both general public and recreational fishers. Therefore, there is a policy need to increase conservation efforts to be directed toward target species, increased protection as well as better overall management of fisheries including bank management in the country. I have already explained that Norwegian Fishing and Hunting Association (NJFF) increased funds for liming by 300% between 1993 and 1995 based on the results of Nuvrud (2001). Then as the results of my study which shows a high social welfare from recreational fishing, Irish government and relevant agencies of fishing sector could get some mitigating actions towards protecting the current quality of fishing and maintaining current fish stock based on my results. The current problems for recreation fishing are mainly falling water quality, flawed permit system, illegal drift netting, and angler dissatisfaction about tackle products and shops; declining fish stock, commercial fishing, and invasive species. European Union Directive (Directive 2006/44/EC) on fresh water quality clearly addresses problems of water quality for fish life in order to support fish life. Therefore as a first step , Irish government could initiate checking regularly water quality of some water bodies for major pollutants such PH value, BOD, nitrates, non-ionized ammonia, total ammonium, total residual chlorine, total zinc, and dissolved copper all of which were identified as main pollutants by the Directive. These main pollutants could be identified in a pilot research and afterwards, regular checking up could be carried out for them. Next it is possible to check water bodies for invasive fish species and take the actions to destroy them from fresh water bodies according to biologists' advice.

Previous research have stressed that the results of the valuation of recreational fishing could be used for resource allocation and management decisions specially between commercial fishing and recreational fishing in a country to maximize social welfare of the country (Navrud 2001 and Rolfe & Prayaga 2007). The Irish government national authorities, departments or agencies should take initiatives in this case to protect and optimize recreational fishing recourses of the country. Therefore, I believe a policy decision which could be easily made is that limiting commercial fishing in places of fresh water bodies which are key angler destinations. Sometimes

fishing in such places is allowed only for one or two days in a week. Also the Irish government could introduce a tax based on the information that an individual would like to per €15.97 per year to preserve current quality of recreational fishing. Then funding could be channelled towards programs for protecting recreational fishing in the country.

4.8 Appendix of Tables 4.1 to 4.5

Table 4.1. WTP estimates for the 2 alternative models

Population	Average WTP Per Individual (€)	Total value preserving fish stock and fishing experience quality (€)
General Population	15.97	57,619,760

Table 4.2. Summary Statistics (general public)

Variable	Mean	St. dev	Min	Max
Payment bid value	12.04227	26.269	0	200
Male	0.4863252	0.4999373	0	1
Age	43.29289	16.57578	15	99
Retired	0.1253 108	0.3311533	0	1
Part time employed	0.1272999	0.3333915	0	1
Unemployed	0.1173545	0.3219223	0	1
Fished in the last 12 months	0.0681253	0.2520235	0	1
Third level education	0.3893585	0.4877261	0	1
Polish	0.0024863	0.0498134	0	1
Irish	0.9293884	0.2562387	0	1
Affiliated to a fishing Club	0.0139234	0.1172023	0	1
Rural Dweller	0.03908503	0.4880623	0	1
Resides in Munster	0.2754848	0.4468694	0	1
Number in Household	3.05271	1.395161	1	8
Social class C1	0.3063153	0.4610769	0	1
Social class C2	0.2531079	0.4349004	0	1
Social class DE	0.2575833	0.437412	0	1
Social class F	0.0566882	0.2313034	0	1

Table 4.3. Summary Statistics of fishers (138) (fished in last 12 months).

Variable	Mean	St. dev	Min	Max
Payment bid value	30.043	44.895	0	200
Male	0.846	0.361	0	1
Age	42. 437	14.52	16	78
Retired	0.116	0.322	0	1
Part time employed	0.109	0.313	0	1
Unemployed	0.175	0.381	0	1
Third level education	0.437	0.497	0	1
Polish	0.007	0.085	0	1
Irish	0.912	0.283	0	1
Rural Dweller	0.364	0.483	0	1
Resides in Munster	0.306	0.462	0	1
Number in Household	3.051	1.352	1	8
Social class C1	0.255	0.437	0	1
Social class C2	0.343	0.476	0	1
Social class DE	0.218	0.415	0	1
Social class F	0.021	0.146	0	1

Table 4.4. Interval regression of WTP for preserving Ireland's natural fish stocks and the current quality of recreational fishing in Ireland for Household Sample.

Variable	General Public Model
Male	4.06 (1.45)***
Age	0.16 (0.05)***
Retired	-1.67 (2.63)
Part time employed	-1.77 (2.14)
Unemployed	-2.19 (2.27)
Fished in the last 12 months	11.92 (3.01)***
Third level education	5.942 (1.59)***
Polish	32.74 (12.97)**
Irish	3.66 (2.8)
Affiliated to a fishing Club	39.89 (6.15)***
Rural Dweller	-6.53 (1.51)***
Resides in Munster	4.31 (1.54)***
Number in Household	0.83 (0.53)
Social class C1	-12.07 (2.31)***
Social class C2	-10.07 (2.48)***
Social class DE	-15.34 (2.58)***
Social class F	-9.11 (3.80)**
Constant	10.24 (4.91)**
Log of the estimated standard error	3.33 (0.02)***
Log likelihood	-6529
Likelihood Ratio c^2 (17) test	236
Left Censored Observations	0
Right Censored Observations	331
Uncensored Observations	10
Interval Observations	1343

Note: Standard error in parentheses. ** means significant at 5%; *** means significant at 1%.

Table 4.5. Reasons Given for Zero WTP Bids.

Reason Given	% of €0 Responses in Household Survey
I cannot afford to pay	38.85
I object to paying taxes or pay too much tax already	7.43
The quality of the fish stocks in Ireland are not important to me	30.76
The Government/Council/other body should pay	3.72
I don't believe the improvements will actually take place	7.9
Don't know or Other reason	7.53
Total % of €0 responses in each sample	53

Chapter 5 Summary and Conclusions

In this concluding chapter, I summarize the main findings of the three empirical chapters that constitute the core of the thesis, along with a brief account of both the limitations of the research and directions for future research arising from the results.

5.1 Summary and Conclusions of Chapter 2 - Behavioural and Economic aspects of Tree Planting in Ireland

The main objective of this chapter was to examine the variables contributing to the decision of planting trees as well as the extent of land area to be or already planted by Irish landowners. This chapter fills a gap in the literature. In addition the empirical contribution is potentially useful for incorporation into policy formulation for promoting afforestation. First time in literature I quantify the impact of irreversibility, inheritance and farmers knowledge on planting trees. Interestingly, landowners feelings' of inheritance, land irreversibility and land users' knowledge of future forest benefits are significant in the decision to plant. However, out of these three variables, only irreversibility is negatively associated with planting more lands. The irreversible nature of the decision to plant may destroy the option of practicing any other land uses. In this chapter I have quantified the impact of irreversibility on the decision to plant. Surprisingly, landowner's satisfaction around the level of the forest premium payment is likely in positively influencing the decision to plant.

The behaviour of age groups is surprising and interesting because only the age group 'greater than 70 years' is significant in making a decision to plant and deciding how much to plant. The age groups 50-59, 60-69, and greater than 70 years are only significant in planting a higher percentage of land area, which means older farmers are likely to plant a higher percentage of their land. Third level education level is significantly influencing tree planting decision and also planting a higher land area. It is obviously because educated farmers easily understand the benefits of planting. The behaviour of off-farm income of landowners is also neutral in tree planting decisions and percentage of tree planting. The financial variables used were the expected incomes from both thinning and clear-felling and were not significant in deciding to plant or in deciding the higher extent of land area to be planted. All these results could be extremely useful in policy formulation to promote afforestation.

5.1.1 Limitations of the Research

Whilst the results from this study are broadly in agreement with the findings in the existing literature some caution is advisable when considering the results. The first major limitation of the paper is that it is a retrospective study, since the dependent variables relate to decisions that have already been taken. Although this is quite common in the literature, e.g. forestry, adoption of organic farming, entering environmental schemes, it means that one should be cautious in assuming a predictive relationship between the variables. While some would argue that really one should model intentions to behave in a certain manner conditional on explanatory variables this approach also has demerits - issues such as hypothetical bias can arise or the respondent may have difficulty processing decisions they have not previously considered thereby introducing other biases.

The second major limitation of the study is that it uses cross-sectional rather than panel data. Thus unobserved heterogeneity may lead to omitted variable bias which could be controlled for in a panel model. Using panel data would overcome the first limitation also as past values of the explanatory variables could be used to explain current planting decisions. I explored this approach through the use of the National Farm Survey (a nationally representative survey conducted annually by Teagasc with circa 1200 farms per year) but due to the low uptake of forestry in any year this approach was not feasible. Thus retrospective decisions were the best available option. These limitations also apply to many of the other studies in the literature. A further limitation of the current study is the absence of useful data on soil quality in the dataset as this is potentially an important driver of planting decisions and should really be controlled for where possible.

5.1.2 Future Research

The Irish farmers (landowners) use land for different agriculture activities such as beef, dairy, sheep, cropping and forestry depending on soil quality. The soil quality does indeed influence land use, especially at the early stages when farmers planted trees in bad lands. Ni Dhubhain & Gardiner (1994) found that those farmers who stated an intention to plant land in the future, 58% said that their land was not good for any thing except forestry and 39% of landowners said that they would not plant

trees as their lands were too good for forestry. However, currently the Irish government is focusing on promoting afforestation in good soils (lands) due to the declining stock of bad lands in the country. Therefore, future research should examine the influence of soil quality for decisions of planting private lands as Stavins & Jaffe (1990) stress that need as well. Such research could be again a face-face or postal survey and most probably a double hurdle model could be used. The private landowner's tree planting behaviour could be influenced by neighbour's tree planting decisions, which I could not examine in this chapter. Therefore, it is not at all difficult to include a dummy variable (independent) on whether the neighbours planted trees before NIPF did, to measure the impact of neighbour's tree planting. The soil quality could be captured either by a binary variable or else ranking variable.

In the literature survey of this chapter, land irreversibility is a significant problem for why landowners are not planting trees mainly due to land irreversibility. There is a need to undertake further research to analyze the irreversibility of planting as it was ranked as the second greatest barrier to afforestation. McDonagh *et al.* (2011) found that 48% of farmers would not plant trees as they need their land for agriculture in spite of a single farm payment (SFP), which had allowed farmers to plant a large proportion of their land without losing any payments. This is because as McDonagh *et al.* (2011) argue that farmers need to have farmland to bequeath to their son/daughter. Therefore the bequest value of farmers on bequeathing farmland to their descendants has to be quantified. Then private landowners desire to bequeath forest for future generations, which was not yet estimated has also to be quantified as Ross-Davis *et al.* (2005) did in USA.

5.2 Summary and Conclusions of Chapter 3 - Determinants of Risk Attitudes of Non-Industrial Private Forest (NIPF) Owners in Ireland for Insuring Forests

In this chapter I discuss the results of profiling those NIPFs who believe in insuring forests and those who do not believe in insuring their forests based on the Probit model employed to analyse the results of the following question, 'Do you believe that forest should be insured?'

5.2.1 Main Findings of Profiling Exercise

I found that any age group out of the age groups 20-39, 40-59, and over 60 is not

significantly different between believers of insuring and non-believers. This means that the age of any NIPF does not influence believing insuring the forest or not. Similar results emerged regarding education levels of NIPFs that included primary education, secondary education and tertiary education levels which were not significantly different between both those who believed in insuring and those who did not believe in insuring forests. Next, the variable gender (male or female) of NIPFs is not significantly different between those NIPFs who believe in insuring forests and those NIPFs who do not believe in insuring forests. In the case of the household income of NIPFs, there is no significant difference between those who believe in insuring and those who don't. However, relatively greater significance is achieved (0.179) at the 10 per cent probability level, which implies that the higher the household income higher the insurance undertaken. But there is a significant difference in the percentage of off-farm income from household income of those NIPFs who believe in insuring forest and those NIPFs who don't, which means the higher the percentage of off-farm income, the higher the probability of believing insuring forest. The variable forested area is not different between the two groups. But interestingly the total landownership is negatively different between two groups. As I explained in my discussion, NIPFs with high landownership are likely not to believe in insuring forest, which is also consistent with our Probit results. The higher the landownership, they do not believe in insuring forest because they could easily diversify the land to different land uses to mitigate the risk. However, expected thinning income and expected profits from final felling are not significantly different between those who believe insuring and those who don't. Finally NIPFs knowledge on forest benefits and impact of inheriting forest property to NIPFs' descendants are not different between two groups.

In summary, I would mention that basically only two variables, total land-ownership of NIPFs and percentage of off-farm income are significant between those NIPFs who believe in insuring forests and those NIPFs who don't believe in insuring forests.

5.2.2 Results of the Probit Model

I asked the question from 206 NIPFs "Do you believe that forest should be insured?" given the options of answering 'yes' OR 'no'. The replies were then used as the dependent variable in the model. A hundred and seventy nine (86.89 %) of NIPFs

said yes and 27 (13.11%) of NIPFs said no. The results from the Probit model for the determinants of risk attitudes (risk belief) for insuring forest are presented in Table 3.2. According to my results, age (any age group) is not at all influencing beliefs in insuring forests or not and is neutral on beliefs in insuring. The NIPFs with tertiary education (degree/diploma), secondary education and primary education have greater belief in insuring forests relative to households with tertiary education as base group. This may reflect NIPFs with higher education levels, having access to more information about forest risks. I find that the variable female is not significant in contrast to Anderson (2012) who finds that female NIPFs are more risk seeking than male NIPFs.

Then NIPFs are more likely to believe in insuring forests when their household income is higher which may be explained by their improved ability to afford annual insurance premiums. The forested area of NIPFs is also a significant contributor to belief in insuring forest. The total landownership is also negatively significant in determining belief in insuring forest. When total land area is higher, NIPFs could mitigate the risk by diversifying their land area to different land uses. I find that expected thinning income does not make a significant impact on belief in insuring forest in contrast to Brunette *et al.* (2011) who finds that the higher the expected loss of forestry income the higher the likelihood of insuring forest. Finally, I find that expected income from final felling, NIPFs' knowledge on forest benefits, and their feeling on inheritance of forest property by their decedents is insignificant in influencing their belief in insuring forests.

5.2.3 Limitations of the Research

I analysed mainly the risk attitudes of NIPFs to insuring forests based on the 'yes' and 'no' responses of them to the question I asked in the postal survey 'Do you believe that the forest should be insured?' I did not provide in this questionnaire any preliminary information to NIPFs on potential insurance schemes and forest management devices to mitigate the risks. I assumed the information the NIPFs had at the time of filling the questionnaire was enough to answer the question. At the outset of the research I carried out some informal discussions with NIPFs where I understood that they had already some knowledge on forest insurance and management, which was the reason not to provide preliminary information on risk

mitigations strategies. The data limitations on both the forest management schemes and practices, and the insurance pricing methods and information represent a serious constraint on a more adequate analysis of the issues and questions.

Another limitation of this research is that I could not capture the WTP of NIPFs to be paid for annual insurance premia for insuring a one hectare of forest land. I had asked an open ended question from the NIPFs. I asked for annual WTP values for insurance premium for one hectare of forest land for each kind of risks of forest fire, storms and wind damage, public liability, employer liability, and replanting cost. Most NIPFs mentioned risks but could not provide WTP insurance premium values. This could be arising from the fact the public good nature of the benefits of forests owned by NIPFs seems to disincentivise owners from taking private insurance.

5.2.4 Future Research

I am planning to conduct a research (postal survey or face-to-face interview) to estimate the risks of NIPFs on their private forest benefits with a developed questionnaire to create more knowledge in order to formulate policies in promoting afforstation in future, based on experience and outcomes of this research. Then my new questionnaire may be totally focused on estimating risk and WTP for insurance premiums. In this questionnaire survey, I would provide more preliminary information to NIPFs on insurances schemes, their compensation, risk mitigation methods of mainly land use diversification and forest management. Here I ask WTP for annual forest insurance premia per for each kind of main risks using payment card instead of open-ended questions to overcome the problem of missing values. If I use Probit model to analyse whether NIPFs would like to insure forests, it could be more meaningful. In addition I can use interval regression (generalised Tobit model) to analyze WTP for insuring each risk given more information on risk mitigations and insurance which could be more meaningful. I can include one question such as risk of any hazard to your forest before clear felling is low, moderate, high and very high and run the ordered Probit model for risk perception.

The application of the precautionary principle through ecosystem based management is a popular key research area but to the best of my knowledge, it appears not to be applied in practice. Cameron & Abourchar (1991) explain that the precautionary

principle could be applied to environmental management for preventing the threat of damage to the ecosystem or human beings from hazards even with little information about future occurrence of damage. It could also be considered as a guiding principle for decision makers to prevent expected damages. As FAO (1996) explains the precautionary principle should take into account uncertainties, identification of undesirable outcomes, and the need to take measures to protect the resources for future generations.

The demand side factors I estimated in this chapter would be helpful to insure forest for future generations. The application of other risk mitigation methods such as proper management to reduce forest fires in spite of having insurance would be a better approach that the precautionary principle to protect the forest ecosystem. Such reduction of risk would indeed reduce insurance risk premium. Lackey (1998) emphasizes that scientific information is required for proper management of resources where as Levin et al (2008) stress the need for developing a management and monitoring system to achieve resource management goals. Therefore, the results of this chapter would be indeed helpful to approach protection of forest resources (private forests) through the precautionary principle developing a forest management method. For example, I have found that NIPFs with high extent of land area are reluctant to insure forest because they can mitigate risk easily by diversification of land. Therefore, such farmers could be motivated to follow a precautionary principle to reduce the risk through proper diversification of their land as Parks (1995) explains. In the same manner those NIPFs with positive attitudes towards insuring their forest (those with high off-farm income and higher education) could be motivated to pursue a precautionary principle to insure forests but still their risks could be reduced more by other forest management practices to take the risk to a lower level as a holistic approach.

5.3 Summary and Conclusions of chapter 4 - Estimating the Non-market Value of Preserving Natural Fish Stocks and the Current Quality of Recreational Fishing in Ireland

In this chapter I estimated WTP of the general public for maintaining current quality of recreational fishing and total social welfare of recreational fishing in Ireland. This study found that the mean predicted WTP for the general population is €15.97 per

person per year and the mean predicted WTP for the recreational angler population is higher at €66.52 per person per year. Finally, I found that the total social welfare of recreational fishing in Ireland is €57.619 million per annum. This high value of total welfare means that it has to be continued to maintain maximized total social welfare of the country. In other words, these results could be used by regulatory agencies to formulate more comprehensive resource allocation policies for recreational fishing sector.

I also found that those who are active anglers are associated with higher WTP in order to preserve the quality of fish stocks and the quality of angling relative to average individuals. Those who have more free time, retired, 'part-time employed' and unemployed don't have significantly lower or higher WTP values. I also found that entire social classes show decreasing WTP, though different social classes have obviously different income levels. I found that Polish nationals and residents in Munster province have high WTP values compared with average Irish individuals.

5.3.1 Limitations of the Research

Non-market valuation in environmental economics is a controversial research area in spite of methodological and theoretical developments. I explain some of the weaknesses of my methodology of valuation of recreational fishing research, which limits the accuracy of the results. Two main problems which limit the accuracy of the results is anchoring effects in payment card based contingent valuation and hypothetical bias in non-market valuations. For non-market valuation of recreational fishing research, I collected data employing stated preference method using a well designed questionnaire. I employed payment card type questionnaire to capture the respondents' WTP values. The payment card was shown to respondents and they were asked to select their maximum WTP from a range of choices. Rowe *et al.* (1996) explain that the National Oceanic and Atmospheric Administration (NOAA) explains, without citing supporting literature, that payment cards are likely to create anchoring and other forms of bias which are twofold; one arising from range bias and the other centering bias but they provide little empirical evidence for such biases. The range bias is the bias arising from different ranges of payment card bid values whereas centering bias arises from different mid-bid WTP values of the payment card. But Green *et al.* (1998) argue that psychometric bias may be a more serious problem in

payment card type questions, a choice from a series of ranges. In this research, I asked respondents how much they would like to pay for preserving current quality of the fishing ecosystem, but the problem is that respondents are not paying it but just willing to pay. Therefore Exel *et al.* (2006) argue that CVM is a measure of intention and their WTP value says more about respondent's attitudes than his/her actual paying behaviour. The CVM is based on a hypothetical market situation which attempts to elicit from respondents their maximum willingness to pay (WTP) for the non-market good. However, Exel *et al.* (2006) argue that saying and doing are two different things. Ajzen *et al* (2004) carried out an experiment to measure the difference between the WTP people mention and what they pay exactly. They found that high percentages of people could not pay the amount they mentioned. They confirm that as a result of the existence of a strong bias, people overestimate the likelihood which they would engage in a socially desirable behaviour. This bias produces unrealistically high estimates of WTP as well as creates inconsistencies between intentions and actions. However, undertaking a meta-analysis, Murphy *et al.* (2005) examine hypothetical bias in WTP contingent valuation and say that the primary factor that explains this bias is the magnitude of the hypothetical value and the other factors that may be associated with hypothetical bias yielded mixed results.

5.3.2 Future Research

I mainly identify future research priorities for recreational fishing for Ireland based on the result of this research and literature review. In my policy discussion, I have emphasised that preserving natural fish stocks and the current quality of recreational fishing in Ireland is essential to maintain social welfare in the country. However, Cooke & Cowe (2004) explain that global fishery resources are facing a number of serious threats for marine ecosystems and sustainable productivity thereof mainly due to commercial fishing and over exploitation (Watson et al, 2003) but they explain that current studies have ignored analysis of negative impacts of recreational fishing and also paid little consideration to freshwater bodies.

Evidence of the negative consequences of recreational fishing in both freshwater and marine systems is mounting rapidly. I discuss below some of the negative impacts of recreational fishing here for which more research is needed for Ireland. Recreational fishing is fundamentally different from commercial fishing such that the primary

reason for participation in recreational fishing is leisure, but the catch is taken for domestic consumption (Cowe, 2002). Also recreational anglers have access to more sensitive places such as shore regions, estuaries, reefs, mangroves, inland water bodies and sometimes their catch is bigger than that of commercial fishermen and even recreational anglers target different life stages of fish including immature fish. There are many examples in which the recreational harvest rates for individual species exceed those of commercial fisheries (Schroeder & Love (2002) as cited by Cooke *et al*., 2004). In addition there can be substantial postrelease mortality as when they catch immature fish, they release them again as well as more subtle sub lethal effects on growth and fitness. Moreover, McPhee *et al*. (2002) explain that recreational boat traffic and the associated noise pollution, wave erosion, and scarring also contribute to degradation of both the environment and the fish stock. Under these circumstances, Cryer *et al.* (1987) explain that the recreational fishing sector has a share of responsibility for all these negative impacts.

McConnell & Stunin (1978) developed theoretical models for optimal allocations and fishing polices between commercial fishers and recreational fishers. But again there is optimal control among recreation fishers themselves which has been examined by Johnston *et al.* (2010). That means every recreational fisher should have his/her own share of recreational fishing. Johnston *et al.* (2010) developed an integrated bioeconomic model to examine angler preferences, angler behaviour, and composition of angler population.

This study suggested optimal regulation for maximizing angler utility and also the key finding of the study was that socially optimal angler regulations resulted in biological sustainability of fish population. Johnston *et al.* (2010) conclude that managers can use their model under diverse and complex situations of angler's behaviour for the optimal control of recreational fishing.

Under these circumstances, more research has to be undertaken to examine levels of all negative impacts of recreational fishing in Ireland and to examine optimal levels of recreational fishing, recreational fishers' preferences and behaviour in order to achieve socially and biologically sustainable harvesting.

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