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National University of Ireland, Galway

Doctoral Thesis

Economic Essays on the Impact of Health Insurance on Healthcare Utilisation and Healthcare Costs for Older People in Ireland

By

Patrick Ward

A thesis submitted in fulfilment of the requirements for

The Degree of Doctor of Philosophy

From the

J.E. Cairnes School of Business and Economics

The National University of Ireland, Galway

Supervisor: Professor Paddy Gillespie

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Table of Contents

Declaration iii

Abstract iv

Acknowledgements v

List of Tables vii

List of Figures ix

List of Abbreviations x

1. Introduction 1

1.1 The Research Focus 1

1.2 The Research Context 3

1.3 The Health Economic Analysis Context 20

1.4 Theoretical Contributions of Relevance to the Research Objectives 27

1.5 Estimating causal effects or associations between health insurance and healthcare utilisation, costs and informal care 33

1.6 Structure of the Thesis 35

1.7 Conclusion 36

2. Generating the Estimation Sample: Data Sources and Descriptive Statistics 37

2.1 Introduction: The Irish Longitudinal Study on Ageing (TILDA) 37

2.2 Generating the Estimation Sample 45

2.3 Descriptive Statistics 59

2.4 Conclusion 86

3. Methodology 87

3.1 Methodological Approaches to Estimating the Effect of Health Insurance Status 87

3.2 The Evaluation Problem with Cross-Sectional Data 88

3.3 The Evaluation Techniques Adopted for the Analysis of Cross-Sectional Data 89

3.4 Theoretical Analysis of Healthcare Costs 95

3.5 Theoretical Analysis of Informal Care 102

3.6 Literature Review Methodology 103

4. Health Economic Analysis of the Role of Health Insurance Status on Hospital and Community

Care Service Utilisation and Costs among over 50s in Ireland 105

4.1 Introduction 105

4.2 Health Economic Analysis of Healthcare Utilisation 107

4.3 Methodology 112

4.4 Results 114

4.5 Discussion 149

5. Health Economic Analysis of the Role of Informal Care on Healthcare Utilisation and Healthcare Costs among over 50s in Ireland 154

5.1 Introduction 154

5.2 Health Economic Analysis of Informal Care 155

5.3 Methodology 161

5.4 Results 162

5.5 Discussion 221

6. Discussion 227

6.1 Introduction 227

6.2 Study Objectives 227

6.3 Study Findings 227

6.4 Study Implications 229

6.5 Study Limitations 233

6.6 Future Research Questions 234

6.7 Conclusion 236

Bibliography 237

Appendix A: Supplementary Material for Chapter 4 250

Appendix B: Supplementary Material for Chapter 4 259

Appendix C: Supplementary Material for Chapter 5 260

Declaration

I declare that this thesis, submitted to the National University of Ireland, Galway for the Degree of Doctor of Philosophy (Ph.D.) has not been previously submitted as an exercise for a degree at this or any other University. All research herein is entirely my own.

_____

Patrick Ward

Date: 11/10/2019

Abstract

This thesis explores the drivers of healthcare utilisation and healthcare costs among older people in the Republic of Ireland, and, in particular, provides estimates for the impact of health insurance on utilisation, costs and informal care. This thesis is informed by projected changes in key policy and contextual factors that will pose questions for the future financing, delivery of and access to formal healthcare services in the Republic of Ireland. First, the complex, tiered nature of the Irish healthcare system and the role that health insurance plays in enabling access to formal healthcare services will change if government proposals for a more universal model of health insurance coverage comes into effect. Second, demographic trends indicate that the proportion of older individuals in the population, who tend to be the highest users of healthcare services, is increasing year on year. It is likely that both of these factors will lead to increasing pressures being placed on already capacity constrained formal healthcare systems to meet these demands. Additionally, such demand side pressures will increase the importance of informal care in the Irish healthcare system, both as a supplement to and a substitute for formal care. Furthermore, the impact of the proposed policy changes will likely influence the existing interactions between the formal and informal care systems. Within this context, the overarching motivation of the thesis is to expand knowledge and understanding of the role of health insurance, both public and private, and informal care in determining the use and cost of formal care services for older people in the Republic of Ireland.

To this end, three sets of empirical econometric analyses were undertaken. The first empirical analysis examined the associations between health insurance status and utilisation of a range of hospital and community healthcare services. The findings suggest that higher levels of health insurance coverage impacted positively on healthcare utilisation generally. The second empirical analysis examined associations between health insurance status and healthcare costs. The findings suggest that higher levels of health insurance coverage impacted positively across the full distribution of healthcare costs. The third empirical analysis examined the associations between informal care and the utilisation and cost of healthcare services. The findings suggest that being in receipt of informal care impacted positively upon healthcare utilisation and costs. The analysis also showed that health insurance increased the likelihood of receiving informal care, although not of providing such care.

Taken together, the findings suggest that projected changes to key policy and contextual factors relating to older Irish people will have important implications for both the formal and informal care systems and may be expected to lead to significant increases in healthcare utilisation and costs. Such evidence may be of interest to those charged with the design and delivery of formal healthcare services for older people and their carers in the Republic of Ireland. Policy-makers should be aware of the potential financial consequences of the proposed changes to the Irish healthcare system and put in place measures to control utilisation and costs in any new system.

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List of Tables

Table 1.1 Public Eligibility for healthcare services in the Irish healthcare system..... 7
Table 1.2 The role of private health insurance in the Irish healthcare system..... 7
Table 1.3 Eligibility for Community Care Healthcare Services in Ireland..... 7
Table 1.4 Goals and Strategic Actions - Slaintecare Implementation Plan..... 13
Table 1.5 High Impact Actions – What will be delivered by 2021?..... 14
Table 1.6 Actual 2016 and projected population growth estimates (‘000) 2016-2051..... 16
Table 2.1 Descriptive Statistics on Nationally Representative Sample..... 41
Table 2.2 Descriptive Statistics on Estimation Sample..... 43
Table 2.3 List of Dependent Variables for Analysis..... 46
Table 2.4 Unit Cost estimates (€) in 2013 prices..... 48
Table 2.5 Descriptive Statistics on Household Imputation Methods..... 56
Table 2.6 Sensitivity Analysis on Imputation Method..... 56
Table 2.7 Descriptive Statistics on Health Insurance Status in TILDA..... 59
Table 2.8 Descriptive Statistics on Hospital Service Use by Health Insurance Status..... 62
Table 2.9 Descriptive Statistics on Community Care Services Use by Insurance Status..... 64
Table 2.10 Descriptive Statistics on Primary Healthcare Service Use by Health Insurance Status..... 66
Table 2.11 Total Healthcare Costs by Health Service..... 68
Table 2.12 Total Healthcare Costs and Resource Use by Insurance Status..... 69
Table 2.13 Descriptive Statistics on Informal Care Receipt..... 71
Table 2.14 Descriptive Statistics on Informal Care Given - Imputed Income Sample..... 71
Table 2.15 Descriptive Statistics on GP and Hospital Healthcare Service Use by Informal Care Receipt..... 73
Table 2.16 Descriptive Statistics on GP and Hospital Healthcare Services Use by Informal Care Provision..... 74
Table 2.17 Descriptive Statistics on Community Healthcare Service Use by Informal Care Received76
Table 2.18 Descriptive Statistics on Community Healthcare Service Use by Informal Care Provision..... 80
Table 2.19 Descriptive Statistics on Total Healthcare Costs by Informal Care Receipt..... 85
Table 2.20 Descriptive Statistics on Total Healthcare Costs by Informal Care Provision..... 85
Table 4.1 Summary of Expanded Health Insurance Coverage..... 114
Table 4.2 Observed Matching Characteristics..... 116
Table 4.3 Average treatment effects on the treated of health insurance status on hospital care services utilisation..... 121
Table 4.4 Average treatment effects on the treated of health insurance status on community care services utilisation..... 125

Table 4.5 Average treatment effects on the treated of health insurance status on community care services utilisation (Cont'd) 128
Table 4.6 Average treatment effects on the treated of health insurance status on community care services utilisation (Cont'd) 131
Table 4.7 Average treatment effects on the treated of health insurance on community care services utilisation (Cont'd) 134
Table 4.8 GLM Model Diagnostics – Mean Cost Analysis 136
Table 4.9 OLS and GLM mean healthcare cost estimates 139
Table 4.10 ATET of health insurance status on mean healthcare costs based on PSM and Mahalanobis matching approaches 142
Table 4.11 ATET of health insurance status on mean healthcare costs based on the inverse probability weighting approach 143
Table 4.12 RIF Unconditional Quantile Regression estimates of health insurance status on healthcare costs 146
Table 5.1 Summary findings healthcare service utilisation by informal care 163
Table 5.2 Observed matching characteristics 165
Table 5.3 ATET of health insurance status on any informal care received 169
Table 5.4 ATET of insurance status on informal care received from a spouse 169
Table 5.5 ATET of insurance status on informal care received from a resident child 170
Table 5.6 ATET of insurance status on informal care received from a non-resident child 170
Table 5.7 ATET of insurance status on informal care received from others 171
Table 5.8 ATET of insurance status on informal care received from more than one person 171
Table 5.9 ATET of health insurance on any informal care provided 174
Table 5.10 ATET of health insurance status on informal care provided to one person 174
Table 5.11 ATET of health insurance status on informal care provided to more than one person 174
Table 5.12 Average treatment effect on the treated of informal care receipt on GP and hospital service utilisation 182
Table 5.13 Average treatment effect on the treated of informal care provision on GP and hospital service utilisation 183
Table 5.14 Average treatment effect on the treated of informal care receipt on Community Care Service Utilisation 190
Table 5.15 Average treatment effect on the treated of informal care provision on community care service utilisation 191
Table 5.16 Average treatment effect on the treated of informal care receipt on total healthcare costs 218
Table 5.17 Average treatment effects on the treated of informal care provision on total healthcare costs 220

List of Figures

Figure 1.1 The Andersen Behavioural Model 25
Figure 2.1 Densities of total expenditures and their residuals 67
Figure 4.1 Balance Plot Depicting Matching and Unmatched Samples 118
Figure 4.2 Coefficients and 95% confidence intervals by quantile of expenditure errors 144
Figure 5.1 Balance Plot depicting Matched and Unmatched Samples 167

List of Abbreviations

A&E	Accident and Emergency
AB	Accelerated Benefits
ADL	Activities of Daily Living
AHEAD	Asset and Health Dynamics among the Oldest-Old Panel Survey
AIC	Akaike Information Criteria
ATE	Average Treatment Effect
ATT	Average Treatment Effect on the Treated
BHPS	British Household Panel Survey
BIC	Bayesian Information Criteria
BMI	Body Mass Index
CAPI	Computer Aided Personal Interviewing
CIA	Conditional Independence Assumption
CLL	Complementary-log-log
CQR	Conditional Quantile Regression
CSO	Central Statistics Office
DEDs	District Electoral Divisions
DGP	Data generating process
DiD	Difference-in-difference
DTSS	Dental Treatment Services Scheme
ELSA	The English Longitudinal Study of Ageing
ESRI	The Economic and Social Research Institute
FFS	Fee-for-service
GLM	Generalised linear models
GP	General Practitioner
HPO	Hospital Pricing Office

HSE	Health Service Executive
HRS	Health & Retirement Survey
IADL	Instrumental Activities of Daily Living
IPW	Inverse Probability Weighting
ISSDA	Irish Social Science Data Archive
IV	Instrumental variable
LTC	Long-term care
LTI	Long-term illness
MC	Medical card
MMSE	Mini-Mental State Examination
NHF	National Health Fund
NCMS	New Cooperative Medical Scheme
OECD	Organisation for Economic Co-operation and Development
OHIE	The Oregon Health Insurance Experiment
OLS	Ordinary least squares
OPT	Optician
OSI	Ordnance Survey Ireland
OT	Occupational Therapy
PHI	Private Health Insurance
PHN	Public healthcare nurse
PRSI	Pay Related Social Insurance
PSM	Propensity Score Matching
QCR	Quantile Conditional Regression
RCT	Randomised Controlled Trial
RD	Regression discontinuity
SCQ	Self-Completion Questionnaire

SHARE	Survey of Health, Ageing and Retirement
SID	Supplier Induced Demand
SUR	Seemingly Unrelated Regression
TILDA	The Irish Longitudinal Study on Ageing
TUG	Timed Up-and-Go
UCD	University College Dublin
UHC	Universal Health Coverage
UHI	Universal Health Insurance
UN	United Nations
UQR	Unconditional quantile regression
VPHI	Voluntary Private Health Insurance
WHO	World Health Organisation

1. Introduction

In broad terms, this thesis employs health economic methodologies to explore associations between health insurance status and informal care on healthcare utilisation and healthcare costs of older people in the Republic of Ireland. This chapter outlines the research questions that I attempt to answer in later chapters and the motivation behind attempting to do so. The chapter describes the wider contextual issues around the delivery of healthcare services for older people in the Republic of Ireland including institutional, policy, demographic and informal care. Of particular importance in this regard, are those within the policy domain given the proposed changes to how healthcare may be funded and delivered, and the role that health insurance status plays in accessing formal care services. In addition, the role of informal care and its interactions with the formal care systems will grow in importance in the years to come, given projected demographic and policy changes. The chapter then provides a description of the health economic analysis context, which addresses how health economic methods may be employed to examine the research questions outlined. That is, the focus of the thesis is confined to estimating associations between health insurance and informal care on healthcare utilization and healthcare costs for the older population in the Republic of Ireland. This empirical analysis is informed by a series of theoretical models of healthcare utilization and costs, which are summarized in the chapter. From this literature, the theoretical model by Andersen (1968) and Andersen and Newman (1973); adopted to underpin the empirical analysis presented in subsequent chapters is described. Finally, the last section of the chapter outlines the structure of the thesis.

1.1 The Research Focus

In this section, the motivation and objectives for the research are outlined.

1.1.1 Motivation & Objectives

The overarching motivation of this thesis can be framed in the following research question:

To expand my knowledge and understanding of the roles of health insurance and informal care in determining the use and cost of formal healthcare services for older people in the Republic of Ireland.

Based on this broad research question, the thesis includes three specific research objectives, which are outlined below:

- To examine associations between health insurance status and utilisation of a range of hospital and community healthcare services for older people in the Republic of Ireland. In particular, this analysis seeks to address the following question: *Does the level of healthcare service utilisation differ depending on the level of health insurance coverage?*

- To examine associations between health insurance status and the costs of healthcare services for older people in the Republic of Ireland. In particular, this analysis seeks to address the following question: *Does the mean and distribution of healthcare costs differ depending on the level of health insurance coverage?*

- To examine associations between health insurance status and informal care, received or provided among older people in the Republic of Ireland. In addition, the chapter examines the relationship between informal care received and provided on the utilisation and costs of healthcare services for older people in the Republic of Ireland. In particular, this analysis seeks to address the following questions: *Does the level of informal care received and provided differ depending on the level of health insurance coverage and does the level of healthcare service utilisation and cost differ depending on informal care received or provided?*

The first objective examines the current state of play with regard to the relationship between health insurance and the utilisation of healthcare services for older people in the Republic of Ireland. As will be outlined in Chapter 4, while much work has examined associations between health insurance status eligibility and primary care service utilisation, less is known about the associations of such eligibility for acute hospital and community care services – services that are of particular importance for individuals, as they get older. Furthermore, and as will be outlined below, this analysis is important in light of government proposals, which would alter the nature of how healthcare is financed, delivered and accessed. While it is not possible to identify what future utilisation might be in the context of the proposed model of healthcare, the evidence produced can at least inform the policy debate.

The second objective examines the current state of play with regard to the relationship between health insurance and the cost of healthcare services for older people in the Republic of Ireland. As outlined below, healthcare expenditures and costs are rising worldwide and it is important to shed light on the potential cost drivers for older people, to inform health policy makers,

healthcare providers and the taxpayers who fund the majority of Irish healthcare services. In addition, this is of particular interest in light of proposed policy changes, which will be outlined below. Again, while it is not possible to identify what future costs might be in the context of the proposed model of healthcare, the evidence produced can at least inform the policy debate.

The third objective examines the relationship between insurance status and informal care, as well as looking at the relationship between informal care and the utilisation and cost of formal healthcare services for older people in the Republic of Ireland. As will be outlined in the sections below, the increasingly important role that informal care plays alongside the formal healthcare system is widely accepted and may be expected to grow given demographic trends towards an ageing population in the Republic of Ireland. In addition, the proposed policy changes, which would alter the nature of how healthcare is accessed, may have impacts for the informal care system. Therefore, further understanding of the dynamic between informal and formal healthcare for older people is required, given potential increased capacity pressures that such demographic changes may place on the formal healthcare sector. While it is not possible to identify what future utilisation and costs might be, the evidence produced can at least inform the health policy debates regarding informal care.

1.2 The Research Context

In this section, I provide context to the research questions set out above in order to highlight their importance and relevance. In particular, I describe the wider context, specifically the institutional, policy, demographic, and informal care factors, which may inform the determination of utilisation and costs of healthcare services for older people in the Republic of Ireland. In particular, these institutional issues are at the heart of the current policy debate around the finance, delivery and access of healthcare services and form a central focus of the thesis. Indeed, I discuss what possible implications these wider issues might have for healthcare utilisation and expenditure in this country.

1.2.1 Healthcare Utilisation and Costs

The research questions addressed in this thesis are set against an environment of increasing population growth, longer life expectancy and decreasing fertility rates. Given older people are the most frequent users of healthcare services (Dollard et al., 2018; Hudson & Nolan, 2015); such dramatic demographic changes are likely to exert increasing demand and supply sides pressures on an already capacity stretched public healthcare system. By extension, such

demographic changes will also lead to significant increases in spending on healthcare in future years (Dieleman et al., 2017; Fernandez, Forder, & Knapp, 2011). In an Irish context, following the introduction of free GP care for those under 6 and over 70 years of age in 2015, Connolly et al; (2018) investigated the potential costs implications of a universal role out of free GP care for the entire population. Their analysis found that the cost of the reform would add between 2 and 3.5 percent to overall public healthcare expenditure and up to 1.2 percent to total healthcare expenditure. Given the institutional context within which healthcare is financed in Ireland at present, and the central role played by health insurance status in accessing healthcare services, as well as to the proposed policy changes to healthcare financing in healthcare detailed above, it is perhaps pertinent to examine the drivers of health expenditure in an Irish setting.

Total healthcare expenditure in Ireland reached €21.5bn in 2016 (Central Statistics Office, 2018b) representing a 10% increase since 2011. The economic crisis led to a small reduction in total healthcare expenditure from 2009 to 2010 but has increased each year since then (OECD and European Observatory on Health Systems and Policies, 2017). Demographic changes and an ageing population will see significant increases in healthcare spending in years to come. For example, the Department of Health has predicted that such demographic pressures will increase expenditure by between 1.4% and 1.6% annually (Government of Ireland, 2018); while Fernandez et al; (2011) predict that long-term care expenditure will reach between 2% and 4% of GDP by 2050. These demographic changes, together with the proposed policy changes to how healthcare is financed, delivered and accessed outlined below provide the motivation for the research questions on costs outlined above.

1.2.2 The Institutional Context

The organisation of the healthcare system, and the way in which it is funded and delivered, influences how people use healthcare services, how much they use and how much these healthcare services cost. The Irish healthcare system is built on a uniquely two-tiered structure of public and private provision of services. In the first instance, the Irish healthcare system is largely financed through general taxation (OECD and European Observatory on Health Systems and Policies, 2017). The remainder is funded through private sources including health insurance and out-or-pocket expenditure (Central Statistics Office, 2018b). All individuals in Ireland are publicly insured to access the public healthcare system. However, the cost of, and access to healthcare services differs across the population, given differences in income, healthcare need and private health insurance (PHI) status. It is precisely these

differences; together with the proposed changes outlined in the Slaintecare Report (Houses of the Oireachtas Committee on the Future of Healthcare, 2017) that seek to significantly alter how healthcare is financed, delivered and accessed in the Republic of Ireland, that provide the motivation for research objectives 1 and 2 which have been outlined above.

At present, given these differences in cost and access to healthcare services, individuals in the Republic of Ireland can be categorised into four distinct insurance coverage categories: (1) public health insurance only (**Base**); (2) public health insurance plus a medical card (**MC**); (3) public health insurance plus private health insurance (**PHI**); and (4) public health insurance plus medical card plus private health insurance (**MC+PHI**). Individuals who fall below a set income threshold[1] are eligible for a full medical card. A medical card entitles the holder to free GP care and free inpatient, outpatient and A&E services in public hospitals. Medical cardholders are subject to small prescription charges[2]. In October 2005, the Irish government introduced the GP visit card[3] conferring eligibility for free GP visits to the holder and their dependents (Citizens Information, 2015). GP visit holders can also avail of free GP visits but must pay the full price of prescription drug costs.

All individuals who are eligible for a full medical card or a GP visit card are known as category 1 individuals in the Irish healthcare system. Medical care holders are entitled to a range of free healthcare services through a range of schemes including the Long-Term Illness (LTI) Scheme, Dental Treatment Service Scheme (DTSS) the Community Ophthalmic Services Scheme and homecare service provided by the HSE. While these services are useful for individuals with a medical card, gaining access without a medical card is difficult and can result in substantial out-of-pocket expenses for non-medical card holders (Houses of the Oireachtas Committee on the Future of Healthcare, 2017). In certain cases, individuals with certain healthcare needs, which cause undue hardship; who would otherwise be ineligible for

[1] Individuals living alone under the age of 66 who earn less than €184 per week or a couple with two children aged under 16 who earned less than €342.5 per week are entitled to a medical card. Income thresholds are slightly higher for those aged 66-69 at €201.50 per week for a single person and €298 per week for couples. The income threshold for those aged 70 and over is €500 per week for a single person and €900 per week for couples (www.citizensinformation.ie).

[2] Medical cardholders are subject to a co-payment charge of €2.50 per item for prescription drugs. This is capped at €25 per person (or family) per month under the General Medical Services Scheme. For over 70s the co-payment is capped at €20 per person per month

[3] The income thresholds for GP visit cards for those under 66 and living alone is €276 per week and €514 per week for a couple with two children under the age of 16.

a medical/GP visit card, may be granted a medical card on a discretionary basis[4][5]. Those ineligible for a full medical or GP visit card are known as Category 2 individuals. Category 2 individuals must pay the full out-of-pocket costs for both GP visits and prescription drugs[6].

The Irish healthcare system is further complicated by the complex mix of public and private provision of secondary care services. While all individuals in Ireland are entitled to access secondary healthcare services for free or at low cost in public hospitals, some individuals may choose to access these services privately, either in private hospitals or as private patients in public hospitals. Individuals do so, mainly, to gain quicker access to hospital services and to avail of perceived better quality of care. In order to access secondary care services privately, individuals purchase private health insurance (PHI) to cover the higher costs. Thus, private health insurance plays a supplementary, complementary and duplicative role in the Irish healthcare system (OECD, 2017; Thompson & Mossialos, 2009). According to the Health Insurance Authority, 45.8% of the population purchased private health insurance in 2016 (The Health Insurance Authority, 2017). Individuals can also avail of tax relief on insurance premiums up to a maximum of €1,000 per adult and €500 per child (Office of Revenue Commissioners, 2016). The existence of such a multi-layered structure within the Irish system has given rise to concerns over inequities of access to healthcare services in Ireland. Furthermore, such concerns are heightened due to the role of the GP in Ireland, in that they act as a gatekeeper to hospital and community care services (Madden, Nolan, & Nolan, 2005). Tables 1.1 and 1.2 below summarise the eligibility criteria across category 1 and category 2 individuals and the role of private health insurance by the type of care in the Irish healthcare system.

[4] Individuals living alone aged under 66 who earn less than €9,568 annually or a couple with two children aged under 16 who earned less than €17,810 annually are entitled to a medical card. Income cut-offs are slightly higher for those aged 66-69. The income limit for over 70s to be eligible for a medical card is €26,000 for a single person and €46,800 for couples (www.citizensinformation.ie).

[5] The Health Act (1970), as amended, states that a person is eligible for a discretionary medical card if "considered by the chief executive officer of the appropriate health board to be unable, without undue hardship, to provide that service for himself or his dependants (Health Service Executive, 2014).

[6] Under the Drugs Payment Scheme prescription drug costs are capped at €144 per month per individual/family for GP visit card holders and category 2 individuals.

Table 1.1 Public Eligibility for healthcare services in the Irish healthcare system

Type of Care	Category 1 (Full medical card)	GP visit card	Category 2 (Non-medical card holders)
GP	Free	Free	Out-of-pocket fees
Prescription medicines	Co-payment charge of €2.50 per item. Capped at €25 per person (or family) per month (General Medical Services Scheme), at €20 if aged 70 or over	Drugs Payment Scheme: Free above €144 out-of-pocket payment per month per family/individual. For Specified Long-term illness (Long-term illness/High Tech Drug Schemes): Free	
Acute public hospital inpatient	Free	€80 per night (annual capped at €800 per person)	
Acute public hospital outpatient (includes Emergency Department)	Free	Free with GP referral. €100 per visit without GP referral. Free access to other outpatient services	
Other	Varied eligibility or community, personal and social care services, dental, ophthalmic, aural care; other benefits		

Source: Slaintecare Report(Houses of the Oireachtas Committee on the Future of Healthcare, 2017).

Table 1.2 The role of private health insurance in the Irish healthcare system

Type of Care	The Role of Private Health Insurance
GP	Some PHI polices provide cover (i.e. coverage varies by policy) for GP consultations
Prescription medicines	Generally, not covered in PHI polices.
Acute public hospital inpatient	Generally, PHI polices provide cover (i.e. coverage varies by policy) for hospital stays in private or semi-private wards in public hospitals
Acute public hospital outpatient (includes Emergency Department)	Generally, PHI schemes provide cover (i.e. coverage varies by policy) for private consultations in public hospitals
Other	Some PHI polices provide cover (i.e. coverage varies by policy) for community, personal and social care services.

There is an absence of clarity on access to community care services. Indeed the rules and regulations on the provision of community care services by the Health Service Executive (HSE) varies depending on the service (Houses of the Oireachtas Committee on the Future of Healthcare, 2017). Table 1.3 below presents an overview of access to social care services in Ireland. Access to social and community care services often depends on geographic location and existing supply in the area at any given time. Generally, access to aids and appliances, public allied health professionals and public healthcare nurses are not available to individuals without a medical card (Citizens Information, 2020). Community care services provided through the public system include public healthcare nurse services; homecare services; physiotherapy and occupational therapy services as well as dental, hearing; optician and respite care services. While all of these services are available publicly through the HSE, free of charge for those with a medical card or a Health Amendment Act Card (Citizens Information, 2015), gaining access to these services is often difficult with long waiting list ensuing due to limited resources. Often times, older people or their family pay out of pocket for these services (Citizens Information, 2020).

The Health Service Executive (HSE) provides a free nursing service to medical cardholders, although a report by TILDA found that 72% of elderly frail individuals do not have access to these services, reinforcing the fact that gaining access to these services is often difficult (Roe et al, 2016). Such public healthcare nurse (PHN) services are not limited to medical cardholders, but they may get priority access to services required. Public health nurses are usually based in, and work out of, the HSE local health centre. The services provided by a PHN vary from area to area and they act as a point of access for other community care services (Citizens Information, 2020). Some Local Health Offices (LHO) employ health assistants as back up to consolidate public healthcare nurse services. The role of the care assistant is to provide personal care rather than domestic services although this varies across carers.

Home support is available to people aged 65 and over who may need help to continue living at home or to return home following a hospital visit. Providers of this type of care help those who need support with everyday activities such as bathing and dressing. In some cases, such services are available to people younger than 65 who need support. There is no charge for the service and it is not means tested. A person's individual needs are assessed to decide what supports they need. However, these services were dramatically reduced as part of the package of austerity measures introduced in response to a contraction in the growth of the Irish economy by 10.8% from 2008 to 2010 and an increase in the unemployment rate to

14.2% by the beginning of 2012 due to the financial bailout by the European Union (Thomas & Burke, 2012). A major issue with regard to the availability of homecare services in the Republic of Ireland is that they are unregulated. In the absence of an entitlement to homecare services, many people pay out of pocket for private homecare services, as it is often difficult to access such support.

Occupational therapy services are employed by local health offices. These services are free with a medical card. As with many community services, long waiting lists may apply to access these services in the public healthcare system. However, applications to see an occupational therapist are prioritised according to need. Prescribed aids and appliances are available free of charge to medical cardholders, people on the long-term Illness Scheme and people who have a Health Amendment Card. To access the services of an Occupational Therapist a patient may apply directly to their local health office (LHO), but it is more usual to be referred by a public health nurse, a GP or a hospital (Citizens Information, 2020).

Chiropody services are available free of charge to those with a medical card. Usually, a GP or public health nurse refers a patient. The availability of chiropody services provided by the Health Service Executive (HSE) varies in different areas. Where available, services may be provided by the Local Health Office (LHO) or by voluntary organisations on behalf of the HSE. Those without a medical card may be able to claim tax relief on chiropody services prescribed by a doctor (Citizens Information 2018). Those with a medical card or a Health Amendment Act card, as well as people with illnesses such as diabetes or arthritis and people with disabilities are prioritised for these services.

Hearing services provided by the HSE include hearing tests and hearing aids. These services are provided free of charge to patients with a medical card and to those under 18 as well as those with Hepatitis C who have a Health Amendment Act card. Referral for such services is generally made through a GP. If individuals are not eligible for a free hearing aid, they may qualify for support under the Treatment benefit Scheme (Citizens Information, 2020). This scheme is operated by the Dept. of Employment Affairs and Social Protection, providing dental, optical and aural services to insured workers and retired people, who have the required number of PRSI contributions. Hearing aids may be provided under the scheme by suppliers who have a contract with the Department. The department contributes towards the cost of the supply or repair of hearing aids. Access to these services is difficult with long waiting lists in

the public system.

Optician services provided by the public health service are free for medical cardholders and their dependants. Individuals with Hepatitis C who have a Health Amendment Act Card also receive these services free of charge. Medical cardholders are entitled to a free optical examination every 2 years and any necessary standard spectacles. All examinations and dispensing require approval from the Local Health Office. At present, there are just 22 HSE community ophthalmic services (Houses of the Oireachtas Committee on the Future of Healthcare, 2017). This results in long waiting lists for publicly provided care, high levels of unmet need and people paying out of pocket for ophthalmic services. For non-medical card or non-Amendment Act cardholders, the treatment benefit scheme may cover them and their dependent spouse for certain free optician services prescribed by a GP. Many individuals may have to pay for such services out of pocket.

The HSE provides some dental services to certain citizens. Dentists employed by the Local Health Office (LHO) and private patients contracted by the HSE provide these services. Non-medical cardholders have to pay for dental services from a private practitioner, although they may claim tax relief for certain specialised dental treatments. Routine treatments such as extractions, scaling and filling of teeth and provision of artificial teeth and dentures are excluded from tax relief. Individuals may also be eligible for free dental care under the Treatment Benefit Scheme available to insured workers, the self-employed and retired people who have the required number of PRSI contributions. However, funding for this scheme was reduced from €62m to €10m between 2010 to 2015, severely limiting access to dental care for non-medical cardholders. The Irish Dental Association submission to the Slaintecare committee highlighted this issue. Even though the number of people with medical cards seeking dental care under the Dental Treatment Services Scheme (DTSS) increased by 35%, the numbers of scale and polishes fell by 97% and fillings fell by 33% between December 2009 and December 2015. Over the same period, surgical extractions and routine extractions increased by 53% and 14% respectively, as dentists are only funded to provide emergency care and carry out extractions.

Respite care or temporary care may be based in the community or in a residential setting. In practice respite care is provided to a varying degree at a number of locations across the country. In some cases, such services are provided by the HSE or through local or national

voluntary organisations. The person being cared for may be admitted to a nursing home for a period of two weeks or longer if necessary. Respite care is organised through your local health nurse or GP and is funded by local HSE areas at no cost to individuals.

Table 1.3 Eligibility for Community Care Healthcare Services in Ireland

Type of Care	**Category 1 (Medical Card Holders)**	**Category II (Non-medical card holders)**
Public Healthcare Nurse Services	Free for medical and Health Amendment Act cardholders. Significant waiting lists apply	Must pay out-of-pocket. Medical cardholders get priority access to services
Home Health Care Services	Service is free and not means tested. Access provided on the basis of need	Service is free and not means tested. Access provided on the basis of need
Occupational Therapy Services	Free with a medical card or Health Amendment Act Card. Significant waiting lists apply. Applications prioritised according to need. Prescribed aids and appliances are free of charge. Referral is made by a GP or a public healthcare nurse	Must pay out of pocket for such services
Chiropody Services	Free of charge – patients usually referred by a public healthcare nurse or GP. Availability of services differs by area. Medical cardholders are prioritised for these services	Must pay out of pocket to see chiropodist privately. Can claim tax relief on chiropody services prescribed by a doctor.
Hearing Services	Free to medical cardholders. Referral is generally made by a GP. Availability differs by area. Access is difficult with long waiting lists in the public system	May qualify for support under the Treatment benefit Scheme operated by the Dept. of Employment & Social Protection
Optician Services	Free of charge. Free examination every 2 years with standard spectacles. Examinations require approval from LHO.	The treatment benefit scheme may cover them and their dependent spouse for certain free optician services. Many patients have to pay out of pocket for such services
Dental Services	Dental examination and two emergency fillings per year, unlimited extractions	Dental scheme for people wo pay PRSI – only one oral examination available.
Respite Care Services	Free of charge. Services are provided by the HSE or through local or national voluntary organisations	Generally do not need to access these services

1.2.3 The Policy Context

In this section, the current state of play with regard to health policy in the Republic of Ireland is examined, with particular emphasis on the issues of direct relevance to this thesis. The section describes the historical background and contextual issues around the Irish Government's desire to move towards a 'universal healthcare' financing model for the Republic of Ireland. I also introduce the main policy documents that has been published in the Republic of Ireland that address capacity issues within the healthcare system in Ireland. These policy documents, together with the other contextual background issues set out in Section 1.2, provide the motivation for the research questions relating to health insurance status and healthcare utilisation and costs that the thesis aims to address and which are set out in Section 1.1.

In 2005, all World Health Organisation (WHO) member states, including Ireland, committed to Universal Health Coverage (UHC) (WHO, 2005). This commitment to UHC was reiterated by the United Nations (UN) and WHO in 2012 (UN, 2012) In 2011, the Irish government made a commitment to a universal healthcare system which would be funded through compulsory universal health insurance (Government of Ireland, 2011). This commitment was reiterated in a Government White Paper on universal health insurance in 2014 (Department of Health, 2014). However, an independent assessment of the 2011 proposals found that the introduction of universal health insurance (UHI) would be too costly to implement (Wren, Connolly, & Cunningham, 2015).

In June 2016, the Irish parliament established the Committee on the Future Healthcare of Ireland with the goal of achieving cross-party consensus on the future direction of healthcare in Ireland and developing a 10 year plan of healthcare reform (Houses of the Oireachtas Committee on the Future of Healthcare, 2017). The work undertaken by the committee led to the publication of the Slaintecare Report in May 2017 (Houses of the Oireachtas Committee on the Future of Healthcare, 2017). The Slaintecare Report details a 10-year plan for health reform in Ireland with two principle aims. First, to establish a universal single-tiered health service where patients are treated based on need, as set out in the terms of reference of the committee is recognition by Government that inequalities persist mainly because of a complex two-tiered system that currently exists and that such a system cannot be allowed to continue. Second, the reform sets out to reorient the healthcare system 'towards integrated primary and community care, consistent with the highest quality of patient safety in as short a timeframe as possible' (Houses of the Oireachtas Committee on the Future of Healthcare, 2017). The

reforms set out in the Slaintecare Report have the potential to completely re-transform how healthcare is financed, delivered and accessed in the Republic of Ireland. Under the proposals set out in the Report the current two-tiered system of public and private provision of healthcare will be abolished in favour of a universal system where patients are treated based on need, and not ability to pay.

Key recommendations from the report include:

- The introduction of the Carta Slainte entitling all residents to access a comprehensive range of services based on need, at no or reduced cost
- Expansion of healthcare services in primary care, social care, mental health, dental care and public hospitals in addition to expansion of physical and human capacity within the healthcare system
- Reduction and removal of co-payments for prescription drugs and inpatient care
- Elimination of private care provided in public hospitals to reduce waiting times in the public sector accompanied by the introduction of waiting time guarantees
- Establishment of the 'National Health Fund' (NHF) as the single payer funded through a combination of general taxation levies and charges
- Limitations to allow private insurance to cover private care in private hospitals

Progress on the implementation of Slaintecare has been slow with early deliverables missed and altered (Burke et al., 2018). Government promised a draft implementation plan for Slaintecare by December 2017. It was published in August 2018 (Government of Ireland, 2018). Slaintecare also recommended an Implementation Office, to oversee the introduction of the Slaintecare Plan be set up in July 2017. An executive director to oversee the implantation of Slaintecare was not put in place until July of 2018. A Slaintecare Advisory council was set up in October 2018 to provide expert and independent advice to the Slaintecare Programme Office.

The Implementation Plan lays out the actions to be taken in the first three years of the Slaintecare implementation process. The Implementation Strategy is designed around 4 key strategic goals and 10 interlocking high-level strategic actions, which are further broken into specific actions. Four overarching goals have been identified as central to reforming the healthcare system, which will be delivered through 10 strategic actions outlined in Table 1.4 below. A timeline of deliverables as part of the Slaintecare Implementation plan are set out in Table 1.5.

Table 1.4 Goals and Strategic Actions - Slaintecare Implementation Plan

Four Goals		10 Strategic Actions	
Goal 1	Deliver improved governance and sustain reform through a focus on implementation	Strategic Action 1	Improve governance, performance and accountability across the health service
		Strategic Action 2	Put in place an effective implementation and governance structure for Slaintecare and establish a Slaintecare transition fund to support key reforms
Goal 2	Provide high quality, accessible and safe care that meets the needs of the population	Strategic Action 3	Improve population health-based planning and develop new models of care to deliver more effective and integrated care
		Strategic Action 4	Expand community based care to bring care closer to home
		Strategic Action 5	Develop and modernise the acute care system to address current capacity challenges and increase integration between the two hospital sector and community based care
		Strategic Action 6	Expand eligibility on a phased basis to move towards universal healthcare and support a shift to community based care
Goal 3	Ensure the health system is financially sustainable	Strategic Action 7	Reform the funding system to support new models of care and drive value to make better use of resources
		Strategic Action 8	Implement measures to reduce inequities in access to public acute hospital care based on the independent impact assessment
Goal 4	Enable the system to deliver its goals	Strategic Action 9	Build a sustainable, resilient workforce that is supported and enabled to deliver the Slaintecare vision
		Strategic Action 10	Put in place a modern eHealth infrastructure and improve data, research and evaluation capabilities

Source: The Slaintecare Implementation Strategy – Government of Ireland

Table 1.5 High Impact Actions – What will be delivered by 2021?

Broad Objective	High Impact Action
Governance and Accountability	Introduce a governing board of the Health Service Executive (HSE)
	Re-configure the HSE to improve accountability and support integrated care
	Introduce stronger clinical governance systems, mandatory open disclosure and enhance managerial performance and accountability
Focused Implementation	Established a dedicated implementation office to drive reform
Citizen Engagement	Public engagement launched on Health Outcomes and a nationwide series of events in 2019/2020 to promote health and wellbeing
Delivering a new model of healthcare	Produce a new Citizen Care Masterplan that is population health centred, setting out an overall design for the health service
	Design new models of care and provide support to locally implement on a significant scale
	Accelerate roll out of eHealth systems and infrastructure.
Enhance community care	Invest in community-based diagnostics facilities.
	Reform GP contract including new chronic disease management programme for GMS/GP visit card population.
	Enhancement of community mental health services.
	Continue programme of investment in primary care centres.
Expand eligibility	Review income threshold for GP visit cards.
	Review eligibility framework to develop a roadmap to achieve universal entitlement.
	Introduce a new statutory scheme for homecare services.
Better access to acute hospital services	Develop an overarching clinical strategy to guide national and regional organisation of acute hospital services.
	Increase bed capacity in public hospitals.
	Select location for new elective hospitals and commence planning processes.
	Invest in the NTPF to reduce waiting times for patients.
	Implement integrated waiting list management system.

Source: The Slaintecare Implementation Strategy – Government of Ireland

The goals and objectives set out in the Slaintecare Implementation Plan represent a significant departure from current Irish healthcare policy in term of how healthcare services are accessed, financed and delivered. As such, it is important to investigate the impact that such a policy change might have on the Irish healthcare system, in terms of individuals' propensity to use healthcare services as well as the potential cost implications of such a change. This, together with the ageing demographic make-up of the Irish population and the growing demand of the formal and informal care as individuals' age, provide the motivation for this thesis as mentioned in Section 1.1 above.

1.2.4 The Demographic Context

The research questions addressed in this thesis are set against an environment of increasing population growth, and longer life expectancy. Given that older people are the most frequent users of healthcare services; such dramatic demographic changes are likely to exert increasing demand and supply sides pressures on an already capacity stretched public healthcare system. In order to tackle such issues, it is important to have an appreciation of the current and future projections for population growth, life expectancy and fertility rates. The research focus on the older population is central to the thesis and provides a basis for using the Irish Longitudinal Study on Ageing (TILDA).

Ireland's rate of ageing since 2008 has been considerably higher than the EU average (Department of Health, 2018). Provisional data from Census 2016 (Central Statistics Office, 2016b) confirm this trend. They show an overall increase of nearly 4% in the total population since the last Census in 2011. The increase is especially stark for the 65+ age group. The population in this cohort has increased by a third since 2007. According to projections from the Central Statistics Office (2018a), (shown in Table 1.6 below) the proportion of the population aged 65 and over is expected to rise to 14.9% by 2021 (it currently stands at 13.3%) and to 18.5% by 2031. Moreover, the greatest increase will be in oldest old i.e. those aged 85 and over. The proportion of the population in this age group is expected to more than double by 2036 and treble by 2046.

Table 1.6 Actual 2016 and projected population growth estimates ('000) 2016-2051

									% Change
Age Group	**2016**	**2021**	**2026**	**2031**	**2036**	**2041**	**2046**	**2051**	**2016-2051**
65 and over	630	743	867	1,000	1,137	1,282	1,441	1,563	148.1
85 and over	67	82	102	133	174	214	256	301	349.3
All ages	**4,740**	**4,992**	**5,207**	**5,395**	**5,572**	**5,743**	**5,900**	**6,031**	**27.2**

Source: Central Statistics Office (CSO) Population and Labour Force Projections 2017-2051[7]

https://www.cso.ie/en/releasesandpublications/ep/p-plfp/populationandlabourforceprojections2017-2051/populationprojectionsresults/

[7] Projection data are based on the M2F2 assumption of moderate growth in migration and a decrease in the total fertility rate to 1.6 by 2031 and to remain constant thereafter to 2051

The trends that we see in population growth are mirrored by those for life expectancy. Life expectancy in Ireland has increased by 2.4 years since 2006 and is now above the average for the EU (Department of Health, 2018). Male life expectancy in Ireland has increased by 3 years and female life expectancy by almost 2 years since 2006. This improvement is largely due to lower mortality and better survival from chronic conditions (Department of Health, 2018). The greatest gains in life expectancy have been achieved in the older age groups reflecting decreasing mortality rates from chronic diseases such as stroke, heart disease and other diseases of the circulatory system (Department of Health, 2018).

There is a generally consensus that this increasing trend in life expectancy will continue in Ireland and internationally for the foreseeable future. The CSO (2018a) predict that male life expectancy in 2051 is projected to be 85.6, a gain of 6.3 years over the 36 year period (2015 – 2051). For females, there is a projected gain of 5 years to 88.3. The gap between male and female life expectancy is projected to reduce to 2.7 years by 2051[8]. Given that older individuals use more healthcare services on average, such projected growth trends are expected to pose significant challenges for the Irish healthcare system in terms of increased demand for healthcare services. A policy shift towards a universal healthcare system where access to healthcare services is based on need rather than on ability to pay, will place even more demand side pressure on an already capacity constrained healthcare system. Thus, it is important to shed light on the impact that such demographic and policy changes might have for the utilisation and costs of healthcare services for the older population in Ireland. As outlined previously, these changing circumstances form the motivation for this research.

1.2.5 The Informal Caregiving Context

Debate within the Irish healthcare policy domain have also centred around future capacity issues within the system (PA Consulting, 2018; Wren et al., 2017). Both reports are borne out of a recognition that, wider demographic and contextual issues will place increasing capacity pressures on an already resource constrained formal healthcare system. Such demographic changes are likely to place more emphasis on the role of informal carers in the Irish healthcare system. As such, given the important role that informal care plays as a 'buffer' for formal healthcare services (Fernandez et al., 2011) it is important to shed more light on

[8] The 2016 - 2051 projections were compiled assuming current trends of 2.5% per annum declines in mortality rates for males and 2.0% per annum for females. This entails a 0.5% reduction in the trend rate used in the 2013 projections for both sexes. Applying these rates of improvement not only reflects current trends but would also preserve the gender differential in life expectancy within historic limits.

the interaction between formal and informal healthcare service utilisation in an Irish setting. As such, an analysis of the associations between health insurance status and informal care is undertaken. Given the increasing capacity constraints, and the complementary role of informal care to support formal care, further analysis estimating the relationship between informal care and healthcare utilisation and costs is also of interest.

The ever expanding literature in the area of informal care is a reflection of these population trends and is a recognition of its importance as the most common substitute for and supplement to long-term care (LTC) worldwide (Grabowski & Van Houtven, 2012). The number of informal care users is expected to rise significantly in the coming years (Oliva-Moreno et al., 2017). The increased demand for informal care services has been driven by demographic factors i.e. an increasing population (Central Statistics Office, 2016b) – a greater proportion of which are aged 65 and over (Wren et al., 2017) and longer life expectancies. (Department of Health, 2017)

The increased demand for informal care services is also driven by shortcoming within the formal healthcare sector to adequately deal with the increased demand for healthcare services in recent years; placing a significant care burden on those providing the required care (Chevreul, 2016; Pentek, 2016; Schneider et al., 2013). Informal care has an important role to play as a 'buffer' for formal healthcare services and as a means of reducing public expenditure in the formal healthcare sector (Fernandez et al., 2011). While care can have an effect on the utilisation of formal healthcare services for those receiving informal care, it can also have significant knock on effects for informal caregivers in the shape of opportunity forgone in the labour force (Schmitz & Westphal, 2017) and increased risk of illness (Coe & Van Houtven, 2009). The proposed policy changes outlined in the Slaintecare Report, which seeks to introduce universal healthcare coverage for all, also has the potential to significantly increase the demand for informal care services. Thus, it is timely to investigate the current state of play with regard to the impact of health insurance status on the provision and receipt of informal care. It is also of interest at this time to investigate what impact informal care has on healthcare services utilisation and costs currently. The estimates from these analyses can help to shed some light of the possible impact that a possible shift towards universal healthcare coverage might have on the utilisation and costs of healthcare services for older people in Ireland.

Many OECD countries have implemented policies to support family carers to help mitigate these negative knock-on effects. These include paid care leave (e.g. Belgium); flexible working time (e.g. Australia); respite care (e.g. Austria and Denmark) and counselling

services (e.g. Sweden). Governments also provide social welfare benefits to carers which can be used to offset the loss of income from not being in the labour force (OECD, 2011). In Ireland, the government provide a number of social welfare payments to carers including Carer's Benefit, Carer's Allowance, (either full or half-rate), as well as free travel for those in receipt of Carer's Allowance (Citizens Information, 2018). From September 2018, a new policy introduced by the government has seen an additional 14,000 carers now eligible for free GP services (Health Service Executive, 2018). Carers already in receipt of either full or half rate Carer's Allowance or Carer's Benefit, and who did not currently hold a medical or GP visit card were eligible to apply for the free GP Visit medical card. It is within this context that I have set out the research questions outlined in Section 1.1. That is, I explore the relationship between informal care and formal healthcare among a cohort of older people. Moreover, I explore this relationship from two perspectives: that of the informal care receiver and that of the informal caregiver. In the following section, I outline how the discipline of health economics can be used to help answer the research question set out.

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1.3 The Health Economic Analysis Context

In this section, I focus on the how the discipline of health economics can be used to assist in answering the research questions set out in Section 1.1. Health economics is a discipline, which consists of the dual and interrelated pillars of theoretical and empirical analytical approaches, which are employed to address the research questions of interest. The focus of the thesis explores associations between health insurance and informal care on healthcare utilization and healthcare costs for the older population in the Republic of Ireland. These empirical analyses, which are described in detail in Chapters 4 and 5, are informed by a series of theoretical models of healthcare utilization and costs, which are summarized in the section below. For the sake of brevity, this discussion is limited to the following three key theoretical contributions. First, the seminal papers by Kenneth Arrow (1963), which provides a theoretical analysis for the market for healthcare, and Michael Grossman (1963), which provides a theoretical analysis for the demand for health and healthcare, are described. Second, the theoretical model by Andersen (1968) and Andersen and Newman (1973), which the thesis adopts as a theoretical framework for the utilization and cost of healthcare services, and which underpins the empirical analysis presented in subsequent chapters, is described. Third, a summary of the theoretical models generated for the analysis of health insurance and informal care are presented, as these are the main independent variables of interest in the thesis.

1.3.1 Kenneth Arrow (1963): Uncertainty and the Welfare Economics of Medical Care

In his seminar paper Kenneth Arrow (1963) contested that the market for healthcare was inherently different to the market for other goods and services. Arrow asserted that the principal characteristic of medical care is uncertainty, and that the special economic problems of medical care can be explained as adaptations to the existence of uncertainty. Such uncertainty manifest itself in two ways. First, individuals are uncertain as to when they will fall ill or the healthcare needed when they do fall ill. Second, there is also uncertainty around how any individual will respond to healthcare. Thus, recovery from a disease is as uncertain as its incidence (Morris et al., 2012). Arrow also noted a number of characteristics unique to the healthcare market that mark it out as unique to other goods and services markets. He noted that, patients fail to act in the same way as consumers in other markets in that; patients cannot 'test' the product before consuming it. Indeed, they often have difficulty in gauging the quality of care even after experiencing it. In addition, there is an inherent information asymmetry in the healthcare market. Individuals lack the medical training and knowledge to make the most informed choices to maximise their utility. Obtaining this knowledge (in the form of medical training) comes at a high cost. When the costs of obtaining such knowledge

outweigh the benefits, individuals (or consumers) may delegate decisions about their healthcare to qualified medical practitioners.

Moreover, doctors do not behave in the same way as firms. Entry into the market is restricted by licencing laws and regulations while advertising is virtually absent in the healthcare market (Cawley & Ruhm, 2012). Healthcare practitioners are assumed self-interested parties who provide treatment based on clinical need. Unlike markets for other goods and services, profit maximisation is not the sole motivation of healthcare providers. Social and ethical factors are likely to be important in determining their behaviour (Bhattacharya, Hyde, & Tu, 2014). In addition, physicians may charge different fees to patients for their services depending on their income threshold (Morris et al., 2012). The central tenant of Arrow's work argued that the unique features of the market for healthcare, which marked it out as different to other goods and services markets, stemmed from uncertainty.

Arrow also noted that the uncertainty surrounding when an individual becomes ill, could be offset by purchasing health insurance. Individuals will purchase insurance to guard against the uncertainty of becoming ill. The ability to guard against such uncertainty introduces the problem of moral hazard whereby individuals change their behaviour in the knowledge that they are insured against ill health (Evans, 1974). In such cases, the demand for medical care will increase without individuals having to face the costs of this extra demand.

The characteristics of the market for healthcare mentioned above are markedly different from the market for other goods and services and suggest that healthcare can be looked upon as a special case. The behaviours of consumers and providers of healthcare are very different from perfectly competitive markets in standard economic theory. Thus, economic analysis of health and healthcare behaviour requires specialised theoretical approaches that acknowledge these differences (Morris et al., 2012). Because the market for healthcare is very different from perfectly competitive markets, the market is unlikely to produce outcomes that are Pareto optimal (Folland, Goodman, & Stano, 2013). Any deviation away from the assumptions of perfect competition (i.e. no barriers to entry and perfect information) will be regarded as Pareto inefficient; leading to distortions in prices, quantities and social inefficiencies (Folland et al., 2013). These inefficiencies or 'market failures' are an inherent part of the healthcare sector, and are the main reason for government intervention. The main causes of market failure in healthcare include asymmetric information, externalities; both 'caring' and 'non-

caring' externalities and public good externalities. Externalities or spill over effects are costs and benefits incurred in the consumption or production of goods and services that are not borne by the consumer or producer involved (Bhattacharya et al., 2014). Such externalities can be either positive or negative. Healthcare markets will not lead to Pareto optimality if there are externalities.

1.3.2 Michael Grossman (1972) On the Concept of Health Capital and the Demand for Health

A theoretical framework for understanding choices about health and healthcare was developed by Michael Grossman in 1972. Michael Grossman's human capital model of the demand for health (Grossman, 1972a, 1972b) has been argued by some to be one of the theoretical innovations to have emerged in the field of health economics (Culyer, 1981). The model is originally based on Becker's theories of human capital (Becker, 1964) and household production (Becker, 1965). In the model, health is viewed as both an output of a household production process (health in demanded as individuals derive utility from it) and as an investment in human capital (individuals produce health in order to make more healthy time available for market and non-market activities (Jones, Rice, & Contoyannis, 2012; Wagstaff, 1986).

Household production theory suggests that the true objects of human desire are basic commodities such as nourishment clothing, leisure and health (Becker, 1965). Grossman's model is founded on this view of health as a basic commodity. Individuals produce health using a range of inputs such as time and market goods including healthcare. They demand healthcare, not because it provides them with utility directly, but because it is one of those inputs in the production process. In other words, health is demanded because it affects a person's ability to work, and by extension, the time available to earn an income. Being in poor health reduces our utility and our ability to earn. Thus, the demand for healthcare is a derived demand (Folland et al., 2013; Morris et al., 2012).

The impact of health on one's ability to work and earn income emphasises its importance as a key component of human capital. The model states that, at any given point, an individual has a stock of health. This depreciates over time with age and deceases when it is used in the production and consumption of other commodities. It can be increased through investments of time, effort and knowledge in health improving activities. An individual's level of

knowledge and skill will determine how efficiently they produce health. In turn, one's level of knowledge and skill will be dependent on how much they have invested in their level of education. According to the model, individuals will invest in their health up to the point where the marginal benefit of investment, which includes a consumption and investment benefit, is equal to the marginal cost of that benefit. The dynamic nature of the model allows for examination of the impact of changes in age, wages and education on the demand for health. As individuals age they are not willing to invest as much in their health stock; that is the marginal cost of health investment rises in older age as the depreciation rate of health stock increases. The marginal benefit from investment in terms of the return on utility from time will decline. The model also predicts that increasing wages and education lead to a higher demand for health.

1.3.3 Andersen et al; (1968; 1973; 1995) The Andersen Behavioural Model

The key theoretical framework that forms the basis of the approach to the analysis of healthcare utilisation and costs throughout the thesis was first proposed by Ronald Andersen (1968). The Andersen Behavioural Model of healthcare utilisation is a multilevel model that incorporates both individual and societal determinants of health services utilisation (Babitsch, Gohl, & von Lengerke, 2012). The framework was initially developed in the late 1960s and focused on the family as the unit of analysis, because the medical care an individual receives is most certainly a function of the demographic, social and economic characteristics of the family as a unit (Andersen, 1968, 1995). In subsequent work, the emphasis was shifted to the individual as the unit of analysis (Andersen & Newman, 1973). A central tenant of the model was the promotion of equitable access to healthcare services. The theoretical model acted as a framework to better understand the determinants of healthcare utilisation and assist in developing policies to promote equitable access to healthcare services (Andersen, 1968, 1995; Andersen & Newman, 1973).

The outcome of the original behavioural model was health service use measured rather broadly in units of physician ambulatory care, inpatient services, and dental care which families consumed annually (Andersen, 1995). The initial model has undergone a number of iterations since the late 1960s. Phase 2 of the model was developed in conjunction with Newman and other colleagues at the University of Chicago in the 1970s (Andersen & Newman, 1973). The healthcare system was explicitly included in this phase, giving recognition to the importance of national health policy and the resources and their organisation in the healthcare system as important determinants of the use of health care services

(Andersen, 1995). The third iteration of the model explicitly recognised the importance of the health status of the population; both as perceived by the population and as evaluated by professionals (Andersen, Davidson, & Ganz, 1994). The latest iteration of the model is depicted below in Figure 1.1. This phase of the model emphasises the dynamic nature of a health services utilisation model which includes health status outcomes (Evans & Stoddart, 1990). This phase portrays the multiple influences on health services utilisation and, subsequently, on health status (Andersen, 1995). It also includes feedback loops showing that outcomes, in turn, affect subsequent predisposing factors and perceived need for services, as well as health behaviour.

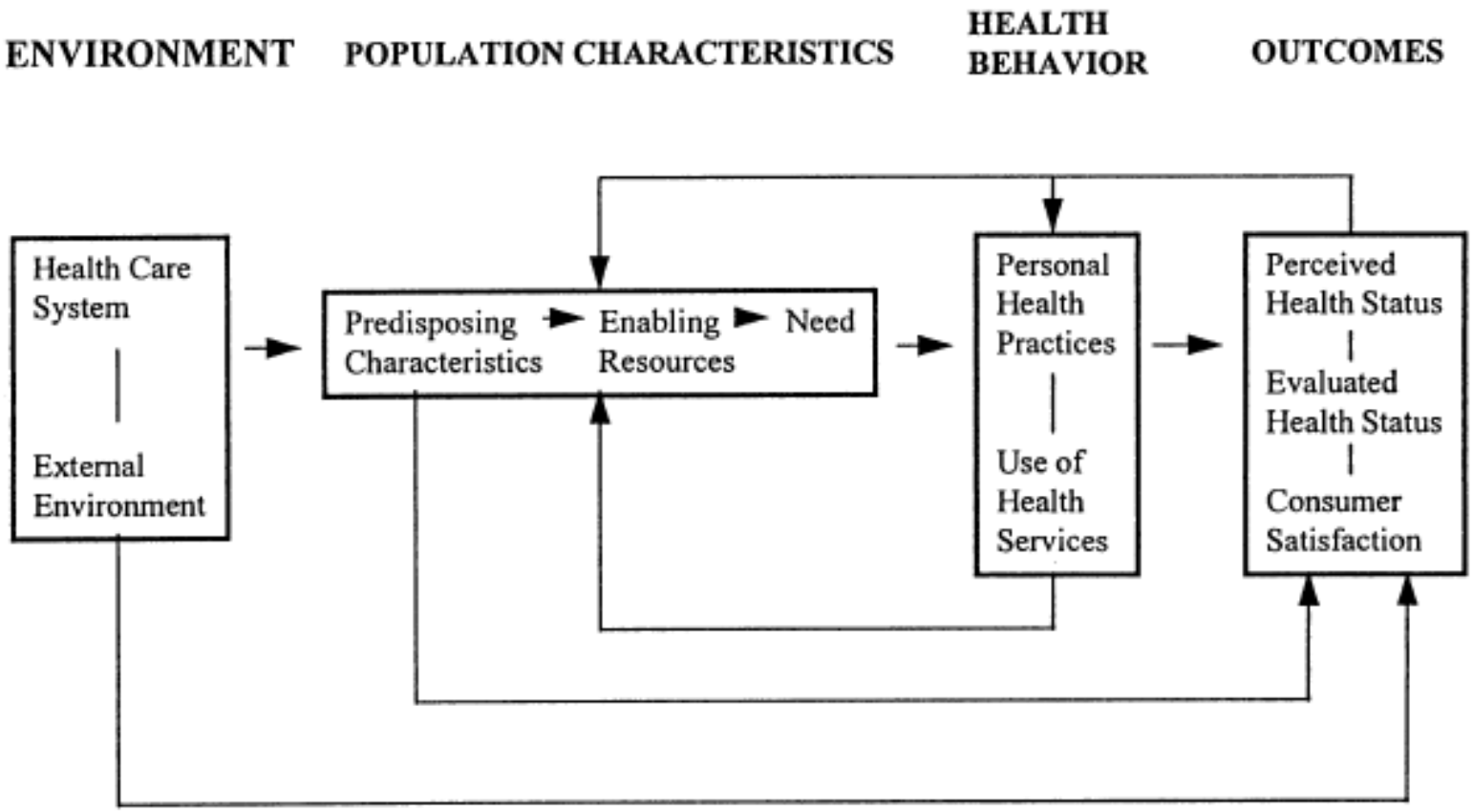


Figure 1.1 The Andersen Behavioural Model

Source: Andersen (1995)

A central tenant of the Andersen Model is **equity** of access to healthcare, based on need and not ability to pay. The model seeks to predict and explain the factors that influence an individual's propensity to use healthcare services. According to Andersen, healthcare services utilisation is a function of a range of predisposing, enabling and need factors and he used these as a yardstick to measure equity within a healthcare system. Predisposing characteristics include demographic factors such as age and gender; social structure factors including education, occupation and ethnicity. Enabling factors include income and health insurance, both of which enable better access to healthcare services. Andersen discusses four concepts within access that can be viewed through the framework. Potential access is the presence of enabling factors, allowing the individual to seek care if needed. The third component of the model encompassed healthcare need variables. These relate to an individual's level of illness either perceived (via an individual's disability or diagnosis) or evaluated (Andersen, 1995). Each of these factors may influence one's propensity to use healthcare services. For instance, those from a higher socio-economic group may or may not use more services. While they may have better access in terms of ability to pay or more knowledge of healthcare services available to them, they may not need to use these services as individuals from higher socio-economic areas, on average, tend to have better overall healthcare. Andersen argued that in an equitable system, the need for care should be the principal determinant of healthcare utilisation. That is, individuals should be able to access healthcare services based on need and not ability to pay. Andersen also introduces the idea of mutability (i.e. things can be easily changed). As such, the model allows policy changes to be examined within the model. For example, if government decides to expand access to healthcare services through the introduction of new policies that eliminate barriers to access the Andersen model allows for such analysis.

The Andersen Behavioural Model is used in the thesis to understand equity within the Irish healthcare system. Ireland is an interesting case study to investigate such a question given the current two-tiered system of public and private healthcare provision within the Irish healthcare system. Individuals can choose to purchase private health insurance in order to gain quicker access to healthcare services, which in turn raises serious question around equity of access for those who do not have or cannot afford to have private insurance. Such a theoretical framework can help to establish the factors that determine healthcare utilisation most. It can help us explore whether differing levels of health insurance status contribute to inequity in accessing secondary and community care services. The framework can also shed light on the relationship between health insurance and informal care activity within the Irish healthcare system. It is even more interesting to look at this question of equity within the Irish healthcare

system given government proposals to move to a universal healthcare system.

1.4 Theoretical Contributions of Relevance to the Research Objectives

As outlined above, the key research questions of interest in this thesis will focus on the empirical analysis of healthcare utilisation and healthcare costs among older people in the Republic of Ireland. These analyses are informed by the theoretical models described above and primarily the Andersen Behavioural Model (Andersen, 1968, 1995; Andersen & Newman, 1973). In particular, the key independent variables of interest are health insurance and informal care, which also have a dedicated body of theoretical literature, which provides further context for our analysis, which follows. In the following section, a selection of relevant theoretical literature is discussed.

1.4.1 Economic Theories of Health Insurance and its Effects on Healthcare Utilisation and Costs

In this section, the important theoretical contributions that have been made in the areas of health insurance are discussed. In particular, the theoretical underpinnings of health insurance and its effect on healthcare utilisation and costs are explored. Important theoretical contributions in the field of health insurance have been made by Friedman and Savage (1948); Pauly (1968) and Nyman (2003) and these are discussed in turn below. The section begins with a general discussion on the importance of health insurance in the field of health economics and introduces the main theories on the effect of health insurance on healthcare utilisation and costs. In addition, concepts of moral hazard and adverse selection and discussed as well as some of the unintended consequences that arise out of the market for health insurance.

A useful starting point for a discussion of the importance of insurance within the discipline of health economics, might be to ask the question - why is the issue of the demand and supply of health insurance within the healthcare market, such an important one? Put another way, why do individuals purchase health insurance in the first place? Put simply, they do so to guard against uncertainty (Arrow, 1963) and because, in the main, individuals are risk averse they will decide to “insure” themselves against this uncertainty. As already mentioned in section 1.3.1 above, uncertainty in healthcare takes many forms. First, individuals purchase insurance to guard themselves against the uncertainty of becoming ill. Second, they do so to guard against the uncertainly of costs of care at a period in the future. Third, individuals also

purchase health insurance to gain quicker access to healthcare services. Fourth, uncertainty can also occur around the effectiveness of healthcare treatment. Because healthcare treatment is, in the main, effective in treating illness, individuals will place a high value on insurance.

The theory behind the demand for health insurance is rooted in expected utility theory. It is borrowed from the theory of demand for insurance, which was concerned with a type of indemnity policy whereby the consumer who holds an asset seeks protection against the possible loss of that asset. The theory was laid out by Friedman and Savage (1948). The model set out the relationship between utility on one hand and wealth on the other. The model states that an individual's utility is increasing in wealth but at a decreasing rate. That is, those on lower levels of income or wealth gain more utility from a unit increase in income than those on higher incomes. In their model, Friedman & Savage argue that an individual will gain a higher utility with certainty under insurance than they would do with no insurance. This difference in utility is the welfare gain from buying health insurance under conventional theory and represents the sole reason for purchasing insurance according to the theory.

One of the many limitations of conventional insurance theory was that it did not recognise the problem of moral hazard. In the health insurance literature, the phenomenon whereby individuals change their behaviour in the knowledge that they are insured against ill health is known as moral hazard first coined by Mark Pauly. In his 1968 paper, written as a comment to Arrow (1963) Mark Pauly argued that health insurance policies paid off, not by paying a lump-sum amount when an individual became ill (as was assumed with the conventional theory) but by paying for any health care that the individual consumed (Pauly, 1968). Thus, following standard microeconomic theory of demand the supply, the impact of insurance was to reduce the price of healthcare, to which individuals responded by demanding more healthcare. According to Pauly, the additional care now consumed because of the reduction in price due to insurance is worth less than the cost to produce it representing a welfare loss from moral hazard.

Theoretically, the demand for health insurance will depend on an individuals expected loss of income due to ill health as well as an individual's degree of risk aversion (Friedman & Savage, 1948). Individuals in poor health are therefore more likely to have a higher expected demand for healthcare and subsequently, a higher demand for health insurance. Because of the way in which insurance markets operate, (individuals who are not ill pay into a pool to benefit the

few members of the pool who become ill during the period of insurance coverage). Healthy individuals are incentivised to "put off" purchasing health insurance coverage for as long as possible, until they too become ill, so as not to be paying health insurance premiums when you do not need healthcare. This phenomenon is known as adverse selection in the health economics literature and is represented by the tendency of those who purchase insurance to be sicker or more prone to becoming sick, and hence, costlier to insure (Cutler & Zerkhauser, 2000; Nyman, 2014). Empirical evidence on adverse selection is mixed. While some studies have found evidence of adverse selection (Bardey & Buitrago, 2017; Cutler & Zerkhauser, 2000; Marton, Yelowitz, & Talbert, 2017; Munkin & Trivedi, 2010), others have found results to the contrary – i.e. advantageous selection, whereby poorer individuals are less likely to purchase insurance (Bolhaar, Lindeboom, & van der Klaauw, 2012; Fang et al., 2008; Finkelstein & McGarry, 2006).

Two principle approaches have been adopted to prevent adverse selection (Morris et al., 2012). The first is experience rating. Often, insurers use a series of health indicators to get a better indication of the agent's output as a method to solve the problem of adverse selection (Fichera, Nikolova, & Sutton, 2014). However, the cost of acquiring such information can be costly. Second, adverse selection may incentivise insurance providers to 'cherry pick' individuals who have a low risk of illness.(Folland et al., 2013). If we have a situation where we know that a Pareto optimal point cannot be achieved; attempting to do so by addressing market failures may not be a desirable outcome (Morris et al., 2012). This known as the theory of second best. In such cases, the principal must design a contract or system of incentives that elicits a second best outcome from the agent (Fichera et al., 2014).

More recently adaptations on the conventional theory of the demand for health insurance have pervaded the literature (Nyman, 2003). Nyman suggests that a major source of value is missing from the conventional theory of the demand for insurance. This value stems from the additional healthcare that an individual consumes with the income that is transferred to him when he becomes ill from those who remain healthy. Nyman's theory is fundamentally different from the Friedman & Savage (1948) theory because it does not incorporate a designated loss when ill as part of the insurance decision i.e. there is no loss of income from illness recognised by the theory. Transfers occur because for most medical procedures, especially expensive treatments, demand for these treatments will only increase for those who become ill and require it. Only those who are ill will respond to the price reduction. This income transfer allows the individual who has become sick to purchase (or gain access to)

medical care he would otherwise not be able to afford on his own income. It is this income transfer that is therefore responsible for a large portion of the additional health expenditures that were deemed to be welfare-decreasing under Pauly's moral hazard model (Nyman, 2012). Nyman's theory re-categorises this moral hazard loss as a welfare gain. The theory is also the first to suggest an access motive for the purchase of health insurance. The income transfer from healthy to sick individuals allows those who are ill to access healthcare that might otherwise been unaffordable and as such any estimation of the value of health insurance needs to take account of the value generated from improved health that health insurance makes possible. Another benefit of health insurance according to Nyman's theory is the altruistic benefit that society derives from seeing those who are ill gain access to the healthcare they need.

1.4.2 Theories of Long-Term Care Insurance

The theoretical underpinnings of long-term care insurance differ from standard theories of insurance purchase mainly due to the role of family and bequests. The prominent theoretical model in the area is Pauly (1990). Assuming imperfect annuity markets, Pauly considers expected utility optimization under several scenarios – single elderly with no children and no bequest motive, with differential quality, and with adult children and a bequest motive. The model explains purchase of long-term care insurance among middle-income individuals. In terms of the first scenario, with single elderly individuals have no children and no bequest motive, the model predicts that because public health insurance is available and acts as a safety net of sorts when wealth is exhausted, the only benefit to purchasing long-term care insurance is to increase consumption is the sick state. The case in which private insurance enables access to higher quality care than that obtained from public insurance is a valid one, in that public healthcare facilities are generally thought of as lower quality. In terms of the bequest motive, one would expect that valuing bequest would lead to a higher propensity to purchase long-term care insurance, as having private insurance allows an individual to retain wealth in a sick state. However, Pauly states that the value of bequests would have to be large in order to lead to purchase for two reasons. First, purchase of private insurance decreases consumption not only at time t put also in the future if the person remains in a healthy state. Second, although insurance may be preferable to savings if the individual lives a long time with chronic illness, this scenario is unlikely, as those with chronic illness die younger on average.

Pauly's model of long-term care insurance also introduces the idea of intra-family bargaining into the conceptualisation of demand for long-term care insurance. The idea behind this

theory is that parents use bequests to elicit caregiving from their children. Pauly modifies this premise somewhat to argue that, once in a sick state, parents will have little control over consumption or bequests, such that, parents purchase insurance in the healthy state but that children control the level of care in the sick state. Parents may prefer care from children and may want to purchase long-term care insurance to preserve bequests that the parent values altruistically and with which to elicit caregiving behaviour on part of their children. However, as children decide on the level of care to provide in the sick state children are subject to moral hazard associated with the presence of insurance. That is, children will choose more formal care in the presence of insurance than what their parent would prefer because the price they face is lower than in the absence of insurance.

Zweifel and Struewe (1998) formalise this intra-family bargaining argument using a principal-agent framework and a two-generation model that is independent of assumptions about altruism. The elderly parent chooses consumption and whether or not to purchase long-term care insurance to maximise expected utility, and the amount of care provided by children is an argument in the utility function in the sick state. According to the model, the child maximises his or her own expected utility, choosing consumption and the amount of care to provide if the parent enters a sick state. By providing care, the child is presumed to forego work in the labour force but also to expect a higher bequest, as less will be spent by the parent on formal long-term care. The authors show that, under these circumstances, the child's response to the purchase of long-term care insurance depends heavily on the child's wage rate. At low wages, the presence of insurance is most likely to produce a moral hazard effect. Anticipating this response, purchase of long-term care insurance is often not in the best interest of parents who desire caregiving by their low wage children.

1.4.3 Economic Theories of Informal Care and its Effects on Healthcare Utilisation and Costs

In this section, the important theoretical contributions that have been made in the areas of informal care are discussed. In particular, the theoretical underpinnings of informal care and its effect on healthcare utilisation and costs are explored. The theoretical literature with respect to the relationship between informal care and healthcare utilisation and cost is much less developed. As a result, some theoretical contributions deemed relevant to the research questions of the thesis are discussed. In particular, the theoretical underpinnings of informal care and its effect of healthcare utilisation and costs are explored. Important theoretical contributions in the field of informal care have been made by Nocera and Zweifel (1996); Van

Houtven and Norton (2004) and Byrne et al. (2009) among others. These are outlined in turn below. The theoretical literature on informal care can be broken into three main strands (Grabowski & Van Houtven, 2012). The first focuses on the decision to supply informal care to an elderly relative. In this scenario, trade-offs need to be made between, work, leisure and the supply of informal care (Nocera & Zweifel, 1996; Norton, 2000; Stern, 1995; White-Means, 1995). The second concerns the relationship between informal care and various types of formal care (Van Houtven & Norton, 2004). The third strand focuses on family bargaining over living arrangements (Byrne et al., 2009; Pezzin, Pollak, & Schone, 2007). These papers generally game theory to model decision-making by parents and their children about living arrangements and informal caregiving.

As mentioned above, the first strand of the theoretical literature on informal care focuses on the decision to supply informal care. Many of the models in this strand of the theoretical literature assume a single household utility function and focus on the child-parent dyad (Heitmueller, 2007; Lilly, Laporte, & Coyte, 2007; Norton, 2000). The second concerns the relationship between informal care and various types of formal care. Van Houtven and Norton (2004) use a model of two decision makers (parent and child) to argue that informal care and formal care could be substitutes or complements, that the relationship will vary across different types of formal care and that informal care is endogenous to formal care utilisation. A sufficient condition to prove substitutability is for the marginal benefit to parent's health of formal care with respect to informal care to be negative or zero. Van Houtven and Norton (2008) extend the theory and argue that the effects are likely to be smaller for married persons versus non-married individuals; that sons are daughters may differ in their effectiveness in delivering different types of care and that children may be more effective caregivers than non-children.

A criticism of the models described above is that they assume a very simplistic view of the dynamic that exists between the individual cared for and their wider family (Byrne et al., 2009). Often, theoretical models assume a single household utility function or often involve only one child in the decision process (Pezzin & Schone, 1999; Pezzin & Schone, 1997). In reality, more than one adult child in a family may be involved in the care of an elderly parent, and adult siblings may disagree regarding the best source of care for an elderly parent. Such a family dynamic motivates the development of game theory approaches to model decision making by parents and their children about living arrangements and informal care (Pezzin & Schone, 1999; Stern, 1995). These models recognise that preferences for living arrangements may differ among family members, and the financial and non-financial consequences of

providing informal care may depend on the actions of other family members (Grabowski & Van Houtven, 2012). A number of theoretical papers (Byrne et al., 2009; Checkovich & Stern, 2002; Engers & Stern, 2002; Hiedemann & Stern, 1999) have sought to accommodate a variable number of children and the possibility that all children play a role in care decisions.

1.5 Estimating causal effects or associations between health insurance and healthcare utilisation, costs and informal care

Much of the empirical literature that attempts to estimate the impact of health insurance status on healthcare utilisation is interested in a 'causal effect'. However, estimating a causal effect is difficult for a number of reasons. First, when attempting to estimate the causal effect of health insurance on healthcare utilisation using observational data, analysts face the potential problem of selection. That is, it may be the case that those who receive the treatment (health insurance) may differ systematically from those who do not receive the treatment in terms of their observable characteristics. In other words, allocation into either the treatment or the control group is non-random. Without attempting to control for such non-randomness, one runs the risk of generating biased causal estimates. Second, the inherent endogeneity that exists between health insurance status and healthcare utilisation poses further problems for causal estimation. When the X and Y variables are correlated, the direction of the effect can sometimes be ambiguous. Finally, omitted variable bias occurs when the individual's insurance choice is determined by some unobservable characteristic that also affects healthcare utilisation.

Attempting to estimate a causal effect is made even more difficult when using cross-sectional data as I do here in this thesis. The analysis of cross-sectional data poses particular problems for econometric analysis and has direct implications for whether or not results can be interpreted as causal or not. With cross sectional data, information on individuals is taken at one snapshot in time. Thus, one encounters what is known as the identification problem i.e. individuals cannot be in the two places at once and so one cannot estimate a counterfactual. To overcome this identification problem, analysts have used instrumental variables and other quasi-experimental designs to estimate a causal effect. However, valid instruments are inherently difficult to find. In the absence of such instruments in this thesis, I applied matching techniques to estimate the impact of treatment (health insurance) on outcome (utilisation). It should be made clear from the outset however, that the use of matching techniques only account for observable heterogeneity between a treatment and the outcome of interest. Thus, any estimate can only be interpreted as an association and not a causal effect.

This has important implications from a policy perspective. Policymakers should seek to implement policy changes from work generating causal effects rather than associations between two variables. However, while I do not estimate a causal effect, the estimates garnered from this work still merit value because, as Ruhm eloquently states, “excessive reliance on such methods (to estimate a causal effect) may move us away from examining issues that are of fundamental significance but for which unambiguous causal inference is more difficult to obtain” (2018, p.2). Thus, while understanding and addressing the identification problem is essential for evidence-based policy, a role for descriptive analysis and the estimation of associations remains an important contribution to the decision-making process.

1.6 Structure of the Thesis

The remainder of the thesis is structured as follows.

Chapter 2 introduces the TILDA dataset; the dataset used in each of the empirical chapters presented in the thesis. The design of the dataset as well as the data collection process are described in detail. The chapter also includes details on the wide range of demographic, socio-economic and health related variables included in the dataset.

Chapter 3 outlines the methodologies applied throughout this thesis. First, the chapter outlines issues related to the estimation of causal effects and the limitations of using cross-sectional data to do so. Second, it introduces the various matching techniques used to account for observable heterogeneity between health insurance and healthcare utilisation, costs and informal care. The various econometric methodologies to estimate healthcare costs are also introduced. Finally, the chapter details the methodology used to collate the literature used throughout the thesis.

Chapter 4 presents results on the associations of health insurance status on healthcare services utilisation and costs. First, the chapter presents a review of the existing theoretical and empirical evidence on the effect of health insurance on healthcare utilisation, both nationally and internationally. Second, the methodological approach adopted is described. The chapter incorporates various matching methods to account for the inherent observable endogeneity that exists between health insurance status and healthcare utilisation and costs. Third, the chapter outlines some of the challenges encountered when analysing healthcare costs. The chapter uses a generalised linear modelling (GLM) approach to examine associations between health insurance status and healthcare costs for individuals over 50 in Ireland. Propensity score matching (PSM) and inverse probability weighting (IPW) is used with GLM to account for observable endogeneity between health insurance status and healthcare costs. The chapter uses a number of formal statistical tests to select the most appropriate link function and the Modified Park Test to identify the most appropriate distributional family for the analysis. Conditional and unconditional quantile regressions, which allow for the analysis of costs across the entire distribution, are also estimated.

Chapter 5 analyses associations between insurance status and informal care – both received and provided. The chapter also investigates associations between both informal care receipt

and informal caregiving on healthcare utilisation and healthcare costs by older people in Ireland. First, the chapter presents a review of the theoretical and empirical literature on informal care, both nationally and internationally. Once again, matching methods are used to account for observable heterogeneity in the relationship between insurance status and informal care, as well as that between informal care and healthcare services utilisation and costs.

Chapter 6 summaries the key findings from the two empirical chapters. The objective of this chapter is to summarise the main conclusions of the thesis and to provide some policy recommendations arising from the work. The chapter also discusses possible future work.

1.7 Conclusion

In this chapter, I have outlined the research questions that I attempt to answer in later chapters of this thesis and the motivation for the work. The wider contextual issues around the utilisation and costs of healthcare services for older people in the Republic of Ireland is described. I have explored how the discipline of health economics can be used to answer the research questions posed in this thesis. In addition, I have provided a brief overview of the theoretical underpinnings of both the demand for health and healthcare and introduced the Andersen Behavioural Model of Healthcare Utilisation, which forms the basis of the empirical analysis in the chapters the follow. In addition, the theoretical literature on the main independent variables of interest in the thesis – (1) health insurance and (2) informal care have been discussed. The structure for the remainder of the thesis was also outlined.

2. Generating the Estimation Sample: Data Sources and Descriptive Statistics

This chapter introduces the sample data used in the analyses presented in the remainder of this thesis. The Irish Longitudinal Study on Ageing (TILDA) is described and discussed. Second, the steps taken to arrive at the estimation sample analysed throughout the thesis are presented. I describe, in detail, the various dependent and independent variables of interest used in each of the empirical chapters that follow. Third, summary descriptive statistics are provided for the dependent and independent variables that form the basis for the analyses in subsequent chapters. In particular, emphasis is placed on the primary independent variables of interest: that is, health insurance status and informal care status. These analyses lay the groundwork for the more complex empirical econometric strategies employed in chapters, 4 and 5. The chapter serves as an introduction to the dataset used throughout this thesis. Its purpose is to familiarise the reader with the dataset used, the variables included in the empirical chapters that follow and to explain how each variable is derived.

2.1 Introduction: The Irish Longitudinal Study on Ageing (TILDA)

Data from each of the empirical chapters of this thesis comes from wave 1 of the Irish Longitudinal Study on Ageing (TILDA). TILDA is one of a number of longitudinal studies on ageing that includes the Health and Retirement Survey (HRS) from the United States, the Survey of Health, Ageing and Retirement in Europe (SHARE), and the English Longitudinal Study of Ageing (ELSA) among others (Kenny, 2013). TILDA is the first population based survey dataset dedicated to the study of individuals aged 50 and over (and their spouses under the age of 50) in an Irish setting (Cronin et al., 2013). TILDA includes a wide variety of demographic, socio-economic and health related information both at the household and individual level.

The remainder of the chapter is structured as follows. The next section provides greater detail on the TILDA dataset. First, I outline the steps take to access the data. Second, I outline the objectives of the study and discuss the study design and data collection of the TILDA dataset. In Section 2.2, the various dependent and independent variables of interest in each of the empirical chapters that follow are described. The analysis in each of the empirical chapters that follow, controls for a wide variety of socio-economic and health related variables within TILDA. Each of these independent variables are described in detail. I describe in detail the

methodological approach undertaken to generate the household income estimation sample used throughout the thesis as well as describing some of the limitations of the generated income variable. Descriptive statistics on these dependent variables are presented in Section 2.3. Similar results for each of the independent variables controlled for in the upcoming chapters are also presented. The conclusions from the chapter are presented in Section 2.4.

2.1.1 Accessing the TILDA Dataset

TILDA provides access to the datasets for research use through anonymised publicly accessible dataset files. These publicly accessible dataset files are hosted by the Irish Social Science Data Archive (ISSDA) based at University College Dublin (UCD). Researchers wishing to access the data must complete a request form, available on either the ISSDA or ICPSR websites. The request form must be signed and emailed to the ISSDA. In completing the request form, researchers must give a brief description of their intended use of the dataset, as well as information on the type of user, the number of users of the data and an estimated end date for the use of the data. When the request is processed and approved, the requested data is securely emailed to the recipient in both SAS and STATA format ready for use. It should be noted that all analysis for this thesis was undertaken in Stata version 13.

2.1.2 The Aims and Objectives of TILDA

As mentioned in Section 2.1, TILDA is the first population based survey dataset dedicated to the study of individuals aged 50 and over (and their spouses under the age of 50) in an Irish setting (Cronin et al., 2013). The overarching aim of TILDA is to provide a greater understanding of the health, social and financial circumstances of the older Irish population and how these factors interact to influence the ageing process (Kenny et al., 2010). Within this overarching objective, TILDA aims to determine a number of factors including; the health status and healthcare needs of the older population; the social and economic and social status and needs of older people and the health, economic and social needs of families and carers of older people among others (The Irish Longitudinal Study on Ageing (TILDA), 2017).

The target population for TILDA consisted of community dwelling individuals aged 50 and over living in the Republic of Ireland together with their spouses or partners of any age. Spouses under the age of 50 were included to provide completed household level information and were not used for most of the person level analysis (Whelan & Savva, 2013). The TILDA dataset was designed in such a way as to provide statistically reliable information on the over 50s population in the Republic of Ireland. To this end, respondents were selected via a multi-

stage selection process, selected households were clustered geographically to minimise interviewer travel costs and stratification implemented to reduce sample error. Adapting such a design strategy meant that each member of the target population and each household containing at least one individual over the age of 50 an equal probability of selection into the final sample.

2.1.3 How did the TILDA sample come about?

TILDA came about as a response to the ageing demographic of the Irish population. People are living longer, and fertility rates have been decreasing steadily in Ireland over a number of years, meaning that older persons represent a larger proportion of the population. According to projections from the Central Statistics Office (CSO), the proportion of the population aged 65 and over is expected to rise to 14% by 2021 (it currently stands at 11%) and to 19% by 2031 (Central Statistics Office, 2013). Moreover, the greatest increase will be in oldest old i.e. those aged 80 and over. The proportion of the population in this age group is expected to treble by 2036 (Central Statistics Office, 2013). Such dramatic demographic changes are expected to place an increased strain on formal healthcare services in the Republic of Ireland. In response to these changes, and as mentioned above, TILDA was created to provide a greater understanding of the health, social and financial circumstances and needs of the older Irish population and how these factors interact to influence the ageing process (Kenny et al., 2010).

2.1.4 The Sample Design of the TILDA Dataset

The first step in the design of the TILDA dataset consisted of selecting an appropriate sampling frame. The sampling frame selected was the Irish Geodirectory, a comprehensive and up-to-date listing of all residential addresses in the Republic of Ireland complied by An Post (The Irish Postal Service) and Ordnance Survey Ireland (OSI). An initial multi-stage probability sample of addresses was selected using the RANSAM sampling procedure developed by the Economic and Social Research Institute (ESRI). RANSAM was chosen as it provided a true probability sample, allowed for clustering and stratification and gave an exact geocode for each selected address (Whelan & Savva, 2013).

The addresses selected for inclusion into TILDA were decided upon in three stages. First, RANSAM grouped all residential addresses in the country into 3,155 first-stage units or clusters. These clusters were subdivisions of District Electoral Divisions (DEDs) each comprising between 50 and 1,180 address. Six hundred and forty of these clusters were then randomly selected using probability proportional to size (size being the estimated number of

persons aged 50 and older in each cluster). The selection process also involved three dimensions of proportionate stratification: (i) according to socioeconomic status (percentage with a professional and managerial occupation; (ii) age structure (percentage of the population in the cluster ≥50) and (iii) geographic location. The second step in the process involved random selection of 50 addresses from each cluster. The resulting 32,000 address were partitioned into two groups: an initial sample of 25,600 (40 addresses from each of the 640 clusters) for immediate use in the field and 6,400 addresses (10 addresses from each of the 640 clusters) to be retained as a reserve list, to be used only if the target sample size was not met. The first wave of TILDA data collection began in October 2009. As part of wave 1 8,175 interviews were conducted with respondents aged 50 and older from 6,279 households – a response rate of 62%. An additional 329 interviews were conducted with spouses and partners of eligible individuals under the age of 50.

The TILDA dataset allows for the incorporation of sampling weights based on the survey design to allow for population weighting. Ideally, one would incorporate such analysis techniques in the empirical analysis that follows. However, one cannot estimate average treatment effects on the treated (ATET) with the '*teffects'* command alongside the '*svy:'* suffix within Stata. As such, in the empirical analysis that follows, I cannot and do not attempt to make inferences for the entire population. To allay fears that the estimated coefficients from the nationally representative sample differ significantly from those of the non-nationally representative sample, as a sensitivity analysis, I present descriptive statistics on each of the dependent and independent variables for both the estimation sample and the population sample - shown in Tables 2.1 and 2.2 below.

Table 2.1 Descriptive Statistics on Nationally Representative Sample

Variable Name	**Variable Description**	**Estimation Sample (N=8,124) %**
Insurance Status		
	Base	11.04
	MC	36.03
	PHI	37.03
	MC + PHI	15.90
Informal Care Received		
	Base	93.82
	Spouse	1.08
	Resident child	0.60
	Non-resident child	0.67
	Others	2.05
	Many	1.79
Informal Care Provided		
	Base	65.93
	Parents only	2.91
	Relatives only	1.14
	Neighbours/Friends only	0.86
	Many	29.16
Age Category		
	Age <55	19.67
	Age 55-64	38.84
	Age 65-74	23.59
	Age 75-84	14.45
	Age 85+	3.45
Gender		
	Male	48.00
Marital Status		
	Married/Cohabiting	65.70
Education Level		
	Primary or less	38.12
	Secondary: Intermediate Certificate	24.86
	Secondary: Leaving Certificate	18.44
	Third Level: Diploma/Certificate	9.32
	Third Level: Degree	5.51
	Third Level: Postgrad or Higher Degree	3.75
Employment Status		
	Employed	35.48
	Retired	36.12
	Other	28.40
Living Status		
	Living alone	24.38
	Living with spouse	36.74
	Living with others	38.88
Location		
	Living in Dublin	26.28
	Living in another town/city	30.52
	Living in a rural area	43.20
Nationality		
	Irish	91.93

Table 2.1 Descriptive Statistics on Nationally Representative Sample (Cont'd)

Variable Name	**Variable Description**	**Estimation Sample (N=8,124) %**
Household income		
	<€20k	33.17
	€20k-<€40k	36.15
	€40k-<€60k	18.86
	€60k-<€80k	7.03
	€80k-<€100k	1.89
	€100k or more	2.90
Illness		
	No long-term illness	61.06
	Long-term illness	14.86
	Limiting long-term illness	24.09
Disability Status		
	Not disabled	87.10
	IADL only	3.96
	ADL only	4.8
	IADL and ADL disability	4.14
Chronic illness		
	No chronic illness	22.87
	One chronic illness	27.55
	Two chronic illnesses	22.79
	Three or more chronic illnesses	26.79
Self-rated health		
	Excellent	14.34
	Very good	27.81
	Good	32.87
	Fair	19.39
	Poor	5.59
Chronic conditions		
	Angina	5.73
	Myocardial infarction	4.79
	Congestive heart failure	1.07
	Diabetes	8.05
	Stroke	1.62
	Chronic lung disease	4.22
	Asthma	9.28
	Arthritis	.27.73
	Osteoporosis	9.38
	Cancer	6.23
	Emotional, nervous or psychiatric problems	8.37
	Alcohol or substance abuse	1.77
	Anxiety	4.68
	Depression	5.26
	Pain	36.61

Table 2.2 Descriptive Statistics on Estimation Sample

Variable Name	**Variable Description**	**Estimation Sample (N=8,124) %**
Insurance Status		
	Base	10.36
	MC	31.98
	PHI	40.30
	MC + PHI	17.36
Informal Care Received		
	Base	94.55
	Spouse	1.10
	Resident child	0.49
	Non-resident child	0.52
	Others	1.72
	Many	1.62
Informal Care Provided		
	Base	65.39
	Parents only	2.86
	Relatives only	1.23
	Neighbours/Friends only	0.87
	Many	29.65
Age Category		
	Age <55	19.92
	Age 55-64	37.28
	Age 65-74	26.40
	Age 75-84	13.58
	Age 85+	2.82
Gender		
	Male	45.80
Marital Status		
	Married/Cohabiting	69.02
Education Level		
	Primary or less	30.54
	Secondary: Intermediate Certificate	23.26
	Secondary: Leaving Certificate	16.70
	Third Level: Diploma/Certificate	15.37
	Third Level: Degree	8.46
	Third Level: Postgrad or Higher Degree	5.66
Employment Status		
	Employed	35.99
	Retired	37.20
	Other	26.81
Living Status		
	Living alone	22.12
	Living with spouse	39.68
	Living with others	38.20
Location		
	Living in Dublin	23.74
	Living in another town/city	28.31
	Living in a rural area	47.94
Nationality		
	Irish	90.67

Table 2.2 Descriptive Statistics on the Estimation Sample (Cont'd)

Variable Name	**Variable Description**	**Full Sample (N=8,124) %**
Household income		
	<€20k	29.90
	€20k-<€40k	35.49
	€40k-<€60k	20.81
	€60k-<€80k	8.44
	€80k-<€100k	2.07
	€100k or more	3.29
Illness		
	No long-term illness	61.77
	Long-term illness	15.19
	Limiting long-term illness	23.04
Disability Status		
	Not disabled	88.01
	IADL only	3.50
	ADL only	4.74
	IADL and ADL disability	3.75
Chronic illness		
	No chronic illness	22.92
	One chronic illness	27.92
	Two chronic illnesses	23.04
	Three or more chronic illnesses	26.12
Self-rated health		
	Excellent	15.68
	Very good	28.62
	Good	32.58
	Fair	18.06
	Poor	5.06
Chronic conditions		
	Angina	5.48
	Myocardial infarction	4.62
	Congestive heart failure	1.07
	Diabetes	7.69
	Stroke	1.60
	Chronic lung disease	4.01
	Asthma	9.17
	Arthritis	27.51
	Osteoporosis	9.63
	Cancer	6.28
	Emotional, nervous or psychiatric problems	8.49
	Alcohol or substance abuse	1.61
	Anxiety	4.76
	Depression	5.36
	Pain	35.41

2.2 Generating the Estimation Sample

In this section, I describe the process used to arrive at the estimation sample used in each of the empirical chapters that follow. As outlined above, the data from each of the empirical chapters of this thesis comes from wave 1 of TILDA. The reasons for concentrating on a cross section of the data are explained in the next section, together with limitations of following this approach. In section 2.2.2, I detail each of the dependent variables of interest that are used throughout the remainder of the thesis and explain how these were derived. Similarly, for the main independent variables of interest – insurance status, informal care receipt and informal care provision respectively, I describe how each appears in the TILDA survey and how they have been categorised as part of the empirical chapters that follow. As mentioned previously, TILDA includes information on a wide variety of socio-economic and health related variables. I include a collection of these variables as explanatory control variables throughout the analysis. Each of these control variables are listed and the process by which each are derived is explained.

2.2.1 Using Wave 1 of the TILDA Dataset

Data from wave 1 of TILDA was used for the empirical analysis that follows in later chapters. In this section, the reasons for limiting the analysis to one cross-section of the TILDA dataset are explained. As mentioned in Chapter 1, the first two research questions from this thesis examine associations between health insurance status and healthcare utilisation and costs. In Wave 1 of the data, the dependent variable, healthcare utilisation is continuous in nature for the following services – GP services; inpatient hospital services; A&E services and outpatient hospital services. That is, data in Wave 1 outline the number of visits to these services in the previous year. In Wave 2 however, these same dependent variables are categorical in nature making comparison between waves difficult. As it was necessary to use the continuous form of the dependent variable in order to calculate total healthcare costs, the decision was made to use the data from wave one only. Taking such an approach is not without its limitations. Using one wave of the dataset provides only a snapshot in time, thus, not allowing for the possibility of longitudinal analysis. However, given the data limitations mentioned, I felt that using wave 1 of the data was the best approach to take.

2.2.2 Dependent Variables of Interest – Healthcare Utilisation, Healthcare Costs and Informal Care

In this section, I will outline each of the dependent variables of interest used in the empirical chapters that follow. The main dependent variables of interest are healthcare utilisation and

healthcare costs and informal care, both received and provided. These variables are described below and are detailed briefly in Table 2.3 below. In the case of informal care, this variable is also the main explanatory variable of interest when examining the association between informal care and healthcare utilisation and costs.

Table 2.3 List of Dependent Variables for Analysis

Dependent Variables			
Healthcare Utilisation Services	**Healthcare Costs**	**Informal Care Received**	**Informal Care Provided**
Inpatient Services	GP services	Any informal care	Any informal care provided
A&E Services	Inpatient Services	Care received from a spouse	Care provided to one person
Outpatient Services	A&E Services	Care received from a resident child	Care provided to many
Public Healthcare Nurse	Outpatient Services	Care from a non-resident child	
Occupational Therapy		Care received from others	
Chiropody Services			
Physiotherapy Services			
Home Help Services			
Optician Services			
Dental Services			
Hearing Services			
Dietician Services			
Social Work Services			
Physiological/Counselling Services			
Personal Attendant			
Meals-on-Wheels			
Daycentre Services			
Respite Services			

2.2.2.1 Healthcare Utilisation

The dependent variables of interest are binary in nature and relate to whether the respondent reported using any of the following State healthcare services in the previous 12 months. Each of the dependent variables of interest in terms of healthcare utilisation are outlined in Table 2.3.

2.2.2.2 Healthcare Costs

The dependent variable of interest, Healthcare Cost, is generated based on each respondent's utilisation data i.e. on their number of GP visits, hospital inpatient admissions, outpatient visits and accident and emergency (A&E) visits in the previous 12 months. The number of visits in each of these categories is multiplied by the relevant unit cost estimate for Ireland. The unit cost per resource use is presented in Table 2.4 below.

2.2.2.2.1 Generating the Healthcare Cost Variable

Healthcare costs are made up of costs from GP, inpatient, outpatient and A&E services. The total figure is derived from information on the total number of visits per patient to each of these settings over the previous year, times an average unit cost per visit for each setting. Unit costs for inpatient, outpatient and A&E visits were received from the Hospital Pricing Office (HPO). Average GP fees per visit were found to equal €51 according to an ESRI report (Wren, Connolly, & Cunningham, 2015) which cited a national survey of 670 GP practices carried out by *WhatClinic.com* in July 2015. Using average unit cost and simply multiplying this figure by the level of utilisation to generate a total cost estimate is not without its limitations. For instance, such an approach assumes that unit costs are constant with regard to output, which is unlikely. Second, given that healthcare cost data is highly skewed generally, using an average unit cost is unlikely to give a true cost value. However, in the absence of verifiable cost data on healthcare services within TILDA, the approach taken is the best that can be done in the circumstances. Another limitation of the healthcare cost variable is the fact that the number of visits to each setting is truncated at a certain value. GP visits are truncated at 25, inpatient visits at 6, outpatient visits at 10 and A&E visits also at 6. However, the proportion of individuals in the highest resource categories are minimal (all under 1% of the sample for GP inpatient and A&E visits and only 2.9% for outpatient visits) and thus, I do expect them to significantly alter the estimates.

Table 2.4 Unit Cost estimates (€) in 2013 prices

Resource Item	Activity	Unit Cost	Source
Healthcare resources			
General Practitioner (GP) visits	Per consultation	€51	ESRI
Outpatient clinic visits	Per consultation	€136	HPO
Inpatient Admission	Per night	€4,555	HPO
Accident and Emergency (A&E) visits	Per consultation	€264	HPO

Economic and Social Research Institute (ESRI), Dublin, Ireland **Hospital Pricing Office (HPO), Dublin, Ireland**

2.2.2.3 Informal Care Receipt

The dependent variable of interest informal care, is made up of two elements; informal care received and informal care given. In this section, I describe, in detail, how I derived the informal care receipt variable. In determining whether or not, an individual is in receipt of informal care, I utilised a number of derived variables in ~Wave 1 of the TILDA dataset on the total number of hours of care received from different family members and others. The variables included the following:

DIShoursspouse: Total number of hours per month the spouse has spent caring for the respondent.

DIShoursreschild: Total number of hours per month a resident child has spent caring for the respondent.

DIShoursnonreschild: Total number of hours per month a non-resident child has spent caring for the respondent

DIShoursothers: Total number of hours per month others have spent caring for the respondent.

Each of these variables were converted to binary variables equal to one if care was received and zero otherwise. In some cases, respondents received care from more than one source. In order to capture this, I generated a binary variable equal to one for any respondents who received informal care from more than one of the above groups and zero otherwise.

2.2.2.4 Informal Care Provided

In determining the level of informal care provision, respondents were asked the following questions outlined below. Respondents were asked whether they provided care to a parent; a relative or to a friend or neighbours

"In the last 2 years, because of health problems, did you and/or your spouse/partner (late spouse/partner) help your parents/father/mother (deceased parents/father/mother) REGULARLY with basic personal activities such as dressing, eating and bathing?"

Second, respondents were asked:

"In the last 2 years, did you (or your (late) spouse/partner) help your parents/father/mother (deceased parents/mother/father) regularly with other things such as household chores, errands, shopping, transportation etc.?"

Respondents were also asks about care provided to relatives:

"In the last 2 years, did you (or your spouse/partner) give any kind of help to your relatives with things like:

1) Practical household help, e.g. with home repairs, gardening, transportation, shopping, household chores

2) Help with personal care, such as dressing, eating, getting into and out of bed, using the toilet

3) Help with paperwork, such as filling out forms, settling financial or legal matters"

Lastly, respondent were asked about care provided to friends and neighbours:

"In the last 2 years, did you (or your spouse/partner) give any kind of help to your friends, and neighbours (who did not pay you) such as:

1) Household help: help with home repairs, gardening, transportation, shopping, household chores

2) Help with personal care, such as dressing, eating, getting into and out of bed, using the toilet

3) Help with paperwork, such as filling out forms, settling financial or legal matters"

Each of these variables equalled one if care was provided and zero otherwise. In some cases, respondents provided care to more than one group. In order to capture this, I generated a binary variable equal to one for any respondents who provided informal care to more than one of the above groups and zero otherwise.

2.2.3 Independent Variables of Interest

In the section that follows, I provide details on the independent variables of interest in the thesis, namely health insurance status; informal care receipt and informal care provision. I describe how each of these variables are derived and present descriptive statistics for each. First, I turn my attention to the health insurance variable, which is described in more detail in the next section.

2.2.3.1 Health Insurance Status

The health insurance system in Ireland involves a complex mix of public and private health insurance coverage. Public health insurance is universal for all residents in Ireland but this falls into one of two distinct eligibility categories: Category 1 and Category II. Those in Category 1 are entitled to a full medical card or GP visit medical card and have access to free public healthcare services including inpatient and outpatient hospital care, GP care and other primary and community care services. Eligibility for a full medical card and a GP visit medical card is assessed primarily based on an income-based means test[9]. In addition, individuals who would otherwise be ineligible for a full medical/GP visit card may be granted a "discretionary" card based on their health status[10]. For those in Category II, who do not qualify for a full medical card or a GP visit card, the main difference in entitlement for free public healthcare services arises from the fact that such individuals must pay the full cost of GP and other primary and community care services. In addition, all individuals in Ireland may voluntarily purchase private health insurance (PHI), if they wish to do so. Questions relating to health insurance status are asked in the CAPI questionnaire at the beginning of the section on healthcare utilisation Respondents are asked:

[9] Individuals living alone aged under 66 who earn less than €9,568 annually or a couple with two children aged under 16 who earned less than €17,810 annually are entitled to a medical card. Income cut-offs are slightly higher for those aged 66-69. The income limit for over 70s to be eligible for a medical card is €26,000 for a single person and €46,800 for couples (www.citizensinformation.ie).

[10] The Health Act (1970), as amended, states that a person is eligible for a discretionary medical card if "considered by the chief executive officer of the appropriate health board to be unable, without undue hardship, to provide that service for himself or his dependants ((Health Service Executive, 2014).

"Are you covered by:"

- *A medical card*
- *GP visit card*
- *Neither of these*

"Do you have private health insurance cover (VHI etc.) in your own name or through another family member?"

- *Yes (in my own name)*
- *Yes (as the spouse of a subscriber)*
- *Yes (as the relative of a subscriber)*
- *No*

From here insurance status was divided into four distinct categories: (1) Base – referring to individuals with no form of insurance cover (i.e. neither medical card cover nor private health insurance cover); (2) MC – referring to respondents with medical card cover only; (3) PHI – referring to respondents with private health insurance only and (4) MC + PHI – referring to those individuals in TILDA who are in receipt of both a medical card and private health insurance.

2.2.4 Other Explanatory Variables

In this section, the explanatory variables included as control variables throughout the thesis are outlined. First, I address the socio-demographic variables included in each of the empirical chapters that follow and second, we detail the health related variables also included. Each variable is discussed in turn below.

2.2.4.1 Age

Our first step is to drop observations where respondents are under 50 years of age. Doing so eliminates a total of 329 observations. I then separate the remaining observations into one of five categories. Those respondents aged 50-54 become our reference category. The remaining four age categories are as follows: (1) those aged 55-64; (2) those aged 65-74; (3) those aged 75-84 and (4) those aged 85 and over.

2.2.4.2 Male

Male is a binary variable equal to one if the respondent is male and 0 otherwise.

2.2.4.3 Marital Status

Marital status is a binary variable equal to one if the respondent is married or is living with a partner as if married and zero otherwise.

2.2.4.4 Education Level

Respondents in TILDA were asked the following:

"What is the highest level of education you have completed?"

Responses are divided into one of six categories. The base case are those with a primary education or less. The other remaining categories are as follows: (1) Second level (Intermediate Certificate); (2) Second level (Leaving Certificate); (3) Third level (Diploma/Certificate); (4) ~Third level (Degree) and (5) Third level (Postgrad or higher degree. Four respondents answered, "Don't know" to the question and these observations were dropped from the analysis.

2.2.4.5 Employment Status

The employment status variable is a derived variable created within TILDA. It is a categorical variable equal to one if respondents are employed; equal to two if respondents are retired and equal to three if they classify themselves as being in the "other" category. The "other" category consists of individuals who are unemployed, students, are sick or disabled and who are looking after the family or home. In this case, I categorised those who are employed as the reference group.

2.2.4.6 Living Status

The living status variable is another example of a categorically derived variable within TILDA. The variables consists of three categories equal to 1 if respondents live alone; equal to 2 if respondents live with a spouse and (3) if respondents live with others. The base case throughout the thesis for this variable, are those who live alone.

2.2.4.7 Location

Respondents were asked to provide the location of their household. In TILDA, household were categorised into one of three groups: (1) Dublin; (2) in another town/city or (3) a rural

area. Respondents living in Dublin became the base case. Observations with missing values (of which there were 12) were dropped.

2.2.4.8 Irish Citizenship

The variable *"Irish"* is binary in nature equal to one if respondents are Irish citizens and zero otherwise.

2.2.4.9 Household Income

In the early stages of the analysis, I found there to be a high number of missing values on household income. Given the potential importance of this variable in determining health insurance status; informal care receipt and provision, and the potential loss of data from doing nothing, I decided to impute a value for household income where this value was missing. The details on the methodological approach adopted are outlined below. As a sensitivity analysis, I run all of the analysis, in each of the empirical chapters that follow, on an imputed income sample (our favoured approach) and a non-imputed household income sample. The estimates generated from the non-imputed income sample are presented in the appendices of the thesis.

2.2.4.9.1 Estimation of Household Income

When analysing data on household income it was found that the variable for total household income generated a high number of missing values. Household income is an important variable to consider when determining the health insurance status of individuals in the Irish setting and thus, needs to be controlled for if examining the effect of insurance status on healthcare utilisation and healthcare costs and indeed in the receipt of informal care. Thus, if this variable were to be left unaddressed it would lead to a significant number of observations "dropping out" at the regression stage introducing a potential bias into our regression results. To guard against such a scenario, I attempted to impute a value for total household income where this value was missing. In this section, details of the estimation approach adopted throughout the thesis are described.

The estimation method used involved a number of steps. First, it was assumed that individuals living in the same household had the same household income. So, for example, where two individuals had the same household ID the same household income figure was assumed for the both persons. Second, for households where no household income was divulged, a figure needed to be estimated. In order to so, household income was regressed on the following covariates: age, marital status, employment status, education level and insurance status. The predicted values from this regression were taken as estimates of household income where a

value for household income was missing.

2.2.4.9.2 Sensitivity Analysis of Imputed Household Income

As a robustness check of the imputation method adopted, I conducted a series of sensitivity analysis around the predicted household income values. The estimates for these various sensitivity analysis are presented below in Table 2.5 below. I ran a series of regression analysis to predict household income, all of which were slight variations on our base case mentioned above. The covariates for each of the imputation methods are detailed in Table 2.6 below. The results suggest very little variation in the mean and standard variation on the predicted household income values. Thus, we can be confident that the imputation method used in the estimation sample (Base) is a robust estimation of household income.

Table 2.5 Descriptive Statistics on Household Imputation Methods

	Observations	Mean	Std Dev	Min	Max
Imputation 1 (Base)	8,124	36,898	54,478	0	2,000,000
Imputation 2	8,124	37,309	54,475	0	2,000,000
Imputation 3	8,124	37,301	54,516	0	2,000,000
Imputation 4	8,124	37,305	54,521	0	2,000,000
Imputation 5	8,124	37,305	54,523	0	2,000,000
Imputation 6	8,124	37,300	54,529	0	2,000,000

Table 2.6 Sensitivity Analysis on Imputation Method

Imputation Method	Covariates controlled for
Version 1 (Base)	Age; marital status; employment status; education status; insurance coverage
Version 2	Base + Household composition; locality
Version 3	Base + Household composition; locality; self-rated health
Version 4	Base + Household composition; locality; self-rated health; illness
Version 5	Base + Household composition; locality; self-rated health; illness, disability status
Version 6	Base + Household composition; locality; self-rated health; illness, disability status, chronic illness

2.2.4.10 Long-term Illness

This variable is a derived categorical variable within TILDA equal to (1) if a respondent has no long-term illness; equal to (2) if the respondent describes themselves as having a long-term illness and equal to (3) if a respondent classifies themselves as having a limiting long-term illness. Those with no long-term illness were included as the reference group.

2.2.4.11 Disability Status

The disability status variable is a derived categorical variable. Respondents are grouped into one of four categories: (1) not disabled; (2) IADL only; (3) ADL only; and (4) having an IADL and an ADL disability. Respondents who are not disabled are deemed to be in the reference category.

2.2.4.12 Chronic Conditions

Respondents were asked the following question in TILDA

"Has a doctor ever told you that you have any of the conditions on this card?"

Conditions on the card included (1) angina; (2) myocardial infarction; (3) congestive heart failure; (4) diabetes; (5) stroke; (6) chronic lung disease; (7) asthma; (8) arthritis; (9) osteoporosis; (10) cancer; (11) emotional, nervous or psychiatric problems; (12) alcohol or substance abuse; (13) anxiety; (14) depression and (15) pain.

Each of these variables are binary in nature equal to one if the respondent had been told they had this condition and zero otherwise. Each of these variables were included separately as control variables in our multivariate analysis in each of the empirical chapters that follow.

2.2.4.13 Chronic Illness

To create this variable, I summed across the number of chronic illnesses that a respondent was reported to have. From there I generated a categorical variable equal to (1) if a respondent reported having no chronic conditions; (2) if they reported having one chronic illness; (3) if they reported having two chronic illnesses and (4) if they reported having three or more chronic illnesses. Respondents with no chronic illness were deemed to be in the base category.

2.2.4.14 Self-rated health

Respondents were asked to rate their own health according to one of the following categories: (1) excellent; (2) very good; (3) good; (4) fair; and (5) poor. Those who considered their health excellent were in the base category. One respondent answered don't know to this question and thus, the decision was taken to drop this observation from the analysis.

In the empirical chapters that follow, the total number of observations in our estimation sample is 8,124 for the imputed household income sample and 6,006 for the non-imputed household income sample. In the next section, I present the descriptive statistics from each of the main independent variables of interest as well as both the univariate and multivariate analysis of each of these main independent variables.

2.3 Descriptive Statistics

In this section, I present descriptive statistics on the dependent variables as well as the main independent variables of interest used throughout this thesis. In addition, descriptive statistics on the other explanatory variables included as control variables in each of the empirical chapters that follow are also presented.

2.3.1 Descriptive Statistics on Health Insurance Status

Descriptive statistics on the breakdown of insurance status by category and by sample size are presented in Table 2.7 below. I present statistics for both the sample where income has been imputed and for the non-imputed income sample for comparison. The results are similar across both samples. Respondents with the lowest level of coverage (Base) make up the smallest portion of the sample at 10.36% and 10.27% respectively. The majority of individuals in TILDA belong to the private health insurance only group (PHI) at 40.30% and 38.05%, while 31.98% and 34.47% are categorised as having a medical card only (MC) while the remaining 17% are categorised as having both a medical card and private health insurance (MC + PHI).

Table 2.7 Descriptive Statistics on Health Insurance Status in TILDA

Variable Name	Variable Description	Estimation Sample (N=8,124) %	Non-Estimation Sample(N=6,006) %
Insurance Status			
	Base	10.36	10.27
	MC	31.98	34.47
	PHI	40.30	38.05
	MC + PHI	17.36	17.22

2.3.2 Descriptive Statistics on Healthcare Utilisation

In this section, descriptive statistics on a range of healthcare utilisation variables are presented by health insurance status. As above, insurance status is presented in four separate categories; the reference group (**Base**) refers to individuals with public health insurance only, **MC** refers to individuals with a medical card only; **PHI** are those individuals with private health insurance only and **MC+PHI** refers to individuals with both a medical card and PHI.

2.3.2.1 Dependent variables on Healthcare Utilisation

The dependent variables of interest are binary in nature and relate to whether the respondent reported using any of the following State healthcare services in the previous 12 months. For

the purposes of presentation and interpretation, these services are categorised into two groupings: (1) Hospital Services and (2) Community Care Services. These services are summarised in the following sections and descriptive statistics for their utilisation are presented for the full sample and for each health insurance status category.

2.3.2.1.1 Hospital Services

Secondary or hospital care services include hospital admissions; accident and emergency (A&E) clinic visits; and outpatient clinic visits. Summary statistics for each of our dependent variables for the estimation sample and by health insurance coverage status group are presented in Table 2.8.

2.3.2.1.1.1 Inpatient Hospital Admissions

Respondents in TILDA were asked to report on how many occasions they were admitted to hospital overnight in the previous 12 months. For the purposes of the analysis, I convert this continuous variable to a binary variable equal to one if the respondent had been admitted to a hospital overnight in the last 12 months and zero otherwise. Almost 13% of those surveyed were admitted as an inpatient to a hospital in the previous year. The highest users of inpatient services were those with both a medical card (MC+PHI), while the lowest users of these services were those respondents with the lowest level of health insurance coverage. Just 5.8% of respondents in this group were admitted to hospital as an inpatient in this period. 16% of respondents with a medical card only (MC) and 10.3% of those with private health insurance only (PHI) used inpatient hospital services in the previous year.

2.3.2.1.1.2 Accident and Emergency (A&E) Admissions

Respondents in TILDA were asked to report how many times they visited a hospital accident and emergency department. The variable was converted to a binary variable equal to one if a respondent had made a visit to an A&E department in the previous 12 months and zero otherwise. Notably, 15% of the sample reported an A&E visit in the last year. This compared to 18.3% in the MC group, who reported highest usage, and 12.4% for the PHI group, who reported the lowest usage. 12.7% of respondents with the lowest level of health insurance coverage (Base) visited an A&E department in the previous year, while the equivalent figure for those with a medical card and private health insurance (MC+PHI) was 16.3%.

2.3.2.1.1.3 Outpatient Hospital Admissions

Respondents in TILDA were asked to report the number of visits they made to the hospital as an outpatient in the last 12 months. Again, for the purposes of the analysis this continuous variable was converted to a binary variable equal to one if a respondent was admitted to a hospital as an outpatient in the previous 12 months and zero otherwise. 41% of respondents surveyed visited a hospital as an outpatient in the previous year. Those respondents with the highest level of health insurance coverage (MC+PHI) visited most (47.4%), while just over 31% of those with the lowest level of health insurance coverage (Base) visited least. 44.2% of those with a medical card only (MC) were admitted to hospital as an outpatient in the previous year, while the equivalent figure for those with private health insurance only (PHI) was just over 38%.

Table 2.8 Descriptive Statistics on Hospital Service Use by Health Insurance Status

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
Inpatient visits							
	Total	8,124	100	7,079	87.1	1,045	12.9
	Base	842	100	793	94.2	49	5.8
	MC	2,598	100	2,182	84.0	416	16.0
	PHI	3,274	100	2,937	89.7	337	10.3
	MC + PHI	1,410	100	1,167	82.8	243	17.2
A&E visits							
	Total	8,124	100	6,907	85.0	1,217	15.0
	Base	842	100	735	87.3	107	12.7
	MC	2,598	100	2,123	81.7	475	18.3
	PHI	3,274	100	2,869	87.6	405	12.4
	MC + PHI	1,410	100	1,180	83.7	230	16.3
Outpatient visits							
	Total	8,124	100	4,799	59.1	3,325	40.9
	Base	842	100	580	68.9	262	31.1
	MC	2,598	100	1,449	55.8	1,149	44.2
	PHI	3,274	100	2,028	61.9	1,246	38.1
	MC + PHI	1,410	100	742	52.6	668	47.4

2.3.2.1.2 Community Services

Respondents in TILDA were asked if they had received a range of State community services in the last 12 months. These State community care services include public health nurse services, occupational therapy services, chiropody services, physiotherapy services, home help services, optician services, dental services, hearing services, dietician services, social work services, psychological and counselling services, personal care attendant services, meals-on-wheels services, daycentre services and respite services. These services are summarised in the following sections and descriptive statistics for their utilisation are presented for the full sample by health insurance status.

Descriptive statistics on community services utilisation by insurance status are presented in Table 2.9 below. As we can see from the results below, the proportion of older people, using a range of community care services in the previous 12 months is somewhat low. The services that are utilised most prevalently are optician and dental services. In total, 11.8% of our sample have used optician services in the last year while the corresponding figure for dental services is 10.9%. The services used least often are social work services (0.2%) and respite care services (0.4%).

People with medical cards and those with both a medical card and PHI use most healthcare services. The importance of health insurance is particularly evident in determining the use of a range of services including public healthcare nurse services, chiropody services, optician services and home help care. For example, while 0.1% of individuals with the lowest level of health insurance have used home help services in the latest year, the equivalent figure for those with a medical card is 5.9%. Less than 1% of individuals with public health insurance only use chiropody services, 7.3% of those with a medical card have done so in the last year. While over 20% of individuals with a medical card have used optician services in the last year, just 3.9% of individuals with the lowest level of health insurance have done so. Interestingly, those with the lowest level of health insurance have not used social work services, personal care attendant services, meals-on-wheels services or respite services at all in the last year. These services tend to be used less often by all individuals in our sample.

Table 2.9 Descriptive Statistics on Community Care Services Use by Insurance Status

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
Public Healthcare Nurse							
	Total	8,124	100	7,653	94.2	471	5.8
	Base	842	100	833	98.9	9	1.1
	MC	2,598	100	2,292	88.2	306	11.8
	PHI	3,274	100	3,245	99.1	29	0.9
	MC + PHI	1,410	100	1,283	91.0	127	9.0
Occupational Therapy							
	Total	8,124	100	8,007	98.6	117	1.4
	Base	842	100	839	99.6	3	0.4
	MC	2,598	100	2,532	97.5	66	2.5
	PHI	3,274	100	3,260	99.6	14	0.4
	MC + PHI	1,410	100	1,376	97.6	34	2.4
Chiropody							
	Total	8,124	100	7,785	95.8	339	4.2
	Base	842	100	837	99.4	5	0.6
	MC	2,598	100	2,408	92.7	190	7.3
	PHI	3,274	100	3,250	99.3	24	0.7
	MC + PHI	1,410	100	1,290	91.5	120	8.5
Physiotherapy							
	Total	8,124	100	7,702	94.8	422	5.2
	Base	842	100	817	97.0	25	3.0
	MC	2,598	100	2,404	92.5	194	7.5
	PHI	3,274	100	3,188	97.4	86	2.6
	MC + PHI	1,410	100	1,293	91.7	117	8.3
Home Help							
	Total	8,124	100	7,880	97.0	244	3.0
	Base	842	100	841	99.9	1	0.1
	MC	2,598	100	2,444	94.1	154	5.9
	PHI	3,274	100	3,260	99.6	14	0.4
	MC + PHI	1,410	100	1,335	94.7	75	5.3
Optician Services							
	Total	8,124	100	7,162	88.2	962	11.8
	Base	842	100	809	96.1	33	3.9
	MC	2,598	100	2,061	79.3	537	20.7
	PHI	3,274	100	3,154	96.3	120	3.7
	MC + PHI	1,410	100	1,138	80.7	272	19.3
Dental Services							
	Total	8,124	100	7,241	89.1	883	10.9
	Base	842	100	793	94.2	49	5.8
	MC	2,598	100	2,170	83.5	428	16.5
	PHI	3,274	100	3,131	95.6	143	4.4
	MC + PHI	1,410	100	1,147	81.3	263	18.7
Hearing Services							
	Total	8,124	100	7987	98.3	137	1.7
	Base	842	100	841	99.9	1	0.1
	MC	2,598	100	2,518	96.9	80	3.1
	PHI	3,274	100	3,262	99.6	12	0.4
	MC + PHI	1,410	100	1,366	96.9	44	3.1

Table 2.9 Descriptive Statistics on Community Care Services Use by Insurance Status

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
Dietician Services							
	Total	8,124	100	8,012	98.6	112	1.4
	Base	842	100	832	98.8	10	1.2
	MC	2,598	100	2,545	98.0	53	2.0
	PHI	3,274	100	3,250	99.3	24	0.7
	MC + PHI	1,410	100	1,385	98.2	25	1.8
Social Work Services							
	Total	8,124	100	8,104	99.8	20	0.2
	Base	842	100	842	100	0	0
	MC	2,598	100	2,585	99.5	13	0.5
	PHI	3,274	100	3,270	99.9	4	0.1
	MC + PHI	1,410	100	1,407	99.8	3	0.2
Psychological/Counselling Services							
	Total	8,124	100	8,049	99.0	75	1.0
	Base	842	100	837	99.4	5	0.6
	MC	2,598	100	2,561	98.6	37	1.4
	PHI	3,274	100	3,255	99.4	19	0.6
	MC + PHI	1,410	100	1,396	99.0	14	1.0
Personal Care Attendant							
	Total	8,124	100	8,082	99.5	42	0.5
	Base	842	100	842	100	0	0
	MC	2,598	100	2,570	98.9	28	1.1
	PHI	3,274	100	3,271	99.9	3	0.1
	MC + PHI	1,410	100	1,399	99.2	11	0.8
Meals-on-Wheels Services							
	Total	8,124	100	8,061	99.2	63	0.8
	Base	842	100	842	100	0	0
	MC	2,598	100	2,551	98.2	47	1.8
	PHI	3,274	100	3,271	99.9	3	0.1
	MC + PHI	1,410	100	1,397	99.1	13	0.9
Daycentre Services							
	Total	8,124	100	8,043	99.0	81	1.0
	Base	842	100	840	99.8	2	0.2
	MC	2,598	100	2,545	98.0	53	2.0
	PHI	3,274	100	3,273	99.97	1	0.03
	MC + PHI	1,410	100	1,385	98.0	25	2.0
Respite Services							
	Total	8,124	100	8,093	99.6	31	0.4
	Base	842	100	842	100	0	0
	MC	2,598	100	2,575	99.1	23	0.9
	PHI	3,274	100	3,273	99.97	1	0.03
	MC + PHI	1,410	100	1,403	99.5	7	0.5

2.3.2.1.3 Primary Care Services

While not analysed explicitly in this chapter as it has been extensively analysed previously (Hudson & Nolan, 2015; Ma & Nolan, 2017), the descriptive statistics for GP service utilisation are presented in Table 2.10 below. Notably, 87% of the sample reported a GP visit in the last year. 95% of respondents with both a medical card (MC) and private health insurance (PHI) visited a GP in the previous year representing the most frequent users of these services. The least frequent users of GP services were those with the lowest level of health insurance coverage (Base) at just under 75%. 93% of respondents with a medical card only (MC) visited a GP and the corresponding figure for those with private health insurance only (PHI) was 83%.

Table 2.10 Descriptive Statistics on Primary Healthcare Service Use by Health Insurance Status

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
GP Visits							
	Total	8,124	100	1020	12.6	7104	87.4
	Base	842	100	213	25.3	629	74.7
	MC	2,598	100	174	6.7	2,424	93.3
	PHI	3,274	100	568	17.3	2,706	82.7
	MC + PHI	1,410	100	65	4.6	1,345	95.4

2.3.3 Descriptive Statistics on Healthcare Costs

In this section, I present descriptive statistics on the healthcare cost variable. As mentioned in section 2.2.2.2, total healthcare costs are generated based on respondents' utilisation data on the number of GP visits, hospital inpatient admissions, outpatient visits and A&E visits in the previous 12 months multiplied by the relevant unit cost. Summary statistics for each of our dependent variables for the estimation sample are presented in Table 2.11. I present mean, median, standard deviation, minimum and maximum values for our dependent variable total healthcare cost as well as by healthcare setting. The data show the greatest proportion of total costs are generated in an inpatient setting where costs are €877 per night on average. Mean costs are lowest in an A&E setting at €59 per consultation. Healthcare cost variation is also highest in an inpatient setting where cost range from zero to just over €27 thousand per year. Healthcare costs data are often characterised by a high level of zero observations and are heavily skewed with long right-hand tails in their distribution. Our dependent variable is no exception. We can see this graphically in the kernel density plot of costs illustrated in Figure 2.1.

Figure 2.1 Densities of total expenditures and their residuals

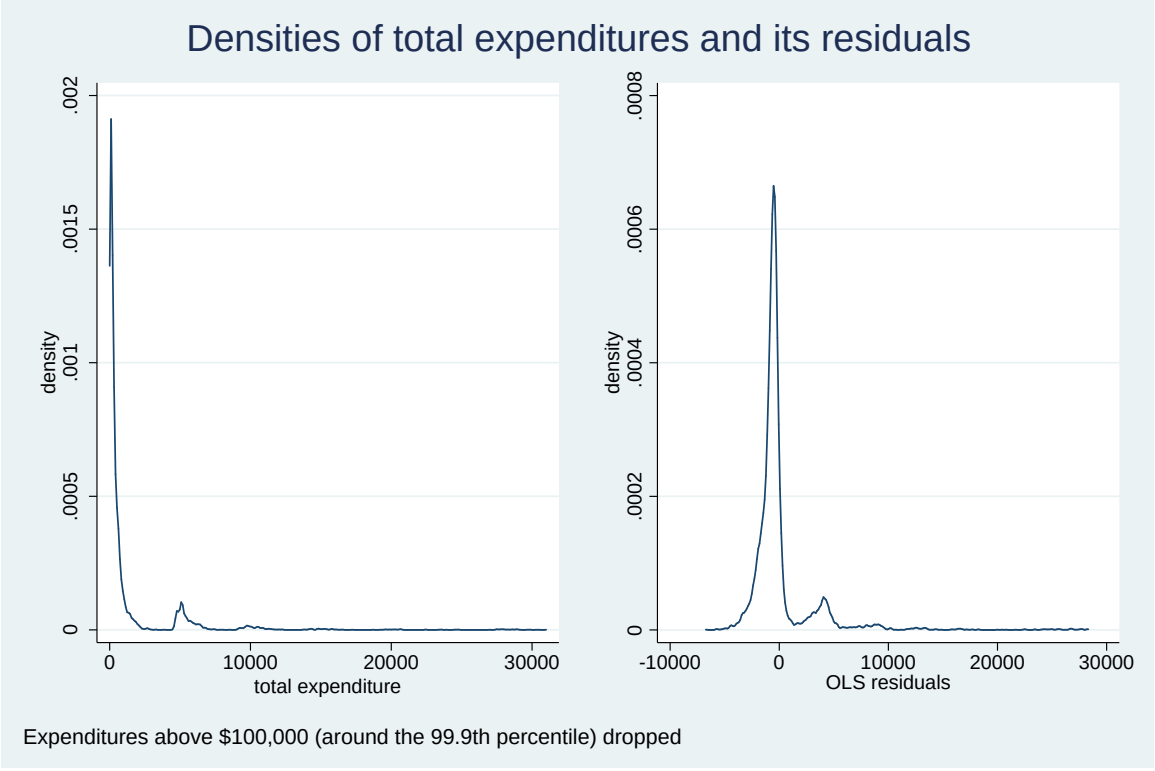


Table 2.11 Total Healthcare Costs by Health Service

Variable Name	Variable Description	N	%	Mean	Median	Std Dev	Min	Max
Healthcare cost								
	Full Sample	8,124	100	1,296	238	3,119	0	31,005
GP cost								
	Full Sample	8,124	100	196	153	211	0	1,275
A&E cost								
	Full Sample	8,124	100	59	0	178	0	1,584
Inpatient cost								
	Full Sample	8,124	100	877	0	2,877	0	27,330
Outpatient cost								
	Full Sample	8,124	100	163	0	298	0	1,360

Summary statistics on our dependent variable by insurance status are presented in Table 2.12 for our estimation sample. From our summary statistics alone, we can see that average total healthcare costs are lowest for those with the lowest level of health insurance coverage (Base) and highest for those with both MC + PHI.

Table 2.12 Total Healthcare Costs and Resource Use by Insurance Status

Variable Name	Variable Description	N	%	Mean	Median	Std Dev	Min	Max	Skewness	Kurtosis
Healthcare cost										
	Full Sample	8,124	100	1296	238	3119	0	31005	4.8	33.2
	Base	842	10.36	678	102	2294	0	28563	7.6	76.7
	MC	2,598	31.98	1679	374	3618	0	31005	4.3	27.3
	PHI	3,274	40.30	985	153	2656	0	29788	5.4	42.3
	MC + PHI	1,410	17.36	1680	340	3398	0	28996	3.7	21.5
GP cost										
	Full Sample	8,124	100	196	153	211	0	1275	2.3	10.0
	Base	842	10.36	117	102	151	0	1275	3.3	19.5
	MC	2,598	31.98	278	205	253	0	1275	1.8	6.6
	PHI	3,274	40.30	131	102	147	0	1275	3.0	17.2
	MC + PHI	1,410	17.36	245		213	0	1275		
A&E cost										
	Full Sample	8,124	100	59	0	178	0	1584	4.7	32.3
	Base	842	10.36	50	0	166	0	1584	5.3	40.6
	MC	2,598	31.98	76	0	203	0	1584	4.0	23.5
	PHI	3,274	40.30	43	0	142	0	1584	5.5	46.7
	MC + PHI	1,410	17.36	70	0	205	0	1584	4.4	26.9
Inpatient cost										
	Full Sample	8,124	100	877	0	2877	0	27330	5.1	37.7
	Base	842	10.36	406	0	2109	0	27330	8..3	89.3
	MC	2,598	31.98	1129	0	3330	0	27330	4.6	30.5
	PHI	3,274	40.30	675	0	2476	0	27330	5.8	48.4
	MC + PHI	1,410	17.36	1166	0	3152	0	27330	4.0	24.7
Outpatient cost										
	Full Sample	8,124	100	163	0	298	0	1360	2.5	9.5
	Base	842	10.36	105	0	228	0	1306	3.4	16.1
	MC	2,598	31.98	197	0	330	0	1360	2.2	7.3
	PHI	3,274	40.30	135	0	266	0	1360	2.9	12.3
	MC + PHI	1,410	17.36	199	0	331	0	1360	2.2	7.6

2.3.4 Descriptive Statistics on Informal Care Receipt and Provision

In this section, descriptive statistics on informal care, from both the perspective of those receiving care and for individuals providing care are provided. As mentioned above, the informal care received variable is disaggregated into the following groups – no care received (**Base**); spousal care received; care received from a resident child; care received from a non-resident child; care received from others and care received from more than one carer. In the case of informal care provision, some respondents provided care to more than one group. In order to capture this, I generated a binary variable equal to one for any respondents who provided informal care to more than one of the above groups and zero otherwise. Thus, informal care provided is disaggregated in to five distinct groups – care provided by a parent only; care provided by relatives only; care provided by neighbours and friends; care provided to more than one person and finally, any informal care provided. The reference category here is no care provided (**Base**). In section, 2.3.4.2, further descriptive statistics are presented on GP, hospital and community care service use by informal care receipt and provision.

The descriptive statistics on informal care received and provided are shown in Table 2.13 and Table 2.14 respectively. The statistics no informal care receipt show that 1.1% of the estimation sample received care from a spouse only; 0.49% received care from a resident child only; 0.52% from a non-resident child only and 1.72% received care from others only. 1.62% of the estimation sample received care from more than one source. In terms of informal care provision, 2.86% of the estimation sample provided care to a parent only; 1.23% of the sample provided care to relative only; 0.87% provided care to neighbours or friends and 29.67% of respondents provided care to more than one person. In total, 34.61% of respondents analysed in the sample provided some form of informal care.

Table 2.13 Descriptive Statistics on Informal Care Receipt

	Spousal care only	**Resident child only**	**Not resident child only**	**Others only**	**Multiple**
	% (N)	**% (N)**	**% (N)**	**% (N)**	**% (N)**
Care Received	1.1 (89)	0.49 (40)	0.52 (42)	1.72 (140)	1.62 (132)
Not received	98.9 (8,035)	99.51 (8,084)	99.48 (8082)	98.28 (7,984)	98.38 (7,992)
Total	100 (8,124)	100 (8,124)	100 (8,124)	100 (8,124)	100 (8,124)

Table 2.14 Descriptive Statistics on Informal Care Given - Imputed Income Sample

	Parents only	**Relatives only**	**Neighbours/Friends only**	**Care to many**	**Any care**
	% (N)	**% (N)**	**% (N)**	**% (N)**	**% (N)**
Care given	2.86 (232)	1.23 (100)	0.87 (71)	29.67 (2,409)	34.61 (2,812)
Care not given	97.14 (7,892)	98.77 (8,024)	99.13 (8,053)	70.33 (5,715)	65.39 (5,312)
Total	100 (8,124)	100 (8,124)	100 (8,124)	100 (8,124)	100 (8,124)

2.3.4.1 GP and Hospital Healthcare Service Use by Informal Care

Whereas research on the relationship between health insurance and GP utilisation has been well developed in the Irish context, less is known about the relationship between informal care and GP services utilisation. Thus, in this section, I bridge this gap in the literature and present descriptive statistics on GP services utilisation by informal care receipt and provision below.

Almost all individuals in receipt of informal care have attended a GP surgery in the previous 12 months, highlighting the important role of the GP for those needing informal care. However, they tend to use other hospital services less frequently. A relatively high proportion of individuals receiving informal care have visited an outpatient department in the last year. The highest proportion of those who have done so receive care from a spouse (73%), while 64% of those receiving care from a non-resident child have done so. Just over half of all individuals who receive care from a resident child or from others used outpatient services in the last year. Smaller proportions of individuals use both A&E and hospital inpatient services. The highest proportion of individuals to use a A&E services are those cared for by a spouse, followed by those who receive care from multiple sources and those receiving care from others. Individuals receiving care from others and from multiple sources use inpatient hospital services most, followed by those who receive care from a spouse and a non-resident child.

The descriptive statistics show a similar trend in terms of utilisation among those providing informal care. That is, carers use GP services most, followed by outpatient services and then A&E and inpatient services. The data tells us that over 80% of all carers have used GP services in the previous 12 months, with the exception of those looking after relatives only (73%). Around 40% of all carers have used outpatient services in the same period. Those caring for neighbours and friends use outpatient services most, followed by those caring for more than one person. Smaller proportions of carers tend to us inpatient and A&E services. Just over 20% of carers looking after a parent have used A&E services in the last year. The next highest users of this service are those caring for more than one person (15%). Similarly, the highest proportion of users for inpatient hospital facilities are those who provide care to parents only (17.67%), followed by those providing care to more than one person.

Table 2.15 Descriptive Statistics on GP and Hospital Healthcare Service Use by Informal Care Receipt

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
GP Visits							
	Total	8,124	100	1,020	12.56	7,104	87.44
	No care received	7,681	100	1,044	13.60	6,677	86.40
	Spousal care received	89	100	1	1.12	88	98.88
	Resident child care received	40	100	2	5.00	38	95.00
	Non-resident child care received	42	100	0	0	42	100
	Care received from others	140	100	8	5.71	132	94.29
	Care received from multiple sources	132	100	5	3.79	127	96.21
A&E Visits							
	Total	8,124	100	6,907	85.02	1,217	14.98
	No care received	7,681	100	6,584	85.72	1,097	14.28
	Spousal care received	89	100	61	68.54	28	31.46
	Resident child care received	40	100	31	77.50	9	22.50
	Non-resident child care received	42	100	32	76.19	10	23.81
	Care received from others	140	100	106	75.71	34	24.29
	Care received from multiple sources	132	100	93	70.45	39	29.55
Inpatient Visits							
	Total	8,124	100	7,079	87.14	1,045	12.86
	No care received	7,681	100	6,760	88.01	921	11.99
	Spousal care received	89	100	64	71.91	25	28.09
	Resident child care received	40	100	33	82.50	7	17.50
	Non-resident child care received	42	100	32	76.19	10	23.81
	Care received from others	140	100	98	70.0	42	30.0
	Care received from multiple sources	132	100	92	69.70	40	30.30
Outpatient Visits							
	Total	8,124	100	4,799	59.07	3,325	40.93
	No care received	7,681	100	4,623	60.19	3,058	39.81
	Spousal care received	89	100	24	26.97	65	73.03
	Resident child care received	40	100	18	45.0	22	55.0
	Non-resident child care received	42	100	15	35.71	27	64.29
	Care received from others	140	100	65	46.43	75	53.57
	Care received from multiple sources	132	100	54	40.91	78	59.09

Table 2.16 Descriptive Statistics on GP and Hospital Healthcare Services Use by Informal Care Provision

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
GP visits							
	Total	8,124	100	1,020	12.56	7,104	87.44
	No care given	5,312	100	590	11.11	4,722	88.89
	PO	232	100	37	15.95	195	84.05
	RO	100	100	27	27.00	73	73.00
	N/F	71	100	13	18.31	58	81.69
	Multiple	2,409	100	353	14.65	2,056	85.35
A&E visits							
	Total	8,124	100	6,907	85.0	1,217	15.0
	No care given	5,312	100	4,533	85.34	779	14.66
	PO	232	100	184	79.31	48	20.69
	RO	100	100	87	87.00	13	13.00
	N/F	71	100	63	88.73	8	11.27
	Multiple	2,409	100	2,040	84.68	369	15.32
Inpatient visits							
	Total	8,124	100	7,079	87.1	1,045	12.9
	No care given	5,312	100	4,590	86.41	722	13.59
	PO	232	100	191	82.33	41	17.67
	RO	100	100	92	92.00	8	8.00
	N/F	71	100	66	92.96	5	7.04
	Multiple	2,409	100	2,140	88.83	269	11.17
Outpatient visits							
	Total	8,124	100	4,799	59.1	3,325	40.9
	No care given	5,312	100	3,153	59.36	2,159	40.64
	PO	232	100	154	66.38	78	33.62
	RO	100	100	61	61.00	39	39.00
	N/F	71	100	39	54.93	32	45.07
	Multiple	2,409	100	1,392	57.78	1,017	42.22

2.3.4.2 Community Care Service Use by Informal Care

In this section, descriptive statistics on utilisation of a range of community care services by informal care are presented. I look at both utilisation of community care services by those who receive care and by those providing informal care. A similar approach to that of section 2.3.2 is taken, by looking at a range of community care services, including public health care nurse services, chiropody services, respite care and dental services among others. The descriptive statistics are presented in Table 2.17 and Table 2.18 respectively.

Looking at the Table 2.17 first, a reasonable proportion of those receiving informal care use public healthcare nurse services. Those who receive care from others use these services most (45%) while 36% of those who receive care from more than one person do so. Those who use PHN services the least are those who receive care from a spouse. Over a fifth (23%) of those receiving care from a non-resident child use chiropody services. This compares favourably to those who receive care from a spouse (7.9%) and resident child (7.5%). A quarter of all individuals either living with a resident child or receiving care from others have used optician services in the last year. Between 10%-20% of those receiving informal care have used physiotherapy and dental services in the previous 12 months. There is a significant difference across each group using home help services. As might be expected, a greater proportion of those who receive care from others tend to use home help care (40%) compared to those who receive care from a spouse (2.25%). A number of services seem to be sparingly used. For example, very few individuals tend to use social work services. Those who receive care from a spouse have not used daycentre services, while those receiving care from a resident child do not utilise respite care services.

Those providing care to others do not tend to use many community healthcare services. The services used by most carers are optician and dental services. Fourteen percent of carers who look after neighbours and friends have used dental services in the previous 12 months. Just over 10% of carers who look after more than one person have done so. As might be expected, a number of community care services are not used by carers. These include social work services, personal care attendant services and respite care services.

Table 2.17 Descriptive Statistics on Community Healthcare Service Use by Informal Care Received

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
Public Healthcare Nurse Services							
	Total	8,124	100	7,653	94.20	471	5.80
	No care received	7,681	100	7,366	95.90	315	4.10
	Spousal care received	89	100	71	79.78	18	20.22
	Resident child care received	40	100	27	67.50	13	32.50
	Non-resident child care received	42	100	28	66.67	14	33.3
	Care received from others	140	100	77	55.0	63	45.0
	Care received from multiple sources	132	100	84	63.64	48	36.36
Occupational Therapy Services							
	Total	8,124	100	8,007	98.56	117	1.44
	No care received	7,681	100	7,607	99.04	74	0.96
	Spousal care received	89	100	84	94.38	5	5.62
	Resident child care received	40	100	37	92.50	3	7.50
	Non-resident child care received	42	100	39	92.86	3	7.14
	Care received from others	140	100	127	90.71	13	9.29
	Care received from multiple sources	132	100	113	85.61	19	14.39
Chiropody Services							
	Total	8,124	100	7,785	95.83	339	4.17
	No care received	7,681	100	7,409	96.46	272	3.54
	Spousal care received	89	100	82	92.13	7	7.87
	Resident child care received	40	100	37	92.50	3	7.50
	Non-resident child care received	42	100	32	76.19	10	23.81
	Care received from others	140	100	118	84.29	22	15.71
	Care received from multiple sources	132	100	107	81.06	25	18.94

Table 2.17 Descriptive Statistics on Community Healthcare Service Use by Informal Care Received (Cont'd)

Physiotherapy Services							
	Total	8,124	100	7,702	94.81	422	5.19
	No care received	7,681	100	7,333	95.47	348	4.53
	Spousal care received	89	100	73	82.02	16	17.98
	Resident child care received	40	100	37	92.50	3	7.50
	Non-resident child care received	42	100	37	88.10	5	11.90
	Care received from others	140	100	114	81.43	26	18.57
	Care received from multiple sources	132	100	108	81.82	24	18.18
Home Help Services							
	Total	8,124	100	7,880	97.0	244	3.0
	No care received	7,681	100	7,542	98.19	139	1.81
	Spousal care received	89	100	87	97.75	2	2.25
	Resident child care received	40	100	35	87.50	5	12.50
	Non-resident child care received	42	100	37	88.10	5	11.90
	Care received from others	140	100	84	60.0	56	40.0
	Care received from multiple sources	132	100	95	71.97	37	28.03
Optician Services							
	Total	8,124	100	7,162	88.16	962	11.84
	No care received	7,681	100	6,811	88.67	870	11.33
	Spousal care received	89	100	78	87.64	11	12.36
	Resident child care received	40	100	30	75.0	10	25.0
	Non-resident child care received	42	100	32	76.19	10	23.81
	Care received from others	140	100	105	75.0	35	25.0
	Care received from multiple sources	132	100	106	80.30	26	19.70
Dental Services							
	Total	8,124	100	7,241	89.13	883	10.87
	No care received	7,681	100	6,862	89.34	819	10.66
	Spousal care received	89	100	77	86.52	12	13.48
	Resident child care received	40	100	32	80.0	8	20.0
	Non-resident child care received	42	100	40	95.24	2	4.76
	Care received from others	140	100	116	82.86	24	17.14
	Care received from multiple sources	132	100	114	86.36	18	13.64

Table 2.17 Descriptive Statistics on Community Healthcare Service Use by Informal Care Received (Cont'd)

Hearing Services							
	Total	8,124	100	7,987	98.31	137	1.69
	No care received	7,681	100	7,566	98.50	115	1.50
	Spousal care received	89	100	87	97.75	2	2.25
	Resident child care received	40	100	37	92.50	3	7.50
	Non-resident child care received	42	100	41	97.62	1	2.38
	Care received from others	140	100	131	93.57	9	6.43
	Care received from multiple sources	132	100	125	94.70	7	5.30
Dietician Services							
	Total	8,124	100	8,012	98.62	112	1.38
	No care received	7,681	100	7,592	98.84	89	1.16
	Spousal care received	89	100	83	93.26	6	6.74
	Resident child care received	40	100	40	100	0	0
	Non-resident child care received	42	100	40	95.24	2	4.76
	Care received from others	140	100	130	92.86	10	7.14
	Care received from multiple sources	132	100	127	96.21	5	3.79
Social Work Services							
	Total	8,124	100	8,104	99.75	20	0.25
	No care received	7,681	100	7,665	99.79	16	0.21
	Spousal care received	89	100	89	100	0	0
	Resident child care received	40	100	40	100	0	0
	Non-resident child care received	42	100	42	100	0	0
	Care received from others	140	100	138	98.57	2	1.43
	Care received from multiple sources	132	100	130	98.48	2	1.52
Psychological/Counselling Services							
	Total	8,124	100	8,049	99.08	75	0.92
	No care received	7,681	100	7,618	99.18	63	0.82
	Spousal care received	89	100	87	97.75	2	2.25
	Resident child care received	40	100	39	97.50	1	2.50
	Non-resident child care received	42	100	42	100	0	0
	Care received from others	140	100	135	96.43	5	3.57
	Care received from multiple sources	132	100	128	96.97	4	3.03

Table 2.17 Descriptive Statistics on Community Healthcare Service Use by Informal Care Received (Cont'd)

Personal Care Attendant Services							
	Total	8,124	100	8,082	99.48	42	0.52
	No care received	7,681	100	7,667	99.82	14	0.18
	Spousal care received	89	100	88	98.88	1	1.12
	Resident child care received	40	100	39	97.50	1	2.50
	Non-resident child care received	42	100	40	95.24	2	4.76
	Care received from others	140	100	126	90.0	14	10.0
	Care received from multiple sources	132	100	122	92.42	10	7.58
Meals-on-Wheels Services							
	Total	8,124	100	8,061	99.22	63	0.78
	No care received	7,681	100	7,641	99.48	40	0.52
	Spousal care received	89	100	88	98.88	1	1.12
	Resident child care received	40	100	38	95.0	2	5.0
	Non-resident child care received	42	100	40	95.24	2	4.76
	Care received from others	140	100	125	89.29	15	10.71
	Care received from multiple sources	132	100	129	97.73	3	2.27
Daycentre Services							
	Total	8,124	100	8,043	99.0	81	1.0
	No care received	7,681	100	7,630	99.34	51	0.66
	Spousal care received	89	100	89	100	0	0
	Resident child care received	40	100	38	95.0	2	5.0
	Non-resident child care received	42	100	39	92.86	3	7.14
	Care received from others	140	100	125	89.29	15	10.71
	Care received from multiple sources	132	100	122	92.42	10	7.58
Respite Services							
	Total	8,124	100	8,093	99.62	31	0.38
	No care received	7,681	100	7,666	99.80	15	0.20
	Spousal care received	89	100	88	98.88	1	1.12
	Resident child care received	40	100	40	100	0	0
	Non-resident child care received	42	100	41	97.62	1	2.38
	Care received from others	140	100	131	93.57	9	6.43
	Care received from multiple sources	132	100	127	96.21	5	3.79

Table 2.18 Descriptive Statistics on Community Healthcare Service Use by Informal Care Provision

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
Public Healthcare Nurse							
	Total	8,124	100	7,653	94.2	471	5.8
	No care given	5,312	100	4,934	92.88	378	7.12
	PO	232	100	224	96.55	8	3.45
	RO	100	100	97	97	3	3
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,327	96.6	82	3.4
Occupational Therapy							
	Total	8,124	100	8,007	98.6	117	1.4
	No care given	5,312	100	5,226	98.38	86	1.62
	PO	232	100	230	99.14	2	0.86
	RO	100	100	100	100	0	0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,380	98.8	29	1.2
Chiropody							
	Total	8,124	100	7,785	95.8	339	4.2
	No care given	5,312	100	5054	95.14	258	4.86
	PO	232	100	225	96.98	7	3.02
	RO	100	100	100	100	0	0
	N/F	71	100	68	95.77	3	4.22
	Multiple	2,409	100	2,338	97.05	71	2.95
Physiotherapy							
	Total	8,124	100	7,702	94.8	422	5.2
	No care given	5,312	100	5,036	94.8	276	5.2
	PO	232	100	222	95.69	10	4.31
	RO	100	100	95	95	5	5
	N/F	71	100	70	98.59	1	1.41
	Multiple	2,409	100	2,279	94.60	130	5.40

Table 2.18 Descriptive Statistics on Community Healthcare Service Use by Informal Care Provision (Cont'd)

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
Home Help							
	Total	8,124	100	7,880	97.0	244	3.0
	No care given	5,312	100	5,105	96.1	207	3.9
	PO	232	100	231	99.57	1	0.43
	RO	100	100	100	100	0	0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,373	98.51	36	1.49
Optician Services							
	Total	8,124	100	7,162	88.2	962	11.8
	No care given	5,312	100	4612	86.82	700	13.18
	PO	232	100	211	90.95	21	9.05
	RO	100	100	92	92.00	8	8.00
	N/F	71	100	65	91.55	6	8.45
	Multiple	2,409	100	2,182	90.58	227	9.42
Dental Services							
	Total	8,124	100	7,241	89.1	883	10.9
	No care given	5,312	100	4,739	89.21	573	10.79
	PO	232	100	201	86.64	31	13.36
	RO	100	100	94	94.0	6	6.0
	N/F	71	100	61	85.92	10	14.08
	Multiple	2,409	100	2,146	89.08	263	10.92
Hearing Services							
	Total	8,124	100	7,987	98.3	137	1.7
	No care given	5,312	100	5,202	97.93	110	2.07
	PO	232	100	231	99.57	1	0.43
	RO	100	100	100	100	0	0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,383	98.92	26	1.08

Table 2.18 Descriptive Statistics on Community Healthcare Service Use by Informal Care Provision (Cont'd)

Dietician Services							
	Total	8,124	100	8,012	98.6	112	1.4
	No care given	5,312	100	5235	98.55	77	1.45
	PO	232	100	227	97.84	5	2.16
	RO	100	100	98	98.0	2	2.0
	N/F	71	100	71	100.0	0	0
	Multiple	2,409	100	2,381	98.84	28	1.16
Social Work Services							
	Total	8,124	100	8,104	99.8	20	0.2
	No care given	5,312	100	5,299	99.76	13	0.24
	PO	232	100	232	100	0	0
	RO	100	100	100	100	0	0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,402	99.71	7	0.29
Psychological/Counselling Services							
	Total	8,124	100	8,049	99.0	75	1.0
	No care given	5,312	100	5,274	99.28	38	0.72
	PO	232	100	228	98.28	4	1.72
	RO	100	100	97	97.0	3	3.0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,379	98.75	30	1.25
Personal Care Attendant							
	Total	8,124	100	8,082	99.5	42	0.5
	No care given	5,312	100	5,277	99.34	35	0.66
	PO	232	100	232	100	0	0
	RO	100	100	100	100	0	0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,402	99.71	7	0.29

Table 2.18 Descriptive Statistics on Community Healthcare Service Use by Informal Care Provision (Cont'd)

Resource Use	**Variable Description**	**Total (N)**	**%**	**No visits**	**%**	**One or more visits**	**%**
Meals-on-Wheels Services							
	Total	8,124	100	8,061	99.2	63	0.8
	No care given	5,312	100	5,261	99.04	51	0.96
	PO	232	100	231	99.57	1	0.43
	RO	100	100	100	100	0	0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,398	99.54	11	0.46
Daycentre Services							
	Total	8,124	100	8,043	99.0	81	1.0
	No care given	5,312	100	5,239	98.63	73	0.37
	PO	232	100	230	99.14	2	0.86
	RO	100	100	100	100	0	0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,403	99.75	6	0.25
Respite Services							
	Total	8,124	100	8,093	99.6	31	0.4
	No care given	5,312	100	5,286	99.51	26	0.49
	PO	232	100	232	100	0	0
	RO	100	100	100	100	0	0
	N/F	71	100	71	100	0	0
	Multiple	2,409	100	2,404	99.79	5	0.21

2.3.4.3 Informal Care and Healthcare Costs

Descriptive statistics on total healthcare costs by informal care receipt and provision are presented in Tables 2.19 and 2.20 respectively. Looking firstly at those who receive informal care, the majority of respondents (almost 95%) do not receive any informal care. Average healthcare costs are highest for those who receive care from multiple sources. For this group, average healthcare costs are €3,468 per year. Average healthcare costs are lowest for those who do not receive any informal care. The standard deviation is highest for respondents who received care from others. Looking at Table 2.20, once again the majority of respondents do not provide any informal care. Average healthcare costs are highest for those who provide care to parents only and lowest for those who provide care to neighbours and friends. Almost 30% of respondents provide care for more than one person.

Table 2.19 Descriptive Statistics on Total Healthcare Costs by Informal Care Receipt

Variable Name		Variable Description	N	%	Mean	Median	Std Dev	Min	Max
Healthcare cost									
		Total	8,124	100	1,296	238	3,119	0	31,005
		No care received	7,681	94.55	1,182	238	2,882	0	30,298
		Spousal care received	89	1.1	3,321	1,020	5,611	51	28,996
		Resident child care received	40	0.49	2,449	612	5,030	51	28,308
		Non-resident child care received	42	0.52	2,779	612	4,675	102	20,024
		Care received from others	140	1.72	3,417	714	5,813	0	31,005
		Care received from multiple sources	132	1.62	3,468	966	5,529	0	30,512

Table 2.20 Descriptive Statistics on Total Healthcare Costs by Informal Care Provision

Variable Name	Variable Description	N	%	Mean	Median	Std Dev	Min	Max
Healthcare cost								
	Total	8,124	100	1,296	238	3,199	0	31,005
	No care provided	5,312	65.4	1,368	255	3,258	0	31,005
	PO	232	2.9	1,535	204	3,097	0	24,843
	RO	100	1.2	1,006	102	3,348	0	28,614
	N/F	71	0.9	713	238	1,267	0	5,414
	Multiple	2,409	29.7	1,143	204	2,814	0	28,996

2.4 Conclusion

This chapter introduced the TILDA dataset, used in each of the empirical chapters that follow. TILDA is the first population based survey dataset dedicated to the study of individuals aged 50 and over (and their spouses under the age of 50) in an Irish setting. TILDA was designed to provide an evidence base for addressing concerns associated with population ageing in Ireland (Cronin et al., 2013). In this chapter, the study design and the sampling frame are set out, as well as the data collection process undertaken to create this unique longitudinal dataset. The TILDA includes a wide variety of demographic, socio-economic and health related information both at the household and individual level, which were detailed throughout the chapter. I outlined the estimation sample, which I have adopted and which will be used in the empirical chapters that follow. Descriptive statistics on our dependent variables of interest were presented as well as univariate and multivariate analysis of the three main independent variables of interest were presented as a starting point to the analysis. Descriptive statistics on the socio-demographic and health related variables used through the thesis were also presented. Various sensitivity analysis on the imputation of household income was conducted and compared as a robustness check. For comparison with the estimation sample, descriptive statistics for the population using survey design techniques were also presented.

3. Methodology

This chapter outlines the methodological approach adopted to explore the research questions of interest throughout this thesis. It also discusses the approach taken to the development of the literature review in the empirical chapters that follow. The methodological approaches taken to investigate associations between health insurance status and healthcare utilisation, costs and informal care will be outlined. As detailed in Chapter 1, and in common with other applied studies of healthcare utilisation, I assume the theoretical framework proposed by the Andersen Behavioural Model (Andersen, 1968, 1995; Andersen & Newman, 1973) to inform the methodological approach adopted in our analysis. Various methodological challenges exist when attempting to estimate a causal effect between health insurance status and healthcare utilisation, costs and informal care. I outline these challenges and explain why estimating such a causal effect was not possible in this thesis. Instead, matching approaches are used to account for the observable heterogeneity between health insurance and healthcare utilisation, costs and informal care. These matching approaches are described in detail as this methodological approach is used extensively throughout each of the empirical chapters that follow. Various methodological challenges also exist in terms of analysing healthcare costs. This chapter presents the sophisticated econometric approaches used to overcome these challenges.

3.1 Methodological Approaches to Estimating the Effect of Health Insurance Status

Attempting to disentangle this causal link presents significant methodological challenges in the form of selection, reverse causality and omitted variable bias (Dor & Umapathi, 2014). First, when attempting to estimate the causal effect of health insurance on healthcare utilisation using observational data, analysts face the potential problem of selection. That is, it may be the case that those who receive the treatment (health insurance) may differ systematically from those who do not receive the treatment in terms of their observable characteristics. In other words, allocation into either the treatment or the control group is non-random. Without attempting to control for such non-randomness, one runs the risk of generating biased causal estimates. Second, the inherent endogeneity that exists between health insurance status and healthcare utilisation poses further problems for causal estimation. When X and Y are correlated, the direction of the effect can sometimes be ambiguous. Finally, omitted variable bias occurs when the individual's insurance choice is determined by some unobservable characteristic that also affects healthcare utilisation.

In order to estimate the causal effect of interest, ideally, a randomised control trail (RCT) would be conducted to randomly allocate participants in the trial to either a treatment group (e.g. PHI) or a control group. That is, participates would either receive the treatment or they would receive the treatment and the decision on who receives the treatment would be taken at random. Conducting such a randomised experiment is not always possible for the analyst due to financial and ethical concerns. Instead, analysts must rely on quasi-experimental approaches to estimate the causal effect of interest. Such quasi-experimental approaches include natural experiments, instrumental variable estimation, longitudinal, panel data analysis, or econometric identification using cross sectional observational data.

3.2 The Evaluation Problem with Cross-Sectional Data

As outlined in Chapter 1, the research questions in this thesis seeks to shed light on the relationship between health insurance status and the utilisation and costs of a range of hospital and community care services. It also attempts to estimate the relationship between health insurance status and informal care and the impact that informal care has on healthcare utilisation and costs. However, the approaches available to us to answer these questions are limited due to the cross sectional nature of the data as described in Chapter 2. As addressed by Jones (2007a), the analysis of cross-sectional data poses particular problems for econometric analysis and has direct implications for whether or not results can be interpreted as causal or not. In simple terms, I wish to estimate an outcome y_i (which in this case is healthcare utilisation) for individual i given a treatment T (in this case health insurance status). The causal effect of interest is the difference between the outcome with the treatment and the outcome without the treatment C. This difference can be formalised as follows:

$$\alpha_i = Y_i^T - Y_i^C$$

Of greater interest to the analyst perhaps is the average treatment effect on the treated (ATT); i.e. the estimated effect of a treatment on the outcome for an individual in the control group had they been exposed to the treatment such that:

$$E(\alpha_t|D=1) = E(Y_t^T - Y_t^C|D=1) = E(Y_t^T|D=1) - E(Y_t^C|D=1)$$

Where $E(.)$ represents the expected value and D is a dummy variable equal to one if the individual receives treatment and zero otherwise. The fundamental problem, termed the "evaluation problem" or "identification problem" is that the counterfactual cannot be observed *i.e.* the outcome of interest Y for individual i cannot be observed with treatment T and without treatment T at the same time. Rosenbaum and Rubin (1983) state that such a scenario is analogous to a missing data problem. Thus, the term $E(Y_t^C|D=1)$ is unobservable and cannot be estimated directly. A further problem for statistical inference of health insurance status on utilisation is that of endogeneity of the insurance choice variable caused by unobservable heterogeneity (Wooldridge, 2006). Endogeneity bias arises if there are unobserved characteristics that influence both whether an individual is selected into the treatment group i.e. an individual in poor health on average, relative to the population may be more likely to take out health insurance and indeed use more healthcare services. Selection into insurance may also differ based on observable characteristics (Jones, 2007a). For example, those with insurance may be older and more affluent than those without insurance. This self-selection into the treatment group will lead to biased estimates of the treatment effect.

From a policy perspective, analysts are interested in the causal effect of one variable on the other. Treating health insurance status as an exogenous explanatory variable in a regression on healthcare utilisation while useful, will determine mere associations or correlations between the two variables, Due to the inherent endogeneity bias in the relationship between the two variables of interest, running a simple OLS regression of insurance status on healthcare utilisation will not give us our desired causal effects. More sophisticated econometric approaches that overcome the problem of endogeneity bias are required to isolate the causal effect of interested and these have been considered elsewhere[11]. I discuss these approaches further in the next section.

3.3 The Evaluation Techniques Adopted for the Analysis of Cross-Sectional Data

Given the concerns presented above, a pragmatic strategy to model choice involving a series of approaches was adopted to address the research questions of interest. I can estimate the treatment effect of health insurance on healthcare utilisation in one of two ways – (1) using selection on observables approaches or (2) selection on unobservable approaches (Jones,

[11] Including instrumental variables, difference-in-difference estimators and Heckit estimators

2007a). In the section below, the strategies employed are outlined.

3.3.1 Selection on Observable Characteristics

Approaches to deal with selection on observables include simple probit or logit analysis; inverse probability weighting (IPW) and propensity score matching (PSM) (Austin, 2011). These approaches assume that, conditional on the observables, treatment is independent of the outcome. In this chapter, the following approach is adopted. These approaches are discussed in the following section.

3.3.1.1 Propensity Score Matching

Propensity Score matching was first advocated by Rosenbaum and Rubin (1983) as a method to overcome the problem of non-random selection into treatment and control groups. It is non-parametric meaning that no functional form assumptions need to be assumed. The propensity score for individual i is defined as the probability of receiving the treatment given the observed covariates such that;

$$e_i(X_i) = P(T_i = 1|X_i)$$

The propensity score distance is thus $e_i(X_{ij}) - e_i(Xik)$ – the absolute distance (Stuart, 2010). The idea behind propensity score matching is to match each treated individual with one or more individuals from the control group who are comparable in terms of their observed statistics. In this way, propensity score matching hopes to replicate the conditions of a randomised control trial (RCT) by finding treatment and comparison individuals who look only randomly different from one another, at least with respect to the observed confounders (Stuart, 2010).

To calculate the propensity score matching estimator first use a probit regression to estimate the propensity to treat based on a set of explanatory variables. The explanatory variables that I use in estimating the propensity score include a range of demographic, socio-economic and health related variables such as age, gender, marital status, education level, employment status, nationality, living status, household income, disability status, self-rated health as well as a range of chronic conditions. Second, individuals in the treatment group are matched with individuals in the control group with the same propensity score, implying the groups are similar in terms of their observable characteristics at least (Rosenbaum & Rubin, 1983). By

eliminating, or at least reducing, covariate imbalance between the treated and control groups, one can estimate the difference in utilisation over and above that which can be explained by each group's observable characteristics. Since the matching procedure uses only observed characteristics, it is assumed that if observed covariates are well balanced between the treated and control group, then unobservable confounding factors are well balanced in both groups also (Dehejia & Wahba, 2002). Our favoured specification is that of nearest neighbour one-to-one matching. Nearest neighbour matching matches each treatment unit to the k nearest controls based on the propensity score[12]. Each of our three nearest neighbour specifications are estimated with and without a caliper. In all cases where a caliper was employed, the width was chosen to be 0.25 standard deviations of the probit of the propensity score as recommended by Rosenbaum and Rubin (1985).

3.3.1.2 The Mahalanobis Distance

The Mahalanobis distance is another distance measure used to determine the closeness of a match between the treatment unit and the control(Cochran & Rubin, 1973). The Mahalanobis distance uses the variance covariance matrix of the covariates to measure the closeness between the treated and the control group. The Mahalanobis distance is given by:

$$\sqrt{(X_i - X_j)T \sum -1 (X_i - X_j)}$$

Where $\sum$ is a variance covariance matrix of a form depending on which treatment effect is being treated and X_i is a matrix of the set of covariate values for individual i (Stuart & Rubin, 2007). The Mahalanobis distance takes the variance and covariance of the covariates into account and computes the normal Euclidian distance (Baltar, De Sousa, & Westphal, 2014). Thus, distance measure is defined in terms of standard deviations away from the covariate values of the treatment unit. As a sensitivity analysis to the models mentioned above, I exact match on marital status and disability level whilst applying nearest neighbour 1:1 matching

[12] The advantage of this method is that it minimises the bias in the matching, because the best comparison unit is matched to the treat unit. However, although bias is minimised 1:1 matching suffers from a loss of efficiency. For comparison, I also performed nearest neighbour 1:5 and 1:10 matching where the five (ten) best comparison units are matched to the treated unit. These results are shown in the Appendices. Although the bias may increase from 1:5 or 1:10 matching resulting from poorer matches (on average) compared with the 1:1 matching approach, the variance would reduce because I use more information to construct the counterfactual for reach treated unit.

on the remaining covariates finding the closest matches based on the Mahalanobis distance[13].

Gu and Rosenbaum (1993) and Rubin and Thomas (2000) compare the performance of matching methods base on Mahalanobis metric matching and propensity score matching, and they find that the two distance measures perform similarly when there are a relatively small number of covariates, but that propensity score matching works better than Mahalanobis metric matching with large numbers of covariates (fewer than 8). One reason for this is that the Mahalanobis metric is attempting to obtain balance on all possible interactions of the covariates, treating all of the interactions as equally important, whereas propensity score matching allows the exclusion of terms from the propensity score model, and thereby the inclusion of only the important terms on which to obtain balance (Stuart & Rubin, 2007).

3.3.1.3 Other econometric cross-sectional methods

The increasing emphasis on the use of experimental and quasi-experimental econometric approaches mentioned above, to estimate a causal effect of interest has led to what has been termed a 'credibility revolution in the field of economics (Angrist & Pischke, 2010). However, Ruhm states, that "excessive reliance on such methods may move us away from examining issues that are of fundamental significance but for which unambiguous causal inference is more difficult to obtain" (2018, p.2). Thus, while understanding and addressing the identification problem is essential for evidence-based policy, a role for descriptive analysis and estimation of associations between important topics remains. In the next section, a number of econometric approaches to estimating the relationship between health insurance status and healthcare utilisation are discussed.

3.3.1.3.1 Bivariate Probit Models

The second empirical strategy employs a bivariate probit model to consider the joint decision of individual i attending a GP and attending the other healthcare service (S). I hypothesise that these outcomes are related after conditioning on regressors and that this relatedness occurs *via* correlation of the error terms in the separate decision models. Allowing for correlation between the error terms of the two equations recognises that there may be unobservable characteristics of individuals that influence both the decision to visit a GP and to visit another

[13] For comparison, I also performed exact matching on two further models. The first model performed exacting matching on marital status and disability level as well as disability status. In the second model, I performed exact matching on marital status, disability status and self-rated health. The estimated coefficients for these additional models are presented in the Appendices.

healthcare service (Jones, 2007a). The model is similar to a seemingly unrelated regression (SUR) model but with separate binary probit models and correlated disturbances and is applicable when an individual faces two inter-related binary decisions or outcomes. The specification of our model is presented below. In this case, there are two latent variables GP_i^* and S_i^*, each of which is assumed a linear function of a set of (separate) explanatory variables and an error term. Notably, both equations include insurance coverage, demographic, socio-economic and health-related characteristics as independent variable variables. Thus, for this model, we have:

$$GP_i^* = \delta_1 Ins_i + \delta_2 X_{2i} + u_{1i}, \text{where } GP_i = 1 \text{ if } GP_i^* > 0 \text{ and } GP_i = 0 \text{ otherwise}$$

and

$$S_i^* = \gamma_1 Ins_i + \gamma_2 X_{3i} + u_{2i}, \text{where } S_i = 1 \text{ if } S_i^* > 0 \text{ and } S_i = 0 \text{ otherwise}$$

The error terms in this model are assumed to have a joint or bivariate normal distribution, which allows for a non-zero correlation (ρ) between the errors. In other words, it is assumed that the two error terms are not independent of each other and this implies $(u_{1i}, u_{2i}) \sim N_2(0,0,1,1,\rho)$, where N_2 represents the bivariate normal distribution. Therefore, the probability of each of the different outcomes can be defined as a function of the explanatory variables and the unknown model parameters (δ and γ), and the latter estimated using maximum likelihood methods. The coefficient of correlation between the two error terms can also be estimated to help assess the appropriateness of the model specification and the model collapses to two separate binary probit models where ρ is found to be equal to zero. This empirical approach recognises that there may be unobservable characteristics of individuals that influence both decisions and accounts for this by allowing for correlation between the error terms in both decisions/outcomes.

3.3.1.3.2 Binary Probit Models

The third empirical strategy is the binary probit, the specification of which is presented in the equation below. I assume a latent variable S_i^* (which represents individual i attending healthcare service S) to be a linear function of a set of explanatory variables including coverage status and an error term. This implies that:

$$S_i^* = \beta_1 Ins_i + \beta_2 Demo_{1i} + \beta_3 X_{1i} + \epsilon_i, \text{where } S_i = 1 \text{ if } S_i^* > 0 \text{ and } S_i = 0 \text{ otherwise}$$

A limitation of the binary probit model approach is that the estimates produced to not infer causality. Instead, one can only infer correlations or associations between observable explanatory variables and the outcome variable. As such, the model fails to address the inherent endogeneity bias that exists between health insurance status and healthcare utilisation.

3.3.1.3.3 Complementary log-log models

The fourth empirical strategy extends the binary outcome specification, but explicitly considers those cases where the event of interest is rare: that is, if the proportion of people using a particular service is low. In this case, I estimate a complementary-log-log (CLL) model. Such a model is asymmetric around zero and is typically used in cases where the event of interest is rare (Cameron & Trivedi, 2010; Hernández-Quevedo, Jones, & Rice, 2008). Estimating such a model allows for comparison with our logit specification. In order to assess which model specification works best with the data I use both Akaike and Bayesian Information Criteria (AIC and BIC) to inform the decision as proposed by Deb et al; (2017). The information criteria are log-likelihood-based measures with differing degrees of freedom adjustments. They capture the trade-off between model fit (measured by maximum likelihood) and the principle of parsimony that favours a simple model, thus penalising model complexity. Smaller values of the AIC and BIC indicate a better model fit. The complementary-log-log model suffers from the same drawback as that of the probit model in that causal inference cannot be draw from such an approach. As with the probit model, the complementary-log-log model does nothing to address the endogeneity bias in the health insurance variable. Thus, the estimates produced from the analysis are mere associations. In all cases, I report results for a restricted analysis, controlling only for insurance coverage status, and for an unrestricted analysis, controlling for insurance coverage status, demographic, socioeconomic and health-related variables. For the purposes of reporting, I only present findings for the main independent variable - insurance coverage status. In the next section, I detail the results from the analysis undertaken. Each of the models mentioned in this section are analysed in turn to estimate the relationship between health insurance status and a number of healthcare services.

Additionally, the methodological approaches to estimates healthcare costs will be discussed. First, the various challenges to measure healthcare costs will be summarised, followed by a detailed discussion on the sophisticated econometric techniques applied in this thesis.

3.4 Theoretical Analysis of Healthcare Costs

To inform the empirical analysis described in this chapter, it is first necessary to consider the theoretical underpinnings of the drivers of health expenditures and/ or healthcare costs. In the next section, a standard theoretical model for the analysis of healthcare costs is presented. Following on from that, I outline the empirical strategy for the analysis of healthcare costs in more detail. First, the empirical literature on the estimation of healthcare costs is summarised briefly, followed by a discussion of the various econometric approaches to modelling healthcare cost data used in this thesis.

3.4.1 A Standard Theoretical Model of Healthcare Costs

Standard economic theory posits that total costs or total expenditure can be calculated by multiplying the price of a good by the quantity demanded (Bhattacharya, Hyde, & Tu, 2014) such that;

$$E = P.Q$$

Where E represents total healthcare costs or total expenditure on healthcare, P is the price of medical care and Q is the quantity of healthcare demanded. The price of healthcare shifts due to changes in the costs of input goods such as prescription drugs, changes in the salaries to medical practitioners and so on. The application of innovative new technologies into the production process can also shift the price of healthcare upwards. Demographic factors such as an ageing population due to increasing life expectancy and declining fertility rates; changes in ethnic diversity throughout a population, household income and insurance coverage can shift the demand curve to the right, which in turn leads to an increase in healthcare prices. Increase in medical expenditures driven by increases in price P, trend to harm healthcare users. For example, if the marginal cost of healthcare is increasing due to resources constraints or a lack of competition in the healthcare sector, then individuals will need to reduce their healthcare consumption or spend more of their income to stay healthy (Bhattacharya et al., 2014). On the other hand, if healthcare expenditure increases are driven by increases in the quantity demanded of healthcare, these may be beneficial, depending on

the relationship between expenditure and health outcomes. Because, some individuals may also be spending more on unnecessary healthcare (Grignon, 2014).

3.4.2 Empirical Modelling of Healthcare Costs

Several approaches of dealing with the complex nature of healthcare cost data have been suggested in literature and will be summarised below. A number of studies have compared different methods and suggested criteria for selecting the most appropriate models (Basu & Manning, 2009; Buntin & Zaslavsky, 2004; Deb & Trivedi, 2012; Jones, 2011; Mihaylova et al., 2011; Mullahy, 2009).

Standard OLS has many advantages that make it appealing for the estimation of costs. First, it is easy to implement and the estimated coefficients produced can be interpreted directly as differences in arithmetic mean cost (Jones et al., 2013). Second, OLS is the best, linear, unbiased estimator (Wooldridge, 2006). However, healthcare cost data often violate the assumptions underlying OLS. First, healthcare cost data is often heteroskedastic (i.e. the assumption under OLS that the variance of the error term is constant – homoscedastic) is sometimes violated. Second, the assumption that the error term is normally distributed is also violated (Jones, 2010). Due to the skewed nature of healthcare cost data OLS performs poorly and can be sensitive to outliers (Jones, 2011). Much of the early work on healthcare cost estimation concentrated on the log transformation of cost data to produce a more systematic distribution (Manning, 1998; Manning et al., 2005; Mullahy, 1998) although square-root transformations and other power functions have also been used (Jones, 2010). However, such approaches are not without their shortcomings. First, when observations have zero costs, their log cost is undefined. Many researches address this problem by adding an arbitrary constant such as 1 to all costs before taking logs. However, one should always determine whether the magnitude of the arbitrary constant affects one's conclusions and the presence of a large number of zeros makes this approach problematic. Second, transformation of the data does not always yield a normal distribution. Third, when deriving predictions on a transformed scale they must be re-transformed back to their original scale to draw meaningful conclusions, a process that is far from straightforward (Jones et al., 2013; Manning, 1998).

The relationship between covariates and costs is also thought to be non-linear (Manning, 2014). Thus, alternative estimation techniques that account for this non-linear relationship as well as the distributional nature of the data may be more appropriate. The large proportion of

zeros often prevalent in cost data have been handled by the use of two-part models, where the probability of incurring expenditure is modelled separately to the level of cost incurred, conditional on having incurred some cost greater than zero. Tobit models have also been applied in this context (Jones, 2000; Jones et al., 2013). Count data models such as the Poisson specification, often used to examine healthcare utilisation, can also be used to model healthcare costs (Jones, 2000, 2007a; Jones et al., 2013). Hazard models and generalised gamma models normally applied to duration data can also be used to estimate healthcare costs (Jones, 2000; Jones et al., 2013; Manning et al., 2005). Several authors have used the generalised linear model (GLM) framework to analyse healthcare costs (Blough et al., 1999; Buntin & Zaslavsky, 2004; Manning, 2012, 2014). GLMs offer greater flexibility in modelling cost data by allowing the mean and variance function to be directly specified by the analyst (Jones et al., 2013). Basu and Rathouz (2005) suggest an extension to the GLM approach – extended estimating equations (EEEs) which allow for the link and variance function to be directly estimated from the data. Finite mixture models. Finite fixture models which include so called latent class models as mixtures of Bernoulli distributed outcomes have been used widely in the literature to estimate costs (Deb & Burgess Jr, 2007; Eckardt et al., 2017; McLachlan & Peel, 2000) and have also been proposed by Deb and Trivedi (1997) to model healthcare utilisation data.

All of the approaches detailed above estimate healthcare costs at the mean of the distribution. These models however, provide only a single snapshot of a wider story. A fuller picture would provide information about the relationship between the outcome variable Y and the set of regressors X at different points along the conditional distribution. Thus, a new strand of literature has emerged in recent years which attempts to estimate healthcare costs across the entire distribution (Jones et al., 2015; Vanness & Mullahy, 2012). Various approaches to quantile regression first introduced by Koenker and Bassett (1978) have been proposed in the literature, including, unconditional quantile regression (Borah & Basu, 2013; Firpo et al., 2009) and quantile regression dynamic panel instrumental variable (QRPIV) models (Galvao, 2011; Tian, Gao, & Yang, 2018).

3.4.3 Empirical Strategy – Econometric Approaches Considered

In this section, we discuss the various econometric methods employed to analyse associations between health insurance status and healthcare costs. We employ various methodologies to analyse mean healthcare costs and discuss the merits of each in turn, in terms of their ability to account for the endogenous heterogeneity between health insurance and healthcare costs.

We also describe in more detail the unconditional quantile regression approach adopted which allows for the analysis of healthcare costs across the entire distribution.

3.4.3.1 Ordinary Least Squares

Standard ordinary least squares has many desirable quantities for econometric analysis (Jones, 2011; Wooldridge, 2006). It is easy to implement and estimated coefficients can be interpreted on the original scale. At such, it provides a useful starting point for our analysis of the effect of insurance status on average healthcare costs. However, because of their distributional nature, healthcare cost data often violate the assumptions underlying OLS meaning more sophisticated econometric models need to be applied. Some analysts use a log transformation of the data to produce a more symmetric and normally distributed function but such an approach is not without its own problems (Manning, 1998; Manning & Mullahy, 2001; Mullahy, 1998). The shortcomings of OLS and logged OLS for healthcare cost estimation have been outlined earlier in section 4.3.2.1. In addition, OLS does nothing to address the unobservable heterogeneity that exists between health insurance status and healthcare costs. That is, it does nothing to address the causal effect of interest in this chapter – the effect of health insurance status on healthcare costs.

3.4.3.2 Generalised linear models (GLM)

GLMs have become the dominant framework in the literature to model healthcare costs (Blough et al., 1999; Buntin & Zaslavsky, 2004; Manning, 2012, 2014; Manning et al., 2005; Manning & Mullahy, 2001). An advantage that the GLM approach has over OLS is that it allows for the mean and variance function of the data to be specified directly by the analyst, thus allowing for the skewed nature of cost data (Blough et al., 1999; Jones et al., 2013). It does this by identifying a "link function" and a "family" based on the data. The link function specifies the relationship between the conditional mean and the linear index specification of the covariates such that;

$$E[y_i|x_i] = \mu_i = f(x_i\beta)$$

GLM allows for the heteroscedastic nature of cost data through the choice of distributional family i.e. a variance structure relating the variance to the mean. Therefore, the second requirement for GLM estimation is to specify the relationship between the conditional

variance and the conditional mean. This is done by specifying the family, which corresponds to a distribution that reflects the mean-variance relationship. For instance, the Gaussian family assumes that the variance and the mean are constant whereas the Poisson family assumes that the variance is proportional to the mean. Another advantage of the GLM framework is that predictions are made on the raw scale, thus avoiding the problem of retransformation that befalls the logged OLS specification (Jones, 2010; Manning, 2014). GLMs are derived using quasi-maximum likelihood estimation. Estimates are consistent as long as the conditional mean is correctly specified (Gourieroux, Monfort, & Trognon, 1984).

3.4.3.2.1 Specification Tests

As a sensitivity analysis, the analysis allowed for a range of different families of distribution (including gamma, Poisson, Gaussian and inverse Gaussian) and link functions (identity, log and power) to investigate which specification worked best for estimating health care costs based on the data used. The modified Park test (Park, 1966) as proposed by (Manning & Mullahy, 2001) is used as a means of identifying the appropriate family for a generalised linear model (Glick et al., 2007). A combination of three statistical tests is used to select the most appropriate link function for the data following the work of Hill and Miller (2010). P-values are reported for the Pregibon link test (Pregibon, 1980); the Pearson test and the Modified Hosmer-Lemeshow test. They each test whether the correlation coefficient between the prediction error and the fitted values on the raw scale equals zero. In addition, I use both Akaike and Bayesian Information Criteria (AIC and BIC) to inform my decision on the most appropriate model (Akaike, 1973; Schwarz, 1978). The information criteria are log-likelihood-based measures with differing degrees of freedom adjustments. They capture the trade-off between model fit (measured by maximum likelihood) and the principle of parsimony that favours a simple model, thus penalising model complexity. Smaller values of the AIC and BIC indicate a better model fit (Cameron & Trivedi, 2010).

While a GLM framework is a better approach to modelling mean healthcare costs, it suffers from the same drawback as OLS in that, it fails to account for the inherent endogeneity between health insurance and healthcare costs. Thus, estimated coefficients from such a model would be associate in nature only and would tell us nothing about the causal effect of the treatment (insurance status) on the outcome of interest (costs).

3.4.3.3 Matching Techniques

Matching provides a general approach to dealing with selection on observables (Jones, 2007b). It addresses the problem that in the observed data confounding factors may be non-randomly distributed over the treatment and control groups. Both propensity score matching and matching based on the Mahalanobis distance were used to account for observable heterogeneity in the relationship between health insurance status and healthcare costs. These techniques were discussed more fully earlier on in this chapter and will not be discussed here. For a more detailed understanding of these matching techniques, I refer the reader to Section 3.31 above.

3.4.3.4 Inverse Probability Weighting

Inverse probability weighting (IPW) was first devised by Rosenbaum (1987) as a form of model based direct adjustment. IPW uses weights based on the propensity score to create a sample in which the distribution of measured covariates is independent of treatment assignment. That is, it takes each observation and weights it by the inverse of the propensity score (Austin, 2011; Polsky & M., 2014). As we define Z_i to be an indicator variable denoting whether or not a subject was treated. Let e_i denote the propensity score for individual i. An individual's weight is defined as being equal to the inverse of the probability of that individual receiving the treatment such that;

$$w_i = \frac{z_i}{e_i} + \frac{(1 - z_i)}{1 - e_i}$$

Using weights as follows allows for the estimation of the ATT such that;

$$w_{i,ATT} = Z_i + \frac{(1 - Z_i)e_i}{1 - e_i}$$

The above approach has the advantage that it allows for observable heterogeneity between health insurance and healthcare cost. Not only that, it can be used together with our GLM specifications and so can be used to deal with the heterogeneity of cost data as well as the skewed nature of the distribution. A drawback of this approach is that coefficients are estimated at the mean of the cost distribution and tell us nothing about the full distribution of

costs.

3.4.3.5 Quantile Regression

The methods detailed above estimate costs at the mean of the distribution. In recent years a growing literature has emerged in techniques that go beyond the mean and produce estimates for the full distribution (Jones et al., 2015; Vanness & Mullahy, 2012). Analysis solely on the mean may miss potentially important information in other parts of the distribution (Bitler, Gelbach, & Hoynes, 2006) and it is precisely these other parts of the distribution that may be of interest to policymakers (Vanness & Mullahy, 2012). In the next section we detail one such approach to dealing with the tails of a distribution, which is the unconditional quantile regression (Firpo et al., 2009). This approach is applied for the analysis of the healthcare cost variable generated for the estimation sample.

3.4.3.5.1 Unconditional Quantile Regression (UQR)

Quantile conditional regression (QCR) was first introduced by Koenker and Bassett (1978) and is a robust semiparametric methodology for continuous response data that allows researchers to obtain estimates across different quantiles of the full distribution of the dependent variable. (Trivedi, 2014). Thus, it allows for response heterogeneity at different conditional quantiles along the distribution of an outcome (Borah & Basu, 2013). With the conditional quantile regression (CQR) approach the effect of an independent variable on a quantile of the outcome distribution is conditional on specific values of the other covariates.

A limitation of the conditional quantile regression (CQR) approach lies with the difficulty in interpretation of its estimates when effects for different conditional quantiles vary (Borah & Basu, 2013). As a result, estimated effects from the CQR are not always generalizable to the population and in a policy context. To overcome this problem of generalisability Firpo et al. (2009) propose a slightly different approach. They suggest an unconditional quantile regression (UQR) model based on the concepts of the influence function (IF) and the re-centred influence function (RIF) as used in the statistics literature by (Hampel et al., 1986). When the statistic of interest is a specific quantile τ of the outcome distribution then;

$$RIF(y; q_\tau) = q_\tau + \frac{\tau - I[Y \leq q_\tau]}{f_Y(q_\tau)}$$

Where q_τ refers to the τth quantile of the unconditional distribution of Y, $f_Y(q_\tau)$ is the probability density function of Y evaluated at q_τ and $I[Y \leq q_\tau]$ is an indicator variable to denote whether an outcome value is less than q_τ or not. After recalculation of the variables of interest in the above equation, the second step is to run an OLS regression of the $RIF(y; q_\tau)$ on the observed covariates. The UQR estimates are computed in STATA using the rifreg command. In terms of the research question being examined, while the unconditional quantile regression allows us to look beyond the mean cost of healthcare it does not account for endogeneity bias between health insurance and healthcare costs. Thus, the approach is unable to shed light on cause and effect between insurance status and costs.

3.5 Theoretical Analysis of Informal Care

In this section, I examine the theoretical underpinnings of the relationship between informal and formal care. As is the case outlined above for healthcare utilisation and costs, I theoretically conceptualise the role of health insurance in informal care in the context of the Andersen model. In this chapter, I also attempt to investigate the relationship between informal care and healthcare utilisation and costs. In terms of informal care provision, my hypothesis of the impact of informal care provision on a carer's propensity to use healthcare services is unclear. It could be that the provision of informal care is a disabling factor in an individual's propensity to use healthcare services (Shaw et al, 1997; Musich et al, 2017). That is, those who provide care to others are less likely to use healthcare services. This may be a result of the burden being placed on carers by the person for whom they are caring. It could be that they are simply too busy to avail of healthcare services or are prevented from doing so because of the needs of the person for whom they are caring. As a result, carers may neglect their own health and well-being; only availing of healthcare services when it is necessary (Ward-Griffin & McKeever, 2000). Conversely, a well-established body of literature suggests that caregiving can have substantial negative mental and physical effects (Coe & Van Houtven, 2009; Schmitz & Westphal. 2015; Do et al, 2015). These negative effects result in higher use of healthcare services on average due to the burden of care, in terms of time and effort, placed on them because of caring for an elderly family member or otherwise.

My hypothesis in terms of healthcare receipt is equally unclear. For example, it could be that informal care acts as a buffer for the formal healthcare system. That is, those in receipt of informal care are less likely to use healthcare services as the care they receive acts as a

substitute for formal healthcare services. It could be the care received in an informal care setting negates the necessity to seek care in the formal healthcare system. Conversely, informal care receipt may lead to higher levels of healthcare services utilisation in the formal setting. This could be because individuals are in greater health need or simply because they have better support network around them in terms of family and friends to ensure they access formal healthcare services more frequently. In the next section, the methodology used to collate references used throughout this thesis is outlined. The approach taken to identify relevant and appropriate references is set out and the process by which publications are identified and selected is explained.

3.6 Literature Review Methodology

This section outlines the methodological approach undertaken to identify relevant articles used throughout this thesis. A number of approaches were used during the course of the literature search, ranging for a simple *Google Scholar* search for relevant publications to a more systematic approach through search engines such as *Econlit* and *Medline*. In this section, I outline, in more detail, the steps taken during each approach and the rationale for doing so. I describe the procedures used to analyse these sources and introduce the criteria used to select the sources identified and used in this thesis.

To begin with, some core texts in the area of health economics were identified. These core texts included "*The Handbook of Economics, Volumes. I and II"*, "*The Oxford Handbook of Economics"* and "*The Elgar Companion to Health Economics"*. For these core texts, chapters that were considered relevant to the research topics of this thesis were identified. From here, the *Snowball method* was used to gather the most relevant papers on the topics of interest. This was done by going to the references of the relevant chapters identified from the core texts mentioned and selecting additional papers that were most relevant and appropriate to the research topics that this thesis seeks to address.

A second approach involved identifying peer-reviewed publications. As a first step in this process, I identified the highest impact factor journal associated with the areas of economics and health economics. The high impact journals identified included, among others, "*The American Economic Review"*; "*The Milbank Quarterly"*; "*Quarterly Journal of Economics"*; "*Journal of Political Economy"*; the "*New England Journal of Medicine"*; the "*Journal of Health Economics"*; and "*Health Economics"*. Relevant search terms within each journal

were used to identify the papers that were most relevant or appropriate for the research topic being addressed.

The third approach to the literature search involved assessing the services available through the James Hardiman Library at NUIG. The James Hardiman Library has access to a range of online databases across various subject areas. For the purposes of the literature review for this thesis, the online databases Econlit and Medline were used to identify relevant papers for the literature review. A variety of descriptive search terms was used within these publications to identify the most appropriate articles. These included terms such as *"healthcare" healthcare utilisation" "costs" healthcare costs" "informal care" "health insurance" "Irish" "Ireland"*. Boolean search operators such as "AND" "OR" and "NOT" were used to either expand or to refine a group of search terms. Resources were evaluated with the following criteria: (a) is the source relevant to the research question under investigation? (b) What journal is the paper coming from? (c) what are the credentials of the papers author and (d) how up to date is the paper? Seminar papers in an area of interest were included given their importance to a research topic. The initial resources were selected by reviewing the article abstracts and then determining if the paper chosen was relevant for the research question at hand. The final number of references included in the thesis was 302. All references used throughout the thesis were collated using the reference manager software package Endnote X7.

4. Health Economic Analysis of the Role of Health Insurance Status on Hospital and Community Care Service Utilisation and Costs among over 50s in Ireland

This chapter provides analysis of healthcare utilisation and cost patterns by older people in Republic of Ireland and explores how these patterns differ for those with different health insurance status. In particular, this chapter presents results from a series of multivariate regression analysis to explore associations between health insurance status and hospital and community care service utilisation and costs. The motivation for this analysis, as outlined in Chapter 1, arises predominantly from the changing policy context in Ireland and the importance of understanding patterns of healthcare utilisation and costs among older people to inform planning for future health needs.

4.1 Introduction

Equity of access to health care is regarded as a key objective of national and international health policy (Brown et al., 2013). Older people are more vulnerable to ill-health and thus require access to both a greater amount and to a wider range of health and social care services (World Health Organisation, 2015). Differences across individual abilities to access health care, through their insurance coverage status, be that public, private or both, is therefore fundamental to judging the equity of healthcare systems. In many instances, access to a general practitioner (GP) is crucial, as they act as a gatekeeper to hospital and community care services (Brekke, Nuscheler, & Straume, 2007; Jelovac, 2014; Malcomson, 2004; McGregor, McKee, & O'Neill, 2006; Scott, 2000). In other instances, the GP does not play a gatekeeping role and the individual accesses the service directly. In all cases, differences in health insurance coverage status, and the resulting differences in the costs incurred by individuals to access services, will impact upon healthcare utilisation. This is becoming increasingly important for ageing populations given their increased need for healthcare services relative to the general population.

Ireland is an interesting case study to examine the question of health insurance coverage and equity of access to healthcare services. As outlined in Chapter 1, the Irish system is built on a uniquely two-tiered structure of public and private provision of services. While all individuals in Ireland are publicly insured to access the public healthcare system, coverage for healthcare

services differ across the population, given differences in income, healthcare need and private health insurance (PHI) status. That is, individuals in Ireland can be categorised into four distinct insurance coverage categories: (1) public health insurance only (**Base**); (2) public health insurance plus a medical card (**MC**); (3) public health insurance plus private health insurance (**PHI**); and (4) public health insurance plus medical card plus private health insurance (**MC+PHI**). In the case of medical cards, those on low incomes, and those with certain conditions are entitled to visit a GP free of charge[14][15]. In the case of private health insurance, which plays a supplementary, complementary and duplicative role in the Irish healthcare system (OECD, 2017a; Thompson & Mossialos, 2009), individuals purchase further coverage in addition to their public coverage. The existence of such a multi-layered structure within the Irish system has given rise to concerns over inequities of access to healthcare services in Ireland. Furthermore, such concerns are heightened due to the role of the GP in Ireland, in that they act as a gatekeeper to hospital and community care services (Madden, Nolan, & Nolan, 2005).

Notably, and as discussed in Chapter 1, proposed health policy reform in Ireland centres on the objective of a more universal healthcare system that seeks to equalise the opportunity for all to access healthcare services and healthcare technologies (Burke et al., 2018). As such, it is timely to consider the role of the existing health insurance coverage arrangements for older people. As outlined in the next section, a large body of empirical work has examined such questions for the Irish healthcare system, primarily by examining the role of health insurance coverage on the utilisation of primary healthcare services for the general population and subgroups of the population including older people. However, little research has concentrated on the impact of health insurance coverage status on the utilisation and costs of hospital and community care services in Ireland. This is particularly important for older individuals who may require greater access to a wide range of healthcare services, not just primary care, but also inpatient, outpatient and community care services. It follows that inequality in access to such services may have detrimental effects on the health and well-being of older individuals in society.

[14] Individuals living alone aged under 66 who earn less than €9,568 annually or a couple with two children aged under 16 who earned less than €17,810 annually are entitled to a medical card. Income cut-offs are slightly higher for those aged 66-69. The income limit for over 70s to be eligible for a medical card is €26,000 for a single person and €46,800 for couples (www.citizensinformation.ie).

[15] The Health Act (1970), as amended, states that a person is eligible for a discretionary medical card if "considered by the chief executive officer of the appropriate health board to be unable, without undue hardship, to provide that service for himself or his dependants ((Health Service Executive, 2014).

In the context of this institutional, policy and research environment, this chapter builds upon the existing evidence base by exploring associations between health insurance coverage status and utilisation of a range of hospital and community healthcare services amongst older people in Ireland. The chapter also analyses the impact of health insurance status on primary care and hospital costs. As outlined in Chapter 2, a dataset of people aged 50 and over from the first wave of TILDA is used to estimate a series of regression models to examine associations' health insurance status and healthcare services utilisation and costs, controlling for a range of other demographic, socioeconomic, and health-related characteristics. In addition, given concerns relating to endogeneity and unobservable heterogeneity arising from the cross sectional nature of the analysis, additional techniques are employed as robustness checks.

4.2 Health Economic Analysis of Healthcare Utilisation

This section examines the application of theoretical and empirical methods to explore questions relating to healthcare utilisation. This is followed by a more detailed discussion of the empirical literature for Ireland and internationally.

4.2.1 Theoretical Analysis of Healthcare Utilisation

To inform the empirical analysis described in this chapter, it is first necessary to consider the theoretical underpinnings of the behaviours informing the utilisation of health and social care services. As outlined in Chapter 1, the theoretical analysis of healthcare utilisation is heavily influenced by the work of Arrow (1963) and Grossman (1972). Building on this work, the key theoretical model adopted for this analysis is the Andersen Behavioural Model (Andersen, 1968, 1995; Andersen & Newman, 1973). The Andersen framework was initially developed in the late 1960s to assist the understanding of health service utilisation; to define and assist in developing policies to promote equitable access to healthcare services (Andersen, 1968, 1995). The model sought to predict and explain the factors that influenced an individual's propensity to use healthcare services. As stated in Chapter 1, the model suggests healthcare services utilisation is a function of a range of predisposing, enabling and need factors. According to the model, predisposing characteristics include demographic factors such as age and gender; enabling or social structure factors including education, occupation and ethnicity and healthcare need variables relate to an individual's level of illness either perceived (via an individual's disability or diagnosis) or evaluated (Andersen, 1995; Andersen & Newman, 1973). In the analysis that follows, the role of health insurance status, which is categorised as

an enabling factor, in determining the utilisation of hospital and community services is presented and discussed. The theoretical framework would suggest that those with higher levels of health insurance coverage are enabled to access and use greater levels of healthcare services.

4.2.2 Empirical Analysis of Healthcare Utilisation and Costs

To inform the empirical analysis described in this chapter, it is also necessary to consider the existing empirical evidence on the utilisation and costs of healthcare services. In this section, a review of the existing evidence, both nationally and internationally is presented.

4.2.2.1 International Evidence

The relationship between insurance and healthcare utilisation is well developed. A large literature has developed around the issue of identifying the impact of insurance on healthcare utilisation. Identifying the effect of health insurance on utilisation (termed the 'moral hazard' effect) (Pauly, 1968) is complicated by the potential existence of adverse selection, i.e. the purchasing of insurance in anticipation of above-average consumption (Cutler & Zerkhauser, 2000). In order to identify the casual effects of health insurance on healthcare utilisation we would ideally need to conduct a randomised controlled trial (RCT) or natural experiment, which divides individuals in the trial into a control group and a treatment group. Due to the high costs, not to mention the ethical issues involved in conducted such experiments are rare. To date, only three randomised evaluations of health insurance coverage have been conducted. The RAND Health Insurance Experiment (Keeler, 1992; Manning et al., 1987) was the first RCT of its kind to be carried out in the United States. The experiment was carried out in six sites across four different states between 1974 and 1977. Families participating in the experiment were randomly assigned to one of 14 different insurance plans that differed in the degree of cost sharing on utilisation and health outcomes. It found that individuals randomly assigned to a plan with full coverage had 37% more physician visits than those facing a co-insurance rate of 25% and 50% more visits than those facing a 50% co-insurance rate.

Studies that are more recent have taken advantage of policy changes and health system reforms to conduct nature experiments (sometimes-called quasi-experiments) in order to identify causality. The Oregon Health Insurance Experiment (OHIE) used a randomised controlled design to examine the effects of expanding access to public health insurance on healthcare utilisation in the state of Oregon. As part of the experiment, a group of uninsured

low-income adults was selected via a lottery system to be given the chance to apply for Medicaid. The study found that, in the year after random assignment, the treatment group selected by the lottery had substantially and statistically significantly higher healthcare utilisation (Finkelstein et al., 2012). The OHIE has spawned much research elsewhere (Baicker et al., 2013; Finkelstein et al., 2012; Finkelstein et al., 2016; Taubman et al., 2014). The 2007-2009 Accelerated Benefits Demonstration Project randomly assigned public health insurance to about 1,000 uninsured adults on Social Security Disability Insurance during their 2-year waiting period for Medicare (Michalopoulos et al., 2011). Individuals were randomly assigned into one of 3 groups – (1) the Accelerated Benefits (AB) group, which had access to healthcare benefits designed as part of the project; (2) the AB *Plus* group, which had access to the same healthcare benefits, as well as voluntary services delivered by telephone to help them navigate the healthcare system and return to work; and (3) a control group which could not receive AB benefits or AB *Plus* services but who could obtain insurance on their own right. The study found that those in receipt of AB benefit or AB *Plus* services used more healthcare services. In addition, AB healthcare benefits reduced reported unmet medical needs.

In the absence of such quasi-experimental approaches, strategies for separately identifying the moral hazard effect of insurance from other potential explanations (such as adverse selection or supplier-induced demand) depend largely on the data available for the researcher. Despite the methodological difficulties and in spite of differences in time periods, country contexts, data sources, methods, and type of healthcare utilisation, the findings on the effect of insurance are largely unambiguous; insurance, by lowering the cost of care, leads to an increase in healthcare utilisation and costs (Anderson, Dobkin, & Gross, 2012; Bago d'Uva, 2006; Cameron et al., 1988; Card, Dobkin, & Maestas, 2008; Finkelstein et al., 2012; Holly et al., 1998; Hullegie & Klein, 2010; Nilsson & Paul, 2018; Olsen & Melberg, 2018; Sarma & Simpson, 2006; Shigeoka, 2014; Waters, 1999). Recent studies from the US have examined the effect of the introduction the Affordable Care Act (ACA) on healthcare utilisation (Miller & Wherry, 2017; Wherry & Miller, 2016). Other studies have estimated the effect of insurance status on particular healthcare services (Lambregts & van Vliet, 2018; Sabik & Gandhi, 2016; Taubman et al., 2014) and on particular disease areas (Andersen, 2018). In addition, a number of studies have specifically examined the impact of health insurance on utilisation by older people (Biro, 2014; Chen et al., 2007; Fernández-Olano et al., 2006; Hurd & McGarry, 1997).

4.2.2.2 Irish Evidence

In the Irish context, much of the previous research has concentrated on the impact of insurance status on the utilisation of GP services. The research findings are clear and consistent; those with full medical or GP visit cards have a significantly higher number of GP visits, even after controlling for health need (Layte & Nolan, 2014a, 2014b; Layte et al., 2009; Layte & Nolan, 2004; Ma & Nolan, 2017; Madden et al., 2005; Nolan & Nolan, 2008; Nolan & Smith, 2012; Nolan, 1993). Layte et al. (2009) examined the impact of the 2001 policy change that extended full medical card eligibility to all those over 70 years of age, regardless of income. From the 1st of January 2009, means testing for medical card eligibility was re-introduced for the over 70s, although with considerably higher income thresholds than those that apply to the under 70s (Government of Ireland, 2008). They found, contrary to expectations, that there was no significant increase in either the probability or frequency of GP visiting among the over 70s after the policy change. (Nolan & Nolan, 2008) examined the determinants of GP visiting patterns, in particular the role of eligibility for free GP care using data from the 2001 Living in Ireland survey. Their results showed that health status and medical card eligibility were consistently the most important factors in explaining differences in GP visiting patterns.

More recently (Hudson & Nolan, 2015) looked at the impact of public healthcare eligibility on GP utilisation for the older population. Their results are consistent with previous research that suggests that eligibility is positively and significantly associated with GP utilisation. Ma and Nolan (2017), also analysing data from TILDA, employed difference-in-difference propensity score matching methods, and found significant effectso f changes in public healthcare entitlements on GP utilisation (i.e. introducing user fees reduces utilisation, while removingthem increases utilisation). Nolan & Layte (2017), using the same methodology use data from the first two waves of the Growing Up in Ireland (GUI) survey to examine transitions in insurance coverage on GP utilisation among children. They find significant effects of changes in public health insurance coverage on GP utilisation (i.e. introducting user fees reduced utilisation while removing them increased utilisation). Walsh et al; (2019) used a difference-in-differences approach, to examine whether the expansion of free GP care to all children under the age of 6, impacted demand for A&E services. they found that the policy change did not reduce the utilisation of A&E services among the age cohort examined. Following the introduction of free GP care for those under 6 and over 70 years of age in 2015, Connolly et al; (2018) investigated the potential costs implications of a universal role out of free GP care for the entire population. Their analysis found that the cost of the reform would add between 2 and 3.5% to overall public healthcare expenditure and up to 1.2% to total healthcare expenditure.

In the context of systems with largely free or heavily subsidised access to public healthcare services, a related strand of the international literature has focused on the identification of horizontal inequities in healthcare utilisation, i.e. differences in utilisation that are not related to the need for care (Bago d'Uva, Jones, & van Doorslaer, 2009; Gerdtham, 1997; Morris, Sutton, & Gravelle, 2005; Sutton, 2002; Van Ourti, 2004). A number of cross-country comparative analyses of income-related inequity in the utilisation of healthcare services among the adult population have been carried out, with Ireland as one of the featured countries (van Doorslaer et al., 2006; van Doorslaer et al., 2000). A number of studies have examined inequalities in the utilisation of healthcare services specifically for older people (Allin & Hurley, 2009; Allin, Masseria, & Mossialos, 2010; Crespo-Cebada & Urbanos-Garrido, 2012; Terraneo, 2015). The most recent analysis of income-related inequity in the delivery of healthcare services in Ireland (using data on adults aged 18+ years from 2000) found a significant 'pro-poor' distribution in expenditure on GP services in Ireland (and also for prescription medicines) (Layte & Nolan, 2004). In contrast to the Irish evidence, the evidence for other countries is more mixed (Allin et al., 2010).

To date, research on the impact of different healthcare financing systems on healthcare utilisation and equity in utilisation has largely concentrated on the total adult population and there has been little research concentrating solely on the older population. This is despite improving trends in life expectancy and the increasing proportion of the overall population in the older age brackets, not to mention the fact that the older population are the heaviest users of healthcare. In addition, different factors may be more important in determining healthcare utilisation among the older population e.g. non-financial barriers to access; limitations in mobility, insufficient social support and reduced access to health and healthcare information. (Chen et al., 2007) examined the impact of an extension in public health insurance to the full population in Taiwan in 1995, focusing on the effect on those aged over 60 years of age. They found that while enhanced access to public health insurance had significant effects on access to healthcare, no significant impact on health status was detected. However, the follow-up period was just four years, potentially too short to identify significant long-run effects on health. Taken together, the above theoretical and empirical evidence goes to inform the analysis presented below. In particular, there is a number of gaps in the literature that need to be addressed. That is, the role of health insurance status on community care services is not well understood. As a result, the analysis below attempts to address this gap in the literature.

4.3 Methodology

This section briefly outlines the methodological approach adopted to explore the research questions of interest – see Chapter 3 for more detailed discussion on methodology.

4.3.1 Data

As outlined in Chapter 2, data from wave 1 of TILDA was used for the analysis. The estimation sample is that for which imputed income for individuals who had no data for that variable in the dataset was generated. The independent variables controlled for include a range of socio-demographic and health related variables, as well as health insurance status, which is the main variable of interest. More information on the independent variables is described in Section 2.2.2 and 2.2.3, and descriptive statistics on the insurance categories by healthcare utilisation and healthcare costs are presented in Sections 2.3.2 and 2.2.3.

4.3.2 Empirical Strategy

The objective of the analysis is to examine associations between health insurance status and hospital and community care utilisation and primary and hospital costs. As detailed above, and in common with other applied studies of healthcare utilisation, we assume the theoretical framework proposed by the Andersen Behavioural Model (Andersen, 1968, 1995; Andersen & Newman, 1973) to inform the methodological approach adopted in our analysis. In this section, we briefly discuss the methodological challenges that exist when attempting to estimate the relationship between health insurance and healthcare utilisation and costs. The various estimation methods that have been used in the literature are briefly outlined – for a more detailed account see Chapter 3.

There are a number of challenges to estimating the relationship between health insurance and healthcare utilisation and costs. The challenge is made all the more difficult when analysing this relationship using cross-sectional data. In estimating this relationship, we would ideally wish to estimate the outcome (utilisation/costs) with and without a treatment (i.e. health insurance). However, when using cross-sectional data we cannot measure the counterfactual. Because we can never estimate this 'pure' treatment effect, we must instead concentrate on estimating an 'average treatment effect' (ATE) by comparing the average outcome among those receiving the treatment with the average outcome among those who do not receive the treatment (Jones, 2007a). A further problem for statistical inference of insurance status on average total healthcare costs is that of self-selection into the treatment group (Jones, 2007a).

For example, those with insurance may be older and have higher household income levels than those without insurance. This self-selection into the treatment group will lead to biased estimates of the treatment effect. Given the concerns outlined above, a pragmatic strategy to model choice involving a series of approaches was adopted to address the research questions of interest.

In estimating the treatment effect of health insurance on healthcare utilisation this chapter uses selection on observables approaches (Jones, 2007a) to account for the inherent endogeneity in the relationship between health insurance and healthcare utilisation. These selection on observable approaches take the form of matching techniques such as propensity score matching and matching based on the Mahalanobis distance. These approaches are formally considered in Chapter 3, section 3.3. There are a number of methodological challenges too in attempting to estimate healthcare costs. While OLS has many desirable qualities for econometric analysis, because of their distributional nature, healthcare cost data often violate the assumptions underlying OLS meaning more sophisticated econometric models need to be applied. Thus, this chapter incorporates generalised linear models to estimate total mean healthcare costs (Blough et al., 1999; Buntin & Zaslavsky, 2004; Manning, 2012, 2014; Manning et al., 2005; Manning & Mullahy, 2001). In order to account for endogeneity in the relationship between health insurance status and healthcare costs, inverse probability weighting is used together with generalised linear estimation. As a sensitivity analysis, the analysis that follows, allows for a range of different families of distribution (including gamma, Poisson, Gaussian and inverse Gaussian) and link functions (identity, log and power) to investigate which specification worked best for estimating health care costs based on the data used. For a more detailed overview of these methods, the reader should refer back to Chapter 3, section 3.4.3.2.1.

The methods detailed above estimate costs at the mean of the distribution. Analysis solely on the mean may miss potentially important information in other parts of the distribution (Bitler, Gelbach, & Hoynes, 2006). In recent years a growing literature has emerged in techniques that go beyond the mean and produce estimates for the full distribution (Jones et al., 2015; Vanness & Mullahy, 2012). One such approach to dealing with the full distribution is the unconditional quantile regression (Firpo et al., 2009). This chapter incorporates this sophisticated econometric technique to estimate the relationship between health insurance status and healthcare costs across the entire distribution. Again, a more formal discussion of unconditional quantile regression is detailed in Chapter 3, section 3.4.3.5.

4.4 Results

This section presents the empirical results from the analysis. The results of the matching process outlined above are presented. The methodological approaches adopted explicitly attempted to identify the most appropriate empirical models for the cross-sectional data analysed. A series of multivariate regression models were estimated to explore associations between health insurance status and healthcare utilisation and costs. For purposes of brevity, only the results from the preferred model specifications are presented below for each of the healthcare services categories of interest. For information and prior to the presentation of the main results, Table 4.1 summarises the findings for each of the healthcare services considered in the analysis.

Table 4.1 Summary of Expanded Health Insurance Coverage

Hospital Services	**Summary Findings**
Inpatient Services	Positive and statistically significant relationship
A&E Services	Positive but statistically insignificant relationship
Outpatient Services	Positive and statistically significant relationship

Community Services	**Summary Findings**
Public Healthcare Nurse Services	Positive and statistically significant relationship
Occupational Therapy Services	Positive and statistically significant relationship
Chiropody Services	Positive and statistically significant relationship
Physiotherapy Services	Positive and statistically significant relationship
Home Help Services	Positive and statistically significant relationship
Optician Services	Positive and statistically significant relationship
Dental Services	Positive and statistically significant relationship (negative and statistically significant relationship on PHI
Hearing Services	Positive and statistically significant relationship
Dietician Services	Positive but statistically insignificant relationship
Social Work Services	No estimates generated
Physiological/Counselling Services	Positive but statistically insignificant relationship
Personal Attendant Services	No estimates generated
Meals-on-Wheels	No estimates generated
Daycentre Services	Positive but statistically insignificant relationship
Respite Services	No estimates generated

4.4.1 Observed matching characteristics

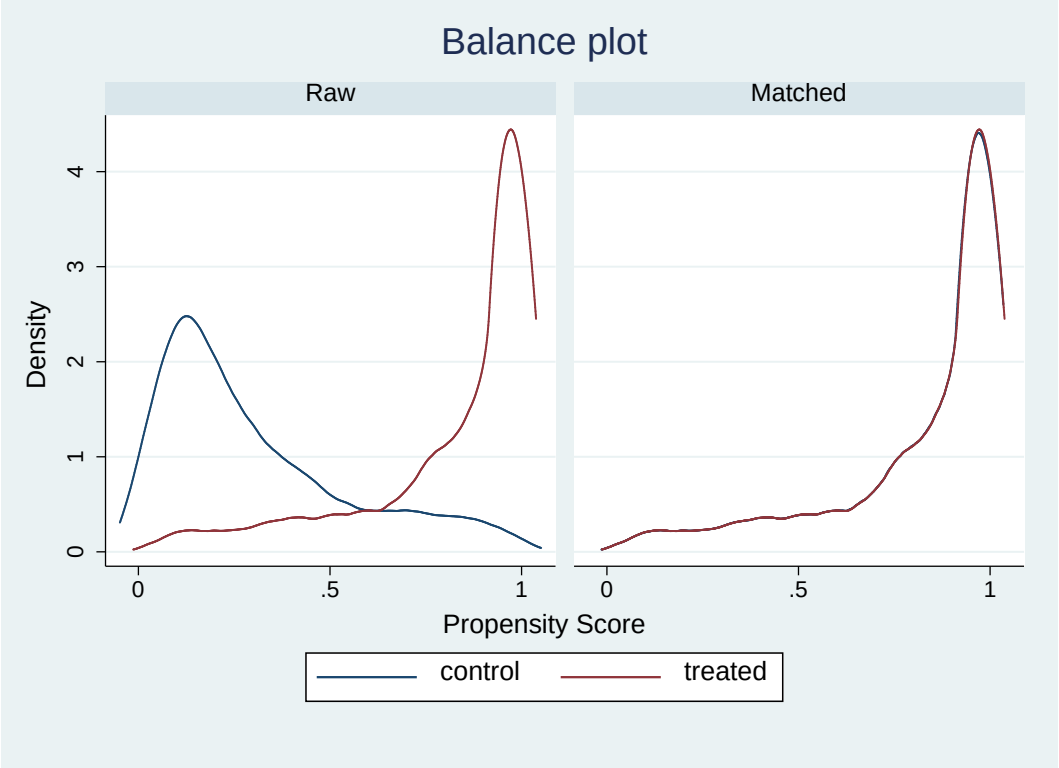
Table 4.2 below presents the matching covariates for both the treated and control groups, before and after matching. The table includes mean values for each of the independent variables for both the treated and control groups, both before and after matching. The table also includes the standardised difference estimates for each independent variables before and after matching. The standardised difference assesses the extent to which the characteristics of both the treated and control group differ (Austin, 2009). Looking at the unmatched covariates, we see that the two groups differ quite substantially, with respect to age categories, gender, employment status and chronic disease prevalence. As can be seen from the table, the standardised difference before matching is considerably higher than that after matching suggesting that both the treatment and control group are much similar in terms of their observable characteristics after matching. Overall, the unmatched sample demonstrates that the treated group are older, have poorer self-reported health and have a greater number of chronic illnesses. In terms of the propensity for being in the treated group, the imbalance in the distributions of the propensity scores that exists before matching is eliminated after matching. As Figure 3.1 below shows, the distributions of the propensity scores of both the treated and control group after matching are virtually identical.

Table 4.2 Observed Matching Characteristics

	Before Matching			After Matching		
	Treated	**Control**		**Treated**	**Control**	
	Mean	**Mean**	**Standardised Difference**	**Mean**	**Mean**	**Standardised Difference**
Independent Variables						
55-64	0.303	0.491	-0.391	0.303	0.306	-0.007
65-74	0.294	0.148	0.355	0.294	0.299	-0.011
75-84	0.217	0.008	0.699	0.217	0.237	-0.049
85+	0.057	0.001	0.337	0.057	0.028	0.141
Male	0.428	0.527	-0.199	0.428	0.535	-0.215
Married	0.530	0.762	-0.500	0.530	0.575	-0.090
Second level – Inter Cert	0.231	0.311	-0.181	0.231	0.174	0.142
Second level – leaving Cert	0.100	0.165	-0.192	0.100	0.110	-0.034
Diploma/Certificate	0.069	0.152	-0267	0.069	0.054	0.061
Degree	0.018	0.056	-0.201	0.018	0.012	0.051
Postgraduate Degree	0.012	0.023	-0.085	0.012	0.010	0.015
Retired	0.445	0.129	0.744	0.445	0.495	-0.101
Other	0.411	0.255	0.336	0.411	0.363	0.100
Other town or city	0.301	0.247	0.122	0.301	0.253	0.109
Rural area	0.542	0.517	0.052	0.542	0.595	-0.107
Irish	0.889	0.875	0.042	0.889	0.892	-0.011
Living with spouse	0.349	0.306	0.090	0.349	0.342	0.015
Living with others	0.324	0.539	-0.445	0.324	0.308	0.034
€20k-<€40k	0.367	0.416	-0.100	0.367	0.389	-0.045
€40k-<€60k	0.052	0.230	-0.531	0.052	0.058	-0.027
€60k-<€80k	0.006	0.075	-0.356	0.006	0.005	0.016
€80k-<€100k	0.003	0.015	-0.135	0.003	0.001	0.035
€100k	0.003	0.006	-0.036	0.003	0.021	-0.161
Angina	0.092	0.018	0.330	0.092	0.101	-0.030
Myocardial Infarction	0.072	0.020	0.249	0.072	0.085	-0.049
Congestive Heart Failure	0.015	0.006	0.089	0.015	0.005	0.101
Diabetes	0.109	0.052	0.208	0.109	0.082	0.092
Stroke	0.027	0.004	0.190	0.027	0.022	0.027
Chronic lung disease	0.062	0.030	0.156	0.062	0.070	-0.029
Asthma	0.110	0.074	0.128	0.110	0.101	0.031

	Before Matching			After Matching		
	Treated	**Control**		**Treated**	**Control**	
	Mean	**Mean**	**Standardised Difference**	**Mean**	**Mean**	**Standardised Difference**
Arthritis	0.342	0.176	0.386	0.342	0.330	0.024
Osteoporosis	0.102	0.045	0.219	0.102	0.048	0.207
Cancer	0.072	0.026	0.212	0.072	0.048	0.099
Emotional/psychiatric problems	0.098	0.065	0.119	0.098	0.129	-0.010
Alcohol substance abuse	0.023	0.012	0.088	0.023	0.015	0.059
Anxiety	0.054	0.042	0.058	0.054	0.048	0.028
Depression	0.066	0.034	0.146	0.066	0.102	-0.128
Pain	0.422	0.327	0.199	0.422	0.367	0.114
Long-term illness	0.137	0.119	0.055	0.137	0.077	0.197
Limiting long-term illness	0.336	0.167	0.396	0.336	0.322	0.029
IADL disability only	0.062	0.029	0.163	0.062	0.057	0.023
ADL disability only	0.067	0.033	0.156	0.067	0.057	0.041
IADL & ADL disability	0.073	0.013	0.299	0.073	0.071	0.009
One chronic illness	0.245	0.318	-0.164	0.245	0.386	-0.308
Two chronic illnesses	0.240	0.191	0.118	0.240	0.126	0.298
Three or more chronic illnesses	0.349	0.122	0.554	0.349	0.327	0.046
Very good health	0.211	0.298	-0.201	0.211	0.351	-0.315
Good health	0.337	0.348	-0.023	0.337	0.297	0.086
Fair health	0.278	0.162	0.284	0.278	0.198	0.188
Poor health	0.095	0.03	0.273	0.095	0.101	-0.019

Figure 4.1 Balance Plot Depicting Matching and Unmatched Samples



4.4.2 Hospital Services Utilisation

The results from the analyses for hospital services utilisation are presented in Table 4.3 and are described below. Results are presented for the propensity score matching and Mahalanobis matching analyses. The use of these matching approaches allows us to estimate associations between health insurance status and hospital services utilisation. In all cases, the impact of health insurance status on hospital inpatient utilisation, is presented for each health insurance category (i.e. MC; PHI, MC+PHI) relative to the base-category of public health insurance only (Base). For each of the healthcare services analysed, results are presented in terms of partial effects.

4.4.2.1 Inpatient Hospital Admissions

The results for the empirical analysis of inpatient admissions are presented in Table 4.3. Such a matching approach estimates associations between health insurance status and hospital services utilisation. The results from both approaches were generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of hospital inpatient utilisation. Nonetheless, there were some differences in estimated coefficients and statistical significance.

More specifically the propensity score matching approach estimates that relative to the base category, the probability of hospital inpatient utilisation is 9.8 percentage points higher for those with MC; 3.82 percentage points higher for those with PHI; and is 14.5 percentage points higher for those with MC+PHI. In addition, this approach allows for the estimation of the impact of having either MC or PHI or both MC and PHI; that is, any form of additional health insurance coverage. The results indicate that relative to the base category, those in the category of either MC or PHI or both MC and PHI were 9.73 percentage points more likely to use hospital inpatient services.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of hospital inpatient utilisation is 9.94 percentage points higher for those with MC; 7 percentage points higher for those with PHI; and is 12 percentage points higher for those with MC+PHI. In addition, the results indicate, that relative to the base category, those in the category of either MC or PHI or both MC and PHI were 8.64 percentage points more likely to use hospital inpatient services. Each of the estimated coefficients are significant at the 1% level. Taken together, the results presented above, suggest a positive and statistically significant association between health insurance coverage and hospital inpatient utilisation.

4.4.2.2 Hospital Accident and Emergency (A&E) Admissions

The results for A&E admissions based on the propensity score and matching analyses based on the Mahalanobis distance are presented in Table 4.3. The results for both approaches were generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of hospital A&E utilisation. More specifically the propensity score matching approach estimates that relative to the base category, the probability of hospital A&E utilisation is 6.56 percentage points higher for those with MC; 4.73 percentage points higher for those with PHI; and 4.68 percentage points higher for those with MC+PHI. In addition, this approach allows for the estimation of the impact of having either MC or PHI or both MC and PHI; that is, any form of additional health insurance coverage. The results indicate that relative to the base category, those in the category of either MC or PHI or both MC and PHI were 4.97 percentage points more likely to use A&E services.

The results from the matching approach based on the Mahalanobis distance indicate a statistically significant association between health insurance coverage and A&E utilisation

compared to the base case of public health insurance. Taken together, the results suggest a positive and statistically significant association between health insurance status and A&E services utilisation.

4.4.2.3 Hospital Outpatient Admissions

The results for the empirical analysis of outpatient admissions are presented in Table 4.3. The results for both propensity score matching and matching based on the Mahalanobis distance, analyses are again mixed. Compared to the base case of public health insurance, having health insurance coverage is associated with a statistically significant higher probability of hospital outpatient utilisation. Nonetheless, there were some differences in estimated coefficients and statistical significance. More specifically the propensity score matching approach estimates that relative to the base category, the probability of hospital outpatient utilisation is 6.42 percentage points higher for those with MC; 7.12 percentage points higher for those with PHI; and is 12.2 percentage points higher for those with MC+PHI. It is worth noting however, that the estimates for MC and MC+PHI are not statistically significant. Once again, we also estimate the impact of having either MC or PHI or both MC and PHI; that is, any form of additional health insurance coverage. The results indicate that relative to the base category, those in the category of either MC or PHI or both MC and PHI were 6.95 percentage points more likely to use hospital outpatient services and this result is significant at a 1% level.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of hospital outpatient utilisation is 13.4 percentage points higher for those with MC; 12.1 percentage points higher for those with PHI; and almost 17 percentage points higher for those with MC+PHI. In addition, the results indicate, that relative to the base category, those in the category of either MC or PHI or both MC and PHI were 12.5 percentage points more likely to use hospital outpatient services. Each of the estimates from the matching approach based on the Mahalanobis distance were statistically significant.

Table 4.3 Average treatment effects on the treated of health insurance status on hospital care services utilisation

Healthcare Service	Model	MC	PHI	MC+PHI	Either MC or PHI
Hospital Care					
Inpatient Services					
	OLS	0.0577***	0.0405***	0.0926***	0.0484***
	PSM 1:1	0.0980***	0.0382	0.145***	0.0973***
	NN (Base) Matching	0.0994***	0.0700***	0.120***	0.0864***
A&E Services					
	OLS	0.0105	-0.00293	0.0172	0.00431
	PSM 1:1	0.0656***	0.0473**	0.0468	0.0497***
	NN (Base) Matching	0.0492*	0.0305**	0.0492**	0.0307*
Outpatient Services					
	OLS	0.0487**	0.0468**	0.0692**	0.0449***
	PSM 1:1	0.0642	0.0712**	0.122	0.0695***
	NN (Base) Matching	0.134***	0.121***	0.169***	0.125***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

4.4.3 Community Services Utilisation

The results from the analyses for community services utilisation are presented in Table 4.4- and are described below. For each of the community care services analysed we two different matching techniques to estimate associations between health insurance status and service utilisation. In all cases, the impact of health insurance status on community care service utilisation, is presented for each health insurance category (i.e. MC; PHI, MC+PHI) relative to the base-category of public health insurance only (Base). For each of the healthcare services analysed, results are presented in terms of partial effects.

4.4.3.1 Public Healthcare Nurse Services

The results for the empirical analysis of public healthcare nurse services are presented in Table 4.4. The results for both matching approaches are generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of public healthcare nurse utilisation. The exception here being for those with PHI coverage only where the effect is not significant.

More specifically the propensity score matching approach estimates that relative to the base category, the probability of public healthcare nurse utilisation is 7.58 percentage points higher for those with MC; and 4.89 percentage points higher for those with MC+PHI. While the direction of the effect for those with a PHI is negative, the magnitude of the effect is minimal and insignificant. The approach also allows for the estimation of the impact of having either MC or PHI or both MC and PHI; that is, any form of additional health insurance coverage. The results indicate that relative to the base category, those in the category of either MC or PHI or both MC and PHI are 4.05 percentage points more likely to use public healthcare nurse services.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of using public healthcare nurse services is 8.8 percentage points higher for those with MC; and 7.51 percentage points higher for those with MC+PHI. After accounting for observable endogeneity in insurance for those with PHI, I find only a slight significant association (at the 10%). Relative to the base category, those in the category of either MC or PHI or both MC and PHI are almost 4 percentage points more likely to use public healthcare nurse services. In summary, the association between health insurance status and public healthcare nurse service utilisation is positive with the exception of those

with PHI. For this group, there is no statistically significant effect on utilisation.

4.4.3.2 Occupational Therapy Services

The results for the propensity score matching and matching analyses based on the Mahalanobis distance are presented in Table 4.4. The results for both approaches are mixed. The estimates are generally positive and indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of occupational therapy utilisation. Nonetheless, there were some differences in estimated coefficients and statistical significance. I find that the propensity score matching (PSM) estimates predict a negative but non-significant relationship between those with a medical and a positive and non-significant association between those with either a MC or PHI and the probability of using occupational therapy services. More specifically the propensity score matching approach estimates that relative to the base category, the probability of occupational therapy utilisation is 0.34 percentage points higher for those with PHI. The result is significant at the 5% level of significance. For each of the other insurance categories, relative to the base case of public health insurance (Base) the probability of using occupational therapy services is statistically insignificant.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of using occupational therapy services is 1.89 percentage points higher for those with MC; 0.28 percentage points higher for those with PHI and 1.82 percentage points higher for those with MC+PHI. Relative to the base category, those in the category of either MC or PHI or both MC and PHI are just over 1 percentage point more likely to use occupational therapy services. To sum up, the estimates suggest that the association between health insurance status and occupational therapy service utilisation is positive but results are mixed.

4.4.3.3 Chiropody Services

The results on the analysis of chiropody services are also presented in Table 4.4-. The results for both matching approaches are consistent and suggest a statistically significant and positive association between health insurance coverage and chiropody services utilisation. More specifically, the propensity score matching approach estimates that relative to the base category, the probability of chiropody service utilisation is 6.3 percentage points higher for those with MC and 8.4 percentage points higher for those with MC+PHI. Once again, I also

estimate the impact of having either MC or PHI or both MC and PHI; that is, any form of additional health insurance coverage. The results indicate that relative to the base category, those in the category of either MC or PHI are 3.3 percentage points more likely to use chiropody services. The estimate for PHI is negative but statistically insignificant.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of chiropody service utilisation is 6.3 percentage points higher for those with MC and 7.3 percentage points higher for those with MC+PHI. In addition, the results indicate, that relative to the base category, those in the category of either MC or PHI or both MC and PHI are 3.8 percentage points more likely to use chiropody services. Each of the estimates from the matching approach based on the Mahalanobis distance were statistically significant with the exception of those with PHI.

Table 4.4 Average treatment effects on the treated of health insurance status on community care services utilisation

Healthcare Service	Model	MC	PHI	MC+PHI	Either MC or PHI
Community Care					
Public Healthcare Nurse Services					
	OLS	0.0175**	-0.000784	0.0175	0.0142***
	PSM 1:1	0.0758***	0.000305	0.0489***	0.0405***
	NN (Base) Matching	0.0880***	0.00429*	0.0751***	0.0463***
Occupational Therapy Services					
	OLS	0.00901*	0.00142	0.00702	0.00504*
	PSM 1:1	-0.0208	0.00336**	0.0163	-0.00687
	NN (Base) Matching	0.0189***	0.00275**	0.0182***	0.0118***
Chiropody Services					
	OLS	0.0192*	-0.000473	0.0252***	0.0115***
	PSM 1:1	0.0627***	-0.00397	0.0837***	0.0387***
	NN (Base) Matching	0.0631***	0.00429	0.0729***	0.0383***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

4.4.3.4 Physiotherapy Services

The results for the empirical analysis of physiotherapy services are presented in Table 4.5. The results for both propensity score matching and matching based on the Mahalanobis distance, analyses are generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of physiotherapy services utilisation. Nonetheless, there were some differences in estimated coefficients and statistical significance. More specifically the propensity score matching approach estimates that relative to the base category, the probability of physiotherapy services utilisation is 2.42 percentage point lower for those with MC; 0.7 percentage points lower for those with PHI; and 2.13 percentage points higher for those with MC+PHI. In addition, relative to the base category, those in the category of either MC or PHI or both MC and PHI are 1.72 percentage points more likely to use physiotherapy services. It should be noted that the estimated coefficients are statistically significant only for those who have any form of health insurance relative to the base case of public health insurance (Base).

The results from the matching approach based on the Mahalanobis distance are; with the exception of those with PHI all statistically significant. They indicate that relative to the base category, the probability of physiotherapy services utilisation is 4.7 percentage points higher for those with MC; and 4.38 percentage points higher for those with MC+PHI. In addition, the results indicate, that relative to the base category, those in the category of either MC or PHI or both MC and PHI are 2.85 percentage points more likely to use physiotherapy services. Taken together, the results presented above, suggest a positive and statistically significant association between health insurance coverage and physiotherapy services utilisation.

4.4.3.5 Home Help Services

The results for the propensity score matching and matching analyses based on the Mahalanobis distance are presented in Table 4.5 and are generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of home help services utilisation. Nonetheless, there were some differences in estimated coefficients and statistical significance. More specifically the propensity score matching approach estimates that relative to the base category, the probability of home help services utilisation is 5.7 percentage points higher for those with MC; 0.4 percentage points higher for those with PHI; and 4.4 percentage points higher for those with MC+PHI. In addition, relative to the base category, those in the category of either MC or PHI or both MC and PHI are 3.1 percentage points more likely to use home help

services. In all cases, the estimated coefficients are statistically significant.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of home help services utilisation is 4.3 percentage points higher for those with MC; 0.3 percentage points higher for PHI and 4.4 percentage points higher for those with MC+PHI. In addition, the results indicate, that relative to the base category, those in the category of either MC or PHI or both MC and PHI are 2.5 percentage points more likely to use home help services. Taken together, the results presented above, suggest a positive and statistically significant association between health insurance coverage and home help utilisation.

4.4.3.6 Optician Services

Results for the empirical analysis of optician services are also presented in Table 4.5. The results for both matching approaches are generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of optician services utilisation. Nonetheless, there are some differences in estimated coefficients and statistical significance. More specifically the propensity score matching approach estimates that relative to the base category, the probability of optician services utilisation is 16 percentage points higher for those with MC; 0.88 percentage points higher for those with PHI; and 4.1 percentage points lower for those with MC+PHI. In addition, relative to the base category, those in the category of either MC or PHI or both MC and PHI are 6.3 percentage points more likely to use optician services. It is worth noting however, that the estimated coefficients are statistically significant, only for those with a medical card (MC) and for those with any form of health insurance.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of optician services utilisation is 15 percentage points higher for those with MC; 0.8 percentage points lower for PHI and 12.1 percentage points higher for those with MC+PHI. Relative to the base category, those in the category of either MC or PHI or both MC and PHI are 7.2 percentage points more likely to use optician services everything else equal.

Table 4.5 Average treatment effects on the treated of health insurance status on community care services utilisation (Cont'd)

Healthcare Service	Model	MC	PHI	MC+PHI	Either MC or PHI
Community Care					
Physiotherapy Services					
	OLS	0.0233**	-0.00558	0.0294**	0.0101
	PSM 1:1	-0.0242	-0.00703	0.0213	0.0172**
	NN (Base) Matching	0.0470***	0.00735	0.0438***	0.0285**
Home Help Services					
	OLS	0.0233**	0.00314*	0.0106	0.00550**
	PSM 1:1	0.0570***	0.00428***	0.0440***	0.0312***
	NN (Base) Matching	0.0438***	0.00368***	0.0438***	0.0251***
Optician Services					
	OLS	0.137***	-0.00293	0.111***	0.0595***
	PSM 1:1	0.166***	0.00886	-0.0411	0.0630***
	NN (Base) Matching	0.149***	-0.00843	0.121***	0.0722***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

4.4.3.7 Dental Services

The results of the empirical analysis on the association between health insurance status and dental services are presented in Table 4.6. The results for both matching specifications are generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of dental services utilisation. Nonetheless, there are some differences in estimated coefficients and statistical significance. More specifically the propensity score matching approach estimates that relative to the base category, the probability of dental services utilisation is just over 14 percentage points higher for those with MC; 0.5 percentage points higher for those with PHI; and 16.3 percentage points higher for those with MC+PHI. In addition, relative to the base category, those in the category of either MC or PHI or both MC and PHI are 8.46 percentage points more likely to use dental services. The estimated coefficients are all statistically significant, with the exception of those with PHI.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of dental services utilisation is 13.8 percentage points higher for those with MC; 3.3 percentage points lower for PHI and 11.3 percentage points higher for those with MC+PHI. Relative to the base category, those in the category of either MC or PHI or both MC and PHI are 3.64 percentage points more likely to use dental services. All of the estimated coefficients are statistically significant.

4.4.3.8 Hearing Services

The results from the empirical analysis on hearing services are also presented in Tables 4.6. The results for both specifications are generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of hearing services utilisation. The propensity score matching approach estimates that relative to the base category, the probability of hearing services utilisation is 3.1 percentage points higher for those with MC; 0.1 percentage points higher for those with PHI; and 3.12 percentage points higher for those with MC+PHI. In addition, relative to the base category, those in the category of either MC or PHI or both MC and PHI are 1.85 percentage points more likely to use hearing services. The estimated coefficients are all statistically significant; except for individuals with PHI only.

The results from the matching approach based on the Mahalanobis distance indicate that

relative to the base category, the probability of hearing services utilisation is 2.7 percentage points higher for those with MC; 0.03 percentage points lower for PHI and 3.06 percentage points higher for those with MC+PHI. Relative to the base category, those in the category of either MC or PHI or both MC and PHI are 1.5 percentage points more likely to use hearing services. Relative to the base case of public health insurance, all of the estimated coefficients are statistically significant with the exception of those with PHI only.

4.4.3.9 Dietician Services

The results for the propensity score matching and matching analyses based on the Mahalanobis distance are presented in Table 4.6. The results for both specifications are generally consistent in that they indicate that greater levels of health insurance coverage are associated with a statistically significant higher probability of hearing services utilisation. The propensity score matching approach estimates that relative to the base category, the probability of dietician services utilisation is 1.3 percentage points higher for those with MC; 0.29 percentage points lower for those with PHI; and 6.95 percentage points lower for those with MC+PHI. In addition, relative to the base category, those in the category of either MC or PHI or both MC and PHI are 0.2 percentage points more likely to use hearing services. The estimated coefficients are all statistically significant, with the exception of those with PHI.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of hearing services utilisation is just under 1 percentage point higher for those with MC; 1.72 percentage points lower for PHI and 2.92 percentage points higher for those with MC+PHI. Relative to the base category, those in the category of either MC or PHI or both MC and PHI are 0.2 percentage points more likely to use hearing services. However, none of the estimated coefficients is statistically significant.

Table 4.6 Average treatment effects on the treated of health insurance status on community care services utilisation (Cont'd)

Healthcare Service	Model	MC	PHI	MC+PHI	Either MC or PHI
Community Care					
Dental Services					
	OLS	0.140***	-0.0201**	0.124***	0.0444***
	PSM 1:1	0.143***	0.00580	0.163***	0.0846***
	NN (Base) Matching	0.138***	-0.0333*	0.113***	0.0364***
Hearing Services					
	OLS	0.0159**	0.00238	0.0162***	0.00901***
	PSM 1:1	0.0308***	0.00153	0.0312***	0.0185***
	NN (Base) Matching	0.0277***	-0.000305	0.0306***	0.0149***
Dietician Services					
	OLS	0.00112	-0.00374	0.000552	-0.000945
	PSM 1:1	0.0133***	-0.00285	-0.0695*	0.00201
	NN (Base) Matching	0.00902	-0.0172	0.00292	0.00197

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

4.4.3.10 Psychological/Counselling Services

The results for the empirical analysis of health insurance status on psychological/counselling services are presented in Table 4.7 and are generally mixed, as there are some differences in the estimated coefficients and statistical significance across both specifications. The propensity score matching approach estimates that relative to the base category, the probability of psychological/counselling services utilisation is 2.81 percentage points lower for those with MC; 0.244 percentage points higher for those with PHI; and 0.142 percentage points higher for those with MC+PHI. I also estimate the impact of having either MC or PHI or both MC and PHI; that is, any form of additional health insurance coverage. The results indicate that relative to the base category, those in the category of either MC or PHI or both MC and PHI are 1.18 percentage points less likely to use psychological/counselling services. It is worth noting that none of the estimates is statistically significant.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of psychological/counselling services utilisation is 2.65 percentage points lower for those with MC; 0.13 percentage points higher for those with PHI; and is 0.58 percentage points higher for those with MC+PHI. In addition, the results indicate, that relative to the base category, those in the category of either MC or PHI or both MC and PHI are 0.56 percentage points less likely to use psychological/counselling services. Each of the estimated coefficients are statistically significant relative to the base case of public health insurance, with the exception of those with a medical care as well as those with PHI only.

4.4.3.11 Daycentre Services

The results for the empirical analysis of daycentre services are presented in Table 4.7. The results for both matching approaches are somewhat similar but there are some differences in the estimated coefficients and statistical significance across both specifications. More specifically the propensity score matching approach estimates that relative to the base category, the probability of daycentre services utilisation is 1.35 percentage points lower for those with MC; 0.122 percentage points lower for those with PHI; and 1.13 percentage points higher for those with MC+PHI. We also estimate the impact of having either MC or PHI or both MC and PHI; that is, any form of additional health insurance coverage. The results indicate that relative to the base category, those in the category of either MC or PHI or both MC and PHI are 0.563 percentage points less likely to use daycentre services. It is worth noting that the estimated coefficients are statistically significant only for those with both MC

and PHI.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of daycentre services utilisation is 1.41 percentage points higher for those with MC; 0.061 percentage points lower for those with PHI; and is 1.46 percentage points higher for those with MC+PHI. In addition, the results indicate, that relative to the base category, those in the category of either MC or PHI or both MC and PHI are 0.744 percentage points more likely to use daycentre services. Each of the estimated coefficients are statistically significant relative to the base case of public health insurance, with the exception of those with PHI only.

4.4.3.12 Other Community Care Services

As part of the analysis, we also attempted to estimate the effect of insurance status on the utilisation of several other community care services. These included social work services, personal care attendant services, meals-on-wheels services and respite care services. As described previously in the descriptive statistics in chapter 2, section 2.3.2, no individual in the dataset who availed of these services had the lowest level of health insurance coverage (i.e. public health insurance). As a result, we could only observe three outcomes for this event making matching individuals to a treatment and control group difficult. Thus, it was decided not to proceed with the analysis of these four community services. In the next section, the results on the empirical analysis of health insurance on healthcare costs, both at the mean and across the full distribution are presented.

Table 4.7 Average treatment effects on the treated of health insurance on community care services utilisation (Cont'd)

Healthcare Service	Model	MC	PHI	MC+PHI	Either MC or PHI
Community Care					
Psychological/Counselling Services					
	OLS	0.00732***	-0.00000804	0.00496	0.00201
	PSM 1:1	-0.0281	0.00244	0.00142	-0.0118
	NN (Base) Matching	-0.0265	0.00134	0.00584*	0.00561***
Daycentre Services					
	OLS	-0.00330	-0.00207	0.000614	-0.000887
	PSM 1:1	-0.0135	-0.00122	0.0113*	-0.00563
	NN (Base) Matching	0.0141***	-0.000613	0.0146***	0.00744***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

4.4.4 Healthcare Costs

This section presents the empirical results from the analysis. The methodological approaches adopted explicitly attempted to identify the most appropriate empirical models for the cross-sectional data analysed and the nature of the dependent healthcare cost variable. A series of multivariate regression models were estimated to explore the potential drivers of healthcare costs including health insurance status, sociodemographic status and health status. The results for all models and all independent variables are presented below. The favoured GLM specification throughout is the Poisson with a power link of 0.3 as dictated by the Park test (Park, 1966) as well as the Pregibon link test, the Modified Hosmer Lemeshow test and the Pearson's Correlation test. A full list of the model diagnostics for each model analysed are shown in Table 4.8 below. A four-step approach is taken to analyse associations between health insurance status and healthcare costs. First, I use an OLS approach as well as a series of GLM approaches to estimate associations between health insurance status and average healthcare costs. Second, in order to account for the observable heterogeneity between health insurance status and healthcare costs I follow two approaches. First, I use propensity score matching to estimate the relationship between health insurance status and average healthcare costs. Second, to account for the distributional nature of cost data, I estimate a series of GLM models in conjunction with inverse probability weights to estimate associations between the main variable of interest and mean healthcare costs. The final approach uses unconditional quantile regression to estimate associations between health insurance status and costs along the entire cost distribution. For both the GLM models and the unconditional quantile regressions, I present cost estimates for a restricted sample (where I control for health insurance status only) on the left-hand-side and for a non-restricted sample (where I control for the full set of explanatory variables (health insurance status, socio-demographic and health related variables) on the right hand side. The results for the mean healthcare cost analysis, estimated using OLS and GLM regression are presented in Table 4.9 and are described below in the three subcategories of interest: (1) health insurance status; (2) socio-demographic status; (3) health status. The results for the propensity score matching, Mahalanobis distance matching and inverse probability weighting matching analyses are presented in Tables 4.10-4.11. Finally, the results for the unconditional quantile regression are presenting in Tables 4.16-4.19. For all models, results are presented in terms of average marginal effects.

Table 4.8 GLM Model Diagnostics – Mean Cost Analysis

		OLS	Identity Gaussian	GLM Log Gaussian	GLM Power 0.1 Gaussian	GLM Power 0.3 Gaussian	GLM Sqrt Gaussian
Model Diagnostics							
	AIC	152896	152896	152762	152772	152793	152818
	BIC	153260	153260	153140	153150	153171	153196
	Log likelihood	-76396	-76396	-76327	-76332	-76342	-76355
	Pearson	1.0000	1.0000	0.5040	0.4842	0.4355	0.4331
	Pregibon	0.0027	0.0027	0.1229	0.1287	0.0749	0.0236
	Hosmer-Lemeshow	0.0000	0.0000	0.5694	0.6923	0.1464	0.0043
	Modified Park Test Coefficient	1.046	1.046	1.037	1.006	0.9206	0.742

Table 4.8 GLM Model Diagnostics – Mean Cost Analysis (Cont'd)

	Diagnostic Test	Identity Poisson	GLM Log Poisson	GLM Power 0.1 Poisson	GLM Power 0.3 Poisson	GLM Sqrt Poisson
Model Diagnostics						
	AIC	-	2.25e+07	-1.12e+07	2.25e+07	2.25e+07
	BIC	-	2.25e+07	2.25e+07	2.25e+07	2.25e+07
	Log likelihood	-	-1.13e+07	2.25e+07	-1.12e+07	-1.12e+07
	Pearson	-	0.3205	0.5062	0.9474	0.6806
	Pregibon	-	0.1969	0.3455	0.8026	0.7182
	Hosmer-Lemeshow	-	0.6810	0.5277	0.2142	0.0797
	Modified Park Test Coefficient	-	1.233	1.244	1.273	1.303

Table 4.8 GLM Model Diagnostics – Mean Cost Analysis (Cont'd)

	Diagnostic Test	**Identity Gamma**	**GLM Log Gamma**	**GLM Power 0.1 Gamma**	**GLM Power 0.3 Gamma**	**GLM Sqrt Gamma**
Model Diagnostics						
	AIC	-	128520	128462	128355	128267
	BIC	-	128899	128840	128733	128645
	Log likelihood	-	-64206	-64177	-64124	-64079
	Pearson	-	0.0000	0.0000	0.0000	0.0002
	Pregibon	-	0.0000	0.0001	0.0028	0.0192
	Hosmer-Lemeshow	-	0.0005	0.0002	0.0038	0.0123
	Modified Park Test Coefficient	-	1.293	1.304	1.329	1.356

4.4.4.1 Mean Healthcare Costs by Health Insurance Status

In all cases, in the impact of health insurance status on healthcare costs, is presented for each health insurance category (i.e. MC; PHI, MC+PHI) relative to the base-category of public health insurance only (Base).Table 4.9 presents the results from the mean cost analysis analyses. The restricted analysis, which controls for health insurance coverage only, indicates that greater levels of health insurance coverage is associated with statistically significant higher healthcare costs. For example, in the OLS analysis, relative to the base category, mean healthcare costs were €1,001 higher for those with MC; €306 higher for those with PHI; and €1,002 higher for those with MC+PHI. In the unrestricted OLS analysis, the results once again indicate that greater levels of health insurance coverage are associated with a statistically significant higher healthcare costs where they were €394 higher for those with MC; €313 higher for those with PHI; and €479 higher for those with MC+PHI. All results were statistically significant. That said, as stated above, concerns exist over the appropriateness of OLS in estimating costs given the distributional nature of the healthcare cost variable.

While the models were generally similar, the preferred GLM specification for the restricted analysis, based on a pragmatic interpretation of the diagnostic tests outlined earlier, was the GLM Poisson with a power link of 0.3. The estimates for the restricted model that controlled for health insurance status alone were the same as those for OLS. In the unrestricted analysis, the results once again indicate that greater levels of health insurance coverage are associated with statistically significant higher healthcare costs. Costs were €439 higher for those with MC; €346 higher for those with PHI; and €503 higher for those with MC+PHI. All results were statistically significant. Notably, these results were generally consistent across the wide range of GLM specifications estimated.

Table 4.9 OLS and GLM mean healthcare cost estimates

Variable Name	**Description**						
		OLS	**OLS**	**GLM Identity Gaussian**	**GLM Identity Gaussian**	**GLM Log Gaussian**	**GLM Log Gaussian**
Insurance Status							
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	1,001***	393.9***	1,001***	393.9***	1,001***	391.6**
	PHI	306.4***	312.9***	306.4***	312.9***	306.4***	412.7**
	MC+PHI	1,002***	479.4***	1,002***	479.4***	1,002***	496.0**

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 4.9 OLS and GLM mean healthcare cost estimates (Cont'd)

Variable Name	**Description**						
		GLM Power 0.1 Gaussian	**GLM Power 0.1 Gaussian**	**GLM Power 0.3 Gaussian**	**GLM Power 0.3 Gaussian**	**GLM Sqrt Gaussian**	**GLM Sqrt Gaussian**
Insurance Status							
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	1,001***	396.6**	1,001***	414.6***	1,001***	436.0***
	PHI	306.4***	411.8**	306.4***	410.7***	306.4***	408.1***
	MC+PHI	1,002***	504.4**	1,002***	526.6***	1,002***	544.4***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 4.9 OLS and GLM mean healthcare cost estimates – (Cont'd)

Variable Name	Description						
		Identity Poisson	Identity Poisson	Log Poisson	Log Poisson	Power 0.1 Poisson	Power 0.1 Poisson
Insurance Status							
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	1,001***	-	1,001***	465.0***	1,001***	459.1***
	PHI	306.4***	-	306.4***	386.7***	306.4***	374.3***
	MC+PHI	1,002***	-	1,002***	545.0***	1,002***	533.7***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 4.9 OLS and GLM mean healthcare cost estimates – (cont'd)

Variable Name	Description						
		0.3 Poisson	0.3 Poisson	Sqrt Poisson	Sqrt Poisson	Identity Gamma	Identity Gamma
Insurance Status							
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	1,001***	438.8***	1,001***	403.1***	1,001***	-
	PHI	306.4***	346.0***	306.4***	309.8***	306.4***	-
	MC+PHI	1,002***	502.6***	1,002***	458.8***	1,002***	-

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

4.4.4.2 Mean Cost Analysis of Health Insurance Status: Matching Approaches

The results for the propensity score matching, Mahalanobis distance matching and the inverse probability weighting analyses are presented in Tables 4.14 and 4.15. These results are directly comparable to the unrestricted analysis from the OLS and GLM specifications above. The results are generally consistent in that they indicate that greater levels of health insurance coverage are associated with statistically significant higher healthcare costs. Nonetheless, there were some differences in estimated coefficients and statistical significance.

In the propensity score matching approach, the estimates indicate that relative to the base category, healthcare costs are €929 higher per year for those with MC; €367 higher for those with PHI; and is €1032 higher for those with MC+PHI. In addition, this approach allows for the estimation of the impact of having either MC or PHI or both MC and PHI; that is, any form of additional health insurance coverage. The results indicate that relative to the base category, healthcare costs for those in the category of either MC or PHI or both MC and PHI were €739 higher.

In the Mahalanobis distance matching approach, the estimates indicate that relative to the base category, healthcare costs were €986 higher for those with MC; €547 higher for those with PHI; and is €975 higher for those with MC+PHI. Relative to the base category, healthcare costs for those with either MC or PHI or both MC and PHI were €764 higher.

In the inverse probability weighting matching approach, the preferred GLM specification for the analysis of healthcare costs, according to the diagnostic tests carried out, is the Poisson distribution, power link 0.1. The estimates indicate that relative to the base category, healthcare costs range from €755 to €770 higher for those with MC. Relative to the base category, healthcare costs ranged between €288 and €364 higher for those with PHI. Looking at the square root Poisson, costs are €689 higher for those with MC+PHI and €577 higher for those with either or both MC+PHI relative to the reference case of public health insurance only.

Table 4.10 ATET of health insurance status on mean healthcare costs based on PSM and Mahalanobis matching approaches

Total Healthcare costs	**Model**	**Medical card only**	**PHI only**	**Both**	**Either**
	OLS	477.8***	249.3**	673.1***	356.6***
	PSM				
	1:1	928.7***	367.2**	852.6***	738.8***
	MM				
	Base	986.4***	547.4***	975.1***	763.5***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 4.11 ATET of health insurance status on mean healthcare costs based on the inverse probability weighting approach

	GLM Link	**Medical Card only**	**PHI only**	**Both**	**Either**
Total Healthcare Costs	**Gaussian**				
	Identity Gaussian	757.1***	286.9**	770.7***	542.3***
	AIC	64253	75971	150516	150516
	BIC	64572	76300	150880	150880
	Poisson				
	Log Poisson	754.9***	287.8***	758.9***	577.6***
	AIC	7769725	8779933	4532945	1.68e+07
	BIC	7770044	8780261	4533243	1.68e+07
Preferred Model	*Power 0.1 Poisson*	770.0***	315.3***	761.2***	591.2***
	AIC	7761412	8786459	4526581	1.67e+07
	BIC	7761731	8786788	4526878	1.67e+07
	Gamma				
	Log Gamma	1,088***	669.0***	962.5***	1,014***
	AIC	52718	60766	60766	119016
	BIC	53038	61095	61095	119380
	Power 0.1 Gamma	1,060***	645.9***	891.7***	950.7***
	AIC	52663	60703	60703	118792
	BIC	52983	61032	61032	119156

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

4.4.4.3 Full Cost Distribution Analysis of Health Insurance Status – Unconditional Quantile Approach

In this section, results for the unconditional quantile regression analysis on the association between health insurance status and total healthcare costs are outlined and presented in Table 4.12. First, estimates using OLS and OLS with robust standard errors as a comparison are presented. In general, in both the restricted and unrestricted analyses, the results indicate that greater levels of health insurance coverage are statistically significantly associated with higher healthcare costs across the full distribution. It is also worth noting that respondents do not incur higher healthcare costs for both the 5th and 10th percentile of the distribution relative to the base case. At both percentiles, healthcare costs are equal to zero.

Figure 4.2 Coefficients and 95% confidence intervals by quantile of expenditure errors

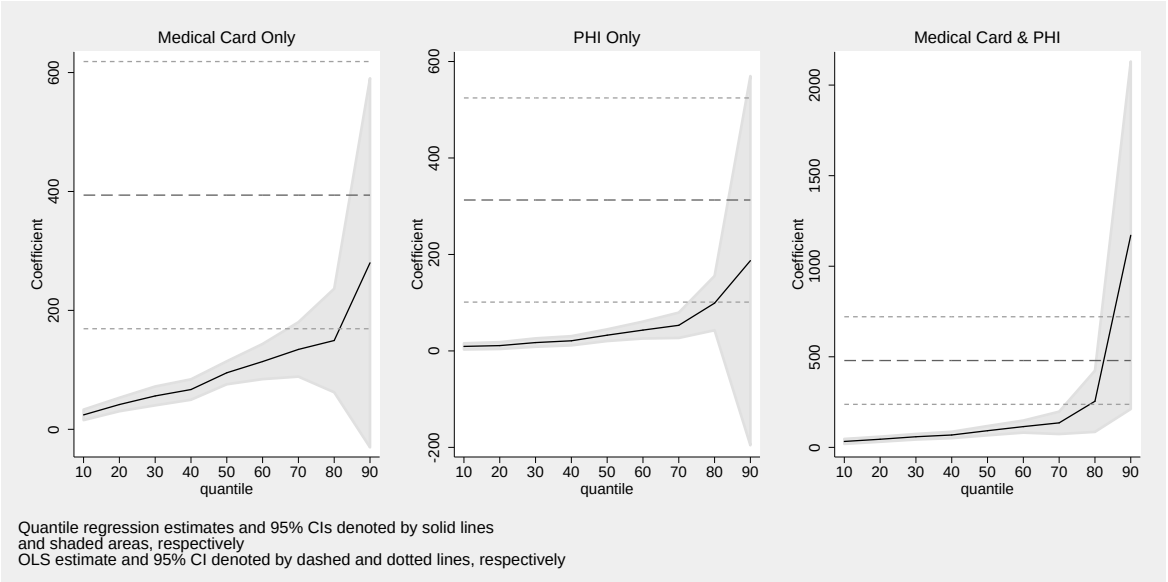


Figure 4.2 above shows the incremental effect of insurance status on total healthcare costs across quantiles of errors. For comparison, dashed lines denote OLS estimates, while 95% confidence intervals are depicted using dotted lines. The figure shows that the median quantile regression produces substantially different estimates than the least squares estimates. In each of the panels above, it is revealing that the quantile regression estimates lie outside the confidence intervals of the least squares estimates for most quantiles, suggesting that the effects of these covariates are not consistent across the error distribution or equivalently across the conditional distributional of total healthcare costs. The OLS coefficients on MC only and PHI only statistically coincides with quantile estimates from the 80th percentile to above the 90th percentile. The OLS coefficients on MC + PHI statistically coincides with quantile estimates from about the 80th through 85th percentiles.

In the case of MC, in the restricted analysis, at the 20th, 40th, 60th, 80th, 90th and 95th percentiles, relative to the base category, those with a MC have higher costs of €95, €210, €344, €1138, €1010, and €2149 respectively. The equivalent estimates for the unrestricted analysis are €57, €102, €129, €515, €477, and €918 respectively. These estimates were statistically significant in all cases up until the 99th percentile.

In the case of PHI, in the restricted analysis, at the 20th, 40th, 60th, 80th, 90th and 95th percentiles, relative to the base category, those with PHI have higher costs of €48, €51, €61, €347, €286, and €530 respectively. The equivalent estimates for the unrestricted analysis are €37, €39, €63, €402, €309, and €535 respectively. These estimates were statistically significant, at either the 0.01, 0.05 or 0.10 levels, in all cases up until the 99th percentile.

In the case of MC+PHI, in the restricted analysis, at the 20th,40th, 60th, 80th, 90th and 95th percentiles, relative to the base category, those with PHI have higher costs of €108, €214, €304, €1096, €1055, and €2193 respectively. The equivalent estimates for the unrestricted analysis of €65, €103, €118, €637, €594, and €1177 respectively. These estimates were statistically significant in all cases up until the 99th percentile. Taken together, the results presented above, suggest a positive and statistically significant effect of health insurance coverage on healthcare costs.

Table 4.12 RIF Unconditional Quantile Regression estimates of health insurance status on healthcare costs

Variable Name	**Description**	**OLS**	**OLS**	**OLS Robust**	**OLS Robust**	**0.05**	**0.05**	**0.10**	**0.10**
Insurance Status									
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	1,001***	393.9***	1,001***	393.9***	0	0	0	0
	PHI	306.4**	312.9***	306.4**	312.9***	0	0	0	0
	MC+PHI	1,002***	479.4***	1,002***	479.4***	0	0	0	0

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 4.12 RIF Unconditional Quantile Regression estimates of health insurance status on healthcare costs (Cont'd)

Variable Name	**Description**	**0.15**	**0.15**	**0.20**	**0.20**	**0.25**	**0.25**
Insurance Status							
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	95.10***	57.31***	95.10***	57.31***	142.8***	74.42***
	PHI	48.23***	36.93***	48.23***	36.93***	49.48***	35.02***
	MC+PHI	107.5***	64.69***	107.5***	64.69***	159.2***	82.40***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 4.12 RIF Unconditional Quantile Regression estimates of health insurance status on healthcare costs (Cont'd)

Variable Name	**Description**	**0.40**	**0.40**	**0.50**	**0.50**	**0.60**	**0.60**
Insurance Status							
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	209.8***	101.9***	213.6***	93.91***	343.8***	128.6***
	PHI	50.50***	39.31***	54.98***	44.50***	60.69**	63.09***
	MC+PHI	213.5***	103.1***	208.9***	89.23***	304.4***	117.9***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 4.12 RIF Unconditional Quantile Regression estimates of health insurance status on healthcare costs (Cont'd)

Variable Name	**Description**	**0.75**	**0.75**	**0.80**	**0.80**	**0.85**	**0.85**
Insurance Status							
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	607.8***	245.7***	1,138***	514.9***	2,684***	1,218***
	PHI	133.7***	154.8***	346.5***	401.9***	975.0***	1,049***
	MC+PHI	548.1***	269.9***	1,096***	637.3***	2,951***	1,833***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 4.12 RIF Unconditional Quantile Regression estimates of health insurance status on healthcare costs (Cont'd)

Variable Name	**Description**	**0.90**	**0.90**	**0.95**	**0.95**	**0.99**	**0.99**
Insurance Status							
	Base	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***	***Ref***
	MC	1,010***	477.2***	2,149***	918.3***	2,199	-154.1
	PHI	286.1***	309.3***	530.1**	534.8*	43.14	-20.49
	MC+PHI	1,055***	593.7***	2,193***	1,177***	1,907	-464.4

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

4.5 Discussion

This chapter examined associations between insurance coverage status and the utilisation of a range of hospital and community care services for older people in Ireland. It also examined associations between insurance status and healthcare costs, both at the mean and for the full distribution. In particular, the analysis sought to address the questions – does the level of healthcare service utilisation and costs differ depending on the level of health insurance coverage?

4.5.1 Study Findings

The results of all three empirical strategies indicated that in general, that for most services analysed more comprehensive health insurance coverage is associated with higher levels of healthcare utilisation and costs generally, even after controlling for a range of socio-demographic and health status variables.

In terms of the matching estimates, our results show a significant relationship between insurance status on healthcare utilisation. In general terms, the results were consistent and confirmed the existence of a significant gradient in healthcare service usage based on insurance status. Those with the lowest level of health insurance status were significantly less likely to use healthcare services than everyone else and have significantly lower healthcare costs on average. Those with a medical card only (MC) were significantly more likely on average to use GP services, public healthcare nurse services, chiropody services, optician, dental and hearing services compared to those with the lowest level of insurance. Interestingly, those with a medical card only, did not use significantly more inpatient and outpatient services compared to those in our reference case (Base). Those with private health insurance (PHI) only, were found to use significantly less healthcare services on average than those with the lowest level of coverage (Base). These included public healthcare nurse services, chiropody services, and physiotherapy, and optician, dental and hearing services. Those with both a medical card and PHI (MC +PHI) used more services on average compared to those in the lowest insurance category. However, insurance status did not seem to affect older individuals' propensity to use A&E, outpatient, occupational therapy, home help and dietician services.

Looking at associations between health insurance status and costs, the analysis found that health insurance coverage, through its role as an enabling factor, is a significant determinant

of healthcare costs even after controlling for predisposing and need characteristics. This result holds for each of the estimated models. In addition, healthcare need factors such as chronic illness and self-reported health are significant determinants of healthcare costs after controlling for a number of demographic, socio-economic and health related variables. Estimates from the GLM models showed that, after accounting for observable heterogeneity between health insurance status and healthcare costs, statistically significant positive differences were evident between individuals with any form of health insurance and those with public health insurance only (Base). The results suggest that those with public health insurance only spend approximately €500-€600 less on average per year compared to those with some form of health insurance, after controlling for a range of socio-economic and health related variables. The results from the unconditional quantile regressions once again point to a positive and statistically significant relationship between insurance status and costs. That is, those with the lowest level of health insurance spend the least amount on healthcare. The UQR also suggest that while costs increase steadily up to about the 60th percentile of the cost distribution and then begin to increase dramatically after this point. We find no significant association between insurance status and costs for the 5th, 10th or 99th quantile.

Overall, the chapter has shown that, in the main, there is a positive and significant association between health insurance status and healthcare utilisation and cost for those aged 50 and over in Ireland. In addition, need variables such as the number of chronic illnesses and self-reported health are significantly associated with healthcare costs for this cohort of individuals. The performance of the estimated GLM models was compared using a series of specification tests. The tests suggest that a Poisson distribution with a power link is the most appropriate fit for our data when it comes to estimating healthcare costs.

4.5.2 Study Implications

Taken together, the findings indicate that the current structure of the Irish healthcare system imposes barriers to access for those older people with the lowest level of health insurance coverage (Base). Importantly, this chapter adds to this literature by explicitly analysing, for the first time the utilisation of a range of secondary and community healthcare services among older people in Ireland. Our results are consistent with other empirical research that suggests that insurance coverage impacts upon health service usage (Manning et al., 1987; Newhouse, 1993). The results are also consistent with previous research on the impact of health insurance on healthcare utilisation among older people (Chen et al., 2007; Hurd & McGarry, 1997). Insurance, by lowering the cost of care, leads to an increase in healthcare utilisation. Previous

research from an Irish context concentrating on the impact of health insurance status on healthcare utilisation found a positive and significant effect even after controlling for healthcare need (Hudson & Nolan, 2015; Layte & Nolan, 2014a; Nolan, 2008, 2011; Nolan & Nolan, 2008; Nolan & Smith, 2012). In particular (Hudson & Nolan, 2015; Layte & Nolan, 2014a; Nolan & Smith, 2012) investigate the effect of differential eligibility for healthcare services in Ireland. They find that those with greater health insurance coverage use more healthcare services a finding that is consistent with the results of this chapter.

However, much of this previous work concentrates on the utilisation of GP services. The analysis undertaken in this chapter aimed to bridge this gap in the literature by examining the impact of health insurance status on a much wider range of healthcare services, not only hospital services, but also those services provided in the community setting. Research on the impact of health insurance coverage on access to a wider range of healthcare services is particularly timely in light of ageing populations and increased life expectancies of older people. Such a trend is likely to continue to put pressure on already resource constrained healthcare systems. Indeed, as older individuals require access to a wide range of primary, secondary and community care services, the demands on such services are likely to increase in the coming years. Thus, differences in insurance coverage status, which lead to differences in access to necessary healthcare services, will continue to result in inequities across the older population. The analysis carried out here is useful in that it highlights the impact that differing levels of health insurance coverage have on the probability of utilisation for a range of healthcare services.

The findings also suggest that greater levels of health insurance coverage are significantly associated with higher healthcare costs. Given population-ageing projections for the Irish population and the fact that older people use more healthcare services relative to the rest of the population, we would expect to see total healthcare costs increasing markedly in the future in any event. These projected trends are likely to lead to significant increases in total healthcare expenditure in the coming years, placing increased pressure on a public healthcare budget already struggling to contain costs.

From a policy point of view, the results would suggest that the introduction of a universal, one tiered healthcare system, as proposed under Slaintecare, would, by increasing the insurance coverage for those with the lowest level of health insurance coverage, lead to an

increase in the utilisation of healthcare services by older people in the Republic of Ireland. At the same time, introducing such a system would add significantly to the costs of providing healthcare services to the State; a finding that is consistent with similar work elsewhere (Connolly et al; 2018). The analysis conducted in this chapter was, however, unable, to identify whether individuals with greater insurance coverage are using the optimal level of care or whether they are using more care than is necessary (Nolan & Smith, 2012). Nonetheless, it offers an insight into the possible implications of equalising access to healthcare services for older people in the future; that is; they are likely to use more healthcare services costing the State more to provide these services in the future.

4.5.3 Study Limitations

The analysis had a number of limitations, which need to be considered. While TILDA provides comprehensive information on the key variables of interest in the Irish setting, the data are not without their shortcomings. First, it is possible that certain indicators are subject to recall bias. This is especially true of our dependent variables where respondents are asked to recall their utilisation of healthcare services over the last 12 months. Second, information on supply-side factors such as hospital, or community care characteristics are unavailable. Third, we are limited in terms of the information we have on the nature of healthcare visits. Notably, we analyse utilisation in terms of a binary response variable, as we did not have complete information on, for example, the number of visits or the length of those visits. Fourth, in analysing the utilisation of community care services, respondents were asked: - "In the last 12 months did you receive any of the following State services". Because some respondents may have sought out such services in the private sector, it is possible that our results underestimate the frequency with which respondents utilise of a number of the community care services in particular. Fifth, this analysis is cross-sectional and based on observational data from one wave of TILDA data. Therefore, the potential unobservable endogeneity of variables such as health status cannot be accounted for. Lastly, while the analysis has attempted to shed more light on the relationship between insurance status and healthcare services utilisation, the analysis does not address the problem of potential unmet need within the healthcare system due to data limitations.

4.5.4 Future Research Questions

Given the difficulties in estimating the causal effects of health insurance status from cross-sectional data, which were raised earlier, panel data analysis can be employed to address potential unobservable endogeneity and would be a possible and useful avenue for future

research. Using panel data model, it might also be useful to examine the effect of transitions into and out of differing health insurance categories on health status and the prevalence of chronic conditions. As referenced earlier, the transition from continuous to categorical measurement between wave 1 and wave 2 of TILDA meant that longitudinal analysis could not be used in this thesis.

4.5.5 Conclusion

This chapter provided a descriptive analysis of healthcare utilisation, cost patterns by older people in Ireland, and estimated associations between health insurance status and healthcare utilisation and costs, not only at the mean but also across the full distribution. Older people are more vulnerable to ill health and thus require access to both a greater amount and to a wider range of health and social care services. It follows that difference in access arrangements, for example due to differences in levels of health insurance coverage, may have detrimental impacts on the health and well-being of those with lower levels of coverage. Such access arrangements raise fundamental questions regarding the equity of healthcare systems. Ireland is an interesting case study to examine such questions given its complex system of co-existing public and private health insurance coverage. Such a two-tiered structure may have serious implications for equity of access to healthcare services. The chapter indicates that more comprehensive health insurance coverage is strongly associated with higher levels of healthcare utilisation and costs generally, even after controlling for demographic, socioeconomic and health status variables.

5. Health Economic Analysis of the Role of Informal Care on Healthcare Utilisation and Healthcare Costs among over 50s in Ireland

This chapter provides an analysis of the association between health insurance status and informal care; both received and provided, among older people in the Republic of Ireland. The chapter also provides an analysis of the role of informal care; both received and given on healthcare utilisation and healthcare costs. First, a series of multivariate regression analysis are undertaken to explore associations between health insurance and informal care, as well as informal care receipt and provision on healthcare utilisation and mean healthcare costs. The motivation for these analyses arises from the need for a better understanding of the interaction between formal and informal care systems for older people for the purposes of informing planning for future health needs in light for the changing policy and demographic contexts and their implications for the formal healthcare system.

5.1 Introduction

The changing demographic make-up of the Irish population presents significant challenges for the Irish healthcare system. Projected population growth figures point to a greater proportion of older people in the population in the coming years. Older people, by their very nature use more healthcare services on average and are at a greater risk of developing chronic conditions. Thus, they require access to a great amount and wider range of healthcare services. These demographic changes are likely to place increased demand on the formal healthcare system; a capacity constrained system, already under pressure to deal with current demand levels. The extra demands being placed on the formal healthcare system will see a growing importance being placed on informal care within the Irish healthcare system. Informal care refers to the unpaid care provided by family or friends to individuals who have difficulties undertaking and managing with their daily activities, (Weatherly, Faria, & Van den Berg, 2014). The expanding literature in the area of informal care is a recognition of its importance as the most common substitute or supplement to long-term care (LTC) worldwide (Grabowski & Van Houtven, 2012). The number of informal care users is expected to rise significantly in the coming years (Oliva-Moreno et al., 2017). The increased demand for informal care services is also driven by shortcoming within the formal healthcare sector to adequately deal with the increased demand for healthcare services in recent years; placing a significant care burden on those providing the required care (Chevreul, 2016; Pentek, 2016; Schneider et al.,

2013). Little is known about the interaction between the formal and informal care systems in the Irish setting. Using data from Wave 1 of TILDA, this chapter attempts to bridge that gap in the literature by exploring associations between informal care; both received and provided; on utilisation and costs of a range of hospital and community healthcare services for the over 50s population in Ireland.

5.2 Health Economic Analysis of Informal Care

This section examines the application of theoretical and empirical methods to explore questions relating to informal care. First, a brief discussion of the Andersen Behavioural Model is given and I outline how such a framework might be applied to inform the research questions being asked in this chapter. This is followed by a more detailed discussion of the empirical literature on informal care for Ireland and internationally.

5.2.1 Theoretical Analysis of Informal Care

The Andersen Behavioural model is adopted to inform the empirical analyses that follows in this chapter. The model is mentioned briefly here, but for a more detailed description of the model and how it applies to the research questions set out in this thesis, please refer back to Chapter3, section 3.5. The model was first developed in the late 1960s and sought to predict and explain the factors that influence an individual's propensity to use healthcare services. Turning to the question of the relationship between health insurance status on informal care receipt and provision, insurance is seen as an enabling factor in an individual's propensity to avail of more services. Thus, one might expect that those with higher levels of health insurance status would use more healthcare services.

When estimating associations between informal care and healthcare utilisation and costs, the role of informal care is again conceptualised in the context of the Andersen model. In terms of informal care provision, the hypothesis is unclear. It could be that the provision of informal care is a disabling factor in an individual's propensity to use healthcare services (Shaw et al, 1997; Musich et al, 2017). That is, those who provide care to others are less likely to use healthcare services. This may be a result of the burden placed on carers by the person they are caring for. It could be that they are simply too busy to avail of healthcare services or are prevented from doing so because of the needs of the person for whom they are caring. As a result, carers may neglect their own health and well-being; only availing of healthcare services when it is necessary (Ward-Griffin & McKeever, 2000). Conversely, a well-established body

of literature suggests that caregiving can have substantial negative mental and physical effects (Coe & Van Houtven, 2009; Schmitz & Westphal. 2015; Do et al, 2015). These negative effects result in higher use of healthcare services on average due to the burden of care, in terms of time and effort, placed on them because of caring for an elderly family member or otherwise.

The hypothesis in respect of those receiving informal care is less clear. For example, it could be that informal care acts as a buffer for the formal healthcare system. That is, those in receipt of informal care are less likely to use healthcare services as the care they receive acts as a substitute for formal healthcare services. It could be the care received in an informal care setting negates the necessity to seek care in the formal healthcare system. Conversely, informal care receipt may lead to higher levels of healthcare services utilisation in the formal setting. This could be because individuals are in greater health need or simply because they have better support network around them in terms of family and friends to ensure they access formal healthcare services more frequently. In the analysis that follows, we attempt to gain a better understanding of the relationship between informal care and a range of primary, secondary and community care services.

5.2.2 Empirical Analysis of Informal Care and Healthcare Utilisation and Costs

As outlined in detail in Chapters 4, a range of econometric and empirical approached are adopted to analyse healthcare utilisation and healthcare costs. This material is not revisited here in detail. In the following section, we attempt to synopsise the wide array of empirical literature focusing on the relationship between informal care and formal healthcare utilisation and costs both nationally and internationally. A summary review of this literature is presented below.

5.2.2.1 International Evidence

Informal caregiving is an area of increasing importance to healthcare systems around the world. Advances in medicine have resulted in longer life expectancies for individuals around the world. Higher life expectancies have placed a significant burden on healthcare systems around the world and with healthcare costs of the elderly (through formal care) increasing year on year. Healthcare systems have sought to promote the importance of informal care as a means to take pressure off financially struggling healthcare systems. As informal care is the backbone of long-term care, it has taken increased prominence in recent years. Much of the

literature in the area has concentrated on demand and supply-side factors of informal care.

The availability of immediate family such as a spouse or adult children, being male, being a minority group and owning a home were all associated with a greater likelihood of informal care utilisation (Charles & Sevak, 2005; Ettner, 1994; Kemper, 1992). When income is treated as exogenous, studies have found that higher income is associated with a lower probability of informal care utilisation (Ettner, 1994; Kemper, 1992). On the supply side, Golberstein et al., (2009) found that older adults in the US with functional limitations offset reductions in Medicare home healthcare with increased informal care, although the effect was only observed for lower income individuals.

Another strand of research on informal care has concentrated on the substitution effect between formal and informal care (Van Houtven & Norton, 2004). Other work concentrates on the effect of informal care on healthcare expenditures (Van Houtven & Norton, 2008). Taking data from the 1998 Health and Retirement Survey (HRS) and the 1995 Asset and Health Dynamics Among the Oldest-Old Panel Survey (AHEAD) Van Houtven and Norton (2004) use a two-part model to examine how informal care affects formal care. Instrumental variables (IV) estimation controls for the simultaneity of informal and formal care. The authors found that informal care reduces total formal healthcare utilisation of the elderly, primarily by reducing home help care and nursing home use. In addition, they found that, while informal care does not affect the likelihood of having an inpatient hospital stay, parents who receive informal care have shorter lengths of stay than those who do not. Musich et al, (2017) in estimating the impact of caregiving on healthcare utilisation and expenditures for Medicare Supplement insured patients found that caregivers had significantly lower medical and prescription drug expenditures. Bonsang (2009) use SHARE data to analyse the impact of informal care by adult child on the use of long-term formal healthcare services by the elderly as well as the effect of the level of disability of the parent on this relationship. Again, IV estimation is used to control for the endogeneity between formal and informal care. Results suggest that informal care substitutes for paid domestic help, but not when the level of disability of the parent increases, suggesting that informal can only substitute for unskilled care needs in the home. Bolin, Lindgren, and Lundborg (2008) use the same dataset and find that informal care and formal care are substitutes while informal care is a complement to doctor and hospital visits and that these relationships differ according to a north-south European gradient.

Given the steady trend in increasing life expectancy and the pressure that is exerted on healthcare spending as a result, the impact of informal care on formal care costs is an important policy question to investigate. Van Houtven and Norton (2008) attempt to measure how informal care affects formal care expenditure using Medicare claims data and the 1993 and 1995 waves of AHAD. They find that informal care by children reduces Medicare long-term care (LTC); specifically, the use of home healthcare and skilled nursing as well as inpatient expenditures of the single elderly. Child caregivers are more effective caregivers compared with others. They also find that children are less effective caregivers among recipients that are married. (Yoo et al., 2004) assess the impact of informal caregiving on LTC expenditures in OECD countries. They find that the availability of a spouse caregiver reduces national LTC expenditures in the OECD. The effect for children is smaller.

While the evidence suggests that informal care may act as a substitute for formal LTC, saving money for the care recipient as well as easing financial pressure on the scare resources of government, it may also come at a cost for the caregiver – i.e. the opportunity cost of caregiving may be reduced time in full-time paid work, reduced income from said work and an increased risk of bad health outcomes. The evidence on the effect of caregiving on labour market participation is mixed. Schmitz and Westphal (2017) estimate the long-run effects of informal care provision on female caregivers' labour market outcomes up to eight years after care provision; and find significant initial negative effects of informal care provision on the probability to work full-time. The probability of working full-time is reduced by 4% according to the results and is persistent over time. In contrast, Leigh (2010) using panel data from 2001-2007 find that, after taking account of individual heterogeneity, the impact of caregiving on labour force outcomes is small or non-existent. Carmichael and Charles (2003) examine the opportunity cost of informal care by gender. They find that both male and female carers bear indirect costs because of caregiving in that they are less likely to be in paid work than otherwise similar non-caregivers are and when they are in paid work, they earn significantly less. Many empirical studies have used IV or simultaneous equation estimation techniques to address the potential endogeneity that exists between caregiving and labour supply. Others have used panel data modelling techniques to unobserved heterogeneity. Using longitudinal data from the Health and Retirement Study (HRS), (Van Houtven, Coe, & Skira, 2013) identify the relationship between informal care and work, both on the intensive and extensive margins, and examine wage effects. They find modest decreases—2.4 percentage points—in the likelihood of working for male caregivers providing personal care. Female chore caregivers, meanwhile, are more likely to be retired. Female care providers, who remain working, decrease the amount of time at work by 3–10 hours per week and face

a 3 percent lower wage than non-caregivers face while the authors find little effect of caregiving on workers' hours or wages. Other studies have found that informal caregivers have a 4% increased risk of not working compared to non-caregivers when informal care is treated exogenously (Heitmueller, 2007).

5.2.2.2 Irish Evidence

In an Irish context, Gannon and Davin (2010) have established the determinants associated with more formal and informal care utilisation . They find that the receipt of informal care by older people is endogenous and negatively related to formal healthcare services using pooled data from Ireland and France. A significant portion of empirical evidence on informal provision has concentrated on estimating the burden of informal care and cost of illness studies. Hanly and Sheerin (2017) have measured the economic value of informal care in Ireland using Irish census data. Using both the opportunity cost approach (OCA) and the proxy good approach (PGA), they estimate the economic value of informal care in Ireland to range between €2.1bn and €5.5bn depending on the valuation approach used.

Gillespie et al. (2014) use longitudinal data from the Enhancing Care in Alzheimer's disease (ECAD) to estimate total costs of formal and informal care for people with Alzheimer's disease. Data were collected at two time points – once at baseline and again at follow up two years later. The authors find a statistically significant increase in costs over time, driven primarily by an increase in estimated informal care costs. Total costs for formal and informal care over six months rose from €9,266 per patient at baseline to €21,266 six months later.

Gillespie, et al. (2013), again used data from ECAD to estimate the costs of formal and informal care for a sample of patients with Alzheimer's disease and mild cognitive impairment. In addition, the authors estimated the effects of dependence and function on the costs of care in these two disease areas. They found that both dependence and function were independently and significantly associated with total formal and informal care costs.

Trepel (2011) used survey data from the Alzheimer's Society of Ireland (ASI) to estimate the informal costs of dementia care by using a proxy good valuation approach. *Per diem* costs of dementia care are estimated to range from €240.96 (early stage) to €570.04 (late stage. Hanly et al; (2013) applied seven valuation scenarios based on variants of the opportunity cost

approach (OCA) and the proxy good approach (PGA) to estimate the time costs associated with informal care of colorectal cancer survivors. They found that significant time is associated with the informal care for those with colorectal cancer although large variations in the cost of care exist depending on the valuation approach used.

Taken together, the above theoretical and empirical evidence informs the empirical analysis presented below. In particular, there are gaps in the literature that need to be addressed. That is, the role of informal care, in terms of both receipt and the provision of care on community care services is not well developed. In addition, little is known about the relationship between informal care on total healthcare costs in the Irish setting. The analysis below attempts to address this gap in the literature.

5.3 Methodology

This section outlines the methodological approach adopted to explore the research questions of interest. For the purposes of brevity, the presentation is limited to material that is new to the reader at this point. As outlined in Chapter 2 and above, data from Wave 1 of TILDA was used for the analysis. The estimation sample is that for which imputed income for individuals who had no data for that variable in the dataset was generated. In this chapter, two dependent variables are analysed: (1) Healthcare Utilisation, and (2) Healthcare Costs. A range of regression methods are employed to estimate the coefficients of interest for the main dependent variables (outlined below). These models are estimated controlling for several independent variables including health insurance status, socio-demographic and health related variables. Two sets of analyses are conducted, each focusing on a main dependent variable of interest relating to informal care. First, a variable was created to indicate if informal care was received by the respondent from a family member or from someone else. Second, a variable was created to indicate if the respondent provided informal care to another individual. The first set of regression models focus on the variable for informal care receipt and the second set of regression models focus on the variable for informal care provision. More information on each of the main independent variables included is provided below. Descriptive statistics on both informal care receipt and informal care provision are detailed in Chapter 2.

5.3.1 Data

As outlined in each of the previous chapters, data from wave 1 of TILDA was used for the analysis. In this chapter, informal care is both a dependent variable and an independent variable in the analysis. Once again, the data for the empirical analysis that follows in this chapter comes from wave 1 of the TILDA dataset. Descriptive statistics on the dependent variables and independent variables included in this chapter are outlined in detail in Chapter 2. These will not be revisited here, but instead, we ask the reader to refer back to section 2.3.4 for more detail.

5.3.2 Empirical Strategy

The empirical strategy outlined in Chapter 3 are employed again in this chapter to estimate the coefficients of interest for informal receipt and informal care provision. For brevity, the reader is directed to chapter 3. The objective of the analysis is two-fold. First, the chapter aims to examine associations between health insurance status and informal care. Second, the analysis also seeks to investigate the role of informal care, both received and provided on hospital and community care utilisation. As before, the approaches adopted are informed by

the ‘evaluation problem for cross sectional data’ (Jones, 2007a) to be addressed and a pragmatic approach to model choice given the data available which, amongst other limitations, is cross-sectional in nature. In summary, the approach adopted and presented for the analysis of health insurance status, healthcare utilisation and costs employs the matching method introduced in Chapter 3. For the analysis of healthcare costs, a series of generalised linear regression models and matching methods are employed.

5.4 Results

This section presents the empirical results from the analysis. The methodological approaches adopted explicitly attempted to identify the most appropriate empirical models for the cross-sectional data analysed. A series of multivariate regression models were estimated to explore associations between informal care and hospital and community care service utilisation and on total healthcare costs. In the following sections we present the results of the analysis looking at the relationship between healthcare service utilisation and informal care, both informal care received and informal care given. We begin by looking at the effect of informal care received on healthcare service utilisation. Next, results on the effect of informal care given by family members or others are presented. The results are detailed below. For information, a summary of the general findings for each healthcare service considered are presented in Table 5.1 below.

Table 5.1 Summary findings healthcare service utilisation by informal care

Hospital Services	**Summary Findings Informal Care Receipt**	**Summary Findings Informal Care Provision**
GP Services	Positive but statistically insignificant	Negative but statistically insignificant
Inpatient Services	Positive but statistically insignificant	Positive but statistically insignificant
A&E Services	Positive and statistically significant	Positive and statistically significant
Outpatient Services	Positive but statistically insignificant	Positive and statistically significant

Community Services	**Summary Findings Informal Care Receipt**	**Summary Findings Informal Care Provision**
Public Healthcare Nurse Services	Positive and statistically significant	Negative and statistically significant
Occupational Therapy Services	Positive and statistically significant	Positive but statistically insignificant
Chiropody Services	Positive and statistically significant	Negative but statistically insignificant
Physiotherapy Services	Positive and statistically significant	Positive and statistically significant
Home Help Services	Positive and statistically significant	Negative but statistically insignificant
Optician Services	Positive but statistically insignificant	Negative and statistically significant
Dental Services	Negative but statistically insignificant	Negative but statistically insignificant
Hearing Services	Positive but statistically insignificant	Negative but statistically insignificant
Dietician Services	Positive but statistically insignificant	Positive but statistically insignificant
Social Work Services	Negative but statistically insignificant	Negative but statistically insignificant
Physiological/Counselling Services	Positive but statistically insignificant	Positive but statistically insignificant
Personal Attendant Services	Positive and statistically significant	Positive but statistically insignificant
Meals-on-Wheels	Positive and statistically significant	Negative but statistically insignificant
Daycentre Services	Positive and statistically significant	Negative and statistically significant
Respite Services	Positive and statistically significant	Negative but statistically insignificant

5.4.1 Observed Matching Characteristics

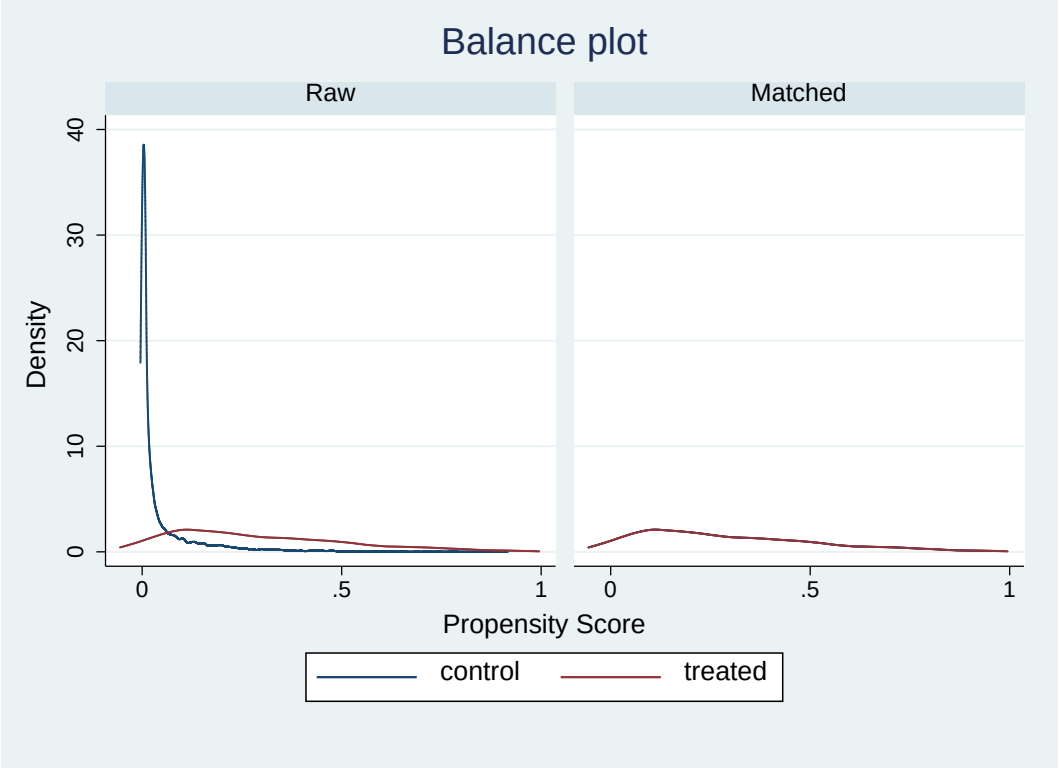
Table 5.2 below presents the matching covariates for both the treated and control groups, before and after matching. The table includes mean values for each of the independent variables for both the treated and control groups, both before and after matching as well as the standardised difference estimates for each independent variables before and after matching. The standardised difference assesses the extent to which the characteristics of both the treated and control group differ (Austin, 2009). Looking at the unmatched covariates, we see that the two groups differ quite substantially, with respect to age categories, gender, employment status and chronic disease prevalence. As can be seen from the table, the standardised difference before matching is considerably higher than that after matching suggesting that both the treatment and control group are much similar in terms of their observable characteristics after matching. Overall, the unmatched sample demonstrates that the treated group are older, have poorer self-reported health and have a greater number of chronic illnesses. In terms of the propensity for being in the treated group, the imbalance in the distributions of the propensity scores that exists before matching is eliminated after matching. As Figure 5.1 below shows, the distributions of the propensity scores of both the treated and control group after matching are virtually identical.

Table 5.2 Observed matching characteristics

	Before Matching			After Matching		
	Treated	**Control**		**Treated**	**Control**	
	Mean	**Mean**	**Standardised Difference**	**Mean**	**Mean**	**Standardised Difference**
Independent Variables						
55-64	0.214	0.383	-0.376	0.214	0.214	-0.028
65-74	0.234	0.266	-0.75	0.234	0.241	-0.099
75-84	0.293	0.125	0.421	0.293	0.294	-0.009
85+	0.167	0.019	0.527	0.167	0.163	0.088
Male	0.348	0.465	-0.241	0.348	0.394	-0.122
Married	0.525	0.701	-0.369	0.525	0.542	-0.095
Second level – Inter Cert	0.185	0.236	-0.126	0.185	0.170	-0.054
Second level – leaving Cert	0.094	0.172	-0.230	0.094	0.091	0.056
Diploma/Certificate	0.102	0.157	-0.164	0.102	0.098	0.026
Degree	0.039	0.088	-0.199	0.039	0.048	-0.099
Postgraduate Degree	0.028	0.059	-0.153	0.028	0.029	-0.045
Retired	0.523	0.362	0.328	0.523	0.537	0.043
Other	0.426	0.258	0.361	0.426	0.402	0.008
Other town or city	0.301	0.282	0.041	0.301	0.303	0.022
Rural area	0.479	0.479	0.0002	0.479	0.470	0.012
Irish	0.921	0.906	0.056	0.921	0.918	0.029
Living with spouse	0.383	0.398	-0.030	0.383	0.395	-0.048
Living with others	0.306	0.387	-0.170	0.306	0.309	-0.092
€20k-<€40k	0.383	0.353	0.062	0.383	0.394	-0.044
€40k-<€60k	0.098	0.216	-0.327	0.098	0.100	-0.020
€60k-<€80k	0.022	0.089	-0.297	0.022	0.020	0.014
€80k-<€100k	0.010	0.021	-0.093	0.010	0.006	0.071
€100k	0.008	0.035	-0.186	0.008	0.010	-0.073
Angina	0.145	0.049	0.331	0.145	0.160	0.023
Myocardial Infarction	0.094	0.043	0.204	0.094	0.098	0.049
Congestive Heart Failure	0.018	0.010	0.063	0.018	0.019	0.049
Diabetes	0.155	0.072	0.265	0.155	0.156	-0.037
Stroke	0.073	0.012	0.303	0.073	0.074	-0.098
Chronic lung disease	0.094	0.037	0.235	0.094	0.090	0.034
Asthma	0.155	0.087	0.208	0.155	0.159	-0.011

	Before Matching			After Matching		
	Treated	**Control**		**Treated**	**Control**	
	Mean	**Mean**	**Standardised Difference**	**Mean**	**Mean**	**Standardised Difference**
Arthritis	0.572	0.255	0.678	0.572	0.582	-0.129
Osteoporosis	0.191	0.090	0.293	0.191	0.180	0.030
Cancer	0.092	0.061	0.119	0.092	0.083	0.042
Emotional/psychiatric problems	0.163	0.080	0.257	0.163	0.165	0.016
Alcohol substance abuse	0.029	0.015	0.096	0.029	0.034	-0.073
Anxiety	0.096	0.044	0.204	0.096	0.093	0.034
Depression	0.110	0.050	0.223	0.110	0.108	0.013
Pain	0.695	0.331	0.782	0.695	0.697	-0.087
Long-term illness	0.077	0.157	-0.252	0.077	0.086	-0.050
Limiting long-term illness	0.735	0.197	1.280	0.735	0.731	0.009
One chronic illness	0.163	0.287	-0.300	0.163	0.153	0.066
Two chronic illnesses	0.195	0.233	-0.094	0.195	0.182	0.061
Three or more chronic illnesses	0.589	0.239	0.760	0.589	0.620	-0.146
Fair health	0.381	0.167	0.494	0.381	0.388	-0.048
Good health	0.236	0.332	-0.214	0.236	0.248	0.037
Very good health	0.084	0.300	-0.568	0.084	0.080	0.029
Excellent health	0.028	0.165	-0.480	0.028	0.026	-0.023

Figure 5.1 Balance Plot depicting Matched and Unmatched Samples



5.4.2 Health Insurance and Informal Care

In this section, the estimates on the association between health insurance status and informal care. First, the estimated coefficients on informal care received are presented, followed by those for informal care provision.

5.4.2.1 Health Insurance and Informal Care Received

In this section, I present and discuss the results of analysis of the impact of health insurance status on people's propensity to receive informal care. The analysis that follows has been analysed from a number of angles. First, in terms of health insurance status, I have followed the approach taken in previous chapters, whereby the health insurance variable contains four distinct groups: those with public insurance only (our reference group), those with a medical card only, those with PHI only and those with both a medical card and PHI. In addition, we create a group "Either" that compares individuals with either a medical care or PHI or both to those who have public health insurance only. As mentioned previously, the TILDA questionnaire lists a number of variables that detail informal care received from a spouse, a resident child, a non-resident child or others. This disaggregation is used to examine the impact of health insurance status on these various caring groups. In addition, results on the

impact of health insurance status on an individual's propensity to receive informal care from any source are presented. As in previous chapters, matching methods are employed to account for observable heterogeneity between insurance status and informal care received. Both propensity score matching and Mahalanobis matching techniques are employed.

The estimated coefficients on the association between health insurance status and informal care received are presented in Tables 5.3-5.8. Looking at the impact of insurance status on an individual's propensity to receive any informal care, the results are consistent and show, for the most part, a positive and statistically significant association between insurance status and informal care received (see Table 5.3 below). The exception here is for those with PHI only, where we find no statistically significant association between it and informal care received. Once we account for observable heterogeneity, we find, that, on average, individuals with either a medical card or PHI or indeed both, are approximately three percentage points more likely to receive informal care from any source. Interestingly, using OLS regression does not find any significant association between insurance status and informal care received highlighting the importance of accounting for observable heterogeneity. Matching on Mahalanobis distance, shows that individuals with a medical card are 6.6 percentage points more likely to receive care compared to those with public health insurance only. Individuals with both a medical card and PHI are approximately three percentage points more likely to receive such care. This result is consistent across both matching techniques used.

The results on the impact of health insurance status on spousal care received are presented in Table 5.4 below. Generally, the estimated coefficients suggest a negative but statistically insignificant relationship between insurance status and informal care received. The analysis finds no significant relationship between resident care received and those with both a medical card and PHI for any of the methods used. Similarly, no significant association is found for those with PHI only. For those with a medical card only and for those with either a medical card, PHI or both, I find a positive and statistically significant association when matching on the propensity score. When matching via the Mahalanobis distance, this statistically significant association disappears. Where a statistically significant association is found, the magnitude is so small as to render it economically insignificant.

Table 5.3 ATET of health insurance status on any informal care received

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	-0.0104	-0.0182**	-0.00586	-0.00321
PSM				
1:1	0.0362***	0.0350	0.00305	0.0338***
MM				
Base	0.0305**	0.0662***	0.00153	0.0293***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 5.4 ATET of insurance status on informal care received from a spouse

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	-0.00400	-0.00164	-0.00460	-0.00256
PSM				
1:1	-0.00567	-0.00269	-0.00305	0.00330
MM				
Base	-0.00213	-0.00731	-0.000916	-0.00247

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 5.5 ATET of insurance status on informal care received from a resident child

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	-0.00153	-0.000486	-0.000815	-0.000662
PSM				
1:1	0.00213	0.0104***	-0.000305	0.00426***
MM				
Base	-0.00567	0.00308	0.000611	-0.000137

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 5.6 ATET of insurance status on informal care received from a non-resident child

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	-0.00169	-0.000751	0.0000221	0.000504
PSM				
1:1	-	0.00963***	0.000382	0.00330
MM				
Base	0.00355*	0.0115***	0.000382	0.00536***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 5.7 ATET of insurance status on informal care received from others

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	-0.00308	-0.00461	-0.000531	-0.000128
PSM				
1:1	0.0234***	0.0327***	0.00275**	0.0103*
MM				
Base	0.0213***	0.0335***	0.00183	0.0162***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 5.8 ATET of insurance status on informal care received from more than one person

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	-0.00194	-0.00774	-0.00170	-0.000956
PSM				
1:1	0.00567	-0.0104	-0.00397	0.00989**
MM				
Base	0.00355	0.0135	0.000305	0.00481

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

The results on the estimated associations between health insurance status and informal care received from a non-resident child are presented in Table 5.6. For the most part, no statistically significant association between almost all of the health insurance categories and care received from a non-resident child is found. The exception here is for those with a medical card only. For individuals in this category, they are, on average, one percentage point more likely (than those with public health insurance) to receive care from a non-resident child after we control for observable heterogeneity. After matching on the Mahalanobis distance, those with both a medical card and PHI and those with either a medical card or PHI or both are significantly more lively (than our base category of public health insurance) on average, to receive care from a non-resident child. The magnitude of the association is minimal however at less than half a percentage point.

I find a strong and statistically significant association between health insurance status and informal care received from others. The results are presented in Table 5.7 below. The estimated coefficients highlight the importance of accounting for observable heterogeneity in the relationship between health insurance and informal care receipt. While OLS finds no statistically significant relationship, our matching methods find a positive and statistically significant relationship between health insurance status and informal care received from others. Our results are consistent across each of the health insurance categories. In broad terms, those with higher levels of health insurance are between 1-3 percentage points more likely to receive informal care from others relative to those with only public health insurance, everything else equal. The magnitude of the association is highest for those with a medical card only and lowest for those with PHI only.

The impact of health insurance status on informal care received from more than one person is also estimated. These are presented below in Table 5.8. In general, no statistically significant association between these two variables is found. However, after matching on the propensity score, individuals with either a medical care, PHI only or both are significantly more likely (compared to those with public health insurance) on average to receive care from more than one person. The magnitude of this association is small however and is less than 1%.

5.4.2.2 Health Insurance and Informal Care Provided

In this section, we analyse the associations between insurance status and informal care given. The health insurance categories are the same as what has been used throughout the thesis. The

informal care given variable is categorical in nature and we look at the impact of health insurance status on three categories of informal care given – any care given; care given to one person and finally, care given to more than one person. First, the results on the impact of health insurance status on one's propensity to provide any informal care are presented in Table 5.9. After accounting for observable heterogeneity by matching on the propensity score, those with both a medical card and PHI are significantly more likely than those with public health insurance to provide informal care, everything else equal. Looking at informal care provided to one person only, I find no statistically significant relationship between health insurance status and informal care given to one person although the direction of the estimated coefficients is negative. The estimated coefficients on the impact of health insurance status on informal care given to more than one person are presented in Table 5.11. The matching methods employed display somewhat contradictory results. Results from matching on the propensity score suggest that individuals with both a medical card and PHI are seven percentage points more likely on average to provide care to someone else compared to the base case (public health insurance only). Those with either a medical card, PHI or both are four percentage points more likely to provide care on average compared to those in the base case. Conversely, after matching on the Mahalanobis distance, those with higher levels of health insurance are statistically and significantly less likely to provide care to more than one person relative to those in the base case. The magnitude of the impact ranges from 6 percentage points for those with either a medical card, PHI or both to ten percentage points for those with a medical card. No statistically significant impact of PHI only on informal care given to more than one person found.

Table 5.9 ATET of health insurance on any informal care provided

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	0.0228	-0.0849***	0.00215	-0.00814
PSM				
1:1	0.0894***	0.0404	-0.00234	0.00437
MM				
Base	-0.0987***	-0.0841***	-0.00789	-0.0602**

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 5.10 ATET of health insurance status on informal care provided to one person

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	0.00576	-0.00106	-0.0103	-0.00650
PSM				
1:1	-0.0240	-0.00673	-0.00357	-0.0133
MM				
Base	-0.0153	-0.0207	-0.00785	-0.0123

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

Table 5.11 ATET of health insurance status on informal care provided to more than one person

	Both	**Medical Card Only**	**PHI Only**	**Either**
OLS	0.0214	-0.0319	-0.0319	-0.00743
PSM				
1:1	0.0737***	-0.0155	0.0504	0.0416**
MM				
Base	-0.0841***	-0.104***	-0.00199	-0.0585**

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Group 1: **(Base)** Public health insurance (no medical card)

5.4.3 The Relationship between Informal Care Receipt and Provision and Healthcare Services Utilisation

In this section, results on associations between informal care receipt and provision on healthcare service utilisation are presented. First, we present results for the hospital services before moving on to discuss the results for the various community care services analysed.

5.4.3.1 GP Services

The results from the analysis of GP services are presented in Table 5.12 and 5.13 respectively and are described below. To account for observable heterogeneity in the relationship between informal care and GP services utilisation we employed two matching approaches – the first based on matching on the propensity score and second, matching based on the Mahalanobis distance. Results are first presented on informal care receipt and then for informal care provision. The impact of informal care receipt is presented across a number of categories – care received from (1) a spouse; (2) a resident child; (3) a non-resident child; (4) others and (5) more than one carer. We also estimate the impact of receiving any informal care on a respondent's propensity to use GP services. The impact of informal care provision is also estimated across a number of categories (1) care provided to one individual and (2) care provided to multiple individuals. Again, I estimate the impact of providing any informal care on the carers' propensity to use GP services. Estimated coefficients are presented as average partial effects.

In terms of informal care receipt, I find no statistically significant relationship between informal care and GP services utilisation, even after controlling for a range of socio-economic and health related variables. For those in receipt of care from others, matching on the propensity score yields statistically significant results. The estimated coefficient suggests that this group are 4.3 percentage points less likely to use GP services all else being equal. I find no statistically significant association between informal care provision and GP services utilisation for any of the matching approaches analysed or indeed across any of the care groups. In summary, I find that informal care is not a significant predictor of GP services utilisation ceteris paribus.

5.4.3.2 Hospital Services

The results from the analyses for hospital services are presented in Table 5.12 and Table 5.13 and are described below. For each of the hospital care services analysed, two different

matching techniques to account for observable heterogeneity between both informal care received and provided on hospital services admissions were employed. For comparative purposes, results are presented for the propensity score matching and Mahalanobis matching analyses. Results are first presented on informal care receipt followed by those on informal care provision. In the case of informal care receipt on hospital service utilisation, results are presented for each category (i.e. spouse; resident child; non-resident child; other, more than one carer and any) relative to the base-category of no informal care received (Base). Results are presented for each informal care provision category (i.e. care provided to one individual, care provided to more than one individual and care provided to anyone) relative to the base-category of no informal care provision (Base). For each of the healthcare services analysed, results are presented in terms of average partial effects.

5.4.3.2.1 Inpatient Hospital Admissions

The results on inpatient hospital services are presented in Tables 5.12 and 5.13 and are described below.

5.4.3.2.1.1 Informal Care Receipt

Looking at informal care receipt first, estimated coefficients for the propensity score matching and matching analyses based on the Mahalanobis distance are presented in Table 5.12. The results for both approaches are generally consistent in that they indicate that individuals who receive informal care are associated with a statistically significant higher probability of hospital inpatient utilisation. Nonetheless, there were some differences in estimated coefficients and statistical significance.

More specifically the propensity score matching approach estimates that, relative to the base category of no informal care receipt, the probability of hospital inpatient utilisation is 1 percentage points higher for those who receive informal care from a spouse and 2.5 percentage points higher for those who receive care from a resident child. In contrast, the probability of utilisation is; 3.57 percentage points lower for those who receive care from a non-resident child. The probability of hospital inpatient utilisation is much higher for those who receive care from others at 17 percentage points and 7.58 percentage points higher for those who receive care from more than one carer. The result is statistically significant for those receiving care from others and from those receiving care from more than one carer. In addition, the approach adopted allows for the estimation of the impact of having received any informal

care. The results indicate that relative to the base category of no informal care receipt, those individuals who receive any informal care were 5.2 percentage points more likely to use hospital inpatient services and this result was statistically significant.

The results from the matching approach based on the Mahalanobis distance indicate that, relative to the base category of no informal care receipt, the probability of hospital inpatient utilisation is 2.8 percentage points higher for those who receive care from a spouse. The probability of utilisation is much lower for those who receive care from a resident child at 17 percentage points. Those receiving care from a resident child are 10 percentage points more likely to use inpatient services and 11.8 percentage points more likely to do so if receiving care from others and finally, 9.2 percentage points higher for those who receive care from more than one carer. The estimated coefficients are statistically significant for those who receive care from a resident child and from others. In addition, the results indicate, that relative to the base category, those who receive any form of informal care were 7.14 percentage points more likely to use hospital inpatient services and this result is statistically significant.

5.4.3.2.1.2 Informal Care Provision

Results on the association between informal care provision and inpatient admissions are presented in Table 5.12. As above, estimated coefficients on two separate matching approaches are presented; one based on propensity score matching and the second based on the Mahalanobis distance matching. The estimated relationship of any informal care provision on hospital inpatient utilisation is also presented. The results for both approaches are generally consistent, but in contrast to those for informal care receipt, the findings here indicate no statistically significant association between informal care provision and hospital inpatient utilisation.

The results based on the propensity score matching approach indicate that relative to the base category, the probability of hospital inpatient utilisation is 0.09 percentage points higher for those who provide any informal care; 1.61 percentage points higher for those who provide care to one individual and 1.01 percentage points lower for those who provide care to multiple individuals. The results for each group are statistically insignificant.

Results from the matching approach based on the Mahalanobis distance indicate that, relative

to the base category, the probability of hospital inpatient utilisation is 0.98 percentage points higher for those who provide any informal care. The probability of utilisation is 3.64 percentage points higher for those who provide care for one person and 0.81 percentage points higher for those who provide care to more than one individual. As with the PSM approach above, the estimated coefficients are statistically insignificant across each of the groups analysed.

5.4.3.2.1.3 Summary

In summary, the results presented above, suggest a positive and statistically significant association between any form of informal care receipt on hospital inpatient utilisation, whilst I find no statistically significant association between informal care provision and inpatient hospital admissions.

5.4.3.2.2 Accident and Emergency (A&E) Admissions

In this section, results on hospital A&E admissions are presented in Tables 5.12 and 5.13 and are described below.

5.4.3.2.2.1 Informal Care Receipt

First, for those in receipt of informal care, estimated coefficients for both matching approaches are presented in Table 5.12. Overall, the results for both approaches were generally consistent in that they indicate that greater levels of informal care receipt are associated with a non-significant but higher probability of hospital A&E utilisation.

Looking first at the propensity score matching estimates, we find that relative to the base category of no informal care receipt, the probability of hospital A&E utilisation is 5 percentage points higher for those who receive spousal care and 2.5 percentage points higher for those who receive care from a resident child. In contrast, the probability of A&E utilisation is 4.8 percentage points lower for those who receive informal care from a non-resident child. Those who receive care from others as well as those who receive care from more than one carer are 5 percentage points more likely to use A&E services. However, none of the estimated coefficients are statistically significant. In addition, this approach allows for the estimation of the impact of having received any form of informal care. The results indicate that relative to the base category, those who receive any form of informal care are 7.22 percentage points more likely to use A&E services, and this estimate is statistically significant.

The results from the matching approach based on the Mahalanobis distance are generally similar to those from the PSM approach. While the estimated coefficients from each of the groups analysed indicate a positive relationship between informal care receipt and A&E utilisation, none are statistically significant. The estimated relationship of any informal care provision on hospital inpatient utilisation is also presented. Individuals in this group are 6.7 percentage points more likely to use A&E services and this result is statistically significant.

5.4.3.2.2.2 Informal Care Provision

Results on the relationship between informal care provision and A&E admissions are presented in Table 5.13. As above, estimated coefficients on two separate matching approaches are presented; one based on propensity score matching and the second matching analyses based on the Mahalanobis distance. The estimated coefficients of any informal care provision on hospital A&E admissions are also presented. The results for both approaches indicate no statistically significant association between informal care provision and hospital A&E utilisation.

Results from the PSM approach indicate that, relative to the base category, the probability of hospital A&E utilisation is 2.42 percentage points higher for those who provide any informal care; 4.22 percentage points higher for those who provide care to one individual and 2.22 percentage points higher for those who provide care to more than one individual. The estimated coefficients are statistically significant for those who provide any care and for those who provide care to more than one person.

Similarly, the results from the matching approach based on the Mahalanobis distance indicate a positive and statistically significant association between any informal care provision and A&E utilisation compared to the base case of no informal care. Individuals who provide care are 3.31 percentage points more likely to use A&E services. Those who care for one person and those who provide care to many are 5.83 and 3.03 percentage points respectively, more likely to use A&E services. Both estimates were also statistically significant.

5.4.3.2.2.3 Summary

In summary, the results presented above suggest contrasting results. I find no statistically significant association between informal care receipt and hospital A&E admissions; whilst I

find a positive and statistically significant association between informal care provision and A&E service utilisation.

5.4.3.2.3 Hospital Outpatient Admissions

The results on outpatient hospital services are presented in Tables 5.12 and 5.13 and are described below. Looking at the estimated coefficients on informal care receipt first, no statistically significant difference between those who receive informal care versus those who do not in terms of their utilisation of GP services is found. In fact, I find no statistically significant difference across each of the informal care receipt groups analysed with one exception. Individuals who receive care from others are significantly less likely to visit a GP when we match on the propensity score. Individuals in receipt of informal care from others are 4.3 percentage points less likely to use GP services, everything else equal. In terms of informal care provision, we find no statistically significant relationship with GP services utilisation.

5.4.3.2.3.1 Informal Care Receipt

In terms of informal care receipt first of all, the estimated coefficients for both matching approaches are similar, in that they indicate that individuals who receive informal care are significantly and statistically more likely on average to use hospital outpatient services. According to the PSM approach, those in receipt of spousal care only are 10.7 percentage points higher more likely to use hospital outpatient services. The likelihood of utilisation of such services is slightly lower but positive (7.5%) for those who receive informal care from a resident child and 4.8 percentage points higher for those who receive care from a non-resident child. Again, relative to the base case, outpatient services utilisation is 1.4 percentage points higher for those who receive care from others and 8.5 percentage points higher for those who receive care from more than one carer. While the direction of the association is positive in all cases, the estimated coefficients are statistically significant for spousal care only. Finally, the results also indicate that, relative to the base category, individuals who receive any informal care are 1.32 percentage points more likely to use hospital outpatient services although this result was statistically insignificant.

Estimated coefficients based on matching on the Mahalanobis distance indicate that relative to the base category, the probability of hospital outpatient utilisation is 14 percentage points higher for those who receive care from a spouse. Those who receive care from a non-resident

child are 15 percentage points more likely to use the services available although this result is not statistically significant. The likelihood of outpatient utilisation is estimated to be 5.7 percentage points higher for those who receive care from others and 5.9 percentage points higher for those who receive care from more than one carer. Neither of these coefficients are statistically significant. In addition, the results indicate, that relative to the base category, those who receive any form of informal care are 7 percentage points more likely to use hospital outpatient services and this result is statistically significant.

5.4.3.2.3.2 Informal Care Provision

Results on associations between informal care provision and outpatient admissions are presented in Table 5.13. As above, estimated coefficients on two separate matching approaches are presented. The results for both approaches vary; both in terms of statistical significance and in terms of the estimated coefficients, depending on the matching approach adopted. Results from the propensity score matching approach indicate that, relative to the base category, the probability of hospital outpatient utilisation is 2 percentage points higher for those who provide any informal care as well as those providing care to more than one person, although neither coefficient is statistically significant. In contrast, those who provide care to one person are 5.6 percentage points more likely to use outpatient services and this result is statistically significant.

The results from the matching approach based on the Mahalanobis distance indicate that relative to the base category, the probability of hospital outpatient utilisation is 6.12 percentage points higher for those who provide any informal care; 1 percentage point higher for those who provide care for one person and 7.23 percentage points higher for those providing care for multiple individuals. The estimated coefficients are statistically significant for those who provide any care as well as for those who provide care to multiple patients.

5.4.3.2.3.3 Summary

The results presented above, suggest a positive but statistically insignificant association between informal care receipt on outpatient utilisation; whilst although we find a positive association between informal care provision on hospital outpatient utilisation generally, the significance level differs across groups and between matching methods adopted.

Table 5.12 Average treatment effect on the treated of informal care receipt on GP and hospital service utilisation

Healthcare Service	Matching method	Spousal care	Resident child	Non-resident child	Others	Care received from more than one carer	Any care
GP Services							
	OLS	0.0306**	-0.0289	0.0131	-0.0489**	-0.0280	-0.0171
	PSM	0.0337	-0.0250	0.0119	-0.0429**	-0.00758	-0.00451
	MM	0.0449	-0.0278	0.0000	-0.0357	0.0000	0.00454
A&E Services							
	OLS	0.0658	-0.0150	-0.00500	0.00616	0.0348	0.0291
	PSM	0.0506	0.0250	-0.0476	0.0500	0.0530	0.0722**
	MM	0.107	-0.0833	0.0750	0.0393	0.0846	0.0669**
Inpatient Services							
	OLS	0.0517	-0.0363	0.0201	0.0836**	0.0580	0.0564**
	PSM	0.0169	0.0250	-0.0357	0.171***	0.0758*	0.0519**
	MM	0.0281	-0.167*	0.100	0.118**	0.0923	0.0714**
Outpatient Services							
	OLS	0.112**	-0.0256	0.0867	-0.0534	-0.0332	0.0108
	PSM	0.107*	0.0750	0.0476	0.0143	0.0846	0.0132
	MM	0.140**	0.0000	0.150	0.0571	0.0590	0.0707**

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Receiving no care

Table 5.13 Average treatment effect on the treated of informal care provision on GP and hospital service utilisation

Healthcare Service	Matching method	Any care	One	Multiple
GP Services				
	OLS	-0.0119	-0.0244	-0.00972
	PSM	-0.0123	-0.00496	-0.00972
	MM	-0.0113	-0.0352	-0.00730
A&E Services				
	OLS	0.0173**	0.0357*	0.0145
	PSM	0.0242**	0.0422	0.0222*
	MM	0.0331***	0.0583**	0.0303***
Inpatient Services				
	OLS	-0.00207	0.0208	-0.00472
	PSM	0.000889	0.0161	-0.0101
	MM	0.00984	0.0364	0.00809
Outpatient Services				
	OLS	0.0220**	0.00805	0.0249**
	PSM	0.0202	0.0558*	0.0212
	MM	0.0612***	0.00993	0.0723***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = providing no care

5.4.3.3 Community Care Services

Estimated coefficients on associations between informal care receipt and provision and community services utilisation are presented in Table 5.14-5.15 and are described below. We adopted a similar approach to that taken for the hospital services described above; that is, for each of the community care services analysed, we employed PSM and Mahalanobis matching approaches. Results are presented from both the perspective of those in receipt of and from those who provide informal care in turn. In all cases, the impact of informal care received is presented for each informal care category (i.e. spousal care; care received from a resident child; care received from a non-resident child, care received from others and care received from more than one carer) relative to the base-category of no informal care received. Similarly, for informal care provision, results are presented for each category (i.e. care provided to one individual, care provided to more than one individual and care provided to anyone) relative to the base-category (Base). As before, estimated coefficients are presented in terms of average partial effects.

5.4.3.3.1 Public Healthcare Nurse Services

The results for the empirical analysis of public healthcare nurse (PHN) services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.1.1 Informal Care Receipt

Concentrating on the results from the perspective of informal care receipt first, the estimated coefficients for both matching approaches are generally consistent, in that they indicate that individuals who receive informal care are associated with a statistically significant higher probability of public healthcare nurse utilisation. Nonetheless, there were some differences in estimated coefficients and statistical significance.

The estimated coefficients from the PSM approach for each of the groups analysed are large and statistically significant. More specifically, the probability of PHN utilisation is 10 percentage points higher for those who receive informal care from a spouse and 25 percentage points higher for those who receive care from a resident child. Those receiving care from a non-resident child are even more likely to use such services (27.5 percentage points higher) while those receiving care from others are 29 percentage points more likely to avail of PHN services. Lastly, those who receive care from more than one carer are 22 percentage points more likely to use such services. As was the case above for hospital services, our approach

allows for the estimation of the impact of having received any informal care. The results indicate that relative to the base category, individuals in this group are almost 21 percentage points more likely to use PHN services and this result too, was statistically significant at the 1% level.

5.4.3.3.1.2 Informal Care Provision

Results for informal care provision on PHN utilisation are presented in Tables 5.15. As above, estimated coefficients on two separate matching approaches are presented. The results for both approaches are generally consistent in that they indicate that individuals who provide informal care are less likely to use PHN services. However, the economic difference is small. In all groups analysed, the probability of PHN utilisation is just over 1% lower, relative to the base case for those who provide informal care. The estimates are statistically significant for those who provide any informal care and for those who provide care to multiple individuals where the probability of utilisation is 1.15 and 1.43 percentage points lower respectively relative to the base case of providing no care.

Turning to our matching estimates based on the Mahalanobis distance, we find that, relative to the base category, the probability of public healthcare service utilisation is once again economically insignificant. For instance, the probability of utilisation is 0.776 percentage points lower for those who provide any care; 3.72 percentage points lower for those who provide care to one person and 0.616 percentage points lower for those who provide care to more than one person. The estimated coefficients are statistically significant for those who provide care to one person only.

5.4.3.3.1.3 Summary

In summary, the results presented above, suggest a positive and statistically significant association between any form of informal care receipt and public healthcare nurse utilisation, although the estimates are economically insignificant. In terms of the results from the perspective of those who provide care, evidence of a significant association is mixed. While, we find a negative association between informal care provision and PHN utilisation, the statistical significance of this association differs across groups and between the matching methods adopted.

5.4.3.3.2 Occupational Therapy Services

The results for the empirical analysis of occupational therapy (OT) services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.2.1 Informal care receipt

Looking first at the effect of informal care receipt on OT services utilisation, the estimated coefficients from both matching approaches throw up some interesting results and suggest that the probability of utilisation is dependent on the family member providing care. The estimated coefficients between both matching approaches are generally consistent, in that they indicate that individuals in receipt of informal care are significantly more likely to use OT services relative to those who receive no such care, everything else being equal.

Estimated coefficients from the PSM approach are statistically significant for those receiving care from others and from more than one carer. For both of these groups our estimates indicate that, relative to the base case, the probability of OT services utilisation is five and nine percentage points higher respectively In addition, the approach adopted allows for the estimation of the impact of having received any informal care. Individuals in receipt of any informal care are just over 6 percentage points more likely to use OT services and this result is statistically significant.

The estimated coefficients from matching based on the Mahalanobis distance are generally consistent with those from the PSM approach. Once again, we find a statistically significant association on OT services utilisation for those who receive care from others (5 percentage points higher) and from more than one carer (12 percentage points higher). We also find a statistically significant association on utilisation for those in receipt of informal care from a spouse. Individuals in this group are 5 percentage points more likely to use OT services on average, relative to the base category. In addition, the results indicate, that those who receive any form of informal care are 6 percentage points more likely to use OT services and this result is statistically significant at the 1% level.

5.4.3.3.2.2 Informal Care Provision

Results on the impact of informal care provision on OT services utilisation are presented in Tables 5.14. As above, estimated coefficients on two separate matching approaches are presented. The results for both approaches are generally consistent and suggest that,

conditional on observable characteristics, there is no association between informal care provision and OT services utilisation. More specifically, estimated coefficients from the PSM approach are both statistically and economically insignificant relative to the base category. Estimated coefficients from matching based on the Mahalanobis distance are similar to those from the PSM approach in that associations between informal care provision and OT services utilisation are both statistically and economically insignificant. However, the direction of the association differs depending on the number of people individual carers care for. For example, individuals who provide care to one person are less likely to use OT services compared to those who provide no such care. In contrast, those who provide care to more than one person are more likely to use such services, relative to the base case. Relative to the base category, those who provide any form of informal care are more likely to use occupational therapy services everything else being equal.

5.4.3.3.2.3 Summary

Taken together, the results presented above, suggest a positive and statistically significant association between OT service utilisation and informal care receipt, whilst I find no statistically or economically significant association between informal care provision and OT service utilisation.

5.4.3.3.3 Chiropody Services

The results for the empirical analysis on chiropody services utilisation are presented in Tables 5.14-5.15 and described below.

5.4.3.3.3.1 Informal Care Receipt

In general, the estimated coefficients from both matching approaches are consistent in that they indicate no significant relationship between informal care receipt and chiropody services utilisation. In terms of the PSM approach more specifically, if one compares across each of the groups analysed, we find a statistically significant relationship exists between chiropody services utilisation and informal care receipt from a resident child only. The estimated coefficients from this model indicate that relative to the base case of no informal care, individuals are 12.5 percentage points less likely to use chiropody services everything else equal. Interestingly, the direction of the association between utilisation and receipt of care is positive for each care group, except for those who receive care from a resident child, highlighting the importance of a resident child in the informal care process. In addition, the approach adopted allows for the estimation of the impact of having received any informal

care. The results indicate that relative to the base category, individuals who receive any informal care are 5.9 percentage points more likely to use chiropody services and this result was statistically significant at the 5% level.

The results from the matching approach based on the Mahalanobis distance are generally consistent with those from the PSM approach in that the direction of the association between chiropody services utilisation and the care groups analysed is the same for both approaches. That is, in most cases we find a positive association between informal care receipt and utilisation with the one exception being for care received from a resident child, where I find a negative association. In contrast to the PSM approach, I find no statistically significant association between utilisation of chiropody services and informal care receipt from a resident child. Instead, for the Mahalanobis matching approach a statistically significant association between informal care and care received from more than one carer is found. Here, individuals in this group are 10 percentage points more likely to use chiropody services. In addition, relative to the base category, those who receive any form of informal care are 4.2 percentage points more likely to use chiropody services and this result too is statistically significant.

5.4.3.3.3.2 Informal Care Provision

Results on the association between informal care provision on chiropody services utilisation are presented in Tables 5.15. Looking at the estimated coefficients from the PSM approach first, I find a statistically significant association between informal care provision to one person and chiropody services utilisation. That is, the estimates coefficients show that, relative to the base category, the probability of chiropody service utilisation is almost 2 percentage points higher for those who provide care for one person. The association between chiropody services utilisation and the provision of care to more than one person is statistically and economically insignificant. Individuals who provide any informal care are 0.41 percentage points less likely to use chiropody services relative to the base care, although this result is also statistically insignificant. The results from the matching approach based on the Mahalanobis distance find no statistically or economically significant relationship between informal care provision and chiropody services utilisation on average, everything else being equal. For each of the groups analysed the direction of the association is negative in nature.

5.4.3.3.3.3 Summary

To summarise, the results presented above, suggest a positive and statistically significant

relationship between receipt of any form of informal care on chiropody services utilisation, while I find no statistically significant relationship between informal care provision and a carers propensity to use chiropody services, everything else being equal.

Table 5.14 Average treatment effect on the treated of informal care receipt on Community Care Service Utilisation

Healthcare Service	Matching method	Spousal care	Resident child	Non-resident child	Others	Care received from more than one carer	Any care
Public Healthcare Nurse Services							
	OLS	0.0985**	0.175**	0.161**	0.283***	0.203***	0.198***
	PSM	0.0899*	0.125***	0.202***	0.250***	0.149***	0.157***
	MM	0.101*	0.250***	0.275***	0.289***	0.221***	0.207***
Occupational Therapy Services							
	OLS	0.0240	0.0396	0.0370	0.0596**	0.102***	0.0612***
	PSM	0.0225	0.0500	0.0476	0.0500*	0.0909**	0.0609***
	MM	0.0449*	0.0278	0.0250	0.0500*	0.115***	0.0590***
Chiropody Services							
	OLS	-0.000830	-0.0396	0.108*	0.0324	0.0645*	0.0352**
	PSM	0.0449	-0.125**	0.0476	0.0429	0.0720	0.0587**
	MM	0.0225	-0.0833	0.100	0.0321	0.100**	0.0420*

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Receiving no care

Table 5.15 Average treatment effect on the treated of informal care provision on community care service utilisation

Healthcare Service	Matching method	Any care	One	Multiple
Public Healthcare Nurse Services				
	OLS	-0.0113**	-0.0156*	-0.0114**
	PSM	-0.0115*	0.0136	-0.0143**
	MM	-0.00776	-0.0372**	-0.00616
Occupational Therapy Services				
	OLS	-0.00142	-0.00915**	-0.000345
	PSM	0.00427	0.00000	-0.000830
	MM	0.00249	-0.00993	0.00457
Chiropody Services				
	OLS	-0.00195	0.00136	-0.00346
	PSM	-0.00409	0.0199**	0.00332
	MM	-0.00231	-0.0124	-0.000623

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = providing no care

5.4.3.3.4 Physiotherapy Services

The results for the empirical analysis on physiotherapy services utilisation are presented in Tables 5.14-5.15 and described below.

5.4.3.3.4.1 Informal Care Receipt

Looking firstly at the relationship between informal care receipt on service utilisation, the estimated coefficients from both matching approaches are generally consistent across the care groups, in that they indicate that informal care receipt is associated with a statistically significant higher probability of physiotherapy services utilisation.

The estimated coefficients from the PSM approach indicate a positive relationship between informal care receipt and physiotherapy services utilisation with the exception of care received from a resident child. We find that relative to the base category, individuals in this group are 5 percentage points less likely to use these services, although this result is not statistically significant. I do find a statistically significant association between utilisation and those who receive care from a spouse, as well as those who receive care from more than one carer. For both groups relative to the base category, the probability of physiotherapy services utilisation is 10 percentage points higher. I also estimated the impact of having received any informal care. The results indicate, that relative to the base category, individuals who receive any informal care are 4.3 percentage points more likely on average, to use physiotherapy services everything else equal, although this result is statistically significant.

The results from the matching approach based on the Mahalanobis distance are somewhat similar to those based on PSM. As above, I find a statistically significant association between physiotherapy services utilisation and care received from more than one person. Relative to the base case, individuals in this group are 9 percentage points more likely on average to use physiotherapy services. In contrast to the PSM approach, matching based on the Mahalanobis distance indicates a positive and statistically significant association between utilisation and informal care received from others. Individuals in this group are 10.4 percentage points more likely on average to use these services relative to those who receive no informal care. Finally, those who receive any form of informal care are just over 8 percentage points more likely to use physiotherapy services and this result too is statistically significant.

5.4.3.3.4.2 Informal Care Provision

Results on the relationship between informal care provision and physiotherapy services utilisation are presented in Tables 5.15. The results for both approaches are somewhat mixed with some differences in estimated coefficients and statistical significance between both matching approaches. More specifically, while the direction of the estimated coefficients is positive, I find both a statistically and economically insignificant association between informal care provision and physiotherapy services utilisation. In addition, I also estimated the impact of having provided any informal care. Once again, the estimated coefficients, while positive in direction are statistically and economically insignificant.

The results from the matching approach based on the Mahalanobis distance are somewhat different to those from the PSM approach. A statistically significant relationship between utilisation and the provision of care to more than one person is found. Individuals in this category are 2 percentage points more likely on average to use physiotherapy services, everything else equal. In addition, the results indicate that relative to the base category, those who provide any form of informal care are just under 1.5 percentage points more likely to use physiotherapy services and this result too is statistically significant.

5.4.3.3.4.3 Summary

In summary, the results presented above, suggest a positive and statistically significant relationship between those who receive care from more than one person as well as individuals who receive any form of informal care receipt and physiotherapy services utilisation. The results on informal care provision are somewhat mixed. The estimated coefficients from the PSM approach find no statistically significant relationship between informal care provision and physiotherapy services utilisation. In contrast, I find a statistically significant relationship between utilisation and the provision of care to more than one person when matching on the Mahalanobis distance. Those who provide any informal care are also significantly more likely to use physiotherapy services, everything else equal.

5.4.3.3.5 Home Help Services

The results for the empirical analysis of home help services are presented in Tables 5.14-5.15.

5.4.3.3.5.1 Informal care receipt

Looking firstly at associations between informal care received and home help service

utilisation, the estimated coefficients from both approaches are generally consistent across the various care groups analysed, in that they indicate a positive association between the receipt of informal care and home help services utilisation, although there are some small differences between both matching approaches. For example, the estimated coefficients from the PSM approach suggest, perhaps unsurprisingly, that those living alone are more likely to use home help services. In addition, the economic significance of this association is quite high. The estimated coefficients are statistically significant for those receiving care from a non-resident child, from others and from those who receive care from more than one carer. Relative to the base case of no informal care, individuals in these groups are 5, 23 and 16 percentage points respectively more likely to use home help services. I also estimate that individuals who receive any informal care are 13 percentage points more likely than the base category to use home help services and this result too is statistically significant.

When matching on the Mahalanobis distance the estimated coefficients suggest a positive association between informal care receipt and home help services utilisation for each of the groups analysed. The estimated coefficients are statistically significant for those who receive care from others and from more than one carer. Individuals in these groups are just under 33 and 24 percentage points more likely respectively to use home help services. Relative to respondents not in receipt of informal care, individuals who are in receipt of any such care are significantly more likely to use home help services, a finding consistent with the PSM approach.

5.4.3.3.5.2 Informal care provision

Results on the effect of informal care provision on home help services utilisation are presented in Tables 5.15. The results for both matching approaches are broadly consistent in that they predict a negative association between informal care provision and home help services utilisation. However, whereas I find a statistically significant negative association between provision of care to more than one person and home help utilisation when matching on the propensity score, a statistically significant and negative association is found between the informal care and utilisation across all groups analysed when matching based on the Mahalanobis distance. The economic significance is small however. More specifically, the estimated coefficients from both matching approaches suggest that individuals who provide care to more than one person are just over 1 percentage point less likely to use home help services. According to the estimated coefficients for the Mahalanobis distance matching approach, the probability of home help services utilisation is 3 percentage points lower for

those who provide care to one person and again 1 percentage points lower for those who provide any informal care, everything else equal.

5.4.3.3.5.3 Summary

In general, the results presented above, suggest a positive and statistically significant association between any informal care receipt on home help services utilisation. Conversely, for both matching approaches, we find a negative and statistically significant relationship between informal care provision to more than one person and home help services utilisation. The Mahalanobis distance matching approach finds a statistically significant by economically small association between each of the informal care provision groups analysed.

5.4.3.3.6 Optician Services

The results for the empirical analysis of optician services are presented in Tables 5.13-5.14.

5.4.3.3.6.1 Informal care receipt

Looking firstly at the association between informal care received and optician services utilisation, the estimated coefficients from both approaches are generally consistent in that they indicate a positive but statistically insignificant relationship between informal care receipt and optician services utilisation. The one exception to this finding is for care received from a spouse based on estimates from the PSM approach. Here individuals in receipt of care from a spouse are almost 12 percentage points less likely to using optician services relative to the base category, after controlling for a range of socio-demographic and health related variables. None of the estimated coefficients based on Mahalanobis distance matching are statistically significant although the direction of the association is positive for all groups analysed with the exception of care received from a spouse, a finding consistent with the PSM approach.

5.4.3.3.6.2 Informal Care Provision

In terms of informal care provision, the estimated coefficients from both matching approaches are generally consistent in that they find no statistically insignificant relationship with optician services utilisation. The one exception to this is for any informal care provision based on the PSM approach. The results indicate that relative to the base category, individuals providing any informal care are 2.2 percentage points less likely to use optician services and this result is statistically significant. Each of the other groups analysed for both matching approaches

are statistically insignificant.

5.4.3.3.6.3 Summary

In general, the results presented above, suggest a positive but statistically insignificant relationship between both receipt and provision of any form of informal care on optician services utilisation for both matching approaches.

Table 5.14 Average treatment effect on the treated of informal care receipt on Community Care Service Utilisation (Cont'd)

Healthcare Service	Matching method	Spousal care	Resident child	Non-resident child	Others	Care received from more than one carer	Any care
Physiotherapy Services							
	OLS	0.0689*	-0.0251	0.00836	0.0824**	0.0661*	0.0607***
	PSM	0.101**	-0.0500	0.0238	0.0429	0.0947**	0.0429
	MM	0.0562	0.0278	0.0750	0.104**	0.0923**	0.0828***
Home Help Services							
	OLS	-0.0198	0.0373	0.00938	0.299***	0.191***	0.149***
	PSM	-0.0112*	-0.0250	0.0476**	0.229***	0.159***	0.131***
	MM	0.0112	0.0833	0.0250	0.326***	0.238***	0.169***
Optician Services							
	OLS	-0.0456	0.0616	0.0307	0.0419	-0.00710	0.00717
	PSM	-0.118**	0.0500	0.0238	0.0429	0.0164	0.0482
	MM	-0.0393	0.111	0.0000	0.0750	0.0205	0.0299

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Receiving no care

Table 5.15 Average treatment effect on the treated of informal care provision on community care services - Cont'd

Healthcare Service	Matching method	Any care	One	Multiple
Physiotherapy Services				
	OLS	0.00591	-0.00806	0.00782
	PSM	0.00314	0.00993	0.00536
	NN	0.0148**	-0.0124	0.0198***
Home Help Services				
	OLS	-0.00898***	-0.0163***	-0.00849**
	PSM	-0.00634	-0.00248	-0.0124**
	NN	-0.0117***	-0.0298***	-0.0103**
Optician Services				
	OLS	-0.0128*	-0.0128	-0.0127*
	PSM	-0.0221**	0.00744	-0.0159
	NN	-0.00154	-0.0261	0.00111

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = providing no care

5.4.3.3.7 Dental Services

The results for the empirical analysis of dental services are presented in Tables 5.14-5.15 and are described below. Once again, I estimate associations between both informal care receipt and provision and services utilisation based on two matching approaches – PSM and matching based on the Mahalanobis distance.

5.4.3.3.7.1 Informal care receipt

In terms of informal care receipt and dental services utilisation, the estimated coefficients from both approaches are somewhat mixed both between matching approaches and in terms of the direction of the association between informal care groups analysed. The estimated coefficients based on PSM suggest that receipt of informal care is, for the most part, positively associated with dental services utilisation. Individuals in receipt of care from a spouse and from others are significantly more likely to use dental services. Relative to the base case, the probability of dental services utilisation is 7 and 11 percentage points higher for those in receipt of care from a spouse and others respectively. When matching based on the Mahalanobis distance individuals in receipt of care from a non-resident child are significantly (at the 10% level) less likely to use such services relative to the base category. All other estimates are statistically significant.

5.4.3.3.7.2 Informal Care Provision

In terms of informal care provision, the results for both approaches are generally consistent between the matching methods in that they suggest no statistically significant association between informal care provision and dental services utilisation. Looking specifically at the propensity score matching approach, relative to the base category, I find a negative association between informal care provided to one person and utilisation. Conversely, the direction of the association is positive for those who provide care to more than one person. Individuals who provide any informal care are less likely to use dental services but again, this association is not statistically significant. We find no significant association between informal care provsion and dental service utilisation based on Mahalanobis distance matching, a finding consistent with PSM. Although the estimates are not statistically significant, the direction of the association between informal care provision and dental services utilisation is positive.

5.4.3.3.7.3 Summary

To summarise, the results presented above, find no statistically significant relationship between informal care receipt or provision and dental services utilisation.

5.4.3.3.8 Hearing Services

The results for the empirical analysis of dental services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.8.1 Informal care receipt

In terms of informal care receipt, the estimated coefficients from both approaches are generally consistent in that they indicate no statistically significant difference between those who receive informal care and those who do not, in their propensity to use hearing services. The estimated coefficients from the PSM approach suggest a positive relationship between informal care receipt and hearing services utilisation. However, the estimates are statistically significant for those who receive care from a resident child only. Individuals in this group are 5 percentage points more likely to use hearing services compared to individuals who do not receive any such informal care. The estimated coefficients from matching based on the Mahalanobis distance are consistent with those from PSM and show no significant relationship between informal care receipt and hearing services utilisation.

5.4.3.3.8.2 Informal Care Provision

Results on the relationship between informal care provision and hearing services utilisation are presented in Tables 5.15. The results for both approaches are generally consistent in that they indicate a negative but insignificant association between informal care provision and hearing services utilisation – with one exception. Estimated coefficients based on Mahalanobis distance matching suggest a statistically significant and negative association between informal care provision to more than one individual and hearing service utilisation. The magnitude of this relationship is minimal at less than one percent.

5.4.3.3.8.3 Summary

In summary, the results presented above, do not find a statistically significant relationship between informal care receipt and hearing services utilisation, while I find a negative and insignificant relationship between informal care provision and hearing services utilisation.

5.4.3.3.9 Dietician Services

The results for the empirical analysis of dietician services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.9.1 Informal Care Receipt

In terms of informal care receipt, the estimated coefficients from both approaches are generally consistent between the matching methods. Both matching approaches suggest a statistically significant positive association between informal care receipt and dietician services utilisation. Relative to the base case, the estimated coefficients from both matching approaches suggest that, the probability of dietician services utilisation is between 4 and 5 percentage points higher for those in receipt of care from others. In addition, individuals in receipt of any informal care are significantly more likely to use the available services, everything else equal. The magnitude of the association based on the Mahalanobis distance matching approach is twice that found from PSM. The estimated coefficients from the Mahalanobis distance matching approach also find a statistically significant association between receipt of care from more than carer relative to the base case. Individuals in this group were just over 3 percentage points more likely to use dietician services.

5.4.3.3.9.2 Informal Care Provision

Looking from the perspective of informal care provision the results for both approaches are somewhat mixed between the matching methods. Whilst I find no statistically significant association between provision and dietician services utilisation based on the PSM approach the estimates based on Mahalanobis distance matching find a positive and statistically significant relationship between provision of informal care to more than one person and dietician utilisation. However, the magnitude of this relationship is minimal at less than 1 percentage point. I also find that the provision of any informal care is a statistically significant predictor of dietician services utilisation, although yet again the association is minimal.

5.4.3.3.9.3 Summary

Taken together, the results presented above, for both matching approaches suggest a positive and statistically significant relationship between both informal care receipt and dietician services utilisation. The results on informal care provision are somewhat mixed between the matching methods. Whilst I find no statistically significant association between provision and dietician services utilisation based on the PSM approach the estimates based on Mahalanobis distance matching find a positive and statistically significant relationship between the provision of informal care to more than one person and dietician services utilisation.

Table 5.14 Average treatment effects on the treated of informal care receipt on Community Care Service Utilisation (Cont'd)

Healthcare Service	Matching method	Spousal care	Resident child	Non-resident child	Others	Care received from more than one carer	Any care
Dental Services							
	OLS	-0.0217	0.0758	-0.0847**	0.0235	-0.00709	-0.00225
	PSM	0.0730*	0.0000	-0.0238	0.107***	0.0240	-0.00150
	MM	-0.0281	0.0556	-0.125*	0.0107	-0.0103	-0.0110
Hearing Services							
	OLS	-0.00824	0.0420	-0.0107	0.0257	0.0167	0.0133
	PSM	0.0112	0.0500**	0.0238	0.0214	0.0126	0.0143
	MM	-0.0112	0.0278	0.0000	0.0321	-0.0103	0.00265
Dietician Services							
	OLS	0.0294	-	0.0213	0.0493**	0.00609	0.0246**
	PSM	-0.0112	-	0.0000	0.0429**	-0.0152	0.0181
	MM	0.0562*	-	0.0500	0.0500**	0.0308*	0.0385***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Receiving no care

Table 5.15 Average treatment effects on the treated of informal care provision on community care service utilisation (cont'd)

Healthcare Service	Matching method	Any care	One	Multiple
Dental Services				
	OLS	0.00784	0.0110	0.00704
	PSM	-0.00735	-0.00496	0.00879
	MM	0.0157*	0.0211	0.0156
Hearing Services				
	OLS	-0.00367	-0.00891***	-0.00265
	PSM	-0.00148	-0.00496	0.000277
	MM	-0.00616*	-0.0136**	-0.00429
Dietician Services				
	OLS	0.00252	0.00812	0.00170
	PSM	0.000356	0.00993	0.00457
	MM	0.00569**	0.0112	0.00540*

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = providing no care

5.4.3.3.10 Social Work Services

The results for the empirical analysis of social work services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.10.1 Informal care receipt

Looking firstly at associations between informal care receipt and social work services utilisation, the estimated coefficients from both approaches are consistent and suggests a positive, yet insignificant association with social work services utilisation. The magnitude of the association is also minimal for both matching approaches. More specifically the PSM approach estimates that relative to the base category, the probability of social work service utilisation is 1.4 percentage points higher for those who receive care from others and 1.5 percentage points more likely for those who receive care from more than one carer; although neither coefficient is statistically significant. In addition, individuals in receipt of any informal care are 0.2 percentage points less likely to use social work services although, yet again, the estimated coefficient is not statistically significant.

The results from the matching approach based on the Mahalanobis are similar to those from PSM. Once again, whilst the direction of the association is positive in nature, neither estimate for the subgroups analysed is statistically significant. In addition, the magnitude of the association between receipt and utilisation is again minimal. Finally, individuals in receipt of any form of informal care are 0.7 percentage points more likely to use social work services although this result too is statistically insignificant.

5.4.3.3.10.2 Informal Care Provision

Results on associations between informal care provision and social work services utilisation are presented in Tables 5.15. As above, estimated coefficients on two separate matching approaches are presented. The results for both approaches are consistent and suggest a negative and statistically insignificant relationship between provision of informal care and social work services utilisation. The magnitude of the relationship is also minimal. The PSM approach estimates that relative to the base category, the probability of social work service utilisation is less than half a percentage points lower for those who provide care to more than one person. The result is not statistically significant.

The results from the matching approach based on the Mahalanobis distance are similar to PSM

and indicate a negative and statistically insignificant relationship between informal care receipt and social work services utilisation. In terms of the Mahalanobis distance matching approach I find that relative to the base category, the probability of social work service utilisation is again less than 1 percentage points lower for those who provide care to more than one person.

5.4.3.3.10.3 Summary

Taken together, the results presented above, find a negative but statistically insignificant association between both informal care receipt and provision on social work services utilisation.

5.4.3.3.11 Psychological/Counselling Services

The results for the empirical analysis of psychological/counselling services are presented in Tables 5.12-5.13 and are described below.

5.4.3.3.11.1 Informal Care Receipt

Looking firstly at relationship between informal care receipt and psychological/counselling services utilisation, the estimated coefficients from both approaches are generally consistent between the matching methods. In general, a positive yet statistically insignificant association between the variables of interest for both matching approaches is found. The one exception is for individuals in receipt of informal care from more than one carer based on estimates from the PSM approach where the estimated coefficient is statistically significant at the 10% level. I find that this subgroup are 2.3 percentage points more likely to use social work services even after controlling for a range of socio-demographic and health related variables. Finally, relative to the base category, individuals in receipt of informal care are more likely on average to use social work services although once again, this result is statistically insignificant.

5.4.3.3.11.2 Informal care provision

Results on the association between informal care provision and psychological/counselling services utilisation are presented in Table 5.15. The results for both approaches are generally consistent between the matching methods in that they indicate a positive and statistically significant association between the two variables analysed. However, the magnitude of the association between provision and utilisation of social work services in minimal in all cases. Our PSM estimates suggest that relative to the base category, the probability of

psychological/counselling services utilisation is 1.74 percentage points higher for those who provide informal care to one person and 0.706 percentage points higher for a person who provides care to more than one person. In both cases, the estimated coefficients are statistically significant.

The results from the matching approach based on the Mahalanobis distance indicates that those who care for more than once person are significantly more likely to use social work services, a finding consistent with the estimates from the PSM approach. The probability of psychological/counselling services utilisation is just under one percentage points higher for individuals in this subgroup. I find no statistically significant difference between those who provide care to one person relative to the base case, once I control for a range of socio-economic and health related variables. Individuals providing any form of informal care are just under 1 percentage point more likely to use psychological/counselling services and this result is statistically significant based on Mahalanobis distance matching.

5.4.3.3.11.3 Summary

In summary, the results presented above, find a positive but statistically insignificant relationship between informal care receipt and psychological/counselling services utilisation. From the point of view of informal care provision, I find a positive association on psychological/counselling services utilisation. The statistical significance of the estimated coefficients varies across the groups analysed and between the matching specifications adopted.

5.4.3.3.12 Personal Care Attendant Services

The results for the empirical analysis of personal care attendant services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.12.1 Informal Care Receipt

Looking firstly at informal care receipt, the estimated coefficients from both approaches are broadly similar and suggest a positive relationship between it and personal care attendant utilisation. It is interesting to note that individuals who do not live with family members are more likely to avail of a personal care attendant. The estimated coefficients for both matching approaches indicate a positive and statistically significant association between informal care receipt from others and from more than one carer and personal care attendant services

everything else equal. For both approaches relative to the base category, the probability of personal care attendant services is nine and six percentage points higher respectively for individuals in receipt of care from others and from more than one carer. Interestingly, estimates from the PSM approach also suggest a positive and statistically significant relationship between care received from a non-resident child and utilisation. Individuals in this subgroup are five percentage points more likely on average to use the services available, everything else equal. Lastly, the relationship between receipt of any informal care relative to the base category is also estimated. Once again, the estimated coefficients are consistent and show a positive and statistically significant relationship between receipt of informal care and utilisation of personal care attendant services, ceteris paribus.

5.4.3.3.12.2 Informal Care Provision

Results on the relationship between informal care provision and personal care attendant services utilisation are presented in Table 5.15. As above, estimated coefficients on two separate matching approaches are presented. The results for both approaches are broadly similar and suggest a positive yet statistically insignificant association between the two variables. The magnitude of estimates coefficients is also minimal. In addition, relative to the base category, I find no statistically significant relationship between any informal care provision and personal care attendant services although the direction of the relationship was positive for both matching approaches.

5.4.3.3.12.3 Summary

Taken together, the results presented above, suggest a positive and statistically significant relationship between informal care receipt from others as well as from more than one carer and personal care attendant service utilisation. Individuals in receipt of any informal care are also statistically more likely to use the available services. Conversely, I find no statistically significant association for informal care provision and personal care attendant services and this result is consistent for both matching approaches.

Table 5.14 Average treatment effect on the treated of informal care receipt on community care service utilisation (cont'd)

Healthcare Service	Matching method	Spousal care	Resident child	Non-resident child	Others	Care received from more than one carer	Any care
Social Work Services							
	OLS	-	-	-	0.00716	0.00688	0.00126
	PSM	-	-	-	0.0143	0.0152	-0.00226
	MM	-	-	-	0.00714	0.0154	0.00680
Counselling Services							
	OLS	-0.00286	0.00524	-	0.0139	0.0119	0.00723
	PSM	0.0000	0.0250	-	0.00714	0.0227*	0.0135
	MM	0.0000	0.0000	-	0.0143	0.0000	0.00907
Personal Care Attendant Services							
	OLS	0.00525	0.0147	0.0341	0.0879***	0.0649***	0.0513***
	PSM	-0.0112	0.0250	0.0476*	0.0929***	0.0606***	0.0519***
	MM	0.0000	0.0278	0.0250	0.0929***	0.0615**	0.0556***

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Receiving no care

Table 5.15 Average treatment effects on the treated Informal Care Provision on Community Care Service Utilisation (Cont'd)

Healthcare Service	Matching method	Any care	One	Multiple
Social Work Services				
	OLS	-0.000758	-	-0.000204
	PSM	0.00000	-	-0.000415
	MM	-0.000711	-	-0.000415
Counselling Services				
	OLS	0.00331	0.00504	0.00310
	PSM	0.000889	0.0174***	0.00706**
	MM	0.00818***	0.00496	0.00872***
Personal Care Attendant Services				
	OLS	-0.000706	-	-0.000403
	PSM	0.00142	-	0.00166
	MM	0.000889	-	0.00104

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = providing no care

5.4.3.3.13 Meals-on-Wheels

The results for the empirical analysis of meals-on-wheels services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.13.1 Informal care receipt

In terms of informal care receipt, the estimated coefficients from both approaches are generally consistent between both specifications and across subgroups. The estimated coefficients for both matching approaches are positive and statistically significant for those who receive informal care from others only. Relative to the base category, individuals in this subgroup are nine and seven percentage points respectively more likely to use meals-on-wheels services, even after I control for a range of socio-demographic and health related variables. For each of the other subgroups analysed, whilst I do not find a statistically significant relationship between receipt and meals-on-wheels utilisation, the direction of the relationship is positive in nature. Similarly, when I estimate the relationship between any informal care receipt on meals-on-wheels utilisation our results are consistent across matching approaches. That is, relative to the base case, individuals in receipt of any informal care are 3 percentage points more likely to use the services available and this result is statistically significant at the 5% level of significance.

5.4.3.3.13.2 Informal care provision

Results on the relationship between informal care provision and personal care attendant services utilisation are presented in Table 5.15. The results for both approaches are consistent in that I find no statistically significant relationship between informal care provision and meals-on-wheels utilisation. This finding is consistent across each of the informal care subgroups analysed. In each of the subgroups analysed, the direction on each of the estimated coefficients is negative in nature, whilst the magnitude of each of the estimates is also minimal.

5.4.3.3.13.3 Summary

To summarise, I find contrasting results for informal care receipt and informal care provision and their relationship on meals-on-wheels utilisation. That is, the results find a statistically significant relationship between care received from others and meals-on-wheels services utilisation. In addition, individuals in receipt of any informal care are significantly more likely to use meals-on-wheels services compared to those who receive no such care. Conversely, I find no such statistically significant relationship on informal care provision.

5.4.3.3.14 Daycentre Services

The results for the empirical analysis of daycentre services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.14.1 Informal care receipt

In broad terms, the estimated coefficients from both matching approaches are broadly similar and suggest a positive association between informal care receipt and daycentre services utilisation. Notably, for both matching approaches analysed I find that, relative to the base category receiving care from others or from more than one carer is a positive and statistically significant predictor of daycentre services utilisation. The estimates indicate that the probability of daycentre services utilisation is 9 percentage points higher for those in receipt of care from others, a result that is consistent across both matching approaches. When matching on the propensity score I also find a statistically significant association between informal care receipt from a non-resident child and daycentre services utilisation. This result illustrates the importance of close family in the informal care equation. Finally, individuals in receipt of any informal care are significantly more likely (6 percentage points) to use daycentre services, everything else equal – a result consistent once again between both matching approaches.

5.4.3.3.14.2 Informal care provision

Results on the relationship between informal care provision and personal care attendant services utilisation are presented in Table 5.15. The results for both approaches are somewhat mixed. In terms of both matching approaches, the estimated coefficients suggest a negative relationship between informal care provision and daycentre services utilisation. In terms of the estimated coefficients from the PSM approach, I find that relative to the base category those who care for more than one person are significantly less likely to use daycentre services, everything else equal, although the magnitude of the estimate is less than one percentage point. In contrast, I find no statistically significant association between informal care provision and daycentre services utilisation based on matching based on the Mahalanobis distance.

5.4.3.3.14.3 Summary

In summary, I find a positive association between receipt of informal care and daycentre services utilisation. In contrast, provision of informal care tends to reduce an individual's utilisation of daycentre services. While the results suggest a positive and statistically

significant association between informal care receipt both from others and from more than one carer on daycentre service utilisation, the result on informal care provision is contradictory and whether one finds a statistically significant association depends on the matching method adopted.

5.4.3.3.15 Respite Care Services

The results for the empirical analysis of daycentre services are presented in Tables 5.14-5.15 and are described below.

5.4.3.3.15.1 Informal care receipt

From the perspective of informal care receipt and respite services utilisation, the estimated coefficients from both approaches are generally consistent across the subgroups analysed. I find a statistically significant positive association between informal care receipt from others and respite services utilisation for both matching approaches analysed. The estimated coefficients are consistent and suggest that the probability of utilisation is 6 percentage points higher on average for individuals in this subgroup, after controlling for a range of socio-demographic and health related variables. I also find a statistically significant relationship for those in receipt of care from more than one carer from matching on the Mahalanobis distance. According to the estimates, individuals who receive care from more than one carer are 4 percentage points more likely on average to use respite service, ceteris paribus. Perhaps unsurprisingly, the results suggest that those who live with their primary carer i.e. their spouse are less likely to use respite services although this finding is not statistically significant. In all of the other informal care subgroups analysed, the direction of the association is positive in nature. Lastly, the impact of receiving any informal care on respite services utilisation relative to the base category was analysed. Once again, the estimated coefficients between both matching approaches are consistent and suggest that individuals who receive any informal care are 3 percentage points more likely to use the services available.

5.4.3.3.15.2 Informal Care Provision

In terms of informal care provision, the results for both approaches are generally consistent between both specifications and across informal care groups. That is, the estimated coefficients predict no statistically significant relationship between informal care provision and respite care services utilisation. The magnitude of any association between provision and utilisation is also minimal. In addition, the approach adopted allows for the estimation of the impact of provision of any informal care. Again, the estimates from both matching

approaches are consistent and show no statistically significant association between provision and utilisation of respite services.

5.4.3.3.15.3 Summary

Taken together, the estimated coefficients presented above, provide contrasting results on receipt and provision of informal care on respite services utilisation. While I find a positive and statistically significant relationship between any informal care received and respite services utilisation everything else being equal; no such statistically significant relationship is found from the perspective of informal care provision.

Table 5.14 Average treatment effects on the treated of informal care receipt on community care service utilisation (cont'd)

Healthcare Service	Matching method	Spousal care	Resident child	Non-resident child	Others	Care received from more than one carer	Any care
Meals on Wheels Services							
	OLS	-0.00218	0.0275	0.0216	0.0846***	0.00147	0.0316***
	PSM	0.0000	0.0000	0.0476	0.0929***	0.0152	0.0316**
	MM	0.0000	0.0556	0.0250	0.0714**	0.0000	0.0272**
Daycentre Services							
	OLS	-	0.0147	0.0341	0.0670***	0.0470**	0.0381***
	PSM	-	0.0250	0.0476*	0.0893***	0.0692***	0.0609***
	MM	-	0.0278	0.0250	0.0929***	0.0538*	0.0567***
Respite Care Services							
	OLS	0.00314	-	0.0147	0.0577***	0.0263*	0.0269***
	PSM	-0.0112	-	0.0238	0.0643***	0.0303	0.0293***
	MM	-0.0112	-	0.0250	0.0571***	0.0385**	0.0249**

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = Receiving no care

Table 5.15 Average treatment effects on the treated of informal care provision on community care service utilisation (cont'd)

Healthcare Service	Matching method	Any care	One	Multiple
Meals on Wheels Services				
	OLS	-0.000895	-0.00231	-0.000997
	PSM	-0.00213	0.00000	-0.00374
	MM	-0.00142	-0.00496	-0.000830
Daycentre Services				
	OLS	-0.00572***	-0.00213	-0.00638***
	PSM	-0.00373*	0.00372	-0.00470*
	MM	-0.00338	-0.00496	-0.00311
Respite Care Services				
	OLS	-0.00196	-	-0.00160
	PSM	-0.00107	-	-0.000415
	MM	0.000356	-	0.00166

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = providing no care

5.4.4 Healthcare Services Costs and Informal Care

In the following sections, I present the results of the analysis looking at the relationship between healthcare service costs and informal care, both received and provided. As mentioned in Chapter 4, total healthcare costs are generated by summing together costs from GP, inpatient, and outpatient and A&E services. The total figure is derived from information on the total number of visits per patient to each of these settings over the previous year, times an average unit cost per visit for each setting. Unit costs for inpatient, outpatient and A&E visits were received from the Hospital Pricing Office (HPO). Average GP fees per visit were found to equal €51 according to an ESRI report (Wren et al., 2015). I begin by looking at the association between informal care received and healthcare service costs. Next, results on the relationship between informal care provision by family members or others on total healthcare costs are presented. The results are detailed below.

5.4.4.1 The Relationship between Informal Care Received and Healthcare Costs

In this section, results on the relationship between informal care received and total healthcare service costs are presented. The results for the propensity score matching, Mahalanobis distance matching and the inverse probability weighting analyses are presented in Table 5.16. I take the same approach detailed earlier when estimating associations between informal care received and healthcare services utilisation. That is, I present the estimated coefficients on the relationship between informal care received from a spouse; a resident child; a non-resident child and from others on total healthcare costs. In all cases, I control for informal care received, in addition to a broader set of socio-demographic and health related variables. The results are generally consistent in that they indicate that greater levels of informal care received are associated with higher healthcare costs. Nonetheless, there were some differences in estimated coefficients and statistical significance.

In the propensity score matching approach, the estimates indicate that relative to the base category of receiving no informal care, healthcare costs are €1,9355 higher per year for those who receive care from others and €1,148 higher for those who receive care from more than one carer. In both instances, the estimated coefficients are statistically significant. In addition, this approach allows for the estimation of the impact of receiving any form of informal care. The results indicate that relative to the base category, healthcare costs for those in this category are €1,427 higher per year and this result too, is statistically significant.

In the Mahalanobis distance matching approach, the estimates indicate that relative to the base category, healthcare costs are €1,228 higher per year on average for those who receive care from others and €1,350 higher per year for those who receive care from more than one carer. The estimated coefficients are statistically significant for both groups. Relative to the base category, healthcare costs for those who received any form of informal care are €1,163 higher per year on average and this result was statistically significant.

In the inverse probability weighting matching approach, the preferred GLM specification for the analysis of healthcare costs, according to the diagnostic test carried out, is the Poisson distribution. The estimates indicate that relative to the base category, healthcare costs are €786 higher per year on average for those who receive care from a spouse; €443 per year lower on average for those who receive care from a resident child, €461 higher for those who receive care from a non-resident child; €207 for those who receive care from others and €876 higher on average per year for those who receive care from more than one carer. The estimated coefficients are statistically significant for those who receive care from a spouse, a resident child and for those who receive care from more than one carer. I also estimated the relationship between the receipt of any informal care on average healthcare costs. Relative to the base category of receiving no informal care, total healthcare costs are €1,173 higher per year on average everything else being equal.

Table 5.16 Average treatment effect on the treated of informal care receipt on total healthcare costs

Total Healthcare Costs	**Matching Method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any informal care**
	OLS	863.6	196.1	495.4	1,088**	847.0*	866.2***
	AIC	145418	144336	144379	146564	146354	152904
	BIC	145766	144669	144713	146898	146709	153261
	PSM	-	-	-	1,935***	1,148***	1,427***
	AIC	-	-	-	147221	146999	153587
	BIC	-	-	-	147235	147013	153601
	MM	-	-	-	1,228**	1,350**	1,163***
	AIC	-	-	-	147221	146999	153587
	BIC	-	-	-	147235	147013	153601
	IPW GLM Poisson 0.3	786.0***	-442.7***	461.2	203.8	875.6***	1,173***
	AIC	1.11e+07	1.80e+07	1.95e+07	1.92e+07	1.69e+07	2.04e+07
	BIC	1.11e+07	1.80e+07	1.95e+07	1.92e+07	1.69e+07	2.04e+07

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = providing no care

5.4.4.2 The Relationship between Informal Care Provision and Healthcare Costs

In this section, results on the relationship between informal care provision and total healthcare costs are presented. The results for PS matching, Mahalanobis distance matching and the IPW analyses are presented in Table 5.17. I adopt the same approach as detailed earlier when estimating associations between informal care provision on healthcare services utilisation. That is, I present the estimated coefficients on the association between informal care provided to one person and informal care provided to more than one person. I also estimate the relationship between any informal care provision on total healthcare costs. In all cases, I control for a broader set of socio-demographic and health related variables. The results are generally consistent in that they indicate no statistically significant relationship between informal care provision and total average healthcare costs.

With the PSM approach, the estimates indicate that relative to the base category of providing no informal care, total healthcare costs are €187 higher per year on average for those who provide care to one person and €48 lower per year on average for those who care for more than one person. In addition, this approach allows for the estimation of the impact of providing any form of informal care. The results indicate that relative to the base category, total healthcare costs for those in this category are €44 higher per year on average and this result too, is not statistically significant. Matching on the Mahalanobis distance indicate that relative to the base category, total healthcare costs are €262 higher for those who provide care for one individual and €130 higher on average for those who provide care to more than one person. Neither of the estimated coefficients are statistically significant. Relative to the base category, total healthcare costs for those who provide any form of informal care are €129 higher per year on average and this result was not statistically significant.

According to the results of the inverse probability weighting matching approach, the preferred GLM specification for the analysis of total healthcare costs, according to the diagnostic test carried out, is the Poisson distribution. The estimates indicate that relative to the base category, total healthcare costs are €92 lower on average per year for those who provide care to one person and €15 lower on average per year for those who provide care to more than one person. Neither of the estimated coefficients are statistically insignificant. I also estimated the association between any informal care provision on average healthcare costs. Relative to the base category of no informal care provision, total healthcare costs are €6 higher on average per year everything else being equal. In the next section, I summarise the findings from this chapter and discuss what implications those findings might have for policy.

Table 5.17 Average treatment effects on the treated of informal care provision on total healthcare costs

Total Healthcare Costs	Matching method	Any care	One	Multiple
	OLS	-8.983	141.5	-28.13
	AIC	152,925	108,046	145,396
	BIC	153,289	108378	145,758
	PSM	43.75	187.2	-47.50
	AIC	153,768	108,602	146,184
	BIC	153,782	108616	146,198
	MM	129.4	262.0	129.8
	AIC	153,768	108,602	146,184
	BIC	153,782	108616	146,198
	IPW GLM Poisson	5.966	-91.67	-15.39
	AIC	2.20e+07	1.29e+07	2.10e+07
	BIC	2.20e+07	.29e+07	2.10e+07

Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Base = providing no care

5.5 Discussion

This chapter explored the relationships between insurance status and informal care receipt and provision. The chapter also estimated associations between informal care receipt and provision on formal healthcare services utilisation and costs for a sample of older people in the Republic of Ireland. In particular, the analysis sought to address the following questions - does the level of informal care receipt and provision differ depending on the level of health insurance coverage? The chapter also seeks to answer the question as to whether healthcare service utilisation and cost differ depending on informal care received or provided. This reflects the growing demands for informal care services and the need for a greater understanding of the relationship between the informal and formal healthcare systems in Ireland.

5.5.1 Study Results

The results in this chapter add to the literature by examining, for the first time, associations between insurance status and informal care; from both the perspective of the recipient and the provider; as well as that of informal care and healthcare services utilisation and costs from an Irish perspective. Looking at the association between health insurance status and informal care, those with higher levels of health insurance are, for the most part, significantly more likely to receive some form of informal care. When one looks at this relationship by family member, the analysis suggests no significant difference by insurance status. In contrast, those with higher levels of health insurance are significantly more likely to receive care from others everything else being equal. In general terms, no statistically significant relationship is found between health insurance status and one's likelihood of providing informal care.

In terms of the association between informal care and healthcare services utilisation and costs, the findings indicate that in the majority of cases analysed, individuals in receipt of informal care use more healthcare services on average compared to those who do not receive such care. They also encounter higher average healthcare costs. There are some interesting differences across the healthcare services analysed as well as by the source of caregiver, be it a family or non-family member. For example, being in receipt of care from a spouse or a child was not significantly associated with utilisation of many healthcare services analysed. Conversely, receiving informal care from others or from more than one caregiver is a positive and significant predictor of utilisation for many of the services analysed. This finding highlights the importance of the relationship between the individual and their carer in determining informal care demand.

The analysis found no statistically significant relationship between informal care receipt and GP services utilisation. In terms of hospital services, individuals in receipt of care from a spouse are significantly more likely to use outpatient hospital services. I found no statistically significant relationship between informal care receipt from another family member or others on hospital services utilisation. In terms of community care services utilisation, results were consistent across all care groups and PHN services utilisation. Interestingly, the magnitude of the association was highest for those receiving care from non-family members. For example, the estimated coefficients were highest for those in receipt of care from others and from non-resident children. In addition, the results suggested that those in receipt of informal care from non-family members were significantly more likely to use a range of community care services including occupational therapy, physiotherapy, home help, dietician, personal care attendant services meals-on-wheels and respite care services. Those in receipt of informal care from more than one individual were also significantly more likely to use a range of community care services including PHN services, occupational therapy and physiotherapy services, as well as home help and personal care attendant services. The association is strongest for those using PHN and home help services. Conversely, individuals in receipt of care from a spouse were significantly less likely to use home help services when matching on the propensity score. As mentioned above, informal care receipt for the most part was found to be positively associated with utilisation of a range of healthcare services. There were however two exceptions. Estimated coefficients following matching based on the propensity score suggested that individuals in receipt of spousal care were significantly less likely to use home help and optician services respectively, everything else equal.

The results on the association between informal care provision and utilisation of a range of hospital and community care services were varied depending on the healthcare service analysed. That is, informal care providers were significantly more likely to use some healthcare services and significantly less likely to use others. In terms of informal care provision, I find that caregivers are significantly more likely to use A&E and outpatient services compared to those who provide no such care. There is no association between informal care provision and GP as well as inpatient services utilisation. For many of the community care services analysed we found no statistically significant relationship with informal care provision. These included OT services, chiropody services, dental, social work and physiological/counselling services as well as meals-on-wheels, respite and personal care attendant services. Perhaps unsurprisingly, informal care providers were significantly less

likely to use home help services and optician services ceteris paribus. While the direction of the association on hearing services utilisation was also negative, the magnitude of the association was minimal at less than 1 percentage point. Similarly, I found a negative but statistically insignificant association between the provision of care to multiple individuals and the use of daycentre services when matching on the propensity score although once again the magnitude of the association was minimal at less than 1%. By contrast, individual caregivers were more likely to use psychological/counselling services.

Total healthcare costs were significantly higher for those receiving care from others and for those receiving care from more than one carer even after controlling for a range of socio-demographic and health related variables. Estimated coefficients from the generalised linear models suggested that those in receipt of informal care from a spouse incurred higher healthcare costs on average, relative to those who received no such care. Interestingly, respondents in receipt of care from a resident child had significantly lower total healthcare costs on average compared to the reference group everything else equal. Finally, I found no statistically significant association between informal care provision and total healthcare costs.

A number of the findings were consistent with existing empirical literature. For example, the negative association between informal care provided by a spouse and home help services usage is consistent with the international literature (Van Houtven & Norton; 2008). In addition, we find that respondents in receipt of care from a resident child had significantly lower total healthcare costs a result consistent with previous literature (Van Houtven et al; 2008). This finding emphasises the importance of close familial support for those in receipt of informal care. Finally, we estimate no statistically significant association between informal care provision and total healthcare costs, a finding consistent with the work of Torbica et al; (2015). As mentioned earlier, this may be for a number of reasons. First, it may be because those providing care are younger, healthier individuals on average, or it may be because those providing care to elderly relatives do so at the expense of their own healthcare.

5.5.2 Study Implications

The findings from this chapter supplement those presented in the previous two chapters and provide additional evidence on the potential demand side pressures facing the Irish healthcare system and in particular, it considered the role of the informal care system. In general, our findings suggest that those with higher level of health insurance are more likely to receive

some form of informal care compared to those with public health insurance only. However, health insurance status is not a significant predictor of informal care provision. Those in receipt of informal care use significantly more healthcare services. By extension, individuals in receipt of informal care tend to have significantly higher healthcare costs everything else being equal. This would suggest that informal care plays a supplementary and complementary role in the care of older people in the Republic of Ireland. The findings also highlight the importance of familial closeness in informal caregiving as a substitute for formal healthcare service utilisation.

From a policy point of view, the findings from this chapter may have important implications for the formal and informal care systems in the Republic of Ireland. If the results hold true, a move to a universal healthcare system will result in more individuals receiving care from individuals other than their close family members. At present, older individuals with higher levels of health insurance are more likely to receive care from these other individuals. It can be argued that the projected demographic changes, which will see a larger older proportion of the population in the coming years, will potentially exert significant demand side pressures on the formal healthcare sector and the informal caregiving community. Indeed, given the findings presented in the previous two chapters and the projected increases in the demands for healthcare and its costs, we might expect that the importance of informal care will grow in the future with more emphasis being placed on informal care as a means to relieve pressures on the formal healthcare sector. However, the results suggest that those in receipt of informal care use significantly more formal healthcare services in any event. It may therefore, be surmised, that the informal care system, which may currently represent a supplementary and complementary model to formal healthcare system, will not be adequately placed to meet the overflow demands from the formal healthcare system. Indeed, our findings suggest those who receive informal care use more formal care and incur more costs.

Given our findings from chapters 3 and 4, these findings have the potential to create a ‘demand spiral’ for healthcare services in Ireland. Such a demand spiral has its roots in the potential for excess demand within the formal healthcare sector as evidenced from the results in this chapter together with the demographic and policy changes outlined previously. This excess demand is further exacerbated by supply side constraints, which have already been highlighted elsewhere (Smith et al; 2019). Together these demand and supply side dynamics will present significant challenges for the Irish healthcare system in the years ahead. It is clear that in addition to appropriately managing the formal healthcare system and its transition to a

universal model of health insurance coverage, policy makers must also carefully consider its approaches for the informal care system in the Republic of Ireland. That is, if informal care is going to grow in importance, public policy in the form of public finance, respite and other support services, caregiver wellbeing and health interventions, must be put in place to ensure that the informal caregiving community can continue to meet the needs of the older population in the Republic of Ireland.

5.5.3 Study Limitations

The analysis undertaken in this chapter had a number of limitations that are highlighted below. While TILDA provides comprehensive information on the key variables of interest in the Irish setting, the data are not without their limitations. First, it is possible that certain indicators are subject to recall bias. This is especially true of our dependent variables where respondents were asked to recall their utilisation of healthcare services over the last 12 months. Second, information on supply-side factors such as GP, hospital or community care practice characteristics are unavailable. Third, we are limited in terms of the information we have on other healthcare visits. Notably, we analyse utilisation in terms of a binary response variable, as we did not have complete information on, for example, the number of visits or the length of those visits. Fourth, this analysis is cross-sectional and based on observational data from one wave of TILDA data. While we have attempted to address the potential observable endogeneity of variables such as health status using various matching approaches, we recognise that unobservable endogeneity remains an issue. Lastly, while the analysis has attempted to shed more light on the relationship between informal care, from the perspective of both those being cared for and those providing care, the analysis has failed to address the problem of potential unmet need within the healthcare system due to data limitations.

5.5.4 Future Research Questions

In this section, we suggest some possible avenues for future research following this analysis. Panel data analysis can shed more light on the issue of unobservable endogeneity highlighted above and may be an avenue of future work. Future work might also use the panel to examine the effect of informal care receipt and provision on the prevalence of chronic conditions. Using the longitudinal nature of the data as well as the rich information on the prevalence of a number of chronic health conditions, it would be interesting to examine how informal care receipt and provision effects an individual's physical and mental health and well-being. For the purposes of the analysis undertaken in this chapter, informal care receipt and provision is defined as binary equal to one if an individual either is in receipt of or provides care for another

individual. Such an approach offers little indication of the intensity of informal care received or provided. Thus, another possible avenue for future research would attempt to address this issue by examining the number of hours spent either receiving or providing informal care as a proxy for intensity. Such an approach could offer insights on the impact of large or small amounts of informal care receipt or provision on healthcare services utilisation and costs.

5.5.5 Conclusion

The objectives of this chapter were two-fold. First, the chapter estimated associations between health insurance status and informal care receipt and provision. Second, analysis also looked at the relationship between informal care receipt and provision on healthcare service utilisation and average healthcare costs. The motivation for these analyses arises from the need for a better understanding of the interaction between health insurance status and formal and informal care systems for older people for the purposes of informing planning for future health needs in light for the changing policy and demographic contexts and their implications for the formal healthcare system. The chapter indicates that those with higher levels of health insurance are significantly more likely to receive some level of informal care. Second, those same individuals with higher levels of health insurance are more likely to receive care from others. Health insurance status does not appear to have any impact on an individual's propensity to provide informal care.

Those who receive informal care are, in general, more likely to use healthcare services and by extension experience higher healthcare costs. In addition, the relationship between an individual and their carer is an important predictor of healthcare services utilisation. That is, individuals who are cared for by non-family members are significantly more likely to use a range of community care services. In terms of healthcare costs, individuals in receipt of informal care from a resident child have significantly lower healthcare costs on average compared to the base category i.e. no informal care. Given the increasing demands that are likely to be placed on the formal care system in light of the demographic and policy changes outlined, as well as the supply side constraints highlighted elsewhere, the Irish healthcare system faces significant challenges in how healthcare is accessed and delivered in the coming years.

6. Discussion

6.1 Introduction

This chapter provides a summary of the thesis and its main findings and their potential implications, as well as acknowledging the limitations of the research and identifying possible avenues for future research. Section 6.2 sets out the study objectives while Section 6.3 contains a summary of the key findings from each chapter as they relate to the research goals set out in Chapter 1. Section 6.4 discusses the various implications of the research undertaken in this thesis while Section 6.5 addresses some of the limitations. In Section 6.6, some possible avenues for future research that address the limitations stated previously are suggested. Some concluding remarks are outlined in Section 6.7.

6.2 Study Objectives

This thesis employed health economic methodologies to explore the associations of health insurance and informal care on healthcare utilisation and healthcare costs of older people in the Republic of Ireland. The research also investigate associations between health insurance status and informal care – both received and provided. The research was undertaken within the wider context relating to the finance and delivery of healthcare services for older people in the Republic of Ireland including the changing policy environment and the growing demands for adjustments to the continuum of care. Of particular importance in this regard is the proposed expansion of public health insurance coverage to a universal model. In addition, the role of informal care and its interactions with the formal care system will grow in importance given projected demographic changes that will see a significant increase in the number of older people in the country leading to increased demands on family carers.

6.3 Study Findings

The first set of analyses examined associations between health insurance status on the utilisation of a range of secondary and community healthcare services for older people in the Republic of Ireland. In particular, the analysis sought to address the following question: '*Does the level of healthcare service utilisation differ depending on the level of health insurance coverage?'* Much of the empirical literature in the Irish context has concentrated on estimating the causal effect of health insurance status on primary healthcare services. Less is known about associations between insurance status and community care services utilisation for older people in an Irish context. Chapter 4 bridges this gap in the literature; using various

econometric methodologies to do so. A number of approaches were adopted to address the question at hand, including matching methods to address the observable heterogeneity between health insurance status and healthcare utilisation. The results for each of the empirical strategies indicated that, for many of the services analysed, those with greater levels of health insurance coverage use more healthcare services, even after controlling for a range of socio-demographic and health related variables. Given the proposed policy changes outlined in the Slaintecare Report, this finding has significant implications for policy makers who have the task of deciding how healthcare is provided and accessed. If these results hold true, a move to a universal healthcare system may put significant capacity constraints on an already struggling public healthcare system.

The second set of empirical, econometric analyses examined, for the first time, associations between health insurance status and the costs of healthcare services for older people in the Republic of Ireland. In particular, this analysis sought to address the following question: *Does the mean and distribution of healthcare costs differ depending on the level of health insurance coverage?* While much of the empirical literature has examined the effects of health insurance on healthcare utilisation, less work has examined associations between health insurance status and healthcare costs. The second part of chapter 4 bridges this gap in the literature by using sophisticated econometric techniques to address this question. A three-pronged approach was employed to the analysis of this question. First, a series of generalised linear models estimated the impact of health insurance status on average healthcare costs. Second, matching methods were employed to account for observable heterogeneity between health insurance status and healthcare costs. Finally, using conditional quantile regression techniques I estimated the relationship between health insurance status and healthcare costs across the full distribution. The results for each of the empirical strategies are unambiguous. Those with higher levels of health insurance have higher healthcare costs even after controlling for a range of socio-demographic and health related variables.

The third set of empirical, econometric analyses examined associations between health insurance status and informal care, as well as examining informal care, received or provided, on the utilisation and costs of healthcare services for older people in the Republic of Ireland. In particular, this analysis sought to address the following questions: First, '*Does the level of informal care, received or provided, differ depending on the level of health insurance coverage?'* Second, *'Does the level of healthcare service utilisation and cost differ depending on informal care received or provided?'*

In relation to the first question, health insurance status is not associated with informal care provision, but it is associated with receipt of informal care. That is, those with higher levels of insurance receive more informal care services relative to those with no such insurance. Having higher levels of insurance allows individuals to access services more readily relative to those with no such insurance and who would have to pay for these services out of pocket.

On the second question, individuals receiving care from others are generally and significantly more likely to use a wide range of hospital and community care services. There are however, some exceptions to this general trend. For example, I find no significant association between the receipt of informal care and GP services utilisation. The relationship between the carer and the person being cared for also matters. Individuals cared for by a resident child are significantly less likely to use inpatient and chiropody services relative to the base category, everything else equal. Similarly, individuals cared for by a spouse are significantly less likely to use home help and optician services compared to those not in receipt of informal care. Individuals who are cared for by non-family members are significantly more likely to use a range of community care services including public healthcare nurse services; personal care attendant services; meals-on-wheels services; daycentre or respite care services, all else equal.

In terms of total healthcare cost estimates, individuals in receipt of informal care have significantly higher healthcare costs on average. In addition, those in receipt of informal care from more than one caregiver have significantly higher healthcare costs. The importance of care received from a caregiver living in the same household again comes to the fore. Those in receipt of care from a resident child have significantly lower total healthcare costs compared to the based case. There is no statistically significant difference in total healthcare costs for those who provide informal care.

6.4 **Study Implications**

The findings detailed above have potentially important implications for formal care and informal care policy in the Republic of Ireland. It is a worthwhile exercise to consider the implications of these findings, in light of the theoretical frameworks set out in Chapter 1; and to reflect on the policy context in which they are set. Equity of access to healthcare services is a stated goal for most healthcare services worldwide (OECD, 2004). Ireland is an interesting case study to investigate the investigate equity around accessibility of healthcare services due to the two-tiered nature of the system as it currently stands. It is even more interesting to consider this question given current government proposals to more to a universal

healthcare system, whereby individuals will be able to access care based on need rather than ability to pay.

As such, the key theoretical framework that forms the basis for the empirical approach that follows throughout this thesis was the Andersen Behavioural Model (1968). A central tenant of the Andersen Model, **equity** of access to healthcare, based on need and not ability to pay. The model examines the determinants of healthcare utilisation and posits that healthcare utilisation is a consequence of three general factors – 1) predisposing characteristics such as age and gender; 2) enabling factors such as income and health insurance status and 3) need characteristics such as health status. Thus, the model incorporates both individual and societal determinants of health service utilisation. These three general factors mentioned above, according to Andersen, offer insight into the equity of a healthcare system based on their influence in determining healthcare utilisation. Healthcare systems that are most equitable emphasise need variables, such as the presence of chronic conditions and self-rated health as the most important factors in determining healthcare utilisation. Enabling factors such as income and health insurance influence access to healthcare services. Andersen advocates expansion of health insurance coverage as a means to eliminate barriers and improve equity of access to healthcare services for all of society.

In particular, the findings from the thesis indicate that the current structure of the healthcare system in the Republic of Ireland may impose barriers to access for older individuals with those on the lowest level of public health insurance coverage having the lowest levels of utilisation and costs. These findings raise concerns about equity within the Irish healthcare system. The results were consistent with the empirical literature on the impact of health insurance status on healthcare services utilisation and costs, as discussed in Chapters 4. That is, public health insurance, by lowering the cost of care to the patient at the point of access, was associated with an increase in utilisation and by extension, an increase in costs.

Chapter 5 considered associations between health insurance status and informal care, received and provided. Results showed that those with higher levels of health insurance coverage were significantly more likely on average to receive informal care, relative to those with just public health insurance. This thesis also considered the relationship between the informal care and formal care systems for older people in the Republic of Ireland. The findings suggest that, for the most part, informal care receipt was a positive and significant predictor of health and

community care service utilisation and healthcare costs. That is, those already receiving informal care generally use more formal care and impose higher costs on the formal care system.

One can also draw on Arrow's seminar paper on "Uncertainty and the Welfare Economics of Medical Care" (Arrow, 1963) to help us explain the empirical results coming out of this thesis. The central tenant of Arrow's theory argued that, the unique features of the market for healthcare, which differentiated it from other goods and services markets, stemmed from uncertainty. Individuals are uncertain about when they may fall ill and secondly, individuals are uncertain about how they will respond to healthcare. Arrow noted that uncertainty surrounding when an individual becomes ill, could be offset by purchasing health insurance. This ability to guard against this uncertainty introduces the potential problem of moral hazard (Evans, 1974). In such cases, individuals increase their use of healthcare services because they do not face the costs out of pocket. While results coming from this thesis cannot say anything definitive about a moral hazard effect, what the results show are a clear association between health insurance status and healthcare utilisation. Those with health insurance use significantly more healthcare services on average compared to those with only public health insurance, everything else equal.

It is also useful to consider the results from each of the empirical chapters against Grossman's human capital model of the demand for health (Grossman, 1972a, 1972b). As outlined in Chapter 1, according to the Grossman Model, health is view as a capital stock that produces an output of healthy time. Individuals start with a stock of health, which depreciates over time with age and decreases when it is used in the production and consumption of other commodities. An individual's health stock can be improved by making investments in one's health. Investments take the form of a healthy diet, exercising and the consumption of healthcare. Thus, ability to access healthcare has an indirect impact on an individual's stock of health according to the Grossman Model. Health insurance, by lowering the cost of care, removes a fundamental barrier to access healthcare and ultimately improving one's health stock. However, for those with the lowest level of health insurance, significant barriers to access to healthcare remain. This barrier to access limits an individual's ability to invest in their stock of health, as one of the key components within the health production function, healthcare is restricted.

Taken together, these findings provide pertinent and timely evidence for policy makers. The findings coming from this thesis are set against a backdrop of both demographic and policy changes with the Irish healthcare context. Recent policy debate has centred on the introduction of Slaintecare in the Irish healthcare system. Slaintecare seeks to eliminate the two-tiered structure of public and private provision of healthcare in Ireland, replacing it with a universal healthcare model based on need rather than ability to pay. Such a shift, will allow individuals, hitherto unable to access required healthcare services, to do so.

Given the projected ageing demographic changes discussed in Chapter 1 and the fact that older people are the highest users of healthcare services, it is clear that ageing will exert significant demand side pressures on the Irish healthcare system. By extension, these demand side pressures will result in significant increases in total healthcare costs in the years ahead. In the context of the contributions from this thesis, the results suggest that the proposed introduction of a more universal model of healthcare in Ireland, which effectively aims to equalise access to healthcare services among older people, while more equitable, has the potential to exacerbate these demand side pressures even further. That is, the results suggest that an increasing proportion of older people with an increasing level of public health insurance coverage will lead to an exponentially increasing demand on the formal healthcare system. The thesis also showed a positive relationship between insurance coverage and the use of informal care services. Insurance, therefore, leads to higher utilisation, higher costs and higher levels of informal care. Therefore, any moves towards greater universality may increase informal care provision, rather than reduce it.

With the projected increases in formal care utilisation and costs relating to the changing demographic and policy contexts described above, there will also likely be resultant impacts for the informal care system. It follows, that there may also be increasing demands placed on informal carers to supplement or substitute for formal care needs of the ageing population. Such a scenario raises the potential for a ‘demand spiral’ for care services in the Republic of Ireland. While not considered explicitly in this thesis, this demand spiral will be potentially exacerbated by supply side constraints. Together, these demand and supply side dynamics will present significant challenges to the Irish formal and informal care systems in the years ahead.

In conclusion, these findings may be of interest to those charged with the design and delivery

of formal healthcare services for older people in the Republic of Ireland. That is, those charged with policy planning and implementation should be aware of the unintended consequences of the proposed changes to the Irish healthcare system and where possible, should attempt to manage the transition to the new more universal health insurance model in a manner that negates the potential negative implications for patients and taxpayers. In addition, policy makers need to ensure that there are sufficient supports in place for informal carers, in terms of finance, respite and other support services, to assist them in providing their key role in the care of older people in the Republic of Ireland.

6.5 Study Limitations

While this thesis provided an analysis of associations between health insurance status and informal care (both received and provided) on the utilisation and costs of a wider range of primary, secondary and community care services for older people in the Republic of Ireland, there are a number of potential shortcomings in the approaches adopted that must be acknowledged. Although the main limitations of the research have been highlighted within the specific chapters, this section considers the limitations of the work at a more general level. Some of the limitations are directly related to the methodologies employed in the thesis, while others relate to the data available.

First, let us consider the data limitations. While TILDA provides comprehensive information on the key variables of interest in the Irish setting, the data are not without their shortcomings. First, it is possible that the indicator variables are subject to recall bias. This is especially true of our dependent variables where respondents are asked to recall their utilisation of healthcare services over the last 12 months. Second, information on supply-side factors such as GP, hospital, or community care practice characteristics are unavailable. This goes directly to influence service utilisation in that people can only use services if they are available to them. Third, we were limited in terms of the information available and the approaches employed with respect to the number of healthcare visits, which is a more powerful variable than the binary response of user or non-user. Notably, throughout the thesis, community care utilisation was analysed in terms of a binary response variable, as we did not have complete information on, for example, the number of visits or the length of those visits. Moreover, for the purposes of consistency, we analysed all healthcare data as binary responses in Chapter 4, even for some variables that were available in count form. Fourth, in analysing the utilisation of community care services, respondents were asked: - “In the last 12 months did you receive any of the following State services”. While the focus is rightly on state services, it does not

take into account private out-of-pocket expenditure on support services, particularly dental and optician services. Therefore, it is possible that the results underestimate the frequency with which respondents utilise a number such community care services and in particular those that are more likely accessed in the private sector. Fifth, the healthcare cost variable did not include any community healthcare services or other costs given lack of count data for such services. In addition, the empirical analysis undertaken in this thesis failed to address the problem of potential unmet need within the healthcare system due to data limitations. Finally, the data from Wave 1 relate to the period 2009 to 2011 and therefore, their representativeness to the ageing population of 2019 may be called into question.

From a methodological viewpoint, the analysis throughout the thesis is cross-sectional and based on observational data from the first wave of TILDA data. Therefore, the potential of unobservable endogeneity of variables such as health status could not be accounted for in all cases. That said, the recursive modelling approaches explicitly account for this issue and is applied where possible. Nonetheless, a legitimate criticism of the work presented in this thesis is that it should only be interpreted as associative impacts rather than casual effects. There are a number of reasons why longitudinal analysis on subsequent waves of the TILDA study was not attempted. First, with regard to the healthcare costs dependent variable of interest, questions were asked differently in Wave 1 and subsequent waves. For example, for questions on A&E, inpatient and outpatient visits, the data on utilisation of these services appeared in count format (i.e. in terms of number of visits) in Wave 1 and interval categories (i.e. 1-2 visits, 3-6 visits etc.) in Wave 2 and beyond. Therefore, it would not be possible to analyse the effect of both insurance status and informal care on healthcare costs, as the use of intervals was not feasible. Admittedly, this is not the case for the binary response variables but for consistency, the decision was made to focus on Wave 1 and to estimate models, which account for both unobservable and observable heterogeneity. While some may argue that the approaches adopted do not go far enough to attempt to estimate causal effects, this is a criticism that can only be acknowledged. Nonetheless, the analysis presented is a comprehensive and thorough treatment of the questions considered.

6.6 Future Research Questions

In order to address some of the shortcomings of the data outlined above, this section considers some possible future avenues for research. First, any future research on the research questions addressed in this thesis could make use of the longitudinal nature of TILDA. Panel data analysis can shed light on any unobservable heterogeneity between either health insurance

status or informal care and healthcare utilisation and/or healthcare costs. Second, as noted above, TILDA is limited in terms of the information we have on the use of community care services. At present, we are unaware of the number of visits made to a community care service provider and such information could give insight into the frequency and intensity with which respondents use these services. Nonetheless, the TILDA team would need to reframe how the pertinent questions are asked in future waves of the study to make such lines of analysis possible.

From a methodological perspective, a further avenue for research could be to adopt an instrumental variable (IV) approach to address the unobservable heterogeneity that exists between health insurance status and informal care (receipt or provision) and healthcare utilisation and/or costs. The empirical literature examining the effect of health insurance on healthcare utilisation has used a number of IV as proxies for health insurance including spousal union membership (Hadley & Waidmann, 2006) and mother's employment status (Kaestner, 1999). Possible instrumental variables for informal care may include gender of the eldest child; the number of female children or proximity to the nearest child. The inclusion of appropriate instruments in the TILDA survey would enable the conduct of such analysis. Furthermore, the inclusion of supply side variables such as hospital level data or the number of clinicians working in a healthcare setting which would enable estimation of their impacts on service utilisation and costs would prove to be valuable in this context.

As mentioned previously, much of the empirical literature has focused on the supply of informal care and the relationship between informal and formal healthcare. Relatively less has concentrated on the impact of informal care from the perspective of the person receiving informal care. In addition, there is relatively little empirical evidence on the effect of informal care on healthcare outcomes. Future avenues for research could take advantage of the unique nature of TILDA. First, the longitudinal nature of TILDA allows one to control for unobservable heterogeneity between informal care and health outcomes. Second, TILDA is unique to other international datasets in that it contains a number of objective healthcare measures collected via nurse-led assessments. Future work could examine the effect of informal care (either given or received) on respondent's health outcomes over time. Given the projected increase in the demand for informal care detailed in this thesis, there will be a need for further research on the impact on the informal care provision on health outcomes, healthcare utilisation, and healthcare costs for informal carers themselves.

Finally, information on the length of a GP visit, an A&E, inpatient or outpatient visit is not

available in TILDA. In addition, no information is provided on either primary or subsequent diagnoses or procedures. Such rich information could represent 'added-value' for TILDA and increase the scope of possible research for academics and policymakers alike. One possible idea might be to create a unique identifier to allow for linkages with the Hospital Inpatient Episode (HIPE) dataset at the ESRI. Such linkages would allow for the study of pathways of care within the Irish healthcare system. Such data would provide the basis for a series of important research studies that could provide evidence that may be useful for policy makers in the Republished of Ireland.

6.7 **Conclusion**

The ageing demographic profile of the Irish population, its growing demands on the formal and informal care systems, in addition to the health policy commitment to move towards a model of universal health insurance coverage in the Republic of Ireland, make the findings of this thesis both timely and relevant. The overarching motivation of the thesis was to expand knowledge and understanding of the relationships between health insurance status and informal care and the use and cost of formal healthcare services for older people in the Republic of Ireland. The main finding is that, in general, those currently with higher level of health insurance coverage use more services and incur higher healthcare costs. Similarly, the findings indicate that, in general, receiving informal care is associated with higher usage of certain services and higher healthcare costs. Any policy change that increases health insurance coverage to all may be expected to result in higher healthcare utilisation and costs. Furthermore, an increase in the role of the informal care system may also be expected to result in higher healthcare utilisation and costs; thereby representing a possible demand spiral and an increasing burden on the formal healthcare system. While limitations of the research exist, the findings presented in this thesis provide valuable insights for policy makers and providers of formal and informal care services for older people in the Republic of Ireland, presently and in the future.

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Appendix A: Supplementary Material for Chapter 4

A. 1 Average treatment effects on the treated of health insurance status on healthcare service utilisation

Healthcare Service	Model	Medical card only	PHI only	Both	Either
Inpatient Services					
	OLS	0.0577***	0.0404***	0.0926***	0.0484***
	Probit	0.0734***	0.0454***	0.102***	0.0633***
	PSM				
	1:1	0.0980***	0.0382	0.145***	0.0973***
	1:1 caliper	0.0980***	0.0382	0.145***	0.0973***
	1:5	0.110***	0.0304	0.140***	0.0868***
	1:5 caliper	0.110***	0.0304	0.140***	0.0868***
	1:10	0.0810***	0.0397***	0.139***	0.0884***
	1:10 caliper	0.0810***	0.0397***	0.139***	0.0884***
	NN Matching				
	Base	0.0994***	0.0700***	0.120***	0.0864***
	Base + LT illness	0.0823***	0.0636***	0.106***	0.0740***
	Base + SRH	0.0891***	0.0690***	0.109***	0.0806***
A&E Services					
	OLS	0.0105	-0.00293	0.0172	0.00431
	Probit	0.0102	-0.00411	0.0169	0.00307
	PSM				
	1:1	0.0656***	0.0473**	0.0468	0.0497***
	1:1 caliper	0.0656***	0.0473**	0.0468	0.0497***
	1:5	0.0685***	0.0197	0.0161	0.0303
	1:5 caliper	0.0685***	0.0197	0.0161	0.0303
	1:10	0.0334	0.0138	0.00979	0.0205
	1:10 caliper	0.0334	0.0138	0.00979	0.0205
	NN Matching				
	Base	0.0492*	0.0305**	0.0492**	0.0307*
	Base + LT illness	0.0223	0.0236	0.0260	0.0122
	Base + SRH	0.0457*	0.0242*	0.0357	0.0273

Appendix A

A.1 Average treatment effects on the treated of health insurance status on healthcare service utilisation (Cont'd)

Healthcare Service	Model	Medical card only	PHI only	Both	Either
Outpatient Services					
	OLS	0.0487**	0.0468**	0.0692**	0.0449***
	Probit	0.0494**	0.0497***	0.0710***	0.0478***
	PSM				
	1:1	0.0642	0.0712**	0.122	0.0695***
	1:1 caliper	0.0642	0.0712**	0.122	0.0695***
	1:5	0.00980	0.0629**	0.0269	0.0727***
	1:5 caliper	0.00980	0.0629**	0.0269	0.0727***
	1:10	-0.0311	0.0564*	0.123	0.0671***
	1:10 caliper	-0.0311	0.0564*	0.123	0.0671***
	NN Matching				
	Base	0.134***	0.121***	0.169***	0.125***
	Base + LT illness	0.0875**	0.104***	0.108***	0.0898***
	Base + SRH	0.124***	0.125***	0.155***	0.124***
Public Healthcare Nurse					
	OLS	0.0175**	-0.000784	0.0175	0.0142***
	Probit	0.0684***	0.000915	0.0489***	0.0353***
	PSM				
	1:1	0.0758***	-0.000305	0.0489***	0.0405***
	1:1 caliper	0.0758***	-0.000305	0.0489***	0.0405***
	1:5	0.0798***	0.00156	0.0539***	0.0393***
	1:5 caliper	0.0798***	0.00156	0.0539***	0.0393***
	1:10	0.0532*	0.00201	0.0101	0.0363***
	1:10 caliper	0.0532*	0.00201	0.0101	0.0363***
	NN Matching				
	Base	0.0880***	0.00429*	0.0751***	0.0463***
	Base + LT illness	0.0804***	0.00465*	0.0708***	0.0422***
	Base + SRH	0.0717***	0.00313	0.0683***	0.0394***

Appendix A

A.1 Average treatment effects on the treated of health insurance status on healthcare service utilisation (Cont'd)

Healthcare Service	Model	Medical card only	PHI only	Both	Either
Occupational Therapy					
	OLS	0.00901*	0.00142	0.00702	0.00504*
	Probit	0.0221**	0.00279	0.0183**	0.0134**
	PSM				
	1:1	-0.0208	0.00336**	0.0163	-0.00687
	1:1 caliper	-0.0208	0.00336**	0.0163	-0.00687
	1:5	-0.0507*	0.00301**	0.00922**	0.00258
	1:5 caliper	-0.0507*	0.00301**	0.00922**	0.00258
	1:10	-0.0178	0.00312**	0.00213	0.00271
	1:10 caliper	-0.0178	0.00312**	0.00213	0.0105***
	NN Matching				
	Base	0.0189***	0.00275**	0.0182***	0.0118***
	Base + LT illness	0.0204***	0.00277**	0.0166***	0.0120***
	Base + SRH	0.0185***	0.00309**	0.0161***	0.0111***
Chiropody Services					
	OLS	0.0192***	-0.000473	0.0252***	0.0115***
	Probit	0.0601***	-0.00150	0.0605***	0.0281**
	PSM				
	1:1	0.0627***	-0.00397	0.0837***	0.0387***
	1:1 caliper	0.0627***	-0.00397	0.0837***	0.0387***
	1:5	0.0637***	-0.00486	0.0806***	0.0388***
	1:5 caliper	0.0637***	-0.00486	0.0806***	0.0388***
	1:10	0.0619***	-0.00847	0.0806***	0.0397***
	1:10 caliper	0.0619***	-0.00847	0.0806***	0.0397***
	NN Matching				
	Base	0.0631***	0.00429	0.0729***	0.0383***
	Base + LT illness	0.0600***	0.00465*	0.0678***	0.0359***
	Base + SRH	0.0623***	0.00400	0.0683***	0.0360***

Appendix A

A.1 Average treatment effects on the treated of health insurance status on healthcare service utilisation (Cont'd)

Healthcare Service	Model	Medical card only	PHI only	Both	Either
Physiotherapy Services					
	OLS	0.0233**	-0.00558	0.0294**	0.0101
	Probit	0.0308**	-0.00454	0.0350**	0.0150
	PSM				
	1:1	-0.0242	-0.00703	0.0213	0.0172**
	1:1 caliper	-0.0242	-0.00703	0.0213	0.0172**
	1:5	0.0100	-0.00281	0.0338***	0.0126
	1:5 caliper	0.0100	-0.00281	0.0338***	0.0126
	1:10	-0.00569	-0.00653	0.0272***	0.0129
	1:10 caliper	-0.00569	-0.00653	0.0272***	0.0129
	NN Matching				
	Base	0.0470***	0.00735	0.0438***	0.0285***
	Base + LT illness	0.0400***	0.00558	0.0392***	0.0233**
	Base + SRH	0.0412***	0.00438	0.0468***	0.0252***
Home Help Services					
	OLS	0.0233**	0.00314*	0.0106	0.00550**
	Probit	0.0308**	0.00220	0.0515***	0.0339*
	PSM				
	1:1	0.0570***	0.00428***	0.0440***	0.0312***
	1:1 caliper	0.0570***	0.00428***	0.0440***	0.0312***
	1:5	0.0547***	0.00397***	0.0479***	0.0291***
	1:5 caliper	0.0547***	0.00397***	0.0479***	0.0291***
	1:10	0.0532***	0.00385***	0.0487***	0.0297***
	1:10 caliper	0.0532***	0.00385***	0.0487***	0.0297***
	NN Matching				
	Base	0.0438***	0.00368***	0.0438***	0.0251***
	Base + LT illness	0.0345***	0.00310***	0.0414***	0.0209***
	Base + SRH	0.0322***	0.00339***	0.0368***	0.0192***

Appendix A

A.1 Average treatment effects on the treated of health insurance status on healthcare service utilisation (Cont'd)

Healthcare Service	**Model**	**Medical card only**	**PHI only**	**Both**	**Either**
Optician Services					
	OLS	0.137***	-0.00293	0.111***	0.0595***
	Probit	0.190***	-0.00314	0.138***	0.0813***
	PSM				
	1:1	0.166***	0.00886	-0.0411	0.0630***
	1:1 caliper	0.166***	0.00886	-0.0411	0.0630***
	1:5	0.125**	0.000479	0.101	0.0698**
	1:5 caliper	0.125**	0.000479	0.101	0.0698**
	1:10	0.152***	-0.00145	0.126***	0.0794***
	1:10 caliper	0.152***	-0.00145	0.126***	0.0794***
	NN Matching				
	Base	0.149***	-0.00843	0.121***	0.0722***
	Base + LT illness	0.151***	-0.00868	0.122***	0.0708***
	Base + SRH	0.151***	-0.00610	0.123***	0.0738***
Dental Services					
	OLS	0.140***	-0.0201**	0.124***	0.0444***
	Probit	0.155***	-0.0192**	0.140***	0.0517***
	PSM				
	1:1	0.143***	0.00580	0.163***	0.0846***
	1:1 caliper	0.143***	0.00580	0.163***	0.0846***
	1:5	0.137***	0.00529	0.169***	0.0817***
	1:5 caliper	0.137***	0.00529	0.169***	0.0817***
	1:10	0.138***	0.000992	0.168***	0.0798***
	1:10 caliper	0.138***	0.000992	0.168***	0.0798***
	NN Matching				
	Base	0.138***	-0.0333*	0.113***	0.0364**
	Base + LT illness	0.105***	-0.0277	0.120***	0.0451***
	Base + SRH	0.110***	-0.0424***	0.121***	0.0421***

Appendix A

A.1 Average treatment effects on the treated of health insurance status on healthcare service utilisation (Cont'd)

Healthcare Service	Model	Medical card only	PHI only	Both	Either
Hearing Services					
	OLS	0.0159***	0.00238	0.0162***	0.00901***
	Probit	0.0491***	0.00302	0.0364***	0.0243**
	PSM				
	1:1	0.0308***	0.00153	0.0312***	0.0185***
	1:1 caliper	0.0308***	0.00153	0.0312***	0.0185***
	1:5	0.0307***	0.00208	0.0311***	0.0173***
	1:5 caliper	0.0307***	0.00208	0.0311***	0.0173***
	1:10	0.0307***	0.000641	0.0311***	0.0176***
	1:10 caliper	0.0307***	0.000641	0.0311***	0.0176***
	NN Matching				
	Base	0.0277***	-0.000305	0.0306***	0.0149***
	Base + LT illness	0.0272***	0.000308	0.0317***	0.0159***
	Base + SRH	0.0271***	-0.000305	0.0299***	0.0160***
Dietician Services					
	OLS	0.00112	-0.00374	0.000552	-0.000945
	Probit	-0.000771	-0.00408	0.00381	-0.00182
	PSM				
	1:1	0.0133***	-0.00285	-0.0695*	0.00201
	1:1 caliper	0.0133***	-0.00285	-0.0695*	0.00201
	1:5	0.0118**	-0.0142	-0.0634*	-0.00505
	1:5 caliper	0.0118**	-0.0142	-0.0634*	-0.00505
	1:10	0.00902	-0.0172	-0.0281	-0.0163
	1:10 caliper	0.00902	-0.0172	-0.0281	-0.0163
	NN Matching				
	Base	0.00902	-0.0172	0.00292	0.00197
	Base + LT illness	0.00816	-0.00496	0.00176	0.0000
	Base + SRH	0.0103	-0.00553	-0.00153	-0.000244

Appendix A

A.1 Average treatment effects on the treated of health insurance status on healthcare service utilisation (Cont'd)

Healthcare Service	**Model**	**Medical card only**	**PHI only**	**Both**	**Either**
Social Work Services					
	OLS	0.00293*	0.00158*	0.00361	0.00275***
	Probit				
	PSM				
	1:1	0.00500***	0.00122**	0.00213*	0.00275***
	1:1 caliper	0.00500***	0.00122**	0.00213*	0.00275***
	1:5	0.00500***	0.00122**	0.00213*	0.00275***
	1:5 caliper	0.00500***	0.00122**	0.00213*	0.00275***
	1:10	0.00500***	0.00122**	0.00213*	0.00275***
	1:10 caliper	0.00500***	0.00122**	0.00213*	0.00275***
	NN Matching				
	Base	0.00442***	0.00123**	0.00219*	0.00253***
	Base + LT illness	0.00340***	0.00124**	0.00226*	0.00217***
	Base + SRH	0.00343***	0.00125**	0.00230*	0.00220***
Psychological/Counselling Services					
	OLS	0.00732***	-0.00000804	0.00496	0.00201
	Probit				
	PSM				
	1:1	-0.0281	0.00244	0.00142	-0.0118
	1:1 caliper	-0.0281	0.00244	0.00142	-0.0118
	1:5	-0.0477	0.00104	0.00397	-0.00451
	1:5 caliper	-0.0477	0.00104	0.00397	-0.00451
	1:10	-0.0265	0.00134	0.00567**	-0.00347
	1:10 caliper	-0.0265	0.00134	0.00567**	-0.00347
	NN Matching				
	Base	-0.0265	0.00134	0.00584*	0.00561***
	Base + LT illness	0.0119***	0.00496***	0.00754***	0.00782***
	Base + SRH	0.0107***	0.00469***	0.00767***	0.00732***

Appendix A

A.1 Average treatment effects on the treated of health insurance status on healthcare service utilisation (Cont'd)

Healthcare Service	**Model**	**Medical card only**	**PHI only**	**Both**	**Either**
Personal Care Attendant					
	OLS	0.00220	0.00100	-0.000786	0.000955
	Probit				
	PSM				
	1:1	0.0108***	0.000916*	-0.000786	0.00577***
	1:1 caliper	0.0108***	0.000916*	-0.000786	0.00577***
	1:5	0.0108***	0.000916*	-0.000786	0.00577***
	1:5 caliper	0.0108***	0.000916*	-0.000786	0.00577***
	1:10	0.0108***	0.000916*	-0.000786	0.00577***
	1:10 caliper	0.0108***	0.000916*	-0.000786	0.00577***
	NN Matching				
	Base	0.00683***	0.000919*	0.00584***	0.00393***
	Base + LT illness	0.00638***	0.000930*	0.00528***	0.00362***
	Base + SRH	0.00601***	0.000938*	0.00230*	0.00293***
Meals-on-Wheels Services					
	OLS	0.00429*	0.00101	0.00569*	0.00385***
	Probit				
	PSM				
	1:1	0.0181***	0.000916*	0.00922***	0.00866***
	1:1 caliper	0.0181***	0.000916*	0.00922***	0.00866***
	1:5	0.0181***	0.000916*	0.00922***	0.00866***
	1:5 caliper	0.0181***	0.000916*	0.00922***	0.00866***
	1:10	0.0181***	0.000916*	0.00922***	0.00866***
	1:10 caliper	0.0181***	0.000916*	0.00922***	0.00866***
	NN Matching				
	Base	0.0153***	0.000919*	0.00729***	0.00716***
	Base + LT illness	0.0128***	0.000620	0.00754***	0.00609***
	Base + SRH	0.0137***	0.000626	0.00691***	0.00629***

Appendix A

A.1 Average treatment effects on the treated of health insurance status on healthcare service utilisation (Cont'd)

Healthcare Service	**Model**	**Medical card only**	**PHI only**	**Both**	**Either**
Daycentre Services					
	OLS	-0.00330	-0.00207	0.000614	-0.000887
	Probit				
	PSM				
	1:1	-0.0135	-0.00122	0.0113*	-0.00563
	1:1 caliper	-0.0135	-0.00122	0.0113*	-0.00563
	1:5	-0.0320	-0.000794	0.0139***	0.000467
	1:5 caliper	-0.0320	-0.000794	0.0139***	0.000467
	1:10	-0.00943	-0.00116	0.0155***	0.00217
	1:10 caliper	-0.00943	-0.00116	0.0155***	0.00217
	NN Matching				
	Base	0.0141***	-0.000613	0.0146***	0.00744***
	Base + LT illness	0.0119**	-0.000620	0.0143***	0.00637***
	Base + SRH	0.0107***	0.0000	0.0123***	0.00615***
Respite Services					
	OLS	0.00369	0.000143	0.00201	0.00210***
	Probit				
	PSM				
	1:1	0.00885***	0.000305	0.00496***	0.00426***
	1:1 caliper	0.00885***	0.000305	0.00496***	0.00426***
	1:5	0.00885***	0.000305	0.00496***	0.00426***
	1:5 caliper	0.00885***	0.000305	0.00496***	0.00426***
	1:10	0.00885***	0.000305	0.00496***	0.00426***
	1:10 caliper	0.00885***	0.000305	0.00496***	0.00426***
	NN Matching				
	Base	0.00522***	0.000306	0.00292**	0.00253***
	Base + LT illness	0.00511***	0.000310	0.00301**	0.00246***
	Base + SRH	0.00515***	0.000313	0.00307**	0.00249***
		3,440	4,116	2,252	8,124

Appendix B: Supplementary Material for Chapter 4

B 1 Average treatment effects on the treated of health insurance status on total healthcare costs – all matching methods

Healthcare Service	Model	Medical card only	PHI only	Both	Either
Total Healthcare Costs					
	OLS	477.8***	249.3**	673.1***	356.6***
	PSM				
	1:1	928.7***	367.2**	852.6***	738.8***
	1:1 caliper	928.7***	367.2**	852.6***	738.8***
	1:5	894.0***	291.8*	1,034***	574.3***
	1:5 caliper	894.0***	291.8*	1,034***	574.3***
	1:10	804.4***	286.9**	1,029***	627.6***
	1:10 caliper	804.4***	286.9**	1,029***	627.6***
	NN Matching				
	Base	986.4***	547.4***	971.1***	763.5***
	Base + LT illness	866.5***	503.9***	847.6***	682.2***
	Base + SRH	886.0***	517.7***	891.1***	693.4***

Appendix C: Supplementary Material for Chapter 5

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
GP Services							
	OLS	0.0306**	-0.0289	0.0131	-0.0489**	-0.0280	-0.0171
	Probit	0.118	-0.0443	-	-0.0701**	-0.0420	-0.0174
	PSM						
	1:1	0.0337	-0.0250	0.0119	-0.0429**	-0.00758	-0.00451
	1:1 caliper	0.0337	-0.0250	0.0119	-0.0429**	-0.00758	-0.00451
	1:5	0.0356**	-0.01000	0.0230*	-0.0388**	-0.0152	-0.00376
	1:5 caliper	0.0356**	-0.0200	0.0381**	-0.0388**	-0.0141	-0.00376
	1:10	0.0180*	-0.0181	0.0333***	-0.0408**	-0.0121	-0.00320
	1:10 caliper	0.0249*	-0.0202	0.0286**	-0.0408**	-0.0140	-0.00567
	NN Matching						
	Base	0.0449	-0.0278	0.0000	-0.0357	0.0000	0.00454
	Base + LT illness	0.0235	-0.0571	0.0000	-0.0284	0.0000	-0.00686
	Base + SRH	0.0000	-0.0333	0.0313	-0.0217	0.0000	-0.0162
A&E Services							
	OLS	0.0658	-0.0150	-0.00500	0.00616	0.0348	0.0291
	Probit	0.0444	-0.0143	-0.00692	0.00239	0.0204	0.0197
	PSM						
	1:1	0.0506	0.0250	-0.0476	0.0500	0.0530	0.0722**
	1:1 caliper	0.0506	0.0500	-0.0476	0.0500	0.0530	0.0722**
	1:5	0.0723**	-0.0150	0.00556	0.0231	0.0318	0.0348
	1:5 caliper	0.0723**	0.0350**	0.0238	0.0231	0.0223	0.0348
	1:10	0.0586***	0.00365	0.0214	0.0366	0.0636	0.0432*
	1:10 caliper	0.0499***	0.0430*	0.0286	0.0366	0.0760**	0.0439*
	NN Matching						
	Base	0.107	-0.0833	0.0750	0.0393	0.0846	0.0669**
	Base + LT illness	0.0412	-0.0571	0.0588	-0.0504	0.0709	0.0538*
	Base + SRH	0.0688	-0.200*	0.0313	0.0772	0.103	0.0452

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Inpatient Services							
	OLS	0.0517	-0.0363	0.0201	0.0836**	0.0580	0.0564**
	Probit	0.0354	-0.0304	0.0110	0.0498**	0.0330	0.0362**
	PSM						
	1:1	0.0169	0.0250	-0.0357	0.171***	0.0758*	0.0519
	1:1 caliper	0.0169	0.0250	-0.0357	0.171***	0.0758*	0.0519
	1:5	0.0633***	-0.00500	-0.00397	0.120***	0.0621*	0.0717***
	1:5 caliper	0.0633***	-0.0100	0.0286	0.120***	0.0482	0.0717***
	1:10	0.0518***	-0.00442	0.0333	0.101***	0.0735**	0.0667***
	1:10 caliper	0.0593***	-0.00977	0.0405	0.101***	0.0899***	0.0665***
	NN Matching						
	Base	0.0281	-0.167*	0.100	0.118**	0.0923	0.0714**
	Base + LT illness	0.0529	-0.114	-0.0441	0.0581	0.126**	0.0561
	Base + SRH	-0.0313	-0.133	0.0313	0.0691	0.103	0.0452

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
Outpatient Services							
	OLS	0.112**	-0.0256	0.0867	-0.0534	-0.0332	0.0108
	Probit	0.117**	-0.0201	0.0883	-0.0484	-0.0271	0.0141
	PSM						
	1:1	0.107*	0.0750	0.0476	0.0143	0.0846	0.0132
	1:1 caliper	0.107*	0.0500	0.0476	0.0143	0.0846	0.0132
	1:5	0.124***	0.0300	0.0841**	-0.00810	0.0227	0.0302
	1:5 caliper	0.124***	-0.0150	0.105	-0.00810	0.00564	0.0302
	1:10	0.0893***	0.0129	0.0857**	-0.00253	0.0189	0.0402
	1:10 caliper	0.0987***	0.0116	0.0952	-0.00253	0.0295	0.0304
	NN Matching						
	Base	0.140**	0.0000	0.150	0.0571	0.0590	0.0707**
	Base + LT illness	-0.0176	-0.0286	0.0000	-0.0478	0.0604	0.0370
	Base + SRH	0.0437	0.0333	0.125	0.0393	0.0228	0.0363
Public Healthcare Nurse							
	OLS	0.0985**	0.175**	0.161**	0.283***	0.203***	0.198***
	Probit	0.0367***	0.0396**	0.0316**	0.0619***	0.0480***	0.0576***
	PSM						
	1:1	0.0899*	0.125***	0.202***	0.250***	0.149***	0.157***
	1:1 caliper	0.0899*	0.150***	0.202***	0.250***	0.149***	0.157***
	1:5	0.0835**	0.185**	0.136***	0.241***	0.130***	0.169***
	1:5 caliper	0.0835**	0.135*	0.138***	0.241***	0.118***	0.169***
	1:10	0.0967***	0.151*	0.157***	0.223***	0.139***	0.161***
	1:10 caliper	0.0899***	0.125*	0.140***	0.223***	0.144***	0.160***
	NN Matching						
	Base	0.101*	0.250***	0.275***	0.289***	0.221***	0.207***
	Base + LT illness	0.0941	0.143	0.250**	0.279***	0.241***	0.207***
	Base + SRH	0.0875	0.200*	0.344***	0.268***	0.211***	0.201***

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
Occupational Therapy							
	OLS	0.0240	0.0396	0.0370	0.0596**	0.102***	0.0612***
	Probit	0.00706	0.00781	0.00939	0.0121***	0.0171***	0.0158***
	PSM						
	1:1	0.0225	0.0500	0.0476	0.0500*	0.0909**	0.0609***
	1:1 caliper	0.0225	0.0500	0.0476	0.0500*	0.0909**	0.0609***
	1:5	0.0337***	0.0550	0.0333	0.0400*	0.103***	0.0623***
	1:5 caliper	0.0337***	0.0450	0.0381	0.0400*	0.105***	0.0623***
	1:10	0.0191**	0.0400	0.0357	0.0400*	0.110***	0.0621***
	1:10 caliper	0.0315**	0.0325	0.0405	0.0400*	0.119***	0.0603***
	NN Matching						
	Base	0.0449*	0.0278	0.0250	0.0500*	0.115***	0.0590***
	Base + LT illness	0.0471*	0.0571	0.0000	0.0465	0.0945**	0.0549***
	Base + SRH	0.0500*	-0.0667	0.0625	0.0813***	0.120***	0.0580***
Chiropody Services							
	OLS	-0.000830	-0.0396	0.108*	0.0324	0.0645*	0.0352**
	Probit	-0.00171	-0.0236	0.0213	0.00500	0.0156	0.00916
	PSM						
	1:1	0.0449	-0.125**	0.0476	0.0429	0.0720	0.0587**
	1:1 caliper	0.0449	0.0000	0.0476	0.0429	0.0720	0.0587**
	1:5	-0.00899	-0.0400	0.0778	0.0186	0.0394	0.0509**
	1:5 caliper	-0.00899	-0.0100	0.0667*	0.0186	0.0462	0.0509**
	1:10	0.0000	-0.0494**	0.0952*	0.00643	0.0614	0.0420*
	1:10 caliper	-0.0168	-0.0225	0.0714***	0.00643	0.0543	0.0402*
	NN Matching						
	Base	0.0225	-0.0833	0.100	0.0321	0.100**	0.0420*
	Base + LT illness	0.0118	-0.0571	0.0000	0.0349	0.0787*	0.0309
	Base + SRH	0.0250	-0.100	0.0625	0.0122	0.103**	0.0360

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
Physiotherapy Services							
	OLS	0.0689*	-0.0251	0.00836	0.0824**	0.0661*	0.0607***
	Probit	0.0257*	-0.0140	0.00287	0.0321**	0.0234*	0.0251***
	PSM						
	1:1	0.101**	-0.0500	0.0238	0.0429	0.0947**	0.0429
	1:1 caliper	0.101**	-0.0250	0.0238	0.0429	0.0947**	0.0429
	1:5	0.0674**	-0.0250	-0.00873	0.0676*	0.0818***	0.0421*
	1:5 caliper	0.0674**	-0.0450	0.00952	0.0676*	0.0785***	0.0421*
	1:10	0.0552**	-0.0300	-0.00238	0.0607*	0.0803***	0.0409*
	1:10 caliper	0.0611**	-0.0173	-0.00476	0.0607*	0.0760***	0.0436*
	NN Matching						
	Base	0.0562	0.0278	0.0750	0.104**	0.0923**	0.0828***
	Base + LT illness	0.0353	0.0000	0.0000	0.103*	0.0315	0.0606*
	Base + SRH	0.0500	0.0000	0.0313	0.117**	0.0513	0.0661**
Home Help Services							
	OLS	-0.0198	0.0373	0.00938	0.299***	0.191***	0.149***
	Probit	-0.00870	0.00202	-0.00576	0.0388***	0.0329***	0.0330***
	PSM						
	1:1	-0.0112*	-0.0250	0.0476**	0.229***	0.159***	0.131***
	1:1 caliper	-0.0112*	0.125**	0.0476**	0.229***	0.159***	0.131***
	1:5	-0.0112	0.0150	0.0437	0.286***	0.177***	0.135***
	1:5 caliper	-0.0112	0.0350	0.0190	0.286***	0.163***	0.135***
	1:10	-0.0124	0.0250	0.0310	0.279***	0.183***	0.120***
	1:10 caliper	-0.0190	0.0650	0.0310	0.279***	0.178***	0.117***
	NN Matching						
	Base	0.0112	0.0833	0.0250	0.326***	0.238***	0.169***
	Base + LT illness	0.0118	0.0000	0.0000	0.287***	0.252***	0.171***
	Base + SRH	0.0125	0.100	0.0000	0.366***	0.248***	0.160***

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
Optician Services							
	OLS	-0.0456	0.0616	0.0307	0.0419	-0.00710	0.00717
	Probit	-0.0344	0.0386	0.0157	0.0214	-0.00502	0.00262
	PSM						
	1:1	-0.118**	0.0500	0.0238	0.0429	0.0164	0.0482
	1:1 caliper	-0.118**	0.0000	0.0238	0.0429	0.0164	0.0482
	1:5	-0.0670*	0.0400	0.00714	0.0333	0.0106	0.0103
	1:5 caliper	-0.0670*	0.0700*	0.0143	0.0333	0.000769	0.0103
	1:10	-0.0545*	0.0356	0.0310	0.0416	0.0136	0.0105
	1:10 caliper	-0.0697**	0.0630***	0.0143	0.0416	0.00775	0.00934
	NN Matching						
	Base	-0.0393	0.111	0.0000	0.0750	0.0205	0.0299
	Base + LT illness	-0.0294	0.114	0.0000	0.119**	-0.0420	0.0233
	Base + SRH	-0.0688	0.100	0.0313	0.0596	0.00570	0.0166
Dental Services							
	OLS	-0.0217	0.0758	-0.0847**	0.0235	-0.00709	-0.00225
	Probit	-0.0135	0.0604	-0.100*	0.0163	1.87e-05	0.000448
	PSM						
	1:1	0.0730*	0.0000	-0.0238	0.107***	0.0240	-0.00150
	1:1 caliper	0.0730*	0.125	-0.0238	0.107***	0.0240	-0.00150
	1:5	-0.0131	0.0950	-0.0468	0.0460*	0.00303	0.0132
	1:5 caliper	-0.0131	0.110*	-0.0381**	0.0460*	0.0126	0.0132
	1:10	-0.0324	0.0937	-0.0381	0.0486**	0.0182	0.0197
	1:10 caliper	-0.0239	0.115*	-0.0310	0.0486**	0.0116	0.0150
	NN Matching						
	Base	-0.0281	0.0556	-0.125*	0.0107	-0.0103	-0.0110
	Base + LT illness	-0.0412	0.114	-0.118	0.0155	-0.0656	-0.0214
	Base + SRH	-0.0688	0.0000	-0.125	0.0488	-0.0456	-0.00773

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
Hearing Services							
	OLS	-0.00824	0.0420	-0.0107	0.0257	0.0167	0.0133
	Probit	-0.00630	0.0154	-0.00499	0.00837	0.00707	0.00558
	PSM						
	1:1	0.0112	0.0500**	0.0238	0.0214	0.0126	0.0143
	1:1 caliper	0.0112	0.0250	0.0238	0.0214	0.0126	0.0143
	1:5	0.00487	0.0550	-0.00476	0.0274*	0.0227	0.00617
	1:5 caliper	0.00487	0.0350	-0.00476	0.0274*	0.0227	0.00617
	1:10	-0.00562	0.0450	0.00238	0.0271*	0.0114	0.00497
	1:10 caliper	-0.0123	0.0452	0.0000	0.0271*	0.0147	0.00612
	NN Matching						
	Base	-0.0112	0.0278	0.0000	0.0321	-0.0103	0.00265
	Base + LT illness	-0.0118	0.0286	-0.0588	0.0349	-0.00262	0.00496
	Base + SRH	-0.0375	0.0286	-0.0313	0.0203	0.0142	0.00271
Dietician Services							
	OLS	0.0294	-	0.0213	0.0493**	0.00609	0.0246**
	Probit	0.00925*	-	0.0151	0.0193***	0.00430	0.0129***
	PSM						
	1:1	-0.0112	-	0.0000	0.0429**	-0.0152	0.0181
	1:1 caliper	-0.0112	-	0.0000	0.0504***	-0.0152	0.0181
	1:5	0.0180	-	0.00476	0.0486***	0.00606	0.0108
	1:5 caliper	0.0180	-	0.0190*	0.0403***	0.00606	0.0108
	1:10	0.0270	-	0.00952	0.0488***	0.00689	0.0186
	1:10 caliper	0.0270**	-	0.0149	0.0447***	-0.00147	0.0186
	NN Matching						
	Base	0.0562*	-	0.0500	0.0500**	0.0308*	0.0385***
	Base + LT illness	0.0588*	-	0.0294	0.0620***	0.0315*	0.0343***
	Base + SRH	0.0250	-	0.0625	0.0569**	0.0256	0.0302**

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
Social Work Services							
	OLS	-	-	-	0.00716	0.00688	0.00126
	Probit	-	-	-	0.00220	0.00208	0.00102
	PSM						
	1:1	-	-	-	0.0143	0.0152	-0.00226
	1:1 caliper	-	-	-	0.0143	0.0152	-0.00226
	1:5	-	-	-	0.00714*	0.0136	-0.00226
	1:5 caliper	-	-	-	0.00714*	0.0107	-0.00226
	1:10	-	-	-	0.00929	0.0129	0.00113
	1:10 caliper	-	-	-	0.00929	0.0107	0.00113
	NN Matching						
	Base	-	-	-	0.00714	0.0154	0.00680
	Base + LT illness	-	-	-	0.00752	0.0154	0.00456
	Base + SRH	-	-	-	0.00813	0.0171	0.00696
Psychological/Counselling Services							
	OLS	-0.00286	0.00524	-	0.0139	0.0119	0.00723
	Probit	-0.00169	0.00492	-	0.00643	0.00842*	0.00545
	PSM						
	1:1	0.0000	0.0250	-	0.00714	0.0227*	0.0135
	1:1 caliper	0.0000	0.0250	-	0.0144	0.0227*	0.0135
	1:5	0.00674	0.0200	-	0.0171	0.0167	0.0117
	1:5 caliper	0.00674	0.0200	-	0.0201	0.0167	0.0117
	1:10	0.00674	0.0225	-	0.0171	0.0182*	0.0100
	1:10 caliper	0.00787	0.0127	-	0.0202	0.0215***	0.0100
	NN Matching						
	Base	0.0000	0.0000	-	0.0143	0.0000	0.00907
	Base + LT illness	0.0118	0.0000	-	0.0155	0.00787	0.0114
	Base + SRH	-0.0250	0.0000	-	0.0163	0.0171	0.0116

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
Personal Care Attendant							
	OLS	0.00525	0.0147	0.0341	0.0879***	0.0649***	0.0513***
	Probit	0.00231	0.000567	0.00164	0.00810***	0.00705***	0.0103***
	PSM						
	1:1	-0.0112	0.0250	0.0476*	0.0929***	0.0606***	0.0519***
	1:1 caliper	-0.0112	0.0250	0.0476*	0.0929***	0.0692***	0.0519***
	1:5	0.00225	0.0200	0.0381	0.0902***	0.0515***	0.0551***
	1:5 caliper	0.00225	0.0000	0.0254	0.0902***	0.0615***	0.0551***
	1:10	0.00235	0.0100	0.0405	0.0900***	0.0606***	0.0538***
	1:10 caliper	0.00235	-0.00159	0.0310	0.0900***	0.0667***	0.0538***
	NN Matching						
	Base	0.0000	0.0278	0.0250	0.0929***	0.0615**	0.0556***
	Base + LT illness	0.0000	0.0286	0.0147	0.0969***	0.0630**	0.0595***
	Base + SRH	0.0000	0.0333	0.0313	0.0976***	0.0569**	0.0557***
Meals-on-Wheels Services							
	OLS	-0.00218	0.0275	0.0216	0.0846***	0.00147	0.0316***
	Probit	0.000908	0.00213	0.00175	0.0123***	-0.000342	0.00836***
	PSM						
	1:1	0.0000	0.0000	0.0476	0.0929***	0.0152	0.0316**
	1:1 caliper	0.0000	0.0500**	0.0476	0.0929***	0.0152	0.0316**
	1:5	-0.00449	0.0300**	0.0381	0.0786***	0.0106	0.0366***
	1:5 caliper	-0.00449	0.0400*	0.0333	0.0786***	0.0154	0.0366***
	1:10	-0.0101	0.0275	0.0429	0.0793***	0.00758	0.0321***
	1:10 caliper	-0.0101	0.0300*	0.0405	0.0793***	0.0124	0.0324***
	NN Matching						
	Base	0.0000	0.0556	0.0250	0.0714**	0.0000	0.0272**
	Base + LT illness	0.0000	0.0571	0.0294	0.0775**	0.00787	0.0343***
	Base + SRH	-0.0125	0.0667	0.0313	0.0894***	0.0171	0.0325**

Appendix C

Table C.1 Average treatment effects on the treated of informal care receipt on healthcare services utilisation (Cont'd)

Healthcare Service	**Matching method**	**Spousal care**	**Resident child**	**Non-resident child**	**Others**	**Care received from more than one carer**	**Any care**
Daycentre Services							
	OLS	-	0.0147	0.0341	0.0670***	0.0470**	0.0381***
	Probit	-	0.000567	0.00164	0.00822**	0.00984***	0.00913***
	PSM						
	1:1	-	0.0250	0.0476*	0.0893***	0.0692***	0.0609***
	1:1 caliper	-	0.0250	0.0476*	0.0893***	0.0692***	0.0609***
	1:5	-	0.0200	0.0381	0.0779***	0.0615***	0.0510***
	1:5 caliper	-	0.0000	0.0254	0.0779***	0.0615***	0.0510***
	1:10	-	0.0100	0.0405	0.0787***	0.0600***	0.0526***
	1:10 caliper	-	-0.00159	0.0310	0.0787***	0.0500**	0.0499***
	NN Matching						
	Base	-	0.0278	0.0250	0.0929***	0.0538*	0.0567***
	Base + LT illness	-	0.0286	0.0147	0.0930***	0.0551*	0.0481***
	Base + SRH	-	0.0333	0.0313	0.110***	0.0855***	0.0661***
Respite Services							
	OLS	0.00314	-	0.0147	0.0577***	0.0263*	0.0269***
	Probit	0.000531	-	0.00118	0.00808***	0.00213	0.00547***
	PSM						
	1:1	-0.0112	-	0.0238	0.0643***	0.0303	0.0293***
	1:1 caliper	-0.0112	-	0.0238	0.0643***	0.0303	0.0293***
	1:5	-0.00449	-	0.0238	0.0629***	0.0348**	0.0266***
	1:5 caliper	-0.00449	-	0.0190	0.0629***	0.0348**	0.0266***
	1:10	0.00133	-	0.0238	0.0600***	0.0326**	0.0280***
	1:10 caliper	0.00133	-	0.0220	0.0600***	0.0328**	0.0283***
	NN Matching						
	Base	-0.0112	-	0.0250	0.0571***	0.0385**	0.0249**
	Base + LT illness	-0.0235	-	0.0294	0.0620***	0.0236	0.0183
	Base + SRH	-0.0120	-	0.0313	0.0569**	0.0325*	0.0229**
		7,770	7,721	7,723	7,821	7,813	8,124

Appendix C

C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation

Healthcare Service	**Matching method**	**Any care**	**One**	**Multiple**
GP Services				
	OLS	-0.0119	-0.0244	-0.00972
	Probit	-0.00883	-0.0177	-0.00677
	PSM			
	1:1	-0.0123	-0.00496	-0.0142
	1:1 caliper	-0.0123	-0.00496	-0.0142
	1:5	-0.00662	-0.0213	-0.0115
	1:5 caliper	-0.00662	-0.0213	-0.0115
	1:10	-0.00685	-0.0196	-0.0146
	1:10 caliper	-0.00685	-0.0196	-0.0146
	NN Matching			
	Base	-0.0113	-0.0352	-0.00730
	Base + LT illness	-0.0184*	-0.0230	-0.0179
	Base + SRH	-0.0000890	-0.0335	0.00391
A& E Services				
	OLS	0.0173**	0.0357*	0.0145
	Probit	0.0164*	0.0354**	0.0132
	PSM			
	1:1	0.0242**	0.0422	0.0222*
	1:1 caliper	0.0242**	0.0422	0.0222*
	1:5	0.0227**	0.0390**	0.0138
	1:5 caliper	0.0227**	0.0390**	0.0138
	1:10	0.0198**	0.0344*	0.0138
	1:10 caliper	0.0198**	0.0344*	0.0138
	NN Matching			
	Base	0.0331***	0.0583**	0.0303***
	Base + LT illness	0.0245**	0.0515**	0.0214*
	Base + SRH	0.0315***	0.0483**	0.0272**

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Inpatient Services				
	OLS	-0.00207	0.0208	-0.00472
	Probit	-0.00165	0.0235	-0.00492
	PSM			
	1:1	0.000889	0.0161	-0.0101
	1:1 caliper	0.000889	0.0161	-0.0101
	1:5	-0.00447	0.0310	-0.00314
	1:5 caliper	-0.00447	0.0310	-0.00314
	1:10	-0.00467	0.0268*	-0.00550
	1:10 caliper	-0.00467	0.0268*	-0.00550
	NN Matching			
	Base	0.00984	0.0364	0.00809
	Base + LT illness	0.0107	0.0444*	0.00643
	Base + SRH	0.00824	0.0424*	0.00602
Outpatient Services				
	OLS	0.0220**	0.00805	0.0249**
	Probit	0.0213*	0.00668	0.0243**
	PSM			
	1:1	0.0202	0.0558*	0.0212
	1:1 caliper	0.0202	0.0558*	0.0212
	1:5	0.0256**	0.0286	0.0175
	1:5 caliper	0.0256**	0.0286	0.0175
	1:10	0.0188	0.0185	0.0209*
	1:10 caliper	0.0188	0.0185	0.0209*
	NN Matching			
	Base	0.0612***	0.00993	0.0723***
	Base + LT illness	0.0431***	-0.0163	0.0542***
	Base + SRH	0.0622***	-0.0140	0.0757***

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Public Healthcare Nurse Services				
	OLS	-0.0113**	-0.0156*	-0.0114**
	Probit	-0.0107*	-0.0193	-0.0110*
	PSM			
	1:1	-0.0115*	0.0136	-0.0143**
	1:1 caliper	-0.0115*	0.0136	-0.0143**
	1:5	-0.00852*	-0.00546	-0.0101**
	1:5 caliper	-0.00852*	-0.00546	-0.0101**
	1:10	-0.00902**	-0.00812	-0.00984**
	1:10 caliper	-0.00902**	-0.00812	-0.00984**
	NN Matching			
	Base	-0.00776	-0.0372**	-0.00616
	Base + LT illness	-0.0110*	-0.0251*	-0.00948
	Base + SRH	-0.0104*	-0.0305**	-0.00927
Occupational Therapy Services				
	OLS	-0.00142	-0.00915**	-0.000345
	Probit	-0.00170	-0.0151*	-0.000576
	PSM			
	1:1	0.00427	0.00000	-0.000830
	1:1 caliper	0.00427	0.00000	-0.000830
	1:5	0.000510	-0.00695**	-0.000457
	1:5 caliper	0.000510	-0.00695**	-0.000457
	1:10	0.000226	-0.00965***	0.000106
	1:10 caliper	0.000226	-0.00965***	0.000106
	NN Matching			
	Base	0.00249	-0.00993	0.00457
	Base + LT illness	0.00107	-0.0101	0.00332
	Base + SRH	0.00302	-0.0102	0.00561*

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Chiropody Services				
	OLS	-0.00195	0.00136	-0.00346
	Probit	0.0000131	0.00942	-0.00182
	PSM			
	1:1	-0.00409	0.0199**	0.00332
	1:1 caliper	-0.00409	0.0199**	0.00332
	1:5	-0.000865	0.00645	0.000360
	1:5 caliper	-0.000865	0.00645	0.000360
	1:10	-0.00158	0.00449	-7.55e-06
	1:10 caliper	-0.00158	0.00449	-7.55e-06
	NN Matching			
	Base	-0.00231	-0.0124	-0.000623
	Base + LT illness	-0.000889	-0.00251	-0.00145
	Base + SRH	-0.00214	-0.00382	-0.000623
Physiotherapy Services				
	OLS	0.00591	-0.00806	0.00782
	Probit	0.00550	-0.0118	0.00776
	PSM			
	1:1	0.00314	0.00993	0.00536
	1:1 caliper	0.00314	0.00993	0.00536
	1:5	0.00569	-0.00637	0.00877
	1:5 caliper	0.00569	-0.00637	0.00877
	1:10	0.00703	-0.00960	0.00762
	1:10 caliper	0.00703	-0.00960	0.00762
	NN Matching			
	Base	0.0148**	-0.0124	0.0198***
	Base + LT illness	0.0102*	-0.0126	0.0140**
	Base + SRH	0.0147**	-0.0153	0.0208***

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Home Help Services				
	OLS	-0.00898***	-0.0163***	-0.00849**
	Probit	-0.00734*	-0.0486**	-0.00633
	PSM			
	1:1	-0.00634	-0.00248	-0.0124**
	1:1 caliper	-0.00634	-0.00248	-0.0124**
	1:5	-0.00734**	-0.00885***	-0.0101***
	1:5 caliper	-0.00734**	-0.00885***	-0.0101***
	1:10	-0.00747***	-0.0117***	-0.0101***
	1:10 caliper	-0.00747***	-0.0117***	-0.0101***
	NN Matching			
	Base	-0.0117***	-0.0298***	-0.0103**
	Base + LT illness	-0.0124***	-0.0276***	-0.0116**
	Base + SRH	-0.0111***	-0.0420***	-0.00817*
Optician Services				
	OLS	-0.0128*	-0.0128	-0.0127*
	Probit	-0.0135*	-0.0150	-0.0137*
	PSM			
	1:1	-0.0221**	0.00744	-0.0159
	1:1 caliper	-0.0221**	0.00744	-0.0159
	1:5	-0.0167**	-0.00835	-0.0159*
	1:5 caliper	-0.0167**	-0.00835	-0.0159*
	1:10	-0.0182**	-0.00765	-0.0152*
	1:10 caliper	-0.0182**	-0.00765	-0.0152*
	NN Matching			
	Base	-0.00154	-0.0261	0.00111
	Base + LT illness	-0.00421	-0.0214	-0.00201
	Base + SRH	0.00433	-0.0280	0.00609

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Dental Services				
	OLS	0.00784	0.0110	0.00704
	Probit	0.00754	0.00670	0.00730
	PSM			
	1:1	-0.00735	-0.00496	0.00879
	1:1 caliper	-0.00735	-0.00496	0.00879
	1:5	0.00426	-0.00265	0.00632
	1:5 caliper	0.00426	-0.00265	0.00632
	1:10	0.00193	-0.00310	0.00558
	1:10 caliper	0.00193	-0.00310	0.00558
	NN Matching			
	Base	0.0157*	0.0211	0.0156
	Base + LT illness	0.0239***	0.0188	0.0244**
	Base + SRH	0.0223**	0.0204	0.0219**
Hearing Services				
	OLS	-0.00367	-0.00891***	-0.00265
	Probit	-0.00390	-0.0212	-0.00266
	PSM			
	1:1	-0.00148	-0.00496	0.000277
	1:1 caliper	-0.00148	-0.00496	0.000277
	1:5	-0.00263	-0.00935**	-0.000996
	1:5 caliper	-0.00263	-0.00935**	-0.000996
	1:10	-0.00294	-0.0114***	-0.00220
	1:10 caliper	-0.00294	-0.0114***	-0.00220
	NN Matching			
	Base	-0.00616*	-0.0136**	-0.00429
	Base + LT illness	-0.00581*	-0.0113*	-0.00387
	Base + SRH	-0.00439	-0.0102	-0.00305

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Dietician Services				
	OLS	0.00252	0.00812	0.00170
	Probit	0.00324	0.00627	0.00307
	PSM			
	1:1	0.000356	0.00993	0.00457
	1:1 caliper	0.000356	0.00993	0.00457
	1:5	0.00268	0.00447	0.00286
	1:5 caliper	0.00268	0.00447	0.00286
	1:10	0.00249	0.00620	0.00155
	1:10 caliper	0.00249	0.00620	0.00155
	NN Matching			
	Base	0.00569**	0.0112	0.00540*
	Base + LT illness	0.00391	0.00879	0.00374
	Base + SRH	0.00498	0.0127*	0.00457
Social Work Services				
	OLS	-0.000758	-	-0.000204
	Probit	-0.000494	-	5.86e-05
	PSM			
	1:1	0.00000	-	-0.000415
	1:1 caliper	0.00000	-	-0.000415
	1:5	-0.000130	-	0.000787
	1:5 caliper	-0.000130	-	0.000787
	1:10	-0.000178	-	0.000502
	1:10 caliper	-0.000178	-	0.000502
	NN Matching			
	Base	-0.000711	-	-0.000415
	Base + LT illness	-0.00142	-	-0.00125
	Base + SRH	-0.00142	-	-0.00125

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Counselling Services				
	OLS	0.00331	0.00504	0.00310
	Probit	0.00285	0.00360	0.00247
	PSM			
	1:1	0.000889	0.0174***	0.00706**
	1:1 caliper	0.000889	0.0174***	0.00706**
	1:5	0.00262	0.0104	0.00310
	1:5 caliper	0.00262	0.0104	0.00310
	1:10	0.00292	0.00844	0.00216
	1:10 caliper	0.00292	0.00844	0.00216
	NN Matching			
	Base	0.00818***	0.00496	0.00872***
	Base + LT illness	0.00747***	0.0000	0.00830***
	Base + SRH	0.00961***	0.00763	0.00997***
Personal Care Attendant Services				
	OLS	-0.000706	-	-0.000403
	Probit	-0.000773	-	-0.000370
	PSM			
	1:1	0.00142	-	0.00166
	1:1 caliper	0.00142	-	0.00166
	1:5	0.000782	-	-0.000318
	1:5 caliper	0.000782	-	-0.000318
	1:10	-0.000142	-	-0.000321
	1:10 caliper	-0.000142	-	-0.000321
	NN Matching			
	Base	0.000889	-	0.00104
	Base + LT illness	0.000178	-	0.000208
	Base + SRH	-0.000178	-	-0.000208

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Meals on Wheels Services				
	OLS	-0.000895	-0.00231	-0.000997
	Probit	0.000237	0.000223	-0.000249
	PSM			
	1:1	-0.00213	0.00000	-0.00374
	1:1 caliper	-0.00213	0.00000	-0.00374
	1:5	-0.00154	0.00000	-0.000789
	1:5 caliper	-0.00154	0.00000	-0.000789
	1:10	-0.00180	-0.000455	-0.00137
	1:10 caliper	-0.00180	-0.000455	-0.00137
	NN Matching			
	Base	-0.00142	-0.00496	-0.000830
	Base + LT illness	-0.000711	-0.00503	0.0000
	Base + SRH	-0.00231	-0.00509	-0.00187
Daycentre Services				
	OLS	-0.00572***	-0.00213	-0.00638***
	Probit	-0.00842***	-0.00307	-0.0101***
	PSM			
	1:1	-0.00373*	0.00372	-0.00470*
	1:1 caliper	-0.00373*	0.00372	-0.00470*
	1:5	-0.00471***	-0.000414	-0.00576***
	1:5 caliper	-0.00471***	-0.000414	-0.00576***
	1:10	-0.00420***	-0.000744	-0.00498***
	1:10 caliper	-0.00420***	-0.000744	-0.00498***
	NN Matching			
	Base	-0.00338	-0.00496	-0.00311
	Base + LT illness	-0.00409*	-0.00251	-0.00436*
	Base + SRH	-0.00338*	-0.00763	-0.00270

Table C.2 Average treatment effects on the treated of informal care provision on healthcare services utilisation (Cont'd)

Respite Care Services				
	OLS	-0.00196	-	-0.00160
	Probit	-0.00291**	-	-0.00226
	PSM			
	1:1	-0.00107	-	-0.000415
	1:1 caliper	-0.00107	-	-0.000415
	1:5	-0.00292	-	-0.00158
	1:5 caliper	-0.00292	-	-0.00158
	1:10	-0.00219	-	-0.00152
	1:10 caliper	-0.00219	-	-0.00152
	NN Matching			
	Base	0.000356	-	0.00166
	Base + LT illness	-0.000711	-	0.00125
	Base + SRH	-0.000712	-	0.00125