ESRI
www.esri.ie

Working Paper No. 193

May 2007

An Analysis of the Impact of Age and Proximity of Death on Health Care Costs in Ireland

Richard Layte

Abstract: Research has shown that older individuals are far more likely to avail of health care and there is concern in a number of countries that the trend toward population ageing may mean that health care expenditures increase to unsustainable levels. However, there is a growing body of evidence that the approach of death rather than age per se may be the main determinant of health care costs. Previous analyses of the relationship between proximity to death and costs have used rare longitudinal data on costs and whether died and none have used a national sample. In this paper we use a more commonly found data type – a national panel survey to show that proximity to death is indeed a more significant predictor of expenditure on GP and hospital services than age. Using random effects panel models we show that there is a significant gradient in costs as death approaches. Controlling for proximity to death there is no age gradient in costs. This conclusion remains unchanged adjusting for differential health inpatient costs across age groups. In fact, adjustment steepens the gradient in costs as death approaches.

Corresponding Author: Richard.Layte@esri.ie

Keywords: Ageing; Cost of Dying; Healthcare Expenditure; Panel Survey

An Analysis of the Impact of Age and Proximity of Death on Health Care Costs in Ireland

1. Introduction

There is now agreement that population ageing is already a serious issue and will be significant in industrialised economies over future decades (OECD 1988). For example, within the 15 countries of the EU before May 2004 the number of people aged over 65 has increased from 34 million in 1960 to 60 million by 1999 (Eurostat 2001). Those aged eighty or more are the fastest growing population group with numbers predicted to increase by almost 50% in the EU 15 over the next fifteen years. What is less well established is the impact that population ageing will have on health care expenditures. Age is certainly related to increased use of health care services (Layte et al. 2005) and this is reflected in higher per capita health care expenditures on older age groups (Meerding et al. 1998). Yet comparative studies have failed to find a relationship between the population share of older people and country per capita health care expenditure (Getzen 1992). Instead there is a growing body of research which suggests that health care costs are actually a function of proximity to death rather than age per se. For example, Zweifel et al (Zweifel, Felder, & Meiers 1999) used data on costs in the last two years of life from two sickness funds in Switzerland to show that age was largely irrelevant as a determinant of health care expenditure in the last two years of life, while the final three months was highly significant. Controlling for proximity to death there was no significant increase in expenditure by age.

Further evidence of the relationship between end of life and health care costs was provided by O'Neill et al (O'Neill et al. 2000) using a sample of 270 individuals aged 65 or more in the Nottingham Health Authority Area in the UK. This study found that those individuals in their last year of life were significantly more expensive to care for than those who survived the duration of the study, but age was not a significant factor in level of costs. The study also showed that among those who died during the study, costs were unrelated to age but were significantly related to proximity to death.

Both Zweifel et al and O'Neill offer evidence of a relationship but both have the limitation of observing the relationship between closeness to death and costs over a relatively short time frame. This was rectified in Seshamani and Gray (Seshamani & Gray 2004) which used data from the Oxford Record Linkage Study (ORLS) from 1970 to 1999 to track hospital costs among a sample of almost 96,000 individuals in the Oxfordshire area of England. The study used a two-step methodology (unlike Zweifel et al, without Heckman correction) and random-effects models to show that costs increase up to 15 years prior to death. Moreover, the tenfold increase in costs in the final 5 years of life easily outweighed the 30% increase in costs which occurred between age 65 and 85.

Seshamani and Gray (Seshamani & Gray 2004) provide compelling evidence for a region of Great Britain, but data such as that found in the Oxford Record Linkage Study are rare. In this paper we look to confirm the findings of Seshamani and Gray at the country level using data from a national panel survey – the Living in Ireland Panel Survey (LII), which is the Irish component of the European Community Household Panel Survey (ECHP). By selecting individuals who died within the panel observation period and examining their previous health care utilisation we are able to put a value on the costs of care as death approaches whilst controlling for the age of the individual. Unlike Seshamani and Gray we cannot examine the average yearly cost of the approach of death as only a small proportion of those in our panel data died, but we are able to examine the hypothesis that health care expenditure is more closely linked to the proximity of the individual to death rather than their age over a substantial period of seven years and for a nationally representative population.

2. Data

For this paper we use data from the Living in Ireland (LII) survey which includes the Irish component of the European Community Household Panel Survey, but has a substantially enhanced range of questions and an enhanced sample size from 2000 on. The survey began in 1994 and respondents were followed every year thereafter until 2001. The LII is based on a two-stage clustered random probability sample which began with a sample of 4048 households and 9904 individuals (a 63% response rate at the individual level). The rate of subsequent non-response was heaviest in 1995, but continued to occur through to the final year used in this paper 2001. In 1995, 89% of the original completed households (3584) and 86% of the original individuals (8532)

were reinterviewed, although some households and individuals were rerecruited in subsequent years. By 1999 the number of households had been reduced to 2378 and individuals to 5451 so the decision was made to supplement the sample. This led to the addition of 2661 households and 3527 individuals in 2000 leading to a total sample of 5027 households and 8056 individuals. It is not necessary that the individuals who die in the sample be in the sample for all eight years of the observation period. As we will go onto show, our aim is to estimate the costs of being N years from death controlling for age and other factors and for this we simply need observations of health care costs and other characteristics for those who subsequently die. We are in this sense analysing 'person periods' rather than persons.

The data extracted for use in this paper contain 53,665 person periods of a single year collected from 15,483 individuals who took part in the LII survey between 1994 and 2001. As shown in Table 1, during that period there where 456 deaths registered among the survey sample of which 192 were women and 264 were men. Not unexpectedly, average age among the sample (the mean age of the person, not person periods) who did not survive was considerably higher than among survivors at 72 compared to 41. Mean age at death for the former was 73 for men and 74 for women.

It is crucial to find out whether the LII data gives us a representative picture of the number of deaths and the costs of care preceding this. Statistics from the Irish Central Statistics Office (CSO) show that deaths among those aged 20 or more were 1.3% of total in 1996 falling to 1.1% in 2001. Death rates in the LII sample were only slightly less than this at between 1.1% and 1% of sample through the period. The LII survey was of private households and would not then interview the 0.9% of the Irish population who are in long-term residential care and this, plus some measurement error, probably accounts for slight difference between the death rates in the LII sample and those from national death registers.

The LII survey has a greater range of measures and indicators than the ECHP survey and it is possible to find out if a person had died even if the household record lapsed with their passing. Combined with the fact that older people were more likely to remain in the sample through the observation period this meant that we are able to detect and register the overwhelming proportion of deaths in the sample.

Another check we can perform on the data is a comparison of the age of those deaths that occur in the LII sample compared to national Irish statistics. Table 1

shows that the pattern of age at death in the LII data largely follows those of data published by the CSO with the largest proportion of deaths occurring in the 75-84 age group.

Table 1: Age at Death in LII & CSO Statistics		
	LII	CSO*
Aged <65	20.0%	18.6%
65-74	21.5%	23.1%
75-84	41.2%	35.9%
85+	17.3%	22.5%
Total	100%	100%

* Deaths by age group in 1996

Before we turn to the multivariate analyses it is useful to get a descriptive overview of differences in health care usage between those respondents who died within the survey observation window ("descendents") and those that did not ("survivors"). Table 2 gives summary statistics on usage of GP, hospital and specialist/consultant services. It is clear from this that descendents who died within the panel observation period were heavier users of hospital and GP services.

Table 2: Descriptive Statistics of Surviving and Non-Surviving Samples			
Mean (std in parentheses)	Men	Women	Both
Survivors			
N Persons	7,462	7,563	15,025
N Person Periods	25,975	26,173	52,148
Age	41.79 (17.71)	43.19(18.03)	42.49(17.88)
Hospital Nights per year	0.95 (7.14)	1.15(6.49)	1.05(6.82)
GP Visits	2.84 (5.28)	4.23(6.23)	3.54(5.81)
Specialist Visits	0.42 (2.05)	0.60(3.3)	0.51(2.75)
Total Costs per year	482.57(2495.73)	626.55(2356.24)	554.83(2427.77)
Descendents			
N Persons	265	193	458
N Person Periods	879	638	1,517
Age	71.43(13.49)	72.11(13.83)	71.72(13.63)
Hospital Nights per year	4.35(13.68)	7.19(20.15)	5.54(16.76)
GP Visits per year	7.89(9.16)	10.26(9.98)	8.89(9.58)
Specialist Visits per year	0.69(2.19)	0.88(2.14)	0.77(2.17)
Total Costs per year	1801.17(4627.36)	2837.01(6745.98)	2236.81(5637.78)
Age at Death	72.71(13.70)	74.21(13.58)	73.34(13.66)

Whereas survivors had just over 1 night in hospital on average, descendents had over 5. Survivors had almost 4 GP visits per year on average whereas descendents had over almost 9. The difference between the groups is less marked for visits to a medical specialist with survivors having around 0.5 specialist visits on average per year compared to 0.77 visits for descendents.

On average then, those individuals who died during the panel observation period where heavier users of GP and hospital services. This is likely to mean that those who died during the panel were also more costly users of healthcare, but it is not possible to say this conclusively until we have a measure of cost. A previous paper Layte and Nolan 2004 developed cost estimates for different types of healthcare in Ireland for the year 2000 using a range of methods and here we use this previous work to develop an estimate of the cost of healthcare used by each individual in each year. Layte and Nolan (Layte & Nolan 2004) estimated that a GP visit cost €32.25, a night in hospital €325.12 and a visit to a specialist €193.50 in 2000. These relativities between the different types of health care may well have changed between 1994 and 2001, but for the purposes of this paper it is sufficient to apply these estimates to usage over the whole so as to get a stable measure for comparative purposes. It would hamper rather than help analysis if we have to take account of changing relativities between types over the period.

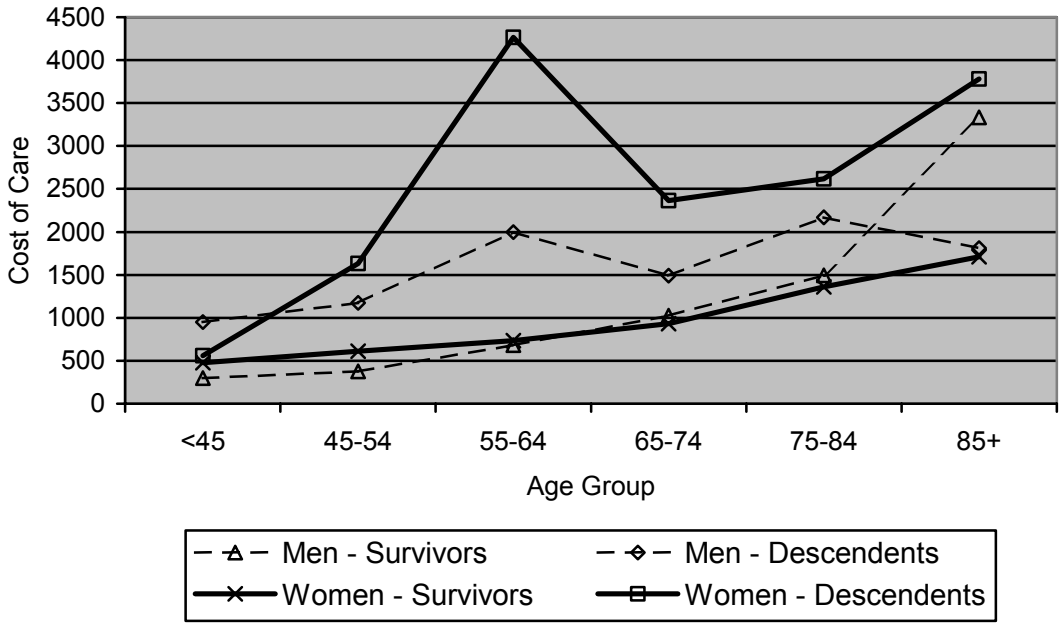
A more serious issue may be the possibility that we may in fact under-estimate the cost difference between those who survive the period and those who do not. Although the severity of the illness may not influence the cost of GP visits, it could increase the cost of specialist visits where certain specialities such as oncology and cardiology are more expensive. Similarly, hospital inpatient costs may vary significantly along a number of dimensions such as final outcome (death, survival), age and other socio-demographic variables.

In this paper we first produce initial estimates of the impact of age and proximity to death based solely upon the frequency of utilisation (section Four). In Section Five we then adjust for the differential costs of inpatient care using data from the Hospital In Patient Enquiry system data file that collects information on hospital discharges in Ireland. This includes a measure of the 'relative value' of in patient care compared to the average as well as a number of other variables. We use this data to produce estimates of the costs of utilisation in the ECHP data (see below).

Before we go onto directly assess this hypothesis it is useful first to examine the relationship between cost and age on a descriptive basis to assess whether dying is associated with a higher cost across age groups and if so whether this difference is uniform. Unfortunately the relatively small number of deaths in the sample, particularly at younger ages means that we are not able to examine cost differences under the age of 45 between those who died and those who did not. However, Figure

1 shows that for both those who survived and those who died that the cost of healthcare rises with age, although the patterns are somewhat different for men and women and between those who died and those who survived. Those who died had a higher level of health care costs at each age than those who survived, but the difference is larger for women than men. Men and women who survived have very similar levels of healthcare costs across the age range except for the oldest group where the mean for men increases substantially. Among women who died there is a pronounced peak in the 55 to 64 year age group. This pattern may simply be an artefact of the relatively small number of cases that we have available for analysis, but it could also represent a real trend in costs.

Figure 1: Mean Cost of Healthcare by Age Group and Whether Died in Panel



It may be for example, that conditions which occur after considerable lifetime exposure to particular lifestyles or circumstances such as heart disease or cancer, emerge around this age and lead to both excess premature death and costs. However, it is difficult to see why this peak would occur for women and not men.

Overall Figure 1 supports the hypothesis that healthcare costs are increased by the approach of death, although we cannot tell if costs increase as death approaches or whether those who subsequently die within each age group have higher healthcare costs generally. To examine whether we see an increase in the cost of care as death

approaches controlling for age we need to specify a model of the process that takes into account the panel structure of the data. It is to this that we turn in the following section.

3. Methods

The methodology that we use for analysis is partially dictated by our aims in the paper and partially by the LII data on deaths. A number of researchers have advocated a two-step approach (Hakkinen, Rosenqvist, & Aro 1996; Buchmueller et al. 2002) to modelling health care utilisation as the most appropriate way of analysing the decision-making process underlying the final outcome. The argument is that the initial decision to use a service is different from the decision about how frequently to do so and so the two-stages should be modelled separately. This is often necessary because a large proportion of most samples will not have incurred health care costs, especially if hospital inpatient care is being studied. In our data however, we have very few zero observations for healthcare costs. Although 89 of the 458 (10% of person periods and just over 19% of persons) respondents who died have at least one year in which they used none of the three health care types we examine across the eight-year observation window, just twelve incurred no healthcare costs across the entire period they were present in the survey. We thus choose to use a single-step procedure.

Our data are derived from a panel survey and this introduces an added complexity since a cross-sectional framework may not control for individual-specific effects. Given this we choose to use a random-effects model which fits an unobserved individual-specific error term ε_i with a zero mean and normal (Gaussian) distribution. As is often found with health care expenditure the sample distribution has a long right tail which produces a skew coefficient of 6.28. A natural log transformation reduces this to 0.42 and we use this form in the equation estimating healthcare costs:

$$1.\ \text{Log(HCE)} = \alpha_i + \beta 1 A_{it} + \beta 2 S_{it} + \beta 3 YBD_{it} + \beta 4 M_{it} + \beta 5 HE_{it} + \beta 6 YR_{it} + \varepsilon_i$$

Where A: Age, S: Female, YBD: Years before death, M: Marital Status, HE: Highest Education, YR: Calendar Year, ε_i: individual level error term.

We confine analyses in this section to the 458 of 15,017 respondents to the LII panel survey for whom we have a year of death. Exclusion of zero cost observations and missing data reduces the sample to 1,357 periods and 444 individuals. As

individuals may have been observed for different lengths of time it is possible that this introduces selection bias (Verbeek 2000). To test for such bias we introduced variables into equation 1 for total number of time periods of observation and its square (Verbeek2000). Both variables were insignificant showing that selection bias would not substantially affect our panel models.

4. Results

Table 3 gives the results for a random effects GLS regression of the log(costs). The coefficient rho in the final line of Table 3 shows that the panel level variance component contributes 36% of total variance. This underlines the importance of using a method of analysis appropriate for panel data.

The results show that there is a pronounced gradient in the impact of year before death ln(cost) of healthcare rises significantly as death approaches controlling for age. The effects for age on the other hand are not significant. It would be useful to examine whether the costs of proximity to death increase in older age groups but given the relatively small number of cases available to us it is not possible to interact age with proximity to death and so this analysis is not possible. Overall the results support our hypothesis that the costs of healthcare are a function of proximity to death rather than age per se.

It is possible to use the coefficients produced by the model of costs in Table 4 to create an estimate of the average cost of healthcare at N years before death setting other covariates at their mean. Simply retransforming the fitted estimates into costs in euros would introduce a retransformation bias (Manning 1998), and so we follow Manning and Mullahy (Manning & Mullahy 2001) and use a smearing estimator to correct for this. Using this approach Table 4 displays the corrected estimates for the marginal costs of healthcare N years before death.

Table 3: Linear Regression Model of ln(Cost)		
	β	S.E
2 Years Before Death	-0.38**	0.11
3 Years Before Death	-0.29*	0.13
4 Years Before Death	-0.68***	0.15
5 Years Before Death	-0.81***	0.18
6 Years Before Death	-0.87***	0.22
7 Years Before Death	-1.22***	0.31
Aged 65 to 74	0.10	0.17
Aged 75 to 84	0.18	0.17
Aged 85+	0.31	0.23
Female	0.39**	0.14
Separated/Divorced	0.51**	0.18
Widowed	0.86*	0.39
Never Married	0.40*	0.20
Lower Secondary	0.09	0.23
Upper Secondary	0.02	0.26
Tertiary	0.08	0.32
1995	-0.08	0.11
1996	-0.13	0.13
1997	0.08	0.15
1998	-0.02	0.18
1999	0.13	0.22
2000	0.06	0.25
Constant	5.98***	0.23
N Persons	444	
N Periods	1357	
σ_{υ}	1.36	
P	0.36	

This shows that costs rise across the seven-year period as death approaches in a steady upward progression. In the final four years of life average costs almost double from €1390 to €2755. As found by Seshamani & Gray we see a steepening of the slope in the final year of life, although unlike that paper the cost at two years to death is lower than at three years.

Table 4: Predictions of Average Yearly Cost by Years Before Death	
Years Before Death	Average Cost
1	2754.57
2	1888.60
3	2066.76
4	1390.39
5	1220.00
6	1152.00
7	813.80

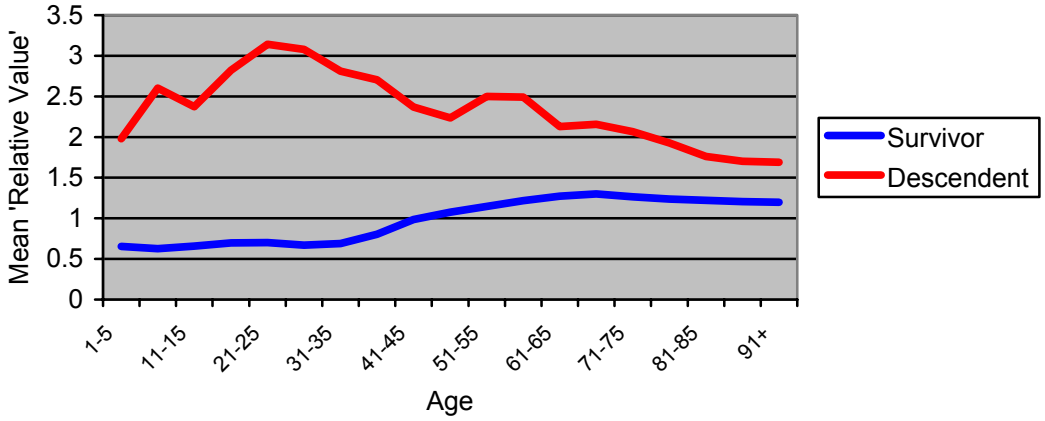
This pattern may be a result of the much smaller sample used here than that used by Seshamani & Gray and that our results are for GP, specialist and hospital costs rather than just hospital costs.

We can use the marginal effects calculated for the model in Table 3 to calculate the approximate impact of ageing on the costs of care compared to those shown in Table 4 for the years to death. Table 4 shows that there is an increase of €1942 between the seventh and final year of life whereas analysis of the age effects shows increases of €278 for those aged 65 to 74 compared to those aged 18 to 64, €540 for those 75 to 84 and €1014 for those aged 85 or more.

5. Adjusting for Differential Hospital Costs

The above analyses indicate that the costs of health care increase as the person approaches death. Our measure of health care costs is based on the frequency of use and this may not be an accurate measure of health care costs if the value of utilisation varies significantly across the population. For example, Figure 2 shows the 'relative value' (RV) of discharges in Irish hospitals compared to the average in the year 2000 across age groups for survivors and descendents. This shows that the RV of treatment for descendents was considerably more on average than that for survivors, but that there was also considerable variation by age. Among survivors costs are relatively flat until the mid-30s after which there is a steady rise until age 70 and a slight decline thereafter. For descendents on the other hand, the RV increases sharply until the mid-20s after which it falls steadily thereafter apart from a temporary rise between age 50 and 65. Both the peak in the mid 20s and the later rise are a consequence of the higher probability of expensive surgical treatments in these periods

Figure 2: Average Hosptial Cost by Outcome and Age



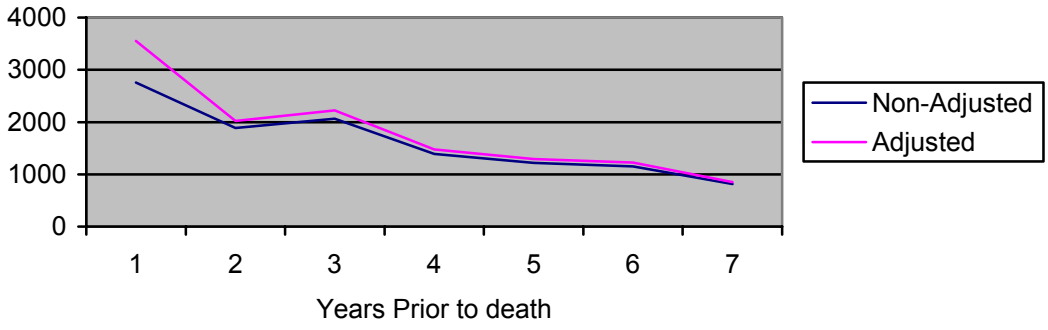
These changes in the relative value of discharges across age groups suggests that factoring differential cost into our estimates of expenditures may produce

interesting results. Doing so, however, requires cost information for the person period data from the ECHP that is not available within the data file. Instead we adopt an imputation procedure based on linking aggregate data from the Hospital Inpatient Enquiry (HIPE) system to the person periods of the ECHP. Although not ideal, this will allow us to make estimates of the role of differential costs across individuals. Of course, it is possible that health expenditures differ along a range of dimensions other than age and this is built into the linking procedure.

We link the data by first, deriving the mean relative value of discharges within the HIPE data for groups defined by the cross-tabulation of the data by the variables sex, medical insurance status, medical card status and of course, grouped age. These means are based only on discharge records in the HIPE data for descendents. The values derived from this procedure are then matched to the person periods for descendents from the ECHP data using variables grouped in a similar manner. Total costs are then calculated by summing the cost figure for each inpatient night over the mean 'rv' for that individual. This value is then added to the existing values we derived for GP and outpatient care.

Results show that adjusting for differential cost has some impact on the rate of increase in costs as death approaches as can be seen from Figure 3 (full results are shown in the Appendix to the paper). This shows a steepening of the cost curve, particularly in the last year of life. Adjustment for differential cost does not change the effects found earlier in this paper for the impact of age.

Figure 3: Health Care Expenditures by with and without Differential Hospital Costs



If we perform the same analysis of the impact of ageing verses that of proximity to death using the adjusted inpatient costs we find that being aged 65 to 74 increases costs by €330 compared to those aged 18 to 64. For those aged 75 to 84 this

increases to €620 and for those aged 85 plus to €1155. In comparison, Appendix Table 2 shows that the increase in cost between the seventh and last year of life is €2700.

6. Discussion

This paper has attempted to test the hypothesis that the costs of healthcare rise as a function of closeness to death rather than as a function of age. There is good evidence that older age is associated with a greater burden of chronic ill health and a higher usage healthcare services and this would imply that the population ageing which most OECD countries will experience over the next half century will lead to an inexorable rise in the costs of health care as a larger and larger proportion of the population enter old age. However, if health care utilisation and costs are actually tied more strongly to the fact that a person is approaching death, irrespective of their age, then population ageing may not increase costs as steeply as previously suggested. This is not to say that costs will not increase at all however. As the numbers of individuals in their final five years of life increases this will inevitably increase the overall average expenditure on healthcare. Although we could not explicitly model the interaction of age with period to death, our analyses showed no statistically significant age gradient in costs for men or women, although the costs for women are significantly more than for men. If we calculate the net marginal affect of age relative to proximity to death the latter is almost three times at large. This differential remained even when we adjusted in patient costs to reflect differentials in expenditure associated with different age groups.

This paper provides further evidence on the relationship between health care costs and proximity to death using a relatively long time period and a national sample. Large panel surveys are available for a number of other counties and it would be possible and useful to investigate the patterns found in these data also.

References

Buchmueller, T., Couffinhal, A., Grignon, M., & Perronnin, M. 2002, *Access to Physician Services: Does Supplemental Insurance Matter?*, National Bureau of Economic Research, Washington, 9238.

Eurostat 2001, *The Social Situation in the European Union 2001*, European Commission, Brussels.

Getzen, T. E. 1992, "Population Ageing and the Growth of Health Expenditures", *Journal of Gerontology: Social Sciences*, vol. 47, p. S98-S104.

Hakkinen, U., Rosenqvist, G., & Aro, S. 1996, "Economic Depression and the Use of Physician Services in Finland", *Health Economics*, vol. 5, no. 5, pp. 421-434.

Layte, R., Nolan, A., Nolan, B., & van Ourti, T. 2005, *Health and Morbidity by Age and Socio-Economic Characteristics*, ENEPRI, Brussels, 15.

Layte, R. & Nolan, B. 2004, "Equity in the Utilisation of Health Care in Ireland", *Economic and Social Review*, vol. 35, no. 2, pp. 111-134.

Manning, W. G. 1998, "The Logged Dependent Variable, heteroscedasticity and the Retransformation Problem", *Health Economics*, vol. 17, no. 3, pp. 283-295.

Manning, W. G. & Mullahy, J. 2001, "Estimating Log Models: To Transform or Not to Transform", *Journal of Health Economics*, vol. 20, pp. 461-494.

Meerding, W. J., Bonneux, L., Polder, J. J., Koopmanschap, M. A., & van der Maas, P. J. 1998, "Demographic and Epidemiological Determinants of Healthcare Costs in Netherlands: Cost of Illness Study", *British Medical Journal*, vol. 317, pp. 111-115.

O'Neill, C., Groom, L., Avery, A., Boot, D., & Thornhill, K. 2000, "Age and Proximity to Death As Predictors of GP Care Costs: Results from a Study of Nursing Home Patients", *Health Economics*, vol. 9, pp. 733-738.

OECD 1988, *Ageing Population: The Social Policy Implications*, OECD, Paris.

Seshamani, M. & Gray, A. M. 2004, "A Longitudinal Study of the Effects of Age and Tome to Death on Hospital Costs", *Journal of Health Economics*, vol. 23, pp. 217-235.

Verbeek, M. 2000, *A Guide to Modern Econometrics* Wiley, Chichester, England.

Zweifel, P., Felder, S., & Meiers, M. 1999, "Ageing of Population and Health Care Expenditure: A Red Herring?", *Health Economics*, vol. 8, pp. 485-496.

Appendix

Table 1: Linear Regression Model of ln(Cost)		
	β	S.E
2 Years Before Death	-0.39**	0.12
3 Years Before Death	-0.29*	0.13
4 Years Before Death	-0.70***	0.16
5 Years Before Death	-0.83***	0.19
6 Years Before Death	-0.89***	0.23
7 Years Before Death	-1.25***	0.32
Aged 65 to 74	0.11	0.18
Aged 75 to 84	0.20	0.18
Aged 85+	0.34	0.23
Female	0.39**	0.14
Separated/Divorced	0.53**	0.18
Widowed	0.88*	0.40
Never Married	0.41*	0.21
Lower Secondary	0.08	0.24
Upper Secondary	0.03	0.27
Tertiary	0.09	0.33
1995	-0.09	0.12
1996	-0.13	0.13
1997	0.07	0.15
1998	-0.03	0.19
1999	0.13	0.22
2000	0.06	0.26
Constant	6.01***	0.24
N Persons	444	
N Periods	1357	
σ_{υ}	1.41	
P	0.36	

Table 2: Predictions of Average Yearly Cost by Years Before Death With and Without Adjustment for Differential Hospital Costs		
Years Before Death	Average Cost	
	Unadjusted	Adjusted
1	2754.57	3551.46
2	1888.60	2023.37
3	2066.76	2225.77
4	1390.39	1477.63
5	1220.00	1295.06
6	1152.00	1222.76
7	813.80	851.52

Year	Number	Title/Author(s) *ESRI Authors/Co-authors Italicised*
2007	192	Measuring Hospital Case Mix: Evaluation of Alternative Approaches for the Irish Hospital System Chris Aisbett, *Miriam Wiley, Brian McCarthy, Aisling Mulligan*
	191	The Impact of the EU-US Open Skies Agreement on International Travel and Carbon Dioxide Emissions *Karen Mayor* and *Richard S.J. Tol*
	190	Comparing the Travel Cost Method and the Contingent Valuation Method – An Application of Convergent Validity Theory to the Recreational Value of Irish Forests *Karen Mayor, Sue Scott, Richard S.J. Tol*
	189	The Impact of Flexible Working Arrangements on Work-Life Conflict and Work Pressure in Ireland *Helen Russell, Philip J. O'Connell* and *Frances McGinnity*
	188	The Housing Tenure of Immigrants in Ireland: Some Preliminary Analysis *David Duffy*
	187	The Impact of the UK Aviation Tax on Carbon Dioxide Emissions and Visitor Numbers *Karen Mayor* and *Richard S.J. Tol*
	186	*Irish Sustainable Development Model (ISus)* Literature Review, Data Availability and Model Design *Joe O'Doherty, Karen Mayor, Richard S.J. Tol*
	185	Managing Term-Time Employment and Study in Ireland *Merike Darmody* and *Emer Smyth*
	184	The Effects of Human Capital on Output Growth in ICT Industries: Evidence from OECD Countries *Gavin Murphy* and *Iulia Traistaru-Siedschlag*
	183	Real Interest Parity in the EU and the Consequences for Euro Area Membership: Panel Data Evidence, 1979-2005 *Martin O'Brien*

	182	Can Small Firms' Perceived Constraints Help Explain Survival Rates? *Seán Lyons*
	181	Understanding the Implications of Choice of Deprivation Index for Measuring Consistent Poverty in Ireland *Christopher T. Whelan*
	180	Economics in Ireland *Frances Ruane* and *Richard S.J. Tol*
	179	Airline Emissions of Carbon Dioxide in the European Trading System *John Fitz Gerald* and *Richard S.J. Tol*
	178	An Environmental Input-Output Model for Ireland *Joe O'Doherty* and *Richard S.J. Tol*
2006	177	The Impact of a Carbon Tax on International Tourism *Richard S.J. Tol*
	176	Economic Integration and Structural Change: The Case of Irish Regions *Edgar Morgenroth*
	175	Macroeconomic Differentials and Adjustment in the Euro Area *Iulia Traistaru-Siedschlag*
	174	The Impact of Climate Change on Tourism in Germany, The UK and Ireland: A Simulation Study Jacqueline M. Hamilton and *Richard S.J. Tol*
	173	Regional Growth Cycle Synchronisation with the Euro Area Gabriele Tondl and *Iulia Traistaru-Siedschlag*
	172	Measuring Material Deprivation with EU-SILC: Lessons from the Irish Survey *Christopher T. Whelan* and *Bertrand Maître*
	171	Levels and Patterns of Material Deprivation in Ireland: After the 'Celtic Tiger' *Christopher T. Whelan* and *Bertrand Maître*
2005	169	The Case for an EU-wide Measure of Poverty *Tony Fahey*