Acute care utilisation, ageing and proximity to death

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Abstract: This analysis demonstrates that across countries and over time the percentage of deaths in a population is a significant driver of acute bed utilisation, whereas age of the population is not. A variable for all deaths as a percentage of population in a year has a positive and significant effect on acute bed days per capita. The percentage of population aged 65 and over is insignificant or negative in its effect, when all deaths are included as a covariate. Per capita national income is also a significant driver of acute bed utilisation. This finding is repeated for a number of cross-country panels, comprising from 15 to 20 OECD countries for varying periods over the years 1985-2006. While cross-country differences in acute bed utilisation remain after controlling for national income, death and age, these differences generally conform to differences between countries in the proportion of deaths that occur in hospital. J.E.L. Classification: I10/ Health, General

I INTRODUCTION

This cross-country analysis shows that death is a significant driver of acute bed utilisation, whereas age is not. The analysis confirms that the relative significance of proximity to death over age, demonstrated for health care expenditure or utilisation within countries in earlier studies, holds true for acute utilisation across countries. Whereas earlier studies of the effect of proximity to death have been based on micro data within countries, this study employs macro data across countries.

Employing acute bed days per capita as a measure of acute care utilisation at country level, the finding that death is a significant driver of utilisation, while age is not, is repeated for a number of cross-country panels, with alternative sources of demographic data. The panels vary in their composition: comprising from 15 to 20 OECD countries; covering from 12 to 22 years, within the period 1985-2006; and with 219 to 355 observations. A variable for all deaths as a percentage of population in a year has a positive and significant effect on acute care utilisation. This remains so whether the percentage of population aged 65 and over is included or excluded as a covariate. The age variable is insignificant or negative in its effect on acute care utilisation, when all deaths are included as a covariate. GDP per capita is included as a covariate, since in other studies it has shown significance as a driver of health spending. In this analysis it has a positive and significant relationship to acute bed days per capita.

Unlike earlier studies employing expenditure or utilisation data for individual hospital patients, this study employs a measure of all deaths in a population, which may or may not occur in hospital. To seek an explanation for differences between countries in acute bed utilisation, which remain after controlling for national income, age and deaths, this paper examines evidence from the literature on location at death. In general, where evidence exists that most deaths occur in hospital, acute utilisation is correspondingly higher; where there is evidence that most deaths occur outside hospital, acute utilisation is lower. This does not hold true for Canada, however, suggesting that further factors should be taken into account in explaining differences in acute utilisation.

The finding that death is a significant driver of acute bed utilisation, whereas age is not, implies that as life expectancy increases, the age at which acute bed demands will be most challenging is the age at, or close to which, death occurs. This cross-country confirmation of the importance of proximity to death as a driver of acute bed utilisation suggests that further analysis of the determinants of location at death will enhance understanding of differences between countries' acute utilisation. Proximity to death emerges from this analysis as a policy driver: a well-managed place of death policy has potential not only to improve the lives of the terminally ill but also to reduce utilisation of acute beds.

The paper is structured as follows. The next section reviews the theory and literature on ageing and health care. Section III outlines the data employed in this analysis. Section IV explains the methodological approach. Section V reports and discusses the findings. Section VI summarises the paper.

II THEORY AND LITERATURE

Most developed countries have ageing populations, with an increasing proportion of people of greater age, due to a combination of declining birth rates and increasing life expectancy for older people. Yet cross-country studies attempting to quantify the influence of age and ageing on health service expenditure have found national income to be a more important determinant of health spending than the age structure of the population. Where ageing has been found to be of significance, there has been great cross-country variability. It has been suggested that factors other than income or ageing, such as the system of health finance and delivery, the use of technology or other unobserved country-specific factors must play an important role (Barros 1998; Gerdtham et al. 1992; Hitiris and Posnett 1992; Newhouse 1977; O Connell 1996; Parkin et al. 1987). A body of evidence has therefore accumulated which challenges the intuitively appealing view of ageing as a significant driver of health spending.

National studies of the costs of care for people close to the end of life (decedents) and for survivors have illustrated that health care costs are more closely related to proximity to death than calendar age. This decedent effect has been demonstrated within: Switzerland (Zweifel et al. 1999; Felder et al. 2000; Zweifel et al. 2004); Canada (McGrail et al. 2000); Ireland (Layte 2007) ; the US (Lubitz and Riley 1993; Spillman and Lubitz 2000); and Japan (Sato and Fushimi 2009). A study in Germany demonstrated that acute hospital bed utilisation is also driven by proximity to death not age (Busse et al. 2002). Cross-country analysis of age-specific health services utilisation employing micro-data for the pre-enlargement EU-15 countries established that, while health services utilisation rises as age increases, much of this variation is removed when differences in socio-economic characteristics and health status are taken into account (Layte et al. 2005). When projecting health and long-term care expenditures to 2050, the OECD has adopted a comprehensive framework, including death-related costs and the health status of the population (OECD 2006).

Whereas previous studies of ageing and health spending employing cross-country macro data did not include the decedent effect, and previous studies of decedent effects employed micro-data for individual countries or across countries, this paper extends the analysis by employing a cross-country macro model incorporating decedent effects. Since the decedent variable is all deaths as a percentage of population in a year, a key consideration is the extent to which deaths occur in acute hospitals. Location at death differs between countries and varies by region and over time within countries (Beccaro et al. 2006; Flory et al. 2004; Cohen et al. 2008; Gomes and Higginson 2008; Jürges 2008; Wilson et al. 2009; Yang et al. 2006). Cross-country analysis of acute utilisation, controlling for the decedent effect, affords an opportunity to examine whether location at death may contribute to understanding differences between countries in acute care utilisation. Location at death is unlikely to provide a full explanation, however, since this model takes into account not only acute utilisation deriving from terminal illness but also all utilisation in the last year of life. By capturing all deaths in a year in the decedent variable, the model incorporates the effect on acute bed utilisation of inpatient hospital care for all people who are admitted to hospital in their last year of life wherever they eventually die.

Some studies suggest that available acute bed capacity influences the proportion of deaths occurring in hospital (Hansen et al. 2002; Wilson and Truman 2001; Yang et al. 2006). A multi-variate analysis of predictors of the rate of hospital death in the USA found that the hospital day rate (analogous to acute bed days per capita) explained almost all variance in place of death, while hospice spending and nursing home use had a lesser but negative effect on the hospital death rate (Pritchard et al. 1998). Such findings could raise a question about endogeneity and the direction of causation if this model were relating acute utilisation to deaths in hospital. However, other studies have found acute bed numbers to be insignificant or inversely related to the proportion of deaths in hospitals, or numbers of nursing home beds to be significant (Cohen et al. 2006; Gruneir et al. 2007; Menec et al. 2010; Van Rensbergen et al. 2006).

This study's measure of acute utilisation - acute bed days per capita - equates to available acute bed capacity multiplied by the occupancy rate (OECD 2009). While available acute bed capacity is a theoretical measure, the product of long-run decisions about capital investment and short-run decisions about resourcing and staffing, acute bed days per capita is a more robust concept, a measure of occupied acute beds. Although endogeneity could be an issue in a model relating acute utilisation to deaths that occur in hospital, with the availability of staffed beds a potential determinant of deaths in hospital and deaths in hospital a potential determinant of bed utilisation, it does not arise in this model because the decedent variable is the overall death rate in a population. The death rate is the product of too many independent and, often, historical factors (such as fertility rates, lifestyle choices, epidemics and war) to be determined by numbers of available or occupied acute beds and is clearly exogenous. While location at death or the hospital death rate is a probable explanation for some variations in utilisation between countries that this model does not explain, the cross-country finding that the death rate is a driver of utilisation whereas age is not is independent of variations in place of death.

III DATA SOURCES

This analysis employs four panels, with differing sources of demographic data (Appendix: Table 1). The primary analysis sources population and decedent data from the Human Mortality Database (HMD panel). This database supplies population and deaths data by single year of age for 26 of the 30 OECD states. The OECD Health Data 2009 database supplies health care and macroeconomic variables. These are: acute bed days per capita; GDP per capita, in national currency units at 2000 GDP prices; and 2000 conversion rates, employed to convert GDP per capita in national currency units into constant US dollars at purchasing power parity. For purpose of comparison, the analysis employs alternative panels: a panel of 15 European states sourcing population data and deaths by single year of age from Eurostat; and two OECD panels sourcing population data and all deaths from the OECD Health Database. The two OECD panels comprise 20 and 23 states respectively (distinguished as OECD20 and OECD23) and are differentiated by the exclusion or inclusion of three states. In all panels, the per capita data conform to the relevant population data. The data are limited by the availability of country observations for acute bed days per capita. The primary HMD panel covers 17 OECD states over the years 1985-2006 and has 355 observations. The OECD panels include more states than the HMD panel but are more limited than the HMD panel in the years they cover. All panels are unbalanced. It has been a matter of judgment to determine to what degree observations and heterogeneity should be sacrificed to achieve greater balance and better estimation.

IV METHODOLOGY

The model is:

$$\text{Beddays} = \beta_1 + \beta_2\text{GDP p.c.} + \beta_3\text{Percent65} + \beta_4\text{PercentDecedents} + \beta_i state_i + \beta_j year_j$$

$\text{Beddays} =$ Acute hospital bed days per capita;
$\text{Percent65} =$ Percentage of population aged 65 and over;

$\text{PercentDecedents} =$ Decedents as percentage of population;

$\text{GDP p.c.} =$ Gross domestic product per capita, constant US dollars(thousands).

This is a two-way fixed effects model specification, with intercepts that vary over countries and over time. This heterogeneity renders pooled ordinary least squares (OLS) estimation inappropriate. Including dummy variables for each state and year enables estimation of country and time fixed effects. Although in some panels and iterations (i.e. differing states, years or covariates), a Hausman tests supports random over fixed effects estimation, this is not generally the case. Given that the panels of states employed in this analysis (European or OECD) cannot be considered random samples of all states, so that inference is restricted to their behaviour, and there is in any event considerable evidence for country-specific effects, the Hausman test is disregarded in favour of fixed effects estimation (Baltagi 2008; Dougherty 2007). Joint tests confirm the significance of such fixed effects, which justifies the inclusion of these dummy variables, to capture country-specific unobserved factors and cross-country time trends that are not explained by the model.

This analysis varies the specification of the model by testing it with the age and decedent variables together and separately. In each specification, a modified Wald test confirms groupwise heteroscedasticity, i.e. errors vary between states, indicating that the model is not structurally stable across the states, so that states have not only different intercepts but different slope coefficients (Baum 2006). A Woolridge test consistently confirms first-order autocorrelation, i.e. correlation between observations that are close in time (Drukker 2003). Less consistently, Pesaran's test for cross-sectional dependence indicates contemporaneous correlation of errors, suggesting the presence of a common shock or shocks, in some but not all panels and iterations (Hoyos and Sarafidis 2006; Pesaran 2004). Given the presence of groupwise heteroscedasticity, first-order autocorrelation and, possibly but not always, cross-sectional correlation, possible estimation methods include:

(1) Fixed effects with a cluster option i.e. OLS estimation with Huber/White/ sandwich estimates of variance and standard errors;
(2) FGLS (feasible generalized least squares) estimation with fixed effects: requiring two sequential transformations, first eliminating serial correlation of the errors and then contemporaneous correlation and heteroscedasticity. The second step employs panel -weighted least squares, an OLS regression of a transformed equation, with variables weighted according to the estimated variance of each state's residuals;
(3) PCSE (panel-corrected standard errors) estimation with fixed effects: requiring an initial Prais-Winsten transformation of the data to eliminate serial correlation of the errors, followed by OLS estimation, with standard errors corrected for cross-sectional correlation (Baum 2006; Beck and Katz 1995; Wiggins 2009).

Method 1 requires N (number of countries) to be significantly greater than T (number of years). Method 2, if there is cross-sectional correlation, requires T to be significantly greater than N, and the panel to be balanced. Method 3 is a better estimator for cross-national panel studies where T is close to N, and there is cross-sectional correlation (Beck and Katz 1995). Since this analysis employs unbalanced panels comprising 15 to 23 countries over a range of between 12 to 22 years, the third method is preferable if there is cross-sectional correlation. When cross-sectional correlation is absent, the second method is preferable.

Each estimation is performed with and without assumed cross-sectional dependence (Method 3 versus Method 2). The tables record results employing the preferred method, as indicated by the Pesaran test in each instance. The alternative estimations generally differ little to the estimations by the preferred method. However, whereas the significance level of the decedent variable in estimations by the preferred methods of the full model specification for the Eurostat and OECD20 panels is respectively 5% (FGLS) and 4% (PCSE); these disimprove to 7% (PCSE) and 8% (FGLS) when estimated by the alternative methods. The confirmation of a common shock or shocks in some estimations and panels requires interpretation in the context of international health care systems and demographic change. Demographic change captured by the death and age variables, encompasses changes in life expectancy and fertility rates, which are influenced by diverse factors such as reproductive choice, medical advance, lifestyle choices and cohort attrition, with World War Two affecting survival and subsequent death rates in combatant countries over this period. Convergence and divergence in demographic experience suggests adequate explanation for the presence or absence of common shocks, depending on the countries and years in each panel.

V ANALYSIS AND DISCUSSION

The main finding of this paper is that deaths in a population are a significant driver of acute hospital bed utilisation whereas age of the population is not. This finding holds for three cross-country panels. The central estimation differs little for the three panels:

HMD panel, 1990-2006:

$$\begin{aligned}\mathrm{Beddays} = &-0.02 + 0.02\,\mathrm{GDPpc}^{***} - 0.01\,\mathrm{Percent65} + 0.4\,\mathrm{PercentDecedents}^{*} \\ &+\beta_i state_i + \beta_j year_j\end{aligned} \tag{1}$$

Eurostat panel, 1990-2006:

$$\begin{aligned}\mathrm{Beddays} = &\ 0.02 + 0.02\,\mathrm{GDPpc}^{***} + 0.01\,\mathrm{Percent65} + 0.4\,\mathrm{PercentDecedents}^{*} \\ &+\beta_i state_i + \beta_j year_j\end{aligned} \tag{2}$$

OECD20 panel, 1994-2005:

$$\begin{aligned}\mathrm{Beddays} = &-0.6^{*} + 0.03\,\mathrm{GDPpc}^{***} + 0.02\,\mathrm{Percent65} + 0.4\,\mathrm{PercentDecedents}^{*} \\ &+\beta_i state_i + \beta_j year_j\end{aligned} \tag{3}$$

$$^{*}p < 0.05, \quad ^{**}p < 0.01, \quad ^{***}p < 0.001$$

The model postulates three drivers of acute bed utilisation: national income, population age and deaths. All deaths expressed as a percentage of population is the measure of deaths. The measure of age is the percentage of population aged 65 and over. GDP per capita is the measure of national income. Regression analysis employing the HMD panel of 17 OECD states consistently shows that all deaths have a positive and significant effect on acute bed utilisation (Table 1).

Table 1: Effect of ageing and death on acute utilisation: HMD panel
Dependent variable: Acute bed days per capita; Alternative years

Years	1985-2006		1990-2006		1994-2006		1985-2006	
Method	PCSE		PCSE		PCSE		PCSE	
GDP p. c.	0.03***	[0.01]	0.02***	[0.01]	0.02***	[0.01]	0.03***	[0.00]
Percent 65	0.02	[0.01]	-0.01	[0.02]	-0.04**	[0.01]		
PercentDecedents	0.43**	[0.16]	0.43*	[0.19]	0.81***	[0.24]	0.53***	[0.15]
AUS	0.56***	[0.05]	0.52***	[0.05]	0.58***	[0.06]	0.55***	[0.04]
AUT	1.32***	[0.05]	1.33***	[0.04]	1.36***	[0.04]	1.33***	[0.04]
BEL	0.65***	[0.05]	0.70***	[0.05]	0.78***	[0.06]	0.67***	[0.04]
CAN	0.64***	[0.06]	0.55***	[0.06]	0.55***	[0.07]	0.63***	[0.06]
CHE	0.72***	[0.06]	0.75***	[0.06]	0.80***	[0.06]	0.76***	[0.05]
CZE	1.53***	[0.09]	1.44***	[0.09]	1.36***	[0.08]	1.47***	[0.07]
DEU	1.28***	[0.06]	1.32***	[0.06]	1.34***	[0.06]	1.30***	[0.05]
ESP	0.38***	[0.06]	0.41***	[0.05]	0.54***	[0.06]	0.38***	[0.05]
FIN	0.44***	[0.05]	0.43***	[0.05]	0.47***	[0.05]	0.43***	[0.05]
FRA	0.64***	[0.04]	0.65***	[0.04]	0.72***	[0.05]	0.66***	[0.04]
HUN	1.40***	[0.12]	1.33***	[0.12]	1.23***	[0.12]	1.32***	[0.10]
IRL	0.46***	[0.06]	0.37***	[0.06]	0.34***	[0.05]	0.41***	[0.04]
ITA	0.62***	[0.07]	0.66***	[0.07]	0.77***	[0.08]	0.66***	[0.06]
NLD	0.35***	[0.04]	0.30***	[0.04]	0.29***	[0.03]	0.35***	[0.04]
NOR	0.14**	[0.05]	0.16**	[0.06]	0.21***	[0.06]	0.18***	[0.04]
PRT	0.45***	[0.07]	0.46***	[0.07]	0.53***	[0.07]	0.43***	[0.07]
Constant	-0.26	[0.26]	-0.02	[0.32]	0.00	[0.35]	-0.08	[0.19]
Observations	355		285		219		355	
R^2	0.94		0.95		0.97		0.94	

Standard errors in brackets; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Excluded country is USA. Constant is the mean for USA, while coefficients for other countries are differences from this mean, which are significantly different from the USA. Coefficients for years omitted.

This decedent effect on utilisation remains whether the percentage of population aged 65 and over is included or excluded as a covariate; and when the range of years is narrowed from 1985-2006 to 1990-2006 or 1994-2006. The coefficient for all deaths as a percentage of population ranges from 0.4 to 0.8 and is at its greatest in the most recent span of years (1994-2006), when age is included as a co-variate. In this panel, age is insignificant or negative in its effect on acute care utilisation, when all deaths are included as a covariate. If deaths are not included as a covariate, age appears to be positive and significant in its effect on acute care utilisation in the years 1985-2006 but its effect is negative and insignificant for the years 1990-2006, or negative and significant in the years 1994-2006 (Table 2). GDP per capita is a positive and significant driver of acute bed utilisation in either specification.

Table 2: Effect of age on acute utilisation, without decedent variable: HMD panel Dependent variable: Acute bed days per capita; Alternative years

	1985-2006		1990-2006		1994-2006	
Method	FGLS		FGLS		FGLS	
GDPpc	0.03^{***}	[0.00]	0.02^{***}	[0.00]	0.01^{**}	[0.00]
Percent 65	0.03^{*}	[0.01]	-0.01	[0.01]	-0.04^{***}	[0.01]
Obs.	355		285		219	

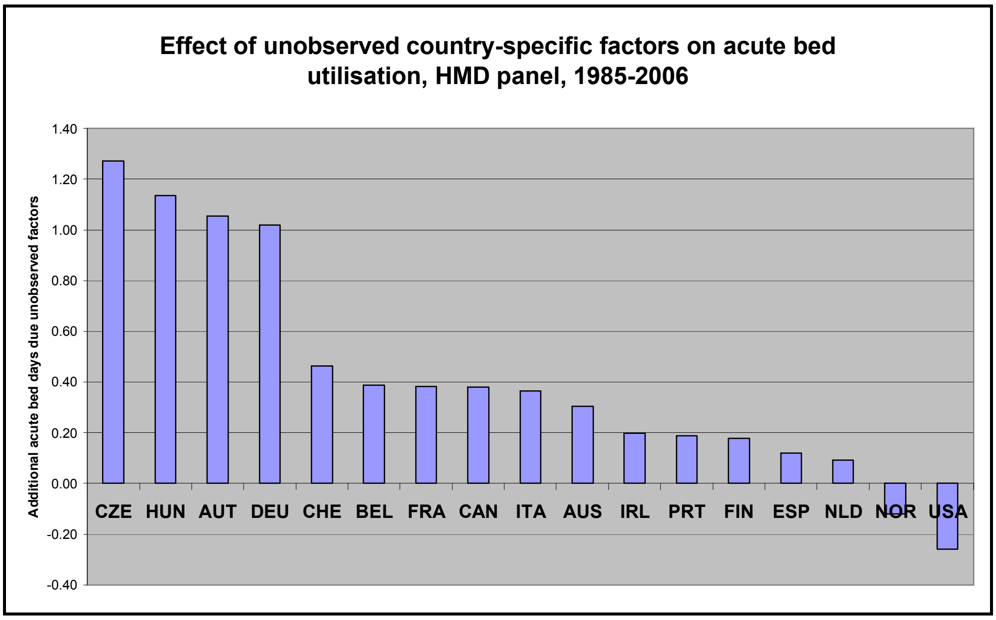
Standard errors in brackets; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; Coefficients for countries and years omitted. FGLS estimation (xtgls in STATA) does not generate an R-square.

Results for the Eurostat panel (1990-2006) and OECD20 panel (1994-2005) concur with the HMD panel (Appendix: Tables 2 and 3). All deaths have a positive and significant effect on acute care utilisation with or without the age variable. The coefficient for the all deaths variable ranges from 0.4 to 0.5. Age is insignificant in its effect on acute care utilisation, with or without all deaths as a covariate. When the OECD panel is extended to include Japan, Mexico and Turkey, which are at the extremes of the OECD range of acute bed days per capita, this renders all deaths no longer a significant driver of acute utilisation while age has a negative effect (Appendix: Table 3). In this estimation, the country coefficient for Japan is the largest (2.14), while the country coefficients for Turkey (-0.45) and Mexico (-0.46) are the smallest. Mexico and Turkey are middle income countries with no history of comprehensive health and social care; while Japan has such a high length of stay in its acute hospitals that they supply what other states would regard as long-term care (Sato and Fushimi 2009). Hospital care in these countries is sufficiently outside the paradigm of health care systems in Europe and North America that their exclusion from this analysis seems justified in the interests of identifying the impact of age and death in countries whose health care systems have more in common.

Equations (1) to (3) capture the effects of national income, age and death on acute bed utilisation that are common to the countries in these panels. The fixed effects model specification also identifies a time trend attributable to unobserved factors experienced across the countries and estimated in the coefficients for the year dummy variables, which are negative and increase with time, indicating a common cross-country trend of unexplained factors reducing acute bed utilisation. Greater use of day procedures is likely to have contributed to this reduction in many countries. OECD data on day procedures are inadequate to include this factor in the model but the limited time series data available for countries included in this analysis confirm a shared upward trend in the surgical day case rate (OECD 2009).

The country coefficients demonstrate how countries differ in acute bed utilisation, having controlled for national income, age, deaths and this shared time trend. Each country's coefficient is a measures of the difference between the effect of unobserved country-specific factors on that country's acute bed utilisation and on utilisation in the state represented by the constant (USA in the HMD and OECD panels; Portugal in the Eurostat panel). For countries other than the country represented by the constant, the full effect of such unobserved factors is measured by adding the constant and that country's coefficient. When graphed, these effects demonstrate the degrees, by which countries' acute bed utilisation remains unexplained by this model (Figure 1).

Figure 1



Note: chart sums individual country coefficients and constant (coefficient for USA) to capture differences between country-specific intercepts in HMD panel regression for age and decedent model.

The literature on location at death offers a possible explanation for some of this remaining divergence between countries in acute bed utilisation. The decedent effect will have a correspondingly greater or lesser effect on utilisation depending on the proportion of deaths that occur in hospital. While the literature offers snapshot data on location at death and some individual country time trends, no international time series database is available. Considerable cross-country differences in location at death have been identified among decedents in Europe (Cohen et al. 2008; Jürges 2008). The SHARE (Survey of Health, Ageing and Retirement in Europe) project found from interviews about the deaths of a small sample of people between 2004 and 2007 across 11 countries that dying in hospital was most common in the countries of Western Europe, whereas dying outside hospital was more common in Northern and Southern countries. In Northern countries 58 per cent died outside hospitals, divided almost equally between deaths outside institutions (typically at home) and in nursing homes. In Southern countries, 50 per cent died outside institutions/at home and 3% in nursing homes (Jürges 2008). Thus the Northern countries had fewest hospital deaths at 42% and in Southern countries 47% of deaths were in hospitals.

The ranking of country-specific effects conforms sufficiently with this evidence from SHARE to suggest that location at death is an important contributory factor explaining divergences between countries in acute bed utilisation. The Western European countries in which the SHARE study found more deaths occurring in hospital (Austria, Germany, Switzerland, Belgium and France) are 3rd to 7th highest in the ranking of country effects on acute utilisation for the 17 countries in the HMD panel (Figure 1). The only Northern country both in the SHARE study and in this panel (Netherlands) comes 15th in the ranking of 17 countries. Additional countries that might be expected to fit in this Northern grouping (Norway and Finland) are ranked 16th and 12th. Further studies have confirmed low hospital death rates in Norway and the Netherlands (Klinkenberg et al. 2005; van der Velden et al. 2009). The USA is ranked 17th in this panel, which is compatible with evidence that hospital deaths declined to 41 per cent of US deaths in 1998 (Flory et al. 2004), just below the proportion for the Northern European countries in the SHARE study.

The SHARE study's geographical groupings are mostly but not entirely supported by a study of all deaths in 6 European countries in 2002-2003 employing death certificates: whereas this study recorded hospital death rates for Belgium and the UK (England, Scotland and Wales) that would place them in the SHARE Western grouping, Sweden's 62.5% hospital death rate was notably higher than even the SHARE Western European average (Cohen et al. 2008). The SHARE sample was limited to people who had lived at home when surveyed in 2004 and died in the subsequent few years, thereby excluding people already in long-term residential care in 2004, which may explain this divergence. Southern countries with a hospital death rate in the middle range in the SHARE study (Italy and Spain) rank 9th and 14th in this panel. Australia and Ireland have country effect rankings at 10th and 11th, below Italy and above Spain, in the HMD panel. This accords with evidence of a 48.6% rate of hospital death in Western Australia in 2000-2002 and a 48% rate in Ireland in 2004-2007 (McNamara and Rosenwax 2007; Irish Hospice Foundation 2010), close to the 47% rate for the Southern countries in the SHARE study. The OECD20 panel with fewer years but more countries also exhibits country effects that are broadly compatible with the evidence on location at death (Appendix Table 3). Eastern European countries, which were not included in the SHARE study, show the highest country effects on utilisation in both panels, which may partially reflect late development of palliative care services outside hospitals (Lynch et al. 2009; International Observatory on End of Life Care 2003).

While location at death offers a contributory explanation for the differences observed in acute utilisation, it is not the entire explanation. Some of the Western countries are closely ranked with some of the Southern countries. Canada's position in the rankings is anomalous: a high hospital death rate accompanies relatively low acute utilisation. In Canada in 2004 61% of deaths occurred in hospital, a decline from 78% in 1994 (Wilson et al. 2009). This suggests that a further factor in decedent effects on utilisation is the duration of hospital stays for people who are terminally ill. This is likely to be influenced by availability of hospital beds and availability of care in other locations for people in their last year of life, reflecting the financial and administrative approach taken to the resourcing of hospital and alternative care. Canada has a relatively high rate of provision of formal home care and a relatively high day surgery rate (Huber et al. 2009; OECD 2009). In Alberta in the 1990s most people who died in hospital received relatively short, low intensity hospital care: over one quarter died within two days of admission (Wilson and Truman 2002). In Canada, regional studies have shown hospital deaths to be both positively and inversely related to hospital bed numbers. When hospital bed numbers were reduced by 50% in the province of Alberta during the 1990s, inpatient deaths were reduced by 18.5% and length of final stay by 83%. Numbers of inpatient deaths and length of final stay rose again when inpatient beds were re-opened (Wilson and Truman 2001). In the more rural province of Manitoba rural residents had higher odds of dying in hospital than urban dwellers, despite greater acute bed availability in urban areas, reflecting the availability of palliative care centres and generally better endowed health services in urban areas (Menec et al. 2010).

It would be surprising were location at death to explain all divergence in countries' utilisation. Since the decedent variable in this model is all deaths as a percentage of population in a year, it should capture all acute bed utilisation in the final year of life. The evidence from Germany is that acute utilisation peaks in the last year of life but that this peak is at its greatest for people aged 55-64 (Busse et al. 2002). Patterns of treatment and utilisation by age may be influenced by the availability of alternative locations of care, particularly nursing home care in older age cohorts (forthcoming papers by this author). Differences in how countries finance their health care systems may offer further explanation for divergences in acute utilisation. The seven countries in the HMD panel with the highest rankings for unexplained country-specific influences on acute utilisation are also the countries with more accommodating social insurance-funded health care systems, whereas countries with tax-funded and more centrally rationed health care are ranked lower (Saltman et al. 2004; Thomson et al. 2009).

VI SUMMARY AND CONCLUSIONS

This analysis demonstrates that across countries and over time the percentage of deaths in a population is a significant driver of acute bed utilisation, whereas age of the population is not. This cross-country finding supports within country studies employing micro-data that have found health care costs or utilisation to be more closely related to proximity to death than calendar age. Per capita national income is also a significant driver of acute bed utilisation. While cross-country differences in acute bed utilisation remain after controlling for national income, death and age, these differences are at least partially explained by differences between countries in location at death. Further factors that might be expected to influence cross-country differences in acute bed utilisation are: duration of hospital stays for people who are terminally ill and in the last year of life; resourcing of hospital care and care in other locations; day surgery rates; and differences in how countries finance their health care systems

This study suggests that ageing per se is not a driver of acute bed utilisation. Insofar as it appears to be, this reflects the greater number of people at older ages, who are in their last year or years of life. The commonality of death as a driver of acute utilisation is striking given considerable cross-country differences in location at death. Studies of location at death often have the objective of determining how best to meet the needs and preferences of people who are dying. This analysis suggests that understanding drivers of acute utilisation is a further reason to investigate location at death, since deaths in a population and, by extension, location at death, are major determinants of utilisation. With a high proportion of deaths in many countries occurring at home or in long-term care settings, it is necessary to understand the complex mixture of factors that determine availability of care outside acute hospitals, in order to understand better the drivers of utilisation within them.

DATABASES

Eurostat. Statistical Office of the European Union, Luxembourg. Available at http://epp.eurostat.ec.europa.eu/ (data downloaded November 2009)

Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org or www.humanmortality.de (data downloaded January 2010).

OECD 2009. OECD Health Data, Statistics and Indicators for 30 countries, Paris: OECD. Available at www.oecd.org

REFERENCES

Baltagi, Badi H. 2008. *Econometric analysis of panel data*. 4th ed. Chichester: Wiley.

Barros, P. P. 1998. "The black box of health care expenditure growth determinants." *Health Economics* 7 (6):533-44.

Baum, Christopher F. 2006. *Introduction to modern econometrics using Stata*. College Station, Tex: Stata.

Beccaro, M., M. Costantini, P. Giorgi Rossi, G. Miccinesi, M. Grimaldi, and P. Bruzzi. 2006. "Actual and preferred place of death of cancer patients. Results from the Italian survey of the dying of cancer (ISDOC)." *J Epidemiol Community Health* 60 (5):412-6.

Beck, Nathaniel, and Jonathan N. Katz. 1995. "What to do (and not to do) with Time-Series Cross-Section Data." *The American Political Science Review* 89 (3):634-47.

Busse, R., C. Krauth, and F. W. Schwartz. 2002. "Use of acute hospital beds does not increase as the population ages: results from a seven year cohort study in Germany." *J Epidemiol Community Health* 56 (4):289-93.

Cohen, J., J. Bilsen, J. Addington-Hall, R. Lofmark, G. Miccinesi, S. Kaasa, B. Onwuteaka-Philipsen, and L. Deliens. 2008. "Population-based study of dying in hospital in six European countries." *Palliat Med* 22 (6):702-10.

Cohen, J., J. Bilsen, P. Hooft, P. Deboosere, G. van der Wal, and L. Deliens. 2006. "Dying at home or in an institution using death certificates to explore the factors associated with place of death." *Health Policy* 78 (2-3):319-29.

Dougherty, Christopher. 2007. *Introduction to econometrics*. 3rd ed. Oxford ; New York: Oxford University Press.

Drukker, David M. 2003. "Testing for serial correlation in linear panel-data models." *The Stata Journal* 3 (2):168–77.

Felder, S., M. Meier, and H. Schmitt. 2000. "Health care expenditure in the last months of life." *J Health Econ* 19 (5):679-95.

Flory, James, Yinong Young-Xu, Ipek Gurol, Norman Levinsky, Arlene Ash, and Ezekiel Emanuel. 2004. "Place Of Death: U.S. Trends Since 1980 " *Health Affairs* 23 (3):194-200.

Gerdtham, U. G., J. Sogaard, F. Andersson, and B. Jonsson. 1992. "An econometric analysis of health care expenditure: a cross-section study of the OECD countries." *J Health Econ* 11 (1):63-84.

Gomes, Barbara, and Irene J. Higginson. 2008. "Where people die (1974-2030): past trends, future projections and implications for care." *Palliative Medicine* 22:33-41.

Gruneir, A., V. Mor, S. Weitzen, R. Truchil, J. Teno, and J. Roy. 2007. "Where people die: a multilevel approach to understanding influences on site of death in America." *Med Care Res Rev* 64 (4):351-78.

Hansen, S. M., S. W. Tolle, and D. P. Martin. 2002. "Factors associated with lower rates of in-hospital death." *J Palliat Med* 5 (5):677-85.

Hitiris, T., and J. Posnett. 1992. "The determinants and effects of health expenditure in developed countries." *J Health Econ* 11 (2):173-81.

Hoyos, Rafael E. De, and Vasilis Sarafidis. 2006. "Testing for cross-sectional dependence in panel-data models." *The Stata Journal* 6 (4):482–96.

Huber, Manfred, Ricardo Rodrigues, Frederique Hoffmann, Katrin Gasior, and Bernd Marin. 2009. *Facts and Figures on Long-Term Care - Europe and North America*. Vienna: European Centre for Social Welfare Policy and Research.

International Observatory on End of Life Care. 2003. "Country Report Poland." http://www.eolc-observatory.net.

Irish Hospice Foundation. 2010. Estimated place of death statistics for Ireland based on 2004, 2006 and 2007 data from various sources.

Jürges, Hendrik. 2008. "Health, Bequests, and Social Support in the Last Year of Life: First Results from the SHARE End-of-Life Interviews." In *First Results from the Survey of Health, Ageing and Retirement in Europe (2004-2007): Starting the Longitudinal Dimension*, ed. A. Börsch-Supan, A. Brugiavini, H. Jürges, A. Kapteyn, J. Mackenbach, J. Siegrist and G. Weber. Mannheim: Mannheim Research Institute for the Economics of Aging (MEA).

Klinkenberg, M., G. Visser, M. I. van Groenou, G. van der Wal, D. J. Deeg, and D. L. Willems. 2005. "The last 3 months of life: care, transitions and the place of death of older people." *Health Soc Care Community* 13 (5):420-30.

Layte, R., A. Nolan, B. Nolan, and T. van Ourti. 2005. "Health and Morbidity by Age and Socio-Economic Characteristics." In *ENEPRI Research Report No. 15*. Brussels: ENEPRI.

Layte, Richard. 2007. "An Analysis of the Impact of Age and Proximity of Death on Health Care Costs in Ireland." In *Working Paper No. 193*. Dublin: ESRI.

Lubitz, J. D., and G. F. Riley. 1993. "Trends in Medicare payments in the last year of life." *N Engl J Med* 328 (15):1092-6.

Lynch, T., D. Clark, C. Centeno, J. Rocafort, L. A. Flores, A. Greenwood, D. Praill, S. Brasch, A. Giordano, L. De Lima, and M. Wright. 2009. "Barriers to the development of palliative care in the countries of Central and Eastern Europe and the Commonwealth of Independent States." *J Pain Symptom Manage* 37 (3):305-15.

McGrail, K., B. Green, M. L. Barer, R. G. Evans, C. Hertzman, and C. Normand. 2000. "Age, costs of acute and long-term care and proximity to death: evidence for 1987-88 and 1994-95 in British Columbia." *Age Ageing* 29 (3):249-53.

McNamara, B., and L. Rosenwax. 2007. "Factors affecting place of death in Western Australia." *Health Place* 13 (2):356-67.

Menec, V. H., S. Nowicki, and A. Kalischuk. 2010. "Transfers to acute care hospitals at the end of life: do rural/remote regions differ from urban regions?" *Rural Remote Health* 10 (1):1281.

Newhouse, J. P. 1977. "Medical-care expenditure: a cross-national survey." *J Hum Resour* 12 (1):115-25.

O Connell, J. M. 1996. "The relationship between health expenditures and the age structure of the population in OECD countries." *Health Economics* 5 (6):573-8.

OECD. 2006. "Projecting OECD health and long-term care expenditures: what are the main drivers? ." In *Economics Department Working Papers*. Paris: Organisation for Economic Co-operation and Development.

———. 2009. "OECD Health Data 2009." OECD.

Parkin, D., A. McGuire, and B. Yule. 1987. "Aggregate health care expenditures and national income. Is health care a luxury good?" *J Health Econ* 6 (2):109-27.

Pesaran, M. H. 2004 "General diagnostic tests for cross section dependence in panels." *Cambridge Working Papers in Economics* 0435.

Pritchard, R. S., E. S. Fisher, J. M. Teno, S. M. Sharp, D. J. Reding, W. A. Knaus, J. E. Wennberg, and J. Lynn. 1998. "Influence of patient preferences and local health system characteristics on the place of death. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Risks and Outcomes of Treatment." *J Am Geriatr Soc* 46 (10):1242-50.

Saltman, Richard B., Reinhard Busse, and Josep Figueras. 2004. *Social health insurance systems in western Europe*. Maidenhead: Open University Press.

Sato, E., and K. Fushimi. 2009. "What has influenced patient health-care expenditures in Japan?: variables of age, death, length of stay, and medical care." *Health Econ* 18 (7):843-53.

Spillman, B. C., and J. Lubitz. 2000. "The effect of longevity on spending for acute and long-term care." *N Engl J Med* 342 (19):1409-15.

Thomson, S., T. Foubister, and E. Mossialos. 2009. "Financing health care in the European Union: Challenges and policy responses." In *Observatory Studies Series*: European Observatory on Health Systems and Policies.

van der Velden, L. F., A. L. Francke, L. Hingstman, and D. L. Willems. 2009. "Dying from cancer or other chronic diseases in the Netherlands: ten-year trends derived from death certificate data." *BMC Palliat Care* 8:4.

Van Rensbergen, G., T. S. Nawrot, E. Van Hecke, and B. Nemery. 2006. "Where do the elderly die? The impact of nursing home utilisation on the place of death. Observations from a mortality cohort study in Flanders." *BMC Public Health* 6:178.

Wiggins, Vince. *FAQ: How does xtgls differ from regression clustered with robust standard errors?* 2009 [cited. Available from http://www.stata.com/support/faqs/stat/xtgls_rob.html.

Wilson, D. M., and C. D. Truman. 2002. "Addressing myths about end-of-life care: research into the use of acute care hospitals over the last five years of life." *J Palliat Care* 18 (1):29-38.

Wilson, D. M., C. D. Truman, R. Thomas, R. Fainsinger, K. Kovacs-Burns, K. Froggatt, and C. Justice. 2009. "The rapidly changing location of death in Canada, 1994-2004." *Soc Sci Med* 68 (10):1752-8.

Wilson, Donna M, and Corrine D Truman. 2001. "Does the availability of hospital beds affect utilization patterns? The case of end-of-life care." *Health Services Management Research* 14 (4):229-39.
Yang, Limin, Naoko Sakamoto, and Eiji Marui. 2006. "A study of home deaths in Japan from 1951 to 2002." *BMC Palliative Care* 5 (2).
Zweifel, P., S. Felder, and A.Werblow. 2004. "Population Ageing and Health Care Expenditure: New Evidence on the ‘‘Red Herring’’." *The Geneva Papers on Risk and Insurance* 29 (4):652-66.
Zweifel, P., S. Felder, and M. Meiers. 1999. "Ageing of population and health care expenditure: A red herring?" *Health Economics* 8 (6):485-96.

APPENDIX

Appendix Table 1 Alternative panels: constituent states, years and observations

	HMD panel				Eurostat panel		OECD23 panel		OECD20 panel	
	Version	1985-2006	1990-2006	1994-2006	1990-2006		1994-2005		1994-2005	
	states	Freq.	Freq.	Freq.	states	Freq.	state	Freq.	state	Freq.
Australia	AUS	22	17	13			AUS	12	AUS	12
Austria	AUT	21	16	12	AUT	11	AUT	12	AUT	12
Belgium	BEL	21	16	12	BEL	16	BEL	12	BEL	12
Canada	CAN	22	17	13			CAN	12	CAN	12
Switzerland	CHE	22	17	13	CHE	17	CHE	12	CHE	12
Czech Rep.	CZE	17	17	13	CZE	17	CZE	12	CZE	12
Germany	DEU	16	16	13	DEU	16	DEU	12	DEU	12
Spain	ESP	22	17	13	ESP	17	ESP	12	ESP	12
Finland	FIN	22	17	13	FIN	17	FIN	12	FIN	12
France	FRA	22	17	13			FRA	12	FRA	12
Greece					GRC	13	GRC	12	GRC	12
Hungary	HUN	16	16	13	HUN	16	HUN	12	HUN	12
Ireland	IRL	22	17	13	IRL	17	IRL	12	IRL	12
Italy	ITA	22	17	13	ITA	17	ITA	12	ITA	12
Japan							JPN	12		
Mexico							MEX	8		
Netherlands	NLD	22	17	13	NLD	17	NLD	12	NLD	12
Norway	NOR	22	17	13	NOR	17	NOR	12	NOR	12
Poland					POL	13	POL	9	POL	9
Portugal	PRT	22	17	13	PRT	17	PRT	12	PRT	12
Slovakia							SVK	10	SVK	10
Turkey							TUR	9		
USA	USA	22	17	13			USA	12	USA	12
OBSERVATIONS		355	285	219		238		264		235
NO. OF STATES		17	17	17		15		23		20

Appendix Table 2: Effect of age and death on acute utilisation: Eurostat panel
Dependent variable: Acute bed days per capita; Alternative models

	1990-2006					
Method	FGLS		FGLS		PCSE	
GDP p. c.	0.02***	[0.00]	0.02***	[0.00]	0.02***	[0.00]
Percent 65	0.01	[0.02]	0.02	[0.02]		
PercentDecedents	0.36*	[0.18]			0.48*	[0.23]
AUT	0.94***	[0.07]	0.95***	[0.07]	0.91***	[0.06]
BEL	0.27***	[0.07]	0.28***	[0.08]	0.26***	[0.06]
CHE	0.35***	[0.09]	0.33***	[0.09]	0.34***	[0.09]
CZE	1.03***	[0.06]	1.08***	[0.06]	1.00***	[0.06]
DEU	0.87***	[0.08]	0.89***	[0.08]	0.87***	[0.06]
ESP	-0.04	[0.06]	-0.09	[0.05]	-0.03	[0.04]
FIN	0.01	[0.07]	0.01	[0.07]	-0.00	[0.06]
GRC	0.11	[0.07]	0.08	[0.07]	0.12*	[0.05]
HUN	0.89***	[0.09]	1.01***	[0.06]	0.85***	[0.10]
IRL	0.03	[0.06]	0.00	[0.06]	-0.01	[0.06]
ITA	0.20*	[0.09]	0.17	[0.09]	0.21***	[0.05]
NLD	-0.08	[0.06]	-0.10	[0.06]	-0.10	[0.07]
NOR	-0.22*	[0.09]	-0.20*	[0.10]	-0.24**	[0.08]
POL	0.72***	[0.09]	0.73***	[0.09]	0.69***	[0.04]
Constant	0.23	[0.30]	0.50	[0.27]	0.27	[0.27]
Observations	238		238		238	
R^2					0.94	

Standard errors in brackets; * $p <= 0.05$, ** $p < 0.01$, *** $p < 0.001$ (*$p = 0.050$ for decedent coefficient in column one); Excluded state is Portugal. Coefficients for years omitted.

Appendix Table 3: Effect of age and death on acute utilisation: OECD panels Dependent variable: Acute bed days per capita; Alternative panels and models; OECD23 includes Japan, Mexico and Turkey

	OECD23		OECD20		OECD23		OECD20		OECD20	
	1994-2005		1994-2005		1994-2005		1994-2005		1994-2005	
Method	FGLS		PCSE		FGLS		FGLS		PCSE	
GDP p. c.	0.01^{*}	[0.00]	0.03^{***}	[0.00]	0.01	[0.00]	0.02^{***}	[0.01]	0.03^{***}	[0.00]
Percent 65	$-.05^{***}$	[0.01]	0.02	[0.01]	$-.05^{***}$	[0.01]	0.01	[0.01]		
PercentDecedents	0.15	[0.19]	0.38^{*}	[0.19]					0.44^{*}	[0.19]
AUS	0.38^{***}	[0.06]	0.56^{***}	[0.05]	0.35^{***}	[0.04]	0.42^{***}	[0.05]	0.55^{***}	[0.05]
AUT	1.39^{***}	[0.04]	1.28^{***}	[0.05]	1.39^{***}	[0.04]	1.29^{***}	[0.05]	1.31^{***}	[0.04]
BEL	0.84^{***}	[0.06]	0.66^{***}	[0.06]	0.85^{***}	[0.06]	0.69^{***}	[0.07]	0.71^{***}	[0.05]
CAN	0.40^{***}	[0.07]	0.56^{***}	[0.04]	0.37^{***}	[0.06]	0.43^{***}	[0.06]	0.55^{***}	[0.04]
CHE	0.83^{***}	[0.07]	0.66^{***}	[0.08]	0.83^{***}	[0.07]	0.68^{***}	[0.07]	0.71^{***}	[0.06]
CZE	1.30^{***}	[0.09]	1.55^{***}	[0.09]	1.31^{***}	[0.09]	1.42^{***}	[0.10]	1.50^{***}	[0.09]
DEU	1.44^{***}	[0.07]	1.23^{***}	[0.07]	1.45^{***}	[0.06]	1.26^{***}	[0.08]	1.29^{***}	[0.05]
ESP	0.42^{***}	[0.07]	0.43^{***}	[0.07]	0.41^{***}	[0.07]	0.33^{***}	[0.07]	0.46^{***}	[0.07]
FIN	0.44^{***}	[0.05]	0.45^{***}	[0.06]	0.44^{***}	[0.05]	0.40^{***}	[0.06]	0.46^{***}	[0.05]
FRA	0.67^{***}	[0.05]	0.61^{***}	[0.05]	0.66^{***}	[0.05]	0.56^{***}	[0.06]	0.65^{***}	[0.04]
GRC	0.59^{***}	[0.09]	0.60^{***}	[0.08]	0.58^{***}	[0.09]	0.50^{***}	[0.09]	0.63^{***}	[0.08]
HUN	1.34^{***}	[0.11]	1.50^{***}	[0.12]	1.39^{***}	[0.09]	1.46^{***}	[0.10]	1.46^{***}	[0.12]
IRL	0.22^{***}	[0.05]	0.46^{***}	[0.06]	0.21^{***}	[0.05]	0.34^{***}	[0.06]	0.42^{***}	[0.05]
ITA	0.77^{***}	[0.07]	0.58^{***}	[0.09]	0.78^{***}	[0.07]	0.58^{***}	[0.08]	0.64^{***}	[0.07]
JPN	2.14^{***}	[0.09]			2.12^{***}	[0.08]				
MEX	-0.46^{*}	[0.21]			$-.54^{**}$	[0.19]				
NLD	0.26^{***}	[0.04]	0.29^{***}	[0.05]	0.25^{***}	[0.04]	0.24^{***}	[0.04]	0.29^{***}	[0.04]
NOR	0.34^{***}	[0.06]	0.09	[0.05]	0.36^{***}	[0.05]	0.19^{**}	[0.06]	0.13^{***}	[0.04]
POL	0.86^{***}	[0.12]	1.35^{***}	[0.11]	0.85^{***}	[0.12]	1.09^{***}	[0.13]	1.27^{***}	[0.11]
PRT	0.46^{***}	[0.09]	0.53^{***}	[0.08]	0.46^{***}	[0.08]	0.43^{***}	[0.09]	0.54^{***}	[0.09]
SVK	0.92^{***}	[0.13]	1.45^{***}	[0.13]	0.92^{***}	[0.13]	1.19^{***}	[0.14]	1.36^{***}	[0.12]
TUR	-0.45^{*}	[0.20]			$-.50^{**}$	[0.19]				
Constant	1.02^{**}	[0.32]	-0.60^{*}	[0.30]	1.18^{***}	[0.26]	0.26	[0.28]	-0.36	[0.25]
Observations	264		235		264		235		235	
R^2			0.95						0.95	

Standard errors in brackets; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$: Excluded country is USA. Coefficients for years omitted.