Studies of health and long-term care expenditure growth in aging populations

Claudine de Meijer

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General introduction | 1

POPULATION AGING AND HEALTH CARE EXPENDITURE GROWTH

In recent decades, elderly populations in most developed countries have increased considerably, both in absolute and relative terms. This growth of the elderly share of the population is mainly attributable to two demographic transitions: the (simultaneous) increase in longevity and decrease in fertility. Additionally, for some European countries a third cause of population aging can be distinguished: the aging of the baby boom generation. The extent to which this third demographic transition contributes to population aging largely depends on the country under consideration. In the Netherlands, the baby boom was larger and lasted for a longer time. The aging of the Dutch population is therefore expected to reach its peak at 2040, later than other western countries. The Dutch population aged 65 and older increased from 770,500 in 1950 to 2,538,300 in 2010 which amounts to an increase of 329 percent. In relative terms, the proportion of the population aged 65 and above doubled, from 7.6 percent to 15.3 percent. However, population aging not only reflects an increasing share of the 65+ population, but also changes in the age distribution within this elderly cohort. The share of the very old has also gradually increased; the population aged 80 and above comprised 12.9 percent of the 65+ population in 1950, but 25.5 in 2010, and is expected to continue to rise to 33.3 in 2040 (Statistics Netherlands, 2011). As the first baby boomers have reached the age of 65 in 2010, population aging will accelerate the coming three decades.

Population aging will definitely have a large impact on society in general and on social security systems in particular. It challenges the financial sustainability of current pension and health care systems. The extent to which population aging threatens this modern welfare state largely depends on the underlying trend in ill-health, e.g. whether it is accompanied by a compression or expansion of ill-health (Fries, 1980; Olshansky *et al.*, 1991). A compression of ill-health is likely to alleviate the societal consequences of population aging. It will not only have enormous benefits for population health, but may help increasing the labor force participation among the elderly and to reduce health care expenditures (HCE). The objectives of this thesis are restricted to improved understanding of the relative impact of population aging on the level of HCE.

Simultaneous to the aging of western populations, an upward trend in HCE has been observed, both in absolute terms and as a percentage of Gross Domestic Product (GDP). In the Netherlands, for instance, the total amount spent on health care in current prices more than doubled over a thirty year period: it increased from 25 billion in 1977 to 56 billion in 2007. The average growth rate of total spending equaled 2.7 percent annually. The growth rate however accelerated in recent years and reached its peak in the period 2001-2003, when the annual growth rate averaged 4.7 percent. This relatively large growth could be explained by a relaxation of inpatient budgets resulting from a growing public dissatisfaction with long waiting lists. In relative terms, the amount spent on health care as a percentage of

GDP rose from 10.1 to 13.1 over the period 1977-2007. Again, the largest relative growth was observed for the years 2001, 2002 and 2003, when spending as a percentage of GDP increased by 0.5, 0.9 and 0.7 percentage points, respectively (Statistics Netherlands, 2011).

PREVIOUSLY IN 'AGING AND HEALTH CARE EXPENDITURES'

The impact of population aging on the level of HCE is an issue addressed by numerous examinations at the macro and microeconomic level. Macroeconomic studies have analyzed the variation in aggregate HCE, either absolutely or as a percentage of GDP, and either across countries or over time, as a function of determinants measured at the national level. The contribution of population aging to the level of spending could only be measured in some approximate way, e.g. the influence of the proportion of the elderly. The vast majority of macroeconomic studies found none or a limited effect of the age structure on national HCE. By contrast, GDP level is found to have a sizeable impact (e.g. Getzen, 1992; Gerdtham *et al.*, 1992, 1998; van Elk, Mot, and Franses, 2010).

Microeconomic studies have investigated the impact of population aging by analyzing the variation in individual spending as a function of individual determinants. These studies first examined the impact of longevity gains on individual spending and then aggregated per capita spending to the level of national spending. Conclusions from these studies evolved over time and varied from a strong upward pressure of aging on the level of HCE to no impact at all (Payne *et al.*, 2007). Traditionally, aging has been viewed as a prime suspect of HCE growth determinant as expenditures are generally higher in older age groups. This view was revised with the publication of the cost-of-dying and time-to-death literature: the high spending at older ages appeared to be associated much more with approaching death than with age itself. Hence, time-to-death was found to replace age as the main demographic determinant of HCE. The impact of population aging on the growth of HCE was reconsidered after consistent findings that the influence of population aging on HCE significantly reduced when time-to-death was taken into account. *Chapter* two provides a more detailed overview of the evidence to date on the impact of population aging on HCE. However, some important questions – that are definitely of interest in examining the relative contribution of population aging to the growth in HCE – remain far from resolved.

UNRESOLVED ISSUES ON THE RELATIVE CONTRIBUTION OF POPULATION AGING

As different as chalk and cheese? Population aging and acute versus long-term care spending

First, a clear and consistent overview of the impact of aging on acute versus long-term care (LTC) spending appears to be lacking. Previous evidence has demonstrated that the impact of population aging strongly depends on the sector under consideration: acute or LTC (e.g. Payne *et al.*, 2007; Werblow, Felder, and Zweifel, 2007; Häkkinen *et al.*, 2008). Although the impact of aging on acute HCE has been studied abundantly, few studies have analyzed the impact of age and time-to-death on spending in the LTC sector. LTC service use is concentrated among the elderly as it is provided when individuals experience disability and/or chronic illnesses and is often provided for a longer period. Hence, population aging is expected to increase LTC spending to a larger extent. LTC service needs most likely increase considerably in the next decades and may exceed the resources that society is willing to invest. It is therefore important to investigate the impact of population aging on LTC in greater depth. In addition, the influence of other driving forces of expenditure growth are likely to differ between the acute and LTC sector.

Going (in)formal

Second, but related to the previous point, is a lack of research on the consequences of population aging for the demand and supply of informal care. Although informal care comprises a substantial part of LTC provision, this important aspect of aging research has not received as much attention and is rather underdeveloped. Informal care has been found to be a substitute for home care and to postpone expensive LTC institutionalization (van Houtven and Norton, 2004; Bonsang, 2009). From a societal perspective, informal care – although often unpaid – is not a free service. The resource impact of population aging on the level of informal care use should therefore not be overlooked. The institutional context of the Netherlands emphasizes the role of informal care as the family is responsible for the provision of at least some basic LTC before becoming eligible to publicly financed LTC. In addition to an increasing demand for informal care, developments in the supply of informal care should not be ignored.

Older does not necessarily mean more expensive: ill-health, not age, is the key to health care use

Third, the majority of microeconomic studies failed to account for trends in health status even though health status should be the prime determinant of HCE (Andersen and Newman, 1973). Examining the impact of aging on HCE in the absence of suitable information on health status assumes constant age-specific (or end of life) health status over time. Hence, a compression or expansion of ill-health – that either decreases or increases the age-specific prevalence of health problems – will be ignored while the impact of population aging largely depends on underlying trends in health status. Projections of acute and LTC expenditures that account for changing health distributions are rather scarce.

It's all relative: population aging is just one of the driving forces behind the HCE growth

Fourth, there is still substantial disagreement regarding the relative magnitude of the impact of aging in relation to other drivers of HCE. Changes in the age composition of the population were found to account for less than one tenth of the total growth in HCE in developed countries over the period 1970-2002 (OECD, 2006). Instead, medical technological progress, facilitated by national income growth, is viewed as the main determinant of HCE growth (e.g. Weisbrod, 1991; Newhouse, 1992). Many studies, however, have neglected the fact that population aging might interact with technological progress. Getting to grips with the relative contribution of aging is therefore a difficult task, but also because evidence on these separate drivers is obtained from either microeconomic (the effect of age) or macroeconomic (technology, income) studies. An overview of the evidence base on aging and other determinants closely associated to the impact of aging is therefore warranted to improve understanding of the relative and overall impact of aging.

Moreover, more empirical evidence that disentangles the contribution of several factors to HCE growth is required. HCE may grow for two broad types of reason. First the levels and/or distributions of the determinants of HCE may change (e.g. population aging, changing health patterns). Second, structural changes may alter the way in which given determinants impact on HCE. Medical technology, other changes in medical practice, and changes in health policy are the most likely sources of shifts in the relationship of HCE to its determinants. Most previous attempts to forecast future trends in HCE, including those that aim to identify the contribution of population aging, estimate a model of HCE and use this to simulate HCE under alternative scenarios about future trends in its determinants (e.g. Zweifel, Felder, and Meiers, 1999; Seshamani and Gray, 2004b; Stearns and Norton, 2004; Breyer and Felder, 2006; Lafortune *et al.* , 2007; Häkkinen *et al.*, 2008). This assumes that the relationship of HCE to its determinants is stable, which is unlikely given that the health care sector is noted for technological progress, high government regulation and many policy reforms. Disentangling the contribution of several factors to HCE growth, including better insight in the contribution of structural changes which is currently a black box, will improve understanding of the nature of the HCE growth and projections of expenditures. Consequently, it provides alternative modes to influence the current HCE growth rate.

STRUCTURE OF THE THESIS

The main objective of this thesis is to enhance understanding of the (relative) impact of aging to acute and LTC expenditure growth in the Netherlands. In particular, it contributes to filling some of the previously unresolved issues in the literature on the role of population aging in HCE growth. The remainder of this chapter provides an overview of this thesis and the research questions addressed in each of these chapters.

The thesis is divided in three parts. Part A '*the impact of population aging and other determinants on health care expenditure growth*' consists of *chapter two.* It provides a general overview of the current state of the literature on the impact of population aging, and other determinants of HCE that are associated with the impact of aging on the recent growth in HCE. Because the literature on the determinants of HCE (growth) is plentiful and the determinants are numerous, we first introduce a conceptual model to structure the discussion of determinants – and their evidence. In line with the thesis structure, *chapter two* makes a clear and consistent distinction between the influence of aging (-related determinants) on acute and LTC expenditures. Next, we discuss HCE projections in aging populations based on various (sets of) models. It will be demonstrated that richer models, with better information on health care need than age only, improve projections by their ability to account for the corresponding trends in need determinants, e.g. a compression or expansion of ill-health. The specific contribution of population aging to HCE growth is placed in perspective by discussing the relative role of aging compared to other driving forces behind the HCE growth.

Part B (*chapter three to six*) and C (*chapter seven*) present original empirical studies for the Netherlands. As much less is known about the impact of aging on LTC use and spending, the objective of part B is to investigate the impact of population aging on LTC spending in greater depth. Improved knowledge on the impact of aging on future LTC use and spending may help preparing the LTC system to its future needs. However, this requires in the first place a better insight in the decision process leading to LTC utilization. Of particular interest is the influence of the prime determinant of LTC use, disability status. Thus far, the vast majority of studies on the impact of aging on LTC use lacked data on disability status. Because disability is viewed as the key determinant of LTC use, disability is a prerequisite to obtain access to publicly financed LTC in the Netherlands, the future trend in disability proves to be of crucial importance for LTC expenditure growth. *Chapter three* therefore focuses on the influence of disability on home care and institutional LTC use as an important prerequisite for a better understanding of the determinants of LTC use.

Once the relationship between disability and LTC use has been empirically determined, *chapter four* then disentangles the respective roles of age, time-to-death and disability in explaining LTC expenditures. In addition, we illustrate the contributions of age, time-to-death and disability by comparing projections of future LTC spending based on trends in the age composition of the population, life expectancy and disability. Results reveal that the impact of aging on LTC expenditure is substantially overestimated when not accounting for longevity gains, but even more so when overlooking improvements in disability status.

Hence, reliable estimates of future trends in disability are required to improve prognoses of LTC spending. The objective of *chapter five* is therefore to estimate future disability rates and combine these with LTC utilization rates by disability, age and sex to obtain forecasts of home care and institutional LTC use. The resulting forecasts then allow accounting for changing disability patterns, e.g. a compression or expansion, instead of approximating it by age or time-to-death.

Because informal care is an important component of LTC, part B would not be complete without contributing to evidence on the impact of aging on informal care supply and spending. We however could only contribute to this in some approximate way. First, to be able to investigate the consequences of aging for informal care costs, informal care should be valued appropriately. Although the bulk of informal care is unpaid, the costs of informal care to society – e.g. the productivity losses – are substantial. *Chapter six* extends previous research on the monetary valuation of informal care by investigating the feasibility of the contingent valuation method to obtain a monetary value for an hour of informal care. Second, *chapter five* accounts for the possible substitution of publicly financed LTC by informal care in projecting future LTC spending. We explicitly compare projections that do and do not account for trends in co-residence status – a proxy for informal care availability as the vast majority of informal care is provided by household members – and comment on the likely changes in the trend of informal care supply.

Part C '*unraveling the determinants of acute health care expenditure growth*' consists of *chapter seven*. The objective of *chapter seven* is to decompose the Dutch acute HCE growth in the period 1998-2004 into a contribution of changes in population characteristics, changes in hospital-related factors, and changes in the HCE function. The contribution of changes in the acute HCE function mainly reflects medical technological progress, government policies, other changes in medical practices, and changes in demand behavior. As such, this chapter provides further evidence on the relative contribution of aging compared to other factors. The growth in two spending components, hospital and pharmaceutical expenditures, will be investigated separately because the contribution of factors to the expenditure growth varies between these two subsectors. In addition, an innovative decomposition method has been employed that decomposes the growth across the full expenditure distribution. The exploitation of this method enhanced insight in the acute HCE growth that could not have been delivered by traditional decomposition analyses.

Finally, *chapter eight* concludes and discusses the main results and take-away messages of the thesis.

A

The Impact Of Aging and Other Determinants on Health Care Expenditure

Aging Perspectives on Health Care Expenditures – Theories, Facts and Forecasts

2

with Bram Wouterse, Johan Polder and Marc Koopmanschap

Submitted for publication

ABSTRACT

Due to the rapid growth in population aging in developed countries, serious concerns have risen about the financial sustainability of health care systems. This chapter discusses the impact of population aging on health care expenditure (HCE). Its contribution is twofold. First, we reveal the different health determinants that constitute the effect of aging on HCE. Second, we analyse the consequences of important societal determinants of HCE that interact strongly with aging, like technological progress and national income. Throughout the chapter, we differentiate between the impact of aging on acute care and long-term care (LTC) expenditures.

Most literature on population aging and HCE is devoted to rough approximations of health determinants: either age or, in more recent years, mortality. Studies that include more detailed information on health and disability are scarce but they show that the influence of age and mortality on HCE is strongly diminished when health and disability are directly included. The direct effect of population aging on HCE growth is relevant, but modest: population aging explains 0.5-1.0 percent of the 4 percent real annual growth in HCE. The strongest driver of HCE seems to be technological innovation, facilitated by economic growth. All determinants, however, interact with each other: aging reinforces the impact of technological change, vice versa. The direct influence of aging is strongest on LTC, where age is a significant determinant of expenditures, even when health and disability are included.

HCE will continue to rise in the coming decades. Although the direct effect of aging is modest, many of the other important drivers of HCE, especially technological progress (for acute care) and disability (for LTC), seem to interact very strongly with age. Therefore, the relationship between age and HCE is still of great importance.

2.1 INTRODUCTION

Over the last decades the impact of population aging on health care expenditures (HCE) has become a growing concern in developed countries. The increase of the relative share of elderly in the population is a combined result of increasing life expectancy and declining fertility rates. Simultaneous to population aging, HCE have risen sharply. In OECD countries, average expenditures increased from approximately 5 percent of GDP in 1970 to 9 percent in 2007. Per capita HCE in current prices have risen from below $1000 in 1977 to over $3000 in 2007 (OECD, 2009). The association between age and HCE has raised serious concerns regarding the financial sustainability of health care systems.

Although consensus exists that growth in HCE can at least partially be attributed to aging (Yang, Norton, and Stearns, 2003; OECD, 2006; Payne *et al.*, 2007; van Elk, Mot, and Franses, 2010), the extent of the impact of population aging on HCE is still unclear. The debate on aging is complicated because aging studies differ largely in approach. Most studies only model the relationship between age and HCE, whereas others also include (approximations of) health. Furthermore, some studies focus on individual HCE while others adopt a macroeconomic approach.

That the relationship between age and HCE largely results from decreasing health seems obvious. As organisms age, organ systems wear and the body's ability to fight diseases declines (Partridge and Mangel, 1999). This decreasing health in turn leads to increasing utilization of health care and expenditures. Less clear is how expected increases in longevity relate to health. There are three competing hypotheses on this relationship: expansion, compression, and postponement of morbidity (Fries, 1980; Olshansky *et al.*, 1991; Payne *et al.*, 2007). The expansion hypothesis assumes that longevity gains will increase the period of time lived with morbidity or disability. The compression hypothesis assumes that this period will shrink. In the postponement hypothesis longevity gains are expected merely to shift the period with morbidity or disability to an older age, while its duration remains constant. Given the fact that the relationship between age and HCE is largely due to health, the consequences of longevity gains on HCE depend on which of these competing hypotheses is true.

Population aging is just one of the driving forces behind HCE. Other individual and societal factors are even more important. In fact, there seems to be a consensus that medical technology is the largest driver of HCE growth, facilitated by economic growth. Both factors, however, are strongly interrelated with aging. Not only can the introduction of new technologies lead to an increase in longevity, the aging of the population could also lead to an increased demand for medical technology aimed at the elderly. Therefore, while the isolated effect of aging might be relatively small compared to other factors, the broader effect of aging, as it interacts with other determinants, could be much more significant. It is difficult, however, to get some grasp of this broader effect because most studies on age and health effects focus on individual persons and their health care consumption, while studies on the effects of income and medical technology are often based on aggregated data.

The aim of this chapter is to provide a consistent overview of the different branches of research on population aging and health expenditure. In the next section we introduce a conceptual model of HCE and its determinants. This chapter centres on two issues. First, we comprehensive discuss the relationship between age and its underlying individual determinants mortality, health and disability. Second, we discuss the full contribution of population aging to growth in HCE by considering its strong relationship with important societal determinants. We classify the evidence from literature according the different parts of the model, we clarify the relationships between determinants and we discuss their impact on projections of future HCE. We conclude with some recommendations for researchers and policy makers.

2.2 CONCEPTUAL FRAMEWORK

The conceptual framework of determinants of HCE in figure 2.1 was largely inspired by the behavioral model of Andersen and Newman (Andersen, 1995; Andersen and Newman, 1973). This model provides a framework for viewing individual utilization of health care, taking into account both individual and societal determinants. We extended the model

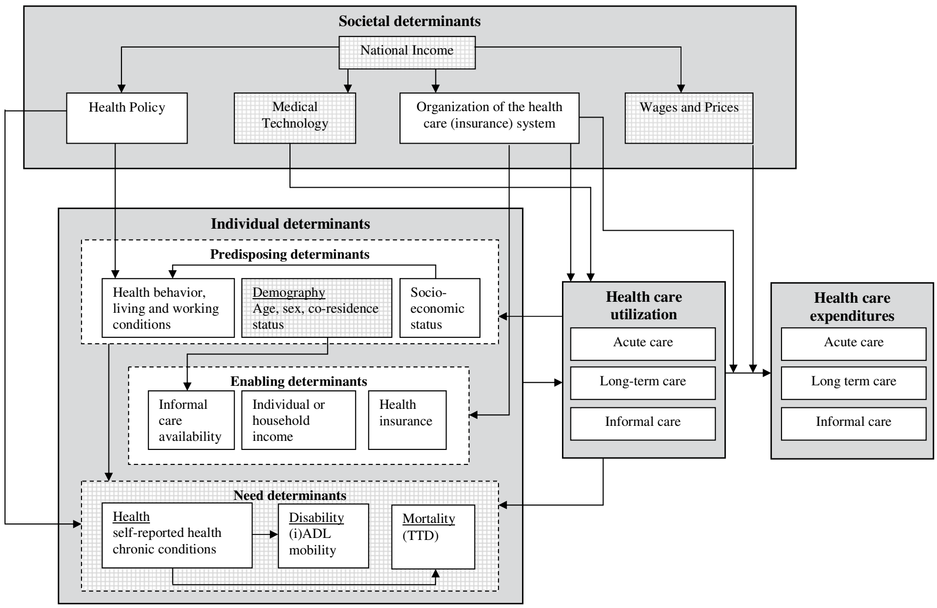

FIGURE 2.1 Conceptual model of individual health care expenditures

with an additional link between utilization of health care and expenditures. This link is mainly influenced by wages and prices, and the organization of the health care system. Furthermore, we distinguish explicitly between expenditures in acute care and LTC. The care involved in both sectors is very different in character and countries often organize the financing and service delivery of services separately. Consequently, determinants will have a different impact on acute and LTC expenditures.

The model has two main features which are relevant for our discussion of aging. First, we use the categorization of individual determinants to discuss the relationship between age, health and HCE. Second, we utilize the distinction between societal and individual determinants, and the interactions between the two, to assess the relationship between aging and income and medical technology.

Individual determinants were classified into three groups: predisposing, enabling, and need determinants. Predisposing determinants reflect the individual's 'propensity toward use'. These determinants influence the likelihood that an individual will use health care, without being directly responsible for that use. Age, sex, marital status, co-residence status, socio-economic status, and living and working conditions are examples. Age, the most important predisposing determinant for our discussion, is closely related to health and illness. However, it should still be considered to be a predisposing determinant, since age itself is not a reason for seeking health care (Andersen, 1995).

Enabling determinants concern the resources available to satisfy a need regarding health care use. Important enabling determinants are the level of health insurance coverage, individual or household income, and informal care supply.

Need determinants regard the direct reasons why an individual, given the presence of predisposing and enabling determinants, seeks the use of health care: ill health and disability. Health can be conceptualised in many different ways: the presence of (chronic) diseases, self-reported health, mental- and physical illness. These different concepts reflect different dimensions of health, with a possibly different influence on HCE. Disability reflects the way in which poor health limits the ability to perform (instrumental) activities of daily living ((i)ADL) and mobility. Although health and disability are related, both determinants have a different relationship to HCE, especially between acute care and LTC. Moreover, effective health care and informal care (e.g., medication or appliances) might limit disability while not curing the disease, which means that the relationship between health status and disability is dynamic. We also include mortality as a need determinant. This might seem a bit strange, since mortality itself cannot lead to utilization of health care. However, many aging studies include time-to-death (TTD) as a proxy for health to explain HCE. We include TTD as a need determinant rather than a predisposing determinant, because instead of age, death is a consequence of ill health and not the other way round.

At the top of figure 2.1 the societal determinants of HCE are shown. We can distinguish between national income, health policy, medical technology, the organization of the health care system and wage/price developments. National income provides the money for health care funding and thus has a constituting influence on the ability to pay. Medical technology influences the principles and techniques available to provide health care, and their costs. It tends to increase use, resulting in a rise in total HCE (Bodenheimer, 2005) and is by many viewed as the key driver of HCE growth (e.g. Newhouse, 1992). The organization of the health care system involves the provision and financing of health care services; it influences expenditures through the incentives it provides for all actors involved. Finally, wages and prices are among the main driving forces of growing HCE.

In the next sections we summarize the evidence from literature on the aging-related determinants that are shaded in figure 2.1. We discuss the individual determinants in depth and will talk about the societal determinants more briefly.

2.3 INDIVIDUAL DETERMINANTS OF HEALTH CARE EXPENDITURE: AGE, MORTALITY, AND HEALTH

A lot of discussion in health economic research on aging has focused on the question whether the relationship between age and HCE holds when health variables, or proxies like TTD, are also included in a model. Given the fact that the predisposing character of age lies mostly in an increasing likelihood of being in poor health, it should indeed be expected that the influence of age on HCE diminishes when health is controlled for. The debate, however, is not so much whether age has an additional predisposing effect on HCE besides health. Instead, the real question is whether age, or even TTD for that matter, can still be used as a good proxy for health when the aim is to assess the influence of population aging, and especially of longevity gains. In this section we discuss how research on aging has developed from age-based models towards TTD models and then towards more health based models.

The impact of age and mortality

Until the end of the 1980's, studies on the consequences of population aging on HCE were mostly based on the observed cross sectional relationship between age and HCE, which showed a strong increase of HCE with age. Consequently, it was argued that population aging was responsible for much of the growth in HCE, since both the share of elderly and expenditures had been growing over time. The combination of cross sectional estimates of the relationship between age and HCE with expectations of the future age distribution led to predictions of large increases in HCE (Longman, 1987; OECD, 1988). Such studies (implicitly) assumed that increases in longevity would not influence the relationship between age and HCE. However, insights from the cost of dying (COD) and TTD literature seemed to suggest that this assumption was incorrect (see Payne *et al.* 2007 for a review of the COD and TTD literature).

The idea behind COD studies is that the largest part of HCE is made in the final year of life. HCE should therefore be differentiated between survivors and decedents. COD studies either analyse aggregate HCE of decedents by age, or compare age-specific HCE between survivors and decedents. For example, recent COD studies found that Medicare expenditures were six to seven times larger for decedents than survivors (Hogan *et al.*, 2001; Lubitz *et al.*, 2003). Also, the ratio of decedents' to survivors' HCE has been found to fall with age (e.g. Hoover *et al.*, 2002; Madsen *et al.*, 2002; Yang, Norton, and Stearns, 2003; Polder, Barendregt, and van Oers, 2006). The magnitude of this ratio depends on the sector under consideration (Madsen *et al.*, 2002; Kildemoes *et al.*, 2006). For LTC, the effect of age on expenditures was found to be particularly strong (McGrail *et al.*, 2000; Spillman and Lubitz, 2000; Yang, Norton, and Stearns, 2003; Polder, Barendregt, and van Oers, 2006). By the 1980's, the large proportion of HCE spent in the last periods of life had been well documented (Lubitz and Prihoda, 1984; McCall, 1984; Scitovsky, 1984). This result suggested that, "as age-specific death rates fall over time, there will be fewer people in the last year of life in any age category, and this will reduce age-specific health care expenditures" (Fuchs, 1984). Thus, predictions of future HCE should be corrected by including the change in the age pattern as a consequence of increased longevity (Fuchs, 1984; Manton, 1982).

A more refined way of making such corrections was offered by TTD studies. Instead of comparing aggregated costs of decedents and survivors by age, TTD studies use individual data to model HCE as a function of the time away from death, allowing for in-depth analyses of the effects of approaching death on HCE over time. In a seminal study, Roos, Montgomery, and Roos (1987) modelled hospital, nursing home, and primary care use as a function of age, sex, and TTD in Canada. Their sample included decedents (individuals in their last 8 years of life) and survivors. TTD was found to have a strong effect on use while the effect of age diminished but remained significant for most age groups. The effect of TTD was found to diminish with age, a finding confirmed by subsequent studies (e.g. Seshamani and Gray, 2004a; Stearns and Norton, 2004; Werblow, Felder, and Zweifel, 2007; Häkkinen *et al.*, 2008).

In 1999, Zweifel, Felder, and Meiers (1999) put TTD squarely on the agenda by stating that age was a red herring, a distraction from the true drivers of HCE. Using Swiss HCE panel data from individuals in their last two years of life, Zweifel, Felder, and Meiers (1999) modelled quarterly HCE conditioning on age, sex, and TTD. Unlike Roos, Montgomery, and Roos (1987), they found that age no longer determined HCE among individuals aged 65+. Instead, TTD explained most variation. Many TTD studies followed. Two types of TTD studies can be distinguished. The majority of studies published before 2004 only investigated the TTD hypothesis for decedents (Zweifel, Felder, and Meiers, 1999; Felder, Meier, and Schmitt, 2000; O'Neill *et al.*, 2000; Seshamani and Gray, 2004a, 2004c). The second type of TTD studies examined the scope of the TTD hypothesis by expanding the model to survivors (Stearns and Norton, 2004; Zweifel, Felder, and Werblow, 2004; Werblow, Felder, and Zweifel, 2007; Häkkinen *et al.*, 2008; Weaver *et al.*, 2009; Felder, Werblow, and Zweifel, 2010). All studies concluded that TTD is the main demographic determinant of HCE. However, TTD studies reported different results concerning the exact time at which the approaching event of death becomes important for HCE. Results are often difficult to compare since studies vary largely in included time prior to death (2-30 years), population samples, and health sectors. Zweifel, Felder, and Meiers (1999) found that TTD had a significant effect on HCE up to 1.5 years before death. A much longer effect of TTD – up to 30 years prior to death – was found in other studies (Roos, Montgomery, and Roos, 1987; Lubitz, Beebe, and Baker, 1995; Seshamani and Gray, 2004c).

Results concerning the remaining effect of age on decedents' HCE are inconclusive. While Zweifel, Felder, and Meiers (1999) reported no effect for age at all, other studies reported that expected HCE of survivors and to a lesser extent decedents were still associated with age, although its effect dropped substantially when accounting for TTD (e.g. Roos, Montgomery, and Roos, 1987; Seshamani and Gray, 2004a; Stearns and Norton, 2004).

Like in COD studies, the effect of age and TTD on expenditures depends on the health sector. For most acute services, age had no or a negative effect on decedents' expenditures and only a weak positive effect on survivors' expenditures (e.g. Werblow, Felder, and Zweifel, 2007; Häkkinen *et al.*, 2008). Although controlling for TTD importantly attenuated the effect of age on expenditures for all services, age still importantly determined LTC expenditures (e.g. Roos, Montgomery, and Roos, 1987; Werblow, Felder, and Zweifel, 2007; Häkkinen *et al.*, 2008; Weaver *et al.*, 2009). LTC expenditures are also the main reason why studies on total HCE still found an age effect for both decedents and survivors.

Reconsidering the impact of age and mortality: controlling for health and disability

COD and TTD studies recognized the role of age as a predisposing determinant, in the sense that the relationship between age and HCE was considered to be mainly the result of the higher probability of dying at higher ages. However, the relationship between mortality and age itself is mostly the result of deteriorating health. Therefore, TTD could be just a proxy of health, or more accurately morbidity and disability, in explaining HCE. The concentration of HCE at the end of life should then be associated with a high burden of disease at the end of life. This was indeed confirmed by Hogan et al. (2001), who reported that decedents have an almost 4 times higher disease rate than survivors.

Studies that include health can be divided into four categories. First of all the classic cost of illness approach can be distinguished. These studies combine demographic and epidemiological data to estimate health care costs for all or specific diseases per age group (Meerding *et al.*, 1998). Häkkinen et al. (2008) examined the influence of various chronic conditions on HCE at individual level in a sample of the non-institutionalized Finnish 65+ population. Most diseases greatly raised expenditures on health care, but the impact differed per disease and type of care. Wong et al. (2008) examined the effect of co-morbidity on Dutch hospital expenditures, demonstrating that the costs of co-morbidity were higher than the sum of the costs of each disease separately.

Second, a number of COD and TTD studies are stratified by cause-of-death (Bird, Shugarman, and Lynn, 2002; Seshamani and Gray, 2004a; Wong *et al.*, 2011). Bird *et al.* (2002) have reported the effect of cause-of-death on decedents' total HCE; Seshamani and Gray considered only hospital expenditures. Decedents from cancer and respiratory diseases had significantly higher end-of-life spending than decedents from heart disease. Seshamani and Gray also reported higher hospital expenditures for decedents from stroke. Wong *et al.* (2011) considered disease-specific hospital expenditures. A significant effect of TTD was found for both strong and less lethal diseases but the effect was larger for the former.

Third, Dormont, Grignon, and Huber (2006) and Shang and Goldman (2008) used both TTD *and* general health measures to HCE. Dormont, Grignon, and Huber analysed the growth in age-specific spending on ambulatory care, pharmaceuticals and hospital care in France over the period 1992-2000. The increasing HCE by age could entirely be explained by differences in health. Hypertension, diabetes, metabolic disorders, and depression increased pharmaceutical expenditures while ambulatory care expenditures were positively influenced by depression and the number of diseases. As in most other TTD studies two parts were distinguished. The first part regards the probability of using hospital care, and this probability was positively influenced by diabetes, cataracts, and TTD (approximated by death risk). The second part regards the conditional expenditure for admitted patients, and Dormont, Grignon, and Huber showed that hypertension and disability status significantly determined this conditional hospital expenditure. Shang and Goldman (2008) evaluated the effect of age on Medicare expenditures while further controlling for TTD (measured by remaining life expectancy), certain chronic conditions and ADL disabilities. As with Dormont, Grignon, and Huber (2006), TTD played only a limited role once morbidity was controlled for, although it is hard to understand their results because some exogenous variables are used twice: in modelling life expectancy and in measuring its effect on HCE once life expectancy is already controlled for.

Fourth, Lubitz *et al.* (2003) and Wouterse, Meijboom, and Polder (2011) analysed the long-term relationship between health status and HCE by examining *cumulative* HCE. Lubitz et al. (2003) quantified the relationship between self-reported health and disability on lifetime HCE from the age of 70 until death in the US. Elderly with better self-reported health lived longer, but incurred similar lifetime HCE than those reporting poor health. With respect to disability, lifetime HCE of non-disabled individuals were on average $9,000 lower while they live on average 2.7 years longer than disabled individuals. Using Dutch hospital data over 8 years, Wouterse, Meijboom, and Polder (2011) reported similar findings. These results demonstrate that improvements in health lead to longer life expectancy, but generally not to lower HCE.

A number of studies have focused on examining the effect of need factors on LTC use (de Meijer *et al.*, 2009; Weaver *et al.*, 2009; Wong *et al.*, 2010; de Meijer *et al.*, 2011;). Weaver *et al.* (2008) and de Meijer *et al.* (2009) separately examined the effect of need factors on institutional and home care use. They also confirmed that disability largely determined spending on institutional and home care, but age remained important as well. Cognitive functioning was found to influence institutional LTC use only (Weaver *et al.*, 2009) while self-reported health or the presence of a chronic disease were not determining home care or institutional LTC use (de Meijer *et al.*, 2009). Wong et al. (2011) analysed LTC use in a sample of discharged hospital patients aged 65+ in the Netherlands. Of the selected diseases, stroke was most strongly related to a nursing home admission, while lung cancer was the strongest determinant of discharge to home care. Finally, de Meijer et al. (2011) analysed home care and institutional LTC *expenditures* for the entire Dutch 55+ population conditioning on cause-of-death. Death due to diabetes, mental illness, stroke, respiratory diseases or digestive diseases had higher LTC expenditures; death due to neoplasm was associated with lower institutional LTC expenditures but higher home care expenditures. Furthermore, using a sample of non-institutionalized individuals, TTD no longer determined home care expenditures once disability was controlled for.

In conclusion, we have seen that the discourse on the impact of aging on health expenditure moved from age models to more sophisticated analyses of time-to-death and most recently of health and disability. Not age as such matters, but the prevalence of disease, disability and co-morbidity in a certain year and even more during the whole span of life. The impact, however, differs for acute care and long term care.

2.4 PREDICTIONS BASED ON INDIVIDUAL DETERMINANTS (AGE, MORTALITY, AND HEALTH)

Age-, TTD- and health-based models lead to different predictions of the effect of population aging on future HCE. Predictions from age-based models implicitly assume that gains in longevity do not influence the relationship between age and HCE. Instead, TTD models assume that the mortality-related component of HCE shifts equivalently with longevity gains. Thus, TTD based projections adhere to the postponement of morbidity hypothesis: the period spent in poor health, as far as it is responsible for HCE associated with TTD, is assumed to be merely postponed to a later age. The findings in the previous sections, for instance the variation in the effect of TTD by cause-of-death, imply that epidemiological changes can affect the relationship between TTD and HCE. Health-based models do not rely on an implicit assumption on the relationship between longevity gains and health. However, they have to rely on predictions of health and disability trends, which are much more ambiguous than trends in mortality.

Projections based on age versus TTD.

Many forecasting studies have compared age-based and TTD models. A general and strong result, regardless of country or model specification, was that population aging had a significantly lower impact on future HCE in TTD models than in naïve models. The difference between naïve and TTD models increases when the expected increase in life expectancy is larger and the projection period longer. Comparison of the exact impact of the inclusion of TTD on predictions between studies is complicated by the fact that demographic changes vary by country and not all studies reported the same type of outcome.

Studies on annual HCE growth rates find a rate roughly between 0.7-2.3 percent due to population aging when TTD is not included and a 0.1-0.5 percentage point lower rate when including TTD. In Switzerland, Steinmann, Telser, and Zweifel (2007) found an annual increase of 0.7 percent between 2005 and 2030 for the naïve projection and 0.55 percent when TTD was taken into account. Although the effect of population aging on predicted HCE is thus significantly smaller when including TTD, over a period of 25 years a growth rate of 0.55 percent still implies a 15 percent increase of HCE due purely to aging. Miller (2001) used a relatively long prediction period (1997-2070) and found somewhat higher average annual growth rates for the US: 1.3 (1.1) percent for a naïve (TTD) model. Shang and Goldman (2007) report an expected annual growth rate of Medicare expenditures over the period 2000-2080 due to population aging of 1.7 (1.5) percent for an age-based (TTD) model. For the Netherlands, Polder *et al.* (2006) predicted a 0.7 percent (naïve) and 0.61 percent (TTD) annual growth between 2000 and 2020 due to population aging.

As the influence of TTD on expenditures varies with health services, the extent of the variations in prediction between age-based and TTD models also depends on the service under consideration. The difference between age-based and TTD models is particularly large for hospital expenditures and much less for primary care and pharmaceutical expenditures. Seshamani and Gray (2004b) predicted hospital expenditures for the UK in 2026, finding that the annual growth rate due to aging dropped by 50 percent (0.8 to 0.4 percent) when TTD was included. Serup-Hansen, Wickstrinm, and Kristiansen (2002) projected Danish hospital and primary care expenditures for the period 1995-2020. The naïve (TTD) model predicted an annual growth rate of 0.78 (0.63) percent for hospital expenditures and 0.33 (0.32) for primary care expenditures. Häkkinen et al. (2008) projected HCE in 2036 for Finland for different sectors. The difference in predicted annual growth rates between an age-based and TTD model was large for inpatient expenditures (1.7 versus 2.2 percent per annum) and somatic specialized care (1.5 versus 1.9 percent), but small for pharmaceutical expenditures (1.6 versus 1.7 percent), which was confirmed by Kildemoes et al. (2006) for Danish pharmaceutical expenditures. Using Dutch data on public LTC expenditures, de Meijer *et al.* (2011) predicted an annual growth rate of per capita LTC expenditures for the 50+ population over the period 2004-2040 of 1.14 percent for a naïve model and 0.69 percent for a TTD model.

Projections using trends in health and disability

As we have discussed, TTD models implicitly assume a postponement of morbidity as the period of morbidity preceding death is expected to shift to higher ages but remains constant in duration. However, recent evidence seems to support, although not unambiguously, the compression hypothesis, i.e. the period lived with disease expands over time, but self perceived health and years without physical limitations tends to increase over time. Due to the complex nature of health, evidence on its time trends tends to vary by country, and sometimes even within countries (Lafortune *et al.* 2007; Parker and Thorslund, 2007; Mackenbach *et al.*, 2008). Despite the widely divergent results, the tendency seems to be that the elderly report more diseases and health problems but fewer disabilities (de Hollander, 2006; Parker and Thorslund, 2007; van der Lucht and Polder, 2010).

In comparison to the extensive TTD literature, few projections of future HCE controlling for trends in better need determinants have been made. Manton and colleagues (2006, 2007) investigated how the decline in disability among the US elderly between 1982 and 1999 affected future Medicare costs. Although their projections are outdated – 2004 and 2009 – the results are still worth mentioning as they demonstrated that projections accounting for the recent disability decline approached the actual amount spend most accurately. For the 2009 projection, the annual growth of Medicare expenditures between 2004-2009 was estimated to be 9.80 percent based on a model that assumed stable disability prevalence and 6.49 percent based on a model that assumed a continuation of the disability decline observed between 1989-1999. Stearns *et al.* (2007) simulated the implications of changing age and disability patterns on LTC spending in the US. The effects of population aging and increasing longevity are found to be modest relative to the effect of changes in disability prevalence.

Whereas Manton *et al.* and Stearns *et al.* examined disability trends in the elderly only, Bhattacharya *et al.* (2004) argued that cohort effects have to be taken into account when projecting HCE for the future elderly. Because the disability trend among the young declines at a lower rate than that of the elderly, they argued that future elderly will be more disabled than projected from an extrapolation of the recent disability trend among the elderly. Using Medicare data, per capita HCE were projected to decline for the next 15-20 years, which is in line with recent projections that used declining disability among the elderly. Accounting for cohort effects, however, per capita HCE were expected to rise after 2020. Therefore, they concluded that cost forecasts for the elderly depend on the incorporation of cohort effects regarding disability; including these effects yielded more pessimistic scenarios for future Medicare expenditures.

De Meijer *et al.* (2011) demonstrated the importance of omitting important determinants by projecting per capita LTC expenditures for the Dutch 50+ population for the year 2040. While a naïve model estimated an annual growth rate of 1.14 percent, accounting for the increasing number of elderly living alone resulted in an annual growth rate of 1.19 percent.

They also estimated the growth rate of per capita home care expenditure to be 0.46 percent when extrapolating recent declines in severe disability (1.5 percent annually; Lafortune *et al.*, 2007; Perenboom *et al.*, 2004), while the growth rate was estimated to be 1.12 percent using a naïve model and 0,74 percent according to a TTD model.

We conclude that TTD, morbidity and disability have a major impact on demographic projections of future HCE. These models, however, are solely based on the individual determinants of HCE. For an even better understanding we should also acknowledge the influence of societal determinants.

2.5 SOCIETAL DETERMINANTS: NATIONAL INCOME, TECHNOLOGY AND WAGES

Income

In general, income reflects the ability and willingness to pay for health care. However, income appears twice in the framework of figure 2.1: as an individual enabling determinant, in the form of individual income, and as a societal determinant, in the form of national income. Although there is a relationship between individual and national income, their influence on HCE can be quite different. Macro studies find that on the national level, income is a major determinant of HCE (Newhouse, 1977). Also, national income growth seems to be strongly correlated with HCE growth (Gerdtham *et al.*, 1992; OECD, 2006; van Elk, Mot, and Franses, 2010). In fact, the national income elasticity of health care is commonly found to be greater than one, suggesting that health care is a luxury good (Newhouse, 1977). On the individual level, however, income is found to have a very small impact on HCE (Getzen, 2000; Doorslaer, Koolman, and Jones, 2004; van Ourti, 2004). This apparent paradox can be resolved by explicitly taking into account the different levels of analysis and the different variation within and between groups. In the presence of health insurance, the marginal price of health care is typically (near) zero. Therefore, on an individual level income differences do not play a large role in explaining differences in HCE among individuals belonging to the same group of insured (which in many cases is more or less the total population). In contrast, collective or national income is a strong explanatory factor when explaining differences between groups (countries, insurance groups) where it does reflect a societal willingness to pay for health care (Getzen, 2000). In relation to the conceptual model, we could say that the political willingness to pay and the societal ability to pay eventually largely accommodates the level of HCE, whereas the distribution of collectively-financed care, moderated by the organization of the health care system, is determined mostly by individual determinants.

Medical technology

Progress in medical technology is often mentioned as the most important driver of HCE growth (e.g. Weisbrod, 1991; Newhouse, 1992). Technological progress has two contrasting effects on HCE. On the one hand, technological progress can mitigate expensive care and reduce costs (Cutler and McClellan, 2001; Cutler, 2007). On the other hand, it also tends to increase use. Or, intuitively stated by Jones (2002): "Medical advances allow diseases to be cured today at a cost that could not be cured at any price in the past". In general, the second effect turns out to be larger resulting in a rise in total HCE (Bodenheimer, 2005). Although intuitively strong, direct evidence on the impact of technological progress is relatively scarce. For instance, Newhouse (1992) reached his conclusion by eliminating other explanatory factors, not by direct evidence. It has, however, been shown that medical spending in general (Cutler, 2007) and pharmaceuticals spending in particular (Lichtenberg, 2007; Civan and Koksal, 2010) often provide health gains at reasonable costs, but the budget impact and costs per additional life year vary substantially among new innovations (Goldman *et al.*, 2005). Moreover, most innovations that provide health gains also raise HCE.

A number of studies have attempted to analyse the role of technological progress explicitly (Breyer and Ulrich, 2000; Jones, 2002; Okunade and Murthy, 2002; Suen, 2005; Goldman *et al.*, 2005; Westerhout, 2006; Dormont, Grignon, and Huber, 2006). Using macro data for Western Germany for the period 1970-1995, Breyer and Ulrich (2000) estimated that technological progress increased per capita HCE by 0.8-1.4 percent annually. Suen (2005) showed for the US that the rising trend in HCE and the significant increase in life expectancy during the second half of the 20th century can be explained by medical technological progress and higher incomes. Okundade and Murthy (2002) approximated medical progress by total R&D spending and health-specific R&D spending in the US, finding a significant effect on HCE for the period 1960-1997. Westerhout (2006) combined the elasticity between the growth rate of new pharmaceutical and the size of their potential market with the expected increase in the number of elderly and estimated an additional 0.6 percent annual growth in HCE due to medical progress.

Dormont, Grignon, and Huber (2006) decomposed the relative contributions of changes in demography, morbidity and health care practices to the HCE growth in France over the period 1992-2000. Changes in practices given a certain level of morbidity were assumed to reflect the impact of medical technology. Their conclusion was that "changes in practices appear to be the main driver in the increase in expenditures", especially for pharmaceutical expenditures. Seventy percent of pharmaceutical spending growth could be explained by changes in practices.

Wages/prices

Research on wages/prices showed that labour productivity in health care tends to develop more slowly than the general economy, causing health care prices to increase faster than inflation – a phenomena called Baumol's disease. Baumol's disease comprises a structural factor causing prices in health care to outpace general inflation. Okunade Karakus, and Okeke (2004) have found an increase of relative prices of health care in OECD countries over most of the 1968-1997 period. The relative price increase of HCE increased the price of health care, but also lowered the demand (through price elasticity). Although study findings vary (Murillo, Piatecki, and Saez, 1993; Murthy and Ukpolo, 1994; Okunade, Karakus, and Okeke, 2004), it seems most likely that Baumol's disease leads to higher HCE and a somewhat smaller volume of health care use (Hartwig, 2008; van Elk, Mot, and Franses, 2010). The size of the effect on HCE can be considerable, approaching the isolated impact of aging. Population aging is expected to lead to serious labour shortages in health care, in particularly in LTC, which likely results in an upward pressure on wages in the health care sector (Dixon, 2003; Simoens, Villeneuve, and Hurst, 2005). Population aging is therefore likely to increase the contribution of Baumol's disease to the HCE growth.

Dynamics

HCE growth due to national income growth and technological innovation is not necessarily age neutral. For instance, medical innovations aimed at diseases occurring at old age have a different effect on the age profile of HCE than innovations aimed at diseases occurring mostly at a young age. When innovations are mostly aimed at the elderly, the broader effects of aging might be larger than the direct effect.

Findings on differences in HCE growth between age groups are not conclusive. Between 1963 and 1987 medical expenditures of the elderly in the US rose more quickly than expenditures for other age groups (Meara, White, and Cutler, 2004), but after 1987 HCE growth has been somewhat higher for middle aged groups than for the elderly (e.g. Hartman *et al.*, 2008; Meara, White, and Cutler, 2004). This finding seems to be related to policy changes, especially in Medicare (Meara, White, and Cutler, 2004). For Germany, Buchner and Wasem (2006) found a steepening of the age curve of HCE during the period 1979-1996. Dormont, Grignon, and Huber (2006) demonstrated that HCE in France grew disproportionately for those aged 60+ over the period 1992-2000. For the Netherlands, Wong *et al* (submitted) investigated the effect of medical patents for different age groups, and found that the influence of innovations on hospital use is largest for the older age groups.

Furthermore, apart from Payne *et al.* (2009), COD and TTD studies have found a relatively larger increase in survivors' than decedents' HCE over time (McGrail *et al.*, 2000; Spillman and Lubitz, 2000; Zweifel, Felder, and Meiers, 1999; Hogan *et al.*, 2001). The downward sloping curve of the costs of dying with age was found to persist over time (McGrail *et al.*, 2000; Spillman and Lubitz, 2000). For Switzerland, Felder and Werblow (2008) found that, after controlling for mortality changes, there was no steepening of the remaining age effect.

Kramarow *et al.* (2007) show that for the US between 1992 to 2003 HCE have grown more for people in better health than they have for people in poor health. Institutional changes may have played a role here. For an earlier period, Manton *et al.* (2006) stated that the decrease in Medicare spending for disabled individuals between 1982 and 1989 was probably related to the establishment of the prospective payment system in 1984, while the increase in the period 1989-1994 was probably due to the expansion of LTC benefits. Goldman *et al.* (2005) used simulations to estimate the effects of ten key technologies, most likely to affect the health of the elderly positively in the future, on HCE in the US. They found that all of these innovations will lead to an increase in HCE: their costs overwhelm any savings in HCE from improved health (Lubitz, 2005).

In conclusion, medical technology plays an important role, but until now the real impact on HCE in the dynamic interaction with individual determinants as morbidity and mortality, remains largely unravelled. Because medical innovations are developed to improve health suggests a relatively large growth of HCE for the unhealthy (i.e. elderly).

2.6 DISCUSSION AND CONCLUSION

Aging in perspective

We have discussed the relationship between aging and HCE from two angles: the relationship between aging and underlying individual determinants such as mortality and health, and the impact of aging in relation to that of other determinants of HCE. What has the discussion contributed? First, we have shown the value of explicitly considering health-related causes of the relationship between age and HCE. Age-based models implicitly assume that increases in longevity have no effect on the age pattern of HCE. The TTD literature has convincingly shown that significant parts of HCE are extended to older ages when life expectancy increases. This has led to a re-appreciation of the role of population aging in rising HCE. Population aging was expected to have limited impact on the growth in acute care spending, but was still expected to contribute importantly to the LTC spending growth. However, as we have argued, TTD itself at best approximates underlying health. An increasing number of studies have shown that when health or disability are included the role of TTD is also limited. A consequence of these findings is that when trends in health or disability do not coincide with trends in mortality, as seems to be the case, TTD models lead to inaccurate predictions of the consequence of longevity gains on HCE. However, due to data limitations and uncertainty about future health trends, projections based on health and disability have remained relatively scarce.

Second, although population aging contributes to the HCE growth, its direct effect is modest in comparison to total HCE growth: population aging explains 0.5-1.0 percent of a total annual real growth rate that can reach 4-5 percent (Burner, Waldo, and McKusick, 1992; Reinhardt, 2003; Richardson and McKie, 1999). National income growth, determining the societal ability and willingness to pay for health care, is strongly associated with HCE growth on an aggregated level. Other major drivers of growth are medical technology and increasing relative prices (Baumol's disease). Results on aggregate HCE are mostly based on macro studies that can only include the effect of population aging in some approximate way (e.g. the share of the population older than 65). However, results on individual HCE show that the distribution of collectively financed care is largely determined by health and disability. Moreover, we have showed that age is not only strongly related to these individual determinants but also to societal determinants. It seems reasonable to expect that a large part of future medical innovations will be used for the groups with the highest needs: the elderly. Although not all studies agree, this expectation seems to be confirmed by the relatively large growth of HCE for the elderly, compared to other age groups.

Although the direct effect of population aging has been shown to be rather limited, it does by no means limit the importance of aging for HCE. Many important drivers of HCE – mortality, need determinants and technological progress – seem to interact very strongly with age. As we have seen, the chance that medical innovation will lead to lower expenditures is very small. Notwithstanding advances in acute care might limit disability and subsequently lower the demand for LTC.

Future research

The evidence summarized in this chapter reveals some important blind spots that could be addressed in future research. A more integrated approach of aging and HCE is needed on two terrains. First, although the inclusion of health and disability measures in HCE models yielded good results, more research is needed. In particular, epidemiological expertise on future health and disability trends has to be combined with health economic models to gain better predictions of future HCE. An especially relevant issue is that most studies that project HCE based on trends in mortality and need determinants assume that the trends are exogenous. Longevity gains and improvements in morbidity and disability, however, may be partly due to HCE growth. This reversed relationship can lead to endogeneity issues. Future HCE might depend on the costs of improving health or prolonging life when additional HCE are spend during the life years gained. So, ideally, this approach should take the mutual relationship between health and HCE into account. An example of such a more integrated approach is the theoretical model by Hall and Jones (2007) that relates HCE and resulting longevity gains to income growth.

Second, the considerable gap between micro studies (mainly concerned with individual determinants of HCE) and macro studies (mainly concerned with societal determinants) is consequential. The impact of interacting individual and societal determinants – e.g. medical innovation and health – on HCE is not fully understood. Research that directly examines the relationship between technological progress and expenditures in the acute and LTC sectors is an example of what is needed here. These studies should also take into account the moderating role of the health care system.

Third, the fit between past projections of HCE and the actual development of HCE should be assessed more frequently to be able to better evaluate current projections of future HCE. Knowledge about future spending levels could be gained by accounting for the goodness-of-fit of past projection models. To our best knowledge, only Manton *et al.* (2007) have studied goodness of fit. The numerous studies in recent years created a window of opportunity for the comparison of projected and realised HCE.

Policy recommendations

The literature generally suggests three types of policies that could be exploited in an attempt to moderate HCE. We will briefly reflect on each of them. First, increasing the health of the general population through prevention is often suggested as a good way to limit HCE growth. Unfortunately, most evidence indicates that the effect of health improvement on HCE is limited at best. Any HCE decrease due to health improvement seems to be counteracted by postponing costs to later ages.

Second, limiting the disabling effect of diseases seems to be a promising approach. As previously discussed, LTC expenditures are strongly associated with disability. If we were to elevate the state of disabled individuals – either by actual improvements in disability or by an increased use of devices that support independent living – at low costs, savings could be substantial.

Third, although institutional reforms are a preferred option to moderate HCE growth, improvements in health and population aging – two important factors of HCE – are seldom stimulated by them. Therefore, more attention should be paid to institutional reforms aimed at as well as moderating HCE as improving health. The evidence on these institutional factors, however, is scarce. Some research funding should be devoted to the understanding of institutional determinants within the dynamic relationships between need and supply.

Conclusion

HCE will continue to rise in the coming decades. Age as such is a limited driver of HCE. Notwithstanding, most determinants of HCE are directly or indirectly age-related. The odds are very high that the larger part of the increase in future expenditures will go to the elderly. If increases in HCE reflect an increasing willingness to pay for health, HCE growth in itself would not be a problem. But the large extent to which HCE will be used by the elderly in combination with a financing system that distributes the costs over the entire population can lead to a strain between age groups. Therefore, although put in perspective, the relationship between age and HCE is still of great importance.

B

The Impact of Population Aging on Long-Term Care Expenditures

3 The Role of Disability in Explaining Long-Term Care Utilization

with Xander Koolman, Marc Koopmanschap and Eddy van Doorslaer

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ABSTRACT

In view of aging populations, it is important to improve our understanding of the determination of long-term care (LTC) service use among the middle-aged and elderly population. We examined the likelihood of using two levels of LTC – home care and institutional care – in the Netherlands and focused on the influence of the measured degree of disability.

We pooled two cross-sectional surveys – one that excluded institutionalized and one that was targeted at institutionalized individuals aged 50+. Disability is measured by impairment in daily activities (iADL, ADL) and mobility. Consistency with official Dutch LTC eligibility criteria resulted in the selection of an ordered response model to analyze utilization. We compared a model with separate disability indicators to one with a disability index.

Age and disability, but not general health, proved to be the main determinants of utilization, with the composite index sufficiently representing the disaggregated components. The presence of at least one disability displayed a greater effect on utilization than any additional disabilities. Apart from disability and age, sex, living alone, psychological problems, and hospitalizations showed a significant influence on LTC use. Some determinants affected the likelihood of home care or institutional care use differently.

Even after extensive control for disability, age remains an important driver of LTC use. By contrast, general health status hardly affects LTC use. The model and disability index can be used as a policy tool for simulating LTC needs.

3.1 INTRODUCTION

Long-term care (LTC) expenditures in Organisation for Economic Co-operation and Development (OECD) countries have increased considerably in recent decades (Cotis, 2003). LTC is provided when individuals experience disabilities and/or chronic diseases and is often required until the end of life. Consequently, the majority of LTC is used by the middle-aged and elderly. This is illustrated by the fact that the Dutch 55+ population accounts for 88 percent of total LTC expenditures (CAK, 2005). Given projections that the ratio of people over 65 to those between 20 and 64 in OECD countries will double between now and 2050 (Cotis, 2003), a higher proportion of the population will inevitably be in need for LTC resulting in a strain on public budgets. Appropriate attention must thus be given to LTC utilization by the middle-aged and elderly to guarantee adequate access to LTC of an acceptable quality. Improved understanding of the factors that influence LTC use will be of great importance for obtaining accurate forecasts of future need and for developing policies to alleviate the pressure caused by aging populations on health care budgets.

Recent studies have suggested that, rather than with age itself, health expenditures are associated with proximity-to-death (Payne *et al.*, 2007; Werblow, Felder, and Zweifel, 2007). An exception is LTC utilization, where aging might matter regardless of proximity-to-death (Payne *et al.*, 2007). However, proximity-to-death might serve as a proxy for health and disability, when data on the latter are lacking. While disability forecasts abound (Fries, 1980, 2003; Picavet and Hoeymans, 2002; Perenboom *et al.*, 2004; Spillman, 2004Lafortune *et al.*, 2007), few studies have related disability to institutional LTC and home care simultaneously. We are able to examine both institutional and home care utilization of the Dutch 50+ population concurrently by pooling representative samples of the institutionalized and non-institutionalized. In particular, we aim to identify the set of disability indicators that performs best in explaining home care and institutional care utilization.

Dutch citizens are entitled to publicly financed LTC. Postponing/preventing institutionalization is an explicit goal of Dutch LTC policy. To reach a desired allocation of public resources, an assessment agency has been established to regulate access to public services by performing objective, independent and comprehensive assessments. Guidelines have been developed to structure this process. These guidelines are based on the International Classification of Functioning, Disability and Health (ICF), which is used in many countries. Next to disability and health, eligibility of individuals is subject to their living situation and availability of (in)formal caregivers (van Gameren and Woittiez, 2005; Peeters and Francke, 2007). Public LTC is not entirely free, because income-related copayments are charged. Next to public LTC, citizens can purchase (additional) private LTC. In 2003, 13.5 percent of the LTC users consumed private LTC (Jonker *et al.*, 2007).

Manton *et al.* have investigated the chronic disability trend between 1982 and 2004 in the US elderly population. They found a decline in disability and used the relationship between disability and Medicare service use to estimate future Medicare expenditures (Manton, Gu, and Lamb, 2006; Manton and Lamb, 2007). They find clear evidence of costs rising with disability level and conclude that a continuation of declines in disability rates could be sufficient to keep Medicare financially sustainable.

The majority of previous studies explaining utilization have tended to focus on either home care (Kemper, 1992; Knol, Haken, and Kempen, 2003; van Campen and Woittiez, 2003) or institutional LTC (Dijkstra, 2001; Pot, Deeg, and Knipscheer, 2001). For the Netherlands, three studies have included both types of LTC. Van Campen & van Gameren analyzed the use of care packages which differed by intensity of service (van Campen and van Gameren, 2005). Instead of imposing a hierarchy they estimated a multinomial model in which the independence of irrelevant alternatives (IIA) assumption is crucial. When analyzing LTC services this assumption is probably violated because a particular service cannot be equally substituted by the remaining services as some are obviously closer substitutes than others. Portrait *et al.* and Geerlings *et al.* investigated LTC utilization among the elderly included in the Longitudinal Aging Study Amsterdam (Portrait, Lindeboom, and Deeg, 1999, 2000; Geerlings *et al.*, 2005). Portrait *et al.* assessed the relationship between five health indicators, and utilization. While their purpose is similar, our study focuses more on the relationship between utilization and disability since disability appears to be more important for LTC than health. Geerlings *et al.* studied the determinants of transitions in LTC service use, including (in)formal home care and institutional care. All three studies found that health, disability and age are important predictors of utilization, and of transitions between care types.

This study extends the existing evidence in two respects. First, unlike many previous studies, it models the probability of home care and institutional LTC use jointly. Home care includes publicly or privately financed domestic help, personal care and nursing care provided by (in)formal providers. Institutional LTC is defined as a permanent admission to a residential or nursing home. Traditionally, residential homes provide living assistance only, whereas nursing homes also provide personal care. We aggregated these two types of admissions (1) for improved international comparability, as most countries do not make this distinction, and (2) because both institutions are converging due to recent policies, e.g. patients receive an indication for admission to an institution generally, not specifically to a residential or nursing home. Secondly, an ordered response model (ORM) is used that is in accordance with the eligibility guidelines which assume a hierarchical ordering of LTC services. An ORM is more efficient than a multinomial model, as it assumes a hierarchy in the outcomes (Long, 1997). We adopt a more flexible ORM that allows disability to have a different impact on the use of each service level; a fixed increase in disability status need not increase the odds to require home care or institutional LTC versus no LTC the same way as it increases the odds to require institutional LTC versus no LTC or home care.

3.2 METHODS

Data and sample selection

We pooled data from two cross-sectional surveys: the Facilities Use Survey (FUS) 2003 and the Elderly in Institutions Survey (EIS) 2004 (GfK, 2004, 2005). The FUS is a population survey among private households, whereas the EIS is a survey among the 55+ residents of LTC institutions (Jonker *et al.*, 2007). The questionnaires of both surveys were identical regarding the variables of interest.

For FUS, households were sampled from a national sample of postal addresses. Of the gross sample, 60% of the households participated containing 4982 individuals aged 50+, our target population. Item non-response further reduced the sample to 3362 respondents.

The sample selection of EIS consisted of two stages. First, institutions were selected based on their capacity. Institutions were stratified by type (residential home, psycho geriatric and somatic ward of a nursing home) and district. Second, in all selected institutions a sample of 5-7 permanent residents and two reserve samples were randomly selected. In order to obtain the desired 1.150 participants, respondents who refused participation were replaced by a reserve. A proxy respondent was interviewed when the respondent was not capable to answer the questions. In total, 1158 residents participated in EIS, resulting in 792 complete cases. The pooled study sample therefore comprised 4154 respondents. In 2004, only 2.4% of the Dutch 50+ population lived in an LTC institution, indicating that the institutionalized were substantially oversampled (Statistics Netherlands, 2008).

The sample selection and non-response may cause selection bias. Selection is likely to cause biased estimates when the selection of a respondent is associated with both the dependent variable and the explanatory variables (Hernan, Hernandez-Diaz, and Robins, 2004). In our case, selection is dependent on use by definition since the FUS excluded institutionalized while EIS targeted institutionalized. In addition, item non-response was dependent on respondent characteristics, especially general health. To correct for selection bias, we applied a two-step procedure. First, Horvitz-Thompson (HT) weights were derived to correct for selection caused by item non-response (Horvitz and Thompson, 1952). HT weighting variables were type of LTC and self-assessed health. Secondly, to generalize the results to the Dutch 50+ population, iterative proportional fitting (IPF) was applied to correct the marginal distribution of key variables in our HT-weighted sample to their equivalent distribution in the Dutch 50+ population (Battaglia *et al.*, 2004; Bethlehem, 2008). The IPF weighting variables are age*sex*marital status, type of institution and province. IPF weights were calculated with the SAS raking macro (Izrael, David, and Battaglia, 2004). Final weights were obtained by multiplying the HT and IPF weights.

Variables

Three types of LTC services could be distinguished: informal home care, formal home care and permanently institutionalized. In accordance with the eligibility guidelines, we assumed a hierarchy going from no LTC, to home care to institutional care. According to the eligibility guidelines, health and disability should be the primary determinants of LTC use. We added socio-demographic and socio-economic determinants to evaluate their influence on use. This selection of determinants corresponds to the individual determinants included in the Health Behavior Model (Andersen and Newman, 2005).

Because our focus is on the relationship with disability, we describe its indicators in more detail. The disability indicators used were iADL (Lawton and Brody, 1969), ADL (Katz *et al.*, 1963), mobility, and being hampered in daily activities by chronic conditions, all self-reported. Table 3.1 describes responses by item and answer categories. Only respondents reporting inability to perform an activity independently were considered to be disabled for this activity.

TABLE 3.1 Results polychoric PCA - contribution of individual items to disability score

DISABILITY ITEM	ABLE TO PERFORM WITHOUT DIFFICULTY	ABLE TO PERFORM WITH DIFFICULTY	NOT ABLE TO PERFORM / ONLY WITH HELP
Hampered in daily activities	-0.11	0.16	0.33
iADL			
daily shopping	-0.08	0.28	0.46
preparing hot meals	-0.07	0.25	0.40
cleaning the bed	-0.10	0.23	0.43
doing laundry	-0.08	0.23	0.39
light housework	-0.06	0.32	0.48
heavy housework	-0.15	0.14	0.35
paying bills	-0.06	0.24	0.37
ADL			
getting in / out of bed	-0.06	0.36	0.64
(un)dressing oneself	-0.06	0.36	0.60
washing face and hands	-0.02	0.50	0.66
washing oneself completely	-0.04	0.40	0.56
toileting	-0.03	0.47	0.66
Mobility			
getting up / sitting down	-0.06	0.35	0.64
walking one flight of stairs	-0.09	0.27	0.49
walking 10 min	-0.07	0.30	0.50
leaving / entering house	-0.04	0.41	0.59
moving outdoors	-0.07	0.33	0.54

One important choice was whether to combine the large number of disability indicators into a single composite index. On the one hand, ease of interpretation, parsimony and the intention to simulate future LTC needs favoured the construction of a single index. On the other hand, a higher explanatory power, and a better insight for policy makers and caregivers favoured the use of separate disability indicators. To meet demands for both, we present two models. Our disability index includes all items listed in table 3.1. It was constructed by means of a *polychoric* principal component analysis (PCA), which is more appropriate for ordinal variables by allowing for non-linearity in the scale of the individual items (Kolenikov and Ángeles, 2004). The index was rescaled from 0 (not disabled) to 10 (severely disabled).

Cognitive impairment has been demonstrated to be a main determinant of institutional care (Weaver *et al.*, 2009). Because cognitive functioning is part of mental functioning, it is measured only crudely by the indicator of 'psychological problems'.

Model specification

To exploit the hierarchy in services, an ordered response model (ORM) is used, like the ordered logit or the proportional odds model (Long, 1997). It assumes a continuous latent variable Y^* and a set of threshold values (j) linking the M ordered outcomes to Y^*. The probability that $Y>j$ for individual i can be written as:

$$\Pr(Y_i > j) = \frac{\exp(X_i\beta)}{1 + \exp(X_i\beta)}, \; j = 1,2,\ldots,M\text{-}1$$

Central to the ordered logit model is the *parallel regression assumption* (PRA), which assumes that the coefficients of the explanatory variables are identical across all possible dichotomizations of the outcome variable, i.e. the β's do not vary depending on the thresholds. In practice the PRA is often violated. Ignoring these violations may result in biased estimates and overlooking important differences in the relationship between explanatory variables at different threshold levels. As the PRA is often not violated by all explanatory variables we chose a model which relaxes the PRA only for the explanatory variables that do violate it: *the partial proportional odds (PPO) model* (Williams, 2006).

If, for instance, only one variable, X_3, violates the PRA, then its coefficient is estimated for each threshold, and therefore receives a subscript j. The probability that $Y>j$ for individual i in a PPO model can then be written as:

$$\Pr(Y_i > j) = \frac{\exp(X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_{3j})}{1 + \exp(X_{1i}\beta_1 + X_{2i}\beta_2 + X_{3i}\beta_{3j})}, \; j = 1,2,\ldots,M\text{-}1$$

In our model M=3, resulting in two coefficients to be estimated for each variable that violates the PRA.

3.3 RESULTS

Sample

The selection issue is clear from a comparison of the characteristics of the weighted and unweighted samples in Table 3.2. The unweighted sample overrepresents the institutionalized population, and therefore shows a higher proportion of females and respondents living alone, who were less wealthy, more disabled and use more LTC services. The last three columns of table 3.2 describe the population stratified by LTC service. Of the weighted sample of institutional residents, 78.3% was admitted to a residential home, 10.5% to a somatic ward and 11.3% to a PG ward. Moving from no LTC to home care to institutional care, an increasing proportion of the population is female, living alone, older, has a lower socio-economic status, and reports worse health and disability status.

Disability Index

Table 3.1 displays the latent score coefficients of the PCA. The non-linear increase in the coefficients per item confirms the appropriateness of using a polychoric PCA. The coefficients show an increasing pattern with negative coefficients for 'no disability'. ADL disabilities are generally most severe, followed by mobility and iADL disabilities, with hampered in daily activities being the mildest disability. The average disability score is 2.3, ranging from 1.6 for respondents not using LTC to 6.5 for institutionalized respondents; 48% reported no disability at all.

Determinants of LTC Use

Table 3.3 shows both models for LTC use: model 1 includes the disaggregated disability indicators, model 2 the disability index. For variables violating the PRA, one coefficient for each threshold is estimated.

In both models, only a minority of determinants violate the PRA. The Wald test indicates that the model is not too restricted by assuming that the PRA is not violated by all determinants. The pseudo R^2's are quite high (around 0.50). While including extensive information on disability and health, the age variables still jointly significantly determine use (p=0.000; not in table 3.3). General health, on the other hand, appears to influence use only marginally, once disability is controlled for.

In model 1 all disability indicators show a significant influence on utilization. The presence of iADL, ADL, and/or mobility increases the probability of using a higher level of care. In addition, the number of disabilities also matters as most coefficients of the indicators increase with the number of reported iADL, ADL and mobility problems. However, the effect of a first disability is substantially higher than that of additional disabilities.

As logit coefficients do not allow for a direct interpretation of the size of the effects, we have computed the average partial effects (table 3.4; Wooldridge, 2002). A partial effect

TABLE 3.2 Description of the study sample stratified by LTC utilization

	TOTAL SAMPLE (UNWEIGHTED)	TOTAL SAMPLE (WEIGHTED)	NO LTC (WEIGHTED) N=3.499	HOME CARE (WEIGHTED) N=555	INSTITUTIONAL CARE (WEIGHTED) N=100
Socio-demographics					
Sex (male=1)	43.9%	46.2%	50.0%	25.7%	25.8%
Age	67.1 ± 12.6	64.6 ± 10.8	62.4 ± 9.3	74.7 ± 10.7	85.5 ± 7.0
Household composition					
Living together	70.5%	71.2%	78.4%	32.8%	32.0%
Living alone widowed	19.0%	14.8%	8.5%	48.7%	48.2%
Living alone other reason	10.6%	17.0%	13.1%	18.5%	19.8%
Socio-economics					
At least middle education	34.7%	38.3%	41.6%	21.7%	13.5%
Income per month*	1435 ± 666	1482 ± 702	1532 ± 720	1230 ± 551	1105 ± 269
Health & Sensory problems					
Self-assessed health					
(Very) Poor	4.7%	3.3%	1.7%	11.5%	15.3%
Fair	20.9%	20.0%	15.3%	45.9%	42.8%
Good	49.0%	50.5%	53.0%	36.9%	39.0%
Very good	25.4%	26.1%	30.0%	5.7%	2.9%
Nr of physical chronic diseases	1.7 ± 1.9	1.6 ± 1.9	1.3 ± 1.6	3.0 ± 2.3	3.1 ± 2.2
Psychological problems†	11.8%	8.0%	6.8%	13.3%	24.0%
Hospitalization last year	12.8%	12.3%	9.7%	26.8%	22.0%
Hearing limitation	9.5%	8.0%	7.0%	12.6%	16.8%
Vision limitation	13.9%	9.9%	8.0%	17.7%	31.7%
Disability status					
Hampered in daily activities	38.2%	31.8%	24.5%	68.8%	83.1%
Prevalence iADL disability	24.8%	15.5%	6.1%	62.0%	84.8%
Number of iADL disabilities+	3.9 ± 2.3	2.6 ± 2.0	2.0 ± 1.7	2.5 ± 1.8	4.5 ± 2.0
Prevalence ADL disability	14.3%	3.2%	0.6%	8.9%	62.6%
Number of ADL disabilities+	2.9 ± 1.6	2.2 ± 1.4	1.8 ± 1.1	2.0 ± 1.2	2.6 ± 1.6
Prevalence mobility disability	18.9%	7.3%	2.1%	27.7%	78.1%
Number of mobility disabilities+	3.1 ± 1.5	2.3 ± 1.3	1.8 ± 0.9	2.1 ± 1.1	3.1 ± 1.4
Disability Index > 0	56.4%	51.8%	43.7%	94.2%	99.8%
Disability Index Score	3.6 ± 0.1	2.3 ± 2.3	1.6 ± 1.7	3.7 ± 2.5	6.5 ± 2.6

* Net equivalent household income per month (equivalence factor: √household members)

† Indicator variable: (1) if respondent has psychological chronic condition, is a resident of PG ward nursing home, or has contacted mental health care institution in last year

\+ Conditional on prevalence

TABLE 3.3 Models LTC with disaggregated disability indicators (model 1) and disability index (model 2)

	MODEL 1		MODEL 2	
	THRESHOLD 1 NO LTC VS HC/IC	THRESHOLD 2 NO LTC/HC VS IC	THRESHOLD 1 NO LTC VS HC/IC	THRESHOLD 2 NO LTC/HC VS IC
	β (Z-VALUE)	β (Z-VALUE)	β (Z-VALUE)	β (Z-VALUE)
Socio-demographics				
Sex (male=1)	-2.060 (-1.92)		-2.658* (-2.48)	
Age	-0.123 (-1.23)	-0.056 (-0.50)	-0.111 (-1.14)	-0.024 (-0.23)
Age²	0.001 (1.92)		0.001 (1.75)	
Age * Sex	0.023 (1.57)		0.030* (2.05)	
Household composition				
Living alone widowed	1.825*** (8.76)	-0.269 (-1.00)	1.881*** (9.25)	-0.206 (-0.80)
Living alone other reason	1.421*** (6.72)		1.383*** (6.59)	
Socio-economics				
At least middle education	-0.456* (-2.29)		-0.262 (-1.40)	
Income per month (x €1000)	-0.028 (-0.20)		0.010 (0.08)	
Health & Sensory problems				
Self-assessed health				
(Very) Poor	-0.034 (-0.08)		-0.066 (-0.16)	
Fair	0.736* (2.36)	0.127 (0.35)	0.497 (1.68)	
Good	0.290 (1.16)		0.132 (0.52)	
Nr of physical chronic diseases	0.036 (0.86)		0.052 (1.28)	
Psychological problems	0.793*** (3.47)		0.711** (3.22)	
Hospitalization	0.821*** (3.74)	-0.057 (-0.16)	0.871*** (3.93)	0.199 (0.65)
Hearing limitation	-1.243*** (-4.17)		-1.107*** (-4.06)	
Vision limitation	-0.301 (-1.40)		-0.433* (-2.07)	
Disability status				
Hampered in daily activities	1.017*** (5.29)			
1 iADL problem	1.731*** (8.02)	0.680 (1.92)		
2 – 3 iADL problems	1.842*** (6.72)			
4 – 7 iADL problems	1.721*** (4.86)			
1 ADL problem	1.188* (2.51)			
2 – 3 ADL problems	0.967* (2.12)			
4 – 5 ADL problems	2.210** (3.05)			
1 Mobility problem	0.690* (2.41)			
2 – 3 Mobility problems	0.803* (2.22)			
4 – 5 Mobility problems	1.538* (2.47)			
Prevalence disability			1.210*** (4.37)	
Disability Index Score			0.459*** (11.03)	
Constant	-2.032 (-0.59)	-9.796* (-2.22)	-2.693 (-0.80)	-12.159** (-2.82)
N	4154		4154	
Mc Fadden's Pseudo R²	0.51		0.49	
Log pseudolikelihood	-1027		-1075	
Wald test for (p-value)	0.29		0.07	

*p<0.05; ** p<0.01; *** p<0.001; Weighted estimates

TABLE 3.4 Average partial effects per LTC service estimated by model 1 & model 2

AVERAGE PARTIAL EFFECTS	MODEL 1 AGGREGATED DISABILITY MEASURES			MODEL 2 DISABILITY INDEX		
	NO LTC	HOME CARE	INSTITUTIONAL CARE	NO LTC	HOME CARE	INSTITUTIONAL CARE
Socio-demographics						
Sex (male=1)	0.025	-0.023	-0.002	0.033	-0.031	-0.002
Age (females)	-0.005	0.003	0.002	-0.004	0.002	0.003
Age (males)	-0.005	0.003	0.002	-0.005	0.003	0.003
Household composition						
Living alone widowed	-0.133	0.136	-0.003	-0.146	0.149	-0.003
Living alone other reason	-0.095	0.072	0.023	-0.098	0.073	0.025
Socio-economics						
At least middle education	0.027	-0.022	-0.005	0.017	-0.013	-0.004
Income per month (per €1000)	-0.002	0.001	0.000	-0.001	0.001	0.000
Health & Sensory problems						
Self-assessed health						
(Very) Poor	0.002	-0.002	-0.000	0.004	-0.003	-0.001
Fair	-0.046	0.044	0.001	-0.032	0.025	0.007
Good	-0.017	0.013	0.004	-0.008	0.006	0.002
Nr of physical chronic diseases	-0.002	0.002	0.000	-0.003	0.003	0.000
Psychological problems	-0.054	0.042	0.011	-0.046	0.036	0.010
Hospitalization	-0.055	0.056	-0.000	-0.056	0.053	0.003
Hearing limitation	0.063	-0.050	-0.013	0.072	-0.055	-0.016
Vision limitation	0.017	-0.014	-0.004	0.028	-0.022	-0.006
Disability status						
Hampered in daily activities	-0.067	0.056	0.012			
1 iADL problem	-0.147	0.141	0.006			
2 – 3 iADL problems	-0.160	0.135	0.025			
4 – 7 iADL problems	-0.146	0.124	0.022			
1 ADL problem	-0.089	0.070	0.019			
2 – 3 ADL problems	-0.070	0.056	0.014			
4 – 5 ADL problems	-0.194	0.149	0.045			
1 Mobility problem	-0.048	0.039	0.008			
2 – 3 Mobility problems	-0.057	0.047	0.011			
4 – 5 Mobility problems	-0.123	0.098	0.025			
Prevalence disability				-0.078	0.061	0.018
Disability Score (0 – 10)				-0.029	0.023	0.006

Partial effect continuous variables: the effect of one unit change of the explanatory variable on the probability to use each type of LTC.
Partial effect discrete and indicator variables: the effect of a change from 0 to 1 on the probability to use each type of LTC. For indicator variables: partial effect with respect to the reference category

is the change in the predicted probability by a one unit change in the explanatory variable. It depends on both the coefficient and the threshold estimates, and was evaluated for each individual and then averaged across the weighted sample distribution. Respondents hampered in daily activities have a 6.7% higher probability of using LTC than respondents not hampered in daily activities, ceteris paribus. Furthermore, respondents who reported one iADL, ADL or mobility problem had on average a 14.1%, 7.0% and 3.9% higher probability of using home care, respectively and a 0.0%, 1.9% and 0.1% higher probability of being institutionalized, than someone who did not report these disabilities. To illustrate the effect of additional disabilities: respondents who reported one, two to three or more mobility problems had respectively a 4.8%, 5.7% and 12.3% higher probability to use LTC than those not reporting mobility problems. The partial effects for institutional care are substantially lower because the additional 'need' required for home care is much smaller than that required for using institutional rather than home care.

Concerning general health, respondents with psychological problems had a significantly higher probability of using more intensive services. A hospitalization is associated with a 5.6% higher probability of using home care but not with institutionalization. Interestingly, respondents with hearing problems had a significantly lower probability of using more intensive services.

Regarding socio-demographics, the partial effect for home care (institutional care) of a one year increase in age is 0.3% (0.2%) for both males and females. Widow(er)s living alone had a 13.6% higher probability of home care but no higher probability of being institutionalized. Other respondents living alone had a 7.2% (2.3%) higher probability on using home care (institutional care). More education resulted in a 2.2% (0.5%) lower probability of using home care (institutional care).

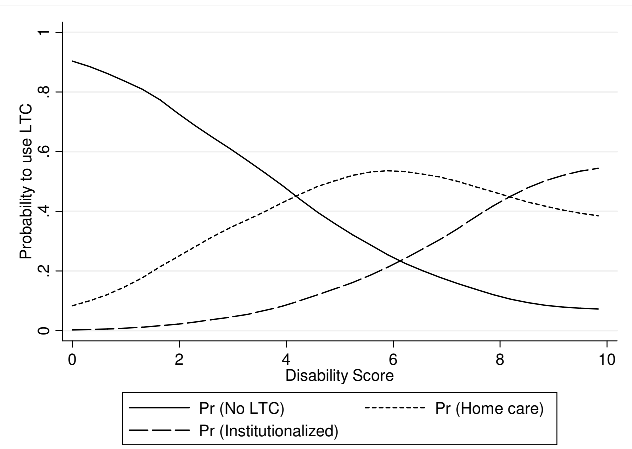

FIGURE 3.1 Relationship between disability index and use stratified by type of LTC

In model 2, almost the same determinants influence utilization. Variables violating the PRA are identical and the partial effects are similar. Unsurprisingly, the disability index has a very large and significant influence on utilization. Respondents with at least one disability had a 6.1% (1.8%) higher probability of using home care (institutional care). Additionally, those with a one point higher disability score had a 2.3% (0.6%) higher probability on using home care (institutional care). Figure 3.1 presents the probability of use as a function of disability, holding everything else constant. The probability of no use decreases fairly linearly with level of disability while the probability of using institutional LTC increases. With an increasing disability score the likelihood of using home care first increases, then decreases. At the maximum, respondents with a disability score of 6 have a 60% chance of using home care. For the more disabled, the probability to use home care decreases, instead their probability to be institutionalized increases. Respondents with a disability score higher than 8.5 are more likely to be institutionalized than to use home care. To illustrate this level of disability: an individual with a disability score of 8.5 is hampered in daily activities, disabled in all iADL activities, and disabled in 4 out of 10 ADL/mobility activities.

3.4 DISCUSSION

We have examined the determinants of LTC utilization among the Dutch middle-aged and elderly population. Our approach goes beyond earlier efforts in a number of respects. First, we were able to pool two data sets – one of independently living and one of institutionalized individuals – with identical questions for the variables of interest, resulting in a data set including institutional care and home care use as well as extensive disability information. Secondly, we use a *partial* proportional odds model to quantify the influence of the determinants of two levels of LTC use, thereby exploiting the underlying hierarchy of services. The crucial assumption of a hierarchy in service use is in accordance with Dutch LTC policy and the eligibility guidelines. Third, we scrutinised a range of disability indicators, optimized the mix of disability indicators for explaining utilization, and compared this to a model using a single disability index. Finally, we selected the most appropriate model among the ordered models, as only a few of the explanatory variables violated the PRA.

Our findings are as follows. First, even after controlling extensively for disability, age remains an important driver of LTC use. Second, next to age, self-reported disability is the other important determinant of LTC use. The more parsimonious model using the single composite index was only marginally less powerful in explaining LTC use, indicating that the disability index sufficiently captures the disaggregated components. Third, both the prevalence and additional disabilities were found to influence utilization, but the presence of at least one disability displays a greater effect than any additional disabilities. Fourth, and not unexpectedly, the average level of disability required to move into home care is considerably lower than the average level required to move from home care to an institution. Finally, after appropriate control for disability, general health hardly affected LTC use.

Recent studies found that the effect of age on LTC utilization decreases considerably – but does not vanish completely – when accounting for proximity-to-death, which presumably acts as a proxy for morbidity/disability (Payne *et al.*, 2007;Weaver *et al.*, 2009;Werblow, Felder, and Zweifel, 2007). In our study, age also remains one of the main drivers of LTC utilization, even after extensively controlling for disability and health. Consequently, as other studies have claimed before, we anticipate that LTC needs of aging populations will keep increasing regardless of trends in disability by age. However, because we found that disability is also an important driver of LTC use in its own right, it still provides an opportunity for policymakers since disability trends can be influenced.

The model and disability index can be useful for a number of purposes under the assumption that the causal relationships correspond with the estimated associations. First, by exploiting the hierarchy in LTC, our model provides a more informative forecast of future LTC needs based on scenario's for developments in demography and disability. When doing so, it is important to bear in mind that not only individual determinants, but also health care organizational features (e.g. the eligibility criteria, informal care availability, and waiting lists) co-determine utilization (Andersen and Newman, 2005). Nonetheless, when reliable forecasts of disability rates are available, models such as ours can prove useful for forecasting LTC needs.

In interpreting the results of this study, the limitations of the data are to be born in mind. The use of cross-sectional data variation does not allow to interpret the partial effects of the determinants as causal effects.

While our findings clearly and to a considerable extent reflect the eligibility criteria used by the assessment agency, the models do not merely replicate the rules. First, they are guidelines which still leave room for discretionary decision making. For example, they allow the agency's decision makers to apply a personal set of weights to all criteria, and they allow personal judgment to influence the categorization of dysfunction. Second, part of the decision power remains with the individual, e.g. the decision to contact the agency and to consume LTC care not indicated by the agency, thereby leaving room for care preferences on the demand side. We believe that the independent needs assessment and the use of eligibility guidelines has made LTC use in the Netherlands relatively insensitive to provider incentives and patient incomes. As a result, the allocation of LTC services appears to occur largely according to need. This is an important result also for other countries facing rising LTC service needs resulting in demand exceeding supply. Clearly, the finding that low income does not appear to be a barrier to utilization is likely to be related to the universal coverage of LTC use in the Netherlands and this might not necessarily hold for countries without such extensive coverage.

Recognizing that disability proves to be a key determinant of LTC use in the Netherlands, policies which aim to achieve a compression of the burden of disability would contribute to the alleviation of the societal consequences of population aging.

Determinants of Long-Term Care Spending: Age, Time-to-death or Disability?

4

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ABSTRACT

In view of population aging, better understanding of what drives long-term care expenditure (LTCE) is warranted. Time-to-death (TTD) has commonly been used to project LTCE because it was a better predictor than age. We reconsider the roles of age and TTD by controlling for disability and co-residence and illustrate their relevance for projecting LTCE.

We analyze spending on institutional and home care for the entire Dutch 55+ population, conditioning on age, sex, TTD, cause-of-death and co-residence. We further examined home care expenditures for a sample of non-institutionalized conditioning additionally on disability.

Those living alone or deceased from diabetes, mental illness, stroke, respiratory or digestive disease have higher LTCE, while a cancer death is associated with lower expenditures. TTD no longer determines home care expenditures when disability is controlled for. This suggests that TTD largely approximates disability. Nonetheless, further standardization of disability measurement is required before disability could replace TTD in LTCE projections models.

4.1 INTRODUCTION

Long-term care (LTC) is provided when individuals experience disability and/or chronic disease and is often required from the onset of such conditions for the remaining lifetime. Consequently, the great majority of LTC is used by the middle-aged and elderly. In 2005, the Dutch 55+ population accounted for 88 percent of public LTC expenditures (LTCE) on home care and institutional LTC. Given the rapid rise in the proportion of elderly and their high LTC use rates, population aging is expected to accelerate LTCE growth in developed countries in the next decades. Considering this increased pressure on the LTC sector, improved understanding of the factors that determine LTC use and expenditure is of utmost importance to enable more accurate projections of the need for such services, and to develop adequate policies to alleviate the pressure that population aging places on healthcare budgets.

Given that both acute and LTC expenditures rise with age, no controversy exists that the expected growth in healthcare expenditures (HCE) can to some extent be attributed to population aging (Pezzin, Kemper, and Reschovsky, 1996; Yang, Norton, and Stearns, 2003; Comas-Herrera *et al.*, 2007). But because the most rapid growth in elderly cohorts has still to occur, it is of interest to identify the relative contribution of population aging. The literature on this subject seems to have concluded that the proclaimed effect of age on HCE is a 'red herring' – i.e. a distraction away from the 'true driver' of HCE: time-to-death (TTD; see Payne *et al.* 2007 for a review). A consensus has emerged that TTD and not age determines expenditures on *acute* care, whereas both determine *LTCE* (Yang, Norton, and Stearns, 2003; Comas-Herrera *et al.*, 2007; Werblow, Felder, and Zweifel, 2007). The inclusion of TTD is therefore advocated in models used to explain and project acute and LTC expenditures.

This study reconsiders the role of TTD in LTCE models. First, while inclusion of TTD in LTCE models usually raises explanatory power, TTD models still do not adequately represent the actual causes of spending. It is not TTD itself but the degree of disability experienced in the period before death which drives the demand for LTC. This suggests that TTD itself is also a 'red herring' if it merely acts as a proxy for disability. Second, the contribution of aging to future growth in LTCE largely depends on the trend in the period lived with disability, i.e. whether a compression, expansion or postponement of disability prevails (Fries, 1980; Payne *et al.*, 2007).[1] While some of the recent evidence supports a compression of disability, in the sense of a compression of the number of absolute years lived with disability (Manton, Gu, and Lamb, 2006; Payne *et al.*, 2007), TTD models implicitly assume a postponement of the absolute years of life lived with disability. They assume that longevity

1 This paper concentrates on trends in disability instead of morbidity because that is the main driver of LTC use (de Meijer *et al.*, 2009), while morbidity explains especially acute care expenditures.

gains merely shift the period lived with disability to higher ages, while its duration remains constant. Relying on TTD models to project LTCE may then lead to biased projections because the relationship between TTD and disability is dynamic, rather than constant. Third, many studies have failed to correct for the endogeneity of TTD which is partly caused by omitting disability (e.g. Zweifel, Felder, and Werblow, 2004; Felder, Werblow, and Zweifel, 2010). Accounting for disability therefore mitigates this endogeneity bias. Clearly, previous studies have included TTD because disability data were lacking. Given improved data availability, we are able to reconsider the roles of both TTD and age in generating LTCE.

Our main objective is to further clarify to what extent aging increases LTCE by disentangling the roles of age, TTD and disability in explaining LTCE. Our approach goes beyond earlier efforts in a number of respects. First, access to population data on public LTC enables us to examine the determinants of LTCE for the *entire* Dutch 55+ population. We separately model total LTCE, institutional and home care expenditures. Second, next to the determinants usually included in expenditure models, our data allow us to examine the influence of cause-of-death (COD) and co-residence status on LTCE. COD information makes it possible to investigate the role of TTD by disease group which is likely to differ as the disabling impact and duration of diseases greatly varies. Considering future trends in epidemiology, this addition will allow for better projections of LTCE. Co-residence status, like TTD, is associated with age and LTCE. Its inclusion is important because it is a proxy for another important determinant: informal care availability (Sundström, 1992). Informal care potentially substitutes for home care and generally postpones LTC admissions (van Houtven and Norton, 2004; Bonsang, 2009). Third, for a representative sample of the non-institutionalized Dutch population, we can take the analysis of home care expenditures one step further and condition also on morbidity and disability. Our analysis sheds new light on the consequences of population aging for LTCE through a re-examination of the relative roles of age and TTD. Although age and TTD are often found to be key predictors of LTCE, neither of them are causes of LTCE in and of themselves, but merely act as proxies for disability. They may even become redundant in explaining LTCE after appropriate control for disability. Finally, LTCE projections based on trends in demographics, co-residence and disability illustrate the usefulness of our models, in particular, by demonstrating the bias introduced when using TTD to approximate disability.

4.2 DEMAND FOR PUBLIC LTC IN THE NETHERLANDS

In this chapter, LTC services include all *publicly* financed institutional LTC or formal home care, except home care financed by a personal care budget (PCB). With a PCB a patient receives a cash benefit to purchase LTC services directly instead of receiving these services as benefits-in-kind – i.e. when the insurer is responsible for the delivery of LTC by the provider of the patient's choice. *Institutional LTC* includes both temporary and permanent admissions to residential and nursing homes. Residential homes merely provide assistance with domestic tasks, whereas nursing homes also provide personal and nursing care. Institutional LTC accounts for 70% of total LTC spending. *Formal home care* services include domestic care, personal care and nursing care. Consequently, the following LTC services are not considered: privately financed LTC, publicly financed home care by a PCB and informal LTC. Informal care *availability* is approximated by co-residence status. Overall, our analysis includes the bulk of public LTC expenditure.[2]

All Dutch citizens are entitled to public LTC currently covered under the *Exceptional Medical Expenses Act* and the *Social Support Act*.[3] Public resources are allocated by an agency that regulates access to public LTC by performing objective, independent and comprehensive assessments. Guidelines – based on the International Classification of Functioning, Disability and Health (World Health Organisation, 2001) – have been developed to structure this process. Next to functioning, disability and health, the guidelines take into account the living situation and informal care availability (van Gameren and Woittiez, 2005; Peeters and Francke, 2007). Public LTC is not entirely free of charge; an income-related copayment is charged. Note that the institutional alternatives – nursing and residential homes – are mutually exclusive while the different home care services are not and the decision to use either one or a combination of different home care services is determined simultaneously (van Houtven and Norton, 2004). Once considered eligible, individuals choose whether to receive this as a benefit-in-kind or as a PCB. Recall that we are only modeling the former services.

4.3 DATA AND METHODS

We first analyze total LTC, institutional LTC and home care expenditures for the entire Dutch 55+ population, conditional on age, sex, TTD, COD, and co-residence.[4] Next, we examine home care expenditures for a random sample of the non-institutionalized 55+ population, conditioning additionally on morbidity and disability information. In the remainder of this chapter we will refer to these distinct models as the 'population model' and the 'extended home care model'.

2 PCB-financed LTCE account for 5-10% of public home care expenditures (Ministry of Health Welfare and Sports, 2006). Institutional LTC is hardly ever paid out of pocket in the Netherlands, privately financed LTC therefore only constitutes a relevant alternative for home care; 1.4% of the 30+ population and 13.5% of the LTC users consumed private home care in 2003 (Jonker *et al.*, 2007).

3 The Social Support Act is implemented in 2007; coverage of domestic care and domestic help has shifted from the Exceptional Medical Expenses Act to the Social Support Act and access to these services is currently regulated by local governments.

4 We restrict our attention to this sub-population, as these are the ones who need LTC. As noted above, in 2005, the 55+ population account for 88 percent of the LTCE in The Netherlands.

Data

Population model

Three data sources linked at the individual level are used: the Registration of the Administrative Office Exceptional Medical Expenses 2004, the Death Causes Registration 2004-2007 and the Municipality Register 1998-2006. These three national registrations register (a) the use and amount of public LTC, (b) TTD and COD, and (c) several household and individual characteristics, respectively. COD is classified according to the International Classification of Diseases (ICD-10). All citizens aged 55 to 90 in 2004 with complete information on co-residence status are selected. This excludes less than 0.5%, mainly those who had moved into an institution before 1998.[5]

Extended home care model

The *General Survey of Living Conditions* (POLS), which includes a detailed Health Survey, is also linked to the datasets described above. POLS is an annual cross-sectional survey among a random sample of the non-institutionalized population. We included all individuals participating in the Health Surveys of 2004 and 2005. POLS respondents were sampled in two stages. First, municipalities were randomly sampled, with the selection probability weighted according to their population size. Second, individuals were randomly selected from the sampled municipalities. Of these sampled individuals, 63% agreed to participate in the original Health Survey of which 5534 individuals were aged 55+. Item non-response reduced the sample to 4176. We refer to this sample as the Health Survey sample.

Due to item and unit non-response the Health Survey sample was on average younger and further away from death than the Dutch independently living 55+ population. We reweighted the Health Survey sample. Weights were derived to correct the joint distribution of the weighting variables in the Health Survey sample to the distribution of the Dutch independently living 55+ population (Horvitz and Thompson, 1952). Weighting variables were age, sex, co-residence and TTD. These weights were used in all analyses presented.

Dependent variables

We transform administrative data on annual expenditures on total LTC, institutional LTC and home care into average monthly expenditures.[6] This approach enables the inclusion of those deceased during the measurement year[7], while correcting for the fact that expenditures of these decedents are observed for less than an entire year. Average monthly expenditures

5 The excluded observations were on average older, more often female and closer to death. Because this selective drop-out comprises less than 0.5% of the population, it is unlikely to have affected our results.

6 Similarly to O'Neill *et al.* (2000) in an analysis of GP care costs in England.

7 The measurement year of expenditure is 2004 for the population models and 2004 or 2005 in the extended home care model as this pools those cross-sections of the Health Survey.

for those who survived the measurement year are computed by dividing annual expenditures by 12. For those who died during the measurement year, yearly expenditures are divided by the days alive in the measurement year and multiplied by 366/12 to approximate average monthly expenditures.[8]

Total LTCE consist of the sum of institutional LTC and home care expenditures. Prices of admission days in a residential and nursing home were taken from Oostenbrink *et al.* (2004). Three different types of nursing home wards could be distinguished: somatic, psycho-geriatric and mixed wards. All three types of nursing home admissions are substantially more expensive than a residential home admission. We used recent approximations of the amount of use of somatic, psycho-geriatric and mixed wards and their relative price differences to estimate separate service prices for these three different types of nursing home use. Concerning home care, maximum hour tariffs per home care service for 2004 were used as unit prices to compute home care expenditures. These tariffs are set by the Dutch Care Authority and are commonly employed by home care providers to set their prices.

Selection of determinants

The Dutch institutional context and findings of previous studies determined our selection of covariates. TTD is measured by an indicator of survival status, i.e. whether the individual is alive 3 years after the measurement year, and a continuous variable measuring TTD in months from 1 January of the measurement year (censored at 48 for survivors) and its square. Given the eligibility guidelines used by the needs assessment agency, informal care availability, morbidity and disability are expected to be strongly associated with use. Informal care availability is proxied by co-residence status, measured at 1 January of the measurement year for non-institutionalized individuals and at the month preceding institutionalization for institutionalized individuals. As previous studies reported evidence of interactions between age, sex and TTD and TTD and co-residence (Seshamani and Gray, 2004c; Werblow, Felder, and Zweifel, 2007; Weaver *et al.*, 2009), we also included these interactions. We further included interactions between co-residence and age/sex. Informal care availability might differentially affect LTCE for males and females due to differences in opportunity costs and ability to provide adequate care. Furthermore, the effect of co-residence may decline with age as elderly become less able to provide adequate care. COD is the only morbidity proxy available for the population models. Although its effect on LTCE has not been investigated, COD is proved to significantly influence hospital expenditures (Seshamani and Gray, 2004c). We categorize COD based on prevalence: cancer, diabetes, mental disease (95% Alzheimer's disease), cardiovascular disease (CVD), respiratory diseases, digestive diseases, and other.

8 This approach yields an overestimation of average monthly expenditures for decedents in 2004 that used LTC because the effect of TTD on expenditures is not linear. We prefer this limitation to not being able to include decedents of 2004. We checked robustness and models using as dependent variable the expenditures incurred during the full year of 2004 (excluding decedents in 2004) returned very similar estimated effects of covariates.

CVD is divided further into cerebrovascular accident (CVA) and other CVD because CVA is associated with a higher burden of disability. The reference category is an external cause of mortality, mainly traffic and work-related accidents. Interactions between COD and TTD are included to account for the differential impact of TTD by disease category. This interaction also approximates the effect of the severity/stage of the disease on LTCE.

A much broader range of morbidity and disability indicators is available for the Health Survey sample. We included the following morbidity indicators: self-reported health, mental health, having a chronic condition, and hospitalized in the preceding 5 years. Disability is measured by activities of daily living (ADL; Katz *et al.*, 1963), mobility, and limitations in daily activities by chronic conditions. Education and equivalent household income are included as measures of socio-economic status because income-related copayments for public LTC push some higher income users into private LTC. Because of smaller sample size, we did not include COD. All covariates apart from TTD, age, sex, co-residence and income were self-reported. For a more detailed description of the covariates, see appendix 4.1.

Model specification

We use a two-part model – which is commonly selected to analyze HCE (Jones, 2000) – to model average monthly LTCE as a function of personal characteristics. This model accounts for the high proportion of non-users (84%) by separately analyzing the decision to use LTC (I) and the level of expenditures conditional on having any (II).[9] Part I is a probit that models the probability of using LTC:

$$\Pr\,(LTCE_{ij} > 0 \mid X_i) = \Phi\,(\beta_{1j} X_i)$$

for individual i and type of LTC j, with j=1 (total LTC, population), 2 (institutional LTC, population), 3 (home care, population), 4 (home care, Health Survey sample). Φ represents the cumulative standard normal distribution, β_1 a vector of parameters to be estimated and X_i a vector of covariates. Part II models the level of expenditures conditional on having any. We followed the procedure proposed by Manning and Mullahy (2001) to select the most appropriate model for part II. We detected heteroskedasticity and skewness in the residuals from ordinary least squares (OLS) models on the logarithm of expenditures in all cases. Hence, log OLS models with a homoskedastic smearing factor to retransform logged expenditures back to its raw scale would lead to biased predictions of means and partial effects. Alternatives are to use heteroskedastic smearing factors, or to use generalized linear models (GLM) that avoid the retransformation problem altogether. We used Box-Cox tests and Modified Park tests to select, respectively, the link function and the family of GLM that best suited our data. The preferred GLM specification was one with power link and

9 See Jones (2000) for a more complete discussion of the relative merits of the two-part model.

gamma family, for all types of expenditures. This specification outperformed OLS as well as log OLS with heteroskedastic retransformation according to mean-squared errors and modified Hosmer-Lemeshow statistics. The preferred GLM model specifies the conditional mean expenditures as:

$$E\,(LTCE_{ij} \mid LTCE_{ij} > 0, X_i) = \sqrt[\lambda]{\beta_{2j} X_i + 1},$$

where β_2 is a vector of parameters to be estimated, and λ the Box-Cox transformation parameter. The conditional variance as a function of the mean is specified as:

$$V\,(LTCE_{ij} \mid LTCE_{ij} > 0, X_i) = \mathrm{E}(LTCE_{ij} \mid LTCE_{ij} > 0, X_i)^2,$$

i.e. the standard deviation is proportional to the mean.[10] The expected value of expenditures combines parts I and II in the following way:

$$E\,(LTCE_{ij} \mid X_i) = \Phi\,(\beta 1_j, X_i) *= \sqrt[\lambda]{\beta_{2j} X_i + 1},$$

where Φ() is the probability given by part I and the last term is the expected level of expenditures estimated by part II. We included the same covariates in part I and part II of the model.

Endogeneity

TTD and co-residence status may be endogenous to the level of LTCE. Endogeneity may arise in the case of co-residing with an adult child (Weaver *et al.*, 2009). The decision to co-reside and to use LTC is a simultaneous one when adult children move in with a parent who experiences increasing disability to provide informal care. Moreover, unobserved heterogeneity may influence both living and care situations. Unfortunately, we could not test for the endogeneity of co-residence status because our data lacks appropriate instruments. Due to failure to correct for the possible endogeneity of co-residence, this study may have underestimated its effect on the level of LTCE, as found by Weaver *et al.* (2009). However, we believe that endogeneity of co-residing is limited in our case because in the Netherlands adult children very rarely move back in with their parents.[11]

Concerning potential endogeneity of TTD, many previous studies have attempted to deal with it (e.g. Stearns and Norton, 2004; Zweifel, Felder, and Werblow, 2004; Weaver *et al.*, 2009; Felder, Werblow, and Zweifel, 2010). The majority of studies, however, focused

10 We also considered an extended estimating equations model (Basu and Rathouz, 2005), which estimates the link and variance power function simultaneously. This model gave similar results to the chosen GLM specification.

11 Among a panel of 55+ sickness-fund insured 1998-2007, of those co-residing with an adult child at t1 only 0.12% of these adult children did not live with a child at t0.

on the possibility of TTD being endogenous to *acute* or *total* HCE as the amount of care consumed is found to increase longevity (Becker, Philipson, and Soares, 2005; Hall and Jones, 2007). None of these studies were able to appropriately solve the endogeneity of TTD because valid instruments were lacking. Studies that partly corrected for endogeneity bias concluded that the effect of TTD on the level of HCE is underestimated in the presence of endogeneity (Stearns and Norton, 2004; Weaver *et al.*, 2009; Felder, Werblow, and Zweifel, 2010). In the specific case of LTCE, however, the endogeneity problem is probably more limited. Evidence for LTC to extend longevity is much rarer than for acute care because the majority of LTC services assist individuals with daily activities instead of treating their medical conditions. Moreover, instead of extending life, it could also be argued that LTC use shortens life because institutionalization decreases the motivation to live. Finally, endogeneity of both TTD and co-residing is mitigated in the extended home care model because of reduced unobserved heterogeneity.

4.4 RESULTS

Descriptive statistics

The first 3 columns of table 4.1 present summary statistics for the Dutch 55+ population, and for the subpopulations of institutional and home care users. Of the population, 15.7% used LTC; 4.5% used institutional LTC and 12.7% used home care. Expected average monthly LTCE in 2004 were €207; €149 on institutional and €59 on home care. 10.7% died in 2004-2007. Home care users and – to a greater extent – institutional LTC users are older, more often female, living alone and closer to death than non-users. A large proportion of cancer deaths exists among non-users and home care users, while deaths due to mental illnesses and CVA are more prevalent among the institutionalized.

The last two columns of table 4.1 describe the Health Survey sample. Users' average monthly home care expenditures amounted to €350. Compared to the entire Health Survey sample, users are older, more often female, living alone, closer to death, have a lower socio-economic status, and report worse morbidity and disability status.

Results for population models

Appendix 4.2 presents full estimates for the population models. The majority of determinants and interactions have significant coefficients on both the probability of use and the conditional level of LTC, institutional care and home care expenditures. Interpretation of the probit and GLM coefficients is complicated by the nonlinearity of the models and the presence of interaction terms (Ai and Norton, 2003). We, therefore, interpret the effect of covariates by means of their average partial effects (APE; table 4.2; Wooldridge, 2002), defined as the average change in the predicted probability or conditional level of expenditures resulting

TABLE 4.1 Description of population and health survey sample

	DUTCH 55+ POPULATION (N=4032772)	INSTITUTIONAL USERS 55+ POPULATION (N=182988)	HOME CARE USERS 55+ POPULATION (N=512055)	HEALTH SURVEY SAMPLE (N=4176; WEIGHTED)	USERS HEALTH SURVEY SAMPLE (N=396; WEIGHTED)
LTC Consumption					
LTC use (%)	15.7	100.0	100.0	11.7	100.0
Average monthly LTC expenditures	207 ±[1] 974	3458 ± 2423	691 ± 1504	50 ± 285	427 ± 735
Institutional use (%)	4.5	100.0	12.0	0.8	6.8
Average monthly institutional LTCE	149 ± 859	3280 ± 2449	230 ± 927	10 ± 162	77 ± 467
Home care use (%)	12.7	33.4	100.0	11.7	100.0
Average monthly home care expenditures	59 ± 448	178 ± 641	461 ± 1180	41 ± 206	350 ± 510
Socio-demographics					
Age	67.1 ± 9.1	80.3 ± 7.1	76.1 ± 8.3	66.6 ± 8.9	76.2 ± 8.4
Male (%)	46.2	29.5	27.4	46.6	25.4
Alive (%)	89.3	42.3	69.3	90.3	72.3
TTD in months if deceased	24.1± 13.9	20.3 ± 13.5	22.2 ± 13.8	25.9 ± 11.0	23.7 ± 11.1
Living alone (%)	26.7	61.7	59.9	25.7	61.5
Socio-economics					
Education (%)					
Low				43.0	59.3
Middle	-	-		37.6	31.5
High				19.4	9.2
Income	-	-		22322 ± 24448	20933 ± 63020
Health					
Cause-of-death if deceased (%)					
External cause-of-death	2.6	2.2	2.3		
Cancer	31.2	14.3	31.5		
Diabetes	2.8	3.6	3.2		
Mental (95% dementia)	4.6	12.4	3.8		

TABLE 4.1 Description of population and health survey sample (table continued)

	DUTCH 55+ POPULATION (N=4032772)	INSTITUTIONAL USERS 55+ POPULATION (N=182988)	HOME CARE USERS 55+ POPULATION (N=512055)	HEALTH SURVEY SAMPLE (N=4176; WEIGHTED)	USERS HEALTH SURVEY SAMPLE (N=396; WEIGHTED)
CVD exclusive CVA	25.1	21.2	24.0		
CVA	7.8	11.4	7.7		
Respiratory disease	10.5	14.4	12.0		
Digestive system	4.0	4.2	4.1		
Other	11.5	16.8	12.5		
Self-reported health (%)					
(very) Good				62.4	29.6
Fair	-	-		30.0	51.2
(very) Poor				7.6	19.2
Chronic condition (%)	-	-		51.4	78.6
Hospitalization (%)	-	-		55.0	81.5
Mental Health Score	-	-		78.7 ± 16.0	71.6 ± 19.7
Disability					
Limited in daily activities conditional on having a chronic condition (%)					
Not limited				60.9	28.0
Mildly limited	-	-		17.1	17.7
Severely limited				22.0	54.3
ADL disability (%)					
Not disabled				79.8	42.9
Mildly disabled	-	-		14.9	30.5
Moderately disabled				3.1	13.0
Severely disabled				2.2	13.6
Mobility disability (%)					
Not disabled				70.1	24.9
Mildly disabled	-	-		17.3	25.5
Moderately disabled				8.5	28.8
Severely disabled				4.1	20.8

[1] standard deviations after ±-sign

TABLE 4.2 Average partial effects of covariates on the likelihood of total LTC, institutional and home care use and average monthly expenditures in 2004

	TOTAL LTC			INSTITUTIONAL LTC			HOME CARE		
COVARIATES	PART I	PART II	PART I * IIA	PART I	PART II	PART I * II[a]	PART I	PART II	PART I * II[a]
Male	-0.061	-109	-79	-0.014	-210	-55	-0.050	-83	-22
Age (overall)	0.010	47	17	0.004	-2	12	0.007	20	4
Age in female survivors	0.013	39	16	0.004	12	12	0.010	13	4
Age in female decedents	0.016	94	93	0.017	5	63	0.003	30	9
Age in male survivors	0.006	19	6	0.002	-23	4	0.004	7	2
Age in male decedents	0.015	29	37	0.010	-28	30	0.006	18	6
Alive (overall)	-0.120	-797	-283	-0.050	-667	-204	-0.086	-365	-80
Alive in females co-residing	-0.137	-929	-283	-0.046	-845	-204	-0.105	-376	-81
Alive in females living alone	-0.179	-744	-516	-0.101	-561	-365	-0.103	-358	-141
Alive in males co-residing	-0.069	-848	-149	-0.026	-783	-113	-0.057	-351	-40
Alive in males living alone	-0.151	-670	-376	-0.063	-625	-257	-0.110	-396	-125
Alive in individuals aged 55-74	-0.108	-866	-203	-0.033	-1067	-140	-0.088	-362	-66
Alive in individuals aged 75+	-0.161	-763	-550	-0.106	-576	-416	-0.080	-366	-127
Cause-of-death (ref. group: external)									
Cancer	0.049	-455	-97	-0.049	-526	-232	0.094	168	152
Diabetes	0.146	469	513	0.093	242	367	0.086	263	135
Mental	0.257	2573	2192	0.351	2025	2267	-0.076	273	-2
CVD apart from CVA	0.012	-8	17	-0.009	95	-11	0.022	33	20
CVA	0.088	891	629	0.104	697	550	0.009	157	45
Disease respiratory system	0.155	690	669	0.107	669	552	0.080	194	108
Disease digestive system	0.067	337	291	0.036	545	247	0.041	38	36
Other	0.112	920	703	0.109	699	567	0.028	326	106
TTD (overall)	-0.006	-46	-35	-0.005	-25	-22	-0.003	-28	-13
TTD in females co-residing	-0.008	-44	-36	-0.004	-25	-24	-0.005	-26	-15
TTD in females living alone	-0.003	-49	-41	-0.006	-24	-28	0.001	-26	-10
TTD in males co-residing	-0.009	-47	-30	-0.004	-26	-16	-0.006	-29	-14
TTD in males living alone	-0.005	-42	-32	-0.005	-26	-22	-0.002	-33	-15
TTD for COD cancer	-0.012	-63	-42	-0.004	-16	-13	-0.011	-75	-33
TTD for COD diabetes	-0.003	-36	-29	-0.004	-26	-22	0.000	-21	-6
TTD for COD mental disease	-0.005	-72	-79	-0.010	-41	-76	0.005	-23	2
TTD for COD CVD excl. CVA	-0.003	-30	-19	-0.003	-21	-15	-0.000	-16	-4
TTD for COD CVA	-0.004	-48	-40	-0.006	-28	-35	0.001	-18	-3
TTD for COD respiratory disease	-0.005	-40	-36	-0.006	-27	-31	-0.000	-19	-5
TTD for COD digestive disease	-0.004	-32	-25	-0.005	-17	-22	-0.000	-13	-3
TTD for COD other	-0.004	-44	-36	-0.005	-24	-28	0.000	-28	-7

TABLE 4.2 Average partial effects of covariates on the likelihood of total LTC, institutional and home care use and average monthly expenditures in 2004 (table continued)

	TOTAL LTC			INSTITUTIONAL LTC			HOME CARE		
COVARIATES	PART I	PART II	PART I * II[a]	PART I	PART II	PART I * II[a]	PART I	PART II	PART I * II[a]
Living alone (overall)	0.107	-95	77	0.019	-611	28	0.099	96	46
Living alone in females 55-74 years	0.082	35	51	0.011	-843	19	0.079	98	31
Living alone in females 75+	0.158	-167	80	0.034	-702	-25	0.150	70	80
Living alone in males 55-74 years	0.085	63	74	0.014	-493	39	0.075	158	31
Living alone in males 75+	0.232	-152	204	0.051	-290	110	0.210	143	115

[a] The presented APE's on PartI*PartII do not simply equal the product of APE's on each part as they are partial effects averaged over the sample (and not partial effects for an average or reference individual). Partial effect continuous variables: the effect of a one unit change in the covariate on the outcome. Partial effect discrete and indicator variables: the effect of a change from 0 to 1 on the outcome. For indicator variables: partial effect with respect to the reference category

from a one unit change in the covariate. APE's were obtained empirically through simulations and we report some APE's for subgroups to demonstrate the effect of interactions.[12]

On average, the probability of using institutional LTC (home care) is 1.4 (5.0) percentage points (pp) lower among males. Expected monthly LTCE for males are on average €79 lower than for females. In all three models, age has a highly significant influence. A one year increase in age raises the average probability of using LTC, institutional LTC and home care, respectively, by 1pp, 0.4pp and 0.7pp. A one year increase in age increases conditional monthly LTC and home care expenditures by €47 and €20, respectively. The negative effect of age on conditional institutional LTCE – mainly driven by males – is probably caused by differences in service prices and population characteristics of residential and nursing homes, with the latter having much higher costs but lower average age of residents (Oostenbrink *et al.*, 2004). However, expected expenditures on both types of LTC increase with age. Age has a larger effect on expected home care and institutional LTCE in females. Although the absolute effect of age is greater for decedents, the relative age effect – e.g. the percentage increase of expected LTCE with age – is greater for survivors.

Survivor status and TTD turn out to be major predictors of both institutional and home care expenditures. Decedents have on average a 12pp higher probability of using LTC and €283 higher expected monthly LTCE, but the effect differs by COD: compared to external causes, all COD, apart from CVD, materially influence the probability of use and the conditional level of expenditures. On average, decedents of a mental illness cost €2192 more than those deceased due to external causes, while cancer decedents have lower (-€97) expected

12 Standard errors are omitted for two reasons: (i) the data we use are stored in a protected remote access environment of Statistics Netherlands. Given the current access rules and costs (in particular the limitations in terms of time available for each analysis) it is simply impossible to bootstrap these APEs as these runs would take weeks to complete; (ii) The significance of APE estimates largely depends on the estimated regression coefficients which we report in appendix 4.2.

LTCE. The effect of a mental COD is particularly large on institutional LTC because dementia patients often need institutional care and are therefore less likely to use home care. The lower average LTCE of cancer decedents derive from their lower expected institutional expenditures, as many cancer patients die at home or in the hospital. All other causes of death have a positive effect on LTCE; individuals deceased from a disease of the respiratory system, CVA or diabetes cost on average €669, €629, and €513 more compared to those deceased due to external causes.

As has previously been found for acute care expenditures (e.g. Zweifel, Felder, and Meiers, 1999; Seshamani and Gray, 2004c; Stearns and Norton, 2004), the relative effect of survival status and TTD decreases with age. The ratio of predicted LTCE among decedents to survivors decreases from 18 at age 55 to 1.7 at age 90. Survival status and TTD have a larger effect for females and individuals living alone: female (male) decedents co-residing have on average €283 (€149) higher expenditures compared to survivors while this is €516 (€376) for females (males) who *live alone*. On average, a TTD of 1 month less results in €35 higher average monthly LTCE. Interactions between TTD and COD demonstrate that the effect of TTD is particularly large in cancer and mental illness decedents. Remember that the effect of TTD in cancer (mental illness) decedents primarily influences home care (institutional LTC) expenditures. For cancer, this larger effect can be attributed to the faster progression of the disease.

Co-residence status significantly influences the probability of positive use, but more so for home care than for institutional LTC. This finding confirms that informal care is a closer substitute for less skilled LTC services (Bonsang, 2009). Figure 4.1 shows the predicted LTCE by age, sex and co-residence. Living alone increases expenditures, but more so for males than for females. The effect of co-residence first increases with age but gradually decreases at older ages, suggesting that the ability to provide adequate care tends to decrease

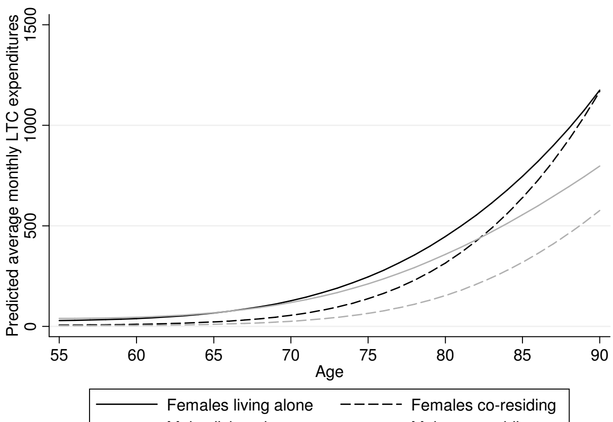

FIGURE 4.1 Predicted average monthly LTCE by age, sex and co-residence status

above a certain age. Females (males) aged 75+ living alone have a 15.8pp (23.2pp) higher probability of using LTC and incur on average €80 (€204) higher expected LTCE than those co-residing. The positive effect of co-residing on conditional institutional LTCE confirms that informal care might postpone institutionalization. During this postponement, the disability status of informal care recipients continues to deteriorate, resulting in higher disability at the time of institutionalization, hence higher conditional institutional LTCE among elderly co-residing prior to institutionalization.

Results for extended home care model

Table 4.3 presents the APE's of covariates on the probability and (conditional) level of home care expenditures.[13] APE estimation was bootstrapped to obtain standard errors for statistical inference (Efron and Tibshirani, 1993). Both parts of the model for home care expenditures fit the data quite well; part I has a pseudo R^2 of 0.39 and part II has a deviance of 1.21. Overall, most covariates affect home care expenditures as expected. Even after including extensive information on morbidity and disability, age still significantly determines the probability of positive use and the level of home care expenditures (the age variables are jointly significant). The influence of age on home care expenditures is larger for females than for males: a one year older female (male) costs on average €3 (€1) more, *ceteris paribus*. The effects of TTD and survival are attenuated considerably with the inclusion of disability and morbidity variables. F-tests reveal that TTD and survival jointly have a significant negative effect on the probability of home care use. By contrast, the APE's and joint significance test (see appendix 4.3) of the disability variables demonstrate that the effect of disability on home care use and expenditures is much more sizeable. It is worth noting that morbidity indicators, apart from previous hospitalizations, do *not* influence home care use, while ADL, mobility, and limitations in daily activities all increase the likelihood of using home care. Individuals moderately (severely) disabled in ADL have on average €29 (€176) higher monthly home care expenditures than those not disabled. This large effect of disability is not surprising given that disability is the foremost prerequisite for obtaining access to publicly financed home care (de Meijer *et al.*, 2009). A second central eligibility criterion is the availability of informal care and this is reflected in the strong effect of co-residence on the likelihood to use home care. Again, this effect is stronger for males than females. Males (females) living alone cost on average €38 (€17) more than those co-residing. Finally, the finding that individuals with higher incomes have a lower probability of home care use confirms that income-related copayments do provide an incentive for higher incomes to substitute public by private home care, even though income does not significantly influence the conditional level of home care expenditures.

13 Appendix 4.3 shows estimated coefficients and joint significance tests for age, TTD and disability.

TABLE 4.3 Average partial effects for the probability of positive use (part I), conditional (part II) and expected (part I * II) average monthly home care expenditures for the Health survey sample

COVARIATES	HOME CARE		
	PART I	PART II	PART I * II[a]
Demographic characteristics			
Age (overall)	0.006***	8*	2***
Age in females	0.007***	9*	3***
Age in males	0.004***	6	1***
Male	-0.026**	24	-3
Alive after 3 years	0.019	-83	-4
Time-to-death in months	-0.005	0	-2
Living alone in females	0.069***	4	17*
Living alone in males	0.117***	120	38***
Socio-economic characteristics			
Education middle	0.012	-79	-3
Education high	-0.011	-9	-4
Income (x €1000)	-0.002**	-2	-1
Health status indicators			
Self-reported health - Good	0.014	-295	-27
Self-reported health – Fair	0.035	-193	-10
Self-reported health – (very) Poor	0.011	-169	-14
Chronic condition	-0.008	45	3
Mental health	-0.000	0	0
Previous hospitalization	0.048***	-26	9
Disability status indicators			
Limited in daily activities - mildly	0.033	35	12
Limited in daily activities - severely	0.058**	51	19
ADL – mildly disabled	0.016	47	8
ADL – moderately disabled	0.071*	101	29*
ADL – severely disabled	0.152**	695***	176***
Mobility – mildly disabled	0.000	-33	-3
Mobility – moderately disabled	0.072**	-30	13
Mobility – severely disabled	0.066*	-3	16

[a] The presented APE's on Part I*Part II do not simply equal the product of APE's on each part, as they are partial effects averaged over the sample (and not partial effects for an average or reference individual).
Partial effect continuous variables: the effect of a one unit change in the covariate on the outcome.
Partial effect discrete and indicator variables: the effect of a change from 0 to 1 on the outcome. For indicator variables: partial effect with respect to the reference category.
Standard errors to obtain significance levels obtained by bootstrapping.

Effect of age and TTD re-evaluated

Figures 4.2a-c evaluate the role of age in determining LTC, institutional LTC and home care for the Dutch population when conditioning on additional determinants. The Y-axis represents the additional average monthly LTCE of individuals aged 56-90 compared to individuals aged 55. The slope of the line thus represents the age effect. The different lines in

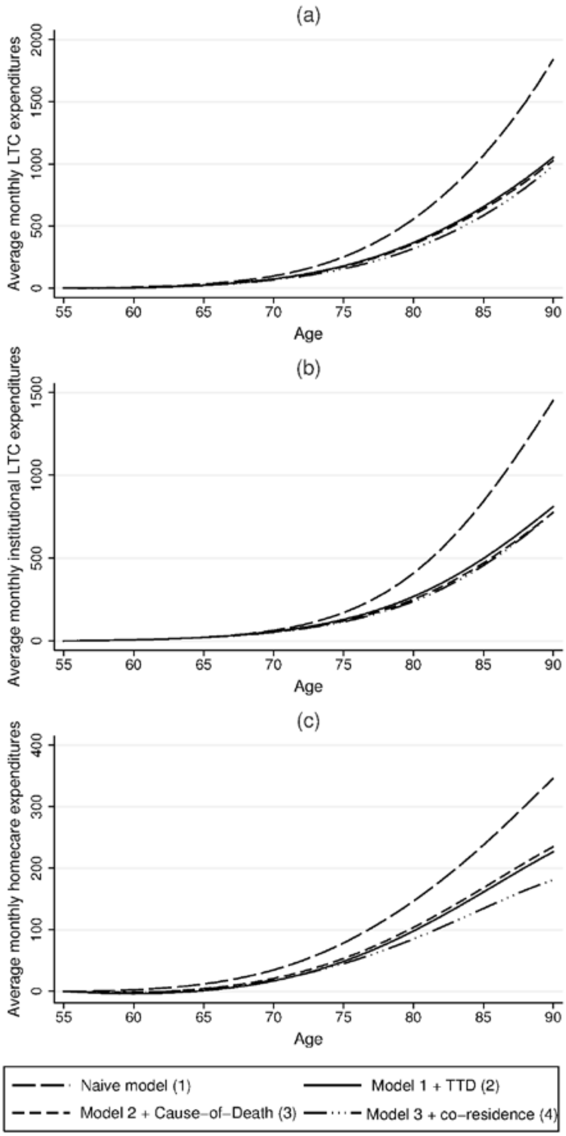

FIGURE 4.2 Additional average monthly (a) LTC, (b) institutional LTC, and (c) home care expenditures by age compared to a 55-year old (population model)

the figure evaluate the age effect in: (1) a naïve model analyzing expenditures as a function of age and sex, (2) a TTD model, including additionally TTD, (3) one adding COD, and (4) one adding co-residence. For all types of expenditures, the age effect increases more rapidly at higher ages. The inclusion of TTD considerably attenuates the effect of age on all types of LTCE, but the effect remains significant. Therefore, TTD could indeed partially explain the higher expenditures among the higher aged. The inclusion of COD only marginally decreases the effect of age on expenditures. By controlling additionally for co-residence, the effect of age on home care expenditures – and to a lesser extent on institutional LTCE – decreases but remains significant for all LTC services.

When moving to the extended home care model we are able to further examine the changes in the age effect on home care expenditures by controlling additionally for disability and morbidity (figure 4.3). Again, by adding TTD to a naïve model, the age effect decreases but remains important. By contrast, controlling instead for disability substantially reduces the effect of age on the level of expenditures. Adding TTD to the former model shows that a marginal part of the age effect left after controlling for disability can be attributed to TTD. Finally, inclusion of co-residence status further decreases the age effect, but it remains significant.

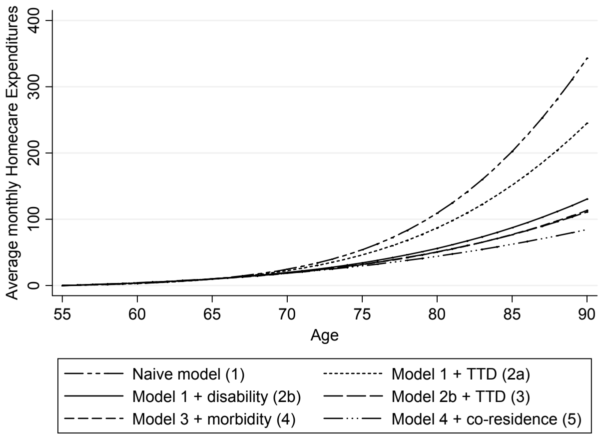

FIGURE 4.3 Additional average monthly home care expenditures by age compared to a 55-year old (Health Survey Sample)

Figures 4.4 and 4.5 illustrate the TTD effect by presenting additional predicted average monthly expenditures of decedents by TTD compared to those of survivors. Figure 4.4 compares the effect of TTD in a TTD-only model to that in models that control in addition for: (1) COD and (2) COD and co-residence status, all estimated with the population model. For both types of expenditures, the TTD effect increases more rapidly when moving

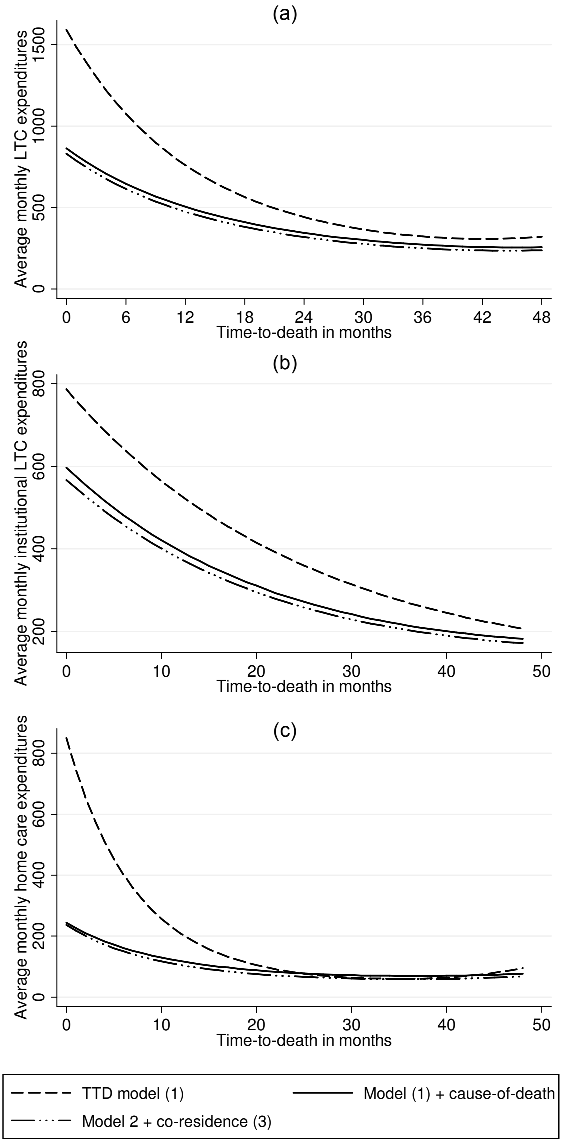

FIGURE 4.4 Additional average monthly (a) LTC, (b) institutional LTC and (c) home care expenditures by TTD of decedents compared to survivors (population model)

closer to death. The consequences of adding COD to a TTD model are striking: the curve both shifts downward and flattens considerably, i.e. the TTD effect is attenuated. Although the effect of survivor status remains – i.e. some excess spending between decedents and survivors persists – the excess spending for decedents falls, particularly for home care. The substantial fall in the impact of TTD on home care expenditures may be associated with the rate of progression of fatal diseases, e.g. individuals suffering from cancer may prefer to die at home while home care may not be an option for those suffering from diseases that are fatal only after a longer period. Further control for co-residence hardly affects the TTD effect on (any type of) expenditure.

Figure 4.5 illustrates the changes in the TTD effect on home care expenditures estimated by the extended home care model. Instead of COD, we condition here on morbidity and disability measures, available for both decedents *and* survivors. As for COD, adding disability to a TTD model substantially attenuates the TTD effect. Expenditure differences between decedents and survivors fall dramatically and expenditures also vary little with TTD among decedents. While the TTD model predicts individuals in their last month of life to cost on average €120 more compared to survivors, these same individuals cost on average only €45 more after controlling for disability. Further control for morbidity and co-residence only marginally changes this TTD effect.

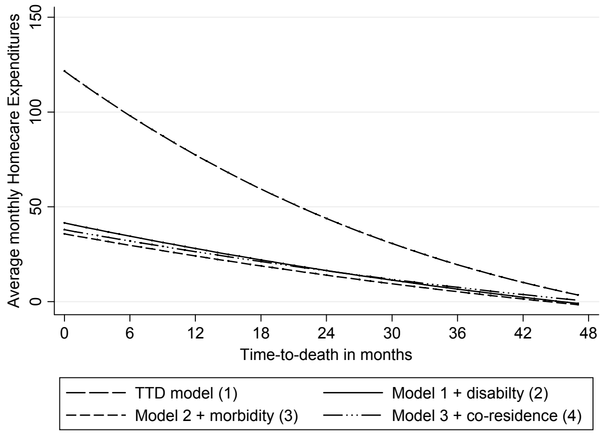

FIGURE 4.5 Additional average monthly home care expenditures by TTD of decedents compared to survivors (Health Survey Sample)

Projections of LTCE

This section outlines some LTCE projections for the 55+ population based on trends in demography, co-residence, and disability. It is important to bear in mind that not only individual determinants, but also health care supply and organizational features (e.g. the eligibility criteria, informal care availability, and waiting lists) co-determine utilization and expenditures (Getzen, 2001; Andersen and Newman, 2005). We assume these constant in our projections. Table 4.4 presents projections of (1) the absolute level of expenditures and (2) per capita expenditures on total LTC, institutional LTC and home care in 2040. While the per capita projections only account for shifting age distributions, the projections for the

TABLE 4.4 Projected growth in (per capita) LTCE for 55+ individuals in 2040 based on various models (index = 100 in 2004)

	LTCE		INSTITUTIONAL LTCE		HOME CARE EXPENDITURES	
MODEL	INDEX 2040	PER CAPITA INDEX 2040	INDEX 2040	PER CAPITA INDEX 2040	INDEX 2040	PER CAPITA INDEX 2040
Naïve model (1)	228	150	233	154	214	141
Naïve + co-residence (2a)	232	153	NA	NA	NA	NA
TTD model (2b)	194	128	196	129	187	124
Disability model (2c)	NA	NA	NA	NA	123	117[a]

[a] Based on a reduced version of the extended home care model (including the covariates age, age^2, sex, age*sex, alive, TTD and disability); The extended home care model estimates home care expenditures to rise by 56%, 51% and 17% between 2004 and 2040 using a naïve, TTD and disability model, respectively. Although the growth rates differ with those estimated by the population model, the projections move in the same direction. The difference is caused by the samples: the population model includes all 55+ individuals; the extended home care model only includes the non-institutionalized 55+ population.

absolute level of LTCE also take into account the growing size of the elderly population. Average monthly (per capita) LTCE in 2004 are indexed at 100. Both indices show a similar trend: LTCE are expected to grow fastest using a naïve projection model, while TTD and especially disability result in much lower LTCE projections. Using a naïve age-based model, per capita LTCE among the 55+ population in 2040 are expected to be 50% higher in 2040, i.e. LTCE in 2040 are indexed at 150; 154 for institutional LTC and 141 for home care. Clearly, TTD models result in more optimistic projections as longevity gains partly shift LTCE to higher ages.[14] According to a TTD model, the index of per capita LTCE is expected to equal 128 in 2040. Predictions using disability as well as TTD could only be estimated for home care (from the extended home care model). Extrapolating recent declines in severe disability[15] (Perenboom *et al.*, 2004; Lafortune *et al.*, 2007), the index of home care expenditures is expected to equal 117 in 2040. This decrease in severe disability is likely to affect institutional LTCE to an even greater extent, as those with severe disability are much more likely to reside in an institution (de Meijer *et al.*, 2009). For all models and types of spending, expenditures are expected to rise more rapidly when accounting for the growing size of the elderly population group, e.g. a naïve (TTD) model projects per capita LTCE to grow by 50% (28%) while the absolute level of LTCE is expected to grow by 128% (94%).

Finally, the expected rise in the share of elderly living alone – especially among males – will lead to higher public expenditures on LTC, *ceteris paribus*. Due to greater expected improvements in longevity among males, they are more likely to live alone in old age in the future (OECD, 2005; Statistics Netherlands, 2010). Other trends contributing to lower

14 Life expectancy is expected to rise for males (females) aged 55-90 on average by 3.0 (2.0) years between 2004 and 2040 in the Netherlands (Statistics Netherlands, 2011).

15 1.5% yearly decline in severe disability

proportions of co-residing elderly are an individualization of society and increasing divorce rates. Projections of per capita LTCE in 2040 that account for these trends are indexed at 153, i.e. 3 pp higher than naïve projections.

4.5 DISCUSSION

We have examined the determinants of public LTCE, including both institutional LTC and home care, for the Dutch 55+ population. We have focused on the relative roles played by age, TTD and disability and have illustrated the usefulness of the various models by means of future LTCE projections based on expected trends in determinants. Our main findings are as follows. First, both co-residence status and COD are important determinants of LTCE. Individuals living alone are substantially more likely to use LTC, especially home care, and their expected level of LTCE is much higher. The large variation in decedent expenditures by COD confirms that the relationship between TTD and LTCE is dynamic: epidemiological changes will affect the importance of each COD and consequently the overall influence of TTD on LTCE. Individuals who will die from diabetes, a mental illness, CVA, a respiratory or digestive disease have significantly higher average monthly LTCE compared to individuals dying due to external causes. The *lower* LTCE among cancer decedents derive from their lower level of institutional LTCE. The common covariates – age, sex and TTD – show the expected effects. However, we have found LTCE – measured in absolute terms – to increase considerably faster with age among non-survivors while (Yang, Norton, and Stearns, 2003) find a similar increase of age-specific nursing home expenditures for both survivors and non-survivors.

Second, the effects of some covariates display substantial heterogeneity. For example, males living alone have substantially higher LTCE compared to females living alone, especially for the oldest elderly. Also the effect of TTD varies considerably by sex and co-residence, with a larger effect of TTD on *expected* expenditures in females and those living alone. The latter finding supports that of (Weaver *et al.*, 2009) who concluded that informal care availability significantly reduces the effect of TTD on the probability of LTC use. We also find that survival status affects conditional LTCE to a greater extent for co-residing individuals. We interpret this finding as further evidence that formal LTC use is postponed by informal care because co-residing individuals tend to be more disabled when they enter LTC institutions.

Third, we demonstrate the age effect to be confounded by TTD and co-residence status, but even more so by disability status: it declines after controlling for TTD and co-residence but these declines are dwarfed by the decrease occurring after controlling for disability, the foremost prerequisite for obtaining access to public LTC. Unfortunately we were not able to examine this for institutional LTC. Despite the substantial fall in its effect after control for disability, age still significantly determines home care expenditures. Next to age, disability and co-residence status are the other two important determinants of home care expenditures. Various mechanisms could explain why age retains a significant impact on LTCE: (1) assessment agencies may take into account the age of the applicant regardless of their objective need for LTC; (2) disability is still incompletely captured by our measures; and (3) co-residence status incompletely approximates informal care availability.

Fourth, the effect of survivor status and the TTD effect clearly diminish after control for COD in the population model, especially for home care, but it remains significant. Only after further control for disability (in the extended home care model), does the effect of TTD on the expected level of home care expenditures become insignificant. This finding – along with the effect of COD on LTCE – confirms that TTD indeed mainly approximates disability.

Finally, projections of LTCE for 2040 vary across models that account for different trends in its determinants. Projections taking into account the increasing share of single living elderly are slightly more pessimistic than naïve age-based projections. On the other hand, TTD projections lead to considerably lower projected LTCE for 2040 compared to naïve projections as they account for changes in age-specific LTCE resulting from longevity gains. Projections that also account for disability trends – instead of mortality trends only – lead to even more optimistic projections of LTCE. The discrepancy in projections based on either mortality or disability trends highlights the bias associated with using TTD to approximate disability when projecting LTCE. Unfortunately, we could only illustrate this discrepancy for home care expenditures.

Three points are worth noting regarding the use of co-residence in modeling and projecting LTCE. First, the relationship between co-residence – as used to approximate informal care availability – and LTCE is probably dynamic. Co-residence reduces LTCE more for males than females which must be due to a higher male labor force participation and lower male uptake of informal care and self-care. This gender gap is expected to narrow as a result of increased female labor participation and increased participation in household duties by males. Second, co-residence only crudely approximates informal care availability because it ignores informal care sources outside the household. Third, because our models – to a large extent – replicate the eligibility criteria applied, the influence of co-residence on LTCE may be stronger in the Netherlands than elsewhere. However, our models do not merely reproduce eligibility rules since the guidelines still leave room for discretionary decision making and personal judgment. Moreover, the decision to demand public LTC by contacting the agency instead of choosing other, private sources of LTC still remains with the individual and her social environment.

Previous studies have already concluded that the rising LTCE with age could partly be attributed to TTD (Yang, Norton, and Stearns, 2003; Werblow, Felder, and Zweifel, 2007). We confirm that TTD itself imperfectly approximates disability in determining LTCE and even becomes redundant after appropriate control for the latter, although it still importantly determines the probability of use (see also Weaver *et al.*, 2009). The insignificant effect of TTD on expected LTCE indicates that TTD itself can be regarded as a 'red herring' for LTC and raises doubts about its validity for projecting LTCE. Projections using TTD rather than disability implicitly assume that longevity gains merely shift disability to older ages. As such, they ignore the dynamics in the relationship between TTD and disability caused by epidemiological changes, and therefore contradict recent evidence favoring a compression of disability (Fries, 1980; , Gu, and Lamb, 2006; Payne *et al.*, 2007). Hence, a TTD model might still overestimate the effect of aging on future LTCE, as is illustrated by our projections. It has often been argued that the contribution of aging to growth in HCE is relatively small compared to the impact of technology (e.g. Breyer and Felder, 2006). Technological innovation is, however, much less likely to increase LTCE because there have been far less advances in the use of technology for LTC provision.

Unfortunately, we were only able to fully examine the relevance of TTD for modeling home care expenditures because disability data on institutionalized individuals were lacking. Finally, our conclusions cannot be generalized to acute HCE as previous studies found the effect of TTD to be much larger for acute than for LTC (Yang, Norton, and Stearns, 2003; Werblow, Felder, and Zweifel, 2007).

Concluding, while previous studies have shown that TTD explains LTCE over and above the effect of age (e.g. Yang, Norton, and Stearns, 2003; Werblow, Felder, and Zweifel, 2007), we demonstrate that, after control for disability, TTD itself becomes a 'red herring', while age and informal care availability remain important determinants of LTCE. The finding that TTD largely acts as a proxy for disability – along with previous evidence supporting a compression of disability – suggests that where possible, inclusion of more appropriate indicators of care needs, like disability, is highly desirable for improved expenditure forecasts. We recognize that this will not always be feasible. Data on mortality are more readily and routinely available than on disability, as is illustrated by the lack of disability information in our own data on institutional LTC users. Unlike survivor status, which is fairly easy to document, disability measures are typically self-reported, lack a universal definition and are therefore less comparable across populations (Payne *et al.*, 2007). This often also complicates the determination of disability trends that are needed for LTCE projections (Cutler, 2001). But it is worth keeping in mind that – unlike in the case of medical care spending – LTC spending is driven more by disability than by survival trends.

APPENDICES

APPENDIX 4.1 Description of variables in population and extended home care model

VARIABLE	DESCRIPTION	MODEL[3]
Dependent variable		
LTC Expenditures	Average monthly LTC, institutional LTC and home care expenditures in 2004	P
	Average monthly home care expenditures in 2004 *or* 2005	E
Covariates		
Male	Sex of respondent: 0 = female; 1 = male	P+E
Age	Age of respondent	P+E
Age^2	Age^2 of respondent	P+E
Age^3	Age^3 of respondent	P
Age * Male	Interaction age * male	P+E
Age^2 * Male	Interaction age^2 * male	P
Alive	Indicator TTD: 0 = not deceased within 3 years after measurement year; 1 = deceased within 3 years after measurement year	P+E
TTD	Time-to-death in months; survivors are set to the maximum of 48	P+E
TTD^2	Time-to-death in $months^2$	P
Living alone	Co-residence status: 0 = co-residing; 1 = living alone	P+E
Alive * male	Interaction alive * male; 1 = male alive; 0 = else	P
TTD * male	Interaction TTD * male: 0 = female; else = TTD of males	P
TTD^2 * male	Interaction TTD^2 * male: 0 = female; else = TTD^2 of males	P
Alive * age	Interaction alive * age; 0 = deceased; else = age of survivors	P
TTD * age	Interaction TTD * age	P
TTD^2 * age	Interaction TTD^2 * age	P
Alive * living alone	Interaction alive * living alone; 1 = alive living alone; 0 = else	P
TTD * living alone	Interaction TTD * living alone; 0 = co-residing; else = TTD of those living alone	P
TTD^2 * living alone	Interaction TTD^2 * living alone; 0 = co-residing; else = TTD^2 of those living alone	P
	Interaction male * living alone; 1 = male living alone; 0 = else	
Living alone* male	Interaction living alone * age; 0 = co-residing; else = age of those living alone	P+E
Living alone* age		P
Education	Highest educational level: 0 = low; 1 = middle; 2 = high	E
Income	Logarithm of monthly net equivalent household income = log(monthly household income/household members^0.5); information obtained from income production system	E
COD	Indicators cause-of-death: external cause of mortality (reference category), cancer, diabetes, mental disease, CVD exclusive CVA, CVA, respiratory disease, digestive disease, else	P
TTD * COD	Interaction TTD * COD; for all indicators of COD. Approximates severity/stage of the disease.	P
TTD^2 * COD	Interaction TTD^2 * COD; for all indicators of COD.	P
Self-reported health	Indicators: very good (reference category), good, fair, (very)poor	E
Chronic condition	Presence of chronic condition: 0 = no; 1 = yes	E
Hospitalization	Hospitalized in last 5 years; Indicator: 0 = no; 1 = yes	E
Mental health	Score on Mental Health Inventory 5; range 0 – 100 (=healthy)	E

APPENDIX 4.1 Description of variables in population and extended home care model (table continued)

VARIABLE	DESCRIPTION	MODEL[3]
Limited in daily activities	Only for individuals who reported to have a chronic condition. Indicators: not limited (reference category), mildly limited, severely limited	E
ADL disability[1]	Indicators: not disabled, could perform all items independently (reference category); mildly disabled, could perform at least one item with some difficulty and all remaining items independently; moderately disabled, could perform at least one item with much difficulty and all remaining items independently or with some difficulty; severely disabled, could not perform at least one item independently	E
Mobility disability[2]	see coding ADL disability	E

[1] ADL items: eating/drinking, (un)dressing, washing hands and face, washing oneself completely, transfer from chair

[2] Mobility items: moving indoors, moving outdoors, walking stairs, transfer from bed, entering/leaving room

[3] Covariate is included in: P = population model; E = extended home care model

APPENDIX 4.2 Estimates of covariate effects on likelihood of total LTC, institutional and home care use and expenditures

	TOTAL LTC		INSTITUTIONAL LTC		HOME CARE	
COVARIATES	PROBIT	GLM	PROBIT	GLM	PROBIT	GLM
Male	0.63 (0.12)***	-0.01 (0.04)	0.67 (0.21)**	13.35 (5.00)**	2.99 (0.12)***	-0.25 (0.10)*
Age	-0.91 (0.02)***	-0.00 (0.01)	-0.23 (0.03)***	-3.35 (0.74)***	-1.49 (0.02)***	0.03 (0.02)
Age^2/1000	12.61 (0.27)***	-0.03 (0.08)	3.42 (0.44)***	43.44 (9.90)***	21.16 (0.26)***	-0.59 (0.21)**
Age^3/1000	-0.05 (0.00)***	0.00 (0.00)	-0.01 (0.00)***	-0.18 (0.04)***	-0.10 (0.00)***	0.00 (0.00)***
Male * Age/1.000	-22.70 (3.43)***	2.59 (1.06)*	12.89 (5.62)*	-236.30 (131.47)	-91.42 (3.43)***	7.07 (2.82)*
Male * Age^2/1.000	0.11 (0.02)***	-0.03 (0.01)***	-0.00 (0.04)	0.56 (0.86)	0.64 (0.02)***	-0.05 (0.02)**
Alive	-2.10 (0.07)***	-0.35 (0.02)***	-2.51 (0.10)***	-19.58 (2.05)***	-2.33 (0.07)***	-0.49 (0.06)***
TTD/1000	-0.04 (0.01)***	-12.64 (1.60)***	-9.86 (8.06)**	-292.40 (149.30)*	-92.44 (6.62)***	-26.20 (4.69)***
TTD^2/1000	0.46 (0.14)***	0.29 (0.03)***	0.27 (0.17)	12.93 (3.22)***	0.88 (0.14)***	0.59 (0.10)***
Living alone	0.23 (0.02)***	0.11 (0.01)***	1.23 (0.03)***	-8.56 (0.72)***	0.15 (0.02)***	0.17 (0.02)***
Alive* male	0.11 (0.01)***	0.02 (0.00)***	0.16 (0.02)***	0.23 (0.33)	0.02 (0.01)	-0.00 (0.01)
TTD/10000 * male	-4.43 (1.28)***	-0.24 (0.26)	1.80 (1.39)	-79.27 (22.99)**	-7.78 (1.23)***	-3.76 (0.78)***
TTD^2/1000 * male	0.01 (0.03)	0.00 (0.00)	-0.08 (0.03)**	1.70 (0.50)**	0.03 (0.03)	0.08 (0.02)***
Alive * age	0.02 (0.00)***	0.00 (0.00)***	0.03 (0.00)***	0.22 (0.02)***	0.03 (0.00)***	0.00 (0.00)***
TTD/1000 * age	0.43 (0.07)***	0.11 (0.02)***	-0.04 (0.09)	0.34 (1.61)	1.24 (0.07)***	2.05 (0.05)***
TTD^2/1000 * age	0.01 (0.00)***	-0.00 (0.00)***	-0.00 (0.00)	-0.11 (0.04)**	-0.01 (0.00)***	-0.00 (0.00)***
Alive * living alone	0.08 (0.01)***	8.62 (3.33)**	0.07 (0.02)***	0.10 (0.32)	0.13 (0.01)***	0.02 (0.01)**
TTD/1000 * living alone	18.53 (1.31)***	-0.29 (0.26)	0.83 (1.38)	-33.06 (22.71)	20.14 (1.24)***	2.98 (0.80)***
TTD^2/1000 * living alone	-0.19 (0.03)***	-0.00 (0.00)	0.00 (0.03)	0.53 (0.49)	-0.19 (0.03)***	-0.06 (0.02)***
Living alone * male	0.30 (0.00)***	-0.00 (0.00)	0.14 (0.01)***	1.98 (0.13)***	0.29 (0.00)***	0.03 (0.00)***
Living alone * age/1.000	-3.30 (0.23)***	-1.32 (0.07)***	-14.01 (0.38)***	0.07 (0.01)***	-3.89 (0.23)***	-1.95 (0.19)***

APPENDIX 4.2 Estimates of covariate effects on likelihood of total LTC, institutional and home care use and expenditures (table continued)

	TOTAL LTC		INSTITUTIONAL LTC		HOME CARE	
COVARIATES	PROBIT	GLM	PROBIT	GLM	PROBIT	GLM
Cause-of-death (ref: external)						
Cancer	1.32 (0.04)***	0.02 (0.01)*	0.11 (0.05)*	-3.53 (0.74)***	1.23 (0.04)***	0.31 (0.03)***
Diabetes	0.50 (0.05)***	0.03 (0.01)*	0.34 (0.06)***	1.24 (0.89)	0.23 (0.05)***	0.13 (0.04)***
Mental	1.19 (0.06)***	0.11 (0.01)***	1.69 (0.06)***	8.76 (0.80)***	-0.66 (0.05)***	0.16 (0.04)***
CVD exclusive CVA	0.07 (0.04)	-0.00 (0.01)	-0.03 (0.05)	-0.18 (0.74)	0.11 (0.04)**	0.05 (0.03)
CVA	0.42 (0.05)***	0.05 (0.01)***	0.57 (0.05)***	3.07 (0.77)***	-0.06 (0.05)	0.09 (0.03)**
Disease respiratory system	0.65 (0.04)***	0.04 (0.01)***	0.50 (0.05)***	2.80 (0.76)***	0.23 (0.04)***	0.11 (0.03)***
Disease digestive system	0.34 (0.05)***	0.01(0.01)	0.23 (0.05)***	1.19 (0.87)	0.18 (0.05)**	0.03 (0.04)
Else	0.50 (0.04)***	0.05 (0.01)***	0.49 (0.05)***	2.87 (0.76)***	0.12 (0.04)**	0.19 (0.03)***
TTD * cause-of-death						
TTD/1000*Cancer	-82.23 (3.96)***	-6.49 (0.90)***	-22.34 (4.40)***	-45.88 (71.89)	-66.54 (3.89)***	-27.63 (2.76)***
TTD/1000*Diabetes	3.29 (5.22)	0.70 (1.12)	4.77 (5.51)	18.27 (87.80)	3.74 (5.03	-2.14 (3.47)
TTD/1000*Mental	-12.70 (5.22)*	1.47 (1.01)	-27.33 (5.22)***	107.65 (76.85)	26.26 (4.80)***	-6.31 (3.57)
TTD/1000*CVD excl. CVA	-1.01 (3.95)	0.15 (0.91)	-0.16 (4.37)	79.07 (71.12)	-1.12 (3.90)	-3.01 (2.77)
TTD/1000*CVA	-5.48 (4.34)	0.32 (0.97)	-10.26 (4.37)*	52.52 (75.07)	9.06 (4.26)*	-2.54 (3.02)
TTD/1000*respiratory	-5.15 (4.21)	0.75 (0.94)	-2.89 (4.55)	88.19 (73.47)	2.96 (4.11)	-2.42 (2.90)
TTD/1000*digestive	-6.26 (4.81)	1.10 (1.07)	-2.44 (5.21)	153.12 (85.62)	-3.17 (4.70)	-1.12 (3.26)
TTD/1000*else	-7.35 (4.17)	0.42 (0.94)	-4.03 (4.52)	79.66 (73.00)	-1.74 (4.09)	-6.60 (2.91)*

APPENDIX 4.2 Estimates of covariate effects on likelihood of total LTC, institutional and home care use and expenditures (table continued)

	TOTAL LTC		INSTITUTIONAL LTC		HOME CARE	
COVARIATES	**PROBIT**	**GLM**	**PROBIT**	**GLM**	**PROBIT**	**GLM**
TTD^2 * cause-of-death						
TTD^2/1000*Cancer	1.05 (0.08)***	0.12 (0.02)***	0.23 (0.09)**	2.88 (1.49)	0.79 (0.08)***	0.46 (0.05)***
TTD^2/1000*Diabetes	-0.15 (0.11)	-0.02 (0.02)	-0.16 (0.11)	-0.73 (1.82)	-0.09 (0.10)	0.00 (0.07)
TTD^2/1000*Mental	-0.05 (0.11)	-0.04 (0.02)*	0.14 (0.10)	-3.73 (1.57)*	-0.29 (0.09)**	0.09 (0.07)
TTD^2/1000*CVD excl. CVA	-0.02 (0.08)	-0.00 (0.02)	0.01 (0.09)	-1.59 (1.46)	-0.02 (0.08)	0.04 (0.05)
TTD^2/1000*CVA	-0.02 (0.09)	-0.01 (0.02)	0.06 (0.09)	-1.42 (1.55)	-0.17 (0.09)*	0.03 (0.06)
TTD^2/1000*respirator	-0.05 (0.08)	-0.02 (0.02)	-0.06 (0.09)	-2.41 (1.51)	-0.09 (0.08)	0.02 (0.06)
TTD^2/1000*digestive	0.02 (0.10)	-0.03 (0.02)	-0.06 (0.11)	-2.82 (1.78)	0.02 (0.09)	0.02 (0.06)
TTD^2/1000*Else	0.03 (0.08)	-0.01 (0.02)	0.00 (0.09)	-1.98 (1.50)	0.00 (0.08)	0.08 (0.06)
Intercept	20.28 (0.45)***	1.83 (0.14)***	2.74 (0.79)***	125.32 (18.55)***	33.68 (0.45)***	1.83 (0.37)***
Power function (GLM link;fixed)		0.072		0.444		0.121
N	4032772	633839	4032772	182988	4032772	512055
Pseudo R^2 / (1/df) Deviance	0.355	2.016	0.366	0.811	0.268	1.489

(*), (**), and (***) denote statistical significance at the 5%, 1% and 0.1% level respectively. Standard errors are in parentheses

APPENDIX 4.3 Estimates of covariate effects on the probability of and expenditures on home care

	HOME CARE			
COVARIATES	PROBIT		GLM	
Socio-demographic characteristics				
Male	-0.99	(0.71)	0.17	(0.35)
Age	0.08	(0.06)	-0.01	(0.03)
Age^2/1000	-0.22	(0.46)	0.03	(0.02)
Male * Age	0.01	(0.01)	- 0.00	(0.00)
Alive after 3 years	0.16	(0.31)	-0.09	(0.10)
TTD in months	-0.02	(0.01)	-0.00	(0.00)
Living alone	0.41	(0.10)***	0.00	(0.04)
Male * Living alone	0.67	(0.16)***	0.13	(0.08)
Socio-economic characteristics				
Education (low = 0)				
Middle	0.10	(0.08)	-0.06	(0.04)
High	-0.09	(0.12)	-0.01	(0.06)
Income (logged)	-0.24	(0.09)**	-0.04	(0.04)
Health status indicators				
Self-reported health (very good = 0)				
Good	0.13	(0.16)	-0.30	(0.18)
Fair	0.30	(0.18)	-0.17	(0.18)
(very) Poor	0.10	(0.21)	-0.15	(0.19)
Respondent has chronic condition	-0.07	(0.14)	0.05	(0.08)
Mental Health Score	-0.00	(0.00)	-0.00	(0.00)
Previous hospitalization	0.42	(0.09)***	-0.03	(0.04)
Disability status indicators				
Limited in daily activities (no = 0)				
Mildly limited	0.28	(0.14)*	0.04	(0.08)
Severely limited	0.45	(0.15)**	0.06	(0.09)
ADL (not disabled = 0)				
Mildly disabled	0.13	(0.11)	0.07	(0.05)
Moderately disabled	0.49	(0.19)*	0.14	(0.07)*
Severely disabled	0.92	(0.22)***	0.56	(0.09)***
Mobility (not disabled = 0)				
Mildly disabled	0.00	(0.11)	-0.04	(0.06)
Moderately disabled	0.51	(0.14)***	-0.03	(0.06)
Severely disabled	0.47	(0.20)*	-0.00	(0.07)
Intercept	-3.34	(2.52)	2.34	(1.27)**
Power function GLM (link; fixed)			0.155	
N	4176		401	
Pseudo-R^2/Deviance	0.390		1.213	

(*), (**), and (***) denote statistical significance at the 5%, 1% and 0.1% level respectively. Standard errors are in parentheses.

Statistics joint F-test age variables: 74*** (part I) and 15*** (part II)

Statistics joint F-test TTD and alive: 7* (part I) and 4 (part II)

Statistics joint F-test disability variables: 100*** (part I) and 77 (part II)

Forecasting Lifetime and Aggregate Long-Term Care Spending: Accounting for Changing Disability Patterns

5

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ABSTRACT

The impact population aging exerts on future levels of long-term care (LTC) spending is an urgent topic in which few studies have accounted for disability trends. We forecast *individual* lifetime and *population* aggregate annual LTC spending for the Dutch 55+ population to 2020 accounting for changing disability patterns.

Three levels of (dis)ability were distinguished: none, mild, and severe. Two-part models were employed to estimate LTC spending as a function of age, gender, and disability. A multistate life table model was used to forecast age-specific prevalence of disability and life expectancy (LE) in each disability state. Finally, two-part model estimates and multistate projections were combined to obtain forecasts of LTC expenditures.

LE is expected to increase while life years in severe disability remain constant, resulting in a relative compression of severe disability. Mildly disabled life-years increase, especially for women. Lifetime home care spending – mainly determined by mild disability – increase while institutional spending remains fairly constant due to stable LE with severe disability. Lifetime LTC expenditures, largely determined by institutional spending, are thus hardly influenced by increasing LE. Aggregate spending for the 55+ population is expected to rise by 19.2 percent.

Life extension with improved disability profiles will not seriously increase lifetime spending. The growth of the elderly cohort, however, will considerably increase aggregate spending. Stimulating a compression of disability is among the main solutions to alleviate the consequences of longevity gains and population aging to growth of LTC spending.

5.1 INTRODUCTION

The impact of population aging on the level of health care expenditures has become a topic of growing attention over the last decades. Of particular interest is its impact on long-term care (LTC) spending. While the increase in the acute care expenditure age profile can entirely be explained by age-specific differences in health status (often approximated by time-to-death), LTC expenditures increase with age even after accounting for variations in health status. Besides, LTC use is more concentrated among the middle-aged and elderly. Hence, the most dramatic spending growth due to population aging is expected in the LTC sector (Liu, Manton, and Aragon, 2000; Spillman and Lubitz, 2000; Yang, Norton, and Stearns, 2003; Polder, Barendregt, and van Oers, 2006; Payne *et al.*, 2007; Werblow, Felder, and Zweifel, 2007; Häkkinen *et al.*, 2008; Weaver *et al.*, 2009).

Population aging, defined as the increasing share of elderly in a population, results from lower birth rates, longevity gains, and baby boomer aging. The increasing proportion of elderly and the growing proportion of the very old in the elderly cohort will swell the need for LTC. And longevity gains means needing LTC for longer periods. Population aging thus impacts the group of individuals requiring LTC, aggregate annual LTC spending, and individual lifetime LTC spending. Since disability is the main determinant of LTC use, (Lubitz *et al.*, 2003; Manton, Gu, and Lamb, 2006; de Meijer *et al.*, 2009) the growth of aggregate and lifetime LTC spending is strongly associated with future disability trends (Stearns, Norton, and Yang, 2007).

Forecasting individual lifetime and population aggregate LTC spending is challenging because it requires estimates of disability prevalence and mortality. Estimating such trends is complicated: disability is a stock measure governed by inflows (incidence) and outflows (recovery or mortality) that are likely to change over time. While past disability trends have been investigated abundantly (Waidmann and Liu, 2000; Freedman, Martin, and Schoeni, 2002; Freedman *et al.*, 2004; Manton, Gu, and Lamb, 2006; Lafortune *et al.*, 2007; Manton and Lamb, 2007; Manton, 2008), few studies have exploited the trends to forecast future LTC use or spending. We aim to assess the effect of aging (the growing number of elderly and longevity gains) on the future trend of lifetime and aggregate LTC spending for the Dutch 55+ population by explicitly accounting for changing disability patterns. Given further population aging, it is important to estimate future levels of LTC spending to prepare the LTC sector for future needs.

Disability trends and LTC spending forecast

Evidence on disability trends varies across and even within countries (Lafortune *et al.*, 2007; Parker and Thorslund, 2007). Trends depend on the selected measure of disability (iADL, ADL, or mobility) and the severity of disability. A consistent decrease in disability prevalence has been documented for the US (Waidmann and Liu, 2000; Freedman, Martin, and Schoeni, 2002; Freedman *et al.*, 2004; Manton, Gu, and Lamb, 2006; Lafortune *et al.*, 2007;

Manton and Lamb, 2007; Manton, 2008). Evidence on disability trends in other developed countries is less conclusive (Jacobzone *et al.*, 1998; Lafortune *et al.*, 2007; Jang and Kim, 2010). Although Puts *et al.* (2008) report declining ADL and mobility prevalences for the Dutch non-institutionalized elderly from 1987 to 2001, Picavet *et al.* (2002) found a declining mobility prevalence for males and a constant ADL disability trend for the period 1990-1998. Finally, a meta-analysis on the disability trend in the non-institutionalized Dutch population over 1990-2007 reported constant ADL and mobility disabilities (van Gool *et al.*, 2011).

Disability-free life expectancy (DFLE) as a proportion of total LE increased for both males and females in the US in 1980-1990 (Crimmins, Saito, and Ingegneri, 1997; Manton, Gu, and Lamb, 2006). A similar trend has been observed for males in several European countries, but the trend for females was inconclusive (Perenboom, van Oyen, and Mutafova, 2003; Robine, Romieu, and Michel, 2003). In the Netherlands a decrease of LE with moderate and severe disability and an increase of LE with mild disability have been observed (Perenboom *et al.*, 2004). A US study extrapolated the annual disability decline of 0.8% observed in 1910-1999 and estimated a DFLE at age 65 to grow from 79.9 percent in 2015 to 85.2 percent in 2080 (Manton, Gu, and Lamb, 2006).

Future disability trends are shown to largely impact LTC spending forecasts. LTC spending in OECD countries from 2005-2050 will increase from 1.1 to 2.8 percent of GDP under stable age-specific severe disability prevalence but only to 1.9 percent with declining severe disability rates (Lafortune *et al.*, 2007). Similar results were found in other studies (Manton, Gu, and Lamb, 2006; Comas-Herrera *et al.*, 2007). Moreover, forecasts using an extrapolation of the disability decline were more optimistic *and* best approached the actual amount spent (Manton and Lamb, 2007). If and to what extent recent disability declines will continue given less healthy lifestyles and higher disability rates of the middle-aged population is, however, debatable (Lakdawalla *et al.*, 2003; Bhattacharya *et al.*, 2004; Sturm, Ringel, and Andreyeva, 2004).

Our study extends findings of previous studies in three respects. First, we estimate future disability prevalence *and* DFLE for the Dutch 55+ population. As the trends of disability and DFLE have been shown to depend on the severity of disability, we simultaneously forecast mild and severe disability. Second, we use the forecasts to estimate lifetime and aggregate public LTC spending. Previous studies have only applied LTC spending by age and gender to the future age-sex decomposition of the population. Third, unlike previous studies, our LTC forecasts distinguish between home care and institutional LTC.

All Dutch citizens are entitled to publicly financed LTC. For our purposes, services include publicly financed institutional LTC and home care but not home care financed by a personal care budget (PCB; 5-10% of publicly financed home care). Institutional LTC includes residential and nursing home admissions. Residential homes provide living assistance; nursing homes also provide personal and nursing care. Overall, our analysis includes the bulk of public LTC expenditure.

5.2 METHODS

To forecast future LTC spending by accounting for changing disability patterns, we first estimate the relation between disability and LTC and then combine them with disability prevalence forecasts from a previously published multistate model (Majer, van Baal, and Mackenbach, 2011). The multistate-model explicitly accounts for trends in the disability incidence and mortality over time.

Data to model individual LTC function

We used three data sets to model yearly LTC expenditures: the Health Survey 2004/5, the Registration of the Administrative Office Exceptional Medical Expenses (CAK) 2004/5, and the Elderly in Institutions Survey 2004 (EIS). We used the Health Survey, an annual cross-sectional survey among a representative sample (n≈10,000) of the Dutch non-institutionalized population, to obtain information on disability. Health Survey respondents were selected by a two-stage sampling design: first, local governments proportional to their size were selected; second, individuals within the selected local governments were randomly sampled. Our study population comprised individuals aged 55-97. Disability was measured by the inability to (un)dress, wash face and hands, wash oneself completely, transfer from chair, transfer from bed, move outdoors, climb stairs, and enter/leave the house. Mild disability was defined as the inability to perform at least one item without difficulty; severe disability as the inability to perform at least one item.

We obtained information on LTC spending by linking the Health Survey to a second data set, CAK, which registers public LTC use for each citizen aged 18 or older by type of service. Total LTC spending is composed of institutional LTC and home care expenditures. Because the Health Survey excludes the institutionalized population, we added a random sample (n=1,000) of institutional LTC users from CAK 2004/5. As we did not have disability information on this subsample, we used a third data set, the Elderly in Institutions Survey 2004 (EIS; de Meijer *et al.*, 2009), to assign disability status to this subsample. The EIS is a national representative sample of the 55+ institutionalized population whose disability items are identical to the Health Survey. We assigned disability status to our institutionalized sample such that the distribution of disability by sex and type of LTC institution equalled the EIS sample. 95.8 and 86.5% of LTC residents were mildly and severely disabled, respectively. The high disability rates are consistent with eligibility guidelines to obtain access to public LTC institutions.

Item non-response excluded four individuals, leaving a sample of 6,512 individuals. Post stratification weights were obtained to correct the joint distribution of weighting variables in our sample to those of the Dutch 55+ population. Weighting variables were age*sex*institutionalized.

Modelling individual LTC expenditure

We employed a two-part model – common to health care expenditures analysis (Jones, 2000) – to estimate LTC spending given age, sex, and disability status. A two-part model accounts for the high proportion of non-users by separately analysing use (part I) and the level of expenditures conditional on use (part II). Part I contains a probit model that analyses the probability of using LTC. We followed the procedure proposed by Manning and Mullahy (2001) to select the most appropriate model for part II. A generalized linear model with power link and gamma family best suited our data. The Box Cox transformation parameter was used as the power link. Expected expenditures for individual *i* are obtained by multiplying parts I and II:

$$E\,(LTCE_{ij} \mid X_i) = \Phi\,(\beta 1_j, X_i)\ {*}{=}\ \sqrt[\lambda]{\beta_{2j} X_i + 1},$$

where Φ() is the probability given by part I and $\sqrt[\lambda]{()}$ is the conditional level of expenditures

given by part II for individual *i* and type of LTC *j*, with j=1 (total LTC), *j*=2 (institutional LTC), j=3 (home care). β_1 and β_2 are vectors of parameters to be estimated by part I and part II, respectively, and X_i is a vector of covariates, i.e., orthogonal age variables of severity one and two, sex, disability, and interactions between disability and age.

Forecasting disability prevalence and (DF)LE

To forecast disability prevalence and (DF)LE we used a multistate life table model that distinguished three states: non-disabled, disabled, and dead. Connecting the health states, transition probabilities were estimated as a function of age and calendar year. We forecast transition probabilities up to 2020 based on trends over the period 1989-2007. Forecasts of all the transition rates employed the Lee-Carter (1992) method, a popular method used by demographers and actuaries to forecast life expectancy.

Having obtained the future age-specific transition probabilities, life expectancy with and without disability could be estimated. The model was employed twice to estimate the prevalence of mild and severe disability. The reader is referred to Majer, van Baal, and Mackenbach (2011) for an extensive description of the model used to forecast life expectancy with and without disability by age and sex.

We used different sources to estimate all the parameters of the model. The Human Mortality Database gave us gender- and age-specific (55+) mortality rates from 1989 to 2007. The Health Surveys 1989-2007 were used to estimate disability prevalence in the non-institutionalized population. National statistics on LTC institution residents by age and sex were pooled to the Health Surveys to obtain complete age- and gender-specific disability prevalence for the entire 55+ population. Finally, the data set was linked to the Death Registry to obtain mortality rates by disability status.

Forecasting LTC expenditure

Forecasting *lifetime* expenditures required combining the probabilities of surviving to future ages, being disabled, and using LTC plus the conditional expenditures of LTC. In accordance with the forecasts of (DF)LE, lifetime expenditures were computed using a period rather than cohort measure. Expected lifetime spending for an individual *(E(LT_LTCE))* could be expressed as the sum of the product of (i) the probability of being alive (S_i) at a certain age given sex and disability status, and (ii) the expected level of LTC spending at a certain age given sex, disability, and survival status summing over all the ages between 55 years and death:

$$E\,(LT\_LTCE_{ij} \mid S_i, X_i) = \sum_{age \geq 55}^{d} \Pr(S_i = 1 \mid X_i) * E(LTCE_{ij} \mid X_i)$$

where the first term on the right hand side is the survival probability as a function of age, sex and disability status as forecasted by the model.

Aggregated expenditures were estimated to 2020. Aggregate LTC expenditure was defined as the sum of individual expenditures given the number of individuals forecasted by Statistics Netherlands (2011) combined with the disability prevalence forecasts of our model.

5.3 RESULTS

Descriptives

Table 5.1 provides summary statistics for the study sample and for the subsamples of institutional and home care users: 14.7% used LTC (average cost = €1,647), 11.6% used home care (€522), and 3.5% used institutional care (€1,125). Home care users – and to a greater extent

TABLE 5.1 Description of LTC estimation sample (weighted; standard deviations after ±-sign)

	TOTAL SAMPLE (N=6,512)	INSTITUTIONAL USERS SAMPLE (N=1,049)	HOME CARE USERS SAMPLE (N=679)
LTC consumption			
LTC use (%)	14.7	100.0	100.0
Mean LTC costs	1,647 ± 8,167	32,617 ± 26,961	5,124 ± 8,257
Institutional LTC use (%)	3.5	100.0	3.2
Mean Institutional LTC costs	1,125 ± 7,778	32,081 ± 27,092	619 ± 5310
Home care use (%)	11.6	10.6	100.0
Mean home care costs	522 ± 2,569	536 ± 2,410	4504 ± 6249
Demographics			
Age	67.6 ± 9.4	83.1 ± 7.6	77.0 ± 8.7
Male (%)	45.7	25.1	25.3
Disability (%)			
Non-disabled	66.8	6.3	20.9
Mildly disabled	30.7	23.3	78.6
Severely disabled	2.5	70.4	0.5

institutional users – were older, more often female and more often disabled. The prevalence of mild disability was lower for institutional residents than home care users because the institutionalized are more often severely disabled.

LTC spending by age, sex and disability

Figure 5.1 displays home care and institutional LTC use and spending by age, sex, and disability status. The first, second and third rows present the predicted probabilities of use, conditional expenditures, and expected expenditures, respectively. The probability of using LTC and the level of (un)conditional spending increase with the severity of disability. Home

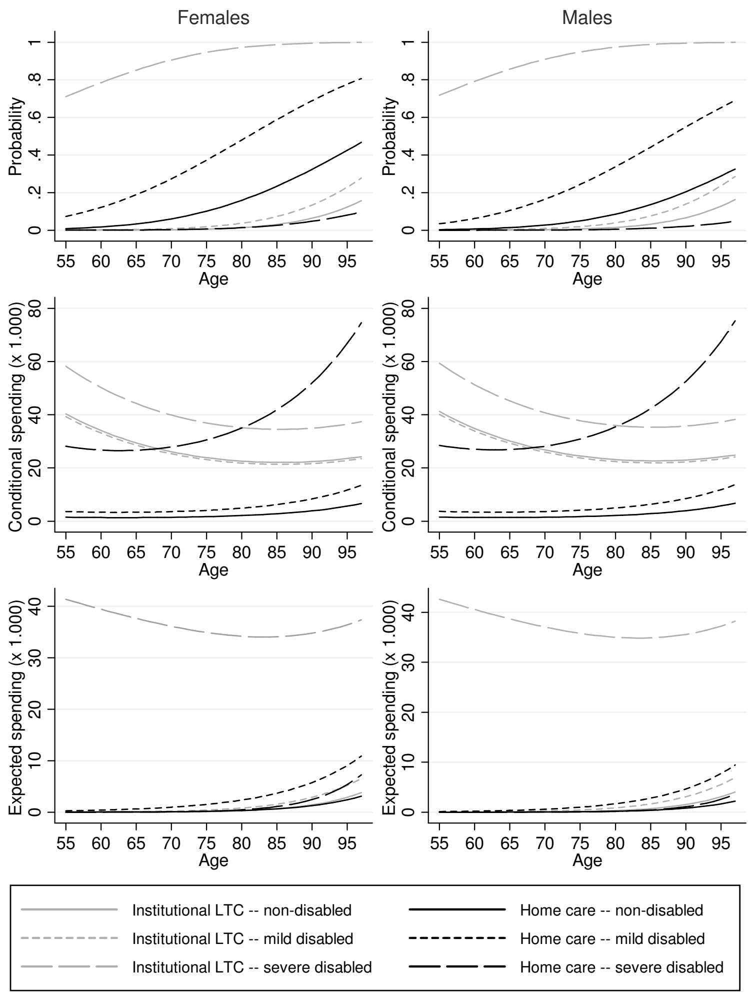

FIGURE 5.1 LTC use and (un)conditional spending stratified by age, sex and disability status

care use and spending, however, is highest for the mildly disabled elderly; the severely disabled elderly are more likely to be institutionalized. The probability of using home care or institutional LTC increases with age. Conditional home care spending increases and institutional LTC spending decreases with age. The latter finding is caused by the fact that the

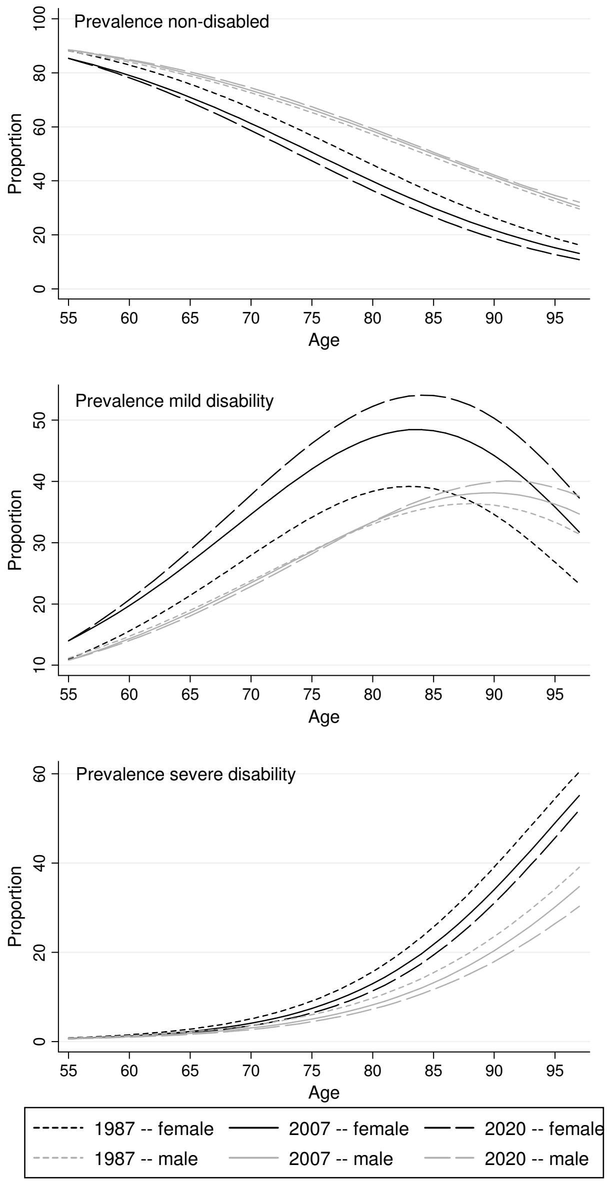

FIGURE 5.2 Trends in mortality rates and disability prevalence stratified by age and sex

younger institutional LTC users are rarely admitted to residential homes (the least expensive LTC institution) but more often to somatic nursing homes. Females are more likely to use both types of LTC and spend on average more than males. This finding could either be due to their higher morbidity level or lower availability of adequate informal care sources. No substantial differences in conditional expenditures were found between males and females. The difference in unconditional expenditures is thus driven mainly by the probability of using LTC.

Disability prevalence trend

Figure 5.2 presents the trend in mild and severe disability prevalence. The proportion of non-disabled elderly decreased for females, but remained fairly constant for males. The higher disability rates among females are entirely driven by increases in mild disability. Mild disability rates also increased for males, but less seriously. The prevalence of severe disability decreased for both sexes and is expected to further decrease the coming years.

(DF)LE trend

The trend in life expectancy (LE) at age 55 stratified by disability status is illustrated in figure 5.3. LE at age 55 will continue to increase, but more for males than for females. LE for males is expected to increase by 2.0 years, from 24.9 (2008) to 26.9 (2020); for females it is expected to increase by 1.1 years (28.6 to 29.7). For both sexes, the number of severely disabled

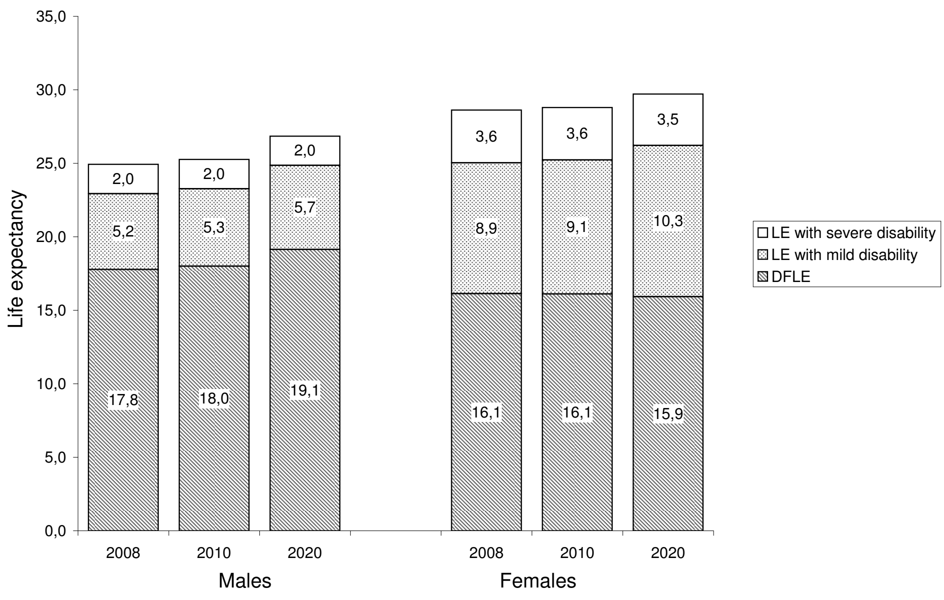

FIGURE 5.3 Trend in life expectancy at age 55 stratified by life years with no, mild and severe disability

life years will remain constant, but the number of mildly-disabled life years will probably increase. For females, the expected increase in life years with mild disability dominates the total increase in LE, resulting in a slight decrease of absolute LE years without disability. A relative compression of severe disability accompanying an expansion of mild disability is estimated for both sexes. In 2008, 8.0 (13.0) percent of the remaining LE for males (females)

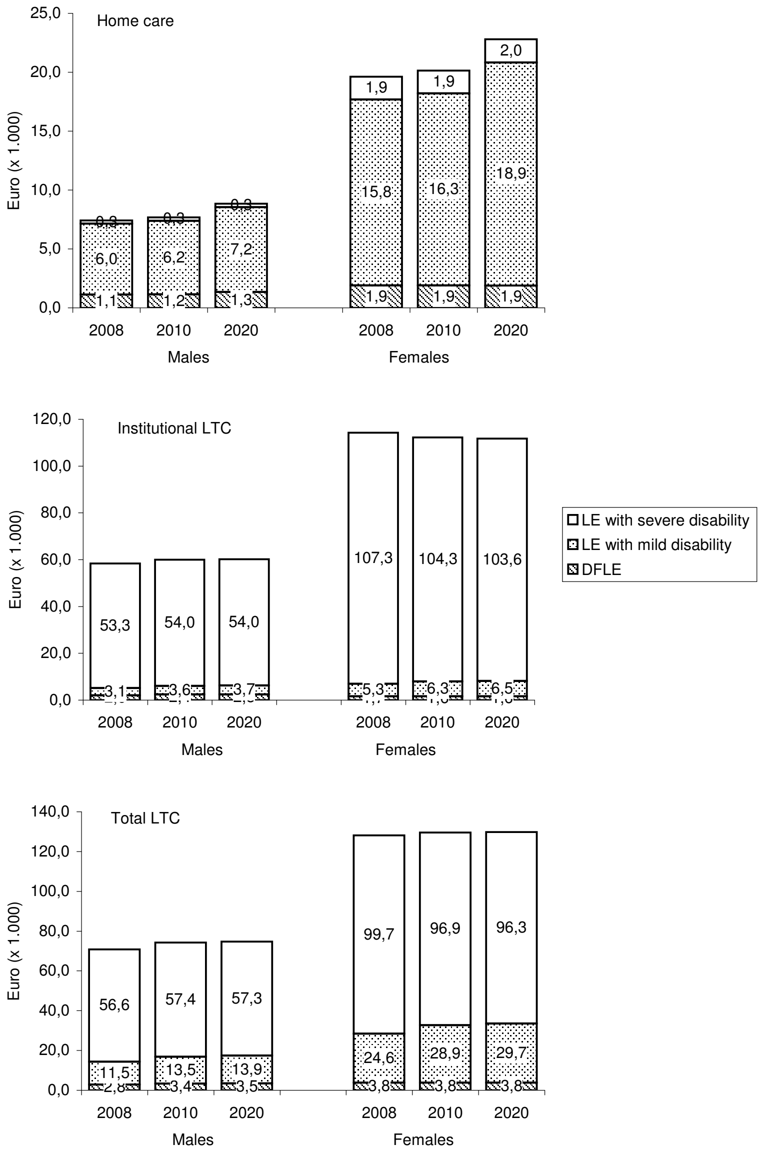

FIGURE 5.4 Trend in lifetime spending from the age of 55 accounting for the disability trend

was spent severe disability; this is expected to decrease to 7.0 (12.0) percent by 2020. The proportion of life years lived with mild disability is expected to increase from 20.7 to 22.1 percent for males and from 31.0 to 35.0 percent for females. Overall, the proportion of DFLE will remain constant for males and decrease for females.

Lifetime spending forecasts

Figure 5.4 presents lifetime spending per capita at age 55 stratified by LTC service. Females spend about twice as much as males on both LTC services. Home care spending is expected to increase by €1416 for males and €3169 for females. Most of the growth is caused by the expansion of mild disability as most spending on home care is incurred during mildly disabled life years. The bulk of institutional LTC spending is incurred during severely disabled life years. The pattern of lifetime spending on institutional LTC therefore coincides with the trend in severely disabled life years: lifetime institutional LTC spending slightly increases for males and decreases for females. Overall, total spending on LTC is expected to increase by €3836 (5.4 percent) for males and €1694 (1.3 percent) for females. Additional LTC spending per life year gained is €1585 for males and €1540 for females.

Aggregated spending forecasts

The effect of the increasing number of elderly and the oldest of the old becomes apparent in the aggregated spending forecasts. Accounting for the trend in disability prevalence, aggregated LTC spending for the 55+ population is expected to increase from €22.0 to €26.2 billion between 2008 and 2020, a 19.2 percent growth. Increased use of institutional LTC is responsible for about three quarters of the total aggregate growth in LTC spending.

5.4 DISCUSSION

We have forecasted lifetime and aggregated LTC spending among the Dutch 55+ population out to 2020. Our approach goes beyond earlier efforts in that (i) our forecasts explicitly account for changes in disability patterns and longevity with and without mild and severe disability, and (ii) we distinguish forecasts of home care and institutional LTC expenditures.

There are several notable findings. First, disability trends depend on the severity of disability. A prevalence shift has been observed from severe to mild disability. Concerning DFLE, a simultaneous compression of severe and expansion of mild disability prevails. For females, the proportion of non-disabled years is expected to decrease. Second, lifetime spending for females is approximately double that of males primarily because females have a higher LE (with disability) and secondarily because they more often rely on formal care in the absence of informal care sources. Third, future longevity gains coinciding with a compression of severe disability are not very costly. Home care is mainly used during life years with mild disability; institutional LTC is strongly associated with severe disability. As such, a compression of severe and expansion of mild disability will increase lifetime spending on the least intensive LTC service: home care. Finally, the substantial effect of population aging on aggregate LTC spending reflects the substantial growth of the elderly cohort. Given such dramatic growth in future public LTC spending, changes in LTC financing might be necessary to keep LTC provision efficient and equitable.

Recent studies have found that disability is the main determinant of LTC use and spending, which is reflected in the tremendous effect of the disability trend on lifetime and aggregate LTC spending (Lubitz *et al.*, 2003; Manton, Gu, and Lamb, 2006; de Meijer *et al.*, 2009, 2011). Our study revealed that disability profiles in the Netherlands have improved. Evidence from other countries, however, especially the US, found a declining mild disability trend while our study found a prevalence shift from severe to mild disability (Jacobzone *et al.*, 1998; Waidmann and Liu, 2000; Freedman, Martin, and Schoeni, 2002; Stallard, 2007; Manton, Gu, and Lamb, 2006). Most studies, however, define mild disability as the inability to perform instrumental activities of daily living. Our conclusions therefore do not necessarily contradict previous findings. Our results do, however, confirm previous evidence of a compression of life years with severe disability and an expansion of life years with mild disability (Perenboom *et al.*, 2004).

We expect the observed decline in disability prevalence and DFLE to be partly explained by improvements in health status. Simultaneous to the disability decline, however, the prevalence of chronic conditions has reportedly increased (Parker and Thorslund, 2007; Jang and Kim, 2010). Moreover, the relationship between disability and health status has been proven to depend on personal capacity and environmental factors. The observed decline in disability could therefore at least to some extent be caused by environmental improvements that allow greater independence given a certain level of body functioning, such as changes in the perception of disability, reduced informal care, or technological improvements like electronic shopping and easy-to-prepare meals (Spillman, 2004; Wolf, Hunt, and Knickman, 2005; Parker and Thorslund, 2007). Further research should disentangle the causes of the disability decline to improve prognoses and possibilities of a continuation of it, and in turn stem LTC spending.

Most studies projecting future LTC spending based on disability trends assume that the trends are exogenous. The observed declines in disability prevalence and DFLE, however, are likely to be partly caused by the growth in acute care spending. Technological advances in the acute care sector are often able to mitigate disability – at a price. The decrease in LTC spending therefore probably occurs at the cost of the acute care sector. This is confirmed by the finding that in most developed countries, disability improvements have been accompanied by an increase in chronic diseases (Parker and Thorslund, 2007; Jang and Kim, 2010).

Our study has a number of limitations. First, our forecasts do not account for future changes in informal care availability, which have been found to co-determine formal LTC spending in developed countries (Yoo *et al.*, 2004; de Meijer *et al.*, 2011) The higher probability of females relying on formal LTC might be partly explained by the fact that they more often reside alone; even if co-residing, their partners are less likely to provide sufficient informal care. Given that our forecasts assume stable informal care availability rates, they might underestimate the future level of LTC spending as co-residence rates are expected to decrease; more importantly, increases in the female labour force and the retirement age are likely to decrease the availability of informal care. Second, our model assumes stability of the LTC expenditure function and constant prices but LTC service prices will most likely increase due to a number of reasons such as labour shortages and quality improvements in the LTC sector. A final limitation is the likely endogeneity of disability. In addition to the impact of disability on LTC use, use of LTC could in turn influence disability rates, which might bias our results.

Concluding, we have shown the importance of accounting for changing disability trends when modelling future LTC expenditures. Life extension with an improved disability profile does not substantially increase individual lifetime spending. Aggregate spending, however, will increase considerably due to the sheer number of elderly. Stimulating a compression of disability might alleviate the consequences of longevity gains and a growing elderly population on LTC spending growth.

6 The Value of Informal Care – A further investigation of the feasibility of contingent valuation in informal caregivers

with Werner Brouwer, Marc Koopmanschap, Bernard van den Berg and Job van Exel

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ABSTRACT

Including informal care in economic evaluations is increasingly advocated but problematic. We investigated three well-known concerns regarding contingent valuation (CV): (1) the item non-response of CV values, (2) the sensitivity of CV values to the individual circumstances of caring, and (3) the choice of valuation method by comparing willingness-to-pay (WTP) and willingness-to-accept (WTA) values for a hypothetical marginal change in hours of current informal care provided.

The study sample consisted of 1453 caregivers and 787 care recipients. 603 caregivers (41.5%) provided both WTP and WTA values, 983 (67.7%) provided at least one. Determinants of non-response were dependent on the valuation method; primary determinants were education and satisfaction with amount of informal care provided. Caregivers' mean WTP (WTA) for reducing (increasing) informal care by one hour was €9.13 (€10.52). Care recipients' mean WTA (WTP) for reducing (increasing) informal care by one hour was €8.88 (€6.85). Values were associated with a variety of characteristics of the caregiving situation; explanatory variables differed between WTP and WTA valuations. The differences between WTP and WTA valuations were small.

Based on sensitivity CV appears to be a useful method to value informal care for use in economic evaluations, non-response however remains a matter of concern.

6.1 INTRODUCTION

Informal care is a substantial part of total patient care, especially in situations of chronic illness and palliative care. Its costs and effects can be profound and economic evaluations should thus not ignore them (e.g. Gold *et al.*, 1996; Drummond *et al.*, 2005). Indeed, neglecting informal care is identical to considering it a zero-cost substitute for formal care, which may lead to sub-optimal allocation of resources from a societal perspective (Brouwer *et al.*, 1999; van den Berg, Brouwer, and Koopmanschap, 2004; Koopmanschap *et al.*, 2008). Economic evaluations conducted from the societal perspective therefore must consider informal care when substantially present. Neglecting informal care also implies ignoring the effect its provision may have on the health and well-being of caregivers (Hughes *et al.*, 1999; Schulz and Beach, 1999). While caregiver costs may well be deemed irrelevant from the narrower health care perspective, this is in fact not the case for the health effects associated with informal care (Bobinac *et al.*, 2010).

Even in economic evaluations that claim to adopt a societal perspective, informal care is rarely included (Stone *et al.*, 2000). A central reason is lack of knowledge and consensus on methods to value informal care in monetary terms. Recent discussion of methods to value informal care in monetary terms (e.g. van den Berg, Brouwer, and Koopmanschap, 2004; Koopmanschap *et al.*, 2008; van Exel *et al.*, 2007) has centred on the proxy good method, the opportunity cost method, contingent valuation (CV), conjoint analysis (CA), and the well-being valuation method. The first two only value the time invested in informal care (van den Berg *et al.*, 2006). CV and CA give a total value of informal care based on caregivers' hypothetical preferences (van den Berg *et al.*, 2005a-c). The well-being valuation method gives a total monetary value of informal care based on the loss of well-being due to providing informal care (van den Berg and Ferrer-I-Carbonell, 2007).

Our study employed CV, which is increasingly used in health economics to value non-market commodities like informal care. CV studies present research subjects with a hypothetical market situation to obtain their monetary valuation of a hypothetical change in it. CV is rooted in applied welfare economics and has been promoted in health economics since the early 1990s (Johannesson and Jonsson, 1991), although it is still controversial (Cookson, 2000; Blumenschein *et al.*, 2001; Frew, Whynes, and Wolstenholme, 2003). Its major advantage is the (theoretical) possibility to value the full impact of providing or receiving informal care, sensitive to the individual situation and reflecting the preferences of caregivers and care recipients (van den Berg *et al.*, 2005c). However, there also are some concerns regarding the use of CV to value informal care. This study researched the method and its controversy in a threefold manner. Using a sizeable sample of Dutch caregivers and care recipients, we investigated (1) non-response to CV questions, (2) the sensitivity of CV values to the individual circumstances of the caring situation, and (3) the choice of valuation method by comparing willingness to pay (WTP) and willingness to accept (WTA) values.

A first concern relates to the *feasibility* of the CV method. Respondents may find answering CV questions to value informal care difficult or even awkward (Smith and Wright, 1994). They may dislike thinking of informal care in terms of money or have ethical objections against putting a 'price' on care provided to a loved one. Consequently, respondents may refuse to answer CV questions or give protest answers (e.g. zero) leading to a high and potentially selective non-response and answers that do not reflect true preferences. Moreover, respondents may not always have well-developed preferences, leading to starting-point bias or anchoring of answers, e.g. payment for domestic help, for instance, is a reference point for the value of informal care resulting in a higher CV value of informal care among caregivers having a domestic help (van Exel *et al.*, 2006). The feasibility of a CV study to value informal care is then put into question. Although its feasibility in this context appears to be good at first glance (van den Berg *et al.*, 2005b-c), it cannot be determined without an in-depth non-response analysis, which to our knowledge did not exist. This study adds to the literature by analysing the selectivity of item non-response in caregivers' CV using a broad range of characteristics and care situations. Because less than 5 percent of the sample reported protest answers, these are not analysed.

A second concern relates to the sensitivity of the CV method. Although CV is sensitive to the individual circumstances of caring in theory, it is unclear in practice. Van den Berg *et al.* (2005b-c) provide evidence indicating that CV is sensitive to caregiving circumstances. We complement these studies by using a larger sample and a greater variety of characteristics of the informal care situation, and by introducing the possibility to obtain CV values for various informal care tasks – an important aspect of sensitivity. This enables us to test the sensitivity of CV values against a broad range of caregiving characteristics.

A final concern relates to the *valuation method*, that is, WTP or WTA. While standard economic theory suggests that WTP and WTA should yield approximately the same value, previous studies have shown that WTA values systematically exceed WTP values by a ratio of 2:1 or more (Bromley, 1995; Brown and Gregory, 1999; Shefrin and Caldwell, 2001). The theoretical reasons for this disparity (Kahneman and Tversky, 1979; Smith, 2003) notwithstanding, it leads us to question which method best reflects the 'true' value of, in this case, informal care. According to (Bromley, 1995) WTP is more appropriate when asking people to value a potential welfare gain (i.e., the buyer's perspective) and WTA when valuing a potential welfare loss (i.e., the seller's perspective). This argues in favour of using WTA values in the informal care setting, since it involves 'selling' time in order to provide informal care (van den Berg *et al.*, 2005c). On the other hand, WTP is sometimes favoured over WTA as it provides a lower bound valuation and it confronts respondents with a budget constraint. In practice this is also the method most studies use by referring to the NOAA Panel recommendation (Arrow *et al.*, 1993). Because there are arguments in favour of both, and because CV studies applied to informal care have so far revealed only relatively small differences between the values (van den Berg *et al.*, 2005b), this study provides values for informal care by using both WTP and WTA. We thus further investigate and compare WTP and WTA, and relate their differences to respondents' characteristics.

In the following pages we discuss the sample, measures and analysis (section 2); the results (section 3); and overall findings and conclusions (section 4).

6.2 METHODS

Sample

We conducted a secondary analysis on a pooled dataset from two Dutch cross-sectional studies among informal caregivers and their care recipients. The data for these studies were collected by sending (nearly) identical postal questionnaires to sample respondents registered at informal care support centres (van Exel *et al.*, 2002) and the association of personal care budget-holders[16] (van den Berg *et al.*, 2002). Separate questionnaires were used for caregivers and care recipients. The pooled dataset consisted of 1453 caregivers aged 18 years and older and 832 care recipients, all with a matching caregiver. Part of the caregiver and care recipient data had previously been reported in van den Berg *et al.* (2005b).

Measures

The outcome variables in this study were WTP and WTA values for hypothetical marginal changes in the current level of informal care giving. Caregivers were asked about their willingness to pay (accept) for one less (more) hour of informal care per week. Care recipients were asked about their willingness to pay (accept) for one more (less) hour of informal care per day. WTP and WTA were measured using an open-ended question format (Appendix 6.1). A limitation is the interpretation of the care recipients WTP: How do we interpret a hypothetical internal household transfer? We return to this in section 6.4.

WTP and WTA values could also be related to the *type* of informal caregiving tasks. Caregivers and care recipients were asked which of five tasks – domestic help, personal care, outdoor mobility, organisational tasks, or social support – they would prefer to give (receive) one hour more (less) of. Respondents could also opt for not reducing (increasing) informal care hours. Furthermore, caregivers were asked to give an alternative use for the hour gained (lost): paid work, unpaid work, or leisure time.

Although CV values are not normally distributed, no log-transformation was applied since a squared-root transformation of CV values better approached the normal distribution than a log-transformation. The models with the squared root CV values as dependent

16 In the literature the personal care budget is sometimes referred to as cash benefits, consumer directed services, or direct payments.

variable had similar results to the models with the untransformed CV values. For ease of interpretation we chose not to transform the values.

The questionnaires also elicited a broad range of characteristics of the caregiver, care recipient and the caregiving situation. Caregiver and recipient health status were assessed using the EQ-VAS (The EuroQol Group, 1990). Additionally, the change in health status over the last 12 months was measured by a categorical question, i.e., 'has it deteriorated?' Furthermore, caregivers were asked whether the health complaint of the care recipient was physical, mental, or both. The Frenchay Activity Index (FAI) was included in the care recipient's questionnaire (Holbrook and Skilbeck, 1983; Turnbull *et al.*, 2000). FAI scores were reversed to a 0 to 10 scale for comparability with other measures, i.e., higher FAI scores now represented a lower functional ability. Objective burden of the caregiver was measured by total time[17] and total number of informal care tasks provided using a list of 16 pre-specified (instrumental) activities of daily living (van den Berg *et al.*, 2002; van Exel *et al.*, 2002). Subjective burden was assessed using both the Self-Rated Burden (SRB) scale (van Exel *et al.*, 2004) and the Caregiver Strain Index (CSI; Robinson, 1983). Process utility from providing informal care was measured for both caregivers and care recipients. Respondents were asked to rate their happiness on a 0 to 10 scale for (1) their current situation and (2) a situation without providing (receiving) informal care. Process utility is the difference between those values (Brouwer *et al.*, 2005). Finally, socio-demographic and socio-economic measures for caregiver and care recipient were elicited, as well as whether a care recipient received a personal care budget (PCB). Both socio-economic measures and PCB were expected to influence the CV value since it is obviously related to ability to pay. Net household income was measured as an ordinal variable. Income was included in the analysis as a dichotomous variable indicating whether the net household income was above or below median for caregivers (€1569 (fl. 3500)) and care recipients (€1121 (fl. 2500)). Appendix 6.2 presents a complete list of selected variables.

Analysis

First, we analysed item non-response to the CV questions. We restricted this to caregiver data since caregiver valuation of informal care is the primary measure used in economic evaluations. The relationship between response, caregiver characteristics, and caregiving situation was explored by using univariate chi-square and t-tests followed by a multivariate logit with the dependent variable being "provided at least one of the two CV values" ($p<0.05$).

Second, we explored the sensitivity of WTP and WTA values among caregivers and care recipients using OLS. A distinction was made in the caregiver sample between those below

17 Time per task and total caregiving time were maximized at 126 hours per week (18 hours per day * 7 days per week).

and over the age of 65 years, the formal pension date in the Netherlands. The underlying hypothesis was that labourers and pensioners have different role responsibilities, claims on their time, and expectations of life (e.g. professional career, caring for children, quiet old age) and consequently provide different values. The analysis of care recipient values was restricted to people 18 years or older because we assumed the valuation task might be too complex for minors. This was confirmed by the fact that 93.3 percent of the care recipients below the age of 18 did not provide a value. Using OLS, a core set of explanatory variables was entered into each model: age, gender, health status, care intensity (number of caregiving tasks) and duration of the informal care relationship. SRB was forced only in the caregiver model.[18] Because of the explorative nature of this study, the large number of characteristics, and the broad heterogeneity of the dataset in caregiving situations, a stepwise procedure was used for the other variables with a fairly generous significance level (.20) for adding variables to the model.

Finally, we investigated differences in WTP and WTA values provided by caregivers and care recipients. It is important to note that comparability of these values was restricted by several factors. First, the WTA question referred to public financing and WTP to out-of-pocket expenses (appendix 6.1). Different budget constraints thus enter in and may lead to variance with respect to mental accounting. Therefore we had to be cautious with interpreting *intra-personal* comparisons of WTP and WTA values. Second, the caregiver questions referred to a change of one hour per *week* whereas the care recipient questions referred to a change of one hour per *day*. There is no acceptable way to rescale these values to make them comparable. Perhaps more important is that an hour of informal care is not equivalent in the minds of caregivers and care recipients. Losing an hour of informal care is undoubtedly more meaningful to the recipient than the caregiver and therefore should be valued higher in recipient response. For these reasons the values provided by caregivers and care recipients cannot be compared directly, that is, *inter-personally*. We thus focused on exploring the characteristics of caregivers who provided a higher WTP than WTA value. This subgroup is most interesting because it behaves counterintuitively.[19] A WTP to supply one hour less that exceeds a WTA to supply one hour more implies a negatively sloped supply curve and thus a strong latent resistance to reduce the amount of caregiving and a strong latent preference for extending their informal care supply. We hypothesize that this subgroup of caregivers derives substantial *process utility* from providing informal care (Brouwer *et al.*, 2005). We focus on caregivers for two reasons: (1) the value of informal care in economic evaluations is usually based on caregiver valuations; (2) the caregiver sample is much larger, yielding more robust data. The WTP/WTA disparity was analysed using univariate analyses ($p<.05$).

18 SRB was selected as measure of subjective burden since it was more strongly correlated with the CV values than the CSI score.

19 In discussions of the WTP/WTA disparity, WTA is commonly found to be (much) higher than WTP (e.g. Bromley, 1995; Brown and Gregory, 1999; Shefrin and Caldwell, 2001).

6.3 RESULTS

Sample characteristics

Of the 1453 caregivers, 1087 (74.8%) were 18-64 years old and 366 (25.2%) were 65 or older. All 787 care recipients were older than 18. Table 6.1 presents the characteristics of the caregivers and care recipients who responded to at least one CV question. Caregiver data between the two age groups is considerably different. Apart from the characteristics that normally coincide with older age, the sample of caregivers 65+ consisted of more males; the duration of the caregiving relationship was shorter; the caregiver was more often the sole caregiver; the caregiver more often provided care to a partner; cohabitation with the care recipient was more common; caregiver educational level was lower; the caregiver more often had domestic help; the care recipient more often had a mental health problem; the care recipient more commonly had a PCB; and the preferred task to give up or get more of (at the expense of social support) was more often domestic help.

Response

746 (51.3%) caregivers provided a WTP value for one hour less informal care; 840 (57.8%) a WTA value for one hour more informal care; 603 (41.5%) for both; and 983 (67.7%) for one of the two values. 41 provided a zero WTP value and 32 a zero WTA value. Table 6.2 compares the characteristics of caregivers who provided at least one CV value and those providing no CV value (univariate analysis). A range of variables is significantly associated with responding to CV questions. A multivariate analysis (n=919) showed that only a lower educational

TABLE 6.1 Descriptive statistics study sample

	CAREGIVERS						CARE RECIPIENTS	
	TOTAL SAMPLE (N=983)		AGE 18-64 (N=785; 79.9%)		AGE 65+ (N=198; 20.1%)		TOTAL SAMPLE (N=289)	
VARIABLE	STAT.	S.D.	STAT.	S.D.	STAT.	S.D.	STAT.	S.D.
Age (mean)	54.4	13.1	49.7	9.8	73.3	5.4	67.7	17.2
Male (%)	29.1		25.7		42.4		47.9	
Duration (mean)	161.5	134.8	168.1	138.5	134.1	114.6	110.1	92.7
Intensity (mean)	7.8	3.7	7.7	3.7	8.1	3.5	8.0	3.6
Health status (mean)	72.4	16.7	73.1	17.0	69.9	15.5	48.6	20.0
Health deteriorated (%)	16.1		15.0		20.4		58.3	
FAIrev (mean)							7.4	1.9
Self-rated burden (mean)	54.3	26.8	53.7	26.8	56.8	26.6		
Relationship: partner (%)	45.4		37.4		77.4		59.6	

TABLE 6.1 Descriptive statistics study sample (table continued)

	CAREGIVERS						CARE RECIPIENTS	
	TOTAL SAMPLE (N=983)		AGE 18-64 (N=785; 79.9%)		AGE 65+ (N=198; 20.1%)		TOTAL SAMPLE (N=289)	
VARIABLE	STAT.	S.D.	STAT.	S.D.	STAT.	S.D.	STAT.	S.D.
Relationship: parent (%)	23.0		27.6		4.6		20.2	
Relationship: child (%)	15.7		17.8		7.2		6.3	
Relationship: other (%)	15.9		17.2		10.8		13.9	
IC network (mean)							1.9	1.3
IC: single caregiver (%)	53.9		51.5		63.4		53.6	
Co-residence (%)	61.8		56.9		81.5		65.6	
Child(ren) <18y (%)	27.9		33.0		7.3			
Education low (%)	30.5		28.3		39.6		51.1	
Education middle (%)	47.4		47.7		45.8		34.9	
Education high (%)	22.1		23.9		14.6		14.0	
Employment PT (%)	22.6		27.7		2.1			
Employment FT (%)	14.4		17.9		0.0			
Breadwinner (%)	43.5		42.3		48.1			
Income high (%)	48.6		49.4		45.5		30.0	
Domestic help (%)	40.1		33.4		66.7		22.4	
HC: physical (%)	86.2		86.1		86.9			
HC: mental (%)	36.8		35.0		44.0			
PU negative (%)	32.8		33.5		30.2		11.2	
PCB (%)	50.7		57.1		24.6		18.4	
AltTime: paid work (%)	26.6		32.2		2.2			
AltTime: unpaid work (%)	15.3		15.6		14.0			
AltTime: leisure (%)	74.5		73.1		80.4			
Less IC: domestic help (%)	40.8		39.2		47.6		31.3	
Less IC: personal care (%)	12.7		13.1		11.0		15.4	
Less IC: mobility (%)	10.4		10.1		12.0		17.6	
Less IC: organisation (%)	5.3		5.3		5.2		18.0	
Less IC: social (%)	12.6		13.9		7.3		17.6	
Less IC: no (%)	18.1		18.4		16.8			
More IC: domestic help (%)	29.5		26.4		42.2		24.2	
More IC: personal care (%)	15.6		15.8		14.4		12.6	
More IC: mobility (%)	19.3		20.1		16.0		22.4	
More IC: organisation (%)	5.1		5.2		4.8		8.3	
More IC: social (%)	19.4		21.3		11.8		32.5	
More IC: no (%)	11.1		11.2		10.7			

Note: see Appendix 6.2 for glossary

TABLE 6.2 Response analysis

VARIABLE	CAREGIVERS		
	CV VALUE (N=983)	NO CV VALUE (N=470)	T-VALUE
Age (mean)	54.4	59.5	6.89
Male (%)	29.1	25.7	-1.35
Duration (mean)	161.5	148.3	-1.69
Intensity (mean)	7.8	7.1	-2.92
Health status (mean)	72.4	72.0	-0.42
Health deteriorated (%)	16.1	17.0	0.45
Self-rated burden (mean)	54.3	51.6	-1.59
Relationship: partner (%)	45.4	44.6	-0.29
Relationship: parent (%)	23.0	20.0	-1.30
Relationship: child (%)	15.7	12.4	-1.72
Relationship: other (%)	15.9	23.0	3.12
IC: single caregiver (%)	53.9	61.7	2.77
Co-residence (%)	61.8	56.7	-1.82
Child(ren) <18y (%)	27.9	20.9	-2.91
Education low (%)	30.5	44.1	4.91
Education middle (%)	47.4	42.1	-1.87
Education high (%)	22.1	13.8	-3.94
Employment PT (%)	22.6	15.7	-3.19
Employment FT (%)	14.4	9.8	-2.56
Breadwinner (%)	43.5	41.2	-0.77
Income high (%)	48.6	39.5	-3.15
Domestic help (%)	40.1	40.5	0.14
HC: physical (%)	86.2	82.1	-1.96
HC: mental (%)	36.8	43.0	2.24
PU negative (%)	32.8	25.9	-2.53
PCB (%)	50.7	44.4	-2.16
AltTime: paid work (%)	26.6	12.3	-6.56
AltTime: unpaid work (%)	15.3	15.5	0.10
AltTime: leisure (%)	74.5	72.9	-0.60
Less IC: domestic help (%)	40.8	23.3	-6.48
Less IC: personal care (%)	12.7	9.7	-1.64
Less IC: mobility (%)	10.4	11.8	0.70
Less IC: organisation (%)	5.3	5.1	-0.13
Less IC: social (%)	12.6	10.7	-0.98
Less IC: no (%)	18.1	39.4	7.56
More IC: domestic help (%)	29.5	19.0	-4.15
More IC: personal care (%)	15.6	10.4	-2.58

TABLE 6.2 Response analysis (table continued)

VARIABLE	CAREGIVERS		
	CV VALUE (N=983)	NO CV VALUE (N=470)	T-VALUE
More IC: mobility (%)	19.3	17.6	-0.74
More IC: organisation (%)	5.1	4.1	-0.79
More IC: social (%)	19.4	17.9	-0.66
More IC: no (%)	11.1	31.0	7.59

level and care task preferences increased non-response. With regard to the latter, caregivers who did not want to increase their informal care hours at all were less likely to respond to at least one CV value. However, caregivers who preferred to reduce domestic help, personal care, or social support (reference group: no reduction) were more likely to respond to at least one CV value. Caregivers satisfied with the amount of care they provided were thus less likely to respond to CV questions.

Providing a WTP value but not a WTA (n=143) was more likely among caregivers who provided more care tasks; provided more hours of care; were part of a wider informal care network; experienced higher subjective burden or negative process utility; had a higher educational and income level; were employed fulltime; had domestic help; provided care to a partner or household member; preferred to increase or decrease domestic help, outdoor mobility, or personal care tasks; did not want to increase care tasks at all; and/or would use alternative time for leisure. Providing a WTA value but not a WTP (n=237) gives exactly a mirror image of the above group.

Of the care recipients in the sample, 261 (33.2%) provided a WTP value for one more hour of care, 251 (31.9%) a WTA value for one fewer hour of care, 223 (28.3%) for both values, and 289 (36.7%) for one of each. No response analysis was conducted.

WTP and WTA of caregivers

Caregivers' average WTP value for one fewer hour per week was €9.13 with a skewed distribution to the right (SD 5.81; min 0.0; max 40.84; 25%/75% percentiles 6.81/11.34). Caregivers' average WTA value for one extra hour was €10.52 (SD 6.79; min 0.0; max 45.37; 25%/75% percentiles 6.81/11.34). Figures 6.1a-c present the distribution of the CV values and WTP/WTA disparity. Caregivers in the older group provided significantly lower WTP (€7.89 vs €9.44, t=6.82) and WTA (€9.19 vs €10.82, t=4.86) values.

Table 6.3 explains the caregivers' WTP for one hour less informal care, which is significantly associated with the type of informal care task. The average WTP ranged from €6.75 for not willing to give up an hour informal care to €10.93 for one fewer hour of organisational tasks. The valuations (i.e. coefficients) of personal care, mobility, and social help did not differ greatly. The relation between health and WTP had a parabolic shape with

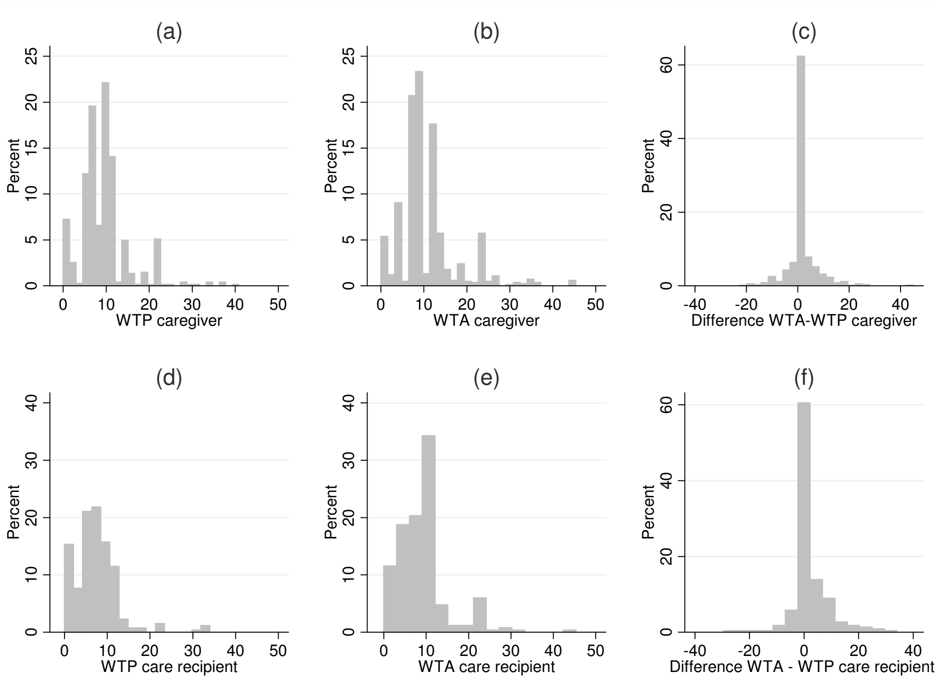

FIGURE 6.1 Caregivers' and care recipients' CV values in euro's

the maximum at nearly 85 on the 0-100 health scale. Up to a health score of 85, health was positively associated with the WTP; beyond that health has a negative effect on WTP. Additionally, the WTP of caregivers with a deteriorating health is €1.18 higher than the WTP of caregivers with a stable or improving health, ceteris paribus (p=0.09). Furthermore, the WTP of caregivers with above average incomes and caregivers who provide care to their own child is higher. Finally, caregivers who take care of a PCB-holder have on average a €2.68 higher WTP value. Having a higher education level or a part-time job is close to being significant in increasing the WTP value.

As expected, marked differences were found between the age groups. As table 6.3 shows, health status, taking care of a child, taking care of a PCB-holder and a higher than average income only have significant influence on WTP for the younger group. The type of care task is less important for the older population; only providing one hour less of organisational help results in a significantly higher WTP, especially compared to the younger group (a coefficient of 12.01 versus 3.1). Older group caregivers whose health had deteriorated in the previous year and those with higher education levels had significantly higher WTP values. Last, the explanatory power of the model is substantially higher for the older age group (0.31 vs. 0.14).

TABLE 6.3 Caregivers' willingness to pay for one hour less informal care

	WILLINGNESS TO PAY								
	TOTAL SAMPLE (N=578)			AGE 18-64 (N=474; 81.9%)			AGE 65+ (N=104; 18.1%)		
VARIABLE	COEF.	S.E.	T	COEF.	S.E.	T	COEF.	S.E.	T
Age *	-.006	.022	-0.25	-.005	.031	-0.15	-.051	.089	-0.58
Male *	-.880	.570	-1.54	-1.095	.662	-1.65	.304	1.014	0.30
Duration	.013	.009	1.44	.0127	.010	1.21	-.000	.004	-0.04
Duration^2	-.000	.000	-1.77	-.000	.000	-1.58			
Intensity	.094	.073	1.28	.065	.083	0.78	.028	.138	0.20
Health status *	.170	.076	2.24	.175	.081	2.17	-.025	.035	0.71
Health status^2	-.001	.001	-2.08	-.001	.001	-2.16			
Health deteriorated	1.184	.705	1.68				3.476	1.193	2.91
Self-rated burden *	-.006	.011	-0.51	.003	.012	0.22	-.0160	.018	-0.87
Relationship: child	1.592	.677	2.35	1.480	.727	2.03			
Education middle							2.431	1.014	2.40
Education high	.988	.572	1.73	1.210	.629	1.92	2.280	1.380	1.65
Employment PT	.974	.587	1.66	.762	.613	1.24	5.009	3.213	1.56
Income high	1.533	.493	3.11	1.658	.557	2.98			
Domestic help	.632	.519	1.22	.735	.597	1.23			
PCB	2.679	.662	4.05	3.207	.737	4.35			
AltTime: unpaid work							2.341	1.244	1.88
Less IC: domestic help	1.444	.894	1.62	1.419	.985	1.44			
Less IC: personal care	3.078	1.059	2.91	3.745	1.166	3.21			
Less IC: mobility	3.709	1.084	3.42	3.981	1.204	3.31			
Less IC: organisation	4.553	1.312	3.47	3.108	1.448	2.15	12.01	2.349	5.11
Less IC: social	3.714	1.062	3.50	4.204	1.164	3.61			
Constant	-2.320	3.019	-0.77	-2.312	3.325	-0.70	7.534	7.508	1.00
Adjusted R^2	.14			.14			.31		

Note: * variable forced into the model, other variables introduced stepwise (see Appendix 6.2 for glossary). The variables *Age^2, Intensity^2, Self-rated burden^2, Relationship: partner, Relationship: parent, Co-residence, IC: single caregiver, Child(ren) <18y, Employment FT, Breadwinner, HC: physical, HC: mental, PU negative, AltTime: paid work, AltTime: leisure* were omitted from this table because these variables were not picked up by any of the models.

Table 6.4 indicates that caregivers' WTA value of one extra hour of informal care is positively related to subjective burden, a high education level, an above average income, having domestic help, paid work as an alternative use of time, taking care of a person with either physical or mental health problems, taking care of a PCB-holder, and a preference for organisational tasks. The duration of the care situation had a parabolic shape with a maximum of approximately 13 years. Up to 13 years, informal care was positively associated with the WTA; beyond that duration has a negative effect on WTA.

TABLE 6.4 Caregivers' willingness to accept one hour more informal care

VARIABLE	WILLINGNESS TO ACCEPT								
	TOTAL SAMPLE (N=639)			AGE 18-64 (N=529; 82.8%)			AGE 65+ (N=110; 17.2%)		
	COEF.	S.E.	T	COEF.	S.E.	T	COEF.	S.E.	T
Age *	.205	.122	1.68	.060	.032	1.88	.020	.116	0.17
Age^2	-.002	.001	-1.65						
Male *	-.658	.598	-1.10	-1.371	.671	-2.04	.592	1.210	0.49
Duration *	.025	.009	2.59	.026	.011	2.47	-.004	.006	-0.74
Duration^2	-.000	.000	-3.22	-.000	.000	-3.06			
Intensity *	.137	.081	1.69	.198	.089	2.22	-.257	.178	-1.44
Health status *	.003	.016	0.20	.008	.018	0.43	-.001	.038	-0.02
Self-rated burden *	.035	.011	3.17	.033	.012	2.63	.073	.023	3.13
Child(ren) <18y	-.999	.661	-1.51						
Education high	2.067	.636	3.25	2.416	.687	3.52			
Income high	1.124	.546	2.06	.925	.589	1.57	2.392	1.195	2.00
Domestic help	1.202	.576	2.09	1.528	.648	2.36			
HC: physical	1.871	.860	2.18	1.526	.966	1.58	3.546	1.776	2.00
HC: mental	1.597	.652	2.45	1.867	.749	2.49			
PCB	2.852	.695	4.10	2.998	.750	4.00			
AltTime: paid work	2.572	.627	4.10	2.071	.645	3.21	7.473	3.090	2.42
More IC: domestic help	-.785	.605	-1.30						
More IC: mobility	.915	.695	1.32	3.168	1.241	2.55			
More IC: organisation	3.773	1.157	3.26	1.513	.714	2.12	8.238	2.676	3.08
More IC: social							4.624	1.856	2.49
Constant	-3.764	3.837	-0.98	-2.266	2.629	-0.86	.938	10.155	0.09
Adjusted R^2	.15			.15			.22		

Note: * variable forced into the model, other variables introduced stepwise (see Appendix 6.2 for glossary). The variables *Intensity^2, Health status^2, Health deteriorated, Self-rated burden^2, Relationship: partner, Relationship: parent, Relationship: child, IC: single caregiver, Co-residence, Education low, Employment PT, Employment FT, Breadwinner, PU negative, AltTime: unpaid work, AltTime: leisure, More IC: personal care* were omitted from this table because these variables were not picked up by any of the models.

Marked differences were again observed in the age groups. Only the impact of subjective burden, alternative time use of paid work, and preferences for providing organisational help in the extra hour informal care had significant influence on the WTA value in both groups. However, the strength of the influence is far from identical in the groups: coefficients in the older age group were more than twice as high.[20] Being female, the duration of the care,

20 We should note here that of the older caregivers who provided a WTA value, only 5 (2.0%) chose paid work for an alternative time use preference.

providing more care tasks, having a higher education, having domestic help, taking care of a mentally ill person, taking care of a PCB-holder, and a preference for mobility tasks were positively associated with the WTA value of younger caregivers. Taking care of a physically disabled person, having an above average income, and a preference for social support tasks were positively associated with the WTA value of older caregivers.

Among caregivers who provided both WTP and WTA values, the mean difference between them was €1.13 (t=51.2; see figure 6.1c). In terms of WTP/WTA disparities generally observed, this is fairly low. About half of the caregivers (54.4%) provided identical WTP and WTA values, 29.2% a higher WTA value, and 16.4% a higher WTP value. The last group (99 caregivers) did not behave as expected: what they would pay to forego an hour of caregiving was *more than* what they would have to be paid to provide another hour. This subgroup more often (1) provided care for a longer period, (2) experienced deteriorating health, (3) provided care to their own child, (4) had children below the age of 18 years, (4) had an above average income, (5) took care of someone with a PCB, and (6) preferred not to reduce hours of informal care ($p<0.05$). Our expectation that they would possibly derive more utility from providing informal care was not confirmed because the process utility variable was equal to caregivers with WTP greater than WTA. Caregivers with a higher WTA nonetheless explicitly signified that they were not willing to reduce their caregiving hours, indicating a (strong) preference to provide informal care.

WTP and WTA of care recipients

Care recipients would on average be willing to pay €6.85 (SD 5.49; min 0.0; max 34.03; 25%/75% percentiles 4.54/9.08) to get an extra hour of informal care per day. They would on average be willing to be paid €8.88 (SD 6.21; min 0.0; max 45.37; 25%/75% percentiles 4.54/11.34) to forego one hour per day. Both distributions were heavily skewed to the right (see figures 6.1e and 6.1f).

Table 6.5 presents the sensitivity of care recipients' WTP and WTA values. The WTP value for an additional hour was positively associated with age and negatively associated with functional ability, assistance with organisational tasks, and the situation where the principal caregiver had child(ren) younger than 18 years old. Close to significant were the effects of health status, PCB, and caregiver age. That *caregivers* value organisational help higher than other types of informal care while care *recipients* value it lower than other tasks is worth noting. Care recipients' WTA is only significantly influenced ($p<0.05$) by having a PCB, increasing its value on average by €4.40. Close to significant in lowering the price of forgoing an hour were functional ability and having the caregiver as a partner.

Among care recipients who provided both a WTP and a WTA value, the mean difference was €2.05 (t-value: 29.2; see figure 6.1f), which again is fairly low. 51.6% provided identical WTA and WTP values, 36.8% a higher WTA value and 11.7% (against expectations) a higher WTP value. The counter-intuitive group was too small to analyse further.

TABLE 6.5 Care recipients' willingness to pay for one hour more informal care and willingness to accept one hour less informal care

	WILLINGNESS TO PAY (N=185)			WILLINGNESS TO ACCEPT (N=184)		
VARIABLE	COEF.	S.E.	T	COEF.	S.E.	T
Age *	.062	.029	2.15	-.036	.026	-1.41
Male *	.044	.839	.05	.462	.901	.51
Duration *	-.001	.005	-.21	.003	.005	.57
Intensity *	.092	.135	.68	.164	.149	1.10
Health status *	.043	.022	1.92	.005	.022	.23
Health deteriorated	1.188	.864	1.38			
FAIrev	-2.981	1.385	-2.15	2.512	1.482	1.70
FAIrev^2	.195	.103	1.90	-.206	.107	-1.92
Relationship: partner				-1.890	1.006	-1.88
Co-residence	1.534	1.094	1.40			
Education low	-1.372	.837	-1.64	-1.273	.903	-1.41
PCB	2.189	1.122	1.95	4.399	1.090	4.04
More IC: organisation	-3.228	1.506	-2.14			
CG age	-.086	.046	-1.86			
CG child(ren) <18y	-3.429	1.275	-2.69			
CG employed				-1.611	1.027	-1.57
Constant	15.457	5.379	2.87	3.801	5.813	.65
Adjusted R^2	.13			.11		

Note: * variable forced into the model, other variables introduced stepwise (see Appendix 6.2 for glossary). The variables *Age^2*, *Duration^2*, *Intensity^2*, *Health status^2*, *Relationship: parent*, *Relationship: child*, *IC: network*, *IC: network^2*, *IC: single caregiver*, *Less IC: domestic help*, *Less IC: personal care*, *Less IC: mobility*, *Less IC: organisation*, *Less IC: social*, *More IC: domestic help*, *More IC: personal care*, *More IC: mobility*, *More IC: social* were omitted from this table because these variables were not picked up by any of the models.

6.4 DISCUSSION AND CONCLUSION

This study analysed caregivers' and care recipients' value of informal care using CV. Discrepancies between WTP and WTA values in both groups were much smaller than those normally found in the literature. On average caregivers and care recipients valued an hour informal care at €9.83 and €7.87[21] respectively, but the values varied substantially by kind of task. Caregiver and care recipient values could not be compared directly because we used different time scales and an hour less of more of care will have very different implications for the recipient and the care giver.

21 Year 2001 values. A correction of 14.4% based on the consumer price index 2001-2008 would result in equivalent year 2007 values of €11.20 and €9.00, respectively (Statistics Netherlands, 2008).

We tested CV feasibility to value informal care by investigating non-response and the sensitivity of CV to the heterogeneity of informal care situations. While univariate analysis indicated selectivity in response to a range of variables, multivariate analysis found only minor selectivity. Educational level and care task preferences alone significantly influenced non-response. Caregivers not satisfied with the current amount of informal care they provided were more likely to respond to CV questions. Consequently, caregivers' CV values might be biased upwards since we expect dissatisfied caregivers to value informal care higher than satisfied caregivers. Van den Berg *et al.* (2005c) also observed a relationship between response rates and educational level but, unlike this study, they found that older caregivers were less willing to answer CV values. We found substantial differences in the type of respondents answering WTP or WTA questions. As a result, the choice of CV method used to value informal care can result in substantial differences in terms of participating respondents. There were too few protest answers to analyse selectivity within that category.

The low exploratory power of some of the models notwithstanding, our analysis showed that WTP and WTA values were sensitive to a variety of characteristics of the caregiver, care recipient, and caregiving situation. Striking results were (1) differences in characteristics associated with WTP and WTA values, and (2) the considerable impacts of kind of care task, alternative time use (i.e., opportunity costs) and having a PCB. Noticeable differences were also found in the models explaining the CV values of caregivers above or below the age of 65. Different variables were selected and in both models their coefficients differed substantially. How stable these age group differences are is unclear. It is important to consider that the results are based on cross-sectional data. Cohort effects – changing socio-cultural values (emancipation), labour market gender ratios, individualisation, and so on – are thus not taken into account.

The number of factors associated with the CV value of care recipients was much lower. Care recipients' WTP as a monetary value of informal care has limitations in terms of comparability and interpretation. How can we interpret the willingness to pay for care provided when this represents a hypothetical internal family/household transfer? In theory, care recipients might deliberately value informal care provided by a household/family member higher. We found no evidence supporting this theory, however, since the WTP of care recipients was not associated with either caregiver-recipient relationship or co-habitation.

The results suggest that CV values are sensitive to the heterogeneity and dynamics of informal care, implying that the CV method has the capability of capturing the full effects of the informal care situation in monetary terms.

Finally, we explored the characteristics of caregivers providing WTP values to forgo one hour of care higher than WTA values to provide an additional hour of care. Such valuations are unexpected, uncommon, and not easily explained. The main conclusion may be that these caregivers showed resistance or were unwilling to reduce their informal care task. Our hypothesis that this would be related to process utility from providing care was not confirmed, indicating perhaps other reasons for preferring not to reduce informal care hours. Van Exel *et al.* (2007) found that care recipients' resistance to substituting their informal care with another type of care or a different caregiver is an important factor in some caregiving situations. We were not able to test this hypothesis with the available data.

The systematic positive association of informal care values with the care recipient having a PCB is worth noting. It raises the question of whether it is related to *ability to pay* or perhaps is a result of the introduction of economic thinking and incentives into what was a non-market situation, confirming the concerns expressed by (van den Berg and Schut, 2003) that PCBs can drive up long-term care expenditures by monetising "free" informal care. This elevating effect of a PCB can be caused by different mechanisms. First, PCB-holders and their caregivers may be more familiar with formal home care tariffs and subsequently use this as a reference point in the valuation of informal care. Second, the ability to pay informal care is substantially larger with a PCB than without one, i.e., costs are out-of-pocket. Third, most caregivers and care recipients with a PCB do not lose money by paying for informal care since it is most often provided by the partner, which amounts to paying oneself. On the other hand, PCB-holders who choose formal over informal care do lose money.

A main limitation of this study was related to the model selection. When theoretical and empirical evidence is ample enough to build an empirical model and avoid stepwise modelling, it is preferable. There is common agreement that the stepwise method can result in poor models when used improperly. The danger is especially high in the presence of multicollinearity, which increases the probability of a type II error since the standard errors of the coefficients (which affect the p-value of a coefficient) will increase, resulting in the exclusion of good predictors. However, a correlation matrix showed no correlations close to 0.80 and none of the variance inflation factors (VIF) came close to 10 (Myers, 1986). In addition, both a likelihood ratio test and a Wald test concluded that the omitted variables were not jointly significant. The robustness of the models was further tested by looking at the presence of influential outliers using Cook's distance (Cook and Weisberg, 1982). None could be identified using either the critical value of 1 for Cook's distance or the critical F-value at p=0.10. Moreover, stepwise modelling appears to be justified for exploratory model building (Wright 1997), which is the case of this study. In our particular case of variable selection from the large set of caregiver, care recipient, and caregiving situation characteristics, the literature offered insufficient guidance.

A final limitation is that the sample is not representative of Dutch informal caregivers and care recipients. Although difficult to determine, the fact that our respondents reported themselves to an informal care support centre or were members of the association of PCB holders indicates that they may represent caregivers with a higher than average caregiving burden. On the other hand, if response to the questionnaire is indeed lower among caregivers with substantial burden (the expected case), the sample may well represent a 'middle group'. Our sample also consisted of a self-selected group of people motivated to participate in this type of research. It is unclear whether the response rate to CV questions would be different among those who did not return this questionnaire, or whether these questions perhaps were the reason for not returning it. In sum, our results cannot be generalised to the wider population of informal caregivers.

In conclusion, this chapter has investigated the feasibility and sensitivity of the CV method for derivation of monetary values for informal care. Our results appear favourable in terms of the method's sensitivity but the feasibility of CV remains a matter of concern. In addition, the choice of CV method importantly influences the value of informal care as well as the type of respondents answering the CV questions. The WTA and WTP disparity estimates were much smaller than those of existing empirical literature. All in all, the use of CV appears to be a passable route to value informal care for use in economic evaluations.

APPENDICES

APPENDIX 6.1 WTP / WTA question format

Caregiver	one hour more	*Suppose the person you provide informal care to needed an additional hour of care per week and government would pay you for it. How much would you minimally want to receive from government to provide this additional hour of care?*
	one hour less	*Suppose it were possible to decrease your informal caregiving by one hour per week. Someone else would take over this hour, so that the care recipient would still receive the same amount of care. How much would you maximally be willing to pay to have this hour taken over by someone else?*
Care recipient	one hour more	*Suppose you could receive one extra hour of care per day from your principal informal caregiver and that you had to pay for this yourself. How much would you maximally be willing to pay for the extra hour of care?*
	one hour less	*Suppose you were to receive one less hour of care per day from your principal informal caregiver and government would compensate you financially for it. How much would you minimally want to receive as compensation for this hour?*

APPENDIX 6.2 Glossary

VARIABLE	EXPLANATION			
Age	Age	†	‡	*
Male	Gender (0=female; 1=male)	†	‡	
Duration	Time providing informal care (in months; maximum set to 30 years)	†	‡	*
Intensity	Number of care giving tasks (1-16)	†	‡	*
Health status	EuroQoL EQ-VAS score	†	‡	*
Health deteriorated	Health status deteriorated over last 12 months (1=yes; 0=no)	†	‡	
Functional ability	Frenchay Activity Index (reverse scored and recoded 0-10)		‡	*
Self-rated burden	Self-rated burden (0-100)	†		*
Relationship: partner	Relationship caregiver - care recipient (1=CR is partner; 0=other)	†	‡	
Relationship: parent	Relationship caregiver - care recipient (1=CR is parent; 0=other)	†	‡	
Relationship: child	Relationship caregiver - care recipient (1=CR is child; 0=other)	†	‡	
IC: network	Number of informal caregivers the care recipient has		‡	*
IC: single caregiver	Care recipient has one informal caregiver (1=yes; 0=no)	†	‡	
Co-residence	Co-residence caregiver - care recipient (1=yes; 0=no)	†	‡	
Child(ren) <18y	Caregiver has child(ren) below 18 years of age (1=yes; 0=no)	†	‡	
Education low	Caregiver's level of education is low (1=yes; 0=no)	†	‡	
Education middle	Caregiver's level of education is middle (1=yes; 0=no)	†	‡	
Education high	Caregiver's level of education is high (1=yes; 0=no)	†	‡	
Employment PT	Caregiver is employed part-time(1=yes; 0=no)	†		
Employment FT	Caregiver is employed full-time (1=yes; 0=no)	†		
CG employed	Caregiver is employed (1=yes; 0=no)		‡	
Breadwinner	Caregiver is the breadwinner (1=yes; 0=no)	†	‡	

APPENDIX 6.2 Glossary (table continued)

VARIABLE	EXPLANATION		
Income high	Caregiver has above average income in sample (1=yes; 0=no)	†	‡
Domestic help	Caregiver has domestic help (1=yes; 0=no)	†	‡
HC: physical	Care recipient's health complaints are predominantly physical (1=yes; 0=no)	†	
HC: mental	Care recipient's health complaints are predominantly mental (1=yes; 0=no)	†	
PU negative	Caregiver experiences negative process utility (1=yes; 0=no)	†	‡
PCB	Care recipient has personal care budget (1=yes; 0=no)	†	‡
AltTime: paid work	Alternative time use preference: paid work (1=yes; 0=no)	†	
AltTime: unpaid work	Alternative time use preference: unpaid work (1=yes; 0=no)	†	
AltTime: leisure	Alternative time use preference: leisure time (1=yes; 0=no)	†	
Less IC: domestic help	Preferred task to reduce: domestic help (1=yes; 0=no)	†	‡
Less IC: personal care	Preferred task to reduce: personal care (1=yes; 0=no)	†	‡
Less IC: mobility	Preferred task to reduce: outdoor mobility (1=yes; 0=no)	†	‡
Less IC: organisation	Preferred task to reduce: organisational tasks (1=yes; 0=no)	†	‡
Less IC: social	Preferred task to reduce: social support (1=yes; 0=no)	†	‡
Less IC: no	Preferred task to reduce: no reduction in any task (1=yes; 0=no)	†	
More IC: domestic help	Preferred task to increase: domestic help (1=yes; 0=no)	†	‡
More IC: personal care	Preferred task to increase: personal care (1=yes; 0=no)	†	‡
More IC: mobility	Preferred task to increase: outdoor mobility (1=yes; 0=no)	†	‡
More IC: organisation	Preferred task to increase: organisational tasks (1=yes; 0=no)	†	‡
More IC: social	Preferred task to increase: social support (1=yes; 0=no)	†	‡
More IC: no	Preferred task to increase: no increase in any task (1=yes; 0=no)	†	

Note: † variable included in caregiver model. ‡ variable included in care recipient model. * squared value included in model(s)

C

Unraveling the Determinants of Acute Health Care Expenditure Growth

7 Explaining growth across the distribution of health care expenditures

with Marc Koopmanschap, Owen O'Donnell and Eddy van Doorslaer

Submitted for publication

ABSTRACT

In the period 1998-2004, Dutch health care expenditures grew by 28 percent but the growth was not uniform across the spending distribution. We decompose total, hospital and pharmaceutical spending growth *across the full expenditure distribution* into parts deriving from changes in its determinants and from changes in their functional relationship with spending levels.

Hospital expenditure growth was concentrated at the middle of the distribution and is largely explained by increased admission rates, stimulated by policies to reduce waiting lists. Growth at the top of the distribution is constrained by shortened length-of-stays and more intensive day care and policlinic use. Pharmaceutical expenditure growth was concentrated at the top of the distribution. Technological progress dominates the explanation of the growth, especially at higher quantiles. Shifts towards less intensive hospital treatment and population aging also moderately explain pharmaceutical expenditure growth. We conclude that it is worth looking beyond averages when examining expenditure growth and considering attempts to control growth.

7.1 INTRODUCTION

Expenditures on health care continue to increase substantially, both absolutely and relative to national income, throughout most of the developed world. In the Netherlands, for instance, the amount spent on health care as a percentage of Gross Domestic Product (GDP) rose from 4.1 in 1972 to 13.1 in 2007 while real per capita spending has more than doubled over this thirty-five year period from around €1600 to over €3400 in 1998 prices[22] (Statistics Netherlands, 2011). Expenditure growth on this scale has profound implications for both health and economic policy. Not surprisingly, accounting for it has been the purpose of much research (e.g. Getzen, 2000; Dormont, Grignon, and Huber, 2006; Mehrotra, Dudley, and Luft, 2003; Newhouse, 1992; van Elk, Mot, and Franses, 2010; Koopmanschap *et al.*, 2010). Medical technology is widely considered to be the key driver of health care expenditure (HCE) growth (e.g. Weisbrod, 1991; Newhouse, 1992). Since the public financing of health care is typically substantial, government policies can be expected to exert a strong influence on HCE growth. A third contributing factor is the rate of increase in health care wages and prices, which outpace general inflation through the Baumol (1967) effect. Trends in population health and demographics should also play a role but identification of their contribution is difficult given the sparsity of reliable data covering both health status and costs over time at the individual level. One study with access to suitable data found that changes in disease patterns constrained HCE growth in France in the nineties (Dormont, Grignon, and Huber, 2006). There is much literature on the contribution of population aging to HCE growth (e.g. Getzen, 1992; Richardson and McKie, 1999; Zweifel, Felder, and Meiers, 1999; Reinhardt, 2003; Steinmann, Telser, and Zweifel, 2006; Payne *et al.*, 2007; Häkkinen *et al.*, 2008; Koopmanschap *et al.*, 2010; de Meijer *et al.*, 2011). Estimates vary around a figure of roughly one percent real HCE growth per annum due to aging but this largely operates through trends in health (Koopmanschap *et al.*, 2010).

This chapter decomposes the change in the distribution of acute HCE in the Netherlands over the period 1998-2004. It contributes to the literature on health expenditure growth in three ways. First, we use very rich individual level health insurance claims data that measure the actual expenditures reimbursed for hospital treatment and medication of the entire sickness fund population (two-third of the Dutch population). These data are linked to the hospital discharge and mortality registers allowing medical expenditures to be explained not only by disease patterns, time-to-death and cause-of-death, but also by medical procedures carried out in hospital and other factors measuring hospital practice styles. This allows us to open the black box of medical technology and other sources of change in practice styles. We could therefore identify the expenditure growth that can be directly attributed to changes in medical practices in the treatment of specific conditions.

22 According to broad definition of HCE.

Second, we do not merely account for the growth in total or mean HCE but decompose the change in its *full* distribution. This allows us to describe variation in the growth of expenditures across the distribution and so, for example, determine whether high cost cases are becoming even more relatively expensive and are driving the total expenditure growth. It also makes it possible to distinguish between the contributions of determinants at different points of the distribution. For example, we can address not only the question of how much population aging is contributing to the growth of mean expenditure but also whether this contribution is stronger at high expenditures than low expenditures and so whether aging stretches or narrows the distribution of HCE. For health insurers, risk adjusters and health care providers paid prospectively, it is important to know not only how average expenditures vary with observable characteristics but also how their variance differs.

Third, there was a policy decision to increase the funding of inpatient care during the period of analysis resulting in real spending increases in excess of four percent in two successive years. The intention was to reduce waiting lists for hospital admission for particular procedures (van de Vijsel, Engelfriet, and Westert, 2011). There is seldom an opportunity to trace how an injection of funding gets distributed across patients. In addition, we further disaggregate the growth in acute expenditures by separately examining the growth in its two largest components: hospital and pharmaceutical care. Not only the rate of growth but also the explanation of the growth differs substantially between these two acute health care services. This disaggregation also reveals whether changes in hospital practices (e.g. a higher proportion of outpatient hospital care, reduction in the length-of-stay) have had spill-over effects on pharmaceutical spending, or vice versa.

The distribution of HCE may change for two broad types of reason. First the levels and/or distributions of the determinants of HCE may change. Through its impact on population health, population aging is the most obvious contributor to this source of change. Second, structural changes may alter the way in which given determinants impact on HCE. Medical technology, changes in medical practice, and changes in health policy at both the micro level of hospitals and insurers and the macro level of government and regulators are the most likely sources of shifts in the relationship of HCE to its determinants. Most attempts to forecast future trends in medical expenditures, including those that aim to identify the contribution of population aging, estimate a model of HCE and use this to simulate HCE under alternative scenarios about future trends in the covariates (e.g. Zweifel, Felder, and Meiers, 1999; Seshamani and Gray, 2004b; Stearns and Norton, 2004; Breyer and Felder, 2006; Lafortune *et al.*, 2007; Häkkinen *et al.*, 2008). This assumes that the relationship of HCE to its determinants is stable, which is unlikely. At best, these forecasts indicate what will happen in the absence of structural changes within a sector that is noted for technological progress, high government regulation and many policy reforms.

We employ a decomposition method that separates the observed change in HCE into the part due to changes in determinants and that due to their changing impact. The size of the second part gives an indication of how wrong a forecast of HCE growth would be if made on the assumption of a stable relationship. In this respect, our study is similar to that of Dormont, Grignon, and Huber (2006) who decomposed the growth in French HCE over the period 1992-2000 using a method in the spirit of Oaxaca (1973) - Blinder (1973). While Dortmont *et al.* explained the change in mean HCE, we decompose the change in the full marginal distribution. This allows us to establish whether the contribution of shifts in determinants, such as aging and population health, is constant across the distribution and also whether the structural shifts in the relationship are more evident for high or low cost cases. We implement this by using distributional regression to generate counterfactual distributions (Chernozhukov, Fernandez-Val, and Melly, 2009). This approach delivers findings that could not have been uncovered by a standard decomposition of mean HCE. For example, not only the growth itself, but also the explanation of the growth varies at different points in the expenditure distribution.

In the next section of the chapter we describe important changes in health policy and other structural changes that occurred within the period over which we explain the growth in HCE. In the third section we present the decomposition method employed. The data are described in the fourth section and the results are given in the fifth. The final section concludes with implications for health policy in the Netherlands and beyond, and the acknowledgement of limitations.

7.2 STRUCTURAL CHANGES IN THE PERIOD 1998-2004

Policy changes

From 1983-2001, the volume of inpatient care was constrained by fixed global budgets, i.e. a priori defined budgets determined an income ceiling for hospitals. Hospital use was further constrained by financial incentives to under produce: hospitals could keep the surplus when production was lower than a priori agreed. In addition, from 1995 medical specialist in hospitals were paid by fixed lump sums instead of fee for services. Budget funding successfully contained costs; HCE as a percentage of GDP remained fairly constant at 11.2 percent of GDP over the period 1983-2000. The real spending growth in the period 1983-2000 equaled 2.5 percent annually (Statistics Netherlands, 2011).

However, budgets were set too tight to capture demographic developments and technological progress resulting in growing waiting lists for inpatient care. In addition to increasing public dissatisfaction with the waiting lists, pressure on the government was raised by (inter)national verdicts in legal procedures ruling that patients have an enforceable right to timely care (van de Vijsel, Engelfriet, and Westert, 2011). Maximum waiting time standards were developed. The mounting pressure on the government resulted in a sudden relaxation of inpatient budgets in 2001. Output growth was no longer restricted to the budget;

hospitals received posterior compensation when output exceeded their *a priori* set budget (TKSG, 2000). Although the additional investments could only be spent on waiting list reduction, in practice budgets became open-ended. As additional measures to increase hospital production, medical specialist's fees were made dependent on realized production and recalculation based on realized production was established to remove financial incentives to under produce. These changes in hospital funding led to substantial increases in HCE, with aggregate HCE spending growth in constant prices reaching levels of 5.3, 4.4 and 4.3 percentage points in 2001, 2002 and 2003, respectively (Statistics Netherlands, 2011).

The sudden relaxation of inpatient budgets indeed resulted in improved access to hospital care and a reduction of waiting times. In the period 1998-2002, the waiting lists for hospital care decreased by 4,000 patients (TCOZ, 2004). Waiting times for several diagnoses were however still longer than the agreed maximum waiting time (van de Vijsel, Engelfriet, and Westert, 2011). Elderly and individuals in need for treatments previously on the waiting list (e.g. cardiovascular, orthopaedic, cataract and plastic surgery) benefited most from the relaxation of budgets as their hospitalization rates increased disproportionately. Moreover, it is suggested to have contributed to the renewed progress in life expectancy, which had stagnated at the beginning of the 21st century (Mackenbach and Garssen, 2010).

Medical technological progress

Medical technological progress is generally viewed as the key driver of HCE growth (e.g. (Weisbrod, 1991; Newhouse, 1992). Although technological progress can, in principle, also reduce costs (Cutler and McClellan, 2001; Cutler, 2007), it often tends to promote a more widespread use, resulting in a rise in total HCE (Bodenheimer, 2005). The influence of medical technology has been found to be especially relevant for pharmaceutical spending (Dormont, Grignon, and Huber, 2006; Häkkinen *et al.*, 2008). A good example of innovative pharmaceuticals is the introduction of TNF alpha blockers in 2000-2004 to treat rheumatoid arthritis. TNF alpha blockers improve the quality of life of rheumatoid arthritis patients, but increase pharmaceutical treatment costs considerably.

Medical technological progress may also have contributed to increased efficiency in Dutch hospital care during our study period. It has facilitated a shift from clinical (overnight) admissions to day care admissions or policlinic visits. As a result, the number of clinical admissions and the length of stay have fallen while the number of day care admissions and policlinic visits has risen (TCOZ, 2004; Borghans *et al.*, 2008). The possibility to substitute more intensive by less intensive hospital care strongly depends on the diagnosis. Next to these substitutions of treatment within the hospital, a substitution from hospital to GP treatment for some specific diagnoses has also been observed. An important example is the increased responsibility of GPs for diabetic care and their active involvement in the detection of diabetes within their patient population (Rutten *et al.*, 1999; Niessen *et al.*, 2003).

Other structural changes

In addition to deliberate governmental policy and technological progress, other possible sources of structural change are: medical profession policies, consumer preferences and other changes in medical practices. Medical profession policies are potentially important causes of structural changes that may affect treatment costs of specific diseases. Examples include the introduction of integrated care programs, the introduction and enforcement of treatment protocols and drug formularies. A well-known example of an integrated care program is the introduction of specialized stroke units. These stroke units were implemented on a large scale from about 2000 (van Exel *et al.*, 2005). Average treatment costs could either be lower or higher after the introduction of the stroke service as average length-of-stay of admitted stroke patients decreased from 22 to 12 days between 1998 and 2004, but treatment intensified during the shorter stay. A related medical profession policy, also for stroke, is the development of GP guidelines to admit all stroke patients to the hospital. This resulted in increased hospitalization rates for stroke patients while the average severity of an admitted stroke patient decreased.

7.3 METHODS

Decomposition method

We will decompose changes in the full marginal distribution of acute HCE into a contribution of changes in covariates and a contribution of changes in the functional relationship between HCE and its covariates, i.e. changes in coefficients. We apply a decomposition method of Chernozhukov, Fernandez-Val, and Melly (2009) who have extended the classical Oaxaca (1973) – Blinder (1973) decomposition of the mean to a decomposition of the full marginal distribution using distributional regression (Foresi and Peracchi, 1995). Distributional regression permits covariates to impact the outcome by changing its location, scale and entire shape of the distribution. It performs well in the presence of nonlinear conditional quantile functions. Unlike any mean regression based decomposition, full distribution decomposition allows us to examine whether changes at the top of the distribution are characterized differently from those at the bottom or middle. In the case of HCE, it is not unlikely that, say, technological progress or population aging have affected HCE growth differently at different points in the expenditure distribution. For example, new medicines are likely to increase pharmaceutical spending more in the upper half of the distribution, resulting in a greater shift in the relationship of HCE to its observable determinants at the top of the distribution.

The decomposition is achieved by first obtaining estimates that fully describe the conditional distribution of HCE and then simulating changes in the marginal distribution by combining these estimates with different samples of covariates. A distributional model is used to estimate the conditional HCE distribution; *m* percentiles of the unconditional HCE distribution are estimated. For each of these *m* percentiles, the conditional distribution function at this level is estimated by a linear probability model (LPM). That is, we simply estimate the impact of covariates on the probability of HCE lying below each percentile point. We used LPM models as estimation time was considerable lower than in logit or probit models while decomposition results were virtually identical. *m* was set to 400. Bootstrapped standard errors (100 iterations) were obtained to take into account the sampling variation due to the estimation of the conditional model.

A simulation of the marginal distribution for each year is obtained by combining the covariate distribution of each year with the distributional model estimated for the same year. Simulations of the counterfactual distribution are obtained by combining the coefficients with the sampled covariates from the other year. The changes in HCE observed between 2004 and 1998 can be decomposed as follows:

$$f(h_{04}) - f(h_{98}) = f^*(h_{04}) - f^*(h_{04};X_{98})) + (f^*(h_{04};X_{98}) - f^*(h_{98}))+\varepsilon \qquad (7.1)$$

where $f(h_t)$ denotes the empirical density of HCE directly estimated from the data, $f^*(h_t)$ the simulated marginal distributions, $f^*(h_t;X_t)$ the simulated counterfactual distributions, X a vector of covariates, and ε the residual caused by differences in the empirical and simulated distributions. The first and second terms on the right-hand side are the contributions of changes in covariates and changes in coefficients, respectively.

We decompose both changes in the distribution of hospital and other secondary acute care expenditures, and changes in pharmaceutical expenditures. Because differences in utilization rates over time complicate interpretation of the results (e.g. is growth caused by higher utilization rates or by more expensive treatment conditional on use), we additionally decompose changes in each expenditure category conditional on any use.

A detailed decomposition of the contribution of covariates could distinguish the contribution of changes in specific covariates. This detailed decomposition could therefore measure the contribution of changes in the age composition, health patterns, and medical practice styles over time. The contribution of changes in a specific covariate to the aggregate contribution of covariates (X; the universe of $X1$ and $X2$) is computed by first resampling from the 1998 distribution such that the specific covariate ($X2$) is distributed as in 2004 while the remaining covariates remain distributed as in 1998 ($X1$), then decomposing the changes in expenditures between the newly defined sample of 1998 ($f(h_{98};X1_{98};X2_{04})$) and the sample of 2004 similar to equation (7.1):

$$f(h_{04}) - f(h_{98}; X1_{98}; X2_{04}) = (f^*(h_{04}) - f^*(h_{04};X1_{98}; X2_{04})) + (f^*(h_{04};X1_{98}; X2_{04}) - f^*(h_{98}; X1_{98}; X2_{04}))+\varepsilon$$

(7.2)

Finally, the contribution of changes in a specific covariate to the HCE growth is the difference between the aggregate contribution of changes in covariates given by the first expression in equation (7.1) and the contribution of covariates given by the first expression in equation (7.2). This procedure is repeated a number of times to compute the contribution of changes in each (group of) covariate(s). However, the procedure to resample the 1998 sample such that a specific group of covariates is distributed as in 2004 holds correlations between this group of covariates and remaining covariates constant. Hence, the distribution of the correlates has also changed which entails that the sum of the contributions of changes in specific covariates exceeds the aggregate contribution of changes in covariates.

Improved insight into the contribution of changes in specific coefficients is obtained by testing the null of no change in the effect of a covariate over time. A two-part model including a full set of time interactions is used to estimate these coefficients. A two-part model is commonly used to analyze HCE as this model is able to account for the high proportion of non-users by separately analyzing the decision to use and the level of expenditures conditional on use (Jones, 2000). A probit model has been selected to analyze the decision to use. We followed the procedure proposed by Manning and Mullahy (2001) to select the most appropriate model for part II. Residuals from ordinary least squares (OLS) models on the logarithm of expenditures were not skewed (k=3.08). Hence, log OLS models are appropriate to identify the relationship between HCE and its covariates at the mean. Stability of coefficients in both parts is tested separately through significance of the interaction term in each part of the model.

7.4 DATA

Sample

A variety of data sources linked at the individual level is used. Detailed information on acute HCE is obtained from sickness fund records (Vektis). Vektis covers the entire sickness fund population, approximately two-third of the Dutch population. A probability linkage process is used to link sickness fund records to the municipality registration. Linkage to the municipality registration is required as each of the core data sets used (hospital registry, death registry) could also be linked to the municipality registration. Linking variables were date of birth, sex, zip code and survival status. Due to incompleteness of date of birth, only 49% of the records could be linked to the municipality register (N= 9,082,279). Information on *inpatient* hospital use and survival status, as recorded in the national hospital and death registry respectively, were also linked to the municipality registration. Of the linked individuals, we randomly selected 165,000 insured for each year to obtain a sample for which computation was feasible. Decedents and inpatient hospital users were oversampled to be able to estimate the effects of covariates related to decedent status and inpatient hospitalization more precisely.

Iterative proportional fitting (IPF) weights were derived to correct for the sample selection caused by the linking process and oversampling. IPF corrects the marginal distribution of the weighting variables in our study sample to that of the total sickness fund population (Deming and Stephan, 1940; Bethlehem, 2008). We selected age*sex*decedent status, the linking keys, plus hospitalization status as weighting variables. The weighted distribution of the weighting variables in our study sample was identical to that of the total sickness fund population indicating that the derived weights adequately corrected for the selection.

Measures of health care expenditure

The three dependent variables, acute HCE, hospital and other secondary acute spending (hereafter: hospital expenditures) and pharmaceutical spending, measure average *monthly* spending, deflated to 1998 values. We model the log of each. Acute HCE comprised the sum of spending on hospital care, pharmaceuticals, transport, devices, obstetrics and maternity care covered by the basic benefit package. Dental and paramedic care were excluded because they were partly removed from the basic benefit package in 2004 resulting in a drop in the level of these expenditures in 2004. In addition, general practitioner (GP) expenditures were excluded because, given that GP's were mainly funded on a capitation base during the study period, payments made by the insurer do not correspond to the cost of the GP care used. Hospital expenditures include the costs of use of: hospital and other secondary acute care including care provided by rehabilitation centres and private clinics that are allowed to supply care covered by public insurance. Pharmaceutical expenditures comprise spending on outpatient pharmaceuticals. Apart from pharmaceutical expenditures, expenditures were deflated to 1998 values using the consumer price index (CPI). Due to several price policies the price of pharmaceuticals decreased by 22 percent in the period 1998-2004 (SFK, 2009). Hence, pharmaceutical expenditures were deflated by this proportion. In addition to correcting for general price changes, we corrected for the Baumol effect as it purely reflects changes in health care specific prices and not quality improvements. We applied this additional correction for the Baumol effect to labour intensive services only (0.8 percent annually; Douven *et al.*, 2006).

Changes in the empirical distribution of expenditures

Table 7.1 reports summary statistics of monthly expenditures on acute care, stratified by year and both for the full sample and the samples of users. Figure 7.1 present the empirical distributions of the logarithm of the three spending categories for 1998 and 2004. The distribution of log acute HCE clearly shifted to the right indicating a substantial increase in log HCE in the period 1998-2004. Nominal growth rate of monthly spending at the mean equals 42 percent; it rose from €83 to €119. Our nominal growth rate for the period 1998-

TABLE 7.1 Summary statistics per capita monthly spending (1998 prices) stratified by year and service type

	ACUTE HCE			HOSPITAL AND OTHER SECONDARY ACUTE CARE EXPENDITURES			PHARMACEUTICAL EXPENDITURES		
	1998	2004	Growth rate	1998	2004	Growth rate	1998	2004	Growth rate
Entire sample									
Zero spenders (%)	17.4	21.6		49.5	45.9		23.4	29.2	
Mean	84.3	107.8	28%	57.8	68.0	18%	17.7	29.8	69%
10th percentile	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%
25th percentile	1.2	1.0	-14%	0.0	0.0	0%	0.3	0.0	-100%
Median	9.1	12.5	38%	0.8	2.3	202%	3.3	3.5	5%
75th percentile	46.3	64.4	39%	15.5	19.5	26%	14.0	23.6	69%
90th percentile	153.6	201.4	31%	67.3	77.2	15%	49.1	80.3	64%
95th percentile	308.1	387.0	26%	201.3	217.0	8%	83.2	134.7	62%
Conditional on use									
Mean	102.0	137.4	35%	114.5	125.3	10%	23.1	42.1	82%
10th percentile	1.3	1.9	46%	2.4	2.7	14%	0.8	1.1	37%
25th percentile	4.0	6.2	54%	5.1	5.8	13%	2.1	2.8	34%
Median	16.5	26.3	60%	15.1	16.7	10%	6.0	10.2	70%
75th percentile	61.6	92.0	49%	46.9	50.8	8%	22.5	42.6	90%
90th percentile	186.4	253.8	36%	199.0	192.9	-3%	61.7	106.0	72%
95th percentile	371.9	488.5	31%	463.5	482.2	4%	98.7	165.1	67%

2004 is similar to previously reported growth (Statistics Netherlands, 2011). After correcting for price effects, the real growth rate at the mean equals 28 percent. This growth at the mean is mostly driven by increases in the upper half of the distribution. The 25th, 50th and 75th percentile of acute HCE increased by -14, 38, and 39 percent, respectively. Expenditure growth conditional on use is positive across the entire distribution and is concentrated at the centre of the distribution.

Figure 7.2 plots the growth of monthly log spending between 1998 and 2004 (so the vertical difference between the solid and dotted lines in figure 7.1) for each quantile, for the full sample and the subsample of users. The spikes in the three expenditure distributions for the full sample that follow after some percentiles of zero spending reflect differences in non-spenders between 1998 and 2004. The proportion of acute health care users decreased from 82.6 to 78.4 percent. This decrease entirely explains the reduction in acute HCE at the lower percentiles as a positive growth is observed for the subgroup of users. The reduction in acute health care users is driven by a decrease in pharmaceutical users which is almost entirely caused by the removal of the oral contraceptives from the basic benefit package in

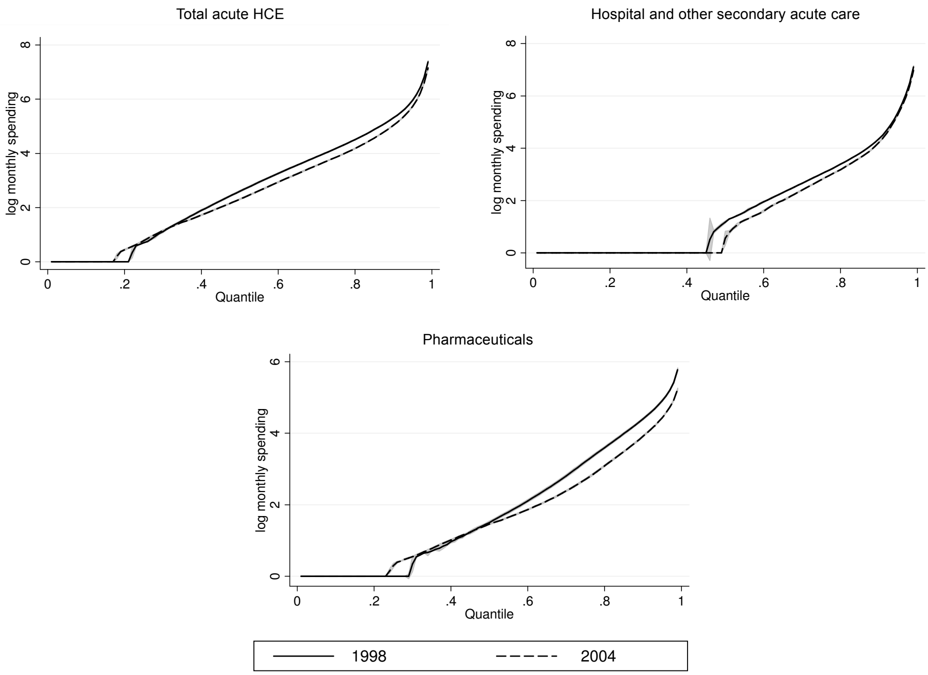

FIGURE 7.1 Observed log monthly expenditures by service type in 1998 and 2004
Note: 95% confidence intervals are included but hardly visible due to large preciseness.

2004.[23] The share of hospital users increased which would be expected from policy decision to reduce waiting lists.

Hospital and pharmaceutical spending together comprise approximately 90 percent of mean acute HCE. The growth rates in hospital and pharmaceutical spending show markedly different patterns. Mean pharmaceutical spending increased by no less than 69 percent, mean hospital spending only by 18 percent. Although the expenditure growth of both services is situated in the upper half of the distribution, the relative growth of hospital expenditures is highest at the centre of the distribution while most of the relative growth of pharmaceutical expenditures is highest at the high end of the distribution. Comparing the growth rates in the full and user sample reveals that the hospital spending growth is mainly driven by an increased proportion of users; hospital expenditures conditional on use show only a moderate growth (figure 7.2). Pharmaceutical spending growth, on the other hand, is exclusively driven by a rise in the conditional expenditures, pointing towards more expensive and/or intensive pharmaceutical treatment, of fewer users. Combining the contrasting growth rates of hospital and pharmaceutical spending leads to a fairly constant growth of total HCE spread out over most of the upper half of its distribution.

23 The likelihood of pharmaceuticals use significantly decreased for females aged 25-34 only (appendix 7.3).

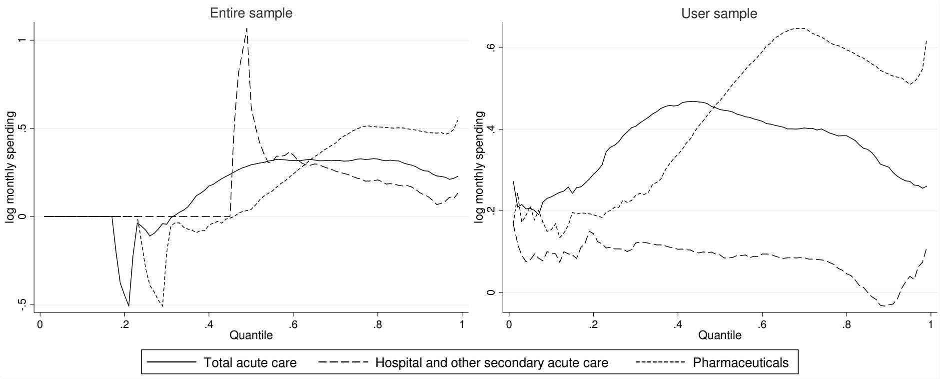

FIGURE 7.2 Growth in log monthly expenditures by type of service between 1998 and 2004

Covariates

Table 7.2 presents the distribution of covariates in each year and the change in the distribution of covariates over time which provides an indication of the possible contribution of changes in covariates to the growth in HCE. Table 7.2 only presents the (changes in) the distribution of covariates for the entire sample; the distributions are very similar for the subgroup of users, which is not surprising given that the user sample comprises approximately four fifths of the full sample.

We capture the impact of demographics on HCE through age-sex group dummy variables defined for 10 years age bands, plus 0-14 years and 85+ years. Longevity is measured by an indicator of whether the person dies within 5 years of the time of observation and the time-to-death (TTD) in months and its square. The Dutch sickness fund population has aged: mean age significantly increased by about one year; the 5-year survival rate increased, though not significantly.

Another population characteristic included is co-residence status. Couples and married individuals are often found to be healthier than those living alone. Co-residence is measured by dummy variables: living alone (reference group), couple alone, other private household, institutionalized. While institutionalized individuals have a greater need for acute care services, their acute health care use is postponed due to basic in-home health care services provided by residential and nursing homes. In the Netherlands, cost of these in-home health care services is covered by long-term care insurance rather than health care insurance. The proportion of females and individuals living alone increased over the period 1998-2004.

Covariates that measure hospital practice styles include: number of first policlinic visits, type and number of inpatient hospital admission, type of hospital admitted to, length-of-stay (LOS), and primary hospital procedure. Clinical (overnight) and day care admission are distinguished. The share of individuals using outpatient (inpatient) hospital care increased

TABLE 7.2 Descriptive statistics of covariates and test of change over time

COVARIATE[b]	1998	2004	CHANGE[a]
Age	38.75	39.56	0.81†
Deceased within 5 years (%)	4.70	4.60	-0.10
Male (%)	46.34	45.51	-0.83†
Co-residence status: Living alone (%)	14.49	15.39	0.91†
Co-residence status: Couple alone (%)	26.00	25.11	-0.89†
Co-residence status: Other private household (%)	57.80	58.00	0.20
Co-residence status: Institutionalized (%)	1.71	1.49	-0.22†
Outpatient (policlinic) visit (%)	28.60	35.43	6.83†
Mean first policlinic visits if>0	1.52	1.60	0.08†
Inpatient admission: day care (%)	3.56	5.07	1.51†
Inpatient admission: clinical (overnight; %)	7.16	6.67	-0.50†
Mean length of stay if>0	9.08	7.08	-2.00†
Admission to university hospital (%)	10.24	10.71	0.46
Admission to other teaching hospital	20.48	29.61	9.13†
Admission to specialized hospital	1.07	0.92	-0.14
Admission to general hospital	72.35	63.67	-8.69†
Hospital procedure: PT(C)A (% inpatient stay)	1.07	1.77	0.70†
Hospital procedure: surgery eye (% inpatient stay)	5.91	7.47	1.55†
Hospital procedure: other bone and joint surgery(% inpatient stay)	9.34	9.55	0.22
Hospital procedure: other therapeutic/preventive procedure (% inpatient stay)	50.68	50.54	0.14
Hospital procedure: diagnostics	12.71	14.46	1.76†
Hospital procedure: no procedure (% inpatient stay)	26.65	24.62	-2.03†
Work disabled (%)	10.03	10.09	0.06
Cause-of-death: external (% decedents)	4.18	3.91	-0.27
Cause-of-death: neoplasm (% decedents)	27.60	28.73	1.13
Cause-of-death: endocrine, nutritional, metabolic disease (% decedents)	3.35	3.49	0.13
Cause-of-death: mental and behavioral disorder (% decedents)	3.03	4.92	1.89†
Cause-of-death: disease of the nervous system/sense organs (% decedents)	2.26	2.74	0.47*
Cause-of-death: cardiovascular disease (% decedents)	36.13	32.38	-3.75†
Cause-of-death: respiratory disease (% decedents)	9.95	10.30	0.35
Cause-of-death: digestive disease (% decedents)	3.68	4.01	0.34
Cause-of-death: disease of the genitourinary system (% decedents)	1.83	2.16	0.34
Cause-of-death: symptoms, signs and ill-defined conditions (% decedents)	5.31	4.22	-1.09†
Cause-of-death: else (% decedents)	2.66	3.13	0.47*
Hospital diagnosis: infectious disease (% inpatient stay)	1.39	1.24	-0.15
Hospital diagnosis: neoplasm (% inpatient stay)	6.95	7.41	0.46*
Hospital diagnosis: endocrine, nutritional, metabolic disease (% inpatient stay)	1.92	2.08	0.16
Hospital diagnosis: disease of the blood (forming organs) (% inpatient stay)	0.88	1.02	0.14*

TABLE 7.2 Descriptive statistics of covariates and test of change over time

COVARIATE[b]	1998	2004	CHANGE[a]
Hospital diagnosis: mental and behavioral disorders (% inpatient stay)	1.6	1.23	0.07
Hospital diagnosis: disease nervous system/sense organs (% inpatient stay)	11.34	12.54	1.21†
Hospital diagnosis: cardiovascular disease(% inpatient stay)	12.97	13.17	0.21
Hospital diagnosis: respiratory disease (% inpatient stay)	9.71	7.98	-1.73†
Hospital diagnosis: disease digestive system (% inpatient stay)	9.55	10.39	0.84†
Hospital diagnosis: disease genitourinary system (% inpatient stay)	7.99	8.22	0.23
Hospital diagnosis: pregnancy, childbirth, contraception (% inpatient stay)	12.05	10.21	-1.84†
Hospital diagnosis: disease skin, subcutaneous tissue (% inpatient stay)	1.53	1.56	0.03
Hospital diagnosis: disease musculoskeletal system (% inpatient stay)	13.06	13.40	0.31
Hospital diagnosis: congenital abnormalities (% inpatient stay)	1.16	1.12	-0.04
Hospital diagnosis: conditions originating perinatal period (% inpatient stay)	2.32	1.66	-0.66†
Hospital diagnosis: injury and fractures (% inpatient stay)	7.23	7.00	-0.24
Hospital diagnosis: symptoms, signs, ill-defined conditions (% inpatient stay)	7.27	9.76	2.49†
Hospital diagnosis: not allocated and not disease related	6.79	9.49	2.69†

a. P-value null of no change in distribution covariate over time. † p<0.001; ‡ p<0.01; * p<0.05
b. See appendix 7.2 for a complete overview of changes in each category of hospital diagnosis and procedure

by 6.8 (0.5) percent. The increase in inpatient hospital use was purely driven by increased day care admission rates. LOS is measured by the number of nursing days and its square. Average LOS for inpatient hospital users decreased from 9.1 to 7.1 days. Concerning type of hospital, university hospitals, other teaching hospitals and specialized hospitals are more expensive than general hospitals as they often receive a more severe case-mix of patients. A greater share of patients was admitted to teaching hospitals in 2004 than in 1998, fewer to general hospitals. Although a shift away from general hospital admissions measures changes in practice styles, it might also reflect deteriorations of hospital morbidity. We selected 47 indicators for hospital procedures. Table 7.2 only shows (changes in) the distribution of some waiting list procedures compared to remaining procedures. Appendix 7.2 presents changes in each of the 47 procedures. As a proportion of the total number of inpatient admissions, the share of procedures previously on the waiting list (e.g. PTCA, surgery of the eye and lens, bone and joint surgery) increased significantly. Several other procedures also increased, but to a lesser extent. Changes in the distribution of hospital procedures could therefore largely be attributed to policy change as admissions for 'waiting list' procedures increased disproportionately. Type of hospital and procedures are excluded from the pharmaceutical expenditures model.

The only individual health indicator available for the entire study population is work disability status. In addition, information on hospital diagnosis and cause-of-death is available for *inpatient* hospitalized individuals and deceased sample members, respectively. Because we do not have diagnostic information for the entire population but only for individuals admitted to the hospital, changes in the distribution of hospital diagnosis do not reflect changes in disease burden perfectly and should be interpreted cautiously. Changes in the distribution of hospital diagnoses reflect changes in the distribution of health and changes in admission rates, i.e. the disproportional growth in waiting list diagnoses reflects to an important extent the higher admission rates for these diagnoses. Hospital diagnoses are grouped into 39 categories according to ICD-10 chapter and prevalence rates (see appendix 7.1). Table 7.2 presents the distribution of diseases per ICD chapter; appendix 7.2 presents (changes in) the distribution of each of the 39 diagnoses. Because we already controlled for several admission variables, (changes in) the effect of a hospital diagnosis on acute HCE should be interpreted carefully. The effect of a diagnosis captures any diagnostic-specific resources used, that are not captured by variation in type and number of hospital admission, LOS and procedure (e.g. inpatient medication). Changes in the effect of diagnoses could reflect changes in the diagnostic-specific resources used not captured by other hospital-related covariates (e.g. changes in medication use) or changes in the underlying distribution of hospital diagnoses since hospital diagnoses are aggregated.

Changes in diagnoses are closely related to the observed changes in procedures. As a proportion of the total number of inpatient admissions, the diagnosis related to procedures previously on the waiting list increased significantly (e.g. other cardiovascular disease, eye disorders, osteoarthritis). In addition, significant rises of hospital diagnosis shares were observed for neoplasms, diseases of the blood (forming organs), other diseases of the nervous system or sense organs, stroke, digestive diseases, rheumatoid arthritis, symptoms signs and ill-defined conditions and other not allocated and not disease related. Inpatient hospital admission shares fell for epilepsy, ear disorders, CHD, respiratory diseases, dorsopathy, conditions originating in the perinatal period, and pregnancy, childbirth and contraception. Cause-of-death is grouped into 10 categories with an external cause-of-death as the reference group. Compared to 1998, a larger proportion died from mental and behavioural disorders or a disease of the nervous system/sense organs while the opposite is true for cardiovascular death or symptoms, signs and ill-defined conditions.

See appendix 7.1 for a detailed description of the covariates. Note that a number of variables (age, survival status) is endogenous to the level of HCE. Since we do not aim to estimate causal effects but rather to account for variation in HCE, we are not concerned about potential endogeneity.

7.5 RESULTS

Relation of covariates at the mean

Before presenting the decomposition results, we discuss the relationship between HCE and its determinants as has been estimated by a two-part model. Due to the large number of determinants, estimates of the two-part model are included in appendices 7.3 and 7.4.

As one would expect, HCE is higher for females than males and increase with age. The relatively high level of HCE for females in the fertile age range is due to reproductive or contraceptive health care use. Individuals within five years of death are more likely to incur acute HCE (1998 only) and their conditional expenditures are significantly higher. The significance of higher order terms of TTD reveals that the effect of TTD is nonlinear: the effect of TTD on conditional expenditures is greater the closer to death, while the effect on the probability of incurring expenditure decreases when approaching death. Those who eventually die from a mental and behavioral disorder are less likely to use acute care than those that die from an external cause-of-death. This group of decedents often resides and dies in nursing homes (de Meijer *et al.*, 2011). Individuals that die from cancer or an endocrine, nutritional or metabolic disease (mainly diabetics) were more likely to be hospitalized than those that die from an external cause-of-death. The latter group of decedents are also more likely to use pharmaceuticals and incur significantly higher conditional pharmaceutical expenditures. Individuals that die from a cardiovascular or digestive disease are more likely to be hospitalized in 2004, those that die from a genitourinary disease or disease of the nervous system or sense organs are more likely to be hospitalized but less likely to use pharmaceuticals in 2004. Conditional HCE are significantly higher for individuals that die from most other causes than an external cause. Work disabled have both a higher probability and a higher level of acute, hospital, and pharmaceutical expenditures.

Co-residing individuals are more likely to use acute care, hospital care and pharmaceuticals, but their conditional spending levels are lower than individuals living alone, probably because co-residing (married) individuals are healthier. Institutionalized individuals are less likely to use acute care, but their conditional expenditures are considerably higher than for individuals living alone. This latter finding is driven by pharmaceutical spending. Institutionalized individuals are less likely to receive acute care and incur lower hospital spending conditional on use, most likely because they can receive basic care from their LTC institution which postpones hospitalization and accelerates hospital discharge.

The effect of hospital-related determinants was only measured on conditional expenditure levels. Inpatient care is more expensive than outpatient hospital care. Of the inpatient care admission, clinical admission are more expensive than day care admissions. Inpatient admissions to general hospitals result in lower spending than in other hospitals. LOS positively contributed to conditional acute HCE.

The majority of hospital procedures significantly influenced conditional acute HCE and conditional hospital expenditures. Most procedures raise the level of spending. Surgery of the heart, vessels, arteries, kidneys, facial bones, and obstetrics and PT(C)A were among the most expensive hospital treatments.

Given medical practice styles, many hospital diagnoses significantly influenced conditional HCE in both years. Some hospital diagnoses increased conditional expenditures on both hospital and pharmaceuticals while others only have a positive influence on either one of them. Accounting for medical practice styles, the most costly diagnoses for hospital care are: colorectal cancer, breast cancer, prostate cancer, rheumatoid arthritis, and osteoarthritis. Diagnoses with the highest pharmaceutical expenditures are diabetes, rheumatoid arthritis, COPD and asthma, and multiple sclerosis.

Decomposition of acute HCE growth

Figure 7.3 and table 7.3 present the decomposition of acute HCE growth. Figure 7.3 presents the decomposition results for the full sample and the user sample separately. It plots the difference in the two simulated distributions along with the absolute contribution of changes in determinants and changes in their impact on expenditure growth at all quantiles. The explanation of acute HCE growth greatly varies across the distribution which indicates the superiority of our approach over a decomposition of the mean only. This superiority is also confirmed by a Kolmogorov-Smirnov test evaluating the null of equality of all quartile effects to the median effect (p=0.000 for all three expenditure categories).

The contribution of changes in determinants is as important as the contribution of the changing impact of determinants to acute HCE growth. Changes in determinants positively contributes to the growth at all quantiles, but its contribution is lower at higher quantiles. Changes in the functional relationship between determinants and expenditures constrained growth in the lower half of the distribution, but positively contributed to growth in the upper half of the distribution. Table 7.3 presents the contribution of changes in determinants (covariates), their effect (coefficients) and the residual to growth at 9 quantiles of the expenditure distribution. Because the simulated distributions approach the empirical distribution of expenditures closely the residual is very small. Changes in coefficients contribute relatively little to HCE growth at the centre of the distribution. Median HCE increased by 29 percent, of which 26 percentage points could be explained by changes in covariates and 3 percentage points by changes in coefficients. However, from the median the contribution of coefficients increases, both absolutely and relatively, implying that treatment costs of patients that were already treated at relatively high costs further increased. From the 80^{th} percentile, the contribution of coefficients becomes larger than that of covariates. Changes in the effect of covariates explain 20 percentage points of the 27 point increase in the 90th percentile.

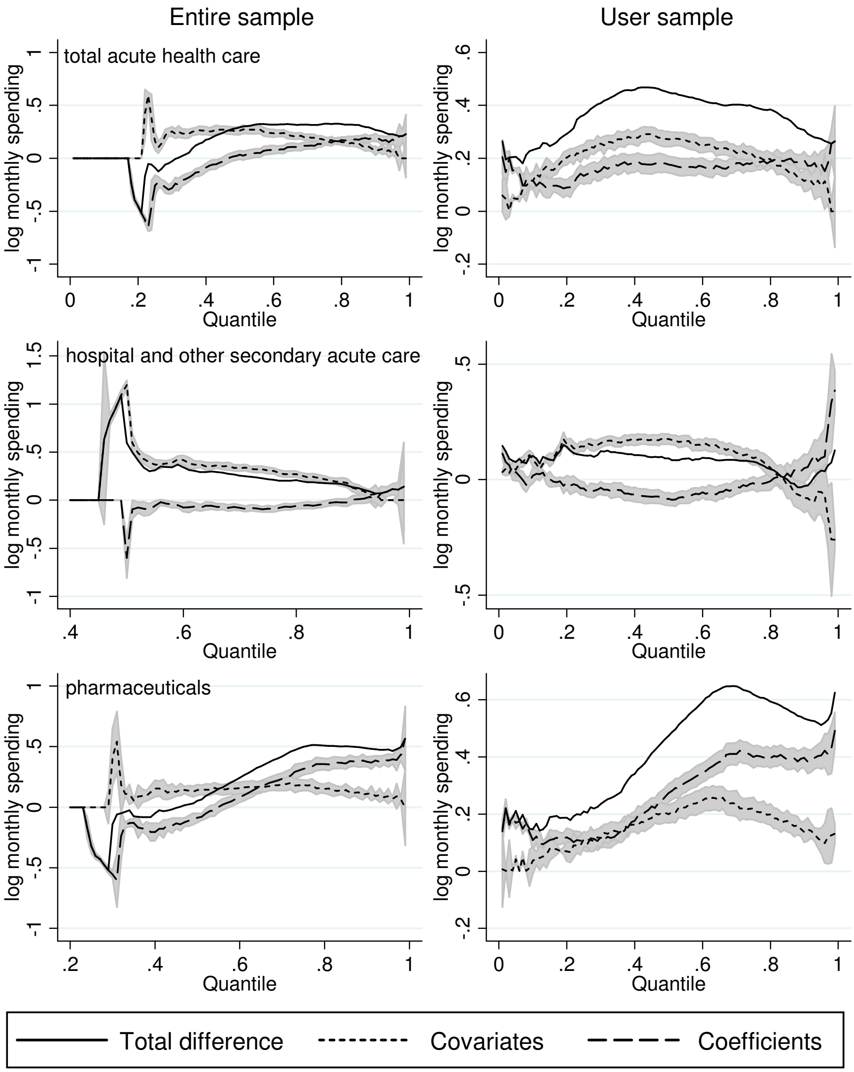

FIGURE 7.3 Decomposition of spending growth in contribution of covariates and coefficients
Note: Results are derived by application of the decomposition method as illustrated by equation (7.1). The total difference is given by the left hand side, the contribution of changes in covariates by the first term and the contribution of changes in coefficients by the second term of equation (7.1).

The right column of figure 7.3 illustrates the decomposition of the growth in expenditures among the subgroup of users. Table 7.4 presents the decomposition results for the subgroup of users for 9 quantiles. The decomposition reveals that changes in covariates and coefficients both positively contribute to the spending growth in the users group. Hence, the negative contribution of changes in coefficients to changes in the lower half of the acute HCE distribution in the full sample is due to the increase in the proportion of

TABLE 7.3 Decomposition of changes in log monthly expenditure distribution in the period 1998-2004

	OBSERVED VALUES			DECOMPOSITION OF GROWTH		
QUANTILE	1998	2004	GROWTH	COVARIATES (S.E.)	COEFFICIENTS (S.E.)	RESIDUAL
Total acute health care expenditures						
0.20	0.45	0.00	-0.45	0.00 (0.00)	-0.45 (0.01)	0.00
0.30	1.16	1.12	-0.04	0.25 (0.01)	-0.28 (0.01)	-0.01
0.40	1.73	1.90	0.17	0.26 (0.01)	-0.09 (0.01)	0.00
0.50	2.31	2.60	0.29	0.26 (0.01)	0.03 (0.01)	0.00
0.60	2.94	3.26	0.32	0.24 (0.01)	0.08 (0.01)	0.00
0.70	3.56	3.87	0.32	0.20 (0.01)	0.12 (0.01)	0.00
0.80	4.18	4.51	0.33	0.15 (0.01)	0.17 (0.01)	0.01
0.90	5.04	5.31	0.27	0.07 (0.01)	0.20 (0.01)	0.00
Hospital and other secondary acute care expenditures						
0.50	0.56	1.18	0.62	1.20 (0.01)	-0.60 (0.06)	0.02
0.60	1.60	1.95	0.35	0.42 (0.01)	-0.08 (0.01)	0.01
0.70	2.40	2.66	0.26	0.33 (0.01)	-0.08 (0.01)	0.00
0.80	3.18	3.39	0.21	0.27 (0.01)	-0.06 (0.01)	0.00
0.90	4.22	4.36	0.14	0.13 (0.01)	0.01 (0.01)	0.00
Pharmaceutical expenditures						
0.30	0.55	0.34	-0.21	0.41 (0.05)	-0.55 (0.01)	-0.07
0.40	1.01	0.97	-0.04	0.15 (0.01)	-0.20 (0.02)	0.01
0.50	1.46	1.50	0.04	0.14 (0.01)	-0.09 (0.01)	-0.01
0.60	1.86	2.11	0.25	0.16 (0.01)	0.08 (0.01)	0.01
0.70	2.39	2.80	0.41	0.19 (0.01)	0.23 (0.01)	-0.01
0.80	3.09	3.60	0.51	0.15 (0.01)	0.36 (0.01)	0.00
0.90	3.91	4.40	0.49	0.11 (0.00)	0.38 (0.01)	0.01

Note: The growth of log spending differs from the growth rate reported in table 7.1 due to approximation. Decomposition results are obtained by application of the decomposition method as illustrated in equation (7.1). The contribution of covariates (coefficients) is given by the first (second) term. The residual is the difference between the observed growth and the sum of the contribution of covariates and coefficients. Bootstrap standard errors between brackets.

zero-spenders. Although HCE growth across all quantiles could to some extent be explained by the changing impact of certain events (e.g. condition treated at higher cost), the absolute and relative contribution of changes in coefficients increase from the 20th percentile. The contribution of changes in determinants to HCE conditional on use, on the other hand, is concentrated around the centre of the distribution and contributed little to the growth at both tails of the distribution.

TABLE 7.4 Decomposition of changes in log monthly expenditure distribution among users in the period 1998-2004

	OBSERVED VALUES			DECOMPOSITION OF GROWTH		
QUANTILE	1998	2004	GROWTH	COVARIATES (S.E.)	COEFFICIENTS (S.E.)	RESIDUAL
Total acute health care expenditures						
0.10	0.84	1.08	0.24	0.11 (0.01)	0.12 (0.01)	0.01
0.20	1.40	1.69	0.29	0.20 (0.01)	0.09 (0.01)	0.00
0.30	1.85	2.26	0.41	0.25 (0.01)	0.15 (0.01)	0.01
0.40	2.34	2.80	0.46	0.28 (0.01)	0.18 (0.01)	0.00
0.50	2.86	3.31	0.45	0.27 (0.01)	0.18 (0.01)	0.00
0.60	3.37	3.79	0.42	0.25 (0.01)	0.17 (0.01)	0.00
0.70	3.87	4.27	0.40	0.22 (0.01)	0.18 (0.01)	0.00
0.80	4.44	4.82	0.38	0.20 (0.01)	0.19 (0.01)	-0.01
0.90	5.23	5.54	0.31	0.11 (0.01)	0.19 (0.01)	0.01
Hospital and other secondary acute care expenditures						
0.10	1.22	1.31	0.09	0.09 (0.01)	0.02 (0.01)	-0.02
0.20	1.57	1.71	0.14	0.16 (0.01)	-0.01 (0.01)	-0.01
0.30	1.99	2.11	0.12	0.16 (0.01)	-0.04 (0.01)	0.00
0.40	2.38	2.49	0.11	0.17 (0.01)	-0.06 (0.01)	0.00
0.50	2.78	2.87	0.09	0.18 (0.01)	-0.08 (0.01)	-0.01
0.60	3.17	3.26	0.09	0.15 (0.01)	-0.05 (0.01)	-0.01
0.70	3.62	3.70	0.08	0.12 (0.01)	-0.03 (0.01)	-0.01
0.80	4.21	4.25	0.04	0.05 (0.01)	-0.01 (0.01)	0.00
0.90	5.30	5.27	-0.03	-0.08 (0.02)	0.05 (0.02)	0.00
Pharmaceutical expenditures						
0.10	0.60	0.75	0.15	0.04 (0.01)	0.11 (0.01)	0.00
0.20	0.95	1.14	0.19	0.07 (0.01)	0.12 (0.01)	0.00
0.30	1.30	1.54	0.24	0.12 (0.01)	0.12 (0.01)	0.00
0.40	1.61	1.95	0.34	0.16 (0.01)	0.18 (0.01)	0.00
0.50	1.94	2.42	0.48	0.20 (0.01)	0.27 (0.01)	0.01
0.60	2.35	2.94	0.59	0.25 (0.01)	0.35 (0.01)	-0.01
0.70	2.86	3.50	0.64	0.24 (0.01)	0.41 (0.01)	-0.01
0.80	3.46	4.06	0.60	0.20 (0.01)	0.40 (0.01)	0.00
0.90	4.14	4.67	0.53	0.14 (0.01)	0.40 (0.01)	-0.01

Note: The growth of log spending differs from the growth rate reported in table 7.1 due to approximation. Decomposition results are obtained by application of the decomposition method as illustrated in equation (7.1). The contribution of covariates (coefficients) is given by the first (second) term. The residual is the difference between observed growth and the sum of the contribution of covariates and coefficients. Bootstrap standard errors between brackets.

Decomposition of hospital and pharmaceutical expenditure growth

In addition, figure 7.3 and table 7.3 also present the decomposition of hospital and pharmaceutical expenditure growth. Marked differences in the explanation of the growth in hospital and pharmaceutical expenditures exist. The growth in hospital expenditures is mainly driven by changes in determinants, which is not surprisingly given the large number of hospital-related determinant. The contribution of changes in the effect of determinants is close to zero and only plays a larger role from the 90th percentile. The second column of figure 7.3 and table 7.3 show that a slightly different pattern is observed for the growth in conditional hospital spending. Again, changes in determinants explain most of the growth in the subgroup of hospital users. However, changes in determinants constrain expenditure growth at the last quintile that mainly comprises inpatient hospital users. This negative contribution of changes in determinants results from a higher proportion of day care admission in 2004 and a reduction in LOS. Unlike changes in determinants, changes in coefficients negatively contribute to the hospital expenditure growth among the subgroup of users until the last quintile. In the last quintile, changes in coefficients positively contribute to hospital expenditure growth conditional on use, which might indicate that technological progress further increases costs of the most expensive hospital treatments and reduces costs of less expensive hospital treatments.

Regarding the growth in pharmaceutical expenditures, changes in coefficients play a much more important role than changes in covariates, indicating a large innovation component in the pharmaceutical sector. Moreover, the contribution of coefficients increases when moving towards higher quantiles. Changes in coefficients explain approximately 30 and 75 percent of the growth at the 60th and 90th percentile, respectively. Table 7.4 shows that changes in covariates and coefficients both positively contribute to the growth of pharmaceutical spending among users at all quantiles. However, the latter contribution dominates the former across the entire distribution indication a large innovation component in the pharmaceutical sector.

The contribution of changes in the distributions of covariates

Figure 7.4 shows the aggregate contribution of changes in determinants to the expenditure growth disaggregated into the contributions of changes in specific determinants. The shaded areas indicate the contribution of changes in the determinant indicated in the subheading to the spending growth. Remember that the contribution of a specific determinant also incorporates changes in the distribution of its correlates. Therefore, the sum of the shaded areas in figure 7.4 may exceed the aggregate contribution of changes in determinants. Although we examined the contribution of changes in all determinants, figure 7.4 only presents the contribution of changes in determinants that showed a clear contribution to spending growth.

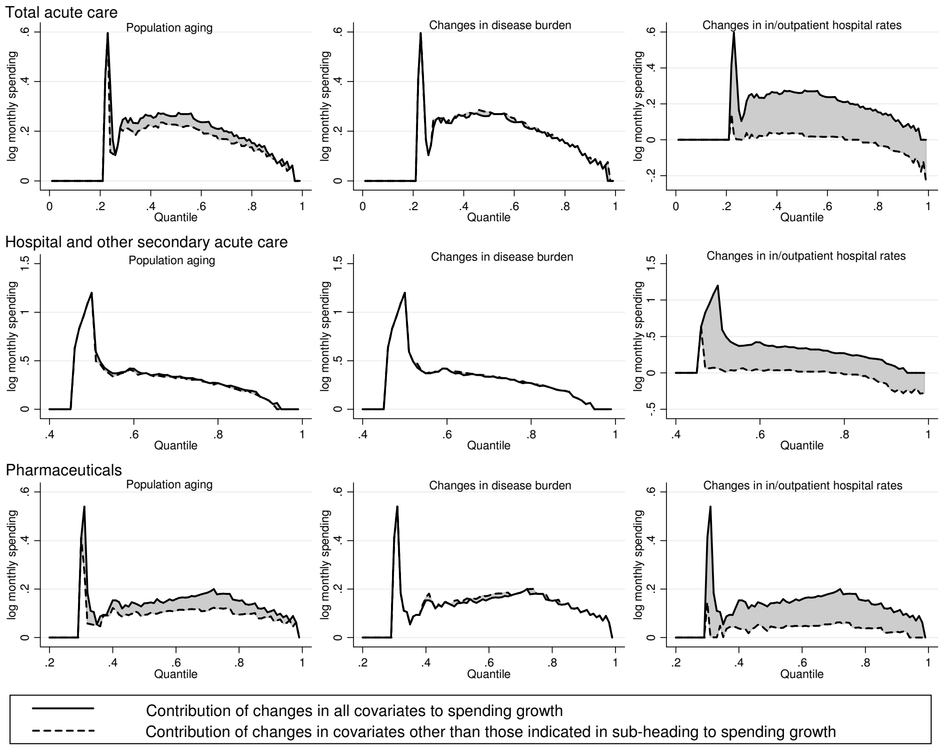

FIGURE 7.4 Contribution of population aging, changes in disease burden and changes in hospital rate to growth in acute HCE

Note: Contribution of changes in all covariates is given by the first term of equation (7.1). The contribution of changes in covariates other than those indicated in the sub-heading is given by the first term of equation (7.2). The shaded area is the difference between the first terms in equation (7.1) and (7.2), and therefore presents the contribution of changes in the covariates indicated in the sub-heading.

Of the changes in population characteristics, population aging measured by changes in the age composition and survival rates, contributes most to acute HCE growth. Aging mostly contributes to the growth in pharmaceutical spending, not to hospital spending. Changes in general disease burden (i.e. work disability and cause-of-death) did not contribute importantly to the acute HCE growth, nor did hospital disease burden. Changes in disease burden seem to have only marginally lowered acute HCE and pharmaceutical spending growth. Instead, most of the growth that could be explained by changes in determinants, for all types of spending and at all quantiles, is attributable to increased use of hospital care, i.e. day care admissions and policlinic visit. The last row of figure 7.4 shows a negative contribution of changes in other determinants at the higher percentiles of acute HCE and hospital expenditures after accounting for increased hospitalization rates. This negative contribution indicates that changes in other determinants constrained expenditure growth at the higher quantiles.

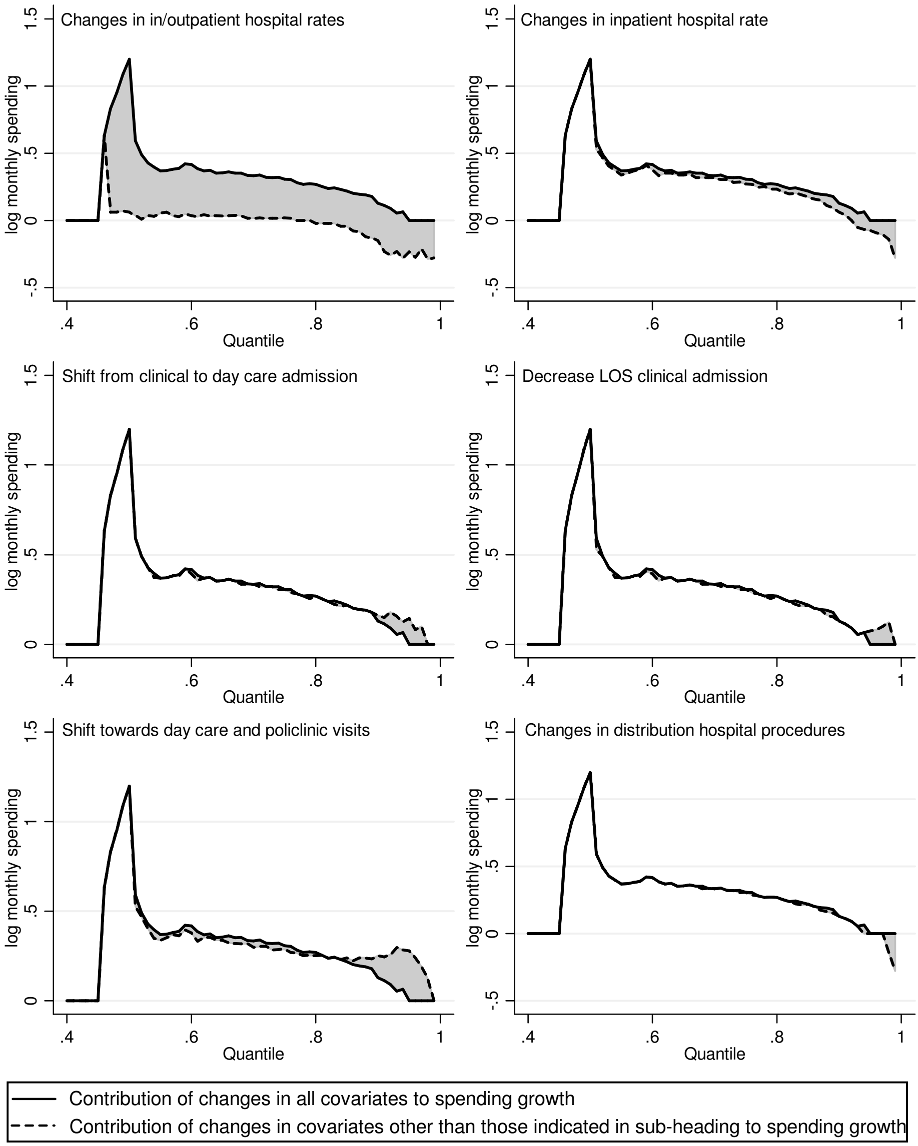

FIGURE 7.5 Contribution of changes in hospital practice styles to growth in hospital and other secondary acute care spending

Note: Contribution of changes in all covariates is given by the first term of equation (7.1). The contribution of changes in covariates other than those indicated in the sub-heading is given by the first term of equation (7.2). The shaded area is the difference between the first terms in equation (7.1) and (7.2), and therefore presents the contribution of changes in the covariates indicated in the sub-heading.

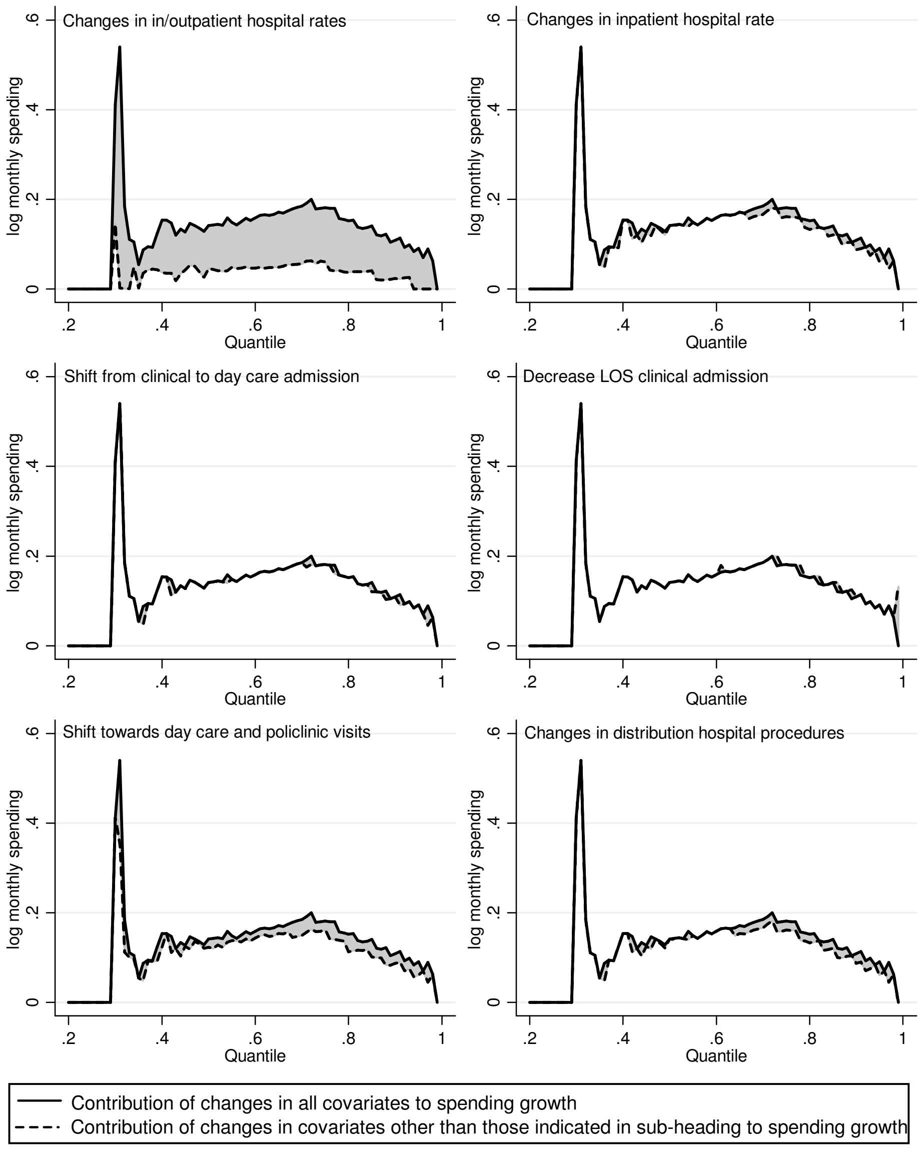

FIGURE 7.6 Contribution of changes in hospital practice styles to pharmaceutical spending growth
Note: Contribution of changes in all covariates is given by the first term of equation (7.1). The contribution of changes in covariates other than those indicated in the sub-heading is given by the first term of equation (7.2). The shaded area is the difference between the first terms in equation (7.1) and (7.2), and therefore presents the contribution of changes in the covariates indicated in the sub-heading.

Figures 7.5 and 7.6 therefore further disentangle the contribution of changes in specific hospital-related factors. Figure 7.5 does this for hospital spending growth, figure 7.6 for pharmaceutical spending growth. The upper left graph again presents the contribution of changes in hospitalization rates (plus correlates). Comparing the above two sub-graphs reveals that increased use of inpatient care is only responsible for a small proportion of the growth in hospital and pharmaceutical expenditures. Hence, increased use of outpatient hospital care must be responsible for the majority of the spending growth in both services. This finding is not surprisingly given that outpatient visits increased by 6.8 percent while inpatient hospitalizations only grew by 0.5 percent. The contribution of changes in inpatient care to the expenditure growth is concentrated at higher quantiles, as can be expected, given the relatively larger cost of inpatient care.

Changes in other hospital-related determinants contribute very differently to hospital versus pharmaceutical expenditure growth. While shifts to less intensive hospital care decreased hospital spending at higher quantiles and increased it at lower quantiles, it increased pharmaceutical expenditures at all quantiles. This strongly suggests that hospital care is partly substituted by pharmaceutical treatment. Furthermore, a decrease in the LOS of a clinical admission resulted in a lower growth of hospital spending at higher quantiles but did not affect the pharmaceutical spending growth. Changes in procedures (e.g. higher proportion of bypass surgery, PTCA and hip replacement) increased hospital expenditures only at the very top end of the distribution but pharmaceutical expenditures at nearly all quantiles. Increased use of pharmaceuticals might be explained by increased use of drugs to prevent post surgical thrombosis and wound infections.

Contribution of changes in the functional relationship with determinants

The contribution of changes in the effect of a specific determinant to the aggregate contribution of changes in the functional relationship with determinants not only depends on the magnitude of the change in the relationship but also on the size of the population to which it applies. Table 7.5 presents stability tests of changes in the effect of (group of) determinants in part I and part II of the two-part model over time. Appendices 7.3 and 7.4 present these stability test for each individual determinant. Although we have decomposed expenditure growth – and the contribution of changes in the relationship with determinants to this growth – across the full marginal distribution, table 7.5 only indicates change in the relationship with determinants (1) on the probability to incur positive expenditures and (2) at conditional mean expenditures. The results in table 7.5 could therefore not be used to explain variation in the contribution of changes in the relationship with determinants at different points of the distribution.

Changes in the effect of some determinants positively contribute to acute HCE growth, changes in the effect of other determinants negatively. Of the population characteristics, the increased effect of age, especially older age, on both the probability and conditional level of spending is most evident, in particular for pharmaceutical spending. The main exception is that females aged 25-44 became less likely to use pharmaceuticals and their conditional pharmaceutical expenditures decreased. This finding is caused by the removal of oral contraceptives from public reimbursement. In addition to age, the effect of work disability on the probability to use hospital care and pharmaceuticals, and on conditional pharmaceutical expenditures increased. The effect of survival status on conditional hospital and pharmaceutical expenditures significantly decreased. The reduced impact of survival status on hospital expenditures is likely related to the increased use of waiting list procedures which are typically not performed in life threatening situations.

Concerning the hospital-related covariates, the effect of an inpatient admission (i.e. effect of type of hospital and type of inpatient admission) on conditional acute HCE and hospital expenditures significantly decreased. Improved access to inpatient care may have brought milder cases of disease into the hospital, resulting in lower average treatment costs. On the contrary, more intensive policlinic treatment probably resulted in the increased effect of policlinic use on expenditures. In addition, the effect of policlinic visits on pharmaceutical spending increased which probably reflects a partial shift of hospital treatment to pharmaceutical treatment.

The joint effect of hospital procedures significantly changed over time. The effect of surgery of the urinary ways and bladder, PT(C)A, diagnostic endoscopy lower gastrointestinal and other diagnostic procedures on conditional acute HCE and hospital spending significantly decreased while the effect of surgery of the male genital organs and obstetric surgery increased. Overall, the joint effect of hospital diagnoses on acute HCE significantly changed over time. The effect of the following hospital diagnoses on acute HCE significantly increased: colorectal cancer, lung cancer, other malignant neoplasm, diabetes, mental and behavioral disorders, eye disorders, CHD, heart failure, other cardiovascular disease, acute respiratory infections, and rheumatoid arthritis. On the contrary, the effect of conditions originating in the perinatal period on acute HCE significantly decreased. The following coefficients on diagnosis in the hospital spending function increased significantly: infectious diseases, prostate cancer, other malignant neoplasm, mental and behavioral disorders, heart failure, acute respiratory infections, asthma and COPD, and rheumatoid arthritis. The increased impact of rheumatoid arthritis is likely to be caused by the introduction of the TNF alpha blocker infliximab, an expensive inpatient drugs. The effect of a hospital diagnosis for diseases of the skin and subcutaneous tissue and conditions originating in the perinatal period significantly dropped. A lower impact of the latter is probably related to a decrease in the proportion of surgeries and an increase in non-surgical procedures. Regarding the changing impact of determinants on pharmaceutical expenditures over time, the effect of most diagnoses on pharmaceutical spending decreased. Only the effect of osteoarthritis, dorsopathy and conditional originating in the perinatal period increased significantly. However, the effect of the majority of diagnoses on the probability to use phar-

TABLE 7.5 Change in effect of covariates on probability to use and conditional mean expenditures over time (1998-2004)

	TOTAL ACUTE CARE				HOSPITAL AND OTHER SECONDARY CARE				PHARMACEUTICALS			
EFFECT ON	PROBABILITY TO USE		CONDITIONAL MEAN SPENDING		PROBABILITY TO USE		CONDITIONAL MEAN SPENDING		PROBABILITY TO USE		CONDITIONAL MEAN SPENDING	
GROUP OF DETERMINANTS	TEST STATISTICA	IN-/DECREASE EFFECT	TEST STATISTICA	IN-/DECREASE EFFECT	TEST STATISTICA	IN-/DECREASE EFFECT	TEST STATISTICA	IN-/DECREASE EFFECT	TEST STATISTICA	IN-/DECREASE EFFECT	TEST STATISTICA	IN-/DECREASE EFFECT
Age and sex	811†	+	3.77†	+	394†	+	8.84†	+	1236†	+	24.25†	+
35-56 years	166†	+	3.50‡	+	149†	+	6.71†	+	207†	+	10.99†	+
>65 years	235†	+	3.86†	+	256†	+	4.45†	+	302†	+	11.83†	+
Deceased	14†	–	0.00		9‡	–	0.09		5*	–	0.05	
TTD	152†	+	2.21		21†	+	3.33*	+	180†	+	5.08‡	+
Coresidence status	10		0.43		10*		0.22		10*	d.	2.51	
Work disabled	34†	+	9.65‡	+	7	+	2.67		86†	+	30.24†	+
Cause-of-Death	15		0.69		10		0.68		9		1.70	
Nr of first policlinic visits			62.45†	+			68.93†	+			97.97†	+
Nr of day care admissions			13.82†	–			6.70‡	–			3.11*	e.
Nr of clinical admissions			15.99†	–			7.58†	–			1.22	
Length of stay			1.49				1.59				7.68†	+
Type of hospital			3.19*	–			0.61					
Hospital Procedures			2.38†	b.			2.30†	b.				
Hospital diagnosis			2.67†	c1.			3.38†	c2.			3.59†	c3.

a A model with a full set of time interactions is used to test the joint significance of a change in the effect of a (group of) covariate(s) on expenditures over time. Null of change in effect (group of) covariate(s) on the probability to use (χ^2-statistic) or conditional mean expenditures (F-statistic); † $p<0.001$; ‡ $p<0.01$; * $p<0.05$

b Effect increased for: surgery male genital organs, obstetric surgery; Effect decreased for: surgery urinary ways and bladder, nonsurgical procedures obstetrics, PT(C)A, diagnostic endoscopy lower gastrointestinal, other diagnostic procedures

c1 Effect increased for: colorectal cancer, lung cancer, other malignant neoplasm, diabetes mellitus, ,mental and behavioral disorders, eye disorders, coronary heart disease, heart failure, other cardiovascular disease, acute respiratory infections, rheumatoid arthritis; Effect decreased for: conditions originating in the perinatal period, other not allocated and disease related

c2 Effect increased for: infectious disease, colorectal cancer, other malignant neoplasm, mental and behavioral disorders, acute respiratory infections, asthma and COPD, rheumatoid arthritis; Effect decreased for: diseases of the skin and subcutaneous tissue, conditions originating in the perinatal period, other not allocated and not disease related.

c3 Effect increased for: osteoarthritis, dorsopathy, conditions originating in the perinatal period; Effect decreased for: mental and behavioral disorder, eye and ear disorders, asthma and COPD, other respiratory disease, digestive disease, pregnancy childbirth and contraception, symptoms signs and ill-defined conditions, other not allocated and not disease related.

d The additional probability to use pharmaceuticals of couples alone compared to individuals living alone decreased over time but remained positive.

e Effect of having one day care admission becomes larger; effect of having more than one day care admission becomes smaller.

maceuticals increased over the period 1998-2004 (not shown in table 7.5). This increase was significant for diabetes, mental and behavioural disorders, ear disorders, CHD, heart failure and stroke. Moreover, individuals hospitalized for prostate cancer or rheumatoid arthritis all used outpatient pharmaceuticals in 2004, but not in 1998.

7.6 DISCUSSION

We decomposed the growth of Dutch acute HCE in the period 1998-2004 across the full spending distribution into a contribution of changes in population characteristics, changes in hospital-related practices, and changes in the functional relationship between HCE and its determinants. In addition, we separately decomposed the growth in the two largest components of acute care, hospital and pharmaceutical care, to examine whether changes in hospital practices had any spillover effects on pharmaceutical expenditures.

Our main findings are as follows. First, although the growth in acute HCE was fairly evenly spread across the spending distribution, the growth in hospital and pharmaceutical spending varied across the distribution. Hospital spending growth, mainly driven by an increased proportion of users, was highest around the centre of its distribution. This was related to the much greater increase in the proportion of outpatient rather than inpatient hospital users. By contrast, pharmaceutical spending growth resulted primarily from more intensive and/or more expensive drug use. Its growth was highest at the higher quantiles, implying that largest rise occurred among those who were already very intensive drug users.

Second, the explanation of the growth in acute HCE differs across the distribution. While changes in the distribution of determinants and changes in the relationship between HCE and these determinants both play an important role, the contribution of changes in determinants generally decreased along the distribution while the contribution of changes in the effect of determinants on HCE increased along the distribution. Changes in particular determinants (e.g. population aging and growing proportion of outpatient and day care users) particularly affected the middle of the distribution, while changes in the spending consequences of certain events (e.g. same diagnoses treated at higher cost) mainly affected growth at the high end of the distribution.

Third, a marked difference in the explanation for the rise in hospital and pharmaceutical expenditures became apparent. Hospital expenditure growth can almost entirely be explained by changes in determinants. Their contribution, however, falls at higher quantiles while changes in the effect of determinants on HCE only contributed to the hospital expenditure growth at the top of the distribution. This strongly suggests that technological progress in the hospital sector will increase treatment of high-cost conditions even further. By contrast, changes in determinants and their effect on HCE are both important in the explanation of pharmaceutical expenditure growth. Changes in determinants being much more important for the hospital expenditure growth is related to our selection of determinants that includes changes in hospital practices but not changes in pharmacotherapeutic treatment styles. Instead, the introduction of new expensive medicines, previously viewed as the most important source of changes in pharmaceutical treatment, is captured by the contribution of the effect of determinants. The relatively high price of innovative medicines, due to patent rights (i.e. monopolistic price setting), explains the rise in the contribution of coefficients at the higher quantiles of the pharmaceutical expenditure distribution.

Fourth, changes in determinants that measure population characteristics only marginally contribute to the rise in acute HCE but among these – population aging – is the most important contributing factor. Among the contributions of changes in determinants, changes in hospital practice styles are by far the most important. Increased hospitalization rates, in particular for outpatient care, explain nearly the entire contribution of changes in determinants to the rise in acute HCE. Because hospital expenditure growth is almost entirely driven by changes in determinants, increased hospitalization rates nearly explain its entire growth. However, changes in other hospital-related factors, have contributed to cost savings at the higher quantiles. Growth at the higher quantiles is constrained by a reduction in LOS of clinical admissions and a relative larger increase in the number of policlinic visits and day care admission than clinical admission. Growth at the centre of the hospital expenditure distribution and across the entire pharmaceutical contribution could however be attributed to changes in type of hospital use/admission strongly suggesting that hospital care can to some extent be substituted by pharmaceutical care. We cannot, however, conclude anything on the direction of the causal effect: the introduction of expensive innovative pharmaceuticals may have saved hospital costs, as has been concluded for the US (e.g. Lichtenberg, 2006, 2007, 2009), or the less intensive hospital treatment may have shifted costs to the pharmaceutical sector.

Fifth, further decomposition of the contribution of changes in the effect of determinants on HCE revealed that the effect of some covariates was in opposite directions. The positive effect of age and outpatient visits combined with the negative effects of inpatient hospital admissions explains the rather small contribution of changes in the impact of determinants to the rise in hospital expenditures. For pharmaceutical spending growth, increases in the effects of age, especially old age, work disability and policlinic visits show significant and important contributions. While the effect of several hospital diagnoses and procedures on hospital and pharmaceutical expenditures significantly changed over time, they have contributed relatively little to the overall, aggregate contribution of coefficients as the proportion of hospitalized patient with these particular diagnoses or procedure was relatively low.

Our study is not the first that attempts to decompose expenditure trends. Our study exhibits most similarities with Dormont, Grignon, and Huber (2006) who not only applied a similar method to decompose expenditure growth but had also access to rich data enabling to analyze expenditures as a function of other determinants than demographics only. Most other previous studies on individual HCE analyzed expenditures as a function of demographics (age, sex, TTD; see Payne *et al.*, 2007 for a review). Our study differentiates from previous literature in a number of respects. First, unlike Dormont, Grignon, and Huber (2006) we explained change in the full marginal distribution of HCE. Our extended approach delivered findings that could not have been uncovered by a standard decomposition of mean HCE. Our results revealed that the growth rate of hospital and pharmaceutical expenditures differs across the expenditure distribution. It has been shown that hospital expenditure growth has been concentrated around the median while pharmaceutical expenditure growth was highest at the end of the distribution. In addition to the growth rate itself, we demonstrated that the explanation of the growth also varies by location in the expenditures distribution. While previous studies could only conclude that drug expenditures were largely driven by technological progress (Dormont, Grignon, and Huber, 2006; Häkkinen *et al.*, 2008), our results further reveal that technological progress accounts mostly for growth at the end of the drug expenditure distribution. Concerning hospital care, the rise in hospital expenditures could almost entirely be explained by changes in determinants.

Second, we had the unique opportunity to trace how an injection of funding gets distributed across patients. Policies to reduce waiting lists resulted in additional resources spent on hospital care. Unsurprisingly, our findings demonstrate that most of the increase in expenditures could indeed be explained by a greater propensity to admit inpatients, as reflected by the increased hospitalization rates, rather than the use of more expensive hospital care. The relaxation of budgets successfully, but inefficiently, reduced waiting times: although hospital use for treatments on the waiting list grew disproportionately, use of treatments not on the waiting lists also grew.

Third, richness of our data enabled to explain the observed expenditure growth more completely. In addition to individual-specific determinants, we had suitable data that measured medical practice styles. While Dormont, Grignon, and Huber (2006) could only conclude that changes in medical practices dominate the expenditure growth, we opened the black box of medical practices by further disentangling the contribution of specific changes in hospital practices. While technological progress accounts for an important part of pharmaceutical expenditures growth, our results strongly suggest that cost-increasing technological innovations in hospital care are targeted at the most expensive treatments. On the other hand, technological progress, but also improvements in for example logistics, seem to have increased efficiency in hospital care by reducing LOS and shifting treatment to day care and policlinics.

Our study also has its limitations. First, although we have unique and rich data, the absence of health information on non-hospitalized patients somewhat complicates the interpretation. In the absence of general population health measures, much of its effect may be captured by the age dummies as old age tends to come with health deterioration. Secondly, changes in the prevalence rates of inpatient hospital diagnoses and changes in the effect of these diagnoses on HCE should be interpreted cautiously. A fall in a specific hospital diagnosis does not necessarily imply a decrease in the overall prevalence of that condition but may also be due to substitution of inpatient by outpatient care (e.g. policlinic, GP, pharmaceuticals). Similarly, changes in the effect of inpatient hospital diagnoses may not fully capture (changes in) the effect of a disease on acute HCE, hospital expenditures and pharmaceutical. Take the example of outpatient TNF-alpha blockers: while their introduction has increased pharmaceutical treatment costs for rheumatoid arthritis, this cannot be seen from a change in the effect of the hospital diagnosis rheumatoid arthritis as improved pharmaceutical treatment is likely to have decreased the probability of an inpatient admissions for rheumatoid arthritis. Third, due to the lack of data on GP spending (funded by a capitation system), we could not examine possible substitutions of hospital treatment by GP treatment, although some of the prescribing consequences are captured indirectly in pharmaceutical spending patterns

In conclusion, we find that changes in medical practices, probably to an important extent caused by technological progress and the relaxation of budgets, dominate the acute HCE growth. While there is a discernible contribution of population aging to spending growth, it is moderate: population aging could explain 3.5 percentage point of the 29.4 percent growth at the median. Its impact can, however, not be seen in isolation from technological progress and the relaxation of hospital budgets. Both of these developments seem to have disproportionately benefited the elderly given that the effect of older age groups rose more than for younger age groups, and the expanded waiting list treatments (e.g. cataract and orthopedic surgery, PTCA, knee and hip replacement) were more concentrated among the elderly. Finally, policymakers should be aware that predictions of HCE solely based on changes in population characteristics (e.g. population aging, changing health patterns) are very naive and grossly underestimate projections of future HCE. In our case, such projections would only have estimated a 6 percent growth at the median instead of the 29 percent actual growth observed between 1998 and 2004.

APPENDICES

APPENDIX 7.1 Description of covariates

VARIABLE	DESCRIPTION	DATA SOURCEA
Dependent variables	The dependent variables comprise spending on acute health care services covered by the basic benefit package.	Vektis
log acute HCE	Logarithm of average monthly spending on hospital and other secondary acute care (excluding paramedical care), pharmaceuticals, obstetrics and maternity care, transport and devices. Spending is first corrected for inflation and Baumol's disease, then logarithmically transformed.	
log hospital spending	Logarithm of average monthly spending on hospital and other secondary acute care (excluding paramedical care).	
log drug spending	Logarithm of average monthly spending on outpatient pharmaceuticals	
Age and sex	Dummy categories: females 0-14 (reference category), females 15-24, females 25-34. females 35-44, females 45-54, females 55-64, females 65-74. females 75-84, females 85+, males 0-14, males 15-24, males 25-34. males 35-44, males 45-54, males 55-64, males 65-74. males 75-84, males 85+.	GBA
Coresidence status	Co-residence status on January 1st; dummy categories: living alone (reference category), couple alone, other private household, institutionalized.	GBA
Work disabled	Indictor: individual received work disability benefits	Vektis
Number of first policlinic visits	Defined as the number of different policlinic specialists an individual visited during the year; dummy categories: none (reference category, 1 first policlinic visit, 2 first policlinic visits, 3 or more policlinic visits	Vektis
Number of day care admissions	Number of day care admissions during the year; dummy categories: none (reference category), 1day care admission, 2 or more day care admissions	LMR
Number of clinical admissions	Number of clinical admissions during the year; dummy categories: none (reference category), 1 clinical admission, 2 or more clinical admissions	LMR
Length of stay	Number of inpatient admission days and its square	LMR
Hospital diagnosis	*Inpatient* hospital diagnosis. 39 indicators; coded according to the International Classification of Disease 10th version (ICD-10). See Appendix 7.2 for an overview of the selected diagnoses	LMR
Hospital procedures[b]	Restricted to primary procedures during *inpatient* hospital stays. 47 indicators. See Appendix 7.2 for an overview of the selected procedures.	LMR
Type of hospital[b]	Indicators for type of hospital individual was admitted to for inpatient hospital stay: general hospital, university hospital, other teaching hospital, specialized hospital	LMR
Deceased	Indicator: deceased within 5 years after the measurement year	DO
TTD	TTD in months (set at a maximum of 60 for survivors) and its square	DO
Cause-of-Death	10 dummies; measured by the ICD-10. External cause of death (reference category); neoplasm; endocrine, nutritional or metabolic disease; mental and behavioral disorder; disease of the nervous system or sense organs, cardiovascular disease; respiratory disease; digestive disease; disease of the genitourinary system; symptoms signs and ill-defined conditions, else.	DO

a. sickness fund records (Vektis); hospital registry (LMR), municipality register (GBA), national death registry (DO)
b. not included in pharmaceutical expenditure model

APPENDIX 7.2 Distribution of hospital diagnosis and procedures and change over time

	1998	2004	CHANGE[a]
Hospital procedure (% of inpatient stay)	72.35	63.67	-8.69†
Neurosurgery	2.62	2.97	0.35‡
Surgery endocrine glands	0.21	0.19	-0.02
Surgery lense and eye	5.91	7.47	1.55†
Surgery ear	2.85	2.38	-0.46†
Surgery nose and sinuses	1.67	1.45	-0.22*
Surgery airways, tonsils and adenoid	4.70	3.66	-1.04†
Surgery heart and thoracic vessels	1.39	1.46	0.06
Surgery other vessels	1.14	1.37	0.23‡
Other surgery arteries	0.97	0.88	-0.08
Surgery spline, bone marrow, lymphatic system	0.41	0.36	-0.05
Surgery mouth	1.03	1.03	0.00
Surgery stomach and esophagus	0.44	0.57	0.13*
Surgery colon and intestines	0.98	1.17	0.19*
Surgery appendix	0.77	0.68	-0.09
Surgery rectum and anus	1.03	1.06	0.03
Surgery gall bladder, bile ducts, liver, pancreas	1.53	1.75	0.22*
Surgery abdominal hernia	2.06	2.02	-0.04
Other surgery abdominal wall, peritoneum	0.50	0.48	0.02
Surgery kidneys	0.28	0.30	0.02
Surgery urinary ways and bladder	1.22	1.43	0.21*
Surgery male genital organs	2.49	2.42	-0.07
Surgery female genital organs incl. curettage	4.69	4.59	-0.09
Obstetric surgery	5.14	4.81	-0.33
Surgery facial bones	0.25	0.22	-0.03
Surgery for fractures and luxations	1.88	1.74	-0.14
Other bone and joint surgery	9.34	9.55	0.22
Surgery soft tissue	1.77	1.78	0.01
Other surgery skeletal and muscular system	0.30	0.24	-0.06
Surgery mamma	2.05	1.82	-0.23*
Surgery skin	2.38	2.35	-0.03
PT(C)A	1.07	1.77	0.70†
Nonsurgical procedures obstetrics	1.62	1.57	-0.05
Nonsurgical procedures musculoskeletal system	0.48	0.52	0.04
Radiotherapy	0.18	0.13	-0.05
Chemotherapy	0.36	0.40	0.04

APPENDIX 7.2 Distribution of hospital diagnosis and procedures and change over time (table continued)

	1998	2004	CHANGE[a]
Other therapeutic or preventive procedures	3.67	5.09	1.42†
Biopsy	2.46	2.45	-0.01
Diagnostic endoscopy respiratory tract	0.84	0.75	-0.09
Diagnostic endoscopy upper gastrointestinal	0.90	1.25	0.35†
Diagnostic endoscopy lower gastrointestinal	1.61	3.13	1.52†
Diagnostic endoscopy urogenital tract	0.54	0.74	0.20‡
Diagnostic laparoscopy	0.69	0.46	-0.23†
Diagnostic arthroscopy	1.01	0.76	-0.25†
Other and unspecified diagnostic endoscopy	0.02	0.04	0.01
Diagnostic radiology	1.94	1.64	-0.30‡
Other diagnostic procedures	3.14	3.97	0.83†
No procedure	26.65	24.62	-2.03†
Inpatient hospital diagnosis (% inpatient stay)			
Infectious disease	1.39	1.24	-0.15
Colorectal cancer	0.52	0.58	0.06
Lung cancer	0.50	0.52	0.01
Breast cancer	0.72	0.63	-0.09
Prostate cancer	0.22	0.22	0.00
Other malignant neoplasm	2.39	2.60	0.21
Benign neoplasm	2.73	3.05	0.31*
Diabetes mellitus	0.70	0.73	0.03
Other endocrine, nutritional, metabolic disease	1.23	1.36	0.13
Disease of the blood (forming organs)	0.88	1.02	0.14*
Mental and behavioral disorders	1.6	1.23	0.07
Multiple sclerosis	0.25	0.23	-0.02
Epilepsy	0.48	0.33	-0.15‡
Eye disorders	5.91	7.48	1.57†
Ear disorders	2.82	2.30	-0.53†
Other disease nervous system/sense organs	1.96	2.30	0.33‡
Coronary heart disease (CHD)	4.52	4.05	-0.47‡
Heart failure	1.35	1.27	-0.08
Stroke	1.60	1.83	0.23*
Other cardiovascular disease	6.19	6.84	0.65†
Acute respiratory infections	1.93	1.75	-0.18
Asthma and COPD	1.64	1.22	-0.42†
Other respiratory disease	6.46	5.28	-1.18†
Disease of the digestive system	9.55	10.39	0.84†

APPENDIX 7.2 Distribution of hospital diagnosis and procedures and change over time (table continued)

	1998	2004	CHANGE[a]
Disease of the genitourinary system	7.99	8.22	0.23
Pregnancy, childbirth and contraception	12.05	10.21	-1.84†
Disease of the skin and subcutaneous tissue	1.53	1.56	0.03
Rheumatoid arthritis	0.25	0.35	0.10*
Osteoarthritis	1.85	2.51	0.66†
Dorsopathy	3.03	2.70	-0.33*
Other disease of the musculoskeletal system	8.21	8.15	-0.06
Congenital abnormalities	1.16	1.12	-0.04
Conditions originating in the perinatal period	2.32	1.66	-0.66†
Hip fracture	1.01	0.91	-0.09
Other fracture	1.42	1.49	0.07
Injury	4.92	4.73	-0.20
Symptoms, signs and ill-defined conditions	7.27	9.76	2.49†
Cancer not allocated	0.42	0.43	0.01
Other not allocated and not disease related	6.79	9.49	2.69†

a. P-value null of no change in distribution covariate over time. † p<0.001; ‡ p<0.01; * p<0.05

APPENDIX 7.3 Average partial effects of covariates on the probability to incur any expenditure by type of service and stability of covariate effect over time

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY CARE			PHARMACEUTICALS		
	1998	2004	CHANGE	1998	2004	CHANGE	1998	2004	CHANGE
Age and sex (ref = Females 0-14 years)									
Females 15-24 years	0.169†	0.202†	0.033†	0.061†	0.130†	0.069 †	0.232†	0.258†	0.026‡
Females 25-34 years	0.218†	0.223†	0.005	0.179†	0.252†	0.073 †	0.276†	0.239†	-0.037†
Females 35-44 years	0.166†	0.212†	0.046†	0.145†	0.230†	0.085 †	0.210†	0.243†	0.033†
Females 45-54 years	0.160†	0.240†	0.080†	0.169†	0.261†	0.092 †	0.206†	0.281†	0.075†
Females 55-64 years	0.159†	0.264†	0.105†	0.201†	0.305†	0.104 †	0.206†	0.313†	0.107†
Females 65-74 years	0.200†	0.329†	0.129†	0.295†	0.433†	0.138 †	0.250†	0.404†	0.154†
Females 75-84 years	0.227†	0.342†	0.115†	0.351†	0.466†	0.115 †	0.289†	0.425†	0.136†
Females >=85 years	0.233†	0.346†	0.113†	0.278†	0.427†	0.149 †	0.304†	0.441†	0.137†
Males 0-14 years	0.001	0.027†	0.026†	0.035†	0.042†	0.007	-0.007	0.015*	0.022*
Males 15-24 years	-0.094†	-0.038†	0.056†	-0.040†	-0.003	0.037	-0.097†	-0.034	0.063†
Males 25-34 years	-0.043†	0.020‡	0.063†	-0.022‡	0.032†	0.054 †	-0.031†	0.034†	0.065†
Males 35-44 years	0.022†	0.088†	0.066†	0.030†	0.085†	0.055 †	0.042†	0.118†	0.076†
Males 45-54 years	0.056†	0.142†	0.086†	0.072†	0.149†	0.077 †	0.081†	0.179†	0.098†
Males 55-64 years	0.094†	0.209†	0.115†	0.129†	0.240†	0.111 †	0.126†	0.253†	0.127†
Males 65-74 years	0.167†	0.293†	0.126†	0.274†	0.403†	0.129 †	0.209†	0.365†	0.156†
Males 75-84 years	0.197†	0.336†	0.139†	0.339†	0.468†	0.129 †	0.253†	0.414†	0.161†
Males >=85 years	0.220†	0.353†	0.133†	0.288†	0.434†	0.146 †	0.288†	0.442†	0.154†
Deceased	0.058‡	0.019	-0.039	0.005	-0.053	-0.058	0.032	0.045	0.013

APPENDIX 7.3 Average partial effects of covariates on the probability to incur any expenditure by type of service and stability of covariate effect over time (table continued)

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY CARE			PHARMACEUTICALS		
	1998	2004	CHANGE	1998	2004	CHANGE	1998	2004	CHANGE
Coresidence status (ref = living alone)									
Couple alone	0.027†	0.031†	0.004	0.022†	0.026†	0.004	0.028†	0.024†	-0.004
Other private household	0.007	0.022†	0.015*	-0.018†	-0.003	0.015 *	0.010‡	0.020†	0.010
Institutionalized	-0.112†	-0.113†	-0.001	-0.048†	-0.072†	0.024-	-0.260†	-0.252†	0.008
Work disabled	0.064†	0.101†	0.037†	0.125†	0.135†	0.010	0.064†	0.119†	0.055†
Cause-of-Death (ref = external cause)									
Neoplasm	-0.009	0.039	0.048	0.099†	0.129†	0.030	0.034	0.038	0.004
Endocrine. nutritional or metabolic disease	0.007	0.084*	0.077*	0.109‡	0.194†	0.085	0.058*	0.070*	0.012
Mental and behavioral disorder	-0.243†	-0.211†	0.032	-0.155†	-0.075*	0.080	-0.212†	-0.291†	-0.079
Disease of the nervous system or sense organs	-0.095‡	-0.040	0.055	0.024	0.083*	0.059	-0.069	-0.072*	-0.003
Cardiovascular disease	-0.015	0.012	0.027	0.037	0.059*	0.022	0.012	-0.010	-0.022
Respiratory disease	-0.035	-0.036	-0.001	0.041	0.053	0.012	0.009	-0.041	-0.050
Digestive disease	-0.036	0.083*	0.119†	0.053	0.109‡	0.056	0.002	0.029	0.027
Disease of the genitourinary system	-0.043	0.005	0.048	0.025	0.139‡	0.114	-0.031	-0.086*	-0.055
Symptoms. signs and ill-defined conditions	-0.045	-0.003	0.042	-0.006	0.025	0.031	0.009	-0.024	-0.033
Else	-0.030	-0.016	0.014	0.079	0.077	-0.002	-0.015	-0.052	-0.037

APE's estimated by a probit model including a full set of time interactions. Null of change in APE's tested by difference in means. † $p<0.001$; ‡ $p<0.01$; * $p<0.05$

APPENDIX 7.4 Model for conditional mean expenditures on total acute care, hospital care and pharmaceuticals

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY ACUTE CARE			PHARMACEUTICALS		
	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]
Age and sex (ref = Females 0-14 years)[b]	†	†	†	†	†	†	†	†	†
Females 15-24 years	0.567†	0.562†	-0.006	0.130†	0.234†	0.104†	0.635†	0.536†	-0.099†
Females 25-34 years	0.763†	0.785†	0.022	0.175†	0.335†	0.160†	0.678†	0.509†	-0.169†
Females 35-44 years	0.750†	0.783†	0.033	0.185†	0.289†	0.104†	0.787†	0.742†	-0.045†
Females 45-54 years	0.937†	0.985†	0.048*	0.201†	0.280†	0.079‡	1.014†	1.054†	0.040*
Females 55-64 years	1.117†	1.142†	0.025	0.210†	0.219†	0.009	1.242†	1.285†	0.043
Females 65-74 years	1.454†	1.508†	0.054*	0.244†	0.261†	0.017	1.662†	1.757†	0.095
Females 75-84 years	1.619†	1.672†	0.053	0.261†	0.279†	0.018	1.768†	1.909†	0.141†
Females >=85 years	1.670†	1.835†	0.165†	0.188†	0.242†	0.054‡	1.684†	1.875†	0.191†
Males 0-15 years	0.088†	0.082†	-0.006	0.013	0.035	0.022	0.059†	0.069†	0.010
Males 15-24 years	0.201†	0.279†	0.078‡	0.104†	0.203†	0.099†	0.117†	0.192†	0.075‡
Males 25-34 years	0.289†	0.380†	0.091†	0.125†	0.203†	0.078‡	0.258†	0.334†	0.076*
Males 35-44 years	0.520†	0.592†	0.072‡	0.129†	0.211†	0.082‡	0.539†	0.607†	0.068†
Males 45-54 years	0.753†	0.859†	0.106†	0.160†	0.187†	0.027	0.807†	0.956†	0.149†
Males 55-64 years	1.030†	1.098†	0.068*	0.207†	0.219†	0.012	1.129†	1.255†	0.126†
Males 65-74 years	1.428†	1.527†	0.099†	0.350†	0.286†	-0.064*	1.578†	1.813†	0.235†
Males 75-84 years	1.536†	1.610†	0.074*	0.344†	0.334†	-0.010	1.685†	1.862†	0.177†
Males >=85 years	1.509†	1.620†	0.111*	0.176†	0.244†	0.068	1.547†	1.743†	0.196†
Time-to-death[b]	†	†		†	†	*	†	†	*
Deceased	0.404†	0.398†	-0.006	0.389†	0.355†	-0.034	0.389†	0.364†	-0.025
TTD	-0.077†	-0.083†	-0.006	-0.096†	-0.103†	-0.007	-0.030†	-0.042†	-0.012‡
TTD^2	0.001†	0.001†	0.000	0.001†	0.001†	0.000	0.000†	0.000†	0.000*

APPENDIX 7.4 Model for conditional mean expenditures on total acute care, hospital care and pharmaceuticals (table continued)

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY ACUTE CARE			PHARMACEUTICALS		
	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]
Coresidence status (ref = living alone) [b]	†	†							
Couple alone	-0.050†	-0.059†	-0.009	-0.004	-0.004	0.000	-0.083†	-0.090†	-0.007
Other private household	-0.117†	-0.132†	-0.015	-0.030‡	-0.038†	-0.008	-0.153†	-0.169†	-0.016
Institutionalized	0.174†	0.190*	0.016	-0.036	-0.047	-0.011	0.401†	0.506†	0.105*
Outpatient hospital care (ref = none) [b]	†	†	†	†	†	†	†	†	†
1 first policlinic visit	1.090†	1.042†	-0.048†	0.724†	0.803†	0.079†	0.320†	0.389†	0.069†
2 first policlinic visits	1.455†	1.527†	0.072†	1.250†	1.397†	0.147†	0.544†	0.754†	0.210†
3 or more policlinic visits	1.625†	1.785†	0.160†	1.496†	1.707†	0.211†	0.802†	1.131†	0.329†
Inpatient care: day care admission (ref = none) [b]	†	†	†	†	†	‡	†	†	*
1 day care admission	0.351†	0.204†	-0.147†	0.346†	0.260†	-0.086‡	0.133†	0.095†	-0.038
2 or more day care admissions	0.523†	0.416†	-0.107*	0.538†	0.514†	-0.024	0.366†	0.423†	0.057
Inpatient care: clinical admission (ref = none) [b]	†	†	†	†	†	†	†	†	
1 clinical admission	1.047†	0.917†	-0.130†	1.250†	1.209†	-0.041	0.236†	0.191†	-0.045
2 or more clinical admissions	1.199†	1.142†	-0.057	1.376†	1.434†	0.058	0.461†	0.417†	-0.044
Length of inpatient hospital stay [b]	†	†		†	†		†	†	‡
Length of stay	0.023†	0.022†	-0.001	0.031†	0.030†	-0.001	0.007†	0.007†	0.000
Length of stay^2	-0.000†	-0.000†	0.000	-0.000†	-0.000†	0.000	-0.000†	-0.000†	0.000‡
Type of hospital inpatient admission [b]	†	†	*	†	†				
University hospital	1.072†	0.952†	-0.120†	1.114†	1.093†	-0.021			
Other teaching hospital	0.689†	0.612†	-0.077*	0.855†	0.877†	0.022			
Specialized hospital	0.687†	0.560†	-0.127	0.677†	0.705†	0.028			
General hospital	0.591†	0.526†	-0.065*	0.775†	0.784†	0.009			

APPENDIX 7.4 Model for conditional mean expenditures on total acute care, hospital care and pharmaceuticals (table continued)

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY ACUTE CARE			PHARMACEUTICALS		
	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]
Hospital procedures [b]	†	†	†	†	†	†			
Neurosurgery	0.065	0.056	-0.009	0.145†	0.144†	-0.001			
Surgery endocrine glands	0.182	0.292‡	0.110	0.366†	0.393†	0.027			
Surgery lense and eye	0.003	-0.029	-0.032	0.209‡	0.210†	0.001			
Surgery ear	0.467†	0.280†	-0.187	0.437†	0.324†	-0.113			
Surgery nose and sinuses	0.345†	0.231†	-0.114	0.340†	0.250†	-0.090			
Surgery airways. tonsils and adenoid	0.170†	0.193†	0.023	0.006	0.020	0.014			
Surgery heart and thoracic vessels	0.466†	0.439†	-0.027	0.559†	0.619†	0.060			
Surgery varices	0.531†	0.436†	-0.095	0.538†	0.444†	-0.094			
Other surgery arteries	0.576†	0.450†	-0.126	0.636†	0.567†	-0.069			
Surgery spline. bone marrow and lymphatic system	0.293†	0.291†	-0.002	0.247‡	0.307†	0.060			
Surgery mouth	0.253†	0.265†	0.012	0.159†	0.204†	0.045			
Surgery stomach and esophagus	0.175	0.056	-0.119	0.202*	0.150*	-0.052			
Surgery colon and intestines	0.140*	0.092*	-0.048	0.237†	0.255†	0.018			
Surgery appendix	0.444†	0.507†	0.063	0.240†	0.315†	0.075			
Surgery rectum and anus	0.078	0.099*	0.021	0.016	0.020	0.004			
Surgery gall bladder. bile ducts, liver, pancreas	0.148‡	0.095*	-0.053	0.309†	0.275†	-0.034			
Surgery abdominal hernia	-0.184†	-0.128†	0.056	-0.042	0.039	0.081			
Other surgery abdominal wall and peritoneum	0.283†	0.257†	-0.026	0.335†	0.265†	-0.070			
Surgery kidneys	0.414†	0.617†	0.203	0.459†	0.692†	0.233			
Surgery urinary ways and bladder	0.178†	-0.017	-0.195‡	0.336†	0.125‡	-0.211†			

APPENDIX 7.4 Model for conditional mean expenditures on total acute care, hospital care and pharmaceuticals (table continued)

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY ACUTE CARE			PHARMACEUTICALS		
	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]
Surgery male genital organs	-0.006	0.094‡	0.100*	0.029	0.123†	0.094*			
Surgery female genital organs incl. curettage	0.003	0.074‡	0.071	0.298†	0.306†	0.008			
Obstetric surgery	0.472†	0.679†	0.207†	0.498†	0.629†	0.131*			
Surgery facial bones	0.674†	0.366†	-0.308	0.603†	0.393†	-0.210			
Surgery for fractures and luxations	0.528†	0.412†	-0.116	0.469†	0.414†	-0.055			
Other bone and joint surgery	0.407†	0.373†	-0.034	0.436†	0.455†	0.019			
Surgery soft tissue	0.145‡	0.067	-0.078	0.194†	0.138†	-0.056			
Other surgery skeletal and muscular system	0.119‡	0.080	-0.039	0.163	0.274‡	0.111			
Surgery mamma	0.102*	0.082	-0.020	0.213†	0.136‡	-0.077			
Surgery skin	0.080	0.078*	-0.002	0.087*	0.137†	0.050			
PT(C)A	0.542†	0.378†	-0.164*	0.585†	0.451†	-0.134*			
Nonsurgical procedures obstetrics	0.429†	0.530†	0.101	0.377†	0.339†	-0.038			
Nonsurgical procedures musculoskeletal system	0.359†	0.399†	0.040	0.188*	0.235†	0.047			
Radiotherapy	-0.135	-0.007	0.128	-0.006	0.090	0.096			
Chemotherapy	0.053	0.370	0.317	-0.029	0.463*	0.492			
Other therapeutical and preventive procedures	0.006	0.067‡	0.061	-0.006	0.069‡	0.075			
Biopsy	-0.058	0.000	0.058	0.044	0.083‡	0.039			
Diagnostic endoscopy respiratory tract	-0.029	-0.064	-0.035	0.158‡	0.065	-0.093			
Diagnostic endoscopy upper gastrointestinal	0.058	0.033	-0.025	0.172‡	0.151†	-0.021			
Diagnostic endoscopy lower gastrointestinal	0.057	-0.068*	-0.125*	0.223†	0.127†	-0.096*			
Diagnostic endoscopy urogenital tract	-0.096	0.024	0.120	0.002	0.080	0.078			
Diagnostic laparoscopy	0.302†	0.308†	0.006	0.375†	0.248†	-0.127			

APPENDIX 7.4 Model for conditional mean expenditures on total acute care, hospital care and pharmaceuticals (table continued)

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY ACUTE CARE			PHARMACEUTICALS		
	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]
Diagnostic arthroscopy	0.212†	0.275†	0.063	0.183†	0.278†	0.095			
Other and unspecified diagnostic endoscopy	-0.011	-0.286	-0.275	-0.041	-0.128	-0.087			
Diagnostic radiology	-0.014	0.058	0.072	0.016	0.055	0.039			
Other diagnostic procedures	0.216†	0.093†	-0.123‡	0.209†	0.082‡	-0.127‡			
No procedure	0.248†	0.188†	-0.060	0.193†	0.163†	-0.030			
Work disabled	0.450†	0.501†	0.051‡	0.159†	0.135†	-0.024	0.523†	0.622†	0.099†
Cause-of-Death (ref = external cause) [b]	†	†		*	†		†	†	
Neoplasm	0.142*	0.150*	0.008	0.156	0.250†	0.094	0.029	0.047	0.018
Endocrine. nutritional or metabolic disease	0.407†	0.374†	-0.033	0.055	0.151	0.096	0.405†	0.372†	-0.033
Mental and behavioral disorder	0.017	-0.042	-0.059	0.423‡	0.177	-0.246	-0.238*	-0.162	0.076
Disease of the nervous system/sense organs	0.159	0.276*	0.117	0.205	0.192*	-0.013	0.028	0.156	0.128
Cardiovascular disease	0.093	0.028	-0.065	0.048	0.099	0.051	0.041	0.003	-0.038
Respiratory disease	0.215‡	0.237‡	0.022	0.095	0.155*	0.060	0.165*	0.263‡	0.098
Digestive disease	0.008	0.101	0.093	0.025	0.120	0.095	-0.095	0.150	0.245
Disease of the genitourinary system	0.305‡	0.269*	-0.036	0.172	0.203	0.031	0.122	0.364‡	0.242
Symptoms. signs and ill-defined conditions	0.091	0.123	0.032	0.097	0.094	-0.003	0.030	0.054	0.024
Else	0.222*	0.274‡	0.052	0.275*	0.281‡	0.006	0.145	0.189	0.044
Hospital diagnosis [b]	†	†	†	†	†	†	†	†	†
Infectious disease	0.171†	0.236†	0.065	0.016	0.165†	0.149*	0.201‡	0.117	-0.084
Colorectal cancer	-0.174*	0.075	0.249‡	0.031	0.281†	0.250*	-0.599†	-0.476†	0.123
Lung cancer	-0.352†	-0.145*	0.207*	-0.139	0.059	0.198	-0.141	0.010	0.151
Breast cancer	-0.034	0.140*	0.174	0.179*	0.339†	0.160	-0.413†	-0.251‡	0.162

APPENDIX 7.4 Model for conditional mean expenditures on total acute care, hospital care and pharmaceuticals (table continued)

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY ACUTE CARE			PHARMACEUTICALS		
	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04} - \beta_{98}$ [a]
Prostate cancer	0.031	0.056	0.025	0.128	0.402†	0.274	0.514†	0.211	-0.303
Other malignant neoplasm	-0.335†	-0.095‡	0.240†	-0.213†	0.008	0.221†	-0.084	-0.005	0.079
Benign neoplasm	-0.063*	-0.072*	-0.009	-0.010	0.013	0.023	-0.256†	-0.318†	-0.062
Diabetes mellitus	-0.086	0.133*	0.219*	-0.088	-0.171‡	-0.083	0.834†	0.880†	0.046
Other endocrine, nutritional, metabolic disease	0.120	0.061	-0.059	0.038	0.016	-0.022	0.355†	0.310†	-0.045
Disease of the blood (forming organs)	-0.166‡	-0.163†	0.003	-0.064	-0.110*	-0.046	0.170*	0.053	-0.117
Mental and behavioral disorders	-0.899†	-0.683†	0.216*	-1.731†	-1.222†	0.509†	0.469†	0.203‡	-0.266†
Multiple sclerosis	0.383‡	0.371*	-0.012	0.064	-0.041	-0.105	1.022†	0.943†	-0.079
Epilepsy	0.025	0.050	0.025	-0.145	-0.011	0.134	0.445†	0.266*	-0.179
Eye disorders	-0.338†	-0.150*	0.188*	-0.129	0.014	0.143	-0.131†	-0.228†	-0.097*
Ear disorders	0.121	0.222‡	0.101	-0.134	-0.050	0.084	0.010	-0.175†	-0.185‡
Other disease nervous system or sense organs	-0.155‡	-0.183†	-0.028	-0.167†	-0.184†	-0.017	-0.010	-0.148‡	-0.138
Coronary heart disease	-0.193†	-0.083‡	0.110‡	-0.009	0.055†	0.064	0.462†	0.486†	0.024
Heart failure	-0.490†	-0.286†	0.204†	-0.146‡	0.031	0.177‡	0.101*	-0.009	-0.110
Stroke	-0.361†	-0.282†	0.079	-0.064	0.050	0.114	-0.349†	-0.276†	0.073
Other cardiovascular disease	-0.307†	-0.216†	0.091*	-0.122†	-0.047*	0.075	0.015	-0.039	-0.054
Acute respiratory infections	0.036	0.191†	0.155*	0.034	0.254†	0.220†	0.207†	0.080	-0.127
Asthma and COPD	-0.029	0.073	0.102	0.014	0.138‡	0.124*	0.913†	0.737†	-0.176*
Other respiratory disease	-0.038	0.066	0.104	-0.129‡	-0.030	0.099	0.026	-0.136†	-0.162†
Disease of the digestive system	0.033	0.084†	0.051	0.042	0.072‡	0.030	0.023	-0.089†	-0.112‡
Disease of the genitourinary system	0.061*	0.100†	0.039	0.032	0.092†	0.060	-0.059	-0.085‡	-0.026
Pregnancy. childbirth and contraception	0.149†	0.219†	0.070	-0.244†	-0.233†	0.011	-0.554†	-0.660†	-0.106*

APPENDIX 7.4 Model for conditional mean expenditures on total acute care, hospital care and pharmaceuticals (table continued)

	TOTAL ACUTE CARE			HOSPITAL AND OTHER SECONDARY ACUTE CARE			PHARMACEUTICALS		
	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]	β_{1998}	β_{2004}	$\beta_{04}-\beta_{98}$ [a]
Disease of the skin and subcutaneous tissue	0.093	-0.015	-0.108	0.044	-0.120‡	-0.164*	0.264†	0.142*	-0.122
Rheumatoid arthritis	0.143	0.450†	0.307*	0.306†	0.581†	0.275*	0.749†	0.660†	-0.089
Osteoarthritis	-0.043	-0.036	0.007	0.352†	0.340†	-0.012	-0.326†	-0.069	0.257†
Dorsopathy	-0.066	-0.100‡	-0.034	-0.019	-0.069*	-0.050	-0.199†	-0.069	0.130*
Other disease of the musculoskeletal system	-0.165†	-0.116†	0.049	-0.115†	-0.074‡	0.041	-0.236†	-0.276†	-0.040
Congenital abnormalities	0.383†	0.403†	0.020	0.042	0.078	0.036	-0.087	-0.209‡	-0.122
Conditions originating in the perinatal period	0.826†	0.633†	-0.193*	0.303†	-0.057	-0.360‡	-0.049	0.301†	0.350†
Injury	-0.424†	-0.381†	0.043	0.003	0.121*	0.118	-0.494†	-0.550†	-0.056
Hip fracture	-0.122	-0.075	0.047	-0.076	-0.095	-0.019	-0.453†	-0.361†	0.092
Other fracture	-0.051	-0.063*	-0.012	-0.156†	-0.162†	-0.006	-0.073*	-0.111‡	-0.038
Symptoms. signs and ill-defined conditions	-0.163†	-0.202†	-0.039	-0.192†	-0.241†	-0.049	0.162†	0.077‡	-0.085*
Cancer not allocated	0.003	-0.237	-0.240	-0.078	-0.425*	-0.347	0.377‡	0.382†	0.005
Other not allocated and not disease related	-0.004	-0.087†	-0.083*	-0.079‡	-0.166†	-0.087†	0.129†	0.010	-0.119‡
Intercept	2.934†	3.015†	0.081	3.365†	3.181†	-0.184*	1.853†	2.189†	0.336
Pseudo R2	0.591	0.607		0.671	0.710		0.346	0.388	

a Null of change in coefficients tested by Wald stability test on interaction between a time dummy and the respective covariate
b Joint significance of group of variables
† $p<0.001$; ‡ $p<0.01$; * $p<0.05$

Discussion | 8

The main purpose of this thesis was to enhance understanding of the (relative) impact of population aging to the health care expenditure (HCE) growth in the Netherlands and other developed countries. This chapter identifies and places the main conclusions in perspective, and discusses (policy) implications, recommendations and the remaining issues that need to be addressed in future research.

MAIN FINDINGS

Point of departure of the thesis is that population aging is just one of the driving forces behind the HCE growth. Societal and other individual determinants are even more important, e.g. need determinants (health and disability) and technological progress. Both factors, however, are strongly interrelated with aging. Nevertheless, few studies thus far adopted an integrated approach in investigating the (relative) impact of population aging on the level of HCE by integrating either (a) public health and health economics research or (b) evidence on the influence of societal and individual determinants. The adoption of these integrated approaches indeed provided important new insights.

Time to drop time-to-death?

Due to data limitations, most previous studies that analyzed individual HCE data failed to account for the foremost important determinant of HCE, need determinants. Given that the relationship between age and HCE is largely due to ill-health requiring medical treatment, the contribution of population aging to HCE growth could not be fully considered in these studies. In the absence of adequate data on need determinants, mortality (time-to-death) has often been used to approximate health and disability. Time-to-death (TTD) studies have concluded that population aging has shifted an important part of HCE to older ages, especially for acute care, but to a lesser extent for long-term care (LTC) expenditures. As a consequence, population aging was anticipated to have a limited effect on the growth in acute HCE (0.5-1.0 percent annually), but would impact LTC spending more substantially. We have shown that also TTD approximates health and disability incompletely. The impact of TTD on acute and LTC spending was found to diminish – or even to become redundant – after appropriately controlling for health and disability status. Consequently, when future trends in health or disability do not coincide with mortality trends, TTD models probably still lead to inaccurate predictions of future spending.

We discussed three competing hypotheses on the relation between longevity gains and trends in health and disability: expansion, compression, and postponement of morbidity (Fries, 1980; Olshansky *et al.*, 1991; Payne *et al.*, 2007). Using TTD to approximate health or disability inherently assumes a postponement hypothesis: the trend in ill-health is shifted along the age range, while its duration remains constant. Most recent evidence however favors the compression hypothesis. This strongly suggests replacing TTD with information on better need determinants, as TTD is unable to fully capture the effect of (healthy) aging on HCE. It does, however, by no means indicate that one should dispose of TTD in predicting future expenditures. Unlike future trends in health and disability, forecasts of life expectancy are readily available for most countries and probably less prone to uncertainty than forecasts of disability and health which increases the usefulness of TTD in forecasting HCE.

Multicolored gray: the impact of aging depends on the trend in ill-health

This thesis improved insight in the relationship between need determinants and health care use and spending in the Netherlands. Disability is indeed the most important need determinant of LTC use. However, age remains an important driver of LTC spending, even after controlling for disability. Population aging is therefore anticipated to further increase LTC expenditures, regardless of the trend in disability. However, the extent to which it will do so greatly depends on the disability trend.

Furthermore, population aging impacts lifetime and aggregate LTC spending to different extents but both depend on the trend in disability. In the Netherlands, longevity gains are expected to be accompanied by a compression of severe and expansion of mild disability. As institutional LTC use is mainly driven by severe disability and home care use by mild disability, longevity gains increased lifetime spending on home care. Because home care is relatively inexpensive compared to institutional LTC, longevity gains are expected to only slightly increase lifetime spending on LTC. By contrast, the increasing proportion of elderly is expected to substantially increase aggregate LTC spending. To what extent it will do so depends on the underlying disability trend; accounting (not accounting) for the trend in disability, Dutch home care spending is expected to increase by 23 (87) percent between 2004 and 2040. A continuation of the disability decline therefore importantly alleviates the consequences of population aging on the LTC sector.

It's all relative: population aging is just one of the driving forces behind the HCE growth

In addition to largely neglecting need determinants, the vast majority of microeconomic studies have studied the impact of population aging in isolation of the societal determinants. The partial effect of population aging, defined as changes in the population age composition, deviates importantly from the full effect of population aging that also incorporates the interaction between population aging and other individual and societal determinants of HCE. Changes in de age composition of the population contribute moderately to the total HCE growth; it explains 0.5-1.0 percent of a total annual real growth rate that can reach 4-5 percent (Burner, Waldo, and McKusick, 1992; Richardson and McKie, 1999; Reinhardt, 2003). At the macroeconomic level, medical technological progress, facilitated by economic growth and willingness to pay, is the strongest driver of HCE growth, in particular for acute care and to a lesser extent for LTC. Medical technology alters treatment patterns and could decrease, but more often turns out to increase, treatment costs for a specific health problem. Baumol's disease is another societal determinant that structurally contributes to HCE growth. Its contribution has been found to approach the partial effect of population aging (e.g. 0.6 percent annually for the Netherlands; Douven *et al.*, 2006). Unlike most studies, *chapter seven* simultaneously unraveled the contribution of individual and several societal determinants to acute HCE growth. Changes in population characteristics (e.g. aging, health) could only marginally explain the rise in acute HCE. Instead, changes in medical practice styles, mainly due to changed government policy and technological progress, contributed to three quarters of the acute HCE growth in the Netherlands.

Although the partial effect of population aging is limited, its full effect could be substantial as the impact of population aging is strongly related to that of other important individual and societal determinants. In addition to the strong association between age and need determinants, the impact of population aging is strongly related to influential societal determinants. First, because medical technological progress largely depends on the demand for it, e.g. the health of the population, population aging and corresponding trends in population health largely stimulate medical technological progress. Innovations are likely to be targeted at individuals with the highest need for health care. Consequently, elderly benefit more from technological progress than younger generations. Second, government policies (i.e. relaxation of budgets) are likely to disproportionately benefit elderly populations. Third, population aging increases the relative importance of Baumol's disease. Due to population aging, serious labor force shortages in health care, in particularly in the LTC sector, are expected. Population aging is therefore likely to put an upward pressure on wages in health care. Hence, population aging importantly influences the HCE growth. Its relevance is underestimated when not considering that the impact of population aging is interrelated to other important driving forces of the HCE growth.

As different as chalk and cheese? The drivers of acute versus LTC spending

Driving forces of expenditure growth vary by health care sector. LTC spending growth seems to depend most on changes in the determinants of LTC expenditures: the age composition and disability rates. On the contrary, acute HCE growth is mainly subject to structural changes that alter the impact of determinants on HCE by changing medical practice patterns. Important sources of structural change are technological progress and government policy. Instability of the acute HCE function explains three quarters of the Dutch acute HCE growth over the period 1998-2004 while changes in population characteristics (e.g. aging, health) contributed only moderately to acute HCE growth. An important message to be derived from this finding is that forecasts of acute HCE solely based on trends in population characteristics are likely to considerably underestimate the actual growth. For instance, only a 6 percent growth of median acute care spending over the period 1998-2004 would have been predicted in 1998, while the actual growth amounted to 29 percent.

The relatively low impact of medical technology on LTC spending growth is related to the aim of the LTC sector which is to care for instead of cure. In addition, LTC expenditures are mainly composed of personnel and housing costs. However, the limited effect of medical technology does by no means imply stability of the LTC expenditure function. Instead, instability of this function is caused by other developments. Structural changes to improve the quality of care have definitely increased LTC expenditures, e.g. the shift from six person bedrooms to two person or private bedrooms in LTC facilities at the beginning of the 2000s (TKSG, 2000). Even higher quality standards are expected to be adopted in the near future. Elderly increasingly demand "more hands around the bed" resulting in a rise of personnel costs (Eggink, Oudijk, and Woittiez, 2010). Although the above structural changes in LTC provision result in rising per capita LTC expenditures, structural changes might also lead to a decrease in per capita LTC expenditures, e.g. the separation of the housing and caring function. All these examples illustrate that structural changes will definitely impact the LTC expenditure function resulting in inadequate forecasts of LTC spending that would be projected by combining future trends in determinants with current LTC functions.

In addition to the different drivers of acute and LTC expenditure growth, explanation of the rise in expenditures varies between sub sectors of acute health care. Application of an innovative decomposition method to explain hospital and pharmaceutical expenditure growth revealed important new insight: not only the growth itself, but also the explanation of the growth varies across the expenditure distribution and between hospital and pharmaceutical care. Hospital expenditure growth can almost entirely be explained by increased hospital rates facilitated by changes in government policy (i.e. relaxation hospital budgets), while changes in other hospital practices (e.g. decreased length-of-stay, shift to less intensive hospital treatment) decreased spending at the top end of the distribution and increased spending at lower percentiles. By contrast, the pharmaceutical spending growth resulted primarily from more intensive and/or more expensive drug use. Technological progress (i.e. the introduction of medicines) seems to be the most important driver of pharmaceutical spending growth, especially at the higher percentiles of the pharmaceutical expenditure distribution.

LIMITATIONS

The present thesis has several limitations, of which the most important will be outlined. First, our forecasts of LTC spending in *chapter four and five* did not control for possible changes in the impact of determinants on LTC expenditure. More research is needed on the magnitude of the instability of the LTC function to shed light on this conjecture and to be able to forecast LTC expenditures more adequately. Second, the impact of population aging on the supply of and demand for informal care is far from clear yet. Continuing shifts from severe to mild disability might increase future demands for informal care as informal care is a better substitute for the less skilled LTC services (Bonsang, 2009). Simultaneously, increases in the female labor force participation, retirement age and the number of single living elderly are likely to decrease informal care supply. Consequently, the gap between supply and demand for informal care is likely to increase. Given that informal care partly substitutes formal LTC, research on the consequences of population aging on informal care is required to be able to improve prognoses of LTC expenditures in aging populations. Third, the relationship between health and disability and HCE is complex as causality works in both directions. We were, however, unable to control for this endogeneity which has probably underestimated the effects of health and disability on acute and LTC spending. Fourth, although we have been able to illustrate the improvement in HCE models when accounting for variation in health and disability, we could not actually show that these richer models also improved the accuracy of expenditure forecasts. Finally, in the absence of individual data on general health, we could not fully capture the effect of changing population health on the growth in acute HCE.

POLICY IMPLICATIONS AND FURTHER RESEARCH

Instability of the expenditure function is shown to considerably impact HCE growth. Government policies being an important source of instability of the HCE function, suggests that it is indeed possible to influence future growth rates. However, our study period was characterized by a centrally governed and supply-restricted health care sector. Given that the Netherlands has moved towards a demand-driven health care system with less involvement of the central government, it is of utmost importance that health insurers take over the responsibility as guardians of HCE growth while simultaneously respecting the wishes of their clients. Early evidence of regulated competition indeed revealed that health insurers were able to increase efficiency by lowering prices of drugs and hospital services (CVZ, 2009; NZa, 2009). The different nature of spending growth in acute and LTC calls for sector tailored recommendations on modes to influence future spending growth. The list of recommendations to influence acute and LTC expenditure growth is not exhaustive, but is restricted to options that more or less arise from the results.

Long-term care

Various policy options recently passed the review to relieve the consequences of population aging on public LTC expenditures. Options could be organized under three headings: changes in epidemiology, improvement in efficiency, and support of informal caregivers.

The first option directly evolves from our main findings as LTC spending growth largely depends on the future trend in disability. Hence, policies stimulating a continuation of the disability decline alleviate LTC spending growth. It is however uncertain to what extent the current decline in disability will continue. E.g. inclining obesity rates with a concurrent rise of chronic conditions might boost HCE. More research is needed to reduce uncertainty surrounding the future disability trend. Research on the causes of the disability decline will for example reduce uncertainty surrounding its future trend. Suggested causes of the disability decline are: a reduction in the prevalence of chronic illnesses, a reduced disabling impact of these diseases, better educated elderly, development of (non)medical technology that enhances the ability to live independently (e.g. appliances, micro wave). From an public health perspective, decreasing disability by preventing or treating chronic conditions is the most preferred mode as this option intrinsically prevents disability instead of providing modes to deal with disability independently. However, reaching a compression of disability by preventing or curing health problems most probably demands a large medical innovation component resulting in further increases in acute HCE. This strong interaction between acute and LTC spending calls for a better linkage between acute and LTC financing in the Netherlands.

Second, numerous modes have been suggested to improve efficiency in LTC provision. Some initiatives have recently received attention by the Dutch government. First, a renewed focus on the substitution policy to keep individuals at home as long as possible has received full attention. Part of this policy is the government proposal to separate the housing and caring function in LTC that will be stimulated by the introduction of the "complete home package" (EKSG, 2011). The housing function of institutionalized elderly will only be publicly financed if institutionalization is inevitable. This renewed emphasis on the substitution policy definitely will alter per capita LTC expenditures: institutional LTC use will partly be replaced by home care use. As long as the most severely disabled individuals could enter LTC institutions, this substitution policy is likely to lower growth rates of LTC spending. The observed shift from severe to mild disability indeed suggests that future LTC could be more targeted at independently living individuals as home care services could adequately meet the needs of mildly disabled individuals.

A second mode to improve efficiency is to replace the current pay-as-you-go financing system by LTC saving accounts. In a system of LTC saving accounts, LTC is funded on a capital basis. LTC users become more responsible for their expenses and have a greater freedom of provider choice. Besides possible efficiency improvements and increases in informal LTC provision, LTC savings accounts improve the intergenerational solidarity. Currently no international experience regarding LTC savings account exists. More research is needed to investigate under which conditions LTC saving accounts improve efficiency

A third mode to increase efficiency in LTC provision is extending cash benefits in LTC. Cash benefits are shown to be more efficient than in-kind benefits (Sadiraj *et al.*, 2011; van den Berg and Hassink, 2008). However, on the short run extending cash benefits also attracts public LTC users that would not have used publicly financed care in the absence of the extension of cash benefits. Moreover, the introduction of cash benefits has monetized previously unpaid informal care. Nonetheless, extending the personal care budget might be a viable option to further explore given the expected labor shortages in formal LTC. Extending cash benefits not only improves efficiency but also provide a way to stimulate informal care. As demographic development are likely to increase the gap between supply of and demand for informal care, future shortages of informal care are likely to further accelerate the demand for public LTC. Governments therefore need to consider policies that stimulate the provision of informal care as its supply is likely to fail meeting its demand. In addition to LTC saving accounts and extending cash benefits, informal care provision could be stimulated by employment of the informal caregiver at government/municipality possibly with pension benefits similar to some Scandinavian countries.

Acute health care

Modes to control acute HCE growth mainly constitute initiatives to improve system performance. The prominent roles of changes in hospital practices and technological progress to acute HCE growth provide two key initiatives how to influence future growth rates. First, it is worth to further examine to what extent expensive acute care services could be substituted by less expensive ones. Medical technological progress has facilitated an increased efficiency of the provision of hospital care. Expensive hospital care has been substituted by less expensive hospital care, primary care and pharmaceuticals, which has been proved to reduce acute HCE. In addition, further reductions in length of hospital stay could be reached given that length-of-stay in the Netherlands is still above average compared to other countries (Borghans *et al.*, 2008). Reductions in length of stay could only be reduced if it is beneficial for all three parties involved: patients, hospitals and insurers. Health insurers could use their negotiating power to reward hospitals close to the benchmark. However, in the absence of full information on the quality of care and length-of-stay health insurers do not have sufficient insight in the performance of hospitals resulting in an inappropriate reward system.

Second, (stricter) efficiency criteria could restrict diffusion and reimbursement of technologies. Establishing or tightening of efficiency criteria for innovative technologies, however, has its pitfalls. Besides possible public dissatisfaction, the acute care spending growth might have contributed to the observed disability decline. Hence, restricting the growth by medical technological progress too rigorously might shift expenditures to the LTC sector. Concerning technological progress in hospital care, new procedures can access the basic benefit package relatively easy given that they are evaluated on effectiveness only and do not have to pass a cost-effectiveness hurdle. A systematic evaluation of efficiency as part of the reimbursement decision for hospital procedures could lead to acute HCE savings.

The large innovation component in the pharmaceutical sector implies that tightening reimbursement (criteria) of (new) medicines is especially a relevant mode to reduce drug expenditure growth. Currently, the Dutch reimbursement criteria and reimbursement prices of outpatient drugs depend on the therapeutic value. For new drugs with therapeutic equivalent value, a reference pricing system applies: reimbursement equals the average price within a therapeutic equivalent group of drugs. Evidence of the therapeutic value is required to obtain a reimbursement decision. In addition, for new drugs with therapeutic added value, cost-effectiveness evidence and an assessment of the national budget impact is required. Drugs with a therapeutic added value are fully reimbursed.

Drug expenditure savings could be reached by several adaptations of the drug reimbursement (criteria). First, as no rating in the amount of therapeutic added value exists, costs savings could be substantial by defining a reasonable threshold for therapeutic added value. Second, although cost-effectiveness is a formal reimbursement criterion for drugs with therapeutic added value, it does not seem prominent in actual decision-making (Franken, Sandman, and Koopmanschap, 2011). A more systematic assessment of efficiency should lead to better value for money of publicly financed drugs. Third, regulations could be introduced to hold manufacturers more accountable when aggregated costs of their drug exceed their assessment of the budget impact, e.g. manufacturers could be obliged to discount drug prices once the estimated budget impact has been exceeded (Le Polain *et al.*, 2010). Fourth, cost-effectiveness of drugs is evaluated at launch only and is not systematically reviewed. A systematic reevaluation of the cost-effectiveness of reimbursed drugs will reduce drug expenditures by excluding drugs from the reimbursement system based on updated (cost-) effectiveness evidence. Fifth, savings could be substantial by changing the reference pricing system, e.g. set the reference price equal to the price of the least expensive drugs within a group of equivalent drugs instead of the average. Finally, European Union member states should collaborate in assessing the (cost)-effectiveness of orphan drugs. Currently, these drugs are often reimbursed despite solid evidence on (cost-)effectiveness (Denis *et al.*, 2010; Vegter *et al.*, 2010).

In addition to improving efficiency by adjusting the drug reimbursement system, pharmaceutical expenditures could be saved when insurers collectively bundle their power to lower the price of reimbursed drugs and to restrict full reimbursement to the lowest priced drugs. Preferential policies of insurers and claw-back agreements between government and pharmacy retail have led to substantial savings in the past (€1.5 million in 2008; CVZ, 2009).

In conclusion, the integrated approaches adopted by this thesis to investigate the relative contribution of population aging to the HCE growth provided important new insights. Nonetheless, more research is needed to fully understand the contribution of population aging by incorporating trends in health and disability. To facilitate this research, improved data on disability and ill-health is needed to enable reliable forecasts of their trends over time. Epidemiological expertise on future trends in ill-health and disability has to be combined with health economics models to improve predictions of future spending levels. As the causality chain of the relationship between health and HCE works in both directions, future research should account for this mutual relationship between health and disability and HCE. Finally, it is of utmost importance to further disentangle sources of the instability of the HCE function that alter medical practice styles, and most often cause a rise in expenditures.

Summary

INTRODUCTION

In recent decades, populations in developed countries have aged considerably. In the Netherlands, the proportion of the population aged 65 and above doubled, from 7.6 to 15.3 percent in the period 1950-2010. This proportion will reach its peak in 2040 when 25.9 percent of the population will be aged 65 and above. On top of the increased share of the 65+ population, population aging also reflects gradual increases in the share of the very old (85+) within the 65+ population. This share increased from 12.9 to 25.5 percent in the period 1950-2010, and is expected to rise to 33.3 percent in 2040.

Population aging will definitely have a large impact on society. It will challenge current social security systems, among others the financial sustainability of health and long-term care systems. Simultaneous to population aging, an upward trend in health care expenditures (HCE) has been observed. In the Netherlands, the amount spent on health care as a percentage of GDP rose from 8.7 to 13.1 percent over the period 1972-2007 while per capita HCE in constant prices more than doubled. The main objective of this thesis is to improve understanding of the (relative) impact of population aging on acute and long-term care (LTC) expenditure growth in the Netherlands. Point of departure of the thesis was that population aging is just one of the driving forces behind the HCE growth: societal and other individual determinants are even more important, and are strongly interrelated with aging. This thesis therefore adopted an integrated approach in investigating the relative impact of population aging on the level of HCE by integrating: (a) public health and health economics research and (b) evidence on the influence of societal and individual determinants.

The thesis consists of three parts. Part A provides a general overview of the current state of the literature on the causes and consequences of HCE growth in aging populations. Although the impact of population aging on acute HCE has been studied abundantly, few studies have analyzed its influence on LTC expenditures. Part B therefore investigates the impact of population aging on LTC expenditures in the Netherlands in greater depth. Part C further disentangles the contribution of several factors to acute HCE growth.

A. THE IMPACT OF AGING AND OTHER DETERMINANTS ON HEALTH CARE EXPENDITURES

Chapter two provides a literature overview of the impact of aging(-related) factors on HCE growth. It discusses the consequences of population aging to the HCE growth in relation to other determinants of HCE that interact strongly with aging, like health and technological progress. A distinction is made between the influence of determinants on acute and LTC expenditures.

Given that HCE are generally higher in older age groups, population aging has traditionally been viewed as a prime suspect of HCE growth determinant. This view revised as a result of the cost-of-dying and time-to-death literature: the high spending at older ages appears to be associated with time-to-death (TTD) rather than with age. Because individuals can die only once, this means that the impact of population aging on HCE growth is recognized to be significantly lower than traditionally believed. Still, TTD is at best a proxy for health, the real determinant of HCE (needs). The extent to which population aging impacts on HCE therefore depends primarily on the underlying trends in population health. Most of the literature on population aging and HCE could however only include rough approximations of health determinants, like age or TTD. It is shown that the influence of population aging on HCE could not accurately be estimated when ignoring important trends.

The strongest driver of expenditures, in particular for acute care, seems to be technological progress, facilitated by economic growth. The contribution of the increased share of elderly to HCE growth is relevant but modest. It explains 0.5-1.0 percent of the 4 percent real annual growth in HCE. The influence of population aging on LTC expenditures is much stronger. Although the partial contribution of population aging to the HCE growth is rather limited, it does not mean that aging is unimportant for HCE. Many important drivers of HCE, especially technological progress (for acute care), developments in wages and prices, and disability (for LTC), interact very strongly with age. E.g. technological progress disproportionately benefits the elderly.

B. THE IMPACT OF POPULATION AGING ON LONG-TERM CARE EXPENDITURES

To enhance our understanding of the LTC expenditure growth, a better insight in the decision process leading to LTC utilization is paramount. The Dutch institutional context imposes a strong influence of disability status on LTC use: the presence of disabilities is an important prerequisite for obtaining access to publicly financed LTC. The objective of *chapter three* is therefore to examine the determinants of home care and institutional LTC use, and focuses on the role of disability.

Age importantly drives LTC use, even after extensive control for disability. LTC needs of aging populations will therefore keep rising irrespective of age-specific disability trends. However, because disability is also an important driver of LTC use in its own right it still provides opportunity policy level to policymakers since disability trends can be influenced. The additional disabilities required to use home care are considerably lower than the additional disabilities to switch from home care use to institutional LTC use: an increase of the disability index by one point increases the probability to use home care (institutional LTC) on average by 2.3 (0.6) percentage points.

Having determined the relationship between disability and LTC use in *chapter three*, *chapter four* disentangles the separate roles of age, TTD and disability in explaining LTC expenditures. Literature on population aging and HCE commonly used age, and more recently TTD, to approximate need determinants. We reconsider the roles of age and TTD by controlling for cause-of-death and disability and illustrate their relevance for projecting LTC expenditures in aging populations. A number of findings emerged. First, the large variation in decedent expenditures by cause-of-death demonstrates that the relationship between TTD and LTC expenditures is dynamic: epidemiological changes will affect the importance of each cause-of-death and consequently the overall influence of TTD on LTC expenditures. Second, after control for disability, the influence of TTD becomes redundant, while age remains an important determinant of LTC expenditures. The decline in the effect of age and the redundancy of TTD after control for disability indeed confirms that age and TTD largely approximate disability. The finding that TTD mainly acts as a proxy for disability raises doubts about its validity for projecting LTC expenditures. Projections using TTD implicitly assume that longevity gains merely shift disability to older ages. Dynamics in the relationship between mortality and disability caused by epidemiological changes are ignored and therefore contradict recent evidence favoring a compression of disability. Hence, using TTD to approximate disability still overestimates the effect of aging on future LTC expenditures as is illustrated by the projections presented in *chapter four*.

Reliable estimates of future trends in disability are required to improve prognoses of LTC spending. This is the objective of *chapter five:* to estimate future disability rates and combine these with LTC utilization rates by disability, age and sex to obtain forecasts of individual lifetime and population aggregate annual LTC spending for 2020. The resulting LTC expenditure forecasts then explicitly accounted for changing disability patterns instead of approximating it by age or TTD. The main findings are as follows. The proportion of life years with severe disability is expected to decrease while the proportion of life years with mild disability is expected to increase. Lifetime home care spending, mainly determined by mild disability, is expected to increase while institutional spending will remain fairly constant due to stable life years with severe disability. Given that lifetime LTC expenditures are largely determined by institutional spending, future longevity gains with improved disability will not seriously increase lifetime spending. It is however important to note that this finding strongly depends on the accuracy of forecasts of life years with severe disability. On the contrary, the growth of the share of elderly will considerably increase aggregate spending for the 55+ population, by 19.2 percent in the period 2007-2020.

Chapter six focuses on informal care, an important component of LTC. We only contribute indirectly to evidence on the impact of population aging on informal care spending. *Chapter four* reveals that informal care acts as an important substitute for formal LTC. Co-residence approximates informal care availability as the bulk of informal care is provided by the partner. Hence, co-residing individuals spend substantially less on formal LTC. The objective of *chapter six* is to examine the feasibility of the contingent valuation (CV) method to obtain a monetary value for one hour of informal care. Main findings are as follows. On average caregivers and care recipients value one hour informal care at €9.83 and €7.87. CV values are sensitive to the heterogeneity and dynamics of informal care implying that the method has the capability of capturing the full effects of the informal care situation in monetary terms. Important determinants of care givers valuations are kind of task, opportunity costs and personal care budget (PCB). The latter finding indicates that PCBs can drive up LTC expenditures by monetising informal care. Although CV values are sensitive to the care giving situation, non-response remains a matter of concern. Selective non-response probably biased CV values upwards.

C. UNRAVELING THE DETERMINANTS OF ACUTE HEALTH CARE EXPENDITURE GROWTH

The objective of *chapter seven* is to improve understanding of the contribution of various factors to the acute HCE growth in the Netherlands over the period 1998-2004. Real acute HCE growth in this period was 28 percent, but the growth was not uniform across the distribution. We therefore examine and unravel this growth across the full expenditure distribution. Growth in acute HCE, hospital and pharmaceutical spending is explained by a part due to changes in determinants – such as health, medical practice styles, aging – and a part due to the changing impact of determinants on acute HCE. The latter results from structural changes (e.g. technological progress) that alter treatment costs of specific conditions. We obtain the following results.

Although the growth in acute HCE was fairly evenly spread across the spending distribution, the growth rate of hospital and pharmaceutical spending varied across the distribution. Hospital spending growth was highest around the centre of its distribution and can largely be explained by a higher proportion of hospital admissions which was stimulated by policies to reduce waiting lists. Reduced length-of-stay and a relatively larger increase in day care admissions and outpatient visits have contributed to lower growth of hospital spending at the top of the hospital expenditure distribution. The picture is quite different for pharmaceutical expenditure growth which could entirely be explained by more intensive and/or expensive pharmaceutical use and was concentrated at the right end of the distribution. Technological progress (the introduction of new drugs) dominates the explanation of the pharmaceutical expenditure growth, especially at the top of the distribution as new drugs are relatively expensive. In addition, pharmaceutical expenditure growth could moderately be explained by shifts to less intensive forms of hospital treatment – day care admissions and outpatient visits – and population aging. This strongly suggests that hospital care can to some degree be substituted by pharmaceutical care. Changes in population characteristics (aging, population health) explain only a very small proportion of acute HCE growth. Although the contribution of population aging to spending growth was moderate, its impact could not be seen in isolation from technological progress and the relaxation of hospital budgets. Both developments seem to have disproportionately benefited the elderly.

DISCUSSION

Chapter eight discusses the main findings, their (policy) implications and recommendations, the main limitations of the present studies and possibilities for further research. This summary is restricted to the main findings and its (policy) implications and recommendations. The main conclusions were:

First, given that the relationship between age and HCE is largely due to health, the full contribution of population aging to HCE growth could only be considered when accounting for changing health patterns. Disability is the most important need determinant of LTC use. In the absence of disability, TTD largely approximates disability. Findings however show that TTD was unable to fully capture the effect of (healthy) aging on HCE suggesting to replace TTD with information on better need determinants.

Second, the impact of changes in the age composition of the population on HCE growth is limited: it could explain 0.5-1.0 percent of a total annual real growth of 4-5 percent. However, the full effect of population aging could be substantial as the impact of population aging is strongly related to that of other important individual and societal determinants. In addition to need determinants, the full impact of population aging is strongly related to technological progress, developments in wages/prices and government policies.

Third, the contribution of several factors to growth in acute HCE and LTC expenditures differed. While LTC spending growth seems to depend most on changes in the population age composition and the future trend in disability, acute HCE growth is mainly subject to changes in medical practices, largely due to medical technological progress and health policies. Not only does the impact of population aging differ between acute and LTC expenditures, it also differs between subsectors of acute care (hospital and pharmaceutical sector) and between individual lifetime and annual population aggregate LTC expenditures.

Longevity gains are expected to slightly increase lifetime spending while the increasing proportion of elderly is expected to substantially increase annual aggregate spending.

The most important (policy) implications and recommendations that are discussed in *chapter eight* are as follows. First, the finding that government policies themselves were an important source of HCE growth, suggests that it is indeed possible to influence future HCE growth. Given that the Netherlands has moved from a centrally governed and supply-restricted health care sector towards a demand-driven health care system with less involvement of the central government, it is important that health insurers take over the responsibility as guardians of HCE growth while simultaneously respecting the wishes of their clients.

Second, it is worth noting that policymakers should be aware that forecasts of HCE solely based on trends in population characteristics are likely to considerably underestimate the actual growth, in particularly for acute care. For instance, only a 6 percent growth of median acute HCE over the period 1998-2004 would have been predicted in 1998, while the actual growth amounted to 29 percent.

Third, the different nature of spending growth in acute and LTC calls for sector tailored recommendations on policy options to control future spending growth. *Chapter eight* briefly discussed modes to influence acute and LTC spending growth that more or less follow from our results. Concerning the LTC sector, options to relieve public LTC expenditure growth are grouped under three headings: changes in epidemiology, improvements in efficiency, and support of informal care provision. First, stimulating a continuation of the decline in disability rates could alleviate the consequences of population aging on the LTC sectors. It is however uncertain to what extent the current decline in disability is time- or cohort-specific. Second, modes to improve efficiency in LTC provision include: a substitution policy to keep individuals at home as long as possible, extending cash benefits in LTC, and LTC savings account as an alternative for the current pay-as-you-go financing system of LTC. The latter two possibilities to improve efficiency also support informal care provision. Given that informal care could substitute more expensive formal LTC services, supporting informal care might relieve pressure on the LTC budgets. Finally, informal care could also be supported by offering employment at government/municipality possibly in combination with pension benefits for informal caregivers.

Regarding acute care, two modes to improve efficiency in acute care provision are briefly discussed: reductions in length-of-stay, for example by substituting expensive hospital treatment by less expensive hospital or primary care treatment, and a more systematic assessment of efficiency to restrict diffusion and reimbursement of medical technologies. Given the large role of technological progress in the pharmaceutical sector, possibilities to save drug expenditures by strengthening the efficiency criteria in the reimbursement decision for (new) drugs are discussed in greater depth. Concerning technologies in hospital care, we simply recommend the introduction of a cost-effectiveness hurdle as the current reimbursement decision of these technologies solely depends on effectiveness.

Samenvatting

INTRODUCTIE

In de afgelopen decennia is de bevolking in ontwikkelde landen sterk verouderd. De proportie 65+-ers in Nederland is verdubbeld, van 7.6 naar 15.3 procent, in the periode 1950-2010. Het aandeel 65+-ers zal naar verwachting zijn piek bereiken in 2040 wanneer 25.9 procent van de populatie 65 jaar of ouder is. Naast een toenemend aandeel 65+-ers leidt de vergrijzing ook tot een toename in de gemiddelde leeftijd van de populatie ouderen. De proportie 85+-ers als percentage van het aantal ouderen is toegenomen van 12.9 tot 25.5 procent in de periode 1950-2010 en zal naar verwachting stijgen tot 33.3 procent in 2040.

De vergrijzing zal beslist zijn impact hebben op de samenleving. Een vergrijzende samenleving vormt een uitdaging voor de huidige sociale zekerheidsstelsels, waaronder de financiële houdbaarheid van het gezondheidszorgstelsel en het stelsel voor langdurige zorg. Gelijktijdig met de vergrijzing is een opwaartse trend in de zorguitgaven waargenomen. Het aandeel van het Brute Binnenlands Product dat in Nederland is besteed aan de gezondheidszorg is gestegen van 8.7 naar 13.1 procent in de periode 1972-2007. De uitgaven in constante prijzen per hoofd van de bevolking is meer dan verdubbeld in deze periode. Het voornaamste doel van dit proefschrift is om beter inzicht te krijgen in de (relatieve) bijdrage van de vergrijzing aan de uitgavengroei voor de curatieve and langdurige zorg. Uitgangspunt van dit proefschrift is dat de vergrijzing slechts één van de drijvende factoren achter de groei van zorguitgaven is: maatschappelijke en andere individuele determinanten zijn nog belangrijker, en zijn sterk verweven met de invloed van de vergrijzing. Dit proefschrift handhaaft daarom een integrale aanpak in het onderzoek naar de relatieve impact van de vergrijzing op de zorguitgaven door integratie van: (a) epidemiologisch en gezondheids-economisch onderzoek en (b) bewijs inzake de invloed van maatschappelijk en individuele determinanten.

Het proefschrift bestaat uit drie delen. Deel A bevat een algemeen overzicht van de huidige stand van de literatuur over de oorzaken en gevolgen van de groei in zorguitgaven in een vergrijzende bevolking. Hoewel de impact van de vergrijzing op de curatieve zorguitgaven overvloedig is onderzocht, hebben weinig studies de invloed van de vergrijzing op de langdurige zorguitgaven bestudeerd. Deel B onderzoekt daarom de gevolgen van de vergrijzing op de langdurige zorguitgaven in Nederland in meer detail. Tot slot ontrafelt deel C de bijdrage van verschillende factoren aan de groei in curatieve zorguitgaven.

A. DE INVLOED VAN DE VERGRIJZING EN ANDERE FACTOREN OP DE ZORGUITGAVEN

Hoofdstuk twee bevat een literatuuroverzicht van de impact van de vergrijzing en gerelateerde factoren op de groei in zorguitgaven. Het bespreekt de bijdrage van de vergrijzing ten opzichte van de bijdrage van andere determinanten van zorguitgaven, die sterk samenhangen met een vergrijzende bevolking, zoals volksgezondheid en technologische ontwikkelingen. Een duidelijk onderscheid wordt gemaakt tussen de invloed van determinanten op curatieve en langdurige zorguitgaven.

Gezien het feit dat zorguitgaven stijgen met de leeftijd, werd de vergrijzing van oudsher gezien als een hoofdverdachte van de toenemende zorguitgaven. Deze visie is herzien als gevolg van studies die zorguitgaven in de laatste levensjaren hebben bestudeerd: de hoge uitgaven op oudere leeftijd zijn namelijk gerelateerd aan de 'tijd tot overlijden' (TTD) in plaats van aan leeftijd zelf. Omdat individuen slechts eenmaal overlijden betekent dit dat de gevolgen van de vergrijzing voor de groei in zorguitgaven aanzienlijk lager liggen dan werd gedacht. Hoe dan ook, TTD is op zijn best een proxy voor gezondheid, de echte determinant van zorguitgaven (behoefte). De mate waarin de vergrijzing van invloed is op de zorguitgaven hangt daarom grotendeels af van onderliggende trends in volksgezondheid. De meeste studies die de invloed van de vergrijzing op de zorguitgaven bestuderen konden gezondheid slechts ruw benaderen, door bijvoorbeeld leeftijd en TTD. Het is aangetoond dat de invloed van de vergrijzing op de zorguitgaven niet nauwkeurig kan worden geschat wanneer belangrijke trends worden genegeerd.

Technologische vooruitgang, gefaciliteerd door economische groei, lijkt de sterkste kostendrijver, voornamelijk voor de curatieve zorg. De bijdrage van het toegenomen aandeel ouderen aan de uitgavengroei is relevant, maar bescheiden. Het verklaart 0.5-1.0 procent van de 4 procent jaarlijkse reële groei in zorguitgaven. Het effect van de vergrijzing op de langdurige zorguitgaven is veel sterker. Hoewel de directe bijdrage van de vergrijzing beperkt is, betekent dit niet dat de vergrijzing onbelangrijk is voor de zorguitgavengroei. Veel belangrijke determinanten van zorguitgaven, in het bijzonder technologische vooruitgang (voor de curatieve zorg), de ontwikkeling in lonen en prijzen, en beperkingenstatus (voor de langdurige zorg), hangen sterk samen met de vergrijzing. Ouderen profiteren bijvoorbeeld onevenredig van technologische vooruitgang.

B. DE IMPACT VAN DE VERGRIJZING OP DE LANGDURIGE ZORGUITGAVEN

Om begrip over de groei in langdurige zorguitgaven te versterken is een beter inzicht in het besluitvormingsproces dat leidt tot langdurig zorggebruik vereist. De Nederlandse institutionele context legt een sterke invloed van beperkingenstatus op langdurig zorggebruik op: de aanwezigheid van beperkingen is een belangrijke voorwaarde voor het verkrijgen van toegang tot publiek gefinancierde langdurige zorg. Het doel van *hoofdstuk drie* is dan ook om de determinanten van het gebruik van thuiszorg en zorg met verblijf (verpleeghuiszorg en verzorgingshuiszorg) vast te stellen, en richt zich voornamelijk op de rol van beperkingenstatus.

Leeftijd beïnvloed langdurig zorggebruik, zelfs na uitgebreide correctie voor beperkingenstatus. Langdurige zorgbehoeften in een vergrijzende samenleving zullen dus stijgen, ongeacht de leeftijdsspecifieke trends in beperkingenstatus. Echter, omdat beperkingenstatus zelf ook een belangrijke invloed uitoefent op langdurig zorggebruik, biedt dit nog kans voor beleidsmakers omdat trends in beperkingenstatus wel beïnvloed kunnen worden. De extra beperkingen nodig voor het gebruik van thuiszorg zijn aanzienlijk lager dan de extra beperkingen die nodig zijn om van thuiszorggebruik naar zorg met verblijf te switchen: een toename van de beperkingen index met een punt verhoogt de kans op thuiszorggebruik (zorg met verblijf) met gemiddeld 2.3 (0.6) procentpunten.

Na de relatie tussen beperkingenstatus en langdurige zorggebruik te hebben bestudeerd, ontrafelt *hoofdstuk vier* de afzonderlijke rollen van leeftijd, TTD en beperkingenstatus in het verklaren van langdurige zorguitgaven. Eerder onderzoek naar de vergrijzing en zorguitgaven hebben zorgbehoefte benaderd door leeftijd, en meer recent TTD, te gebruiken. Wij heroverwegen de rol van leeftijd en TTD door ook rekening te houden met de doodsoorzaak en beperkingenstatus en illustreren de relevantie voor het ramen van langdurige zorguitgaven. Een aantal bevindingen kwam naar voren. Ten eerste, de grote variatie in de uitgaven van overledenen naar doodsoorzaak toont aan dat de relatie tussen TTD en langdurige zorguitgaven dynamisch is: epidemiologische veranderingen zullen het belang van elke doodsoorzaak beïnvloeden en daarmee dus de algehele invloed van TTD op langdurige zorguitgaven. Ten tweede, TTD heeft niet langer een effect op de langdurige zorguitgaven zodra gecorrigeerd is voor beperkingenstatus. De daling in het effect van leeftijd en de redundantie van TTD na controle voor beperkingenstatus bevestigt dat leeftijd en TTD grotendeels proxy's voor beperkingenstatus zijn. De bevinding dat TTD vooral fungeert als een proxy voor beperkingenstatus rijst twijfels over de validiteit van toekomstige ramingen voor langdurige zorguitgaven. Ramingen met behulp van TTD gaan er impliciet van uit dat een toename in levensverwachting resulteert in een verschuiving van beperkingen naar hogere leeftijd. Hierbij wordt dynamiek in de relatie tussen sterfte en beperkingenstatus als gevolg van epidemiologische veranderingen genegeerd wat in tegenspraak is met recent bewijs ten gunste van een compressie van beperkingenstatus. Het gebruik van TTD om beperkingenstatus te benaderen overschat dus waarschijnlijk het effect van de vergrijzing op toekomstige langdurige zorguitgaven zoals wordt geïllustreerd door de ramingen gepresenteerd in *hoofdstuk vier*.

Betrouwbare schattingen van de toekomstige trends in beperkingenstatus zijn dus nodig om toekomstige ramingen van langdurige zorguitgaven te verbeteren. Dat is tevens het doel van *hoofdstuk vijf*: het schatten van de toekomstige trend in beperkingenstatus en deze combineren met langdurige zorguitgaven naar leeftijd, geslacht en beperkingenstatus om prognoses voor individuele levensloopuitgaven en jaarlijkse populatie geaggregeerde uitgaven te verkrijgen voor het jaar 2020. De resulterende ramingen voor langdurige zorguitgaven houden dus expliciet rekening met veranderingen in beperkingenstatus in plaats van deze te benaderen door leeftijd en TTD. De belangrijkste bevindingen zijn als volgt. Het aandeel van levensjaren met ernstige beperkingen zal naar verwachting afnemen, terwijl het aandeel van levensjaren met een milde beperking waarschijnlijk zal toenemen. Levensloopuitgaven voor thuiszorg, voornamelijk bepaald door de trend in milde beperkingen, zullen naar verwachting toenemen, terwijl de levensloop uitgaven voor zorg met verblijf redelijk constant blijven als gevolg van een stabiel aantal levensjaren met een ernstige beperking. Gezien het feit dat levensloopuitgaven aan langdurige zorg grotendeels worden bepaald door institutionele zorguitgaven zal een toename in de levensverwachting gepaard met verbeterde beperkingenstatus niet leiden tot een serieuze verhoging van deze levensloopuitgaven. Deze bevinding hangt echter sterk af van de accuraatheid van de voorspellingen van het aantal levensjaren met ernstige beperkingen. In tegenstelling tot levensloopuitgaven zullen de jaarlijkse uitgaven aan langdurige zorg op populatieniveau aanzienlijk stijgen (19.2 procent in de periode 2007-2020) als gevolg van een toename in het aandeel ouderen.

Hoofdstuk zes richt zich op informele zorg, een belangrijke component van langdurige zorg. We hebben alleen indirect bijgedragen aan beter inzicht over de gevolgen van de vergrijzing op informele zorguitgaven. *Hoofdstuk vier* laat zien dat mantelzorg fungeert als een belangrijk substituut voor formele langdurige zorg. Huishoudencompositie is een proxy voor informele zorg beschikbaarheid aangezien het merendeel van de informele zorg wordt geleverd door de partner. Daardoor besteden personen die samenwonen aanzienlijk minder aan formele zorg. Het doel van *hoofdstuk zes* is de haalbaarheid van de contingent valuation (CV) methode te onderzoeken om een monetaire waarde voor één uur informele zorg te verkrijgen. De belangrijkste bevindingen zijn als volgt. Zorgverleners en zorgvragen waarderen één uur informele zorg gemiddeld op €9.83 en €7.87, respectievelijk. CV-waarden zijn gevoelig voor de heterogeniteit en dynamiek van de informele zorgsituatie wat impliceert dat de methode de mogelijkheid heeft om alle effecten van informele zorg in monetaire termen te vangen. Belangrijke determinanten van waarderingen door zorgverleners zijn soort informele zorgtaak, opportunity costs en persoonsgebonden budget (PGB). Deze laatste bevinding geeft aan dat PGB's de uitgaven van langdurige zorg kunnen opdrijven. Hoewel de CV-waarden gevoelig zijn voor de zorgsituatie blijft non-respons een punt van zorg. Selectieve non-respons heeft waarschijnlijk geleid tot een overschatting van CV-waarden.

C. HET ONTRAFELEN VAN DE DETERMINANTEN VAN DE GROEI IN CURATIEVE ZORGUITGAVEN

Het doel van *hoofdstuk zeven* is om verder inzicht te krijgen in de bijdrage van verschillende factoren aan de groei in curatieve zorguitgaven in Nederland over de periode 1998-2004. De reële groei in curatieve zorguitgaven in deze periode was 28 procent, maar de groei was niet uniform verdeeld over de distributie. We onderzoeken de groei en ontrafelen deze over de volledige uitgavendistributie. De groei in curatieve zorguitgaven, ziekenhuisuitgaven en farmaceutische uitgaven wordt verklaard in een gedeelte dat te danken is aan veranderingen in de distributie van determinanten – zoals gezondheid, medische praktijkstijlen, vergrijzing – en een gedeelte dat is toe te schrijven aan de veranderde impact van determinanten op uitgaven. Dit laatste is een gevolg van structurele veranderingen (bijvoorbeeld technologische vooruitgang) die de behandelkosten van specifieke condities veranderen. De volgende resultaten zijn verkregen.

Hoewel de groei in curatieve zorguitgaven vrij gelijkmatig verspreid was over de distributie, varieerde de groei van ziekenhuis- en farmaceutische uitgaven sterk over de distributie. De groei in ziekenhuisuitgaven is geconcentreerd in het midden van de uitgavendistributie en kan grotendeels verklaard worden door een hoger aandeel ziekenhuisopnames wat gestimuleerd werd door beleid om de wachtlijsten terug te dringen. Kortere verpleegduur en een relatief grotere toename in dagopnames en polikliniekbezoeken hebben bijgedragen aan een lagere groei van ziekenhuisuitgaven aan de bovenkant van de uitgavendistributie. Het beeld is heel anders voor farmaceutische uitgaven: de groei werd volledig veroorzaakt door intensiever en/of duurder geneesmiddelengebruik en was geconcentreerd in de hogere decielen van de uitgavendistributie. Technologische vooruitgang (de introductie van nieuwe geneesmiddelen) domineert de verklaring van de groei in farmaceutische uitgaven, in het bijzonder de groei aan de bovenkant van de distributie omdat nieuwe geneesmiddelen relatief duur zijn. Daarnaast kan een matig gedeelte van de farmaceutische uitgavengroei verklaard worden door verschuivingen naar minder intensievere vormen van ziekenhuisbehandeling – dagopname en polikliniekbezoek – en de vergrijzing. Dit duidt er sterk op dat ziekenhuiszorg tot op zekere hoogte kan worden vervangen door geneesmiddelengebruik. Veranderingen in bevolkingskenmerken (vergrijzing, volksgezondheid) verklaren maar een zeer beperkt aandeel van de curatieve uitgavengroei. Hoewel de bijdrage van de vergrijzing marginaal is, kan deze niet los worden gezien van technologische vooruitgang en beleid om wachtlijsten terug te dringen. Ouderen hebben onevenredig geprofiteerd van beide ontwikkelingen.

DISCUSSIE

Hoofdstuk acht bespreekt de belangrijkste bevindingen, de (beleids)implicaties en aanbevelingen, de belangrijkste beperkingen van de huidige studies en mogelijkheden voor verder onderzoek. Deze samenvatting beperkt zich tot de belangrijkste bevindingen, (beleids) implicaties en aanbevelingen. De belangrijkste conclusies waren als volgt.

Omdat de relatie tussen leeftijd en zorguitgaven grotendeels te wijten is aan gezondheid, kan de volledige bijdrage van de vergrijzing aan de groei in zorguitgaven slechts worden overwogen door rekening te houden met trends in gezondheid. Beperkingenstatus is de belangrijkste determinant van de behoefte aan langdurig zorggebruik. Bij het ontbreken van informatie over beperkingenstatus benadert TTD deze grotendeels. Bevindingen later echter zien dat TTD niet volledig de invloed van (gezonde) vergrijzing op zorguitgaven kan omvangen wat suggereert om TTD te vervangen door betere informatie over zorgbehoefte.

De impact van veranderingen in de leeftijdssamenstelling van de bevolking op de groei in zorguitgaven is beperkt: het verklaart slechts 0.5-1.0 procent van de jaarlijkse reële groei van 4-5 procent. Het volledige effect van de vergrijzing is echter aanzienlijk omdat de gevolgen van de vergrijzing sterk gerelateerd zijn aan die van andere belangrijke individuele en maatschappelijke determinanten. Naast de determinanten die zorgbehoefte meten, is het effect van de vergrijzing sterk gerelateerd aan technologische vooruitgang, de ontwikkeling van lonen en prijzen en overheidsbeleid.

Er is een sterk contrast in de bijdrage van verschillende factoren aan de groei in curatieve en langdurige zorguitgaven. Terwijl de groei in langdurige zorguitgaven het meest wordt beïnvloed door veranderingen in de leeftijdssamenstelling van de bevolking en de toekomstige trend in beperkingenstatus, kan de groei van curatieve zorguitgaven vooral worden verklaard door veranderingen in medische praktijken, grotendeels veroorzaakt door medisch technologische vooruitgang en gezondheids(zorg)beleid. Naast dit contrast, is er ook een sterk verschil in de bijdrage van factoren aan de uitgavengroei van verschillende subsectoren van de curatieve zorg (ziekenhuiszorg en farmaceutische zorg). Verder verschilt het effect van de vergrijzing op de langdurige zorguitgaven naar aggregatieniveau: uitgaven over de levensloop van een individu of jaarlijkse uitgaven geaggregeerd op populatieniveau. Levensloopuitgaven aan langdurige zorg zullen naar verwachting nauwelijks stijging terwijl jaarlijkse uitgaven op populatieniveau sterk zullen toenemen.

De belangrijkste (beleids)implicaties en aanbevelingen die worden besproken zijn als volgt. Ten eerste, de bevinding dat het overheidsbeleid zelf een belangrijke bron van de groei in zorguitgaven is, suggereert dat het inderdaad mogelijk is om de toekomstige groei in zorguitgaven te beïnvloeden. Gezien de verschuiving van een aanbodgestuurd naar een vraaggestuurd zorgsysteem in Nederland, is het belangrijk dat zorgverzekeraars de verantwoordelijkheid nemen als bewakers van de zorguitgavengroei met gelijktijdige inachtneming van de wensen van hun klanten.

Ten tweede is het vermeldenswaardig dat beleidsmakers zich bewust moeten zijn dat prognoses van zorguitgaven uitsluitend gebaseerd op trends in bevolkingskenmerken de werkelijke groei naar grote waarschijnlijkheid aanzienlijk zullen onderschatten. Dit geldt in het bijzonder voor de curatieve zorg. Zo zou slechts een groei van 6 procent voorspeld zijn voor de periode 1998-2004, terwijl de werkelijke groei in 28 procent bedroeg.

Ten derde vraagt de verschillende aard van de uitgavengroei in de curatieve en langdurige zorg om op maat gesneden aanbevelingen op sectorniveau over mogelijke beleidsopties om de uitgavengroei te beheersen. *Hoofdstuk acht* bespreekt deze mogelijkheden beknopt, maar beperkt zich slechts tot mogelijkheden die min of meer voortvloeien uit onze bevindingen. De opties om de publieke uitgavengroei aan langdurige zorguitgaven te beperken kunnen worden onderverdeeld in drie categorieën: epidemiologische veranderingen, efficiëntie verbeteringen en ondersteuning van informele zorgverlening. Ten eerste zou het stimuleren van een continuering van de dalende beperkingentrend de gevolgen van de vergrijzing op de langdurige zorgsector verminderen. Het is echter onzeker in welke mate de huidige daling van beperkingen tijd- of cohortspecifiek zijn. Ten tweede, opties om efficiëntie in de langdurige zorgverlening te vergroten zijn: een substitutiebeleid om personen zo lang mogelijk thuis te laten wonen, een uitbreiding van het systeem van persoonsgebonden budgetten, en het huidige omslagstelsel vervangen door een systeem van zorgsparen voor langdurige zorg. De laatste twee opties kunnen naast het verbeteren van de efficiëntie ook informele zorgverlening ondersteunen en stimuleren. Omdat informele zorg duurdere formele zorg kan vervangen verlicht stimulatie van informele zorg en een betere ondersteuning van informele zorgverleners waarschijnlijk de druk op publieke budgetten voor langdurige zorg. Ten slotte kan informele zorg ook worden ondersteund door het bieden van werkverbanden bij de overheid of gemeente eventueel in combinatie met pensioenuitkeringen voor mantelzorgers.

Met betrekking tot de curatieve zorg worden twee mogelijkheden om efficiëntie in de curatieve zorgverlening kort besproken: een verdere reductie van verpleegduur, bijvoorbeeld door een verschuiving van dure, intensievere ziekenhuisbehandelingen naar minder dure en intensieve behandelmethoden, binnen of buiten ziekenhuis, en een systematischer beoordeling van efficiëntie van medische technologieën in vergoedingsbesluiten. Gezien de grote rol van technologische vooruitgang in met name de farmaceutische sector, worden enkele herzieningen met betrekking tot het besluitvormingsproces rondom de vergoeding van geneesmiddelen besproken die kunnen leiden tot meer value for money. Omdat technologieën geïntroduceerd in ziekenhuizen thans slechts dienen te voldoen aan een effectiviteitcriterium wordt aanbeveelt om een kosteneffectiviteitcriterium in het vergoedingsbesluit van deze technologieën te introduceren om zo een optimalere allocatie van publieke middelen te bereiken.

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After my master's graduation at the faculty of BMG, Eddy and Marc offered me a PhD track at the Health Economics department of iBMG. Despite being a 'homemade product' of BMG, I was not sure if such a PhD track was the right path for me. Obtaining a PhD was certainly not one of the goals I wanted to achieve in my life. And to be honest, I was kind of intimidated by the idea: "How could I possibly write an entire book all by myself, and not just a book, but a book full of intelligent thoughts?" Because that is how I saw a PhD candidacy at that time.

Before coming back to Eddy and Marc, I explored the other opportunities the labor market could have in mind for me. Although I did not know what to expect exactly from a PhD track, I soon noticed that it fitted me best as I was eager to further develop my skills. In addition, the position as PhD student also offered much freedom, flexible working hours and a 4-year contract! I should probably tell you that this last point did not influence my choice at all. But to be honest, it kind of did! The reason for this is called by the name Doğan, my husband. To keep a long story short, we were tired of a long distance relationship and wanted to start a life together but Dutch immigration rules would only allow this if I had a decent contract. Despite what some might call the irrational attributes involved in my job decision, I have never regretted my choice and really enjoyed my position as a PhD candidate at iBMG.

Having heard an awful lot of stories about all the stress involved and the disappointing progression when writing a PhD thesis, I was kind of intimidated by a PhD track. Although I also experiences such periods, they by far do not overshadow the enjoyable and productive work times. The final thesis even evolved quite naturally towards the end. The landscape consisted of hills instead of mountains, with a peak at the end which indeed proved the last mile is the hardest to take. Of course, the smooth process and successful completion of my PhD track would not have been accomplished without the contribution of several others. I owe much to my supervisors, Marc and Eddy. I would like to thank them for the productive and pleasant years, for sharing their knowledge and experience with me, for keeping me motivated and on track. In addition, I would like to thank Marc for his outstanding job as my daily supervisor. Thank you for the regular brainstorms and meetings, especially at the start of my appointment. Despite your busy schedule, you always stood standby to answer my questions, uncertainties and problems.

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Curriculum Vitae

Claudine Dölen-de Meijer was born in Apeldoorn on December 5, 1983. She graduated from secondary school at the Veluws College Walterbosch in Apeldoorn. From 2002 to 2005 she studied the Bachelor Health Sciences at the Erasmus University Rotterdam. After having obtained her Bachelor of Science, she studied the Master Health Economics Policy and Law with a specialization in Health Economics at the Erasmus University Rotterdam (2005-2007). As part of her master she participated in the research project 'Strengthening Micro Health Insurance Units for the Poor in India'.

After her master's graduation (2007) she worked as a PhD candidate in Health Economics at the Institute of Health Policy and Management at the Erasmus University Rotterdam. From 2007 to 2011 she worked on her dissertation. Her research project 'Health of aging populations: impact on health and informal care costs' was part of the research theme 'Living Longer in Good Health' which was financially supported by the Network for Studies on Pensions Aging and Retirement (NETSPAR). She published her research articles in various international journals (Medical Care, Journal of Health Economics and Health Economics) and presented her work at international conferences.

During her PhD candidacy, Claudine also obtained teaching experience. She is involved in the Bachelor program Health Sciences at the Erasmus University Rotterdam where she gives workgroups for the courses 'Methods and Techniques of Academic Research' and 'Statistics'. In addition, she supervises bachelor and master theses.

Currently, she is working on a project on multi criteria decision analysis in health technology assessment. Claudine will continue her research on long-term care (financing) in aging populations at the iBMG. Claudine lives in Apeldoorn, together with her husband Doğan.

PhD Portfolio

PHD PORTFOLIO

PhD Student: Claudine de Meijer
Department: Institute of Health Policy and Management
PhD period: 2007-2011
Promotor: Prof. dr. Eddy van Doorslaer
Co-promotor: dr. Marc Koopmanschap

PHD TRAINING

Training

International doctoral courses in Health Economics and Policy: Econometric Analysis of Health Care Demand – Swiss School of Public Health + (Geneva)	2008
Longitudinal/panel data – Centre for Microdata Methods and Practice (London)	2009
Econometrics I – Erasmus School of Economics	2010
Econometrics II – Erasmus School of Economics	2010
Academic Writing – Academic Language Centre University of Leiden	2010
Short Course Health Econometrics - CEISUC Workshop Demand for Health and Health Care (Coimbra)	

Presentations

7th European Conference on Health Economics (ECHE), Roma (Italy)	2008
1st CEISUC Workshop Demand for Health and Health Care, Coimbra (Portugal)	2010
2nd Lowlands Health Economics Study Group (LoLa HESG), Egmond aan Zee (the Netherlands)	2010
8th European Conference on Health Economics (ECHE), Helsinki (Finland)	2010
8th wolrd congress of the international Health Economics Association (iHEA), Toronto (Canada)	2011

TEACHING QUALIFICATIONS AND EXPERIENCE

Lecturing

Bachelor in Health Policy and Management: Methods and Techniques of Scientific Research — 2008-2011

Bachelor in Health Policy and Management: Statistics — 2010-2011

Bachelor in Health Policy and Management: Statistics and Qualitative Research — 2010-2011

Master in Health Economics Policy and Law: co-reader thesis

Supervising Master's and Bachelor's thesis

Bachelor in Health Policy and Management

Master in Health Economics Policy and Law

PUBLICATIONS NOT INCLUDED IN THESIS

Koopmanschap M., de Meijer C., Wouterse B., and Polder J. 2010. Determinants of health care expenditure in an aging society. *Netspar Panel Paper* 22.

Bakx P., and de Meijer C. In Sickness and Health – the Influence of Spouse Ability to Provide Informal Care on Long-Term Care Use. *Submitted for publication*

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