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Working Paper

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Diskussionsbeiträge, No. 56

Provided in Cooperation with:
Research Center for Generational Contracts (FZG), University of Freiburg

Suggested Citation: Ehing, Daniel; Hagist, Christian (2015) : Dementia vs. somatic conditions in the German LTC-system: A longitudinal analysis, Diskussionsbeiträge, No. 56, Albert-Ludwigs-Universität Freiburg, Forschungszentrum Generationenverträge (FZG), Freiburg i. Br.

This Version is available at:
https://hdl.handle.net/10419/108976

FORSCHUNGS ZENTRUM GENERATIONEN VERTRÄGE

der Albert-Ludwigs-Universität Freiburg

Diskussionsbeiträge
Discussion Papers

Dementia vs. somatic conditions in the German LTC-system: A longitudinal analysis

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No.56 – March 2015

Dementia vs. somatic conditions in the German LTC-system: A longitudinal analysis

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March 2015

Abstract

This paper analyzes prevalence and incidence rates as well as survival times for people above the age of 60 years with a dementia disorder and/or a long-term care status. Using claim data from a social sickness funds in Germany (AOK-Plus), we show that there exists a with age increasing gap between the prevalence of women and men for both fields of study. This discrepancy cannot be explained completely by our estimated incidence rates and is caused by different survival times in long-term care and dementia. In long-term care 50 percent of all women (men) are dead after 44 (25) months, whereas about 57 (49) percent of all women (men) with dementia are alive after the end of our 48 month long observation period. The lower mortality of people with dementia is mainly explained by a large share of people who are not eligible for the German long-term care system. Estimating several cox models shows that the hazard of dying in long-term care increases with age and care level. However younger people with a dementia disorder show lower mortality rates in long-term care than their respective peer group without dementia. Looking at the present value of all long-term care costs for people with and without a dementia diagnosis, we find total average costs of 68,600 (44,857) Euro for women (men) without dementia. Due to their extended stay in nursing home care, women (men) with dementia are more expensive (80,201 (49,793) Euro).

Key Words: Dementia, long-term care, incidence rate, prevalence rate, survival analysis, costs of long-term care

JEL-Classification: I19, H55

* Contact: Daniel.Ehing@vwl.uni-freiburg.de, Forschungszentrum Generationenverträge, Albert-Ludwigs-Universität Freiburg. We are grateful to Ms. Ines Krause and the AOK-Plus who provided the dataset. Financial support by the IDEAL Lebensversicherung a.G., the Research Council of Norway and the German association of family business *ASU – Die Familienunternehmer* is gratefully acknowledged. For helpful comments we thank Christoph Metzger, Stefan Moog and Christian Bührer. All remaining errors remain our own.

1. Introduction

As life expectancy increases constantly throughout OECD countries, it is expected that cases of dementia will almost double over the next five decades. This will put political pressure on long-term care (LTC) and health systems as eligibility criteria for benefits and treatment are often aligned with somatic conditions. Being aware of these upcoming challenges, governments have published roadmaps to reform their health and LTC systems to the needs of persons with a dementia disorder.[1] Germany, as an example, is supposed to change its LTC insurance, which up to now distinguishes between three LTC states on basis of nursing needs, into a more targeted system with five stages.[2] Such reforms will dramatically increase the caseload of patients with dementia in LTC systems, putting more pressure on financing while hopefully leading to a better patient-centered care.

As data on dementia patients and their need for LTC is relatively scarce, only few studies focus on the interaction between dementia and (classic) LTC. For Germany, Rothgang et al. (2010) compare incidence, prevalence, length of stay and mortality in LTC and dementia. Germany is a good case study as its LTC system is separated from public and private health insurance and covers the whole population.[3] Therefore, we want to expand the literature concerning dementia in LTC. By using a large data set from a relatively large social health insurance sickness funds (which also administer LTC although it is a different system), AOK Plus, we are able to analyze differences for gender, age and other variables in dementia and (classic) LTC, also concerning costs.

The paper is organized in the following way: in section 2, the data set, provided by AOK Plus, a social health sickness funds which is especially focussed on Saxony and Thuringia, two states ("Laender") in Eastern Germany, is described. The data is extracted from administrative data, especially claim data. Section 3 presents our findings concerning prevalence, incidence rates as well as survival estimates for people with a dementia disorder and/or a LTC status. The hazard of dying in LTC and dementia is analysed with a cox model in chapter four, in order to disentangle different influence factors. Section five estimates the costs that are related to a stay in LTC and dementia. Section six concludes.

[1] Two examples are the "Dementia Plan 2015" of Norway or the "French Alzheimer Plan". See Norwegian Ministry of health and care service (2008) and Republique Francaise (2008).
[2] The currently applicable regulations that separate between physically disabled persons and persons who are faced with cognitive constraints is supposed to fall and the individual degree of self-reliance is going to be in the centre of the new LTC system. See Bundesministerium für Gesundheit (2014a).
[3] The German LTC system is for example described by Büscher, Wingenfeld and Schaeffer (2011).

2. Data

2.1 Construction of the dataset

The data set was provided by a social health sickness funds (AOK-Plus) which is located in Saxony and insures about 4 million people, mainly living in Eastern Germany. It was extracted from administrative data, especially claim data. The data not only concerns LTC, but also various variables for in- and out-patient treatment in health care.[4] All in all our data set consists of 1.2 million cases who are 60 years and older in 2000. We are able to track these cases for varying time periods, depending on the different benefits of the German health care system.

Since dementia was no eligibility criteria for LTC benefits in the first decade of our century, the analysis relies on ambulant treatment diagnoses from physicians. These treatment diagnoses are available from 2004 to 2008, whereas the LTC data spans from 2003 to 2010. As we only want to include patients with a new dementia or LTC diagnosis into our analysis, the data has to be left censored. Therefore we drop our first year(s) of observation and only include people who have not received a dementia diagnosis or a LTC status before the 1st of January, 2005. Our remaining time span for the analysis is therefore four years, spanning from the 1st of January 2005 till the 31st of December 2008.[5]

The identification of people with dementia, within the ambulant treatment data set, is realized by ICD-codes which each physician assigns after a patient has consulted him.[6] We encode the first diagnosis of dementia for each patient as the onset of dementia, in knowledge that the incidence of dementia is a rather gradual process.[7] Since claim data is used, which is not necessarily as precise as clinical data

[4] Although LTC and health insurance are divided in the German system, social health insurance funds administer both. Our dataset is divided in several sub datasets for the different kind of benefits. These benefit categories are: ambulant treatments, LTC, hospital treatments, pharmaceutical products and allowances in kind. An individual can be identified by a unique pseudo number. Since we are only interested in the interaction of dementia and LTC, we are only using the sub datasets for LTC and ambulant treatments.

[5] Right censoring therefore occurs in three possible ways. First, the end of the observation period arrives and neither a LTC status nor a dementia disorder was diagnosed. Second, the end of the observation period arrives and the person in dementia or/and LTC survived up to that point. Third, the person left AOK Plus to another competitor. For a full analysis of the LTC data see Ehing, Hagist and Saal (2014).

[6] The used ICD-Codes for dementia are: G30 – Alzheimer disease, F00 – Dementia in Alzheimer disease, F01 – Vascular dementia, F02 – Dementia in other diseases classified elsewhere, F03 – Unspecified dementia, G31.0 – Circumscribed brain atrophy, G31.82 – Lewy body dementia, G23.1 – Progressive supranuclear ophtalmoplegia , F05.1 – Delirium superimposed on dementia. See Doblhammer et al. (2012), p. 69.

[7] Even though physicians submit only once a quarter their ambulant treatment data to the public health insurance companies (see Neubauer et al. (2014)), we find a start as well as an end date for the treatment of every single patient within our dataset (see Appendix B). Within this time span it is possible that patients go several times to their physician and therefore receive different ICD-Diagnosis. A unique date for the first dementia diagnosis is therefore not identifiable. However our analysis shows, that the beginning of the treatments for each patient are randomly scattered within the quarter. In addition the time spans are on average smaller than 90 days (on average 46 days (SD=30 days)). After consulting the AOK-Plus we decided to use the start date of the respective treatment time span as the starting date for the dementia disease. It is therefore possible that we identify a person a little too early as being in dementia. However, to our understanding, this is not really a problem since people show usually first signs of a dementia disease (long) before they visit a physician.

concerning the diagnosis, we follow the guidelines of Neubauer et al. (2014, p. 91) in order to confirm the dementia diagnosis. As a consequence only those who receive at least twice a dementia diagnosis within our time horizon are marked as being a demented patient.

The quality of the used dementia diagnosis can be examined in two ways. First, the reliability of the diagnosis: as our final data set shows, about 94 percent of all dementia diagnoses are certified within the same year, whereas six percent are certified within the whole time span of the analysis. Our second concern is related to the type of dementia diagnosis. Since the data set includes several ICD-codes, one should find approximately the same share of Alzheimer- or vascular-dementia-diagnosis as given in the literature. According to Doblhammer et al. (2012, p. 47), 50 to 75 percent of all dementia affections are related to Alzheimer, whereas about 25 percent are related to vascular problems. This differs in our data set. About 60 percent of all dementia diagnoses are flagged with the status "Unspecified dementia" (F03) and only 16 (22) percent are flagged with Alzheimer (vascular dementia).[8] The reasons may be twofold: on the one hand it is possible that a physician is not able to identify a correct ICD-Code after the first consultation. On the other hand it is possible that a detailed ICD-specification is missing as German physicians are remunerated by a point system, basically another form of coding. As a consequence of this outcome, we do not separate the analysis into different types of dementia.

Benefits for LTC can be claimed either for home care or nursing home care once a person is defined as "frail". According to the code of social law (Sozialgesetzbuch XI) a frail person is "a person who requires permanent, frequent, or extensive help for a minimum period of approximately six months in performing a special number of "Activities of Daily Life" (ADL) and "Instrumental Activities of Daily Life" (IADL) due to physical, mental, psychological illness or disability". The Medical Review Board of the Statutory Health Insurance is responsible for assessing the need for LTC and entitles persons with benefits that are differentiated into three different care levels. The eligibility for the different LTC levels is independent of the question where LTC takes place but is connected to the frequency and amount of assistance required for ADL and IADL. In care level I a minimum amount of 90 minutes help per day for combined ADL and IADL is needed. The frequency of assistance needed in care level I amounts to at least one ADL a day and several IADL per week. In care level II the frequency of assistance needed increases to three ADL a day, whereas in care level III assistance is needed day and night. The amount of assistance required increases in care level II (III) to three (five) hours per day.

[8] However, this result is not surprising for administrative data. As the study of Hoffmann et al. (2008, p. 1123) shows, about 60 percent of all dementia diagnosis are related to the ICD-Classification F03 – Unspecified dementia.

Therefore, the further analysis of the LTC system is divided into eight different states: Care level I-III for home care and nursing home care, an interruption in the need of LTC and dead.[9] The analysis, where the incidence of dementia is the starting point, is complemented by another state for those who are not eligible for LTC but are affected by a dementia disorder.

2.2 Descriptive Results

Summing up 116,284 persons (78,032 female; 38,252 male) became eligible for LTC between the 1st of January 2005 and the 31st of December 2008. During the same time period 67,104 persons received a dementia diagnosis (47,024 female; 20,080 male). The overlap of these two groups amounts to 43,825 persons. This in return leads to the result that 23,279 patients with a dementia diagnosis never received any LTC benefits and 72,459 persons eligible for LTC benefits never received a dementia diagnosis within our time horizon.[10]

[Insert Figure 1 here]

Figure 1 shows the age distribution for the onset of LTC and dementia. The mean age for the onset of LTC for women (men) is 81.7 (79.0) years whereas the mean age for the first dementia diagnosis is 81.8 (79.1) years. Regarding the mean age, one could conclude that there seems to be a strong interaction between the onset of LTC and dementia. In order to disentangle this relation, we take a look at the difference between the age of entry into LTC and the age of the first dementia diagnosis for those persons who received a diagnosis in both fields. As Figure 2 shows, about 50 (51) percent of all women (men) became eligible for LTC one year before or after their dementia diagnosis. As dementia is a disease which is often accompanied by a general deterioration of the health status this result is not surprising and should not be interpreted causally. The second result from Figure 2 is related to the timing of dementia and LTC. Since 15,075 persons out of 43,825 received their dementia diagnosis before their entry into LTC and since 23,279 persons with a dementia diagnosis never received any LTC benefits in the respected time horizon, it seems to be evident that dementia is on average diagnosed before the person enters into the LTC system. However, controlling for age shows that with increasing age the likelihood to receive already LTC benefits at the date of the dementia diagnosis increases as well.

[Insert Figure 2 here]

[9] An interruption of more than 3 months in the provision of LTC is marked as "LTC-Gap". For further details on the revision of the LTC data set see Ehing, Hagist, Saal (2014).

[10] The incidence of dementia for those never receiving LTC benefits is almost evenly spaced between the four years of observation. The same applies for those who were eligible for LTC benefits and never received a dementia diagnosis.

In order to understand the timing of dementia and LTC more precisely, we separate the following analysis in four parts. First, we look at prevalence and incidence rates for dementia and LTC. Second, we start a survival analysis with the onset of LTC and then turn to the analysis where the onset of dementia is the starting point. Finally, we look at two cox models for the hazard of dying in LTC and dementia.

3. Results

3.1 Incidence and Prevalence of dementia and LTC

We start our analysis by looking at the prevalence of dementia and LTC on the 31st of December 2008.[11] As Figure 3 shows, prevalence rates for both groups are rising exponentially with age. However, the prevalence of dementia is on average three percentage points below the prevalence of LTC. In addition one can observe an increasing gap between the prevalence of men and women for both states with ageing. Compared to other studies, this gap is smaller since the prevalence of men are higher for dementia as well as LTC in the AOK Plus data set.

[Insert Figure 3 here]

Since we are mainly interested in the interaction of dementia and LTC, we take a closer look at the merged prevalence (see Figure 4). For the age group between 70 and 75 years we find that more than 90 percent of all persons are without a diagnosis in both fields of study. This share decreases with increasing age and above the age of 90 only about 40 (30) percent of all women (men) are without a diagnosis. Looking at those who have a dementia diagnosis between the age of 70 and 75, we find that 70 percent of all persons with dementia are not eligible for LTC. However, this share decreases as older people are. Above the age of 90 there are only 20 percent of all patients with dementia without a LTC state. In line with this decreasing share is the increasing share of people with dementia in LTC. Between the age of 70 and 75 only 30 percent of all LTC patients face a dementia diagnosis. However, 48 percent of all LTC patients above the age of 90 already received a dementia diagnosis.

[Insert Figure 4 here]

All in all there are two possible explanations for the widening prevalence gap in LTC and dementia between men and women. On the one hand it is possible that women show higher incidence rates and therefore exhibit higher prevalence. On the other hand a lower mortality of women would extend their stay in LTC and dementia and may therefore cause higher prevalence. A combination of both is as well possible.

[11] The calculation of the prevalence rates is done with the full dataset (i.e. the data is not left censored). The prevalence rate is calculated as: $prevalence_{t,age} = \frac{number\ of\ cases_{t,age}}{population\ size_{t,age}}$

As our estimated incidence rates in Figure 5 show,[12] higher prevalence for dementia and LTC for women cannot be explained completely by differing incidence rates. For both areas of study the incidence rates for men and women are quite similar. A key factor for differing prevalence rates is therefore the survival time after the onset of the disease. We try to illustrate this argument in the next section.

[Insert Figure 5 here]

3.2 Survival analysis: LTC

Figure 6 shows the survivor functions for men and women in LTC. At the onset of LTC about 24 (20) percent of all women (men) are affected by a dementia disorder. This share rises for both sexes, the longer the length of stay in LTC is. After 48 months more than 50 (40) percent, of all women (men) still alive, are affected by dementia. Looking at the share of people in home care and nursing home care, it is apparent that women tend to stay more often in nursing home care than men do. On average their stay in nursing home care is (adjusted for the overall stay in LTC) almost twice as large as those of men. Considering mortality rates, we also find huge differences between men and women: 50 percent of all female LTC patients are dead after 44 months whereas 50 percent of all male patients are dead after 25 months.[13] A key driver for the higher prevalence of female LTC patients is therefore their lower mortality.

[Insert Figure 6 here]

Since we are interested in the different survival times of people with and without dementia, we split our sample in those two groups. The resulting survivor functions for all females are shown in Figure 7. We find a lower mortality rate within the first months for females, who are affected by a dementia disorder at the beginning of the analysis. However, after round about 39 months the survival lines intersect and in the following months the survival functions of those starting without dementia lies on top. Looking at the age distribution of our two samples, this result is merely surprising: women starting with a dementia disorder into LTC are about 1.5 years older than those who start without dementia into LTC (82.8 vs. 81.4 years). Our hypothesis therefore is that age dominates at some point the generally lower mortality rate of those affected by a dementia disorder. In order to control for this age effect, we separate our further analysis into four age groups. Figure 9 shows the results. We find the largest distance between the survival functions for those who are 60 to 70 years old. The distance between the survivor functions is then declining with increasing age. Looking at the division between

[12] The incidence rate is calculated as: $incidence\ rate_{t,age} = \frac{number\ of\ new\ entries\ into\ disease_{t,age}}{sum\ of\ person\ time\ at\ risk_{t,age}}$

[13] The sharp drop within the first months for both sexes is related to LTC patients who start with LTC level III and therefore have very high mortality rates. For a detailed analysis of the whole LTC data see Ehing, Hagist and Saal (2014).

home care and nursing home care we find that women with dementia stay almost 50 percent of their time in nursing home care, whereas females without a dementia disorder only have a share of 30 percent. Since dementia patients need a higher degree of supervision this result is not surprising.

[Insert Figure 7 here]

Having a closer look at the survivor functions of all male LTC patients with and without dementia reveals as well the higher mortality rates for men without dementia within the first months (see Figure 8). However, as in the female case both survivor functions intersect as well (after round about 40 months). The main reason for this intersection is again related to the age structure of our sample (see Figure 9):[14] as older the patients are, the closer the survival functions of those with and without dementia become. Looking at the time spent in nursing home care, we find that men without dementia spend about 20 percent of their time in a nursing home care center, whereas the share for people with dementia is 10 percentage points higher.

[Insert Figure 8 here]

Concluding one can state that for both genders there seems to be a relation between the age at the onset of dementia and the physical health status. People who receive at a relatively young age a dementia diagnosis and then become eligible for LTC benefits have a significant lower mortality than people in the same age group without a dementia diagnosis but with a LTC status. This relation becomes insignificant, once we look at the older age groups. Now dementia is as well accompanied by diseases that lead to high mortality rates.

[Insert Figure 9 here]

3.3 Survival analysis: Incidence of Dementia

We turn now to the survival analysis using the onset of dementia as reference point. The survivor functions for both sexes are shown in Figure 10. As expected, the average mortality of a person starting with dementia is lower than the average mortality of a person starting in LTC: 50 percent of all male dementia patients are dead after 47 months, whereas 57 percent of all females are still alive after the maximum observation period of 48 months. The key driver of this lower mortality rates are people who are not eligible for LTC benefits and therefore have a rather good health status. At the onset of dementia about 55 (62) percent of all female (male) dementia patients are not eligible for LTC benefits. However the health status deteriorates, the longer our analysis is. After 48 months in dementia, 70 (67) percent of all women (men) still alive are now eligible for LTC benefits.

[Insert Figure 10 here]

[14] Those with(-out) dementia are on average 80.4 (78.6) years old.

Table 1 shows the results of the survival analysis separated by age. The older the patient, when he/she received his/her first dementia diagnosis, the higher the likelihood of being already eligible for LTC benefits. This in turn has an impact on mortality. Generally speaking one can conclude that a dementia diagnosis at the age of 60 is not that frequently accompanied by a severe somatic condition (that leads to a status in LTC) than a dementia diagnosis at the age of 80. Table 1 therefore confirms our findings of chapter 3.2.

[Insert Table 1 here]

Focusing on patients who are not in LTC when they receive a dementia diagnosis is the analysis of the last subgroup we conduct. The estimated survival functions are shown in Figure 11. Since the health status of this subgroup is (at the beginning of the analysis) superior to all other groups we analyzed, we find comparably low mortality rates. After 48 months 31 (40) percent of all female (male) dementia patients are dead whereas 57 (50) percent of those still alive are in need of LTC.

[Insert Figure 11 here]

4. A cox model for dementia and LTC

The analysis of the survival functions offers insights into different mortality patterns. However the analysis has limitations concerning different influence factors (such as care level, age, dementia diagnosis and LTC accommodation) and the interaction of these influence factors which affect mortality rates. In order to disentangle these relations, we estimate a cox-model for the hazard of dying in dementia and/or LTC. The models have the following form:

$$h(t|x_j) = h_0(t)\exp(x_j\beta_x)$$

Our cox models estimate the hazard of dying, separated for men and women as well as LTC and dementia, as an unknown underlying baseline hazard ($h_0(t)$) which is shifted by four covariates and their interactions. The dummy-variables *care level 0 to III* represent the respective LTC states as well as the possibility that no care level is assigned.[15] Our hypothesis is that a higher care level is associated with a higher hazard of dying. Since the care level can be understood as a measure of the health status which is independent of age it should not interact with the variable *age*. The variable *age* itself measures the age at the onset of dementia or LTC and is encoded on a yearly basis. Generally speaking a higher age should increase the hazard of dying. The dummy-variable *nursing home care* reveals, whether the actual LTC level is spent in a nursing home care center or at home. If nursing home care centers do not offer a better treatment quality than ambulant nursing services do and if there is no self-selection into nursing home care centers, this variable should come out as insignificant. Our last

[15] Care level zero refers to the possibility that dementia is diagnosed but no care level is assigned.

variable is connected to a *dementia* diagnosis and therefore only relevant for the analysis where the onset of LTC is the starting point. We suppose that a dementia diagnosis will generally lower the hazard of dying in LTC. However, as outlined in chapter 3.2, it should interact with *age*.

Our first step in the modelling process is to include all named variables and their interactions. We then test for the proportional hazard assumption, by looking at plots of the scaled Schoenfeld residuals.[16] Since we cannot find significant deviations from zero over time in the plotted residuals, we regard the proportional hazard assumption as fulfilled.

Table 2 shows the results for the cox model that is estimated for the stay in LTC. As we assumed our *nursing home care* variable is insignificant. However, it interacts with the *LTC level* and *age*. Compared to an accommodation at home, we find that care level II and III in nursing home care is associated with lower mortality rates. Regardless of the accommodation question, mortality is generally increasing with care levels. The hazard of dying in care level III is compared to care level I 26 (nine) times higher for females (males). *Age* itself is significant as well. We find an age increasing probability of dying in LTC which is intensified if the person stays in a nursing home. A d*ementia* diagnosis generally lowers the probability of dying in LTC. However, this relation changes the older the person is. Our cox model therefore confirms our finding that a dementia diagnosis at a high age is not accompanied with a lower mortality rate. Beyond this we find also a higher probability of dying with dementia in care level III.

[Insert Table 2 here]

Table 3 shows the results for the cox model that is estimated for the stay in dementia. The nursing home care variable is again insignificant but interacts with care level and for females also with age. The hazard of dying in dementia therefore generally increases with the care level but is compared to a home care situation lower, if people stay in a nursing home care center. Furthermore the hazard of dying in dementia increases with age.

[Insert Table 3 here]

All in all the cox models confirm our hypotheses. The hazard of dying in dementia or LTC increases with a worsening health status which is approximated by the different care levels. The hazard also increases with age. An accommodation in a nursing home care center seems to correlate with a lower mortality in care level II and III, compared to a LTC situation at home. In LTC the diagnosis dementia seems to be accompanied with a lower mortality rate, compared to those who do not have a dementia diagnosis. However, mortality rates increase for LTC patients with dementia the older they are.

[16] See Cleves et al. (2008, p. 203).

5. The costs of LTC and dementia

Finally we examine the costs which are connected being eligible for LTC benefits with and without dementia. Since we are not able to witness the full LTC and dementia careers for all persons, we have to model the stay in LTC and dementia after the 4th year. We therefore extrapolate the survival functions until all persons are dead, by using the average monthly transition probabilities of the last year we can observe.[17]

An overview over the transition probabilities we are using is given in Table A 1, Table A 2 (LTC) and Table A 3 (dementia) in the appendix.[18] As the transition matrices show,[19] we are most likely to find that people remain in their current LTC state. However, this probability diminishes the higher the care level is. For those in care level III the probability of dying even outbalances the other states. We can also observe that a switchover into a lower care level is very unlikely since the lower part of the matrices are close to zero. Considering the transition out of "dementia without a LTC state", it is obvious that people are most likely to go into care level I. Beyond that women show a higher probability to go into nursing home care when they come out of this state.

Figure A 1, Figure A 2, and Figure A 3 show the results of our survival function projection. The average woman (man) above 60 stays about 57 (39) months in LTC until he (she) is dead. The average stay in dementia is however, due to people without a LTC state, longer. For women (men) it amounts to 73 (61) months. Considering only those who are not in LTC at the start of dementia extends the average stay even further. Our calculations show that those women (men) stay about 90 (77) months on average in dementia until they die.

Splitting the LTC projection (Figure A 1) into those with and without dementia at the onset of LTC gives us the opportunity to estimate the costs that are connected to those different LTC careers. As our projection results in Table 5 show, the average woman (man) with dementia is 5.2 (1.8) months shorter in LTC than the average woman (man) without dementia. The lower average stay is mainly caused by higher mortality rates in the fourth year and afterwards. Turning to the different care levels both groups move through, we observe that people with dementia exhibit a prolonged stay in nursing home care, especially care level II and III.

[17] This approach implies the assumption that the transition probabilities remain constant after the 4th year. As a comparison with the full analysis of the LTC dataset shows (see Ehing et al. (2014)) our estimated average stay in LTC differs only slightly (around 8 (5) percent for women (men)). We are therefore confident that our results approximate the average stay well enough.

[18] For the sake of simplicity we show the average of the yearly transition probabilities.

[19] Table A 3 shows the transition probabilities for those who haven't been in LTC before the onset of dementia. Including all dementia patients would yield biased estimates, since round about 40 percent of all dementia patients already stayed for some months in LTC when we start our analysis.

[Insert Table 4 here]

The monthly costs, that are associated with the different LTC states, are shown in Table A 4. Since we are not able to differentiate between cash- and service-benefits at the home care level, we assume that all persons receive a service benefit. Furthermore, we assume that the differences between home care and nursing home care regarding food- and housing-costs are negligible. The nursing home care costs therefore only include those costs that are associated with LTC itself.[20] All in all people in home care level I have to pay 694 Euro whereof 450 Euro are paid by the LTC insurance. The amount of self-retention is therefore 244 Euro. The total amount of self-retention increases up to 453 Euro in home care level III and jumps once a person is in nursing home care. Here care level I amounts to total costs of 1855 Euro whereof 832 Euro have to be paid out of the pocket. The large self-retention gap between home care and nursing home care is politically intended and increases with the care level.

Connecting the costs per month given the LTC developments outlined before enables us to estimate the present value of a LTC career.[21] The calculation of the present value starts in the year 2014. We assume a constant growth rate for the benefits of the LTC insurance as well as the costs of LTC. This constant growth rate amounts to 1.5 percent each year in our benchmark scenario and is in line with the assumptions of the "Ageing Report" published by the European Commission (2012). In order to evaluate this assumption, we also assume a growth rate of zero percent. The cash flow is then discounted with a constant interest rate of three percent. We evaluate this assumption as well by using another interest rate which amounts to two percent.

Table 5 shows the results of our calculations.[22] The average present value of the overall costs in our benchmark scenario amounts for all women (men) in LTC to 71,119 (44,993) Euro. The median is to the left of this amount and sums up to 50,425 (30,786) Euro. The right-skewed distribution of the overall costs is not surprising, as it is connected to the underlying survival functions. Regarding the overall costs of those who are not affected by a dementia disorder reveals that they are four (one) percent below the costs of all women (men) in LTC. However, the costs of those, who already received a dementia diagnosis, are due to their rather long stay in nursing home care higher. On average their costs are twelve (ten) percent above the average LTC patient. Since the degree of self-retention in nursing home care is higher than the degree of self-retention in home care, we find differing results between men and women for this area. A woman (man) without dementia has on average a deductible of 26,023 (15,775) Euro whereas the deductible of a woman (man) with dementia amounts to 32,364 (17,944)

[20] This includes investments into the nursing home care center which are allocated to the LTC patients.

[21] We generate a synthetic data set by doing a Monte-Carlo Simulation. The dataset amounts to 100,000 persons at the beginning of the calculation and ensures that we have enough cases to analyze the costs properly. See also Häcker and Hackmann (2011).

[22] Note: The calculated overall costs differ slightly to those calculated in Ehing et al. (2014). The main reason for this difference steams from the fact that our projection starts after the 4th year.

Euro. Regarding the different assumptions concerning the growth- and interest-rate we find an interval for the total costs which is about 8,000 (4000) Euro. The range for men is smaller than one for women which is again related to the higher mortality of men.

[Insert Table 5 here]

6. Summary

Our findings can be summarized as follows: on average we discover that a dementia disorder is diagnosed before a LTC status is assigned. However, the general chances of entering the LTC system in Germany are higher than the chances of a dementia diagnosis. Prevalence rates for LTC are therefore higher than prevalence for a dementia disorder. Looking closer at the prevalence of men and women results in the finding that the higher prevalence of women in both fields of study cannot be explained completely by differing incidence-rates (even though we find slightly higher incidence rates for women in both fields after the age of 80). A key factor for differing prevalence is therefore the different mortality in LTC and dementia. As our results show, the survival functions for dementia lie above the survival functions for LTC. 50 percent of all female (male) dementia patients are dead after 57 (47) months whereas 50 percent of all female (male) LTC patients are dead after 44 (25) months. The mean survival times in dementia and LTC are to the right of these numbers. For dementia they amount to 73 (61) months, whereas women (men) stay on average 57 (39) months in LTC.

Looking at the hazard of dying in both fields reveals that a higher care level is associated with an increase in mortality rates. This result is not surprising, since the different care levels can be seen as a proxy for the health status. However, the hazard of dying is, compared to a situation at home, lower in a nursing home care center for care level II and III. A dementia diagnosis generally lowers the hazard of dying in LTC. However, this effect diminishes the older the people are. Generally speaking, mortality rates increase with age.

The costs that are connected to a LTC career amount for women (men) on average to 71,119 (44,993) Euro. Even though the average man (woman) with dementia stays 5.2 (1.8) months shorter in LTC than the average man (woman) without dementia the associated costs are higher. They amount to 80,201 (49,793) Euro. An explanation for this rather counterintuitive result is hidden in the different care levels each group moves along. On average women (men) with a dementia disorder are 9 (3) months longer in a nursing home center than women (men) without.

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Appendix A

Table A 1: Yearly transition probability LTC-women[23]

t+1

t	Women	HC I	HC II	HC III	HC I d	HC II d	HC III d	NHC I	NHC II	NHC III	NHC I d	NHC II d	NHC III d	Break LTC	Break LTC d	death
	HC I	69%	4%	0%	6%	1%	0%	2%	1%	0%	1%	1%	0%	1%	0%	14%
	HC II	1%	51%	1%	0%	4%	0%	0%	2%	0%	0%	2%	0%	1%	0%	37%
	HC III	0%	1%	31%	0%	0%	3%	0%	0%	1%	0%	0%	0%	0%	0%	64%
	HC I d	0%	0%	0%	58%	10%	1%	0%	0%	0%	9%	6%	1%	0%	2%	15%
	HC II d	0%	0%	0%	1%	48%	5%	0%	0%	0%	0%	11%	2%	0%	1%	33%
	HC III d	0%	0%	0%	0%	1%	33%	0%	0%	0%	0%	0%	5%	0%	1%	61%
	NHC I	1%	0%	0%	0%	0%	0%	60%	4%	0%	12%	3%	0%	0%	0%	19%
	NHC II	0%	1%	0%	0%	0%	0%	1%	50%	2%	0%	11%	1%	0%	0%	35%
	NHC III	0%	0%	0%	0%	0%	0%	0%	1%	38%	0%	0%	8%	0%	0%	51%
	NHC I d	0%	0%	0%	1%	0%	0%	0%	0%	0%	59%	18%	2%	0%	0%	20%
	NHC II d	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	55%	7%	0%	1%	36%
	NHC III d	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	2%	46%	0%	0%	51%
	Break LTC	3%	2%	0%	1%	0%	0%	1%	1%	0%	1%	1%	0%	70%	3%	19%
	Break LTC d	0%	0%	0%	1%	3%	0%	0%	0%	0%	4%	6%	2%	0%	51%	33%
	death	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%

Source: own calculations

[23] HC=home care; NHC= nursing home care; d=dementia

Table A 2: Yearly transition probability LTC-men[24]

t	Men	t+1 HC I	HC II	HC III	HC I d	HC II d	HC III d	NHC I	NHC II	NHC III	NHC I d	NHC II d	NHC III d	Break LTC	Break LTC d	death
	HC I	64%	5%	0%	5%	1%	0%	1%	0%	0%	1%	1%	0%	1%	0%	21%
	HC II	1%	46%	1%	0%	4%	0%	0%	1%	0%	0%	1%	0%	0%	0%	46%
	HC III	0%	0%	28%	0%	0%	2%	0%	0%	1%	0%	0%	1%	0%	0%	68%
	HC I d	0%	0%	0%	55%	12%	1%	0%	0%	0%	4%	4%	1%	0%	1%	22%
	HC II d	0%	0%	0%	1%	41%	4%	0%	0%	0%	0%	6%	1%	0%	1%	46%
	HC III d	0%	0%	0%	0%	1%	30%	0%	0%	0%	0%	0%	4%	0%	0%	65%
	NHC I	1%	0%	0%	0%	0%	0%	58%	3%	1%	9%	2%	0%	1%	0%	24%
	NHC II	0%	1%	0%	0%	0%	0%	0%	46%	1%	0%	9%	1%	0%	0%	41%
	NHC III	0%	0%	0%	0%	0%	0%	0%	1%	35%	0%	0%	7%	0%	0%	55%
	NHC I d	0%	0%	0%	1%	0%	0%	0%	0%	0%	53%	15%	1%	0%	1%	28%
	NHC II d	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	41%	6%	0%	1%	51%
	NHC III d	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	1%	34%	0%	1%	64%
	Break LTC	1%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	66%	1%	31%
	Break LTC d	0%	0%	0%	1%	4%	1%	0%	0%	0%	3%	6%	1%	0%	42%	42%
	death	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%

Source: own calculations

[24] HC=home care; NHC= nursing home care; d=dementia

Table A 3: Yearly transition probabilities for dementia without LTC at beginning

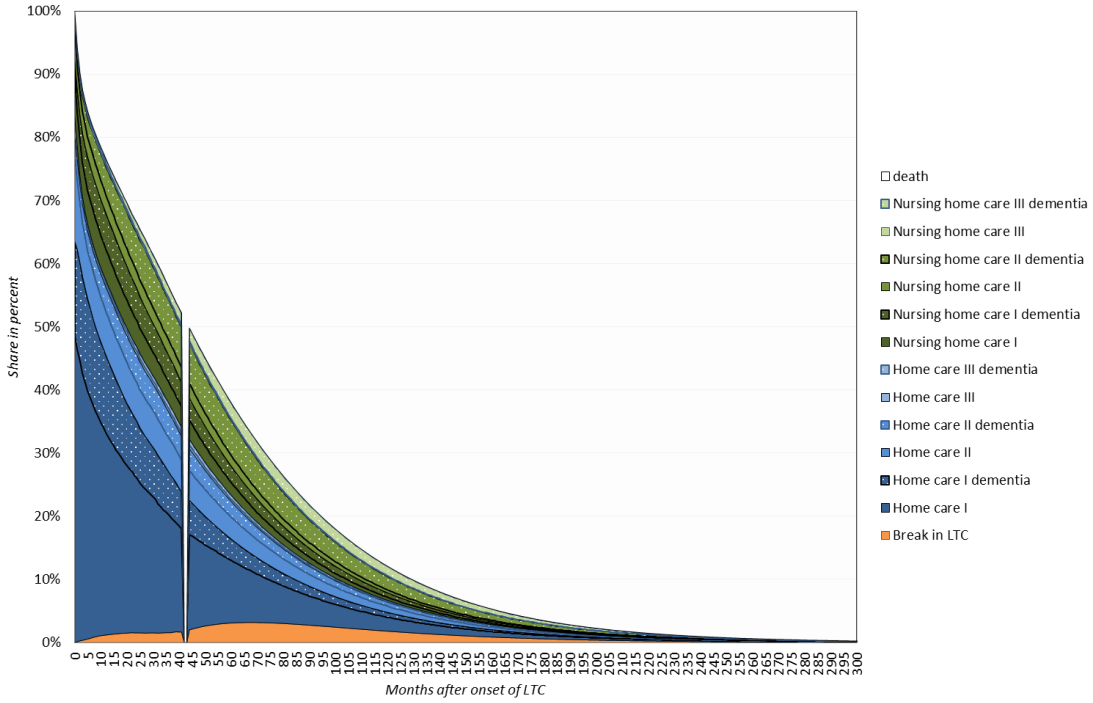
		t+1							
t	Women	Dementia without LTC	HC I	HC II	HC III	NHC I	NHC II	NHC III	Break in LTC	death
	Dementia without LTC	74%	10%	2%	0%	3%	2%	0%	0%	7%
	HC I	0%	56%	11%	1%	8%	6%	1%	2%	15%
	HC II	0%	1%	54%	5%	0%	9%	2%	2%	28%
	HC III	0%	0%	1%	46%	0%	0%	2%	1%	51%
	NHC I	0%	0%	0%	0%	56%	21%	2%	0%	20%
	NHC II	0%	0%	1%	0%	1%	56%	8%	1%	34%
	NHC III	0%	0%	0%	0%	0%	2%	49%	2%	47%
	Break in LTC	0%	2%	2%	0%	6%	3%	1%	54%	33%
	death	0%	0%	0%	0%	0%	0%	0%	0%	100%

		t+1							
t	Men	Dementia without LTC	HC I	HC II	HC III	NHC I	NHC II	NHC III	Break in LTC	death
	Dementia without LTC	74%	8%	3%	0%	2%	1%	0%	0%	11%
	HC I	0%	54%	13%	1%	4%	4%	1%	1%	22%
	HC II	0%	1%	46%	4%	0%	6%	2%	1%	40%
	HC III	0%	0%	2%	32%	0%	1%	5%	0%	60%
	NHC I	0%	0%	0%	0%	51%	17%	2%	0%	30%
	NHC II	0%	0%	0%	0%	0%	42%	6%	2%	50%
	NHC III	0%	0%	0%	2%	0%	1%	42%	0%	55%
	Break in LTC	0%	0%	3%	0%	0%	10%	0%	44%	42%
	death	0%	0%	0%	0%	0%	0%	0%	0%	100%

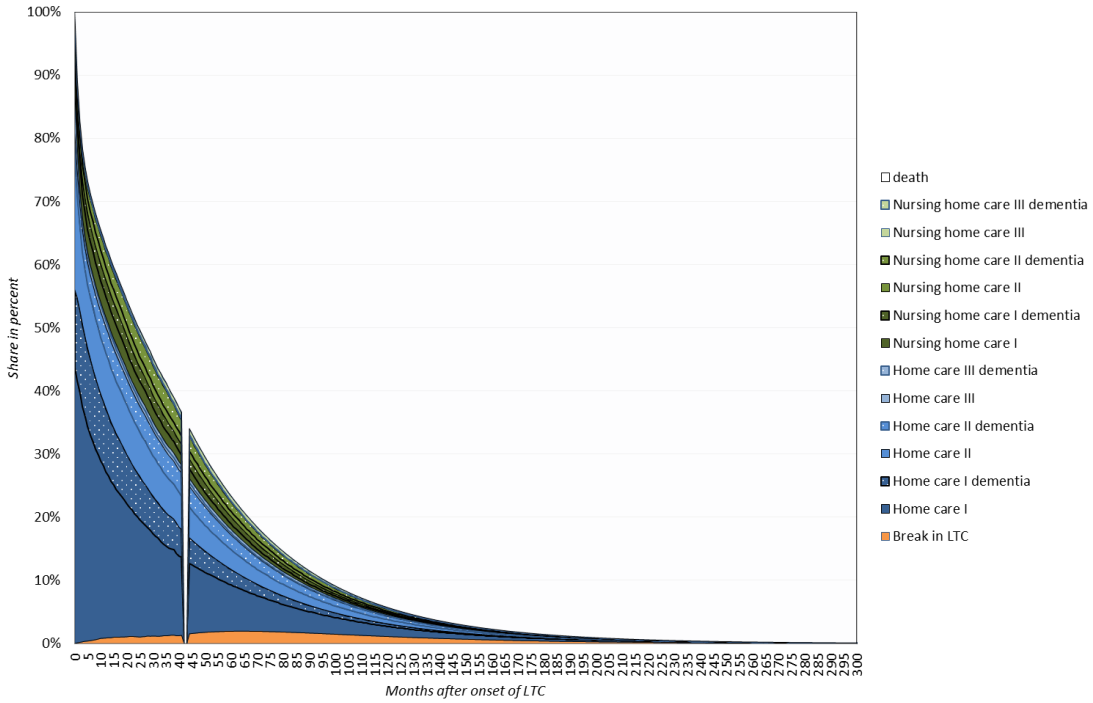
Source: own calculations

Figure A 1: Extrapolated gender specific survival functions for the stay in LTC

a.) female



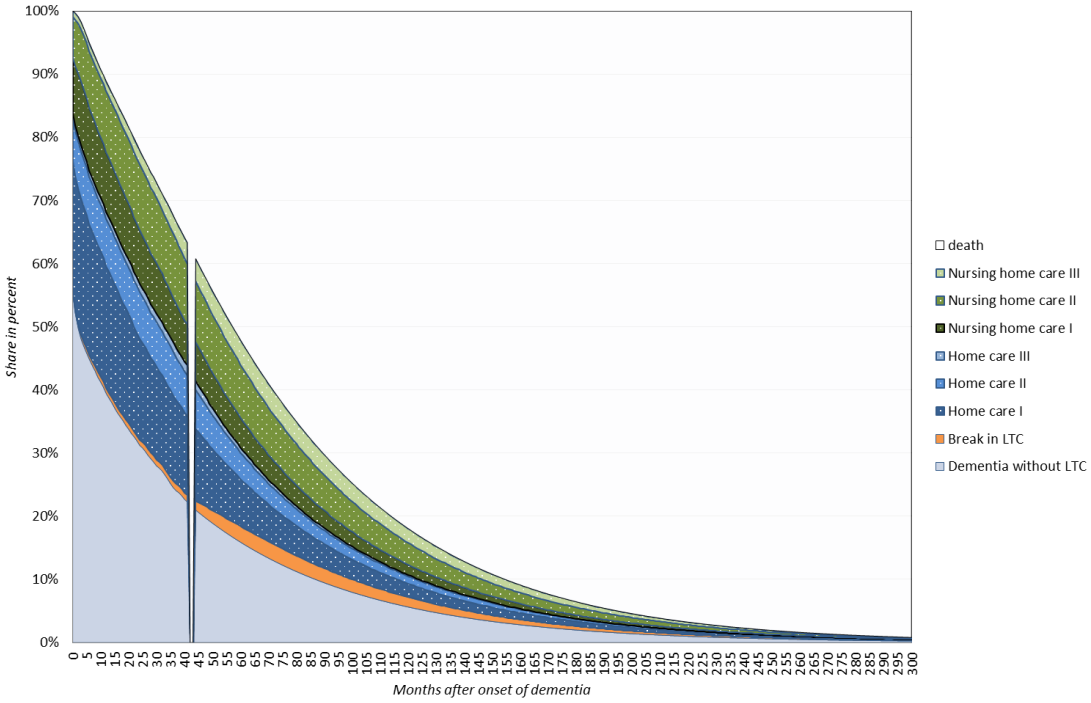
b.) male



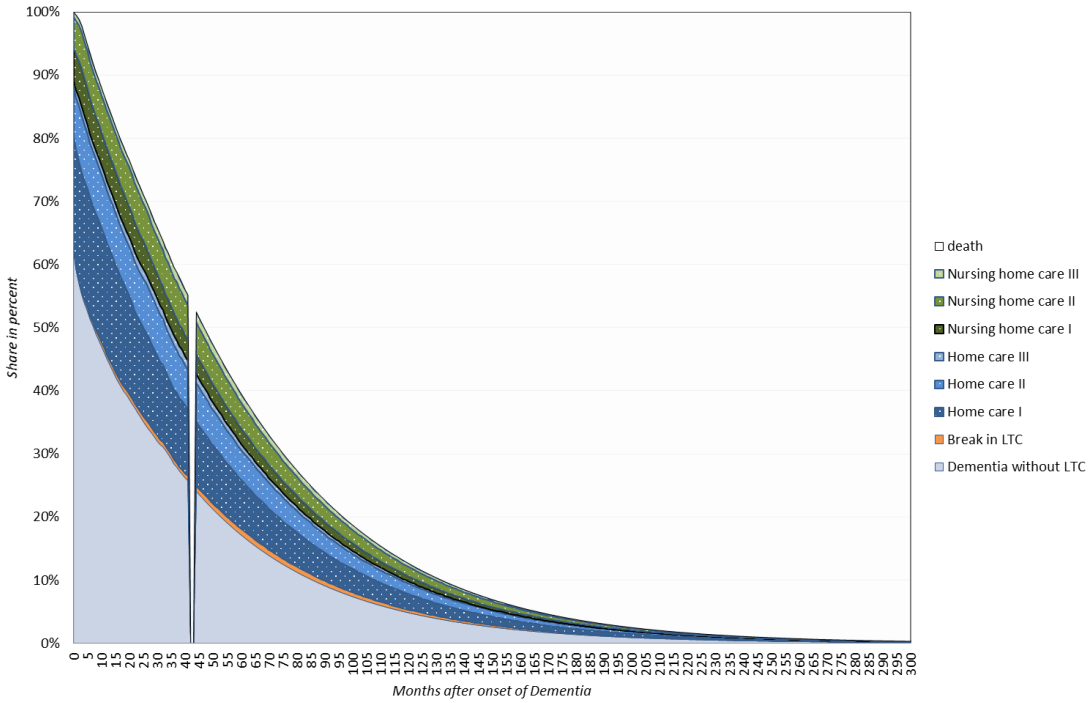
Source: own calculations

Figure A 2: Extrapolated gender specific survival functions for the stay in dementia

a.) female



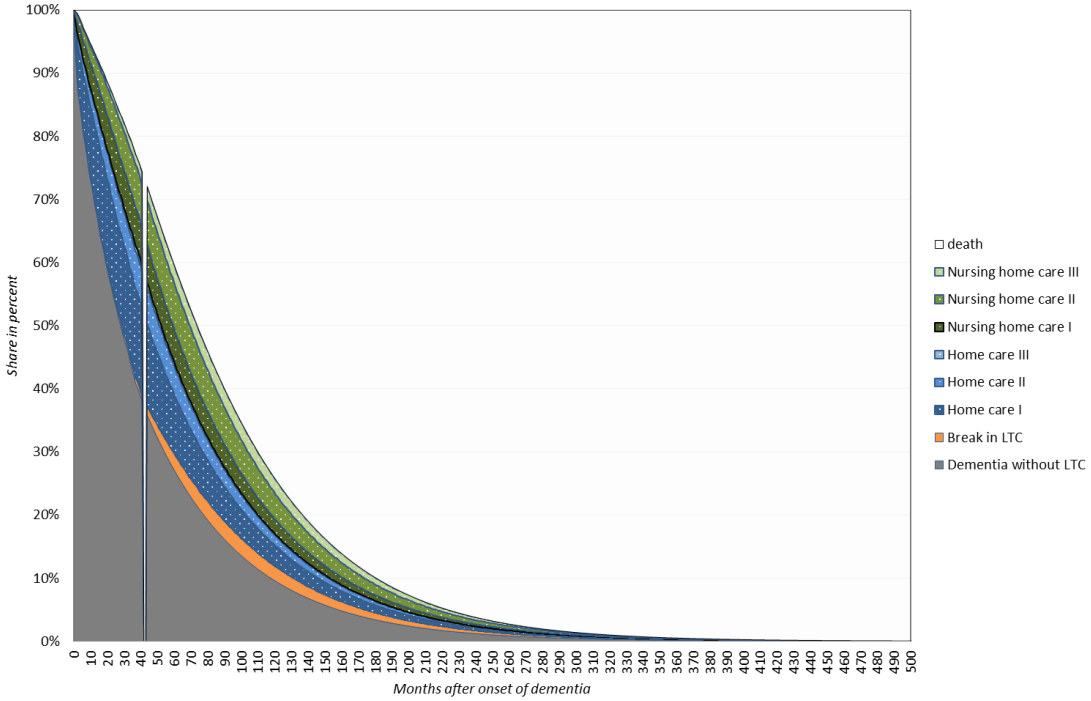
b.) male



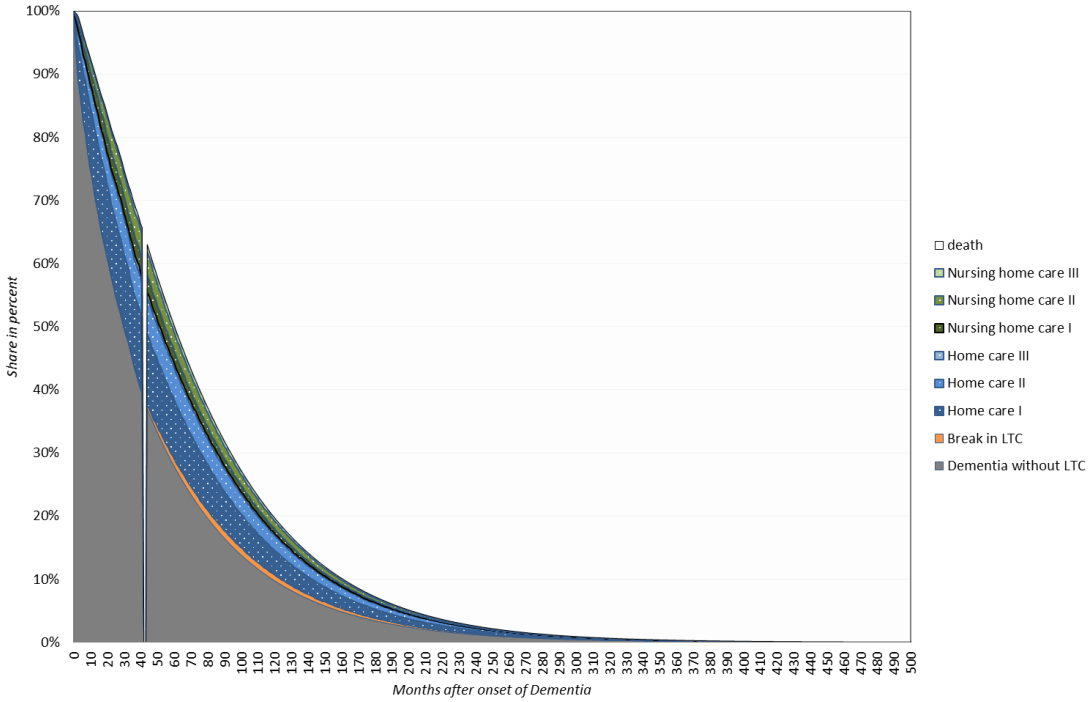
Source: own calculations

Figure A 3: Extrapolated gender specific survival functions for the stay in dementia – no LTC at the beginning

a.) female



b.) male



Source: own calculations

Table A 4: Monthly benefits and costs in LTC

	Home care				Nursing home care		
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
	Cash benefit	Service benefit	Total costs of nursing service	Amount of self-retention (III)-(II)	Service benefit	Total costs for nursing home care	Amount of self-retention (VI)-(V)
Care level I	235 €	450 €	694 €	244 €	1,023 €	1,855 €	832 €
Care level II	440 €	1,100 €	1,484 €	384 €	1,279 €	2,317 €	1,038 €
Care level III	700 €	1,550 €	2,003 €	453 €	1,550 €	2,806 €	1,256 €

Source: Schneekloth and Schmidt (2011) ; Rothgang et al. (2013), Bundesministerium für Gesundheit (2014b)

Appendix B

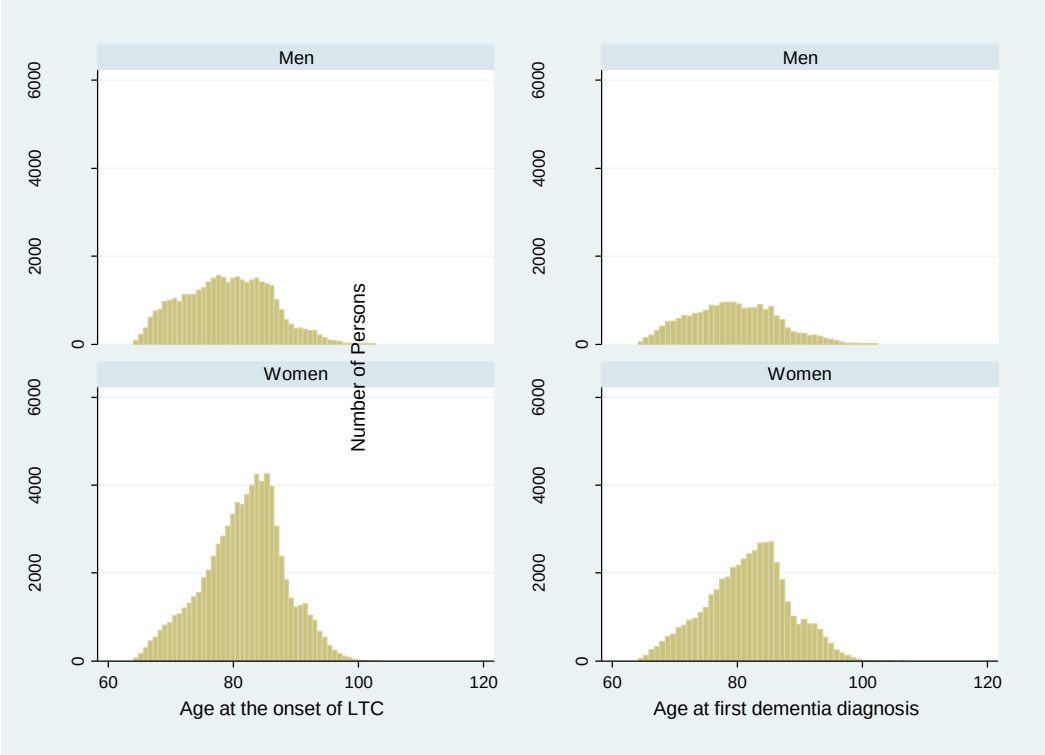
Table B 1: Summary of the used datasets

Name of the dataset	Variables	Description
Versichertenstammdaten (PFL_VST)	Pseudonummer	Unique Number to identify a person
	Geschlecht	Gender variable
	Geb_Jahr	Birthdate on a monthly basis
	Tod	Death date on a monthly basis
Versicherungsverlauf (PFL_VSV)	Pseudonummer	Unique Number to identify a person
	Beginn_Vers	Inception date at the AOK-Plus
	Ende_Vers	Termination date at the AOK-Plus
Versichertenstammdaten mit Zustand (PFL_VSP_Zustand)	Pseudonummer	Unique Number to identify a person
	Beginn_Vers	Inception date at the central public nursing-care insurance
	Ende_Vers	Termination date at the central public nursing-care insurance
	Zustand	Care level based on the Pg-1 statistic
Ärztliche Behandlung (PFL_AMB_2005- PFL_AMB_2008)	Pseudonummer	Unique Number to identify a person
	Abrechquartal	Quarter of the treatment
	Pseudo_IK	Unique Number to identifiy the physician
	FallNr	Unique Case number
	Beh_Von	Start of the treatment (date)
	Beh_Bis	End of the treatment (date)
Ärztliche Behandlung ICD (PFL_ICD_2005-PFL_ICD_2008)	Pseudonummer	Unique Number to identify a person
	Abrechquartal	Quarter of the treatment
	Pseudo_IK	Unique Number to identifiy the physician
	FallNr	Unique Case number
	ICD_Code	ICD-Code

Source: AOK-Plus

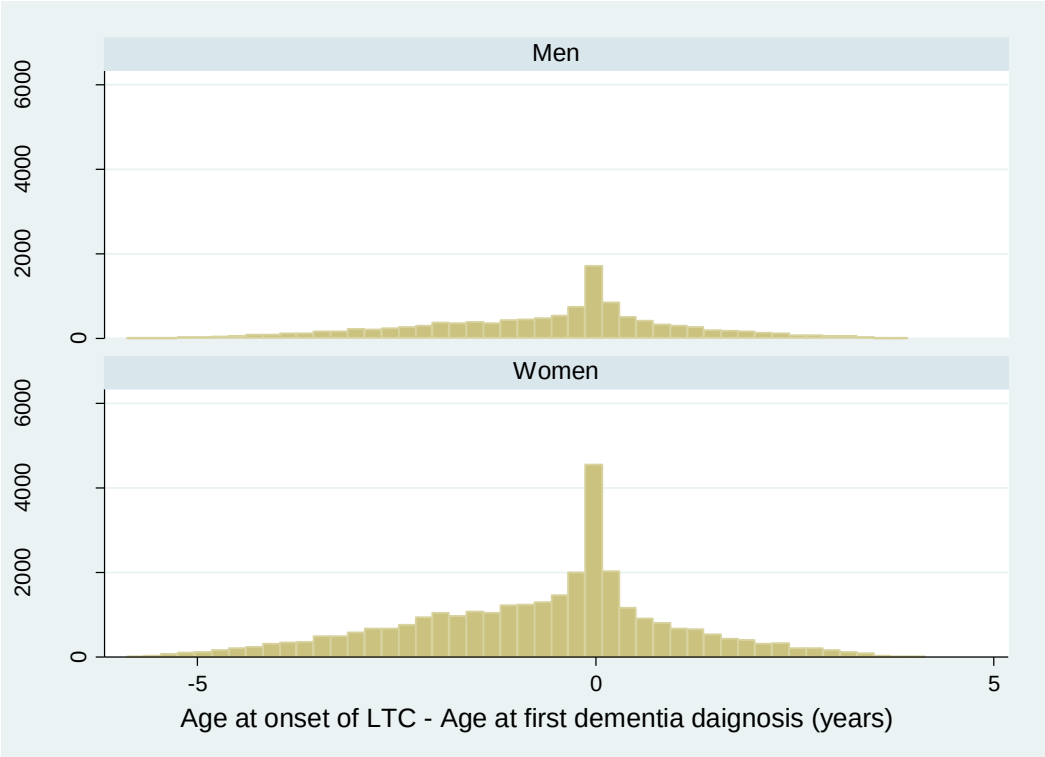
Graphs and Tables

Figure 1: Age distribution for the incidence of dementia and LTC



Source: own calculations.

Figure 2: Difference between the onset of LTC and the first dementia diagnosis (years)[25]

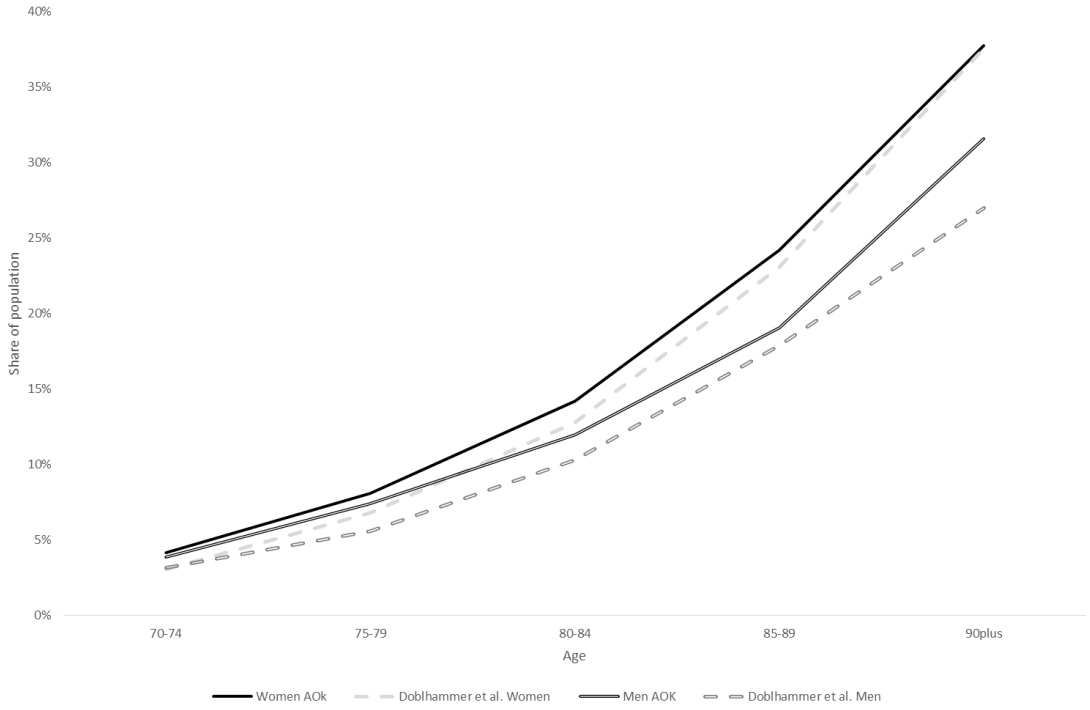


Source: own calculations.

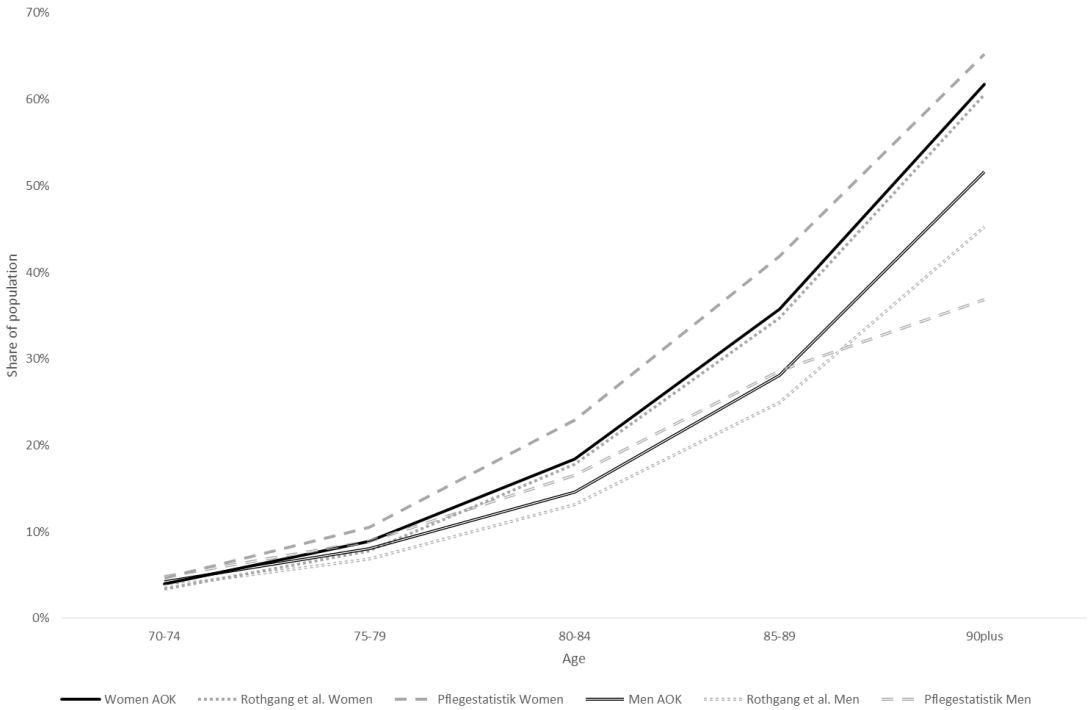
[25] Values larger than zero denote the fact that dementia was diagnosed before the onset of LTC. Values smaller than zero denote the fact that LTC started before the first dementia diagnosis.

Figure 3: Prevalence rates for dementia and LTC (31st December 2008)

a.) dementia



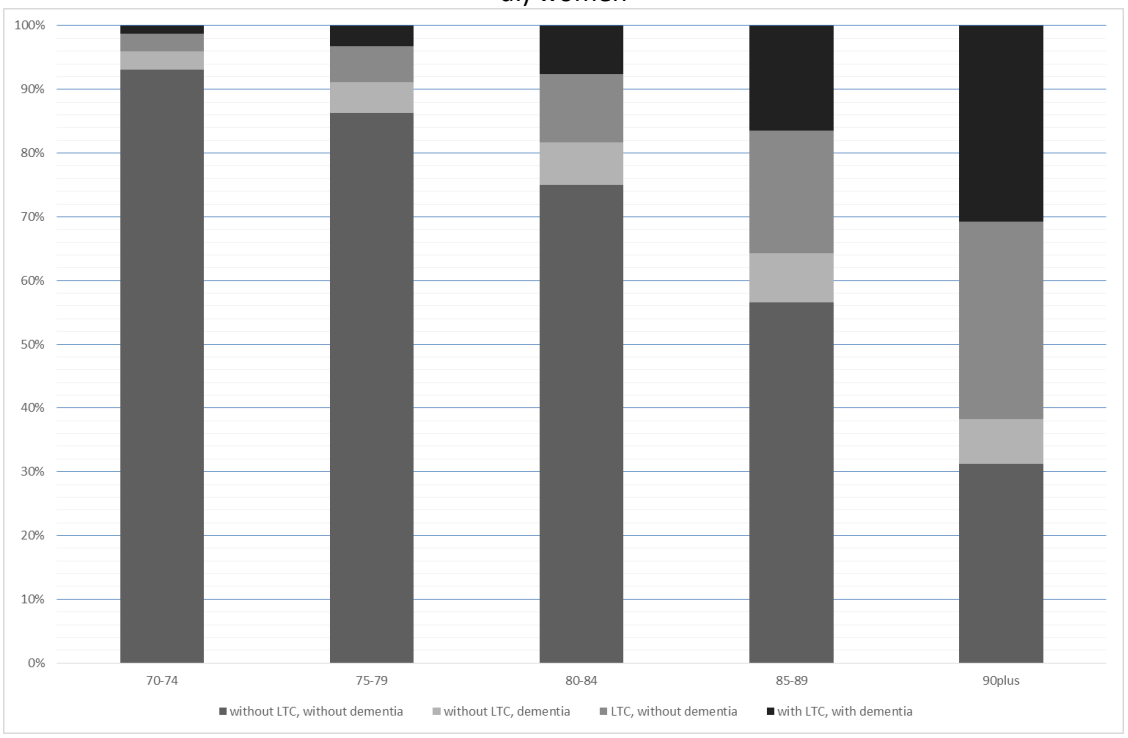
b.) LTC



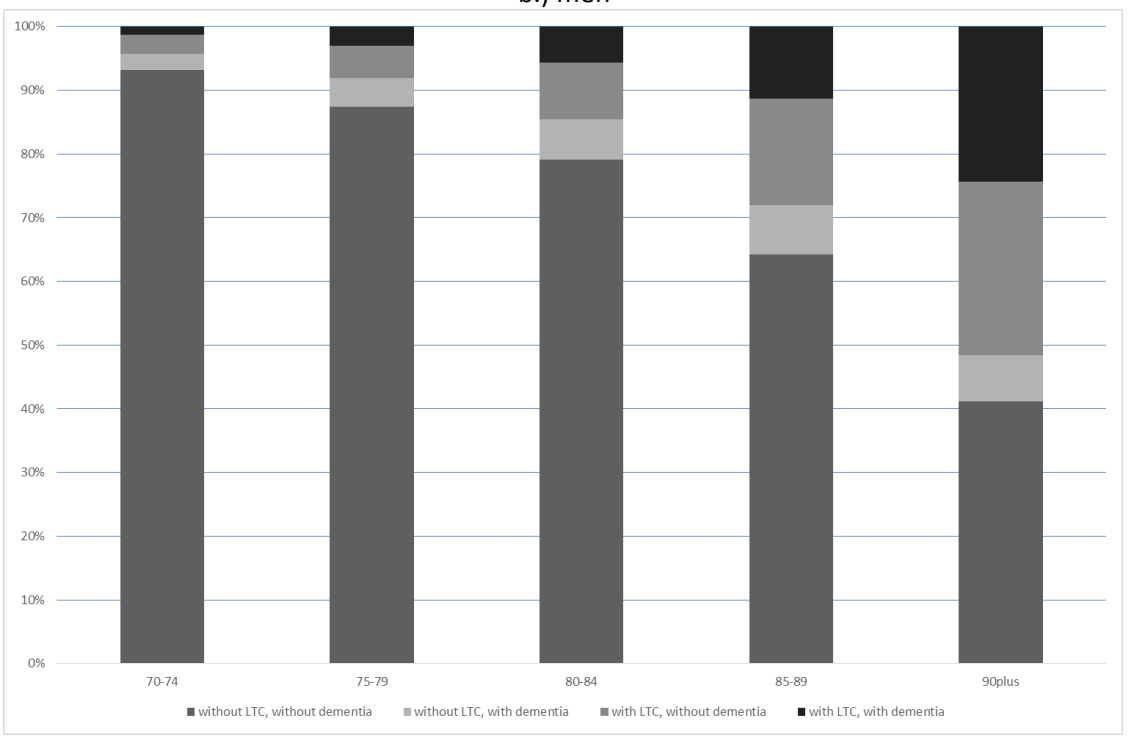
Source: Rothgang et al. (2011, p. 118), Statistisches Bundesamt (2011, p. 9), Doblhammer et al. (2009, p. 285), own calculations.

Figure 4: Combined Prevalence rates for dementia and LTC (31st December 2008)

a.) women



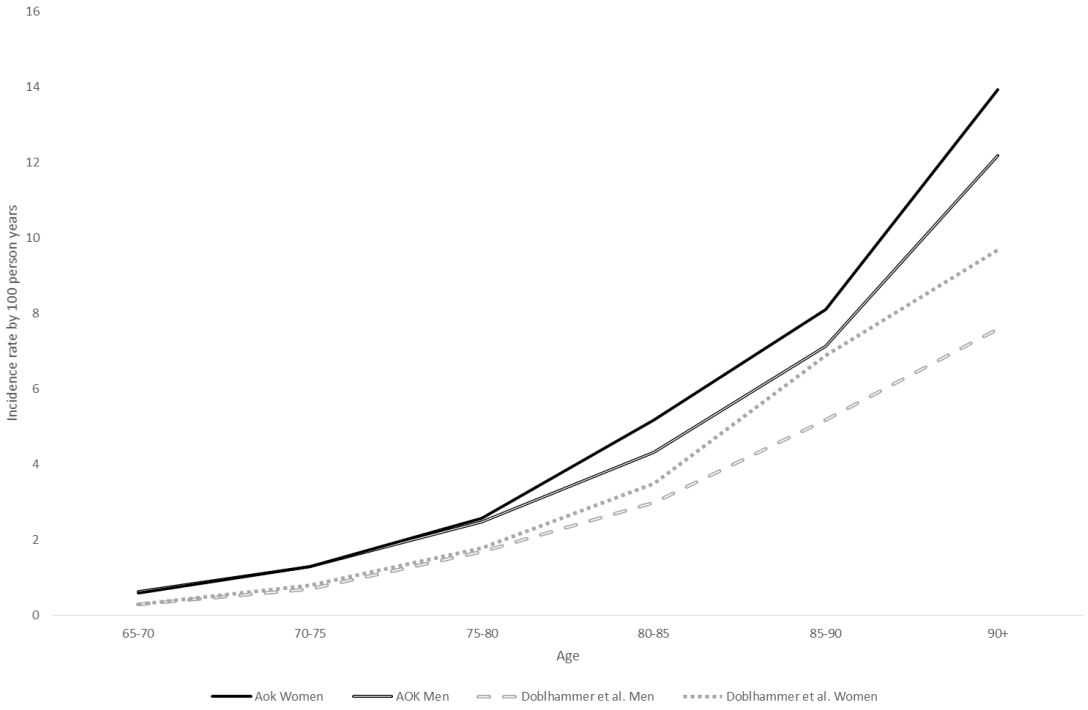
b.) men



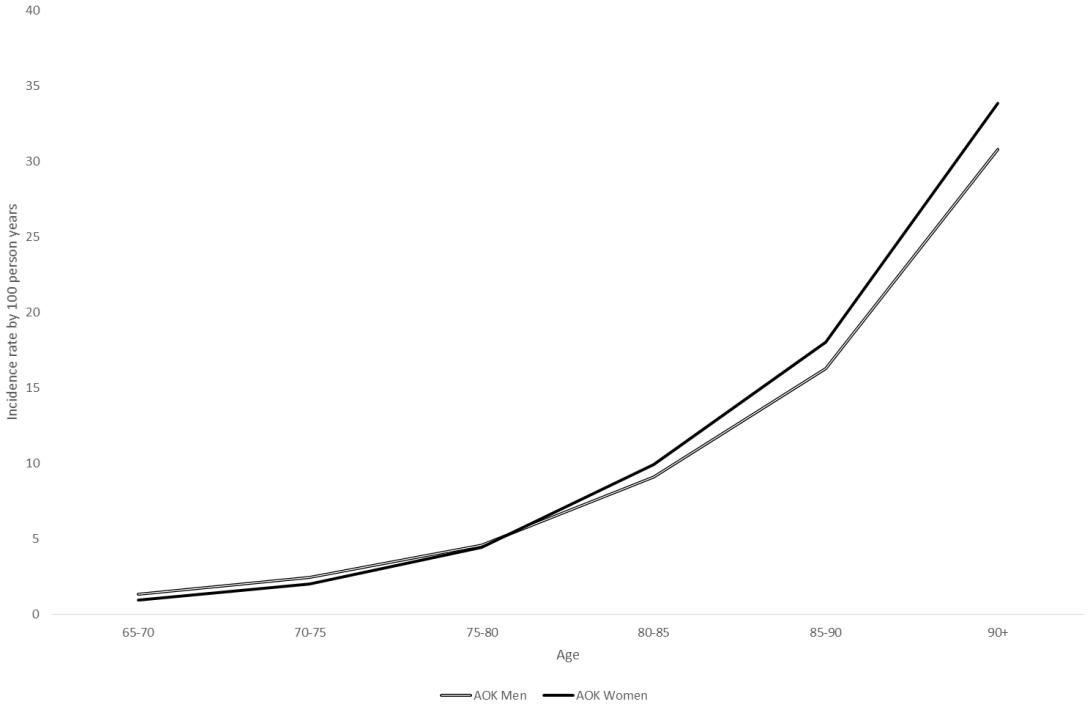
Source: own calculations.

Figure 5: Incidence rates for dementia and LTC (2005-2008)

a.) dementia



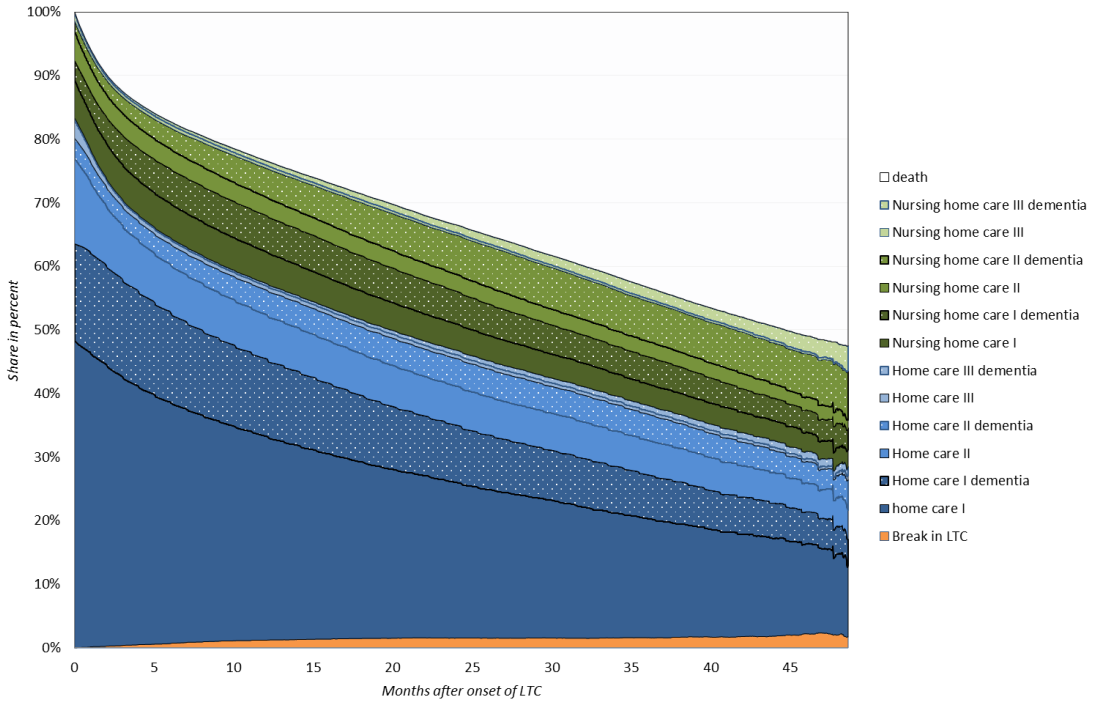
b.) LTC



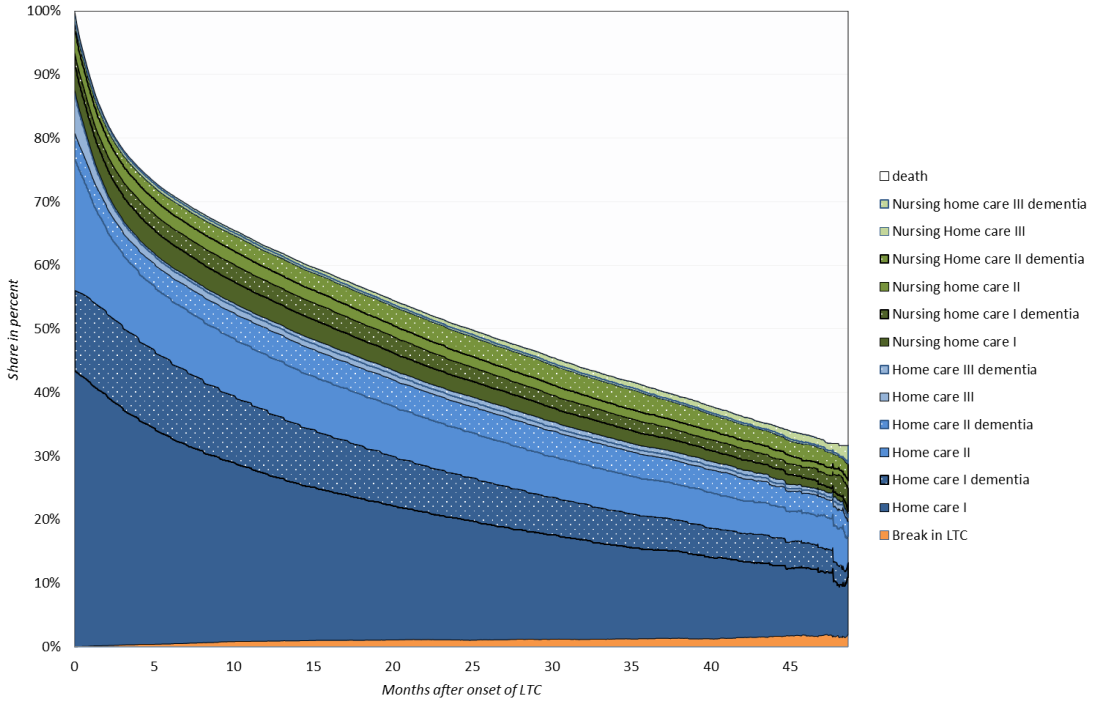
Source: Doblhammer et al. (2009, p. 286), own calculations.

Figure 6: Survival functions for the stay in LTC

a.) women (N=78,032)



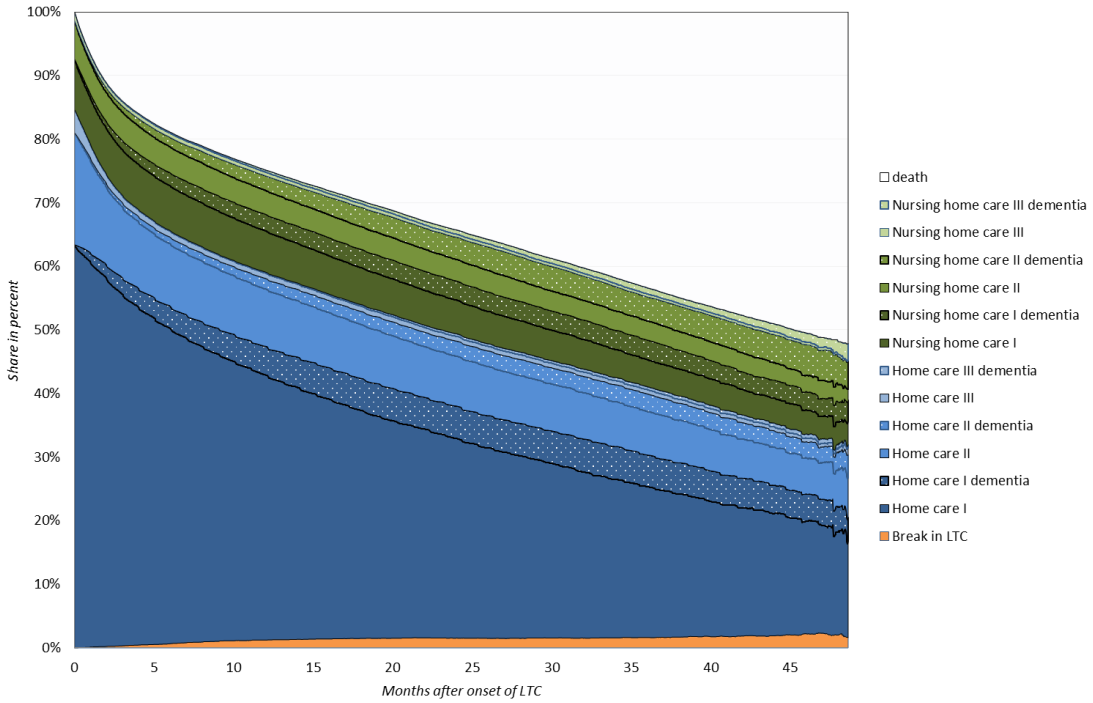
b.) men (N=38,252)



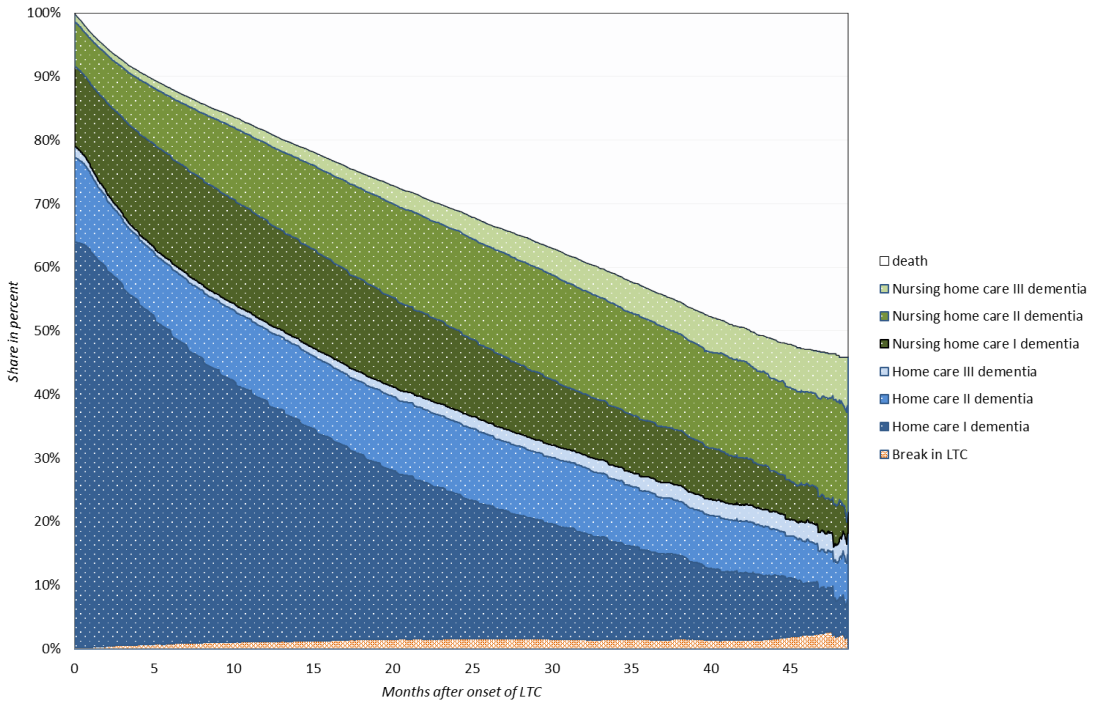
Source: own calculations.

Figure 7: Survival functions for the stay in LTC – women

a.) without dementia (N=59,596)



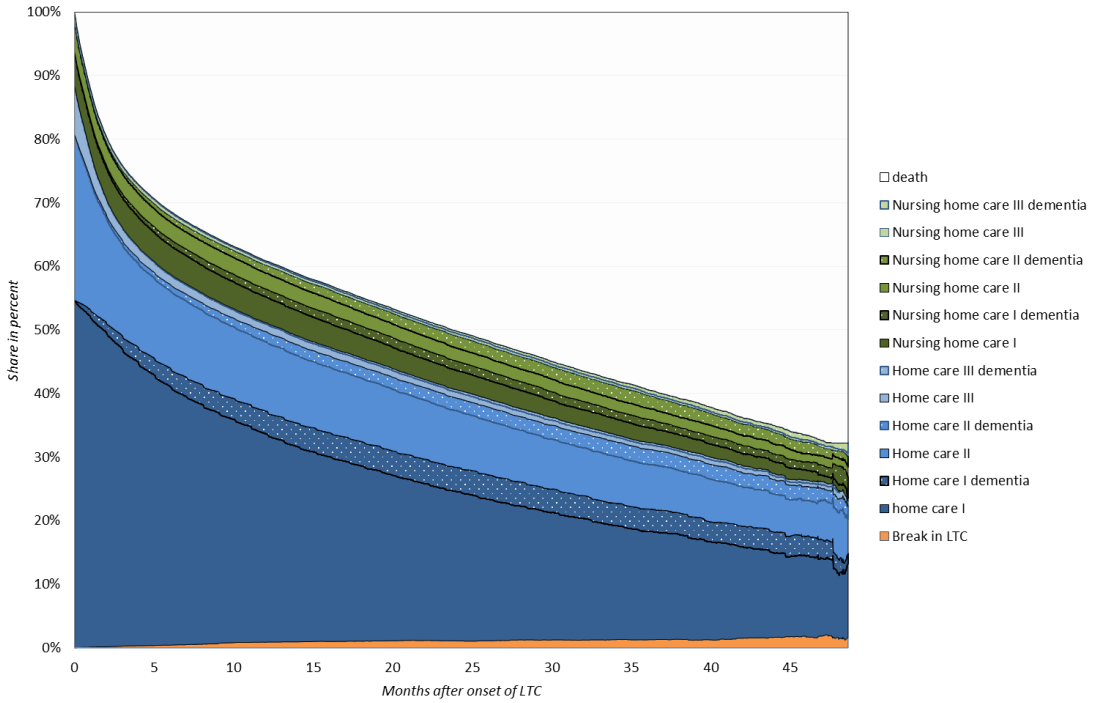
b.) with dementia (N=18,436)



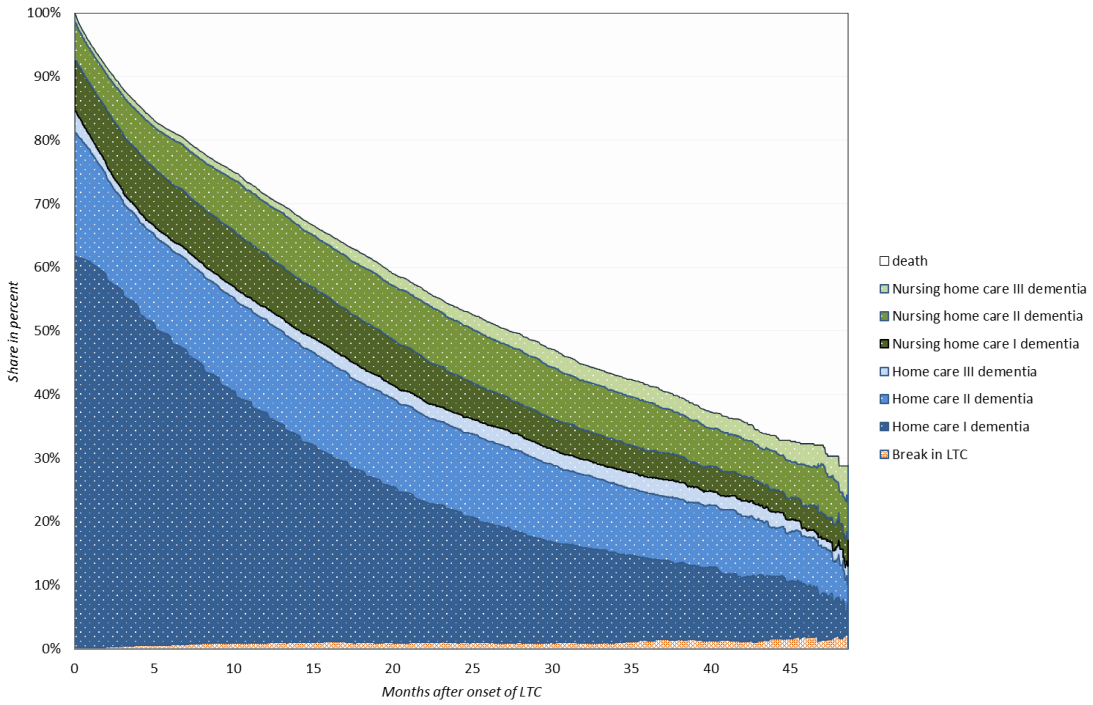
Source: own calculations

Figure 8: Survival functions for the stay in LTC – men

a.) without dementia (N=30,504)



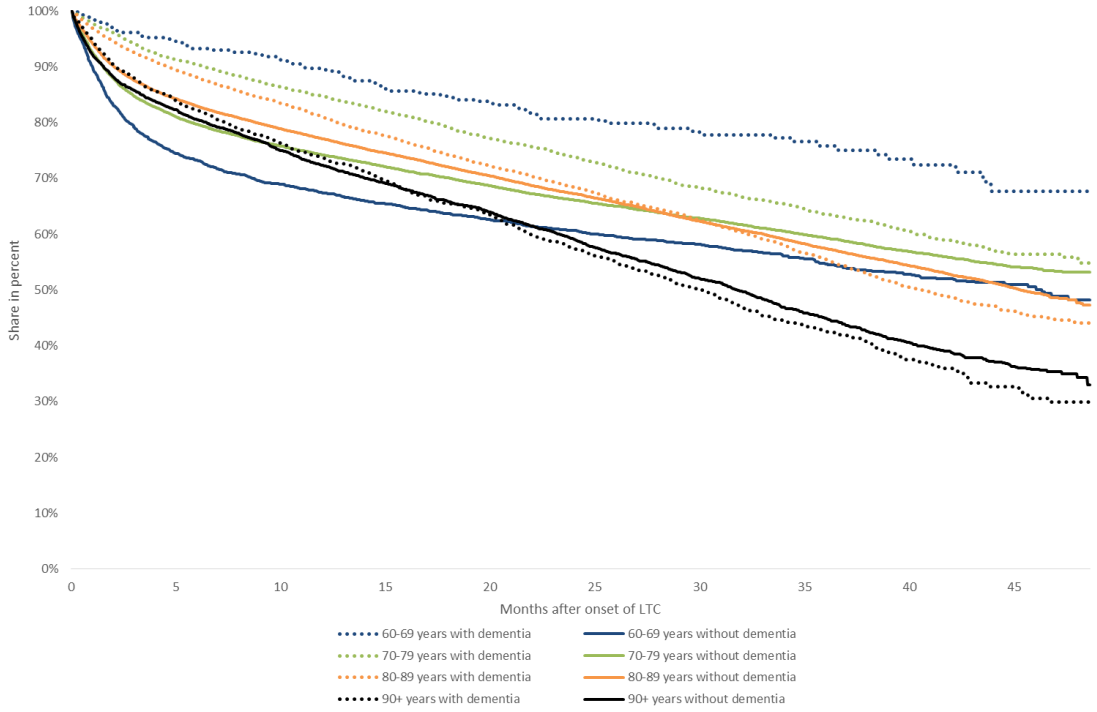
b.) with dementia (N=7,748)



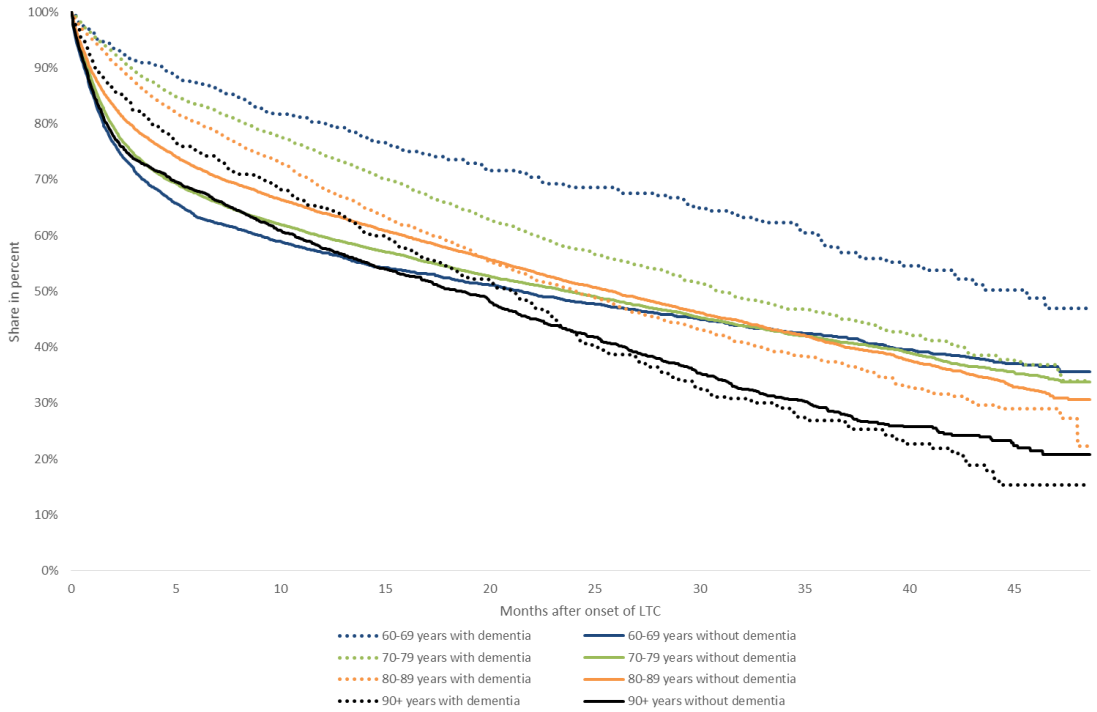
Source: own calculations

Figure 9: Survival functions for the stay in LTC – Differentiation by age groups and dementia status

a.) women



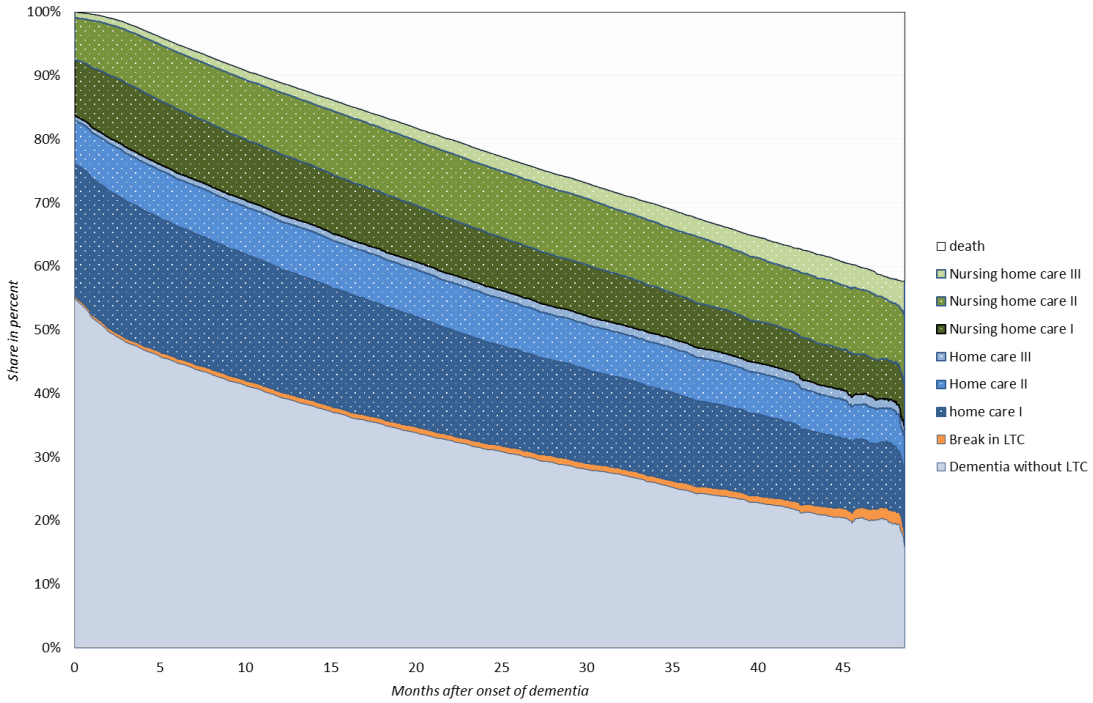
b.) men



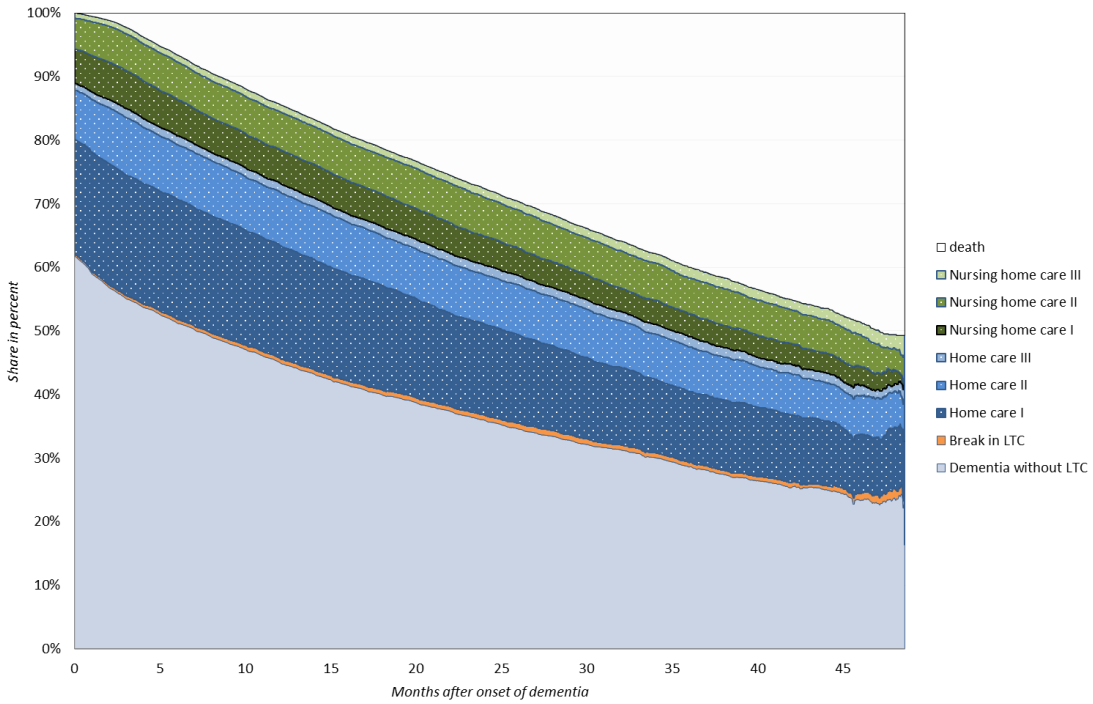
Source: own calculations

Figure 10: Gender specific survival functions for the stay in dementia

a.) female (N=47,024)



b.) male (N=20,080)



Source: own calculations

Table 1: Age specific mortality after onset of dementia

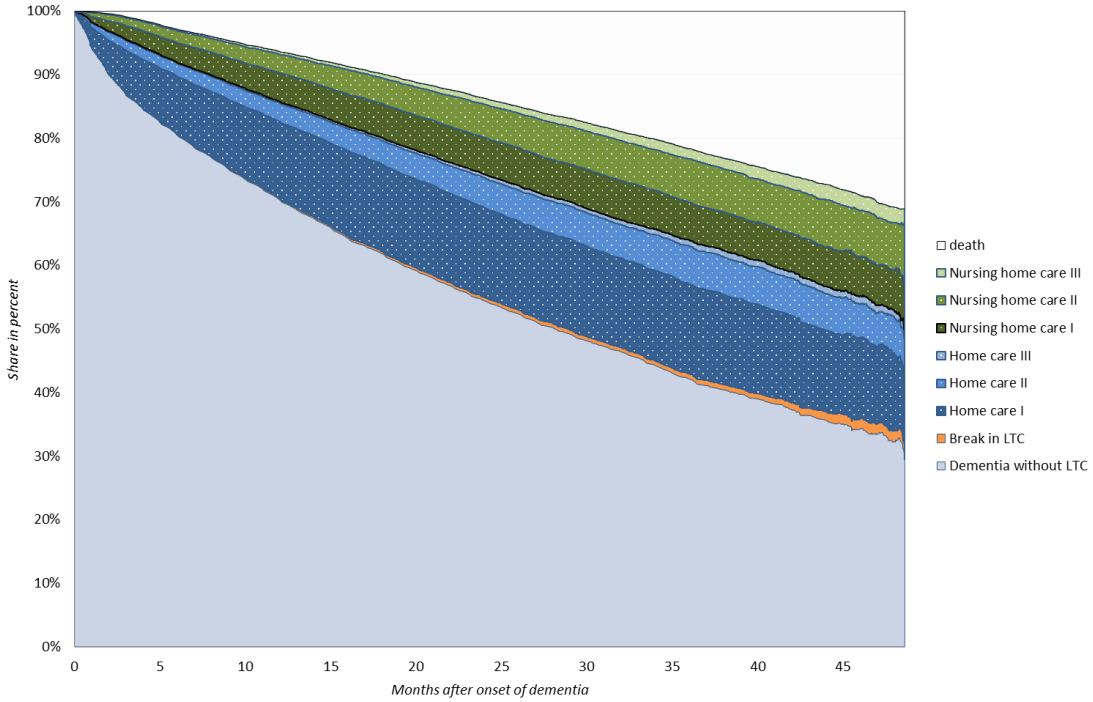
	Women			
	In LTC at onset of dementia	**Mortality in the first year**	**Average mortality in the following years**	**N**
60-69 years	20 %	3.79 %	4.04 %	2207
70-79 years	29 %	6.75 %	8.23 %	15486
80-89 years	50 %	12.20 %	15.72 %	24055
90+ years	76 %	21.08 %	26.41 %	5276

	Men			
	In LTC at onset of dementia	**Mortality in the first year**	**Average mortality in the following years**	**N**
60-69 years	23 %	6.03 %	8.18 %	2033
70-79 years	30 %	10.68 %	13.47 %	9006
80-89 years	45 %	17.92 %	21.61 %	7722
90+ years	72 %	30.32 %	38.31 %	1319

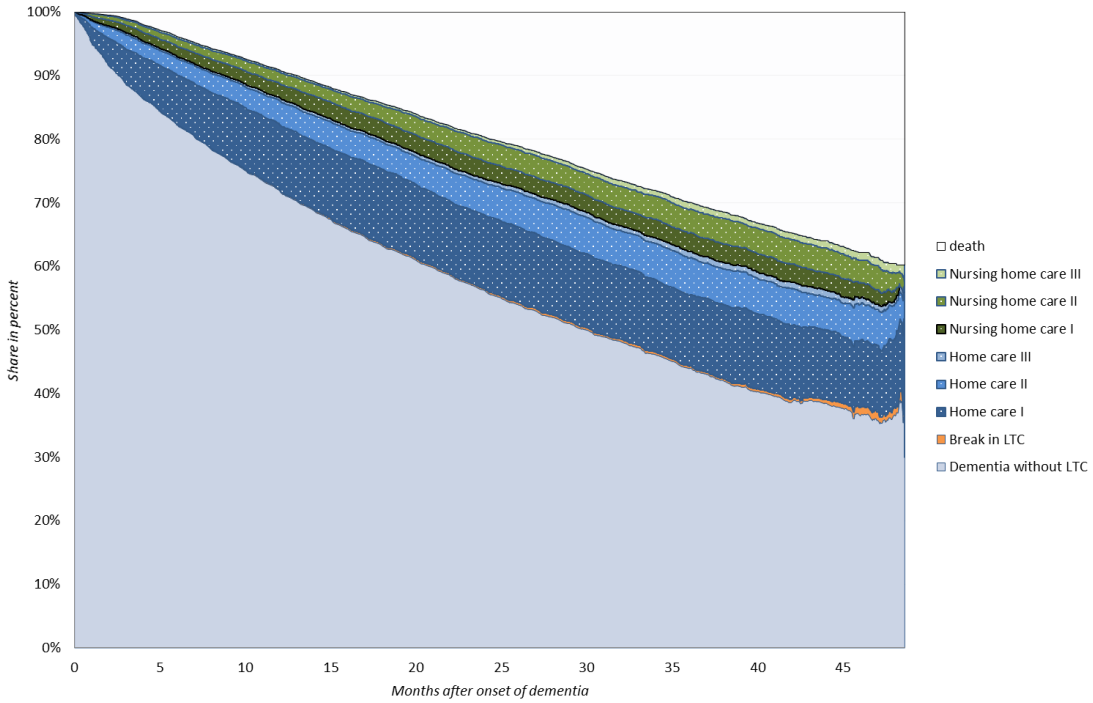
Source: own calculations

Figure 11: Gender specific survival functions for the stay in dementia – no LTC at the beginning

a.) female (N=25,912)



b.) male (N=12,442)



Source: own calculations

Table 2: Cox-model LTC

Hazard Ratios	**(1)** **women**	**(2)** **men**
reference: home care		
nursing home care	1.061	0.856
	(0.217)	(0.212)
reference: care level I		
care level II	8.126***	4.003***
	(1.599)	(0.866)
care level III	26.14***	9.424***
	(7.113)	(2.694)
Age variable encoded in years		
age at onset of LTC	1.010***	1.006**
	(0.00205)	(0.00226)
reference: no dementia		
dementia	0.0418***	0.0729***
	(0.00843)	(0.0164)
Interaction effects		
nursing home care*care level II	0.517***	0.620***
	(0.0174)	(0.0297)
nursing home care*care level III	0.297***	0.357***
	(0.0145)	(0.0231)
nursing home care*age	1.011***	1.012***
	(0.00247)	(0.00308)
age*care level II	0.996	1.003
	(0.00240)	(0.00275)
age*care level III	0.998	1.007
	(0.00335)	(0.00368)
age*dementia	1.027***	1.021***
	(0.00246)	(0.00281)
nursing home care* dementia	1.023	1.098*
	(0.0316)	(0.0474)
dementia*care level II	0.980	1.047
	(0.0326)	(0.0455)
dementia*care level III	1.140**	1.286***
	(0.0545)	(0.0758)
N	239835	108004
Clustered standard errors in parentheses		
** p<0.05 ** p<0.01 *** p<0.001*		

Source: own calculations

Table 3: Cox model dementia

Hazard Ratios	**(1)** **women**	**(2)** **men**
reference: home care		
nursing home care	1.051	2.166*
	(0.316)	(0.796)
reference: care level I		
care level 0	0.00202***	0.0927***
	(0.00103)	(0.0518)
care level II	5.255***	4.341***
	(1.812)	(1.822)
care level III	11.15***	4.040*
	(4.963)	(2.192)
age variable encoded in years		
age at onset of dementia	1.029***	1.036***
	(0.00386)	(0.00473)
Interaction effects		
nursing home care*care level II	0.687***	0.697***
	(0.0351)	(0.0526)
nursing home care*care level III	0.384***	0.414***
	(0.0253)	(0.0402)
nursing home care*age	1.007*	0.999
	(0.00355)	(0.00440)
age*care level 0	1.072***	1.024***
	(0.00657)	(0.00710)
age*care level II	0.996	0.998
	(0.00408)	(0.00509)
age*care level III	1.002	1.013*
	(0.00528)	(0.00674)
N	137646	55845
Clustered standard errors in parentheses		
** p<0.05 ** p<0.01 *** p<0.001*		

Source: own calculations

Table 4: Average stay in LTC

Average life expectation in LTC	All		Dementia at beginning		No dementia at beginning	
	Men	Women	Men	Women	Men	Women
Total (months)	38.6	56.7	37.1	52.5	38.9	57.7
Home care I	49%	43%	38%	28%	51%	46%
Home care II	22%	15%	25%	13%	21%	15%
Home care III	3%	2%	5%	3%	3%	2%
Nursing home care I	9%	12%	11%	15%	8%	12%
Nursing home care II	9%	16%	13%	23%	8%	14%
Nursing home care III	3%	6%	5%	12%	2%	4%
Break in LTC	6%	6%	3%	5%	7%	6%
Share of home care	79%	64%	70%	47%	80%	68%
Share of nursing home care	21%	36%	30%	53%	20%	32%
Share of care level I	61%	59%	50%	46%	63%	62%
Share of care level II	33%	33%	39%	38%	31%	32%
Share of care level III	6%	9%	11%	17%	6%	6%

Source: own calculations

Table 5: Present Value calculations LTC

		Total Costs	Benefits	Self-retention	Total Costs	Benefits	Self-retention	Total Costs	Benefits	Self-retention	Total Costs	Benefits	Self-retention
		g=1,5%; r=2%			g=1,5%; r=3%			g=0%; r=2%			g=0%; r=3%		
All	**Women**												
	Mean	74,305 €	45,554 €	28,751 €	71,119 €	43,632 €	27,486 €	69,455 €	42,628 €	26,826 €	66,627 €	40,921 €	25,706 €
	Median	51,567 €	33,116 €	17,496 €	50,425 €	32,422 €	17,097 €	49,941 €	32,130 €	16,887 €	48,854 €	31,487 €	16,525 €
	SD	76,203 €	44,450 €	32,652 €	70,839 €	41,312 €	30,398 €	68,137 €	39,731 €	29,261 €	63,695 €	37,132 €	27,393 €
	Men												
	Mean	46,506 €	30,062 €	16,444 €	44,993 €	29,086 €	15,907 €	44,194 €	28,571 €	15,624 €	42,823 €	27,686 €	15,137 €
	Median	31,154 €	20,654 €	10,159 €	30,786 €	20,395 €	9,995 €	30,651 €	20,255 €	9,906 €	30,292 €	19,996 €	9,809 €
	SD	49,904 €	31,347 €	19,528 €	47,228 €	29,635 €	18,533 €	45,861 €	28,761 €	18,023 €	43,583 €	27,306 €	17,172 €
no dementia at beginning	**Women**												
	Mean	71,791 €	44,513 €	27,278 €	68,600 €	42,569 €	26,032 €	66,938 €	41,555 €	25,383 €	64,120 €	39,835 €	24,285 €
	Median	49,884 €	32,353 €	16,664 €	48,843 €	31,527 €	16,380 €	48,256 €	31,255 €	16,136 €	47,221 €	30,637 €	15,778 €
	SD	74,362 €	43,800 €	31,512 €	68,921 €	40,599 €	29,240 €	66,191 €	38,993 €	28,101 €	61,721 €	36,362 €	26,234 €
	Men												
	Mean	46,462 €	30,116 €	16,346 €	44,857 €	29,082 €	15,775 €	44,013 €	28,538 €	15,474 €	42,568 €	27,608 €	14,960 €
	Median	30,181 €	20,062 €	9,684 €	29,747 €	19,732 €	9,566 €	29,469 €	19,629 €	9,498 €	28,996 €	19,391 €	9,375 €
	SD	52,152 €	32,630 €	20,485 €	49,189 €	30,750 €	19,367 €	47,681 €	29,794 €	18,796 €	45,175 €	28,209 €	17,846 €
dementia at beginning	**Women**												
	Mean	83,494 €	49,766 €	33,729 €	80,201 €	47,837 €	32,364 €	78,470 €	46,824 €	31,647 €	75,512 €	45,090 €	30,423 €
	Median	58,064 €	36,338 €	20,938 €	56,979 €	35,605 €	20,521 €	56,326 €	35,250 €	20,302 €	55,251 €	34,614 €	19,866 €
	SD	83,475 €	47,742 €	36,557 €	77,908 €	44,553 €	34,157 €	75,079 €	42,931 €	32,937 €	70,392 €	40,244 €	30,916 €
	Men												
	Mean	51,293 €	32,816 €	18,477 €	49,793 €	31,849 €	17,944 €	48,996 €	31,335 €	17,660 €	47,615 €	30,446 €	17,169 €
	Median	36,859 €	23,738 €	12,384 €	36,288 €	23,465 €	12,195 €	36,074 €	23,259 €	12,108 €	35,563 €	22,952 €	11,924 €
	SD	48,990 €	31,132 €	19,012 €	46,582 €	29,549 €	18,149 €	45,334 €	28,729 €	17,701 €	43,229 €	27,346 €	16,943 €

Source: own calculations

Seit 2005 erschienene Beiträge

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No. 21 Oliver **Ehrentraut**/ Matthias **Heidler**
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Konjunktur und Generationenbilanz – eine Analyse anhand des HP-Filters

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Technischer Anhang zu „Konjunktur und Generationenbilanz – eine Analyse anhand des HP-Filters"

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ISSN 1862-913X