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The risk protection and redistribution effects of long-term care co-payments

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Abstract

Co-payments for long-term care (LTC) can impose a substantial financial burden on the elderly. How this burden is distributed across income groups depends on the design of the co-payment. We estimate the lifecycle dynamics of LTC using Dutch administrative data. These estimates are inputs in a stochastic lifecycle decision model. Using the model, we analyze the welfare effects of the Dutch income- and wealth-dependent co-payment system and compare it to alternative systems. We find that the Dutch co-payment system redistributes income to low-income groups, who use the most care over their life but contribute the least co-payments, from high-income groups, who pay the most. Moreover, the Dutch system protects the middle-income groups relatively well against financial risk: although alternative co-payment systems hardly affect these groups average payments, they induce welfare losses of 2% to 4% due to an increased risk of very high co-payments.

KEYWORDS

co-payments, lifecycle analysis, long-term care, semiparametric modeling

JEL CLASSIFICATION

C14, C61, D15, I13

1 | INTRODUCTION

Confronted with an aging population, policy makers around the world are seeking to provide adequate long-term care (LTC) for the elderly, while simultaneously keeping public finances sustainable (Colombo & Mercier, 2012). In designing LTC financing schemes they have to balance the need to control public LTC spending and reduce suboptimal use of care through out-of-pocket payments, and the need to protect the elderly from the substantial financial cost that can come with prolonged dependence on care. The need for financial protection is especially important for lower-income groups, as they not only have less means to self-insure but might also have a high risk of LTC use, due to poor health. To balance these needs, countries with a public LTC insurance system have generally introduced co-payments, based on a fixed percentage of total LTC costs, or means-testing, where individuals can only access public LTC after depleting their own financial means. However, these co-payment schemes can still expose low- and middle-income groups to considerable financial risk.

In this paper, we investigate how the design of the LTC co-payment system affects the financial burden across income and wealth groups. Although the impact of (a lack of) LTC insurance on consumption, savings, and welfare has been investigated before (e.g., Ameriks et al., 2020, 2011; De Nardi et al., 2016; Khwaja, 2010; Kopecky & Koreshkova, 2014; Peijnenburg et al., 2017), the impact of the design of the co-payment on the financial burden of different income groups has not. We focus on LTC co-payments in The Netherlands, which has one of the most-extensive social insurance systems for LTC in the world and where private LTC insurance is absent. Users of LTC pay a co-payment of which the annual maximum is based on a share of the users income and wealth. Compared to most means-based co-payment systems in other countries (see Colombo & Mercier, 2012 and Simmons et al., 2020, for an overview), the Dutch system enables very specific fine-tuning of the financial impact of co-payments across income and wealth groups. To assess the distributional impact of this scheme, we compare it to two more common alternatives: a flat-rate co-payment, independent of a users financial means, and a co-payment that depends on income but not on financial wealth.

We make two specific contributions. First, we take a lifecycle perspective. This is crucial in understanding the distribution of LTC costs across income groups, because these groups do not only differ on average care needs at any given age, but also in (healthy) life expectancy. For instance, a 70-year old with a low income is on average less healthy, and thus more likely to use LTC, than a 70-year old with a high income. At the same time, a 70-year old with a low income has a lower life expectancy and thus a smaller chance of needing LTC at very old age. The dynamics between income, health, and survival thus have to be modeled to fully assess income difference in care costs. As complete data on an individuals LTC costs over the whole lifecycle are not available, these lifecycle dynamics have to be modeled using (short) panel data combining different observations. To do so, we apply a novel, semiparametric estimation method developed by Wong et al. (2016) in the context of curative care.[1]

Second, we go beyond a descriptive analysis based on averages per income group and include the welfare effects of the financial risk that co-payments impose. The distribution of LTC use is very skewed; the probability that an individual needs nursing-home care over many consecutive years is small, but when an individual does need it, the costs can be very high. It is this small risk of very high costs that has the most important welfare impact, especially for

[1] See Hussem et al. (2016), for a descriptive analysis of lifetime LTC costs in The Netherlands using the same approach.

lower-income groups, but this impact cannot be assessed by only looking at the average co-payments across groups (see, for instance, McClellan & Skinner, 2006 on the value of public-health insurance). The fact that it is often difficult or impossible to buy (additional) LTC insurance on the private market makes assessing the welfare effects of incomplete insurance in the public system particularly relevant (Brown & Finkelstein, 2009).

To estimate the full welfare effects of different co-payment schemes, we develop a stochastic lifecycle decision model for singles at retirement age, using our empirical estimates on the dynamics in mortality and LTC use as inputs. This model determines optimal consumption and saving behaviors of the elderly for different levels of initial wealth and pensions at retirement, taking into account the distribution of LTC costs and mortality. We use this model to analyze changes in welfare across income groups when going from the current income- and wealth-dependent co-payment system to other, less fine-tuned systems.

We find that the Dutch income- and wealth-dependent co-payment system protects elderly with low and middle incomes relatively well against LTC costs. Despite the fact that the average lifetime use of LTC of the lowest income group is almost 30% higher than that of the highest income group, their average annual co-payments are considerably lower (600 vs. 1600 Euros per year). Compared to the current system, the introduction of a flat-rate co-payment system would lead to a considerable welfare loss (between 2% and 4%) for the low- and middle-income groups. This loss is largest for the elderly with a middle income: although their average co-payments would increase only slightly, they would be most severely affected by the loss in protection against the risk of very high costs.

This paper is organized as follows. In Section 2 we provide a short description of the Dutch LTC insurance system. In Section 3, we discuss the application of the nearest-neighbor algorithm on Dutch LTC data and describe the estimated lifecycle paths. In Section 4, we introduce a lifecycle model for consumption and saving of retirees in case of LTC co-payments. We also explain the numerical approach that allows us to use the estimated lifecycle paths in this model. In Section 5 we present our results, and in Section 6 we discuss the implications of our findings and the main limitations of our approach. Section 7 concludes.

2 | THE DUTCH LONG-TERM CARE SYSTEM

The Netherlands has one of the most extensive collective LTC arrangements in the world (Colombo & Mercier, 2012). In the period investigated (before 2015), social insurance, the Exceptional Medical Expenses Act (AWBZ), covered a broad range of professional home-care services (social support, personal care, and nursing) and institutional care (nursing homes and residential care).[2] Care was generally provided in-kind.[3] The income-dependent premium for the AWBZ was collected through income tax (including pension income) in the first and second income brackets.

[2] In 2015, the LTC system was reformed. Nursing-home care is still covered by a national social insurance (WLZ), but the provision of home care is now mainly the responsibility of municipalities.

[3] Individuals can also choose a personal care budget, which they can use to buy care themselves. This can also be used to pay informal care givers. We have no microdata on this type of care provision, but the use of these personal budgets was limited within elderly care (Sadiraj et al., 2011)

Given the extensive public arrangements for LTC, privately financed LTC services were as good as absent,[4] and there was no private insurance for LTC. Eligibility for LTC was determined by an independent assessment agency based on needs (see Bakx et al., 2020).

Users of LTC paid a co-payment. This basically functioned as a means-dependent deductible: users pay the full costs of LTC, up to an annual maximum amount. This amount depended on the financial means of the individual, and differed according to the type of care (home or institutional care) and living situation. We explain the details of the co-payment scheme in Section 4.3.

3 | LTC SPENDING OVER THE LIFECYCLE

3.1 | Source data

We use administrative data on LTC use for the period 2008 to 2013 from the Dutch Central Administrative Office (CAK). These include information on all publicly financed formal LTC use in The Netherlands. They contain information on the type of care (institutional care, nursing-home care, personal home care, and support) and the amount of care used (in days for institutional care, and in hours for home care). We derive costs of LTC from use in hours/days in the CAK database and the tariffs provided by the Dutch Health Authority (NZA) for extramural care and derived from the CAK and Dutch Health Care Institute (CVZ) annual reports for intramural care. We do not have information on use of privately financed LTC, which seems to be limited in The Netherlands (Van Ooijen et al., 2018) due to the extensive public system.

The LTC data are linked to other datasets using a unique personal identification number. The Dutch Municipal Register provides basic information on everyone within a municipality. From this register, we obtain date of death, age, sex, and marital status. We use data from the tax services to obtain gross income, net financial wealth, and net housing wealth.[5]

We select individuals alive up to January 1, 2013, who were 67 or older in 2013, and single over the full observation period. These restrictions were imposed to keep the lifecycle model tractable. We purge period effects from the data (see Appendix A.1, for the details).

3.2 | The nearest-neighbor algorithm

We use a semiparametric model, the nearest-neighbor resampling method, to estimate lifecycle paths of mortality, LTC use, income and wealth representative of the Dutch elderly. Although there are many specific implementations, the idea behind nearest-neighbor matching (NNM) is to match an observation from one group (for instance a treatment group) to the most similar observation from another group (a control group). NNM uses a distance metric to determine, based on the covariate values, which observation from the other group is the nearest. Some of the first implementations of NNM in a time series or panel context are by Farmer and Sidorowich (1987) and Hsieh (1991). We used the approach developed by Wong et al. (2016) who use this method to estimate lifecycle paths of curative care costs.

[4]Under some conditions, providers can provide publicly financed nursing-home care in a private residential setting. These kinds of arrangements have been increasing in recent years, but during our study period these did not play an important role.

[5]These microdata are accessible for statistical and scientific research under certain conditions. For more information see: microdata@cbs.nl.

The main advantages of our approach are its flexibility and the ability to use it on short periods of panel data. It enables the modeling of the complex dynamics in LTC cost, together with dynamics in income, wealth, and other relevant variables without having to impose many restrictions on the functional form. Most existing studies use parametric approaches, such as autoregressive models (De Nardi et al., 2010; French & Jones, 2004), Markov models (Ameriks et al., 2011; Jones et al., 2018) or duration models (Fuino & Wagner, 2020). These models require a variety of assumptions that cannot be justified on the basis of the data alone (Wong et al., 2016).[6] Also, when the time dynamics of multivariate outcomes have to be modeled simultaneously, as is the case when microsimulation models are used to assess the economic effects of population ageing (e.g., Boisclair et al., 2019; Goldman & Orszag, 2014), parametric models tend to become increasingly complex. In contrast, the application of our approach to modeling the lifecycle dynamics in different outcomes simultaneously is straightforward.[7]

The basic idea of the NNM algorithm is that we want to simulate N individual lifecycle realizations of LTC spending. Each simulated lifecycle will consist of an age series $Z_i^{A_i} = \{Z_{i,a=0}, Z_{i,a=1}, \ldots, Z_{i,a=A_i}\}$. $Z_{i,a}$ is a vector containing LTC spending and other variables of interest (e.g., income and wealth) of individual i at age a. $a = 0$ denotes the starting age and A_i is the age (index) of death. Our data are a relatively short panel containing observed values of the variables of interest $Y_{j,a,t}$ for individuals $j = 1, \ldots, J$ over time periods $t = 1, \ldots, T$.

The algorithm works as follows. Suppose we already have a simulated lifecycle path for an individual up to age A: $Z_i^A = \{Z_{i,0}, Z_{i,1}, \ldots, Z_{i,A}\}$. To extend this lifecycle path to age $A + 1$ we consider all individuals in our data who have age $A + 1$ in period T. We pick the individual whose life history over the last p age years $\{Y_{j,A-p+1,T-p}, \ldots, Y_{j,A,T-1}\}$ is most similar to $\{Z_{i,A-p+1}, \ldots, Z_{i,A}\}$. Note that, because we want to extend the lifecycle by one period, and the time length of the panel is T, we can use a maximum age lag p of $T - 1$ years. When we have picked an individual j, we use $Y_{j,A+1,T}$ as our simulated realization of Z_{A+1}^i. Then, to obtain a realization for age $A + 2$ we can repeat the procedure using all individuals in the data with age $A + 2$ at time T, matching on the life history over ages $A - p + 2$ to $A + p + 1$. This procedure is repeated until i is matched to an individual who dies in period T.

To initialize the algorithm, we use all individuals with age $a = 0$ at time T. For these individuals we have data on Y over $T - 1$ ages before the starting age $a = 0$. We include the information on the last $p - 1$ ages in the simulated lifecycle path, so we start with $Z_j^0 = \{Z_{-p+1}^i, Z_0^i\}$.

To match a simulated lifecycle path to an observation from the data we use k-nearest neighbor matching. We measure the distance between two p-long blocks $\mathbf{z}$ and $\mathbf{y}$ using a distance measure $d(\mathbf{z}, \mathbf{y})$. We use the Mahalanobis measure, which takes into account the correlation between the components of y and differences in scale. One neighbor is randomly drawn out of the k-nearest neighbors.

We start at the age of 68. The data are stratified by sex, age, and home-ownership, and matched on income, net financial wealth (bank accounts, bonds, and stocks), housing wealth (net value), and LTC expenditures. We simulate 10,000 paths each for women and men.

[6]A recent study by Hurd et al. (2017), for out-of-pocket LTC spending in the United States shows the relevance of a flexible model. They compared their semiparametric method, based on matching, to a more standard parametric Markov model. They found that their approach better fits the data and that the risk (the chances of extreme use or costs) as estimated by their model is substantially greater than the risk as estimated by the parametric model. This, of course, does not imply that a non- or semi-parametric method will always outperform *any* parametric method. Instead, our point is that a model like ours can be applied successfully in many settings because of its flexibility, whereas the performance of a particular parametric approach will often depend strongly on the degree to which the assumptions can be justified based on the specific data characteristics.

[7]This property of our method can also be of practical relevance to analyze joint insurance products, such as life-care annuities (Brown & Warshawsky, 2013). See Hussem et al. (2016) for a first step in that direction.

To choose the number of neighbors k and the number of lags p used in the algorithm, we perform an assessment study (described in Appendix B) where we compare the model fit across different parameter settings (similar to Wong et al., 2016). For a group of individuals with gender g and age a in 2009, we simulate the next 4 years of the life cycles (2010, ..., 2013). We can then compare how well the simulated data match the actual data over these 4 years. We conclude that the setting with 10 neighbors ($k = 10$) and 1 lag for both the categorical and continuous variables ($p = 1$) performs the best across the range of different ages and outcome variables.

3.3 | Estimation results

3.3.1 | The lifetime distribution of LTC costs

Table 1 shows statistics of the estimated lifetime LTC costs. On average, a 70-year-old single person uses almost 31,000 Euros of home care and 45,000 Euros of nursing-home care over the rest of his or her life. The costs are distributed very unevenly: 19% of the elderly do not use any home care, while 5% use more than 138,000 Euros of home care. Almost half of the elderly (48%) do not use any nursing-home care, while the top 5% use 254,000 Euros or more of

TABLE 1 Descriptive statistics for lifetime LTC costs at age 70, for the whole population and by pension wealth group 1 (lowest wealth) to 5 (highest)

					Percentiles (conditional on use)			
Group		**Mean**	***SD***	**% no use**	**p25**	**p50**	**p75**	**p95**
All	Home care	30,828	54,443	19	725	8336	36,487	137,710
	Nursing home	44,773	96,847	48	0	520	34,564	253,662
	Total	75,601	115,108	13	2815	24,197	100,691	320,102
1	Home care	41,666	68,518	19	631	11,914	52,097	184,312
	Nursing home	53,470	107,055	45	0	1647	50,741	282,133
	Total	95,136	131,260	13	3667	39,399	134,608	378,229
2	Home care	36,128	62,571	20	609	9409	45,665	156,545
	Nursing home	50,329	106,662	48	0	904	40,772	276,758
	Total	86,457	127,007	14	3065	31,038	118,524	350,258
3	Home care	28,151	48,228	19	772	7924	34,437	125,686
	Nursing home	47,533	101,113	47	0	994	38,608	261,889
	Total	75,685	115,777	13	3017	23,133	97,968	321,145
4	Home care	22,966	40,352	19	723	6678	26,458	104,716
	Nursing home	35,685	81,948	51	0	0	22,370	216,135
	Total	58,651	94,347	14	2170	16,609	74,110	258,735
5	Home care	24,422	43,268	18	929	7845	28,541	108,673
	Nursing home	35,972	81,358	51	0	0	25,914	216,918
	Total	60,394	95,849	13	2587	18,909	76,217	263,390

Note: Pension wealth groups are quintiles of total lifetime wealth (initial wealth and present value of pension income), see Section 3.3.2. All amounts are discounted using a discount factor of 1.5% (see Table 3).

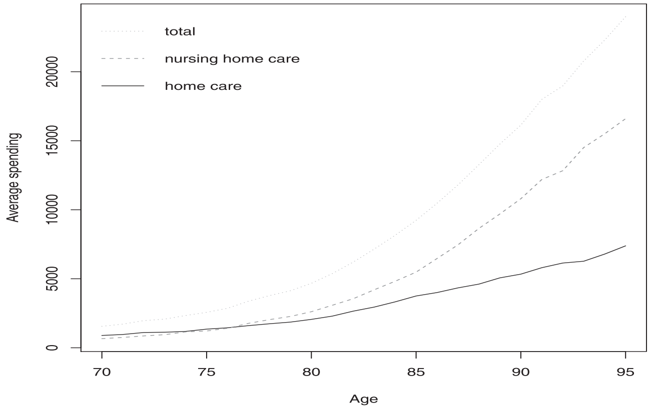

FIGURE 1 Average costs by age

nursing-home care. Thirteen percent of the elderly use neither home care nor nursing-home care, while the 5% of the elderly that use the most LTC overall, have total LTC costs of 320,000 Euros or higher.

Figure 1 shows the average spending by age. Until the age of 80, this amount is limited to 2500 Euros annually for both home and nursing-home care. For home care, the average costs rise gradually to 5000 Euros at the age of 95. The increase for nursing-home care is much steeper, and average cost go up to about 17,000 Euros at the highest ages.

3.3.2 | Distribution of LTC use across pension wealth groups

Our estimates contain income and financial wealth trajectories for each lifecycle path. To simplify both the analysis and the interpretation, we group all lifecycle paths in financial wealth deciles and income quintiles. We assign a fixed income stream (y) to each individual lifecycle path, equal to average net income[8] at age 70 within his income group, and initial financial wealth at age 70, equal to average financial wealth at 70 within his wealth group. This means every lifecycle path has initial financial wealth equal to 1 of 10 wealth amounts at age 70 and an income at every age equal to one of the five income levels defined.

In our presentation of the results, we focus on the distribution of LTC costs across pension wealth groups. Pension wealth is the total lifetime wealth an older person has at his disposal, so both his financial wealth and his fixed pension income. We define pension wealth as the sum of the expected[9] present value of the net income stream over the rest of life and initial financial wealth at age 70. We group individuals in five pension wealth quintiles and show average results for each group. In Appendix E, we also show results for specific combinations of fixed pension income and initial financial wealth.

The top part of Figure 2 shows lifetime income and initial financial wealth across pension-wealth quintiles. The figure shows that higher pension wealth quintiles have, naturally, both

[8]We transform the gross income in our data into net income using the average tax burden by income bracket for older single households in 2013. These are taken from the tax model used by CPB, see Koot et al. (2016).

[9]The expectations are equal to the average per income and gender group.

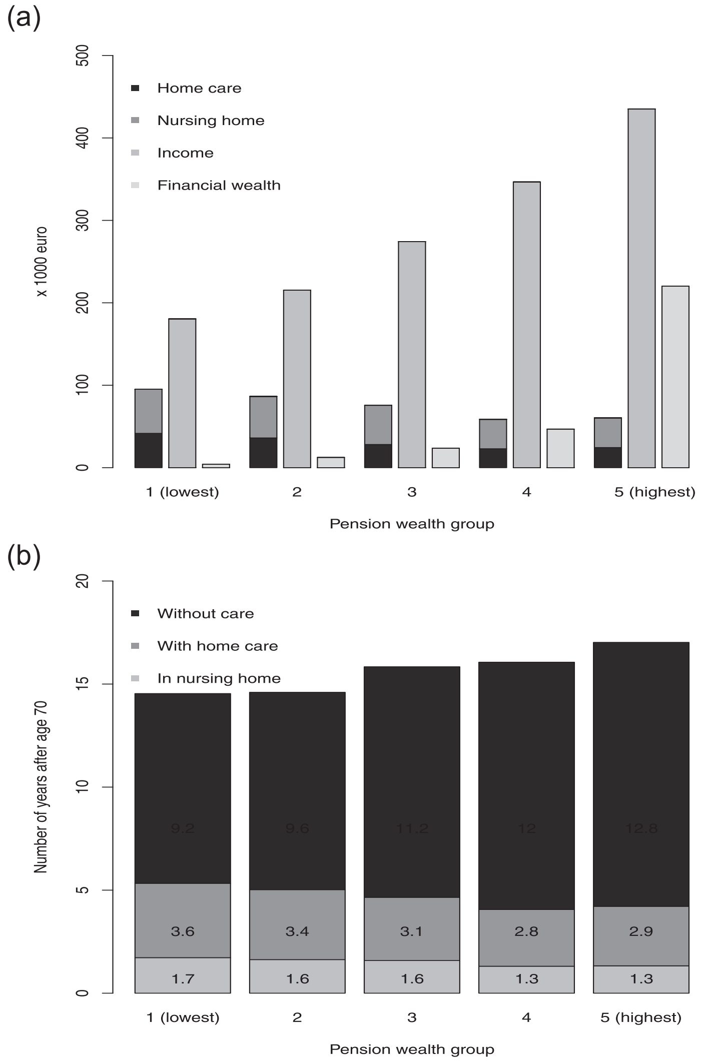

FIGURE 2 Descriptive statistics for each pension wealth group, at age 70. (a) Expected LTC costs, expected lifetime income, initial financial wealth; (b) expected lifeyears (with LTC use). Pension wealth groups are quintiles of total lifetime wealth (initial wealth and present value of pension income), see Section 3.3.2. All amounts are discounted using a discount factor of 1.5% (see Table 3). LTC, long-term care

more remaining lifetime income and higher initial financial wealth at the age of 70. For most elderly, financial wealth at age 70 is quite low.[10]

The bottom part of Figure 2 shows the life expectancy, and expected number of years with use of home care and nursing-home care, for each pension wealth group. Despite a lower life expectancy, the elderly with the least financial means spend more life years, on average, in need of home care and nursing-home care. This also results in the highest expected LTC costs for these groups. Although our data does not provide direct insight into why individuals with

[10] One reason for this is that we only look at singles. Elderly couples tend to have more wealth than singles. See Hussem et al. (2017) and statline.cbs.nl

limited financial means uses more LTC than individuals with high financial means, an important explanation seems to be differences in health: lower incomes, on average, spent considerably more years of their life with disabilities than high incomes.[11] Additionally, *conditional on health* individuals with low incomes seem to use more formal care than individuals with high incomes (Tenand et al., 2020). High-income individuals seem to be better able to adapt their living situation to their disabilities without using formal LTC, for instance because they live in more accessible houses (Diepstraten et al., 2020).

The statistics of the estimated lifetime LTC costs across total wealth groups are also shown in Table 1. TThe total LTC costs for the quintile with the lowest total wealth are 95,136 Euros on average. For the highest quintile, this is 60,394 Euros. Groups with low financial wealth do not have a higher probability of using any LTC. The difference in costs is thus driven by the intensity of use:[12] within the lowest wealth quintile, the 5% users with the highest cost spend 378,229 Euros of LTC or more. For the highest-wealth quintile, this is 263,390 Euros or more.

4 | A MODEL OF LIFECYCLE CONSUMPTION AFTER RETIREMENT

4.1 | The model

We implement a standard lifecycle model with forward-looking individuals to model consumption and saving behavior under uncertainty about mortality and LTC costs. Consumption and saving behavior, conditional on initial financial wealth, are endogenous. LTC costs and mortality, based on the estimated lifecycle paths, are exogenous. The estimated lifecycle paths provide a semiparametric distribution function of LTC costs and mortality: all paths for individuals with the same initial characteristics at 70 are random draws from the same stochastic process. This means that we can use a simulation-based technique to calculate the expected values that individuals need to maximize their expected lifetime utility. We explain this technique more in Section 4.2. First, we discuss the setup of the lifecycle model.

4.1.1 | The baseline model

We model consumption and savings decisions of individuals after retirement. An individual starts at the pension age, $a = 0$, with initial wealth W_0. He receives an annual fixed pension income y.[13] He uses his annual income and initial wealth to finance consumption over a finite number of time periods $a \in 0, 1, ..., A^*$. At each age a an individual does not know his age of death A_i (with $A_i \leq A^*$) and his LTC co-payments at higher ages, but he does know the full

[11] See the data on healthy life expectancies (2014–2017) available at statline.cbs.nl. At age 65, the expected number of life years with disability is 10.9 years for women in the lowest income quintile and 6.5 years for women in the highest quintile. For trends in quality-adjusted life years across education groups that show a similar pattern, see Gheorghe et al. (2016).

[12] Differences on average discounted costs across income groups are also partly explained by differences in timing. High total wealth groups live longer, and thus, on average, use LTC at higher ages than low groups. Differences in timing explain about 10% of the total difference in discounted costs: using a discount rate of 1.5%, the lowest wealth group has average costs that are 40% higher than for the highest wealth group, without discounting this is 37%.

[13] We do not endogenize the annuitization decision, but take the amount of initial wealth that is annuitized as given, which is in accordance with the current Dutch pension system. (see Section 4.3). However, the model can easily be extended to include endogenous annuitziation of initial wealth, see Peijnenburg et al. (2017).

probability distribution of these things based on the realizations of the state variables Z_i^a (including LTC payments) up to age a. An individual derives utility from annual consumption ($u(c_a)$), which might depend on health, and from leaving a bequest at the age of death ($b(w_{A_i})$). The individual wants to maximize his expected utility over his remaining lifetime. With a time-separable utility function, the value function that the individual needs to maximize at each age a is:

$$\mathrm{E}(V_a) = u(c_a) + \mathrm{E}\left[\sum_{j=a+1}^{A}\left(\left(\beta^j\left(\prod_{s=a}^{j-1}p_s\right)(u(c_j)p_j + b(w_j)(1-p_j))\right)\middle|\ Z_i^a\right)\right], \tag{1}$$

with p_s the probability of surviving period s, and β the discount factor.

In each age-period, the individual has to choose the amount of his wealth W_a and income y he wants to consume now (c_a), and the amount he wants to save for later. The individual is also faced with co-payments for LTC costs h_a. He faces the following annual budget constraint:

$$c_a + h_a + (1+r)^{-1}W_{a+1} = W_a + y. \tag{2}$$

Wealth grows with the risk-free interest rate r. The timing is such that an individual first receives his income y, then h_a has to be paid, and then he decides how much of his remaining resources he consumes now (c_a) and how much he saves for the next period ($(1+r)^{-1}W_{a+1}$). We treat the level of co-payments, h_a, as given: the individual does not weight utility gained from LTC use against utility from c_a, but instead h_a is an exogenous shock.

The utility from consumption is defined as a standard CRRA function:

$$u(c_a) = \frac{c_a^{1-\gamma}}{1-\gamma}. \tag{3}$$

In our baseline model, $u(c_a)$ does not depend on health. In a number of sensitivity analyses we let $u(c_a)$ depend on health (see below).

We also include a bequest motive. Individuals derive utility from the wealth w_a they leave when they die at age a. A bequest motive tends to decrease the welfare costs of co-payments, as it reduces the opportunity cost of precautionary saving (Lockwood, 2018). Even at very old ages, individuals have to hold on to part of their lifetime wealth, because they always face the risk of having to pay substantial amounts of out-of-pocket costs for LTC. This means that many individuals, for whom the potential risk of LTC costs never materializes, die with a substantial amount of wealth left. When individuals have a bequest motive, the wealth left behind is still of value, in the sense that it adds to lifetime utility.

Following Kopczuk and Lupton (2007) we use a linear specification for the bequest motive:

$$b(w_{A_i}) = \theta w_{A_i}. \tag{4}$$

This specification gives an intuitive notion of bequests as a luxury good: as wealth increases, the marginal utility from bequests increases relative to the marginal utility of consumption. At the same time, less-wealthy individuals also derive (some) utility from leaving wealth at the moment of premature death.

We impose a consumption floor, so that annual consumption cannot drop below 10,000 Euros.

4.1.2 | Co-payments

The level of the LTC co-payment depends on the amount of LTC an individual needs and on the co-payment rules. We use a general co-payment rule that simulates the Dutch system, where co-payments depend on income and wealth, but also other systems, such as a flat-rate co-payment independent of spending power. Let H_a be the total costs of LTC an individual uses at age a. This total level of LTC use is exogenous. We use the following general co-payment rule:

$$h_a = \min\left[\tau H_a, \nu_y \min\left(y + \frac{\nu_w}{\nu_y} W_a - \delta, 0\right), \mu\right]. \tag{5}$$

The government sets the parameters τ, ν_y, ν_w, δ, and μ. The parameter τ determines what share of total health care spending has to be paid by the individual. The parameters ν_y and ν_w are the maximum shares of income and wealth that have to be spent on co-payments. The parameter δ is a fixed amount of income exempted from the co-payments. The government can also set an overall maximum μ on annual co-payments on top of the income- and wealth-dependent maximum.

The way the government sets the co-payment rules affects the optimization problem of the individuals. When $\nu_w > 0$, co-payments are no longer fully exogenous since they depend on the annual savings chosen by the individual.

4.1.3 | Health state-dependent utility of consumption

The utility an individual derives from nonhealth care consumption could depend on his health status (disability). Finkelstein et al. (2013) find that an increase in the number of chronic diseases has a significant negative impact in the marginal utility of consumption. A priori, however, the effect of poor health could go both ways: individuals might derive less utility from things like eating out or recreation, but at the same time demand for things like domestic help, wheelchairs, and stairlifts might increase (Meyer & Mok, 2009). Indeed, as pointed out by Peijnenburg et al. (2017), there is no consensus in the empirical literature on the size and even the sign of the effect.

As we do not observe health directly, we use the fact that someone uses nursing-home care as a proxy. We only consider the use of nursing-home care as an indicator of severe disability and not the use of home care. A negative effect on the marginal utility of consumption is more likely for nursing-home care users, as this type of care is relatively comprehensive and encompasses most additional consumption needs related to disability (housing and cleaning).

To include state-dependent utility, we use the following commonly used adaptation of the utility function in Equation (3) (De Nardi et al., 2010; Palumbo, 1999; Peijnenburg et al., 2017):

$$u(c_a) = (1 - \kappa\Delta_a)\frac{(c_a + \xi\Delta_a)^{1-\gamma}}{1-\gamma}. \tag{6}$$

The variable Δ_a is a dummy indicator for poor health, which we define as an individual having any nursing home care at age a. The parameter κ determines the relative change in the marginal utility of consumption in poor health ($\Delta_a = 1$) compared to good health ($\Delta_a = 0$). When $\kappa < 0$, marginal utility is lower in poor health. When $\kappa = 0$, marginal utility is equal in both health states. The parameter ξ determines the curvature of the utility function in poor health. At the same time, ξ can be given a practical interpretation in the Dutch context. Nursing homes also cover part of the basic costs of living of their inhabitants (e.g., meals). The parameter can thus be used to model the level of these costs.

4.1.4 | Outcome

To assess the welfare of the pension wealth groups across co-payment variants, we use the certainty equivalent consumption (CEC) at age 70 ($a = 0$). The CEC is the *certain* annual consumption level that gives the same expected lifetime utility as the *uncertain* actual consumption (that depends on realized longevity and dependency). The CEC is calculated as follows:

$$CEC_i = u^{-1}\left(\mathrm{E}\left(\left[\frac{V_0}{1+\sum_{j=1}^{A}\left(\beta^j\prod_{s=a}^{j-1}p_s\right)}\middle| Z_i^0\right]\right)\right) \tag{7}$$

More specifically, we will calculate the averages of this measure $CEC_{g,v}$ for each pension wealth quintile $g = 1, \ldots, 5$ across policy variants v.

To compare the welfare effects of the different co-payment systems, we show the change in CEC when going from the current system ($v = 1$) to one of the two alternatives ($v = 2, 3$) for each group: $CEC_{g,v} - CEC_{g,1}$. We can decompose the change in CEC into two elements:

$$CEC_{g,v} - CEC_{g,1} = \underbrace{\hat{h}_{g,1} - \hat{h}_{g,v}}_{\text{Change in average payment}} + \underbrace{(CEC_{g,v} - CEC_{g,1}) - (\hat{h}_{g,1} - \hat{h}_{g,v})}_{\text{Change in risk premium}}. \tag{8}$$

The first element in this equation measures the change in the *average* annual co-payment[14] a member of group g can expect when the current system is replaced by variant v. This is the "pure" distribution effect, reflecting the extent to which a variant shifts average payments from one group to another. The second element measures the rest of the welfare effect due to changes in risk and a different allocation of lifetime resources. We call this element the "risk premium" as it is equal to the maximum additional annual amount, on top of the average payment, an individual would be willing to pay to stay in the current system instead of going to alternative v.

We show the impact of the alternative co-payment systems by plotting the change in welfare, and its decomposition in the two elements, as a percentage of current welfare:

$$\frac{CEC_{g,v} - CEC_{g,1}}{CEC_{g,1}} = \frac{\hat{h}_{g,1} - \hat{h}_{g,v}}{CEC_{g,1}} + \frac{(CEC_{g,v} - CEC_{g,1}) - (\hat{h}_{g,1} - \hat{h}_{g,v})}{CEC_{g,1}}. \tag{9}$$

4.2 | Numerical approach

The individual's maximization problem can be solved using dynamic programming. The lifecycle optimization problem is divided into smaller yearly optimization problems. The algorithm starts at the highest possible age-period A^*, and is then solved backwards recursively. We solve

[14] $\hat{h}_i = \mathrm{E}\left[\frac{h_0 + \sum_{j=1}^{A}\left(\beta^j\prod_{s=a}^{j-1}p_s h_j\right)}{1+\sum_{j=1}^{A}\left(\beta^j\prod_{s=a}^{j-1}p_s\right)}\middle| Z_i^0\right].$

this problem using the approach developed by Koijen et al. (2010), that has been applied to LTC financing in the United States by Peijnenburg et al. (2017). The approach combines the method of endogenous gridpoints (Carroll, 2006) with a simulation based approximation of the expected values (Brandt et al., 2005). The approach is well suited to use in combination with the semiparametric estimation of the lifecycle paths. Most approaches approximate the stochastic processes (mortality, LTC costs) by a limited number of discrete states. However, the method of Koijen et al. (2010) allows us to directly use the lifecycle paths as inputs. Appendix C provides a detailed overview of the numerical procedure.

4.3 | Implementation

We use the lifecycle paths and the lifecycle model to assess the average payments and the welfare effects of the Dutch income- and wealth-dependent co-payment system across income and wealth groups. To do so, we compare the current system to two alternatives.

4.3.1 | Policy variants

In the Dutch system, users of LTC pay a co-payment that depends on income and wealth. This basically works as an annual deductible: each year, users of care pay all costs out-of-pocket until they reach a maximum amount which depends on the users income and wealth. We emulate the Dutch co-payment scheme in 2013 using the formula in Equation (5). In this scheme, 75% of income and 11% of financial wealth is included in the maximum co-payment for nursing home care and 15% of income and 2% of financial wealth for home care. Housing wealth is not taken into account. In addition, the first 4500 Euros of income for nursing-home care and 16,600 Euros for home care are exempted. An overall maximum annual co-payment of 27,000 Euros applies, regardless of income and wealth.[15]

Figure 3 shows the annual co-payment for nursing-home care at different levels of use across individuals with different income and wealth. At low levels of use, all individuals pay the same co-payment. However, individuals with low income and wealth reach their maximum annual co-payment at much lower levels of use than an individual with a high income and wealth: for an individual with an income of 16,000 Euros and no financial wealth, the maximum co-payment is 7875 Euros (Figure 3a). For an individual with an income of 33,000 Euros and 106,000 Euros of wealth, the maximum co-payment is equal to the overall maximum of 27,000 Euros (Figure 3d).

To assess how the Dutch system affects costs and risk across groups, we introduce two alternative co-payment schemes for the counterfactual analysis. To make a fair comparison, we set the parameters of these alternatives in such a way that they raise an equal amount of aggregated revenues as the current system. The first alternative is an income-dependent

[15]In practice, the calculation of the co-payments is more complex than in our stylized model. First, in case of nursing home care, a "low" co-payment applies over the first half year of LTC use, which is more or less 12.5% of gross income. Second, users of nursing home care pay a 100% of income over the first few thousand Euros above the deductible. To keep the modeling exercises and the distributional effects it generates easily interpretable we have not included these two details. Their inclusion leads to very similar results (see Wouterse et al., 2020). Third, the way wealth is treated in the home care co-payment is different from the nursing home co-payment. In the case of home care, 12% of wealth is added to the income definition, and 15% of this is the co-payment (thus we set $\nu_w = 0.15 \times 0.12 = 0.02$). In case of nursing home care, 4% of wealth is included in the income definition and 8% is added to the co-payment directly (thus we set $\nu_w = 0.75 \times 0.04 + 0.08 = 0.11$).

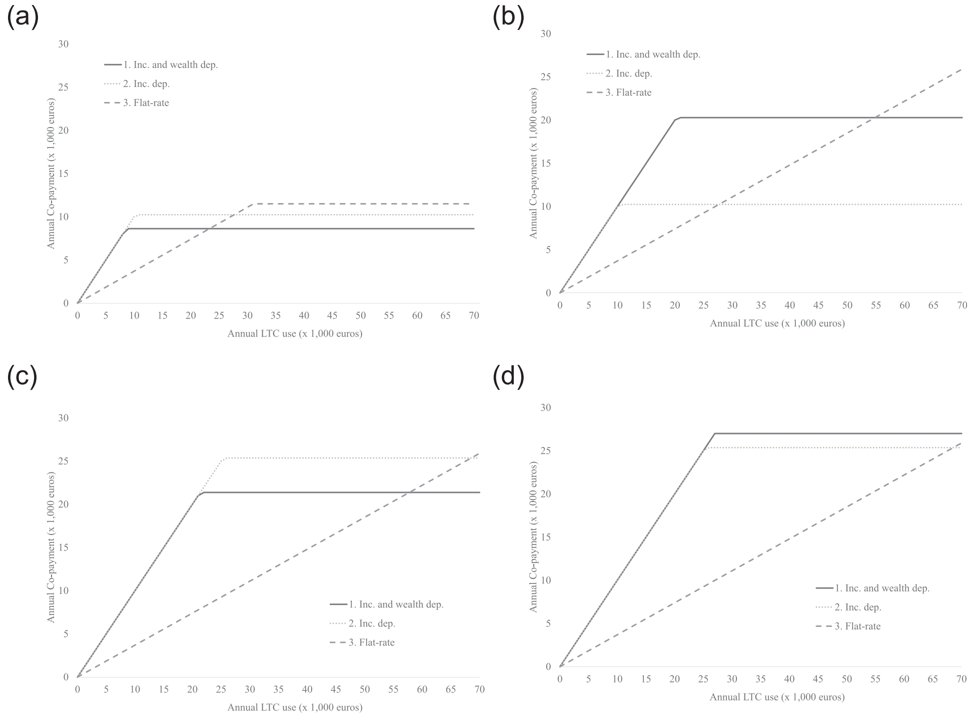

FIGURE 3 The design of the current co-payment scheme and the two alternatives. The relationship between total annual LTC costs and annual co-payments for individuals with different levels of income and wealth. (a) Low income (16,000) and no wealth (0); (b) low income (16,000) and high wealth (106,000); (c) high income (33,000) and no wealth (0); (d) high income (33,000) and high wealth (106,000). LTC, long-term care

co-payment: maximum co-payments are a share ν_y of income, but do not depend on an individual's wealth. We leave the other elements of the current system (the income exemptions and the overall maximum co-payment of 27,000 Euros) intact. As the total revenues of the system are set to be the same, ν_y is higher than in the current system. This variant resembles the co-payment scheme in place before 2013. During the 2017 Dutch election campaign, some Dutch political parties proposed to return to a co-payment system only depending on income (CPB Netherlands Bureau for Economic Policy Analysis, 2017).

Figure 3 shows the impact of this alternative scheme on the co-payment across individuals with different income and wealth. Individuals with a low pension income and a lot of financial wealth (Figure 3b) benefit the most, while individuals with a high pension income and little financial wealth are confronted with the highest increases in the maximum co-payment (Figure 3c). Individuals with high incomes and high wealth are less or not affected by the change in co-payment regime: their income is so high that they (almost) reach the overall maximum of 27,000 Euros in both regimes (Figure 3d).

The second alternative is a flat-rate co-payment: co-payments are a fixed percentage τ of an individual's annual LTC costs, independent of income and wealth. Again, the other parts of the system are left intact. Figure 3 also shows the effects of this system. The flat-rate is less than one, which means that at low amounts of LTC use, co-payments are lower than in the current system. As the annual co-payments are no longer capped at an income- and wealth-dependent maximum, at high amounts of LTC use co-payments will be higher for most individuals.

As shown in the figure, the flat-rate will increase co-payments the most for LTC users who use a lot of care in 1 year and have moderate financial means (the right-hand sides of Figures 3a–c).[16] Individuals with very high financial means benefit the most: even at high levels of use, the flat-rate co-payment does not exceed the maximum co-payment payable under the current regime (Figure 3d).

The policy parameters for the current system and the two alternatives are shown in Table 2.[17] In the two alternative systems, we retain the current maximum co-payment level of 27,000 Euros. In all cases, co-payments do no exceed the actual LTC costs. The consumption floor, set at 10,000 Euros, also restricts the annual co-payments.[18]

4.3.2 | Other parameters

The other parameters are set in line with the literature. See Table 3. In the main specification we include a bequest motive by setting $\theta^{-1/\gamma} = 50,000$. This is in line with the range of values estimated by Kopczuk and Lupton (2007), and means that above 50,000 Euros the marginal utility of leaving a bequest is higher than the annual marginal utility of consumption. We set the risk aversion parameter γ to 3. In the main specification, the utility from consumption does not depend on health.

We perform six sensitivity analyses. In the first, we do not include a bequest motive. In the second, we set $\theta^{-1/\gamma} = 40,000$, which means that the bequest motive becomes more important. In the third and fourth, we set a higher ($\gamma = 5$), respectively lower ($\gamma = 2$) risk aversion. In the fifth, we introduce health state-dependent utility of consumption. We set $\kappa = 0.2$ which means that the marginal utility of consumption is 20% lower for individuals living in a nursing home than for others. De Nardi et al. (2010) chose a similar value for κ and it seems to be at the more extreme side of the range of values found by Finkelstein et al. (2013). In the last analysis, we set $\xi = 5000$. This means that the utility of consumption for nursing home users shifts to the right by 5000 Euros.[19]

4.4 | Match between the lifecycle wealth data and the model

As we are interested in the effects of LTC co-payments across different wealth groups, the ability of the lifecycle model to match the distribution of wealth in the actual population is of particular interest. The semiparametric method we use to estimate the source data for the model has an additional advantage here. We have included financial wealth as one of the matching variables in the nearest-neighbor algorithm. This means that we can directly compare the distribution of wealth generated by the lifecycle model to the wealth data in our lifecycle paths.

[16] As we discuss more extensively further on, the middle income groups lose the most. The first 4500 Euros of income are exempted from the co-payment. As individuals with a low income have relatively little income above this threshold, this means that even in case of the flat-rate their co-payment is effectively capped at a relatively low level (see Figures 3a). Individuals with moderate incomes do not benefit from this implicit protection.

[17] For home care, co-payments are not based on costs (tariffs) but on a (lower) fixed hourly amount. We only observe total annual costs in the lifecycle data. Therefore, we set the share of costs paid by the user (τ) to 26% for the current system and the income-dependent co-payment variant. This 26% is the fixed hourly amount divided by the average hourly tariff.

[18] The consumption floor serves to prevent an individual's utility from dropping below a certain level, which is necessary for computational reasons but also seems reasonable from a practical standpoint. An alternative approach is to not include a consumption floor (the deductible for nursing homes of 4500 Euros that basically functions as the consumption floor) but shift the utility function for individuals living in a nursing home, motivated by the fact that the nursing home takes over some of the costs of living. We use this approach as a sensitivity analysis.

[19] In this case, we lower the consumption floor to the level of the deductible for nursing-home care.

TABLE 2 Policy parameters in each variant, for the main specification

Variant		τ	ν_y	ν_w	δ	μ
1 Inc and wealth dep.	Nursing home	1	0.75	0.11	4,500	27,000
1 Inc and wealth dep.	Home care	0.26	0.15	0.02	16,500	27,000
2 Inc dep.	Nursing home	1	0.89	0	4,500	27,000
2 Inc dep.	Home care	0.26	0.18	0	16,500	27,000
3 Flat-rate	Nursing home	0.37	0	0	4,500	27,000
3 Flat-rate	Home care	0.17	0	0	16,500	27,000

Note: The co-payment rule (Equation 5) is: $h_a = \min[\tau H_a, \nu_y \min\left(y + \frac{\nu_w}{\nu_y} W_a - \delta, 0\right), \mu]$.

In Figure 4 we show the cumulative distribution of financial wealth, in the lifecycle data and as generated by the model in the main specification, across all ages. Each age for each individual (if alive) is one observation here, so we basically treat our lifecycle data as one cross-section. The lifecycle model seems to fit this overall distribution of wealth in the data quite well. The model slightly undersamples low levels of wealth (up to 60,000 Euros) and slightly oversamples observations in the range between 100,000 and 150,000 Euros. In Appendix D we assess how well the lifecycle model matches the age profiles of wealth for individuals with specific combinations of initial financial wealth and income. The model seems to match the lifecycle profiles of wealth well for most of these groups. However, it somewhat underestimates financial wealth at high ages for low-income groups.

5 | RESULTS

5.1 | Results for the main specification

Table 4 shows the certainty equivalent consumption (*CEC*) in the current co-payment system. It also shows on the things on which lifetime wealth is spent: average annual consumption, LTC payments, and annualized bequests (the amount of lifetime wealth at death). The results

TABLE 3 Values of parameters in different specifications

	r	β	γ	$\theta^{-1/\gamma}$	ξ	κ
Main specification	1.015	0.985	3	50,000	0	0
No bequests	1.015	0.985	3	–	0	0
Lower bequest level	1.015	0.985	3	40,000	0	0
Higher risk aversion	1.015	0.985	5	50,000	0	0
Lower risk aversion	1.015	0.985	2	50,000	0	0
State dep. utility	1.015	0.985	3	50,000	0	−0.2
Lower costs in a nursing home	1.015	0.985	3	50,000	5000	0

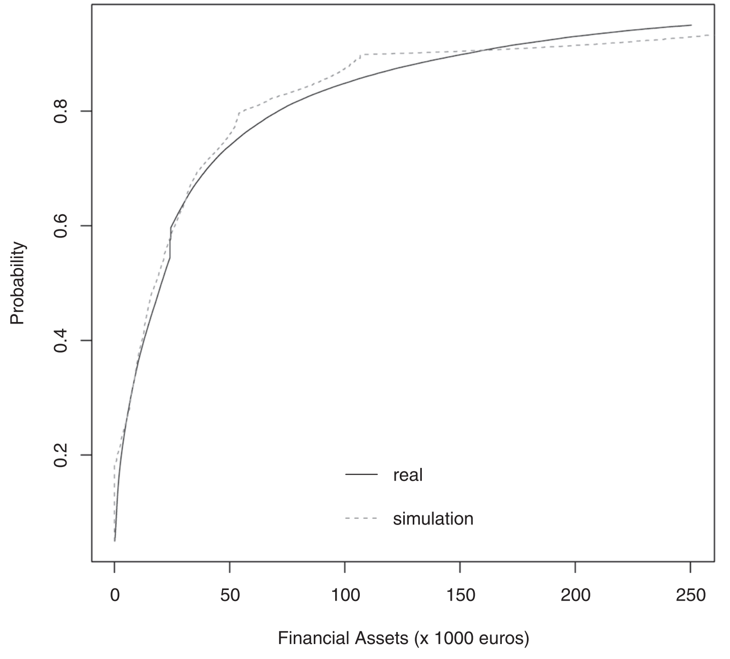

FIGURE 4 Cumulative distribution of financial wealth: lifecycle paths (reall) versus model (simulation)

TABLE 4 Certainty equivalent and average annual consumption, annual LTC payments and annualized bequests by pension wealth group (1–5)

	1	2	3	4	5
1 Inc and wealth dep., in levels					
CEC	13,369	15,553	18,693	24,258	40,164
Consumption	13,650	16,070	19,446	25,095	37,482
LTC	617	1002	1206	1278	1626
Bequest	25	206	690	1451	5387
2 Inc dep., change compared to 1					
CEC	−49	−218	−326	−362	77
Consumption	−52	−249	−428	−483	−213
LTC	27	68	48	0	−150
Bequest	12	215	417	494	364
3 Flat-rate, change compared to 1					
CEC	−313	−574	−802	−420	156
Consumption	−252	−600	−914	−575	−495
LTC	222	229	138	−98	−445
Bequest	10	374	697	519	754

Note: In the current system (1) and the two alternatives. Pension wealth groups (1 is lowest and 5 is highest) are quintiles of total lifetime wealth (initial wealth and present value of pension income), see Section 3.3.2.

are shown for each pension wealth group (see Section 3.3.2). There are considerable differences in *CEC* across pension wealth groups. The group with the lowest financial means has a *CEC* of 13,369 Euros, while the highest has 40,164 Euros. LTC payments also vary considerably across pension wealth groups. The current co-payment system leads to a significant redistribution of income from high to low groups: although the highest pension wealth group uses 37% less LTC than the lowest (see Table 1), its average payments are 2.6 times as high (1626 Euros vs. 617).

To assess the effect of the current co-payment system on the *CEC* across pension wealth groups, we compare it to the two alternatives: a co-payment based solely on income, and a flat-rate co-payment independent of financial means. Table 4 shows how going from the current system ($\nu = 1$) to one of the two alternatives ($\nu = 2, 3$) affects the *CEC* of each group g: $(CEC_{g,\nu} - CEC_{g,1})$. In Figure 5, this change is expressed as a percentage of current welfare, and

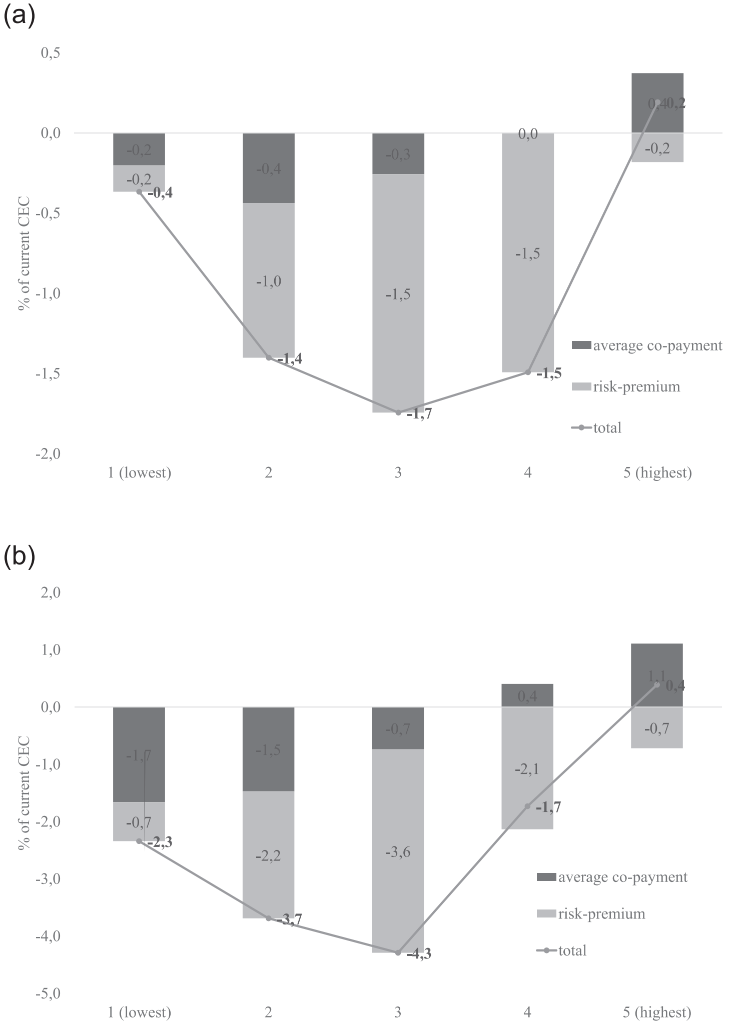

FIGURE 5 The change in total welfare (average co-payment + risk premium), from going from the current co-payment system to one of the alternatives for each pension wealth group (a) Income-dependent co-payment; (b) flat-rate co-payment. Pension wealth groups are quintiles of total lifetime wealth (initial wealth and present value of pension income), see Section 3.3.2. The change in welfare in going from the current system ($\nu = 1$) to alternative system ν, see Equation (9)

TABLE 5 Distribution of lifetime co-payments, by pension wealth group (1, 3, and 5)

Group	Variant	p25	p50	p75	p95
1	1 Inc and wealth dep.	872	4474	11,071	28,586
	2 Inc dep.	887	4774	11,691	29,751
	3 Flat-rate	730	6289	16,559	37,056
3	1 Inc and wealth dep.	915	7386	23,299	66,574
	2 Inc dep.	915	7237	23,596	70,578
	3 Flat-rate	558	4977	25,238	81,855
5	1 Inc and wealth dep.	776	6499	29,073	108,475
	2 Inc dep.	769	6162	26,138	97,171
	3 Flat-rate	477	3979	18,566	87,111

Note: In the current system (1) and the two alternatives. Pension wealth groups (1 is lowest and 5 is highest) are quintiles of total lifetime wealth (initial wealth and present value of pension income), see Section 3.3.2. All amount are discounted to age 70.

decomposed into the change in the average payment and the change in the risk premium, as in Equation (9).

That the current system redistributes relatively strongly from high to low pension wealth groups becomes clear when we consider the average payments in the other two alternatives. The alternatives raise the same overall revenue, which means that the change on average payments is purely a redistribution of the burden across the groups (the change in payments across groups adds up to zero[20]). An income-dependent co-payment would lead to a decrease on average payments for the highest pension wealth group, and an increase for the others, especially the second and third group. A flat-rate co-payment would lead to a decrease on average payments for both the highest and second highest pension wealth group.

Compared to the alternatives, the current co-payment system offers more protection against risk to low- and especially middle pension wealth groups. Table 5 shows the distribution of discounted lifetime co-payments in the three variants, for the lowest, middle, and highest pension wealth group. For both the lowest and the middle groups, going to an income-dependent or flat-rate co-payment would increase payments, especially for individuals using a lot of care (the right-hand tail of the distribution). The increases in payments for heavy users of LTC are most substantial in the case of the flat-rate. In contrast to the low and middle group, heavy users of LTC in the highest pension wealth group would actually be confronted with lower payments. This indicates that the current system puts a relatively strong burden on the intensive users of care with high financial means.

The effects on risk are reflected by the effects on the risk premium. Although the two alternatives raise the same overall revenue, all pension wealth groups, with the exception of the highest, are better of in the current system due to the increased risk. In particular the welfare loss of increased risk associated with going from the current system to a flat-rate is substantial. The low and middle groups loose between 0.7% and 3.6% of their current *CEC* due to the increase in risk (Figure 5). Interestingly, in terms of risk, it is not the lowest pension wealth group that would be most affected by the introduction of a flat-rate, but the middle groups

[20]The numbers in the table do not exactly add up to zero, because of the numerical approximation.

(quintiles 2 and 3). The income of members of quintile 1 is relatively close to the consumption floor. This means that even if the co-payment does not depend on income and wealth, their additional net payments are relatively limited. The middle groups hardly benefit from the consumption floor and thus face a larger risk of having to pay considerable co-payments.

The protection offered by the current system comes at the expense of the highest pension wealth group: they would have a higher *CEC* in an income-dependent system than in the current system. Counter intuitively, in the case of the flat-rate co-payment, the *CEC* of the highest pension wealth group would only be (slightly) higher than it is now. However, these results mask the benefits for individuals with very high financial wealth, as there is heterogeneity in income and financial wealth *within* the groups.[21] The results for specific combinations of income and financial wealth in Appendix E show that elderly with very high financial wealth would have a higher *CEC* in the case of a flat-rate co-payment.

The different co-payment schemes affect saving behavior as well. This can be seen by comparing the bequests across policy variants (Table 4). The amounts shown here are the (discounted) annualized averages. By comparing this to the annual consumption and payments, we can see what share of lifetime pension wealth is, on average, left at death. In both the income-dependent system and the flat-rate bequests increase for all groups with the increase more substantial for the flat-rate.[22]

5.2 | Sensitivity analysis

As described in Section 4.3.2, we run six sensitivity tests using different parameterizations. When we change the parameters of the utility function, this also affects the revenues raised in the current co-payment system. In the absence of a bequest motive, for instance, individuals will save less, which reduces the revenues raised through the wealth-dependent part of the co-payment. To make a fair comparison across the co-payment systems within each sensitivity analysis, we keep the policy parameters of the current system fixed (at the level in Table 2), but we adjust the policy parameters of the alternatives so that they each raise an equal amount of revenue as the current system.

Table 6 shows the relative change in certainty equivalent consumption, $\frac{CEC_{g,v} - CEC_{g,1}}{CEC_{g,1}}$, when going from the current system to an income-dependent or flat-rate co-payment by pension wealth group for the main specification and for the sensitivity analyses (this is equal to what is shown in Figure 5 for the main specification). In general, the results for all pension wealth groups, except the highest, are quite similar across different parameter settings. Going from the current system to one of the two alternatives leads to a welfare loss. This loss is largest for the middle-income groups, and is most substantial in the case of the flat-rate alternative. There are some differences in the magnitude of the effects compared to the main specification though.

[21] Table 5 shows that the risk (of very high costs) is lower in the flat-rate system than in the current system for the highest pension wealth group. This suggests that the welfare loss is due to a shift in payments from more to less wealthy individuals *within* the highest pension wealth group.

[22] The co-payment system affects the bequests in three ways: First, when an individual pays a co-payment this lowers his financial wealth directly. Second, in response to a higher risk of co-payments, individuals increase their savings, which increases average wealth at death. Third, when wealth is taxed (as in the current system) this has a negative effect on savings.

TABLE 6 The change in welfare from going from the current system to one of the two alternatives, by pension wealth group

Main specification					
2 Inc dep.	−0.36	−1.4	−1.75	−1.49	0.19
3 Flat-rate	−2.34	−3.7	−4.29	−1.73	0.39
No bequest motive					
2 Inc dep.	−0.33	−1.35	−1.7	−1.54	−0.12
3 Flat-rate	−2.27	−3.58	−4.24	−1.69	0.08
Lower bequest level					
2 Inc dep.	−0.38	−1.48	−1.85	−1.48	0.71
3 Flat-rate	−2.39	−3.81	−4.34	−1.78	2.34
Higher risk aversion					
2 Inc dep.	−1	−3.31	−3.51	−3.15	−0.06
3 Flat-rate	−3.77	−6.11	−6.3	−2.52	0.1
Lower risk aversion					
2 Inc dep.	−0.22	−0.67	−0.73	−0.85	0.18
3 Flat-rate	−2.18	−1.68	−2.41	−1.41	0.17
State dep. utility					
2 Inc dep.	−0.27	−0.99	−1.45	−1.41	0.18
3 Flat-rate	−2.45	−2.6	−3.9	−1.81	0.21
Lower costs of living in a nursing home					
2 Inc dep.	−0.29	−0.91	−0.94	−1.01	0.16
3 Flat-rate	−2.67	−4.16	−4.25	−1.71	0.61

Note: For different parameter specifications. Pension wealth groups (1 is lowest and 5 is highest) are quintiles of total lifetime wealth (initial wealth and present value of pension income), see Section 3.3.2. The change in welfare in going from the current system ($v = 1$) to alternative system v, for group g is measured as: $(CEC_{g,v} - CEC_{g,1})/CEC_{g,1}$. The parameter values for each specification can be found in Table 3.

As the different parameterizations also affect the outcomes in the current system, identifying the mechanisms underlying these differences in magnitude is not always straightforward. The exclusion of the bequest motive does not seem to affect the outcomes of the low and middle groups very strongly. A higher risk aversion leads to higher losses in welfare, especially when going to a flat-rate co-payment, and a lower risk aversion to lower losses. The effects of health-state dependent utility and lower costs of living in a nursing home are quite heterogeneous, although they seem to lead to less welfare loss for the middle groups when going from the current to a solely income-dependent system.

For the highest pension wealth group, results vary more. In the main specification, the highest pension wealth group would gain from going from the current system to a solely income-dependent co-payment. In the "no bequest" and "higher risk aversion" settings, the group would have a slight loss. In all settings, the highest group benefits from going to a flat-rate co-payment.[23]

[23] In the sensitivity test where we let the bequest motive start at 30,000 Euros, the welfare gain for the highest group is very large. However, this setting would lead to unrealistically high utility gained from bequest for the wealthiest group (lifetime utility for this group would be almost twice as high as in the main specification).

5.3 | Moral hazard and informal care

An important issue in the interpretation of the results is that we treat LTC use as exogenous. In practice, however, LTC use is endogenous, in the sense that individuals might change their use of care in response to a change in the out-of-pocket price. Full insurance of LTC costs leads to moral hazard when individuals choose to use more care than what they would be willing to pay for out-of-pocket. The presence of moral hazard is also the most important reason to introduce co-payments: they reduce inefficient use of care by increasing the marginal costs of care for the user. Ideally, we would include the effects on moral hazard in the assessment of the different co-payment schemes. However, the empirical literature on the effects of co-payments (or prices) on LTC use is still limited (Konetzka et al., 2014), and inconclusive (e.g., Grabowski & Gruber, 2007; Konetzka et al., 2014; Li & Jensen, 2011; Lin & Imanaka, 2020).

In our analysis, we therefore abstract from the effects of co-payments on use and moral hazard by taking the desire of the government to finance a certain share of macroexpenditures out-of-pocket[24] and focusing on how different co-payment schemes shift the financial burden across groups. To give some qualitative assessment of how the different schemes might impact the use of care, we focus on three issues: the effect of the marginal price at different levels of LTC use; the income elasticity of LTC demand; and, the effects of co-payments on the use of privately financed or informal care.

A relevant characteristic of the current Dutch system is that, at low levels of (annual) care use, all users pay full costs out-of-pocket, while at higher levels of use (depending on income and wealth) marginal out-of-pocket costs are zero (see Figure 3). Theoretically, co-insurance rates should be high in relatively good health states, in which elasticity of demand is high, and low or zero in poor health states, in which elasticity of demand is low (Blomqvist, 1997; Drèze & Schokkaert, 2013; Klimaviciute & Pestieau, 2020). This suggests that replacing the current system by a flat-rate co-payment may induce additional welfare losses, as this would shift co-payments from individuals who use a little care (presumably the most healthy and thus price-elastic individuals) to individual who use a lot of care (the least healthy and least price elastic).[25]

A second important characteristic of the Dutch system is that, at higher levels of use, co-payments are higher for high than for low incomes. In standard lifecycle models that include endogenous care use (e.g., De Nardi et al., 2010, 2016), higher incomes are implicitly assumed to have a lower price sensitivity for care, as their marginal utility of consumption is lower than for low incomes. In the case of public insurance, however, high income groups might, in fact, be more price sensitive for public LTC, as they have more possibilities to substitute with private care (see the following paragraph). In addition, the income and wealth-dependence of the current Dutch system ensures that the co-payments are affordable to users with a low income (when individuals abstain for care use not because they are not willing to pay the out-of-pocket price, but because they cannot afford it, this is welfare decreasing, Nyman, 1999).

Formal public LTC can be partly substituted by either privately financed help[26] or informal care (Bonsang, 2009; Mommaerts, 2018). As discussed in Section 3.3, it seems that higher

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[24]Where a theoretical motivation for co-payments sterns mostly from the presence of moral-hazard, in (Dutch) policy discussions co-payments are often motivated by the intrinsic desire to shift part of the costs of public LTC to the users to contain public spending.

[25]The same logic suggests that replacing the current system, which has a cap on *annual* co-payments by a system with a cap on *lifetime* co-payments might be welfare improving (see Wouterse et al., 2020, for a suggestion in this direction).

[26]There is not really a private market for formal care services in The Netherlands. However, individuals can of course hire a cleaner or a help in the household or buy other services that partly substitute for formal care.

incomes use these substitutes more often and this might partly explain why they use less publicly financed LTC than low incomes (Figure 2). It is likely that the higher use of private and informal care by higher incomes is due to their higher (financial) ability to do so. However, if this substitution is partly induced by the co-payments (higher incomes use more informal and private care because they have to pay higher co-payments for public care than low incomes), then we underestimate the (financial) burden of the current system for high incomes. Similarly, we then underestimate the (financial) gains for this group when going from the current system to a flat-rate co-payment. At the same time, if the increased co-payment for the low incomes in the flat-rate system would then induce these groups to use more private or informal care (which probably comes at a higher costs for them than for the higher income groups), we are also underestimating their financial burden in that case.

6 | DISCUSSION

We have estimated the longitudinal dynamics of LTC costs in The Netherlands, using the semiparametric nearest-neighbor approach. We have applied our longitudinal estimates of a structural lifecycle model to evaluate the Dutch LTC financing system, in which co-payments are based on a fixed share of income and wealth. We have found that there is a strong income and wealth gradient in the lifetime use of long-term care. Compared to a flat-rate or a solely income-dependent co-payment raising the same revenue, the Dutch system redistributes the costs of co-payments from the elderly with the lowest financial means, who on average use the most care, to the elderly with the highest means, who use the least care.

Moreover, the lifecycle model allows us to take the welfare effects of risk into account. It turns out that the income and wealth dependency in the Dutch system protects not only the elderly with the lowest financial means, but specifically those in the middle groups against substantial financial risks: when going from the current system to a flat-rate co-payment these groups would lose between 2.1% and 3.6% of their current welfare due to increased risk. Only the elderly with very high pension wealth would benefit from a flat-rate.

Our analysis underlines the point of McClellan and Skinner (2006) that including risk in the analysis of distributional effects of care systems is important. Especially for the middle income and wealth groups, the welfare losses induced by the two alternative co-payment systems, compared to the current system, are much larger than the change on average payments. The finding that the protection against financial risk is even more important for the middle groups, as they actually have something to loose, is similar to what De Nardi et al. (2016) found for higher-income groups in Medicaid. An important element in the Dutch system seems to be that, although co-payments depend on wealth, the elderly do not have to completely deplete their savings before gaining access to public insurance. This means that the system protects the elderly with some income and wealth better against costs than a fully means-tested system (e.g., Brown & Finkelstein, 2007).

We have focused on the distributional effects of co-payments during the retirement phase, starting at age 70. Not modeling the working phase of life helps to keep the model tractable and computationally manageable. This has enabled us to include a relatively large amount of detail, both in the dynamics in LTC costs and the policy variants. However, not modeling the working life phase means we might overestimate the welfare losses due to co-payments, as individuals might increase their savings before retirement as a precaution.

We also restricted the analysis to singles to keep the lifecycle model tractable. The effects for couples will differ, as they can rely more on informal care and are able to share financial shocks. At the same time, it is mostly the longest-surviving partner who will need formal LTC, and for him or her the financial effects might actually be quite similar to those for single households. An extension of the model to multiperson households would be an interesting exercise for further research. Similarly, an empirical analysis on the effect of the design of the co-payment on use and moral hazard (see Section 5.3) would provide further valuable insights to complete a full welfare assessment. In 2013, the Dutch government increased the wealth-dependent co-payment which might offer another opportunity for future research (Non, 2017).

7 | CONCLUSION

Income and wealth dependent co-payments provide more insurance value than flat-rate co-payments that do not depend on the financial means of the LTC user. This is not only the case for the elderly with low financial means, but especially for elderly in the middle-income groups. Elderly with modest financial means benefit from an income- and wealth-dependent co-payment, compared to a flat-rate co-payment, not so much because of lower average payments but mostly because they are exposed to less financial risk. Elderly with higher financial means have to pay more on average, but only for the 20% of the elderly with the highest means does this outweigh the costs of the additional risk that comes with the flat-rate co-payment. Unless one expects that a flat-rate co-payment leads to substantially less distortions during the working life, or substantially decreases moral hazard, the welfare case for an income- and wealth-dependent co-payment seems strong.

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REFERENCES

Ameriks, J., Briggs, J., Caplin, A., Shapiro, M. D., & Tonetti, C. (2020). Long-term-care utility and late-in-life saving. *Journal of Political Economy*, *128*(6), 2375–2451.

Ameriks, J., Caplin, A., Laufer, S., & Van Nieuwerburgh, S. (2011). The joy of giving or assisted living? Using strategic surveys to separate public care aversion from bequest motives. *The Journal of Finance*, *66*(2), 519–561.

Bakx, P., Wouterse, B., van Doorslaer, E., & Wong, A. (2020). Better off at home? Effects of nursing home eligibility on costs, hospitalizations and survival. *Journal of Health Economics*, *73*, 102354.

Blomqvist, Å. (1997). Optimal non-linear health insurance. *Journal of Health Economics*, *16*(3), 303–321.

Boisclair, D., Décarie, Y., Laliberté-Auger, F., & Michaud, P.-C. (2019). *COMPAS: A health microsimulation model for Quebec and Canada*. Technical document, Chaire de recherche sur les enjeux économiques intergénérationnels, Montréal.

Bonsang, E. (2009). Does informal care from children to their elderly parents substitute for formal care in Europe? *Journal of Health Economics*, *28*(1), 143–154.

Brandt, M. W., Goyal, A., Santa-Clara, P., & Stroud, J. R. (2005). A simulation approach to dynamic portfolio choice with an application to learning about return predictability. *Review of Financial Studies*, *18*(3), 831–873.

Brown, J., & Warshawsky, M. (2013). The life care annuity: A new empirical examination of an insurance innovation that addresses problems in the markets for life annuities and long-term care insurance. *Journal of Risk and Insurance*, *80*(3), 677–704.

Brown, J. R., & Finkelstein, A. (2007). Why is the market for long-term care insurance so small? *Journal of Public Economics*, *91*(10), 1967-1991.

Brown, J. R., & Finkelstein, A. (2009). The private market for long-term care insurance in the United States: A review of the evidence. *Journal of Risk and Insurance*, *76*(1), 5–29.

Carroll, C. D. (2006). The method of endogenous gridpoints for solving dynamic stochastic optimization problems. *Economics Letters*, *91*(3), 312–320.

Colombo, F., & Mercier, J. (2012). *Help wanted? Fair and sustainable financing of long-term care services*. OECD Health Policy Studies.

CPB. (2017). *CPB Netherlands Bureau for economic policy analysis*. Keuzes in kaart 2018–2021. CPB, The Hague.

De Nardi, M., French, E., & Jones, J. B. (2010). Why do the elderly save? The role of medical expenses. *Journal of Political Economy*, *118*(1), 39–75.

De Nardi, M., French, E., & Jones, J. B. (2016). Medicaid insurance in old age. *American Economic Review*, *106*(11), 3480–3520.

Diepstraten, M., Douven, R., & Wouterse, B. (2020). Can your house keep you out of a nursing home? *Health Economics*, *29*(5), 540–553.

Drèze, J. H., & Schokkaert, E. (2013). Arrows theorem of the deductible: Moral hazard and stop-loss in health insurance. *Journal of Risk and Uncertainty*, *47*(2), 147–163.

Farmer, J. D., & Sidorowich, J. J. (1987). Predicting chaotic time series. *Physical Review Letters*, *59*(8), 845.

Finkelstein, A., Luttmer, E. F., & Notowidigdo, M. J. (2013). What good is wealth without health? The effect of health on the marginal utility of consumption. *Journal of the European Economic Association*, *11*(Suppl 1), 5221–258.

French, E., & Jones, J. B. (2004). On the distribution and dynamics of health care costs. *Journal of Applied Econometrics*, *19*(6), 705–721.

Fuino, M., & Wagner, J. (2020). Duration of long-term care: Socio-economic factors, type of care interactions and evolution. *Insurance: Mathematics and Economics*, *90*, 151–168.

Gheorghe, M., Wubulihasimu, P., Peters, F., Nusselder, W., & Van Baal, P. H. (2016). Health inequalities in The Netherlands: Trends in quality-adjusted life expectancy (QALE) by educational level. *The European Journal of Public Health*, *26*(5), 794–799.

Goldman, D. P., & Orszag, P. R. (2014). The growing gap in life expectancy: Using the future elderly model to estimate implications for Social Security and Medicare. *American Economic Review*, *104*(5), 230–233.

Grabowski, D. C., & Gruber, J. (2007). Moral hazard in nursing home use. *Journal of Health Economics*, *26*(3), 560–577.

Hsieh, D. A. (1991). Chaos and nonlinear dynamics: Application to financial markets.*The Journal of Finance*, *46*(5), 1839-1877.

Hurd, M. D., Michaud, P. C., & Rohwedder, S. (2017). Distribution of lifetime nursing home use and of out of pocket spending. *PNAS*, *114*(37), 9838–9842.

Hussem, A., TerRele, H., & Wouterse, B. (2017). *Inkomens-en vermogensafhankelijke eigen bijdragen in de langdurige ouderenzorg: Een levensloopperspectief* (Design Paper 87). Netspar, Tilburg.

Hussem, A., Van Ewijk, C., TerRele, H., & Wong, A. (2016). The ability to pay for long-term care in the Netherlands: A life-cycle perspective. *De Economist*, *164*(2), 1–26.

Jones, J. B., De Nardi, M., French, E., McGee, R., & Kirschner, J. (2018). *The lifetime medical spending of retirees* (Working Paper 24599). National Bureau of Economic Research, Cambridge.

Khwaja, A. (2010). Estimating willingness to pay for Medicare using a dynamic life-cycle model of demand for health insurance. *Journal of Econometrics*, *156*(1), 130–147.

Klimaviciute, J., & Pestieau, P. (2020). Insurance with a deductible: A way out of the long term care insurance puzzle. *Journal of Economics*, *130*, 297–307.

Koijen, R. S., Nijman, T. E., & Werker, B. J. (2010). When can life cycle investors benefit from time-varying bond risk premia? *Review of Financial Studies*, *23*(2), 741–780.

Konetzka, R. T., He, D., Guo, J., & Nyman, J. A. (2014). *Moral hazard and long-term care insurance*. Health & Healthcare in America: From Economics to Policy. Ashecon.

Koot, P., Vlekke, M., Berkhout, E., & Euwals, R. (2016). *Mimosi: Microsimulatiemodel voor belastingen, sociale zekerheid, loonkosten en koopkracht*. CPB Background Document, The Hague.

Kopczuk, W., & Lupton, J. P. (2007). To leave or not to leave: The distribution of bequest motives. *The Review of Economic Studies*, *74*(1), 207–235.

Kopecky, K. A., & Koreshkova, T. (2014). The impact of medical and nursing home expenses on savings. *American Economic Journal Macroeconomics*, *6*(3), 29–72.

Li, Y., & Jensen, G. A. (2011). The impact of private long-term care insurance on the use of long-term care. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing*, *48*(1), 34–50.

Lin, H.-R., & Imanaka, Y. (2020). Effects of copayment in long-term care insurance on long-term care and medical care expenditure. *Journal of the American Medical Directors Association*, *21*(5), 640–646.

Lockwood, L. M. (2018). Incidental bequests and the choice to self-insure late-life risks. *American Economic Review*, *108*(9), 2513–2550.

McClellan, M., & Skinner, J. (2006). The incidence of medicare. *Journal of Public Economics*, *90*(1), 257–276.

Meyer, B., & Mok, W. K. (2009). *Disability, earnings, income and consumption* (Working Paper 18869). National Bureau of Economic Research, Cambridge.

Mommaerts, C. (2018). Are coresidence and nursing homes substitutes? Evidence from Medicaid spend-down provisions. *Journal of Health Economics*, *59*, 125–138.

Non, M. (2017). *Co-payments in long-term home care: Do they affect the use of care?* (CPB Discussion Paper 363). CPB Netherlands Bureau for Economic Policy Analysis, The Hague.

Nyman, J. A. (1999). The value of health insurance: The access motive. *Journal of Health Economics*, *18*(2), 141–152.

Palumbo, M. G. (1999). Uncertain medical expenses and precautionary saving near the end of the life cycle.*The Review of Economic Studies*, *66*(2), 395–421.

Peijnenburg, K., Nijman, T., & Werker, B. J. (2017). Health cost risk: A potential solution to the annuity puzzle. *The Economic Journal*, *127*(603), 1598–1625.

Sadiraj, K., Oudijk, D., van Kempen, H., & Stevens, J. (2011). *De opmars van het pgb. De ontwikkeling van het persoonsgebonden budget in nationaal en internationaal perspectief*. Sociaal en Cultureel Planbureau, The Hague.

Simmons, C., Leichsenring, K., Navarini, L., & Rodrigues, R. (2020). *Co-financing residential care for older people: Models and equity implications* (Policy Brief 2020/4). European Centre For Social Welfare Policy and Research, Vienna.

Tenand, M., Bakx, P., & Van Doorslaer, E. (2020). Equal long-term care for equal needs with universal and comprehensive coverage? An assessment using dutch administrative data. *Health Economics*, *29*(4), 435–451.

Van Ooijen, R., De Bresser, J., & Knoef, M. (2018). *Health and household expenditures*. (Design Paper 103). Netspar, Tilburg.

Wong, A., Boshuizen, H., Polder, J., & Ferreira, J. A. (2016). Assessing the inequality of lifetime healthcare expenditures: A nearest neighbour resampling approach. *Journal of the Royal Statistical Society: Series A*, *180*(1), 141–160.

Wouterse, B., Hussem, A., & Aalbers, R. (2020). *Betere risicospreiding van eigen bijdragen in de verpleeghuiszorg*. Policy brief, CPB, The Hague.

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Additional Supporting Information may be found online in the supporting information tab for this article.

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