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Full Length Article

Trade-offs in long-term care for older people in an ageing society: A constrained portfolio choice experiment

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ABSTRACT

Many countries face rapidly ageing populations, resulting in a rising demand for long-term care (LTC) for older people and an increased pressure on LTC systems. In responding to this development, governments face challenging trade-offs between different policy measures and their effects. To inform allocation decisions, this study elicited citizens' policy preferences for LTC for older people in the Netherlands in 2040. We conducted a constrained portfolio choice experiment, in which 997 respondents composed a portfolio of their preferred policies, subject to a budget constraint, while being presented with the expected effects of their choices. Choices were analysed using a Multiple Discrete Continuous Extreme Value (MDCEV) choice model and a Latent Class Cluster Analysis (LCCA). The results suggest a preference for distributing resources towards multiple policies, including both nursing and social care, over investing heavily in one or two particularly. Also, most respondents chose portfolios constituting a substantial public expenditure increase, suggesting a widespread willingness to accept a tax increase to allow for this. Preferences were particularly heterogeneous with respect to expenditure levels and the adoption of supportive care technologies and compulsory social service for young adults. Policymakers may use these results to support the selection of a portfolio of LTC policies that aligns with public preferences.

Introduction

The populations of many countries are ageing rapidly and predicted to continue ageing in the next decades (Eurostat. n.d.; WHO, 2024). Partially because of this demographic development, many of these countries are faced with substantial increases in their expenditures on long-term care (LTC) for older people (e.g., Breyer & Lorenz, 2021). Also, due to population ageing, the caregiving tasks for a growing number of older people will have to be borne and financed by a relatively small group of (potential) caregivers and taxpayers. Hence, the sustainability of LTC is under pressure in many ageing societies, regarding the availability of both financial resources and personnel (Mosca et al., 2017; Swartz et al., 2012). At the same time, there is substantial heterogeneity among countries when it comes to the public funding and delivery of LTC for older people (e.g., Costa-Font et al., 2015; Swartz, 2013), as many different policy options exist with varying costs and benefits.

For policymakers involved in (re)designing the LTC system of the future, important trade-offs can be identified. There is a tension between quality and access to LTC for older people and the affordability of the care system (e.g., Da Roit, 2012). On the one hand, a collective LTC system with a comprehensive coverage guarantees a certain degree of access to care and thus horizontal equity. Also, a comprehensive provision of formal care is likely to reduce the provision of informal care (e.g., Hollingsworth et al., 2022; Miyawaki et al., 2020). Since the provision of informal care, for many caregivers, is associated with a substantial burden in terms of a reduced health and wellbeing (e.g., Bom et al., 2019; Stöckel & Bom, 2022) and economic opportunity costs (e.g., Schmitz & Westphal, 2017), comprehensive collective care provision may mitigate this burden (Hollingsworth et al., 2022; Løken et al., 2017; Miyawaki et al., 2020). On the other hand, comprehensive public provision of care requires large governmental expenditures, which may result in intergenerational inequities and an unsustainable care system in terms of financial and personnel requirements in the long run (e.g.,

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Mosca et al., 2017; Swartz, 2013). Ultimately, this also comes down to the normative question of the extent to which LTC for older people is an individual or a collective responsibility and who should provide for this care and bear the associated burden (e.g., Hoefman et al., 2017; Janus & Koslowski, 2020; Read et al., 2021; Wittenberg et al, 2024).

At the same time, several studies find that changes in the availability of a certain type of LTC may be compensated by changes in the use of other types of long-term or medical care, suggesting substitution to take place to some extent between formal and informal LTC (e.g., Arora & Wolf, 2018; Hollingsworth et al., 2022; Miyawaki et al., 2020; Mommaerts, 2025), long-term and medical care (e.g., Bakx et al., 2020; Costa-Font et al., 2018; Moura, 2022), and different types of formal LTC (e.g., Guo et al., 2015; Kattenberg & Bakx, 2021). Thus, policymakers face the challenging task of balancing all these different aspects in (re) designing a sustainable LTC system for the future (Da Roit, 2012; Mosca et al., 2017; Swartz, 2013).

In decisions about changes to the LTC system, it seems important for governments to incorporate citizens' preferences, since they are stakeholders in the system either as care recipient, caregiver, and/or taxpayer. In this study, we asked a sample of 997 adult citizens from the Netherlands to compose a portfolio of their preferred policy alternatives for LTC for older people in 2040, subject to a budget constraint. They were informed about the alternatives' estimated effect on the fulfilment of nursing care demand, the need for informal care, and governmental expenditure on LTC. We analysed their portfolio choices using a multiple discrete–continuous extreme value (MDCEV) choice model. We then used the resulting estimates as inputs into an optimal portfolio analysis, forecasting the expected utility of each portfolio and ranking the portfolios accordingly.

We find that, overall, respondents derived positive utility from all policy alternatives. Also, the estimated effects of policy alternatives on the fulfilment of nursing care needs and reductions in need for informal caregiving played a significant role in respondents' choices. An optimal portfolio analysis underlines that respondents care about both effects, as each of the highest-ranked portfolios contains policy alternatives that affect both types of outcomes, which is a novel finding. Most respondents composed portfolios that would constitute substantial expenditure increases on LTC, which is both in line with previous studies (e.g., Amilon et al., 2020; Boxebeld et al., 2024a; Milte et al., 2024) as well as partially at odds with recent policy developments in the Netherlands (e.g., Maarse & Jeurissen, 2016). We discuss the implications of these findings, and the additional research required, to inform policy action in LTC in ways that are aligned with public preferences. Also, we discuss how policymakers may use the findings of heterogeneous preferences by respondent characteristics to broaden the support base for particular policy measures.

The remainder of this paper is organized as follows: Section 2 describes the institutional setting, the study's methodology, survey design, and the estimation approach. Section 3 reports the results of the analyses, while Section 4 discusses these findings in the light of previous research, this study's limitations, and policy developments.

Related literature and contributions

This study contributes to the existing literature on public preferences for LTC in two important ways. Firstly, many previous studies have elicited respondents' preferences regarding their own situation, such as characteristics of formal LTC (insurance) (e.g., Brau & Bruni, 2008; Chandoevwit & Wasi, 2020; De Bresser et al., 2022; De Bresser et al., 2024; Kaambwa et al., 2021; Lehnert et al., 2018; Milte et al., 2018) and willingness to provide, receive, or pay for informal care (e.g., De Jong et al., 2022; Hoefman et al., 2017; Hoefman et al., 2019; Mentzakis et al., 2011). Several other studies have asked respondents to make choices for hypothetical individuals (e.g., Amilon et al., 2020; Nieboer et al., 2010; Santos-Eggimann & Meylan, 2017). This study, instead, asks respondents to advise the government on what it should invest in and, therefore, about the LTC system for older people in 2040. This study thus elicits citizens' societal preferences, on a macro-level rather than on the individual level. Respondents' preferences may be different when reasoning from their own perspective compared to reasoning from a societal perspective, as perhaps a broader set of factors would be included when making trade-offs from the latter perspective (e.g., Mouter et al., 2017; Nyborg, 2000). Both perspectives thus seem useful,[1] yet, only few studies have adopted a societal perspective (e.g., Janus & Koslowski, 2020; Milte et al., 2024; Patterson & Reyes, 2024). Also, these studies typically took an attitudinal approach (i.e., asking respondents about their opinion) rather than a preference-based approach (e.g., asking respondents to make choices between different policy options in a choice experiment). Building on those studies, this study takes a preference-based approach, asking respondents to make choices between different LTC policies for older people.[2] In addition, given the focus on the societal level, a broad sample of the adult population is included in this study (as the potential (tax)payers of the system, but also future care recipients and/or caregivers). Many previous studies are either based on samples consisting of older or middle-aged respondents (e.g., Lehnert et al., 2018; Nieboer et al., 2010; Santos-Eggimann & Meylan, 2017), while especially younger generations also have a stake in this policy dilemma.

Secondly, the study extends our knowledge on public preferences for LTC by eliciting preferences not only for policy alternatives, but also for the height of the overall public expenditure on LTC. In this Participatory Value Evaluation (PVE), respondents are presented with a constrained portfolio choice experiment. They are asked to select a portfolio of policy alternatives of their preference, requiring them to trade-off their private expenditure capacity with the level of public spending (Mouter et al., 2021c) (see section 2.2 'Constrained portfolio choice experiment').[3] This should approximate the situation of policymakers more closely than other preference elicitation methods, and provides additional insights into the preferred level of public spending on LTC.

Methods

Institutional setting

The Netherlands is characterized by a universal and comprehensive LTC coverage, in which no private LTC insurance exists (Bakx et al., 2023). Also, LTC expenditure in the Netherlands as a proportion of gross domestic product (GDP) is the highest among OECD countries (OECD. n. d.). The comprehensive coverage and resulting large share of public

[1] It is beyond the scope of this paper to provide an overview of the advantages and disadvantages of taking a societal perspective in preference-elicitation rather than an individual perspective, but several studies have discussed this issue in a variety of contexts (e.g., Costa-Font & Rovira, 2005; Dolan et al., 2003; Mouter et al., 2017; 2018; Nyborg, 2000; Russell et al., 2003). The national guidelines for economic evaluation in the health domain in the Netherlands prescribe taking a societal perspective (Versteegh et al., 2016).

[2] By focusing on public expenditure on formal and informal LTC services, this study regards ex-post approaches of responding to increasing LTC demand, i.e. measures taken after the onset of LTC dependence (Costa-Font et al., 2015). Other studies have elicited preferences for other ex-post approaches, such as introducing reverse mortgages (e.g., De Bresser et al., 2024; Hanewald et al., 2025), and ex-ante approaches like introducing LTC insurance (e.g., Brown et al., 2012; De Bresser et al., 2022).

[3] This is particularly relevant given that several previous studies found that a substantial share of the public tends to believe LTC for older people should be funded publicly rather than privately (e.g., Janus & Koslowski, 2020; Patterson & Reyes, 2024; Simmons et al., 2024). Many people are, however, insufficiently aware of the opportunity costs of increased public expenditure (e.g., Cohen-Blankshtain & Sulitzeanu-Kenan, 2021; Persson & Tinghög, 2020), which may bias their preferences. Therefore, we decided to include an explicit opportunity cost of increased public expenditure in the choice task, in the form of a tax increase.

expenditure on LTC makes the Netherlands vulnerable to population ageing (Bakx et al., 2023). In an attempt to curve this expenditure increase, a number of policy reforms have focused on promoting ageing-in-place. The most recent major reform took effect in 2015 and restricted access to institutional care, widened the availability of home-based care, and put greater emphasis on informal care (Maarse & Jeurissen, 2016). Nevertheless, the government has increased investments in institutional care since then to improve quality of care (Bakx et al., 2023) and to address the increasing LTC demand. More information on the institutional LTC setting of the Netherlands can be found, for instance, in Bakx et al. (2020), Bakx et al. (2023), Bär et al. (2022), Bergeot & Tenand (2023), and (Tenand et al., 2023).

Constrained portfolio choice experiment

PVE is a novel preference-elicitation method that can be characterised as a constrained portfolio choice experiment. After having been introduced in transportation (Mouter et al., 2021b) and environmental economics (Mouter et al., 2021c), the method is now applied in health economics, too (Boxebeld et al., 2024b). In a PVE, respondents are faced with a policy question and presented with a single choice task, consisting of several policy alternatives that are all described by a set of attributes with randomly varying levels. This multi-attribute nature of the choice task, embedded in random utility theory, resembles other preference-elicitation methods like the discrete choice experiment (DCE) or best-worst scaling (BWS) (Boxebeld et al., 2024b). However, unlike those methods, which contain a sequence of choice tasks in which respondents are asked to select their most (and, in case of BWS, least) preferred alternative per choice task, PVE contains a single portfolio-based choice task involving multiple discrete and continuous choices: respondents are asked to compose their preferred portfolio of policy alternatives to address the policy question, subject to a resource constraint (e.g., a public budget). The premise of PVE is that its portfolio-based choice task allows respondents to incorporate synergies between policy alternatives in their choices. Also, the resource constraint forces respondents to acknowledge the scarcity of resources that policymakers face in the context of specific policy issues. This explicit resource constraint is another distinctive element of PVE relative to more common multi-attribute preference-elicitation methods (Boxebeld et al., 2024b) and resembles participatory budgeting methods (e.g., Cost-Font et al., 2015),[4] even though the latter are typically not multi-attribute in nature. However, it is possible to deviate from a fixed constraint (e.g., a fixed budget) in the design of a PVE and allow respondents to choose for an adjustment of the public expenditure level on a policy area. In such a flexible-budget PVE, respondents trade-off the level of public expenditure with their private spending capacity (Boxebeld et al., 2024b; Mouter et al., 2021c). This makes PVE a suitable method for the policy area of LTC for older people, in which multiple policy alternatives (e.g., different care arrangements) can be implemented simultaneously and both public and private resources can be allocated.

Choice task design

The selection of policy alternatives, attributes, levels and a resource constraint for this choice experiment was informed by a review of the literature and interviews with policymakers, other stakeholders, and LTC experts working at the intersection of policy and scientific research. In addition, we conducted three rounds of pre-testing the design and a pilot study. An extensive description of the key considerations in the design selections and more details regarding the design process are provided in Supplementary Material 1.

Three attributes were included in the choice task: 1) the effect of the policy alternatives on the percentage of older people in need of nursing care who receive this in 2040; 2) the costs of the policy alternatives, presented as a uniform increase of the tax burden for all adult citizens in 2040; and 3) the impact on the average amount of informal care required in 2040 (in hours per week per person). Table 1 provides a list of the policy alternatives with level ranges for each of the three attributes.

In the choice task, some policy alternatives were designed to affect the fulfilment of nursing care needs only, while others only affected the required amount of informal care provision. This design choice clarifies and reinforces the trade-off between fulfilling nursing care needs and fulfilling social care needs (with the latter plausibly alleviating the burden on informal caregivers more strongly[5]) in the choice task, which arguably made the task somewhat easier for respondents and reflects the imperfect substitutability of formal and informal care. However, it does not fully capture the complex reality of LTC, as increasing the capacity of nursing care at home and increasing the use of supportive care technologies may also substitute informal care partially (e.g., Anderson & Wiener, 2015).

The status quo for the choice task presented to respondents concerned the scenario in which the supply of formal LTC services for older people in 2040 is maintained at current levels, while the demand is expected to increase substantially due to the projected population ageing. Respondents were informed that in this status quo, 65 % of older people in need of nursing care would receive this in 2040 (compared to

Table 1
Overview of included policy alternatives, attributes and levels.

Policy alternative	Attributes		
	Fulfilment of nursing care needs (%)	**Costs (€ per adult per month)**	**Informal care provision (average N hours/week per adult)**
Increase capacity of nursing homes (by 10,000 places)	2, 4, 6	10, 15, 20	−1, −2
Increase capacity of nursing care at home (by 10,000 places)	2, 4, 6	5, 10, 15, 20	0
Increase use of supportive care technologies	2, 4, 6	5, 10, 15, 20	0
Introduce care homes (per 10,000 places)	0	10, 15, 20	−1, −2. −3
Increase capacity of social care at home (by 10,000 places)	0	5, 10, 15, 20	−1, −2, −3
Provide respite care to informal caregivers (by 3 months)	0	5, 10, 15	−1, −2. −3
Introduce compulsory social service for young adults (by 3 months)	0	5, 10, 15	−1, −2, −3

Overview of attribute level ranges by policy alternative. The distinctions between nursing and social care and between nursing homes and care homes are explained in Supplementary Material 1. See Supplementary Material 2 for full descriptions of the attributes and policy alternatives as presented to respondents.

[4] For a more elaborate conceptual comparison of PVE with other preference-elicitation methods (e.g., DCE, BWS) and with other participatory and deliberative approaches (e.g., participatory budgeting, opinion polls), readers are referred to Boxebeld et al. (2024b) and to Mouter et al. (2021a), respectively.

[5] Given that informal caregivers more often fulfil social care needs than nursing care needs, we assumed that formal social care (i.e., the alternatives of introducing care homes and increasing the capacity of social care at home) would induce a stronger substitution effect than formal nursing care.

95 % now), while the population of 16 years and older would have to provide 12 h of informal care per person per week (compared to 2 h per week now) (see Supplementary Material 1). Implementing policy alternatives could mitigate these consequences; most policy alternatives either increased the capacity of nursing care or reduced the provision of informal care, while all policy alternatives required additional governmental investment (see Table 1). The resource constraint concerned this additional government investment: the chosen portfolio could not exceed an expenditure increase of €105 per adult per month (see Supplementary Material 1). On an aggregate level, this correspondents to an additional spending of €20 billion per year, which would approximately double current public expenditure on LTC for older people. According to recent government estimates (Rijksoverheid, 2023), this is the expenditure increase required for LTC for older people in 2040 given the expected rise in demand and income growth in the absence of any policy change, while maintaining accessibility at current levels. Increasing expenditures for LTC beyond this level is considered unrealistic.

While a budget is used as the choice task constraint, one may argue that another type of constraint could have been relevant as well. For example, in many countries (including the Netherlands), staff shortages are a pressing constraint to the capacity of the care system (OECD, 2023). We considered implementing the personnel capacity as a second constraint, but decided not to do so because it was difficult to operationalize and would increase the cognitive burden for respondents. Also, given that many people exhausted the budget constraint (almost) entirely, it may be questioned to what extent respondents anchor on the budget constraint. To examine this, future research may experimentally vary the height of the budget constraint between respondents.[6] Besides, a uniform tax increase for all adults was included as the payment vehicle in the choice task. Future research may examine the robustness of the elicited preferences to the priming of the opportunity costs of increased public expenditure (e.g., Persson & Tinghög, 2020) and to a different payment vehicle, such as an alternative tax specification or the reallocation of existing public resources away from other spending purposes (e.g., Andersson et al., 2023).

In the choice task, respondents thus faced clear trade-offs: they could increase the capacity of nursing care, so that more older people will receive the nursing care they need. Alternatively, they could reduce the required amount of informal care and alleviate the associated burden on informal caregivers. To a certain extent, trade-offs needed to be made between the policy alternatives fulfilling either of these needs, as both types of policy alternatives potentially exhausted the resource constraint. Finally, respondents could choose not to increase governmental spending on LTC, but this would result in waiting lists and welfare losses for older people with unfulfilled care needs as well as a substantial informal caregiving burden for the population at large. As such, each choice came with clear opportunity costs.

Respondents could choose each of the policy alternatives, which were presented in a random order to mitigate ordering effects (Boxebeld, 2024), between zero and three times by moving sliders. The attribute levels of each alternative were presented in the main screen, while supplementary information for each of the policy alternatives could be accessed via pop-up screens (see Supplementary Material 2). The total effects of their choices on the three attributes were presented in a dashboard on the right of the choice task screen (see Fig. 1 for an exemplary (translated) choice task screen).

Due to the single choice task in a PVE, there is only experimental variation between (i.e., not within) respondents. A 'min–max correlation' design was generated using an algorithm that aims to minimize the maximum level of the correlation between different versions, resulting in 57 different versions of the choice task (i.e., different combinations of attribute levels). This design was created using the Python package PortChoice (Hernandez, 2023). To force respondents to make trade-offs between the policy alternatives and the attributes, in each version the total costs of implementing all policy alternatives three times exceeded the maximum budget (€105 per person per month).

Survey instrument

The survey, embedding the PVE choice task, was programmed in the software platform Wevaluate (Populytics. n.d.). Prior to the choice task, respondents were asked for their informed consent and were informed about the study objective, the policy question, and the choice task design. Also, at the start of the survey, a few screen-out questions for the quota sampling were presented, regarding the respondent's age group, gender, and education level. To induce value learning (i.e., familiarize respondents with the topic), we presented respondents with a few normative questions about the distribution of responsibilities for LTC prior to the choice task (see Supplementary Material 4). To induce institutional learning (i.e., familiarize respondents with the choice environment), the choice task was introduced in an instructional video.

A potential limitation of the choice task design, generally applicable to stated preference research, is a potential lack of perceived consequentiality and unfamiliarity of respondents with the topic and choice environment, which may influence respondents' preferences and could give rise to hypothetical bias (Haghani et al., 2021). To address these aspects, we included a consequentiality script (Lewis et al., 2016) at the start of the survey, stating our intention to share the results with the Ministry of Health, Welfare and Sports. Additionally, we provided respondents with concise background information about the policy issue and the various policy alternatives and attributes, warm-up questions prior to the choice task,[7] and an instructional video. Nonetheless, we cannot exclude (or test for) the possibility of hypothetical bias influencing our results. Future research may elicit respondents' preferences in different policy contexts[8] and use different choice task designs, including a variety of resource constraints and payment vehicles, to further investigate the validity of our results.

After completing the choice task, respondents were asked to motivate their choices using an open-ended question and to provide information about their informal care experience and attitudes and sociodemographic and socioeconomic characteristics.

Data Collection and Sample Description

Respondents were recruited from an online panel (Dynata, 2022) and quote-sampled to be representative of the adult population of the Netherlands in terms of age, sex, and educational attainment. Data collection took place between June 18 and June 25, 2024 and resulted in 997 completed surveys. Descriptive statistics of the sample are presented and related to population-level statistics in Table A1 in Appendix A. The

[6] Two previous PVE applications, using split-samples, varied a fixed and flexible budget between respondents and found that most respondents in the flexible-budget version did not adjust the height of public expenditure (Dekker et al., 2024; Mouter et al., 2021c), but this finding may be application-specific. Also, another PVE study varied the height of the budget constraint within respondents in a sequence of PVE choice tasks (Bahamonde-Birke et al., 2024), finding a high level of consistency, but also variability due to the budget change (Bahamonde-Birke, 2024). No study, thus far, has varied the height of the budget constraint between respondents, however.

[7] These warm-up questions, together with their answers, are documented in Supplementary Material 4. As explained in Boxebeld et al. (2024a), these questions are used to induce value learning, but may have influenced respondents' choices in the choice task.

[8] Given the importance of the institutional context, the results are to some extent context-specific. Many countries provide a less comprehensive LTC coverage than the Netherlands (Bakx et al., 2023), for example, while the populations of many countries will be aging more strongly than the population of the Netherlands (Eurostat, n.d.).

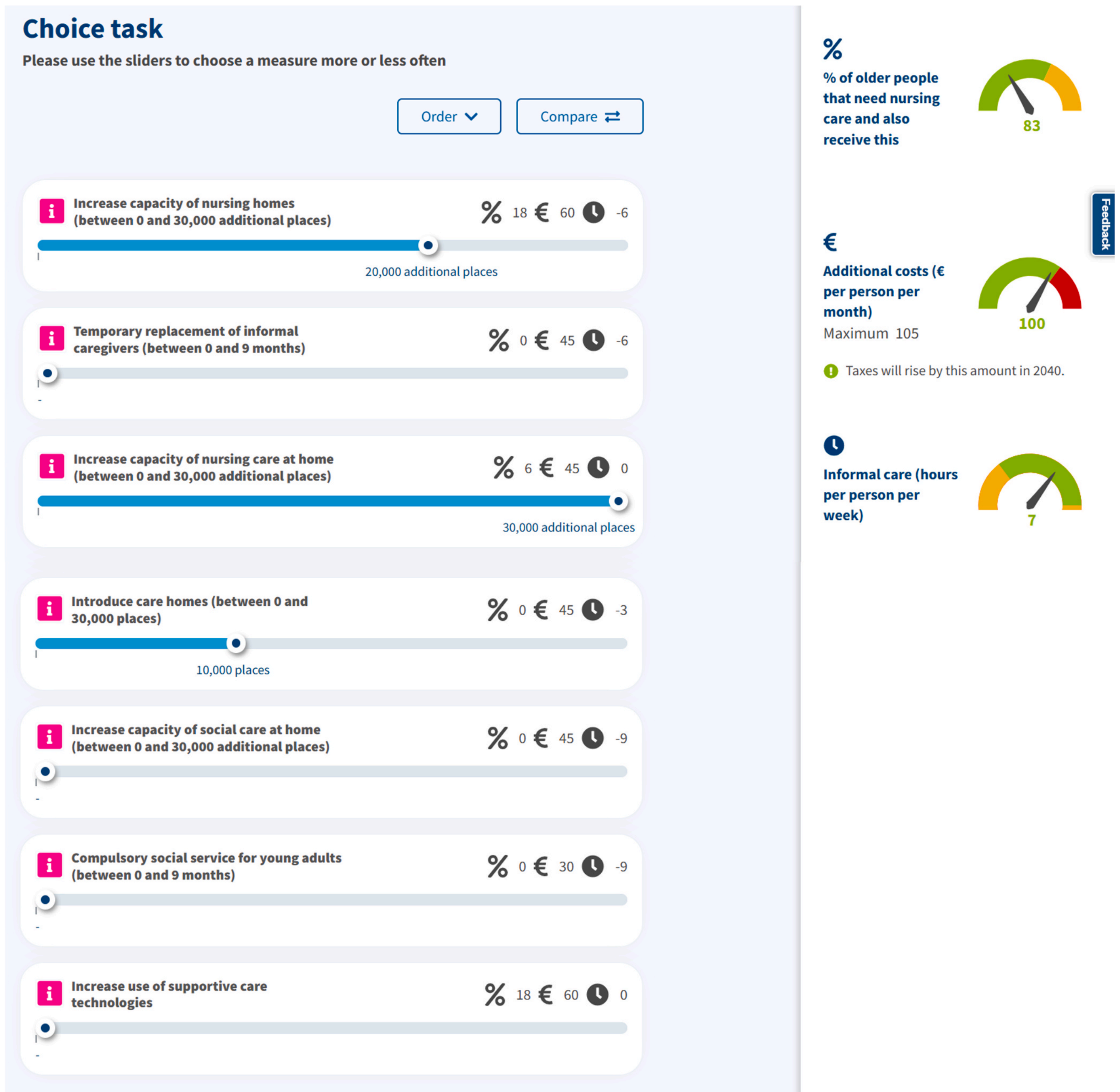

Fig. 1. Exemplary screenshot of the choice task.

sample is roughly representative of the population in terms of gender and education level. In terms of age, older (65 +) respondents are somewhat underrepresented.

All complete responses were included in the main analyses. Additionally, we conducted a sensitivity analysis, reported in Supplementary Material 5, in which responses of suspected low-quality (N = 58, 5.8 % of the total sample) were excluded. Its results support the robustness of the main results.

Estimation approach

First, we estimated a Multiple Discrete-Continuous Extreme Value (MDCEV) choice model. This model accounts for the discrete choices (i.e., whether policy alternatives are included in the chosen portfolio) and the continuous choices (i.e., how often a policy alternative is chosen) that respondents were facing in the choice task, as well as for the constraint (i.e., the budget restriction). The random utility function of the MDCEV model takes the following form (Bhat, 2008):

$$U(x) = \sum_{k=1}^{K} \frac{\gamma_k}{\alpha_k} \left[e^{\sigma(\beta' z_k + \varepsilon_k)} \right] \bullet \left\{ \left(\frac{x_k}{\gamma_k} + 1 \right)^{\alpha_k} - 1 \right\}$$

where $U(x)$ is the utility function with respect to consumption quantity vector x , consisting of K elements (i.e., the policy alternatives (k) in the choice task). The baseline marginal utility of each good (i.e., the marginal utility of each policy alternative at zero ‘consumption’) is represented by $e^{\sigma(\beta' z_k + \varepsilon_k)}$, in which β captures the marginal utility with respect to z_k, which is an attribute of the policy alternative k (or characteristic of the respondent), σ is a scale parameter, and ε_k is a stochastic error term. The translation parameter, γ_k (with $\gamma_k > 0$), allows for corner solutions (i.e., zero ‘consumption’ of a good). Finally, α_k (with $0 \leq \alpha_k \leq 1$), is a satiation parameter that allows for decreasing marginal utility of

consumption (Bhat, 2008). More information on the MDCEV model is presented in Bhat (2008).

We specified the MDCEV model without outside good. Given the potential confounding between the translation and satiation parameters, joint estimation of γ and α is problematic. As a solution, different sub-utility functions (i.e., profiles) can be used (Bhat, 2008), of which we used the α-γ profile.[9] The MDCEV model allows us to examine the marginal utility respondents attached to the policy alternatives and attribute levels in their portfolio choices. Besides, using the preference estimates from the MDCEV model as inputs, we computed the expected utility of each portfolio (i.e., each possible combinations of policy alternatives and attribute levels), averaging over 1,000 repetitions with random draws for the stochastic error term (ε_k). Enumerating over all portfolios, this resulted in a ranking of portfolios with respect to their expected utility. The highest-ranked portfolios are most likely to maximize the expected utility of society given respondents' preferences and the present budget constraint (Dekker et al., 2024). The optimal portfolio analysis is presented as an alternative to the monetary valuation of policy alternatives and attribute level changes. In doing so, we follow Dekker et al. (2024), who adopt a social welfare function approach instead of a consumer surplus approach.[10] Moreover, Chandoevwit and Wasi (2020) argue that an analysis of demand, resembling the optimal portfolio computation presented here, better suits the needs of policy makers than marginal rates of substitution and willingness to pay estimates.

To explore preference heterogeneity, we examined the choice shares by respondents' characteristics. In addition, we conducted a Latent Class Cluster Analysis (LCCA). LCCA uses a factor model in which respondents are assigned to clusters based on simple indicators (i.e., their choices for the policy alternatives in the case of this study). Clusters are formed to maximize preference homogeneity within clusters and preference heterogeneity between clusters (Molin et al., 2016; Vermunt & Magidson, 2002). Since the clusters are latent, the number of clusters is unknown and should be determined by the analyst. A key criterion for this decision is the balance between model fit and model parsimony, which we assessed using the Bayesian Information Criterion (BIC). This criterion was supplemented by criteria regarding the interpretability and communicability of the model and the probabilistic cluster sizes (e.g., Molin et al., 2016). We estimated a three-step LCCA model (Vermunt, 2010). First, a set of models with up to ten clusters was estimated and the preferred model was identified. Next, all respondents were assigned with cluster membership probabilities and, finally, the association between these probabilities and respondents' characteristics (i.e., covariates) was examined (Vermunt, 2010).[11] The LCCA was based on a subsample of the data (N = 928), whereby respondents who answered 'do not know' (for education level) or 'prefer not to say' (for all other covariates) were excluded from this analysis.[12]

Besides the approaches described above, it would have been interesting to include all considered respondent characteristics as interaction terms in the MDCEV models to disentangle preference heterogeneity regarding the policy alternatives from preference heterogeneity regarding the attribute levels in more detail. We have only included respondents' age here as an example (see Table S5 in Supplementary Material 6), because most other respondent characteristics are considered latent variables, which cannot be directly included in an MDCEV model. Instead, one could estimate an integrated choice and latent variable (ICLV) MDCEV model. However, such a model is highly prone to specification issues, difficult to interpret, and may not be suitable to derive policy implications from (e.g., Campbell & Sandorf, 2020; Chorus & Kroesen, 2014), which we considered a disadvantage given our intention to contribute to the public debate. Another alternative is estimating a latent class MDCEV (LC-MDCEV) model with respondent characteristics as covariates. Despite our use of a search algorithm implemented in Apollo incorporating 500 different sets of starting values based on a procedure by Bierlaire et al. (2010), the LC-MDCEV models did not converge for our data. Therefore, we estimated and presented the results of the LCCA model instead.

The MDCEV model has been estimated using the BGW algorithm (Bunch et al., 1993) in the package Apollo (Hess & Palma, 2019) version 0.3.2. in R version 4.2.1. (R Core Team, 2022). The LCCA models were estimated using Latent GOLD 5.1 (Vermunt & Magidson, 2016).

Results

Mean preferences

Descriptive results

The descriptive analysis of the expenditure patterns resulting from respondents' portfolio choices shows that most respondents chose to increase the budget by (almost) the maximum amount that was possible and thus exhausted the resource constraint (nearly) entirely. As can be seen in Fig. 2, two out of three respondents (N = 666) chose portfolios that would constitute a public expenditure increase (through taxation) of between €91 and €105 per adult per month. Almost half of this group (N = 326) chose to exhaust the resource constraint entirely.[13] Less than 4 % of respondents (N = 36) did not choose any policy alternative and thus did not increase public expenditure on LTC for older people at all. On average, respondents' portfolio choices resulted in a public expenditure increase of about €89 (standard deviation: €24).

The choice shares of the policy alternatives, presented in Fig. 3, show that each alternative is included at least once in more than half of respondents' portfolios. Particularly two policy alternatives regarding nursing care (i.e., increasing the capacity of nursing homes, increasing the capacity of nursing care at home) and two policy alternatives regarding formal social care (i.e., introducing care homes, increasing the capacity of social care at home) were often chosen (by 75–77 % of respondents). Two policy alternatives aimed at alleviating the burden on informal caregivers, namely providing respite care to informal caregivers and introducing compulsory social service for young adults, were much less often included (by 57–58 % of respondents). Regarding the number of times the policy alternatives are chosen (i.e., the intensive margin), Fig. 3 shows that each policy alternative is typically chosen not more than once. Depending on the policy alternative, 5–14 % of respondents chose that alternative two or three times. In all descriptive statistics, respondents' preferences for the policy alternatives and for the attribute levels are not yet disentangled. The MDCEV estimates presented below account for this.

[9] The use of the α-γ profile is convenient given our use of the procedure by Pinjari and Bhat (2021), based on this profile, as implemented in Apollo.

[10] They argue: "*The reason for doing so is that the PVE survey is already framed in the application context and the attractiveness of public sector projects can directly be quantified and compared in terms of citizens' cardinal utility without the need for monetary valuation.*" (Dekker et al., 2024, p. 2).

[11] To correct for the underestimation of the association between covariates and class membership probabilities that is typical to a three-step LCCA approach, a maximum likelihood-based correction method was applied. All LCCA models were estimated using 500 sets of random starting values and 500 iterations per set.

[12] Including separate dummies for these answer categories in the models or imputing the most likely alternative answer given the other answers for that respondent were considered as alternative approaches. The first approach yielded many unidentified parameters given the small number of respondents choosing these answer options. The second approach was deemed undesirable because it requires strong assumptions, as we had limited other information on respondents.

[13] It was not possible/feasible for all respondents to come to the amount of €105 exactly, depending on the cost attribute levels of the design version they were presented with.

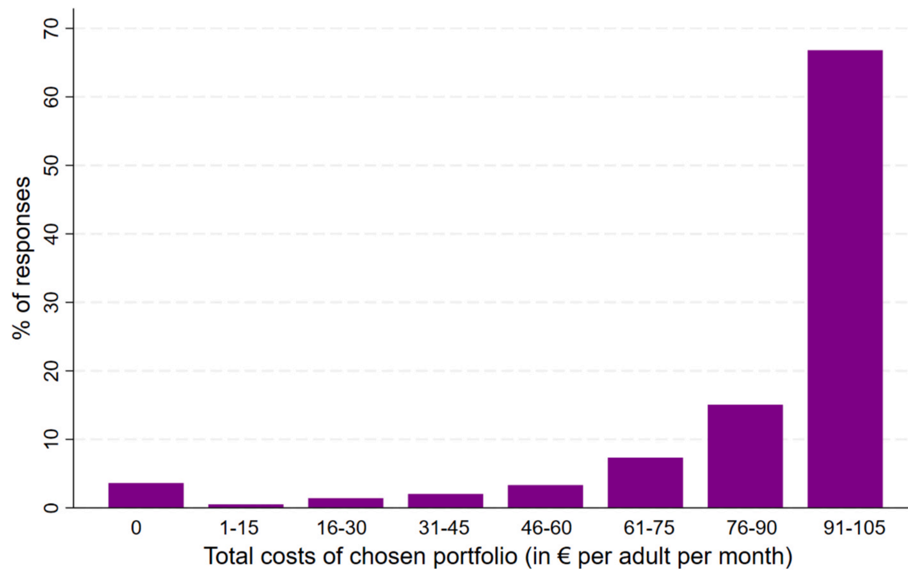

Fig. 2. Distribution of the total costs of respondents' chosen portfolios. *In this Figure, the different cost outcomes have been clustered together in groups of 15 for the sake of clearness of graphical display. In the choice experiment, a large number of cost outcomes was possible, depending on the design version and respondents' choices (see the histogram and Kernel density plot in Fig. S1 in Supplementary Material 3).*

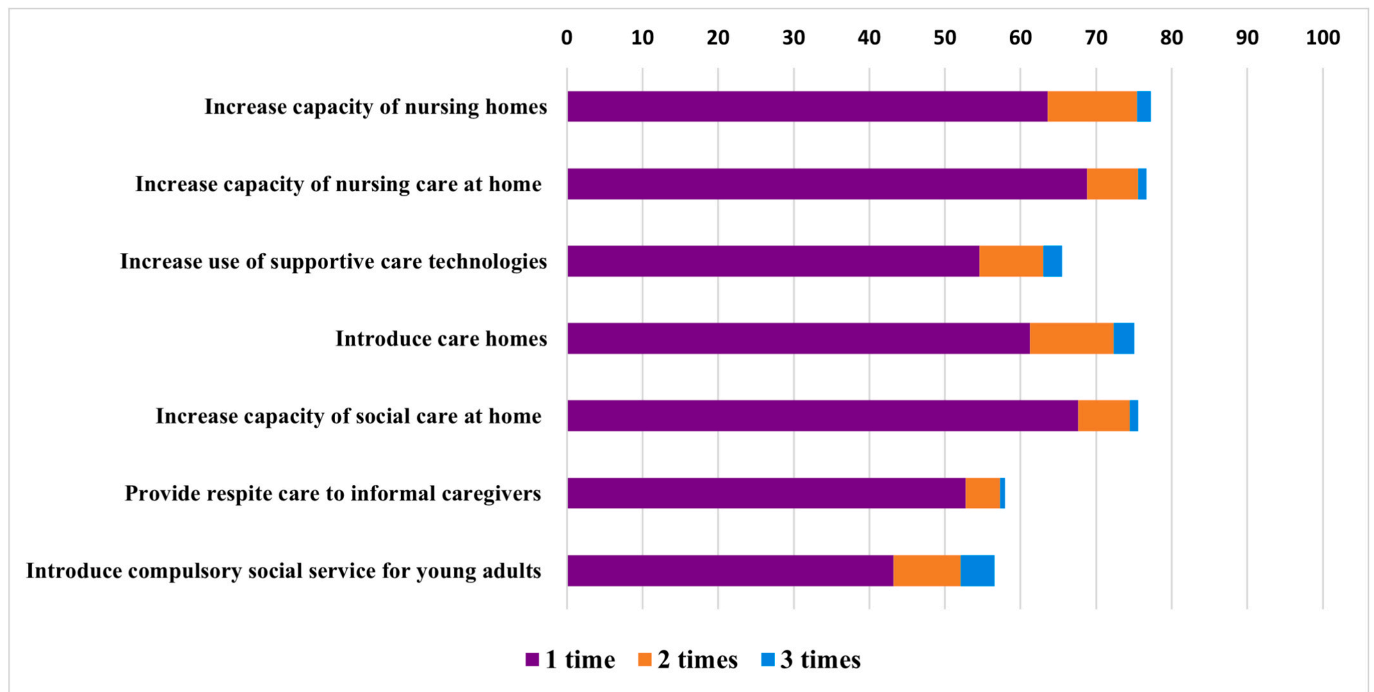

Fig. 3. Choice shares of the policy alternatives. *The percentages of respondents by policy alternative who chose the alternative one, two or three times.*

MDCEV estimates

Table 2 presents the estimated parameters of the MDCEV model. The second column presents the estimates for the utility parameters. For the policy alternative-specific parameters, the estimates in this column describe the relation between 'consuming' a policy alternative (i.e., choosing to allocate funding towards that policy alternative) and respondents' utility, independent of the attributes. All policy alternatives were significantly and positively associated with respondents' utility. The estimates for the taste parameters indicate the association between the attribute levels and respondents' utility, independent of the policy alternatives. Both an increase in the fulfilment of nursing care needs as well as a reduction in the required amount of informal caregiving were significantly associated with respondents' utility. This suggests that respondents' choices are influenced by both attributes, and that respondents prefer to fund policy alternatives that increase the fulfilment of informal care and reduce the required amount of informal care provision. Please note that, in line with other applications of the MDCEV model, no parameter is estimated for the cost attribute, as costs are already embedded in the model through the budget constraint. The fourth column presents the estimates for the translation parameters for the policy alternatives. These parameters govern the continuous choice dimension and represent the level of satiation when choosing a policy alternative more than once, with higher values indicating slower satiation.

Table 2
MDCEV estimates.

Coefficient	Utility parameters (δ/β)	p-value	Translation parameters (γ)	p-value
Remaining budget	NA (fixed)		21.2201 (1.5074)	< 0.0001
Policy alternative-specific parameters				
Increase capacity of nursing homes	3.3404 (0.0740)	< 0.0001	0.8510 (0.0490)	< 0.0001
Increase capacity of nursing care at home	3.1650 (0.0719)	< 0.0001	0.7917 (0.0370)	< 0.0001
Increase use of supportive care technologies	2.7674 (0.0656)	< 0.0001	1.1136 (0.0473)	< 0.0001
Introduce care homes	3.2847 (0.0641)	< 0.0001	0.9368 (0.0423)	< 0.0001
Increase capacity of social care at home	3.3551 (0.0649)	< 0.0001	0.8108 (0.0359)	< 0.0001
Provide respite care to informal caregivers	2.6260 (0.0606)	< 0.0001	1.1024 (0.0380)	< 0.0001
Introduce compulsory social service for young adults	2.3545 (0.0653)	< 0.0001	1.3322 (0.0526)	< 0.0001
Taste parameters				
Additional 1 % fulfilment of nursing care needs	0.0203 (0.0106)	0.0280		
Minus 1 h of informal care provision	0.0748 (0.0184)	< 0.0001		
Scale parameter				
Scale (σ)	0.6112 (0.0101)	< 0.0001		
N	997			
LL(final)	−8929.33			
AIC	17894.65			
BIC	17982.94			

Robust standard errors in parentheses. P-values based on two-sided tests for the policy alternative-specific and scale parameters and one-sided tests for the taste parameters. Abbreviations: AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, LL(final) = Final log-likelihood, N=Number of observations (i.e., respondents).

Optimal portfolio composition

Table 3 shows the ten portfolios with the highest expected utility. For example, portfolio 1 includes an increase in the capacity of nursing care at home by 10,000 places, the introduction of care homes with 20,000 places (i.e., two times 10,000 places), an increase in the capacity of social care at home by 10,000 places, and the provision of respite care to informal caregivers for a maximum of nine months (i.e., three times three months), while increase in nursing home capacity, increase in use of supportive care technologies and compulsory social service for young adults are not selected. Several patterns can be observed from the top ten portfolios. For example, each of these portfolios included at least one of the policy alternatives regarding nursing care and at least one regarding social care. Besides, all portfolios except portfolio 10 contained at least four of the seven policy alternatives. Additionally, increased use of supportive care technologies and provision of respite care to informal caregivers were included at least once in eight out of the ten highest-ranked portfolios. Finally, increasing the capacity of nursing homes and increasing the capacity of nursing care at home seemed strong substitutes: both policy alternatives were included four times while the other was not, and they were included together only once. All ten highest-ranked portfolios exhausted the resource constraint entirely.

Preference heterogeneity

Descriptive results

The choice shares at the extensive margin (i.e., whether a policy alternative is chosen or not) according to respondent characteristics are presented in Figs. S2 and S3 in the Supplementary Materials. Considerable variation was found across policy alternatives, with more heterogeneity for increased use of supportive care technologies and introduction of compulsory social service for young adults. This heterogeneity was most pronounced between age groups: younger respondents included the increased use of supportive care technologies much more often than middle-aged and older respondents, while older respondents included the introduction of compulsory social service for young adults considerably more often than younger and middle-aged

Table 3
Optimal portfolio composition.

Policy alternative	Top 10 portfolios									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Increase capacity of nursing homes	0	1	1	0	2	0	1	0	0	3
Increase capacity of nursing care at home	1	1	0	1	0	1	0	0	1	0
Increase use of supportive care technologies	0	1	1	1	2	1	2	1	2	0
Introduce care homes	2	0	2	0	0	1	1	3	0	0
Increase capacity of social care at home	1	1	0	0	0	1	0	1	1	3
Provide respite care to informal caregivers	3	2	3	3	2	3	3	0	3	0
Introduce compulsory social service for young adults	0	1	0	3	1	0	0	2	0	0
Total costs of portfolio (in € per adult per month)	105	105	105	105	105	105	105	105	105	105

The top ten optimal portfolios within the budget constraint of €105 per adult per month of additional public expenditure. The bold numbers in black in the top row indicate the ranking of the portfolio, the numbers in the bottom row indicate the total costs (in € per adult per month) for each portfolio, and the numbers in the rows in between indicate the frequency of each policy alternative in each portfolio.

Table 4
Estimation results of the LCCA model with four clusters.

Policy alternative	Overall mean	Cluster 1 (51 %)	Cluster 2 (23 %)	Cluster 3 (21 %)	Cluster 4 (5 %)
Increase capacity of nursing homes	77	81	67	95	1
Increase capacity of nursing care at home	77	83	57	97	1
Increase use of supportive care technologies	65	81	54	56	3
Introduce care homes	75	82	58	88	9
Increase capacity of social care at home	76	82	53	100	6
Provide respite care to informal caregivers	58	81	29	44	2
Introduce compulsory social service for young adults	57	82	41	24	8

Prediction of indicators (in % of respondents who included an alternative at least once in their portfolio). Probabilistic cluster shares between brackets.

respondents. Because respondent characteristics may be correlated, these descriptive statistics should not be taken as more than a first indication of preference variation. To address this, we incorporated all respondent characteristics simultaneously as covariates in the LCCA discussed below.

LCCA estimates

After estimating ten cluster models, it became clear from the model fit statistics (presented in Table S2 and Fig. S4 in Supplementary Material 3) that the BIC was minimized for models with between two and four clusters. These models were inspected more closely. Even though the model with three clusters comes with a slightly lower BIC value, the model with four clusters was considered more easily interpretable and communicable.

Table 4 provides the estimates of the four-cluster LCCA model in terms of the choice shares at the extensive margin. Graphical presentations of choice shares by clusters for both the extensive and intensive margin are presented in Figs. S5 and S6 in the Supplementary Materials. From these results, it becomes clear that two of the clusters have rather uniform preferences across the various policy alternatives: Cluster 1 has choice shares of 81–83 % for all policy alternatives and chooses each alternative once on average (between 0.87 and 1.04 times). This cluster, which is the cluster with the largest probabilistic share, thus spreads out the available resources and chooses a diverse portfolio. Cluster 4, on the other hand, has very low choice shares (<10 % on the extensive margin and < 0.19 on the intensive margin) for all policy alternatives. This cluster, with the smallest probabilistic share, thus seems to invest only few additional resources on LTC for older people.

In contrast with Clusters 1 and 4, Clusters 2 and 3 differentiated their portfolio choices over alternatives. Both clusters choose more often for the institutional and home-based nursing and social care policy alternatives and increasing the use of supportive care technologies than for providing respite care for informal caregivers and introducing compulsory social service for young adults. A difference is that Cluster 3 has higher choice shares for the institutional and home-based nursing and social care alternatives (88–100 %) than Cluster 2 (53–67 %). The same pattern applies to providing respite care to informal caregivers (44 % for Cluster 3 versus 29 % for Cluster 2), while the opposite holds for introducing compulsory social service for young adults (24 % and 41 % for Clusters 3 and 2, respectively). The expenditure patterns arising from the clusters' preferences[14] (presented in Fig. S7 in Supplementary Material 3) show that the mean costs of respondents' portfolio choices are higher for Clusters 1 and 3 (€97 and €95, respectively) than for the overall sample (€89). Cluster 2 has a mean portfolio cost of €81, while this amounts to only €7 in Cluster 4.

Table 5
Cluster membership probabilities by respondent characteristics.

Policy alternative	Cluster 1 (51 %) (ref.)	Cluster 2 (23 %)	Cluster 3 (21 %)	Cluster 4 (5 %)	Wald-test score	p-value
Prediction of cluster membership probabilities						
Age					13.042	0.042
18–34 years (ref.)	0	0	0	0		
35–64 years	0	− 0.535 (0.380)	0.292 (0.434)	0.729 (0.565)		
65 + years	0	− 1.062 (0.437)	− 0.571 (0.524)	0.198 (0.640)		
Gender					8.467	0.037
Man (ref.)	0	0	0	0		
Woman	0	− 0.421 (0.314)	0.569 (0.305)	− 0.217 (0.376)		
Work experience in healthcare					8.284	0.041
No (ref.)	0	0	0	0		
Yes	0	− 0.045 (0.337)	− 0.969 (0.358)	− 0.119 (0.377)		
Probabilistic distribution for the covariate levels over the clusters (%)						
Age						
18–34 years	45	33	19	4		
35–64 years	49	19	26	6		
65 + years	66	15	16	4		
Gender						
Man	51	27	17	6		
Woman	52	17	27	4		
Work experience in healthcare						
No	50	19	22	4		
Yes	55	27	13	5		

Probabilistic shares (for the clusters) and robust standard errors (for the coefficients) in parentheses. Please note that the percentages may not sum up to 100 for each covariate level due to rounding to integers. Ref.: Reference category. Other (non-significant) covariates included in the reported model were education level, provision of informal care, self-reported health, housing status, and self-assessed financial situation.

Age, gender, and having work experience in healthcare were the only respondent characteristics significantly associated with cluster membership probabilities (at the 95 % level) (Table 5). Education level, informal care provision, self-assessed health, housing situation and self-reported financial situation did not significantly vary with cluster membership probabilities. Older respondents (age 65 +) were much more likely than younger and middle-aged respondents to belong to belong to Cluster 1. Younger respondents (1 –34 years) were more likely than the two older age groups to belong to Cluster 2, and respondents of middle age (35–64 years) were somewhat more likely to belong to Cluster 4. Men were more likely than women to belong to Cluster 2 and somewhat more likely to belong to Cluster 4, while women were more likely to belong to Cluster 3. Finally, people who have worked in

[14] The expenditure patterns by cluster and choice shares at the intensive margin are derived post-hoc from the LCCA with choice shares at the extensive margin as indicators (i.e., rather than from separate LCCAs with other indicators). For this aim, sample weights based on cluster membership probabilities were applied to the descriptive statistics.

healthcare were more likely to belong to Clusters 1 and 2 than respondents who have never worked in healthcare.

Conclusion and Discussion

In this study, we examined the preferences of a broad sample of citizens in the Netherlands for LTC policies for older people in 2040. In a constrained portfolio choice experiment, respondents composed a portfolio of policy alternatives, subject to a budget constraint of €105 of additional expenditure per adult citizen per month. Four main findings emerge from the study results.

Firstly, on average, respondents derive positive utility from all policy alternatives, and each of the seven policy alternatives is chosen by more than half of the respondents. Policy alternatives regarding institutional and home-based nursing and social care were most preferred, while respite care and compulsory social service for young adults were least preferred. Policy alternatives were typically chosen only once in a portfolio. This suggests a preference for distributing public resources towards multiple policy alternatives over investing substantially in one or two particular policy alternatives, which seems a novel finding relative to the existing literature.

Secondly, the attributes played a significant role in respondents' choice behaviour, since respondents derived positive utility from fulfilment of nursing care needs and reductions in need for informal caregiving. This is also reflected in the optimal portfolio analysis, as all ten highest-ranked portfolios contain policy alternatives affecting both these outcomes. In the optimal portfolios, increased use of supportive care technologies and provision of respite care to informal caregivers were often included. As far as we know, this is also a new finding in the literature, due to our novel approach of combining a multi-attribute preference-based approach with a societal preference-elicitation perspective.

Thirdly, most respondents chose for portfolios that would require substantial increases in expenditures. All ten highest-ranked portfolios completely exhausted the budget constraint. If taken as consequential, this would indicate an average willingness to a accept a substantial tax increase to provide policymakers with the fiscal capacity to adopt additional policy measures to address the rising demand for LTC. This goes against recent policy developments in the Netherlands, relying more strongly on participation of families and the community in providing informal care at home (Maarse & Jeurissen, 2016). At the same time, this finding corresponds with the results of a recent choice experiment in the Netherlands on resource allocation over different healthcare purposes, in which respondents allocated most additional resources to LTC (Boxebeld et al., 2024a). It also corresponds with findings of several recent studies in other countries (using different research designs) documenting support for increasing expenditure to improve and expand (access to) LTC services (e.g., Amilon et al., 2020; Janus & Koslowski, 2020; Milte et al., 2024).

Fourthly, the results show the existence of preference heterogeneity in our sample. The LCCA results suggest this is associated with respondents' age, gender and work experience in healthcare. Previously, studies showed substantial polarization of preferences for resource allocation at the level of prioritizing individual patients (Awad et al., 2022) and at the level of allocating collective resources to different healthcare purposes (Boxebeld et al., 2024a). In this study, heterogeneity in choice shares was most pronounced for increasing the use of supportive care technologies and the introduction of compulsory social service for young adults. This finding may provide directions for governments to broaden the support base for specific policy alternatives. For instance, governments interested in the increased use of supportive care technologies may aim to better understand the reasons for the lower support among middle-aged and older respondents. In turn, this allows governments, LTC suppliers, technology developers and researchers to design targeted solutions in response to the elicited reasons. To this aim, citizens' preferences and broader attitudes towards LTC for older people would need to be further explored, for instance by attending to the motivations underlying these preferences.

Concluding, policymakers can use the study results to align their policy decisions in LTC more closely with citizens' preferences. They are recommended to make use of this capacity to implement a diverse portfolio of policy alternatives, providing in both nursing and social care needs. The policy alternatives regarding the increased use of supportive care technologies and the provision of respite care to informal caregivers are particularly encouraged, conditional on the policies' effectiveness and efficiency in practice. While various forms of respite care are more commonly adopted and arguably less challenging to implement, the use of supportive care technologies in long-term care remains relatively limited. This may have to do with (perceptions of) privacy issues and ethical dilemmas regarding their use in long-term care (e.g., Dickinson et al., 2021; Tian et al., 2025), barriers in usage by healthcare personnel (e.g., Macdonald et al., 2021), and financial reasons (Chapman et al., 2023). At the same time, supportive care technologies are also seen as promising in terms of alleviating the burden on professional and informal caregivers, enhancing productivity, and fostering social interaction (e.g., Chapman et al., 2023; Mosca et al., 2017). Thus, while the presence of public support and the availability of funding could foster the wider adoption of supportive care technologies, more barriers need to be overcome. Potential directions include the development of more guidance and support for caregivers in working with supportive care technologies, the identification of needs for further regulation of such technologies in relation to privacy issues and ethical concerns, and the assessment of the cost-effectiveness of these technologies (e.g., Chapman et al., 2023; Dickinson et al., 2021; Macdonald et al., 2021).

CRediT authorship contribution statement

Sander Boxebeld: Writing – original draft, Visualization, Software, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Niek Mouter:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Job van Exel:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Descriptive sample statistics

Table A1
Study sample compared with the general population in terms of sociodemographic characteristics.

Sociodemographic characteristic	Total sample (N = 997)		LCCA sample (N = 928)		Population [b]
	(N)	(%)	(N)	(%)	(%)
Age					
18–34	266	26.7	234	25.2	27.2
35–64	538	54.0	514	55.4	47.5
65+	191	19.2	180	19.4	25.3
Prefer not to say	2	0.2	–	–	–
Gender [a]					
Man	484	48.5	455	49.0	49.4
Woman	509	51.1	471	50.8	50.6
Non-binary	3	0.3	2	0.2	
Prefer not to say	1	0.1	–	–	–
Education level					
No university (of applied sciences)	647	64.9	599	64.5	64.0
University (of applied sciences)	349	35.0	329	35.5	35.4
Do not know	1	0.1	–	–	0.5

a) Respondents were asked for their gender identity, but the descriptive statistics for the general population are based on registered gender/sex, which is a different but rather strongly correlated concept.
b) Descriptive statistics for the general population aged 18 and older for June 2024 (for gender and age) and aged 15 and older for the second quartile of 2024 (for education level) were retrieved from Statistics Netherlands. (n.d.a); Statistics Netherlands. (n.d.b).

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jeoa.2025.100599.

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