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Households' heterogeneous welfare effects of using home equity for life cycle consumption☆

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ABSTRACT

Using a life-cycle model and a representative sample of households, we analyze the extent to which using home equity leads to (heterogeneity in) welfare gains over the life cycle. The most policy-feasible option to borrow against 50% of home equity over the life cycle leads to median (average) welfare gains of 7% (11%). However, we find substantial heterogeneity with half of the households facing a welfare gain between 3% and 13%. Much of this heterogeneity is explained by heterogeneity in households' income and (housing) wealth and less so by heterogeneity in their demographics or preferences for consumption smoothing and time.

The role of housing wealth over the life cycle

Much research has been devoted to consumption and savings decisions in the life-cycle model (LCM), with a particular interest in the decumulation of wealth at retirement.[1] One of the key observations in the literature is that households decumulate wealth too slowly in retirement according to the life-cycle model (Love et al., 2009; Poterba et al., 2011; De Nardi et al., 2016). Thus far, one of the main drivers suggested by the literature, next to bequest motives (Dynan et al., 2002), is the role of uncertain out-of-pocket medical expenses at older ages (De Nardi et al., 2014; Ameriks et al., 2020) and its interaction with bequest motives (Lockwood, 2018). Many studies, like Cocco (2005) and Yao and Zhang (2005), show the importance of homeownership for life cycle consumption and savings decisions. However, relatively few papers have considered the illiquidity of housing wealth as a viable reason for the slow decumulation of wealth in retirement (Suari-Andreu et al., 2019).

Poterba et al. (2011) show that housing is an important illiquid asset that is conserved until very late in life. In line with this, Cocco (2013) is the first to highlight the importance of alternative mortgage products and argues that products that are characterized by low initial mortgage payments (relative to loan amount) can achieve better life cycle consumption smoothing for those with high and relatively certain expected future income. Moreover, Nakajima and Telyukova (2020) show that dissaving in retirement is much slower among homeowners than among renters. This is due to the fact that homeowners prefer

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[1] i.e. the Retirement-Savings Puzzle.

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to stay in their home, but cannot easily borrow against their housing wealth. Nakajima and Telyukova (2017) shows that liquidating housing wealth through reverse mortgages leads to welfare gains for the average retired homeowner. However, actual take-up rates of reverse mortgages are still low among this group (Achou, 2021).

This paper is the first to quantify welfare gains over the life cycle from liquidating housing wealth using a representative sample of households from a combination of administrative and survey data. It is important to measure the size of possible welfare gains from liquidating housing wealth and discuss how the current system, which largely prevents households from liquidating housing wealth over the life-cycle, prohibits households to benefit from their growth in housing wealth. We hypothesize that there is substantial heterogeneity in welfare gains from releasing housing wealth. We compare the situation of illiquid housing to several scenarios that involve different degrees for using housing wealth to finance consumption.

Our analysis builds forth upon Cocco (2013) and Nakajima and Telyukova (2017), with the premise that the house can be both a savings-device during the accumulation period and an income-device during retirement similar to traditional (pension) savings accounts. However, current mortgage products make it hard for the house to function like regular savings accounts. Since we are primarily interested in the role of home equity in life cycle consumption smoothing, we focus on homeowners and assume homeownership to be exogenous, similar to Yogo (2016).[2] We analyze the welfare gains of increased possibilities to liquidate home equity over the life cycle. As such, this paper focuses on the welfare gains from consumption smoothing and, more particularly, of consuming too little over the life cycle due to liquidity constraints. This contrasts papers that use life-cycle models to calculate the optimality of savings.[3]

Nakajima and Telyukova (2017) show that the welfare gains from reverse mortgages are substantial for retirees in the US.[4] With computationally more advanced techniques that allow for more stochastic parameters, Koo et al. (2022) come to similar conclusions for Australian retirees. Compared to Nakajima and Telyukova (2017), we make three substantial contributions. Firstly, the model calculates welfare gains for a representative sample of households over the life cycle. Whereas Nakajima and Telyukova (2017) focus on retirees, we also investigate the possibility to liquidate (part of the) housing wealth before retirement. This allows us to analyze within-population heterogeneity in welfare gains from liquidating housing wealth to finance consumption over one's complete life cycle. Such population-wide heterogeneity is not considered in calculating welfare effects of liquidating housing wealth before. Secondly, in addition to a traditional reverse mortgages, we analyze financial products in which households (partly) sell their house with a rent-back agreement. Thirdly, we try to understand the drivers of the (heterogeneity in) welfare effects by focusing on (1) heterogeneity in households' actual income and wealth, and (2) heterogeneity in preferences. Our LCM calculates welfare effects given households' elicited preference parameters. This allows us to investigate the extent to which heterogeneity in preferences for smoothing and time drive any heterogeneity in welfare gains for our representative sample of homeowners. Additionally, we show the importance of the strength of bequest motives for welfare effects, which is important as bequests are often not considered in models calculating optimal savings (Scholz et al., 2006; Crawford and O'Dea, 2020; Ciurila et al., 2020). Including such heterogeneity among actual households goes beyond models that include heterogeneity by allowing for a heterogeneous agent, like Bovenberg et al. (2007), or models that use a representative agent with actual data as input into the model, like Scholz et al. (2006), Ciurila et al. (2020, 2022). Gomes (2020) mentions incorporating more household heterogeneity as the prime direction for future research in portfolio decisions over the life cycle.

Using actual households allows us to study the heterogeneity in outcomes in a representative sample. Such heterogeneity is of importance as welfare gains and losses are non-linear in the size of the deviation (Browning and Crossley, 2001). Our approach allows us to estimate the distribution of welfare gains and losses of homeowners, who differ in age, income, and wealth. Data on age, income, and wealth are derived from high-quality administrative records of Dutch households. Moreover, we allow the sample of homeowners to differ in their preferences for intertemporal consumption smoothing and time. Kapteyn and Teppa (2011) and Von Gaudecker et al. (2011) show that heterogeneity in preferences, such as for risk, is large and can explain households' portfolio decisions. Information regarding smoothing and time preferences come from representative survey data of Dutch households. As far as we know, we are the first to combine administrative and stated preferences information to address a population's heterogeneity among households in welfare analyses. As such, our paper follows the main direction for future research as outlined by Gomes (2020).

We use a unique combination of administrative data and elicited preferences from survey data for Dutch households. The administrative data reduces issues with self-reported income and wealth compared to the survey data in other studies. The Netherlands is an interesting case because of high mandatory pension accumulation, universal coverage of (long term) health care insurance with internationally low out-of-pocket medical spending, and a highly subsidized and regulated housing market that typically consists of many households owning a home.[5] This combination implies that Dutch households accumulate relatively many assets in illiquid wealth whilst having relatively low costs at the end of life. Following the approach of Scholz et al. (2006), Ciurila et al. (2020) find that the majority of the Dutch households save more than optimally according to the life cycle model and that most of these savings are illiquid.[6] According to the Mercer Global Pension Index (Mercer, 2009-2020), the lack of flexibility in choices is one of the main threats to the Dutch pension system that otherwise outperforms other pension systems in terms of adequacy and sustainability.

Our results suggest that selling (part of) the house with a rent-back agreement at retirement leads to an average welfare gain of about 3%. Welfare gains exist because liquidating housing equity allows households to smooth consumption over the life-cycle (and avoid unintended bequests). The median welfare gains are much smaller and close to zero. However, there is large heterogeneity in welfare consequences for different households. For some households, this variant even leads to welfare losses. Allowing households to borrow against their housing wealth, at most either 50% or 100%, leads to more substantial welfare gains for the average and median household. These variants cannot lead to welfare losses as they are an option and not mandatory. We argue that the 50%-variant is most feasible to implement. For the median (average) household borrowing against 50% of housing wealth leads to a welfare gain of about 7% (11%). Welfare gains are larger for the first-best option of borrowing against 100% of housing wealth: 11% (19%).

[2] In Section "Institutional framework", we explain that in the highly subsidized and regulated Dutch housing market the choices for renting versus homeownership is limited. The social housing market is only available for vulnerable households and the private rental market is very small and relatively expensive compared to owning a house. Therefore, the assumption for homeownership to be exogenous seems quite in line with the actual situation.

[3] E.g. Scholz et al. (2006), Crawford and O'Dea (2020), Ciurila et al. (2020).

[4] For an overview of the problems and prospects of reverse mortgages for financing consumption in retirement we refer to Caplin (2002).

[5] Hence, the welfare gains from liquidating housing wealth may be interpreted as an upper bound for countries with less regulated pension, (long term) health care insurance, and housing markets.

[6] This is consistent with empirical evidence from Knoef et al. (2016), Been and Goudswaard (2023) and Van Ooijen et al. (2015), Suari-Andreu et al. (2019) showing that Dutch households have high net replacement rates, do not decrease spending, and do not decumulate wealth at retirement, respectively.

Nonetheless, there is large heterogeneity in the welfare consequences among households; half of the households face a welfare gain between 3% and 13% in the most feasible variant. Much of this heterogeneity comes from households' differences in combinations of income and (housing) wealth. We find no empirical evidence for preferences regarding consumption smoothing and time driving this heterogeneity in welfare effects: Firstly, allowing for heterogeneity in these parameters do not statistically explain welfare effects. Secondly, our welfare effects are relatively insensitive to different values assumed for consumption smoothing and time preferences. However, we do find that the strength of the bequest motive is an important factor in determining the welfare gains and their size.

The structure of this paper is as follows. We explain the institutional context in Section "Institutional framework". Section "Data" describes the data. Section "Model" introduces the life-cycle model that is used for our welfare analysis. Section "Results" obtains the welfare effects from different scenarios for liquidating housing wealth. Our model and results are put in perspective in Section "Discussion". Section "Conclusions" concludes.

Institutional framework

The Dutch pension system is considered to be one of the best in the world (Mercer, 2009-2020), especially in terms of providing an adequate income in retirement. The success of the pension system is partially explained by the largely mandatory nature of participating in state pension and occupational pensions. Despite the income adequacy of the pension system, Knoef et al. (2016) show that housing wealth remains an important component of all available wealth available at retirement (about 65% (62%) of average (median) households' total non-pension wealth). Annualizing household wealth would increase income in retirement by about 20% according to Knoef et al. (2016), which makes it a non-negligible source of income next to the traditional state pensions and occupational pensions.

In part, this importance of housing wealth has been induced by the tax-favorable treatment of homeownership. The largest favorable tax treatment in terms of effects on public finance is mortgage interest deductibles (*hypotheekrenteaftrek*) in the Netherlands. Until 2017, up to about 52% of paid interest on the mortgage could be deducted from income taxes for a time span of 30 years. Although mortgage interest rate deductibles stimulate homeownership (about 57% (57%) of all housing is owner-occupied housing in the Netherlands in 2018 (2023)[7]), and thereby saving through housing wealth, it is also seen as the main disruptor of the housing market (OECD, 2021). The favorable tax treatment of the house primarily benefits the wealthy, has a large impact from a public finance perspective, but also because it drives the large growth in housing prices observed in the Netherlands. Therefore, the deductible percentage has been reduced in yearly steps since 2017 to 49.5% (36.93%) in 2018 (2023). Another consequence of the mortgage interest deductions is that redemptions of the mortgage are not stimulated. As of the early 2010s, policy has stimulated redemption of households mortgages by no longer fiscally subsidizing interest-only, i.e., redemption-free mortgages. Together with the high mandatory contributions to second pillar pensions, homeowners are stimulated to accumulate a sizeable portion of illiquid wealth at the retirement age.

The large growth in housing prices (partially) induced by mortgage interest deductions has caused the Dutch housing market to be strongly segregated in three types of housing: homeownership, social rent, and private rent. Whereas homeownership is stimulated through tax deductions, social rent receives heavy subsidies directly. Social rent applies to housing with a rent of at most 711 (808) euros per month in 2018 (2023). Anyone is potentially eligible for this type of housing. However, 80% of social rent housing should be devoted to households with a family income of at most 36,698 (44,035) euros per year in 2018 (2023). Only 10% is allowed to go to households with a family income beyond 41,056 (48,625) euros per year in 2018 (2023). The attractiveness of social rent is further stimulated through housing benefits (*huurtoeslag*) provided by the central government to social renters with both a low household income and wealth below a certain threshold. Due to the large demand for social rent, most municipalities face long waiting lists for allocating households to social renting homes. Due to the highly subsidized options of homeownership and social rent, private rent (with a rent of more 711 euros per month) is often relatively expensive and not an option for many households.[8] Therefore, this type of housing covers only about 13% of the total housing market in the Netherlands in 2020.[9]

Those who are eligible for social rent usually do not have the option for private rent or homeownership. Similarly, those who are not eligible for social rent usually choose homeownership. This has to do with a long history in which home ownership is financially much more attractive than private rent. The availability of owned houses is (therefore) also much larger than for rental houses. Additionally, frictions and transfer taxes limit flows in the Dutch housing market. The highly subsidized and regulated housing market, with limited availability of privately rented houses, along with tax subsidies for owned houses, makes the decision to buy a house quite evident.[10] This justifies assuming homeownership to be exogenous in our model, as the percentage of households who actually endogenously choose between rent and homeownership is relatively small.

Data

Data sources and selection

To obtain the welfare effects of liquidating housing wealth for a representative sample of Dutch households, we use households' characteristics from two merged data sets. Firstly, we use administrative data from Statistics Netherlands with information regarding income and wealth. Secondly, we use survey data from the Dutch *Longitudinal Internet Studies for the Social Sciences* (LISS) panel with information on preferences regarding consumption smoothing and time.

Administrative data

To avoid reporting biases in income and wealth such as present in survey data, we use high quality administrative data from Statistics Netherlands to identify households' income as well as wealth in various types of assets. We take the 2018 *Integral wealth data* which includes the whole Dutch population in 2018, i.e. about 17 million individuals. Information regarding income and wealth reported in these data comes from the national tax office and is complemented with information from banks and pension funds.

The dataset contains detailed information on personal and household income, both gross and net. Different types of wealth are considered in the data including housing wealth, savings accounts,

[7] https://www.cbs.nl/nl-nl/cijfers/detail/82900NED

[8] It is common practice that landlords of private renting also ask for a monthly gross income that is at least four times as high as the gross monthly rent (Verberk et al., 2019).

[9] https://www.cbs.nl/nl-nl/cijfers/detail/82900NED

[10] This is also illustrated by the Dutch Central Bank (DNB). They report about the large imbalance between buying and renting. DNB expresses the concern that, whereas the social rental sector and homeownership are subsidized, the private rental sector is the only one not favored by government policy. Homeowners receive fiscal subsidies for mortgage interest expenses. The current rate of deductibility of the mortgage interest rate is about 37%. For many households in our data it was even 52% in the past. Additionally, they pay hardly any tax on their property wealth, while renters who accumulate wealth outside their home are taxed on this (https://www.dnb.nl/algemeen-nieuws/dnbulletin-2020/woningmarkt-en-samenleving-gebaat-bij-betere-balans-tussen-koop-en-huur/).

stocks/bonds, company wealth, and movable property. Additionally, there is information on debt which allows us to compute net wealth. In particular, mortgage debt and non-mortgage debt are considered.

Since state pensions and occupational pension wealth are important in the Netherlands, we add information from the 2018 *Pension entitlements statistics*. These data provide us with persons' wealth accumulated through occupational pensions. Together with the detailed information on personal wealth, this gives an almost complete picture of households' wealth. We miss wealth accumulation through voluntary pension products, i.e. third pillar, but (Knoef et al., 2016) have shown that this wealth component is fairly small compared to total wealth.

LISS survey

LISS is a reoccurring panel that is administered by Centerdata at Tilburg University. The panel is recruited through address based sampling (no self selection), and households without a computer and/or internet connection receive an internet connection and computer free of charge. This household panel, representative for the Dutch population, receives online questionnaires each month on different topics. When respondents complete a questionnaire they receive a monthly incentive. The response rate is generally around 80%. In this study we use data about pensions, collected in May and June 2018.[11]

We select homeowners and merge the LISS data with administrative data from Statistics Netherlands. This leaves us with 3892 households. For a detailed overview of the data selection and representativeness of the LISS panel, we refer to Appendix A. In particular, the characteristics of the admin and survey samples are quite similar (compare columns (2) and (3) in Appendix A). Focusing on the sample of homeowners, however, shows that homeowners tend to have different characteristics than the average person. Especially, homeowners tend to have higher income and wealth, on average (compare columns (3) and (4) in Appendix A). Unfortunately, the questions on preferences regarding risk (i.e. the inverse of preferences for smoothing in a setting without risk) and time are not answered by all respondents. Using both risk and time preferences we are left with 933 households. On average, those who responded to the preferences questions do not differ a lot from the total sample of LISS respondents regardless of whether they responded to the preference questions or not (compare columns (4) and (5) in Appendix A). Empirically, we find in our regression estimates no evidence for systematic differences between respondents that did or did not fill out these preferences questions.

Regarding preferences, respondents answer the following questions. Firstly, respondents are asked about their risk aversion by responding to the following statement on a 7-scale ranging from "totally agree" to "totally disagree":

Q_{risk}: *I am prepared to take the risk of losing money if there is also a chance that I will win money.*

Respondents' average is $\overline{Q_{\text{risk}}} = 3.5$ on a scale from 1 to 7 with a standard deviation of 1.7. Note that, in our setting with CRRA utility without income risk, this question may also be interpreted as preferences for consumption smoothing since this is inversely related to risk preferences. We explain this more extensively below. Secondly, people are asked about their time preference:

Q_{time}: *I am prepared to spend money now without worrying too much about what the future will bring.*

Respondents' average is $\overline{Q_{\text{time}}} = 3.4$ on a scale from 1 to 7 with a standard deviation of 1.7.

Although the survey questions we can merge to the administrative data to measure people's preferences are of a qualitative nature, we find that the distribution of our elicited preferences is relatively similar to the quantitatively elicited distribution presented by Goossens et al. (2022). This gives us confidence in that potential issues regarding eliciting preferences more qualitatively, such as respondents being overly inclined to choose the middle-answer, may not be a big issue in our application. Ideally, the risk and time preferences are elicited using more quantitative measures.

Summary statistics

Table 1 shows summary statistics regarding personal and household characteristics, income, (housing) wealth, and preferences. Based on the standard deviation relative to the mean, we observe that households are especially heterogeneous with respect to income and wealth in Table 1.

Model

Model set-up

As our basis for the welfare analysis we use a life-cycle model with a bequest motive. Each household in our sample starts with the empirically observed characteristics on age, gender, household type (single or pair), income, and wealth. All variables are observed in the year of our LISS survey (2018). Projections of future income are based on age-specific income profiles with households assuming no future changes in the age-specific income percentile.[12] Mortality is stochastic. In case the last household member dies, the remaining assets a_t are left as a bequest, which provides utility $v(a_t)$ to the household.[13]

Households choose the series $c = \{c_t\}_{t=1}^{T}$ of standardized consumption that maximizes the value function V_t at $t = 1$:[14]

$$V_t = \max_{c} \left[u\left(c_t\right) + \beta \left[p_t v\left(a_t\right) + (1 - p_t) E[V_{t+1}] \right] \right] \tag{0.1}$$

subject to initial assets $a_0 = \overline{a}_0$ (measured at 1 January 2018), terminal value $V_{T+1} = 0$ and the budget constraint[15]

$$a_t = a_{t-1} + r\left[a_{t-1} - h^o_{t-1}\right]^+ + r^m\left[a_{t-1} - h^o_{t-1}\right]^- + y_t - c_t \qquad t = 1, \ldots, T, \tag{0.2}$$

where

- (a_t) net total assets (liquid assets + net housing wealth h^o).
- (c_t) consumption, consumed just after receiving net income y_t.
- (h^m_t) housing assets as collateral for mortgages (i.e., face value of mortgage debt outstanding).
- (h^o_t) predetermined net housing wealth.
- (p_t) mortality probability at household level, just after consumption decision ($p_T = 1$).
- (y_t) predetermined household net income (after housing costs). Consists of liquid income and illiquid income (return on housing wealth).

[11] A description of the questionnaire in English can be found at this link: https://doi.org/10.17026/dans-2zv-ze72

[12] Details are in Appendix B.

[13] In the model we do not consider future reception of bequests. While this results in an underestimation of the true amount of assets, we expect this underestimation to be small. Firstly, because for many older cohorts in our sample, it is likely that their parents have already passed away (and the bequest is already included in the assets). Secondly, for most people bequests are not that high. E.g. in 2020, the median (gross) bequest is 'only' 33,000 euros per deceased and needs to be distributed among the heirs (see https://www.cbs.nl/nl-nl/cijfers/detail/84242NED). Consequently, the after-tax amount per beneficiary is relatively small compared to the life-cycle income and assets we are considering in our model.

[14] Technical details are in Appendix C.

[15] $[x]^+ = \max(x, 0)$ and $[x]^- = \min(x, 0)$.

Table 1
Summary statistics.

	N	Mean	SD
Characteristics			
Female (0, 1)	3,892	0.532	0.499
Number of children (0–6)	3,892	1.737	1.870
Immigrant (0, 1)	3,892	0.151	0.360
Immigrant gen. (1–2)	588	1.503	0.500
Couple (0, 1)	3,892	0.680	0.467
Age (cont.)	3,892	51.173	16.958
Age partner (cont.)	2,647	51.408	14.943
Income & Wealth (x 1,000 euro)			
Personal income (gross)	3,892	39,148	31,474
Personal income (gross) partner	2,646	39,984	33,810
Accumulated pensions	3,892	5,741	9,645
Accumulated pensions partner	2,646	6,520	10.497
Projected pension income	3,892	11,093	14,448
Projected pension income partner	2,647	12,319	14,969
Total HH wealth	3,892	256.385	584.362
HH housing wealth	3,892	287.084	155.835
Mortgage debt	3,892	154.654	135.436
Preferences			
Consumption smoothing (1–7)	934	3.475	1.685
Time (1–7)	973	3.358	1.686

Table 2
Overview of parameter and exogenous variables.

Parameter	*Homogeneous preferences*	*Heterogeneous preferences*
Smoothing preference	$\gamma = 2.26$ (mean(γ_i) ~ (Koijen et al., 2016))	$\gamma_i = 4 - \frac{1}{2} Q_{i,\text{risk}}$ from LISS survey June 2018.
Time discount	$\beta = 0.97$ per annum (Crawford and O'Dea (2020), middle and higher educated, multiple year steps)	$\beta_i = 0.97^{\wedge}\{\frac{Q_{i,\text{time}}}{Q_{\text{time}}}\}$ from LISS survey June 2018.
Bequest scaling factor	$\theta = 1.09$ (Ameriks et al., 2020).	
Bequest translation	$\kappa = 0.85 \cdot 7.83 \cdot 10^3$ euros (Ameriks et al., 2020).	
Real return on liquid assets	$r = 1\%$ per annum.	
Real return on housing wealth	$r^h = 1\%$ per annum.	
Rental rate	$r^r = 2\%$ per annum.	
Real mortgage rate	$r^m = 2\%$ per annum.	
Equivalence factors	$\chi_1 = 1$ and $\chi_2 = 1.37$ (Nakajima and Telyukova, 2017).	
Initial net total assets	$\overline{a}_{0i}$ from Statistics Netherlands, measured on 1 January 2018.	
Initial mortgage debt	h^m_{0i} from Statistics Netherlands, measured on 1 January 2018.	
Initial net housing wealth	h^o_{0i} from Statistics Netherlands, measured on 1 January 2018.	
Projected income	y^{hh}_t (See Appendix B).	
Projected pension	c1_schat from Statistics Netherlands, measured on 1 January 2018.	

- utility from consumption and bequests are as in Ameriks et al. (2020)

$$u(c) = \begin{cases} \frac{c^{1-\gamma}}{1-\gamma} & \gamma \neq 1 \\ \ln(c) & \gamma = 1 \end{cases} \qquad v(a) = \begin{cases} \frac{\theta^{-\gamma}(a+\kappa)^{1-\gamma}}{1-\gamma} & \gamma \neq 1 \\ \frac{1}{\theta}\ln(a+\kappa) & \gamma = 1. \end{cases}$$

In the utility function $u(c)$, γ yields the risk parameter. In the case of a CRRA utility function and no risk, like in our life-cycle model, the risk parameter γ and the intertemporal elasticity of substitution are inversely related: $IES = 1/\gamma$. Therefore, different values of γ can be interpreted as the heterogeneity in households' willingness to substitute their current consumption against future consumption. Here, the larger γ the stronger the preference for intertemporal consumption smoothing: $IES = 1/\gamma = 0$ means full intertemporal smoothing of consumption. In Table 2, we show the conversion from Q_{risk} to reasonable values of γ.

In the bequest function $v(a)$, γ has the same interpretation as in $u(c)$, θ yields the bequest scaling factor, and κ the bequest translation in euros.

Household net (liquid and illiquid) income in (0.2) consists of a number of components:

$$y_t = y^{hh}_t + y^h_t - y^m_t - y^r_t$$

with

- y^{hh}_t disposable household income.
- $y^h_t = \left(h^m_{t-1} + h^o_{t-1}\right) r^h$ return on housing.
- $y^m_t = h^m_{t-1} r^m$ mortgage payment on housing wealth h^m with a mortgage.
- $y^r_t = h^r_{t-1} r^r$ rent on the rented housing wealth h^r, only applicable in variants $V1a$ and $V1b$ (see Section "Four variants to release housing wealth").

The value of the collateral of the mortgage (h^m) is predetermined.[16] As such, returns on this asset are assigned to the net housing wealth h^o, which is also predetermined (but differs between the variants)

$$h^o_t = h^o_{t-1} + y^h_t = h^o_{t-1} + r^h \left(h^m_{t-1} + h^o_{t-1}\right).$$

[16] We allow for different variants in which households are allowed to immediately take-up increases in housing wealth. For details of these variants, we refer to Section "Four variants to release housing wealth".

Note that we consider interest-only, i.e., redemption-free, mortgages. In such mortgage products, households can redeem their mortgage during the term of the mortgage, but households are not obliged to do so. In our model, households may have redeemed parts of their mortgage until we observe them, but will not make any projected future redemptions, i.e. h^m does not further decrease over time and housing wealth only increases because of the return on housing (y^h). In practice, interest-only mortgages are often accompanied by a savings product that helps households redeem the mortgage at maturity and/or people save in regular saving accounts. In the data and the model, these saving products are part of the net total assets a_t (although mortgage related saving products are not so liquid as regular saving accounts). Van Ewijk et al. (2023) show that the share of interest only mortgages is still substantial among households aged 40 and over in 2022. For new mortgages, to qualify for mortgage interest rate deductibles, one needs to opt for an annuity mortgage. In our model this would imply a decrease in mortgage debt over time, yet it would also result in a smaller increase in total assets. Therefore, we do not expect substantial effects on the results.

Of the aforementioned parameters, several are known constants: the initial net assets $\bar{a}_0$, the discount factor β, the real return r on liquid assets ($a - h^o$), the real return r^h on housing wealth ($h^m + h^o$), the mortgage rate r^m (without redemption) on housing assets h^m with a mortgage, the real rental rate r^r on rented housing wealth h^r, and the utility parameters γ, κ and θ. All return rates are net-of-costs and net-of-taxes.

For tractability of our results, we consider a deterministic setting similar to Koijen et al. (2016), except for mortality risk:[17]

- Mortality risk is the single demographic risk. Mortality probabilities are as observed in 2019 by age and gender. Independent mortality realizations by household member.
- No marriage, no separation, no children in the household,[18] and no other life events.
- No income risk: Until retirement, real income is expected to remain in the same income percentile for each age.[19] Future pension income equals currently projected old age pension. This includes state and occupational pensions.
- No financial market risk: deterministic return on assets.
- No housing market risk: deterministic return on housing, deterministic mortgage rates, and deterministic rental rates.

Compared to Nakajima and Telyukova (2017), important differences between our model setup and theirs is that we do not model endogenous homeownership (see Section "Institutional framework"), house price risk, health risk, and medical expenses. Modeling health risk and medical expenses is less relevant in the case of analyzing Dutch households, because long-term care is available regardless of private health insurance. As a consequence, out-of-pocket health spending is low compared to other countries, such as the US where out-of-pocket health spending can be considered as one of the main drivers to save for retirement (De Nardi et al., 2014) and where home equity is found to be used as a substitute for long-term care insurance (Davidoff, 2010; Achou, 2021). A final important difference with Nakajima and Telyukova (2017) is that only households aged 65 and over are considered whereas we consider Dutch households as from age 30 in order to analyze the welfare effects of liquidating home equity over a larger portion of the life cycle. .

The analysis in this paper restricts its focus on variants in which households continue to inhabit their current house (as a homeowner or renter) until all household members have passed away. In other words: the variants that we consider do not differ from each other in terms of "housing consumption", which allows us to abstract from a separation between housing consumption and other consumption in the utility function.[20] Hence, we assume that housing is solely an investment good and not a consumption good (i.e. it does not enter the utility function). As a consequence, we have no potential downsizing in housing wealth. However, downsizing can take place by selling the house and renting. The issue of downsizing is likely to be relatively unimportant, because we do not consider children in the model.

Parameters and exogenous variables

Table 2 contains parameters and exogenous variables and shows what parameter values we assume and what information we use for exogenous variables. The summary statistics of the exogenous variables can be found in Table 1. The heterogeneous preferences are taken from the two preferences questions Q_{risk} and Q_{time} available in LISS and described in Section "LISS survey".

In our model, each period t represents $T_0 = 3$ years. The return parameters are annualized to ease comparability with other literature. The return on liquid assets r equals the real return on housing wealth r^h. This means that substituting housing wealth for liquid assets (or vice versa) affects the financial liquidity of the household, but not the return on assets. The rental rate r^r equals the mortgage rate r^m. Thus, renting and buying with mortgage debt have the same initial cost $r^r = r^m$. However, buying a house with a mortgage provides a future return r^h on the collateral.[21]

The above assumptions on the rates of return can be motivated as follows. As our analysis is restricted to a certain world it is impossible to take account of the risk premium in the return on housing, which in reality is certainly positive (see e.g. Jorda et al. (2019)). The returns in our paper should therefore be interpreted as the certainty equivalent of market rates. The assumption of return on housing then being equal to that of financial assets seems to be a natural benchmark. Admittedly, there may be little arbitrage on the demand side of the housing market by households. However, there may be more active arbitrage on the supply side of the rental market by real estate investors who can choose between investing in real estate or assets in financial markets. With regard to the equality of mortgage rates and rental rates this is considered again as the natural benchmark. Arbitrage can take place at the initial choice between renting and buying a home. Consistency of the rental rate with the lower return on housing assets can be explained by the difference in maintenance costs for home-owners and real estate investors, and/or differences in the appreciation of home-ownership by individual owners.

[17] Future analyses can extend our stylized setting by allowing for other risks, such as income risk (Scholz et al., 2006; Bayer et al., 2019) and financial market risk (Bovenberg et al., 2007).

[18] Recent empirical evidence shows that the role of children in explaining the life-cycle consumption profile is less important than previously thought in the literature (Gant, 2022).

[19] Assuming no income risk implies that households hold lower wealth as precautionary savings. However, in the case of the Netherlands, this is not an extreme assumption as precautionary savings levels are relatively low because of generous unemployment insurance benefits (Alessie and Kapteyn, 2001). Most unemployed receive a replacement rate of 70% for at least 24 months after which unemployed can opt for welfare benefits. Mastrogiacomo and Alessie (2014) find that precautionary savings do not count for more than 30% of savings among Dutch households. Importantly, income risk is absent in all our variants, which suggests a minor impact on the differences in outcomes of the variants we consider.

[20] This also abstracts from possible misallocation between housing and other consumption over the life-cycle. Downsizing housing consumption after retirement – or when the children have left home – could be another source of freeing up illiquid capital in housing, but empirical evidence shows that downsizing happens only marginally in countries with large institutional rigidities (Banks et al., 2012), such as the Netherlands.

[21] A mortgage borrower bears some economic risk, which is not in our model. Still, it is widely accepted that homeowners have a tax favorable position in the Netherlands (Section "Institutional framework").

In Figures 4 and 5 in Appendix D, we show the distribution of γ_i and β_i, based on respondents' choices to $Q_{i,\text{risk}}$ and $Q_{i,\text{time}}$, respectively. The figures indicate that the modus of heterogeneous parameters is close to the homogeneous parameters assumed, but that heterogeneity in preferences exists among respondents. The distribution of the heterogeneous parameter values is close to the distribution of parameter values that are quantitatively elicited from households by Goossens et al. (2022). Since γ is in the range of 0.5 to 3.5, the inverse relationship with the IES implies values in the range of 0.29 to 2 which is consistent with the contemporary literature (Ameriks et al., 2020). Also, with recent estimates for the Netherlands (Been and Goudswaard, 2023; Been et al., 2023).

For the bequest parameters θ and κ, we take values from Ameriks et al. (2020). For the conversion from US dollars to euros in κ, we assume a conversion rate of 0.85. For the equivalence factor χ, we take values from Nakajima and Telyukova (2017). This equivalence scale for singles and couples is the same as the official scale used by Statistics Netherlands.

In Section "Sensitivity of welfare gains to γ, β, and θ", we show the sensitivity of our results to different values of the preference parameters γ, β, and θ. In the case of γ and β, we present sensitivity checks for both different homogeneous values and heterogeneous values.

Four variants to release housing wealth

This section explains and motivates four cases (variants $V1ab$ – $V2ab$) that allow households to liquidate housing wealth in our life-cycle model compared to the baseline $V0$ of no short selling of net housing wealth ($a_t \geq h_t^o$):

- $V1$: **Sell house and start renting at state pension age**
  - $V1a$: rent 50% by selling 50% of housing wealth $h^o + h^m$.
  - $V1b$: rent 100% by selling all housing wealth $h^o + h^m$.
- $V2$: **Option to borrow against home equity over the life-cycle**
  - $V2a$: Short selling ($a_t \geq 0.5h_t^o$) allowed up to 50% of net housing wealth h_t^o.
  - $V2b$: Short selling ($a_t \geq 0$) allowed up to 100% of net housing wealth h_t^o.

In our baseline variant $V0$ and both variants $V1a$ and $V1b$ with a rent-back arrangement, we exclude short-selling of assets by imposing the additional constraints to our model in Section "Model set-up".

$$V0, V1ab: \quad a_t \geq h_t^o \tag{0.3}$$

This means that net total assets cannot be lower than the assets from housing without a mortgage, which precludes a negative value for liquid assets. In our variants where borrowing is allowed, borrowing is restricted by a lower bound on total assets a_t:

$$V2a: \quad a_t \geq \frac{1}{2}h_t^o \tag{0.4}$$

$$V2b: \quad a_t \geq 0 \tag{0.5}$$

The base case $V0$ is characterized by the feature that households cannot use their housing wealth h^o for consumption during their lifetimes. This is close to the actual situation in the Netherlands: Statistics Netherlands shows that less than 4% of the 60+ population moved in 2017.[22] Preferences of elderly to move are very low and not many households want to downsize their home. Statistics Netherlands shows that in 2015, only 3% of households aged 65 and older wanted to move within two years, and only a quarter of them managed to do so. In the small group of elderly homeowners who wanted to move, only 44% wanted to move to a smaller house. This makes V1 a realistic option, as not many household want to move and not many households want to downsize their home, while tapping into housing wealth for consumption may substantially increase welfare.

The Dutch Authority for the Financial Markets (AFM) reports that no more than 4000 households had taken out a reverse mortgage during the period January 2018–July 2019.[23] These low numbers may either represent a sales constraint (there are only four providers of reverse mortgages currently in the Netherlands[24]), strong bequest motives, or a combination of both. The result is that housing wealth remains illiquid and largely accrues to heirs in the form of a bequest, whether is it intentional (due to strong preferences) or unintentional (due to a sales constraint). The latter hinders an optimal distribution of assets a_t across consumption and bequests, and produces suboptimal outcomes for most households (the constraint is not binding only for households with relatively low housing wealth h^o and/or a relatively high bequest motive). The four variants $V1ab - V2ab$ all alleviate this constraint, but in different ways and up to a different extent.

Variants $V1$ and $V2$ can be considered as two extreme options in which there is no room for flexibility in $V1$ and there is a lot of flexibility in $V2$. Variant $V1$ implies housing wealth is liquidated at the state pension age by selling the house. In $V2$ liquidating housing wealth by borrowing against home equity (instead of selling) can be exerted at any point in the life-cycle. Since $V2$ is an option and not an obligation to liquidate, welfare gains are never negative. In $V1$ welfare losses are possible because the gains from increased consumption may be smaller than the losses from fewer bequests and/or returns on housing wealth. Below, we provide a detailed explanation of the different variants.

Variants of $V1$

Variants $V1a$ and $V1b$ alleviate the constraint of the base case by selling the house and subsequently renting it at the retirement date. In $V1a$, the household rents 50% of the house during retirement, by selling 50% of the house at the retirement date. In $V1b$, the household fully rents the house during retirement, by fully selling it at the state pension age (or equivalently, renting another house of equal size and quality, thus without changing housing consumption). The sale of the house takes place at one particular point in time, viz retirement. The motivation is that a change in the ownership structure of a house is likely to occur at one particular moment, and not step-by-step or gradually over time. The choice for the moment that the house is sold (the state pension age) is somewhat arbitrarily, but may be regarded as a natural point in the life cycle of a household to make such a big one-time decision, and can be part of retirement planning.

Variants $V1a$ and $V1b$ have the advantage that they allow households to liquidate their housing wealth h^o (partially or fully) to increase consumption, and thus alleviate the constraint of the base case. However, both variants also come with a disadvantage in comparison to the base case, namely that the households are unable (or only partially able) to reap the benefits from homeownership – e.g. the risk premium on housing assets – after the sale of the house. In our model, the benefits from homeownership take the form of the real return on housing wealth. To see this, note that the parameter values feature the property that $r^r = r^m > r$, $r = r^h$ and $r^h > 0$. This choice of the model parameters results in the situation in which renting a house is less attractive than buying the same house with an interest-only mortgage. This difference can be explained by the risk premium on housing capital, tax incentives on homeownership, or by savings on maintenance costs which tend to be higher for renters due to transaction costs and moral hazard in

[22] https://www.cbs.nl/nl-nl/longread/statistische-trends/2020/een-analyse-van-het-verhuisgedrag-van-zestigers

[23] https://www.afm.nl/nl-nl/professionals/nieuws/2020/december/verzilverhypotheken-moeten-productontwikkeling-verbeteren?

[24] https://www.consumentenbond.nl/hypotheek/55-plusser/opeethypotheek-overzicht-aanbieders

caretaking and maintenance of the home (see Section "Institutional framework"). The difference between both strategies is taken to be 1% per annum: this extra return on housing wealth happens to be equal to the capital gain due to rising house prices in our parameter settings. It may be noted that this extra return is tied to owning the housing assets, and adds thus to illiquid wealth only. In this regard, the decision to rent the home does not free any income available for consumption over the life-cycle.[25] It may, however, avoid any unintentional bequests due to illiquid housing and thus free capital locked up in the home, and in that manner increase the means available for consumption. This advantage of larger liquidity has to be weighed against the disadvantage of missing the extra return on housing capital. The balance between the advantage and disadvantage may be different for each household depending on e.g. whether they envisage unintentional bequests that they would like to avoid. The advantage of freeing liquidity may be expected to dominate for households with substantial unintentional bequests, while for households with an interior solution for bequest the disadvantage of the missed return on housing assets will dominate.

Variants of $V2$

Variants $V2a$ and $V2b$ alleviate the constraint of the base case in a different way, namely by allowing the household to borrow against housing wealth h^o. In other words: the household is able to use housing wealth h^o as collateral for a loan that can be used for consumption. In the case of variant $V2a$, up to 50% of housing wealth h^o can be borrowed against, while this is allowed up to 100% in variant $V2b$. Compared to variants $V1$, variants $V2$ are an option to exercise and not an obligation.[26]

Variants $V2a$ and $V2b$ have an important advantage over variants $V1a$ and $V1b$, respectively, namely that housing wealth h^o can be used for consumption while at the same time the household continues to fully reap the benefits from homeownership. In our model setting, this implies that the household can continue to fully benefit from the real return r^h on the full value of the house during the decumulation phase – be it illiquid –, while at the same time 'eating up the house'. Another advantage of variants $V2a$ and $V2b$ in comparison to $V1a$ and $V1b$ is that the benefits from 'eating up the house' can also be reaped before the retirement date (the moment of the sale of the house in variants $V1a$ and $V1b$). In this respect, these variants stand for more flexible arrangements in the mortgage market, allowing for greater flexibility over the life-cycle.

Variant $V2b$ can be interpreted as the 'first best' (upper limit) situation: it fully alleviates the constraint of the base case while not introducing the two suboptimal features of renting (missing out on the benefits of homeownership, and suboptimal intertemporal consumption). In variant $V2a$, the welfare gains from variants $V2b$ are 'truncated' for households for whom the optimal borrowing against house wealth h^o exceeds 50%. At the same time, variant $V2b$ may not be feasible in practice in the presence of house price risk. After all, the issuer of the loan that enables the household to use housing wealth h^o for consumption will typically require the household to preserve a certain level of equity (own funds) as a buffer against a fall in house prices. This prevents a situation in which the household passes away with a negative wealth in an economic scenario in which house prices fall and do not recover during the lifetime of the household. Indeed, it is observed in practice that reverse annuities enable households to use housing wealth h^o for consumption only up to a certain extent. Therefore, the variant $V2a$, or a mix between $V2a$ and $V2b$, may be considered as more realistic in most institutional settings. Variant $V2b$ may only be realistic, for example, in a setting in which a government-backed entity provides a 'no negative equity guarantee' to stimulate the market for reverse mortgages.

Comparison of variants

Notice that reverse mortgages may be an implementation device for all variants $V1a$–$V2b$. Reverse mortgages exist in many different forms. Variants $V1a$ and $V1b$ can be representative for a reverse mortgage in which the issuer of the reverse mortgage acquires partial of full ownership of the house, and thus reaps the benefit of rises in the value of the house price (and also the downward risks associated). On the other hand, variants $V2a$ and $V2b$ can be regarded as representative for reverse mortgages in which the household remains the full owner of the house and fully reaps the benefits from house price rises as well as the associated risk of house price losses. In variants $V1a$ and $V1b$, welfare gains are by definition smaller in comparison to variants $V2a$ and $V2b$, because two suboptimal features of renting are introduced (missing out on the benefits of homeownership, and suboptimal intertemporal consumption before and after retirement). In variants $V1a$ and $V1b$, the welfare effect can even be negative for some households if the disadvantages associated with the renting construction dominate the advantages of freeing capital included in the house. In this situation, the household could decide not to switch to renting and avoid this welfare loss. Nonetheless, we show the welfare effects for $V1a$ and $V1b$ for all households including those with negative welfare effects. The results in which negative welfare effects are avoided in variants $V1a$ and $V1b$ (because these people will in practice not choose for $V1a$ and $V1b$) are simply the same with negative welfare effects 'truncated' at zero.

Results

Consumption and wealth paths by age

In this section, we show how the different variants lead to different consumption paths compared to the baseline. These consumption paths are important to understand the welfare effects we obtain in the following sections as welfare effects are calculated using certainty equivalent consumption.

In Fig. 1(a) we show that variants $V1a$ and $V1b$ (based on homogeneous parameters and the full sample) generate increases in consumption from the age of 65, which is assumed to be the date at which households sell their house in these variants. In contrast, variants $V2a$ and $V2b$ already generate increases in consumption earlier in the life-cycle, because households do not wait until the age of 65 to make their housing wealth liquid. Overall, this results in higher life-cycle consumption paths in variants $V2a$ and $V2b$ than in variants $V1a$ and $V1b$. Around the age of 90 the consumption in variants $V1a$ and $V1b$ drop below the red line. Those households with a longer life especially miss out on the benefits of homeownership (see Table 2). For these households missing out the accumulated benefits of homeownership of 1% per annum is relatively costly.

Similarly, Fig. 1(b) shows the development of net wealth. Consistent with the consumption paths, net wealth decreases more in variants $V2a$ and $V2b$ than in variants $V1a$ and $V1b$ in order to finance the increase in consumption. The drop in wealth in the thirties is attributable to a composition effect. Homeowners aged 30 are on average very wealthy households. At higher ages, less wealthy households enter our sample, which decreasing the average wealth at a given age. The latter effect dominates the increase in wealth of the initial homeowners aged 30.

In Fig. 1(c), we show the development of illiquid wealth in the different variants. The household keeps ownership of the home in variants ($V2$) and, therefore, shows the same development as the baseline case $V0$. In these scenarios, illiquid wealth increases because of increasing house prices. In variants $V1$, the home is sold upon

[25] It does, however, increase welfare as also unintentional bequests add to the welfare of households, but less so than making the capital available for consumption during lifetime.

[26] Our variant $V2$ is somewhat comparable to existing mortgage rules in Australia which have a redraw facility. This redraw facility implies that households can access the extra principal repayments they have made on their mortgage.

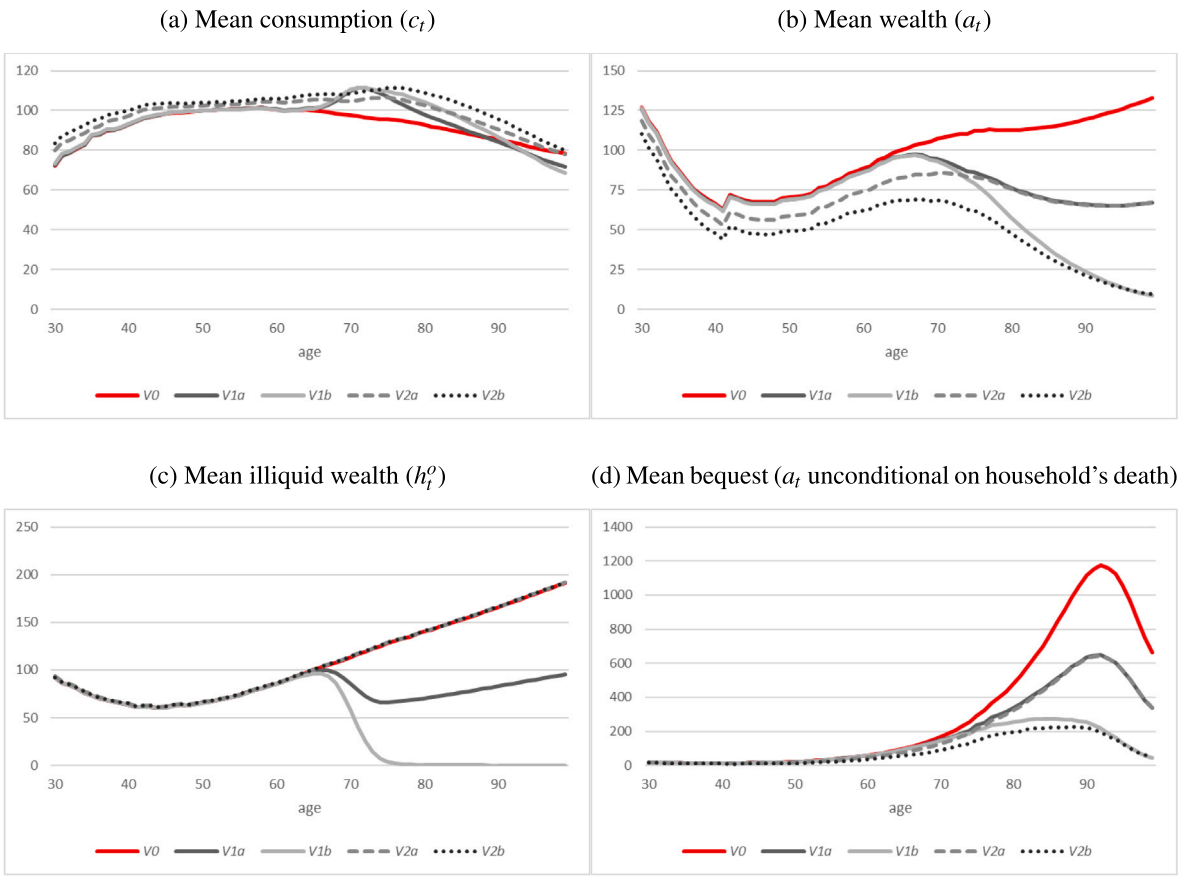

Fig. 1. Consumption and wealth by age (variant $V0$ at age 65 = 100).

retirement. In variant $V1a$, the household reaps the benefits of house price increase as they still own half of the house. The development of bequests (unconditional of dying) in the different variants are shown in Fig. 1(d). In the baseline scenario $V0$, home equity is not used to finance consumption which implies that it is translated into a bequest at the end of life. Bequests are smallest in the variants $V1b$ and $V2b$. In these variants, 100% of the home is used to finance consumption. The bequest is smallest in $V2b$ as home equity if used to finance consumption over the life cycle. In the case of $V1b$, the bequest is higher than in variant $V2b$, because the household may have had less opportunity to use home equity for consumption as home equity is freed up as of the retirement age.

Patterns of consumption and wealth are similar if we look at medians instead of means (see Figures 6a–6d in the Appendix) and if we assume (i) homogeneous parameters and (ii) heterogeneous parameters in preferences for smoothing and time.

Welfare gains with homogeneous preferences

In this section, we present the welfare effects of $V1$ and $V2$, taking into account the financial situation of the representative sample of the Dutch population (using administrative data), and assuming the "*Homogeneous preferences*" from Table 2. Welfare effects are expressed in percentage changes in the Certainty Equivalent Consumption (CEQ) over the remaining life cycle relative to the baseline of no selling or short selling of housing wealth. This baseline is the outcome of optimizing households' choices in the life-cycle model without allowing the households to liquidate their housing wealth.

In Table 3 we show the calculated welfare effects of variants $V1a$-$V2b$. In particular, we show the mean and median effects as well as the welfare effect for the bottom quarter (P25) and the top quarter (P75) of the welfare effects distribution. The table provides some interesting

Table 3
Welfare effects (%) of $V1a - V2b$.

	$V1a$	$V1b$	$V2a$	$V2b$
Mean	4.3	6.9	11.2	18.6
Median	2.3	3.7	6.6	10.9
P25	0.9	1.3	3.3	5.3
P75	5.6	9.0	13.1	20.1

patterns. Firstly, mean effects are bigger than median effects which suggests the existence of outliers at the top-end of the welfare effects distribution. This applies to all variants $V1a$-$V2b$. On average, we find the largest welfare gains for $V2b$ (18.6%), $V2a$ (11.2%), $V1b$ (6.9%) and $V1a$ (4.3%), respectively. This pattern is similar for the median welfare gain: $V2b$ (10.9%), $V2a$ (6.6%), $V1b$ (3.7%) and $V1a$ (2.3%). However, P25 and P75 suggest that there is substantial heterogeneity among households. In the case of $V2b$, 50% of the households face a welfare gain between 5.3% and 20.1%. In Appendix G, we show that these welfare gains are robust to using a sample of households aged 30+ only.

To investigate this heterogeneity further, we analyze the distribution of the welfare consequences in Figs. 2(a)–2(d).

Fig. 2(a) shows that most of the households face a welfare gain if they sell 50% of their housing wealth at retirement. However, for most households the welfare gain is only small and close to zero. A small selection of households face substantial welfare gains in this variant with welfare gains around 10%. In contrast, we also observe a non-negligible number of households that face a welfare loss from this variant: 9.0% of households face a welfare loss in variant $V1a$. Welfare losses can be explained by missing real returns on housing assets.

Similar to variant $V1a$, Fig. 2(b) shows that most of the households face a welfare gain in case they sell 100% of their housing wealth

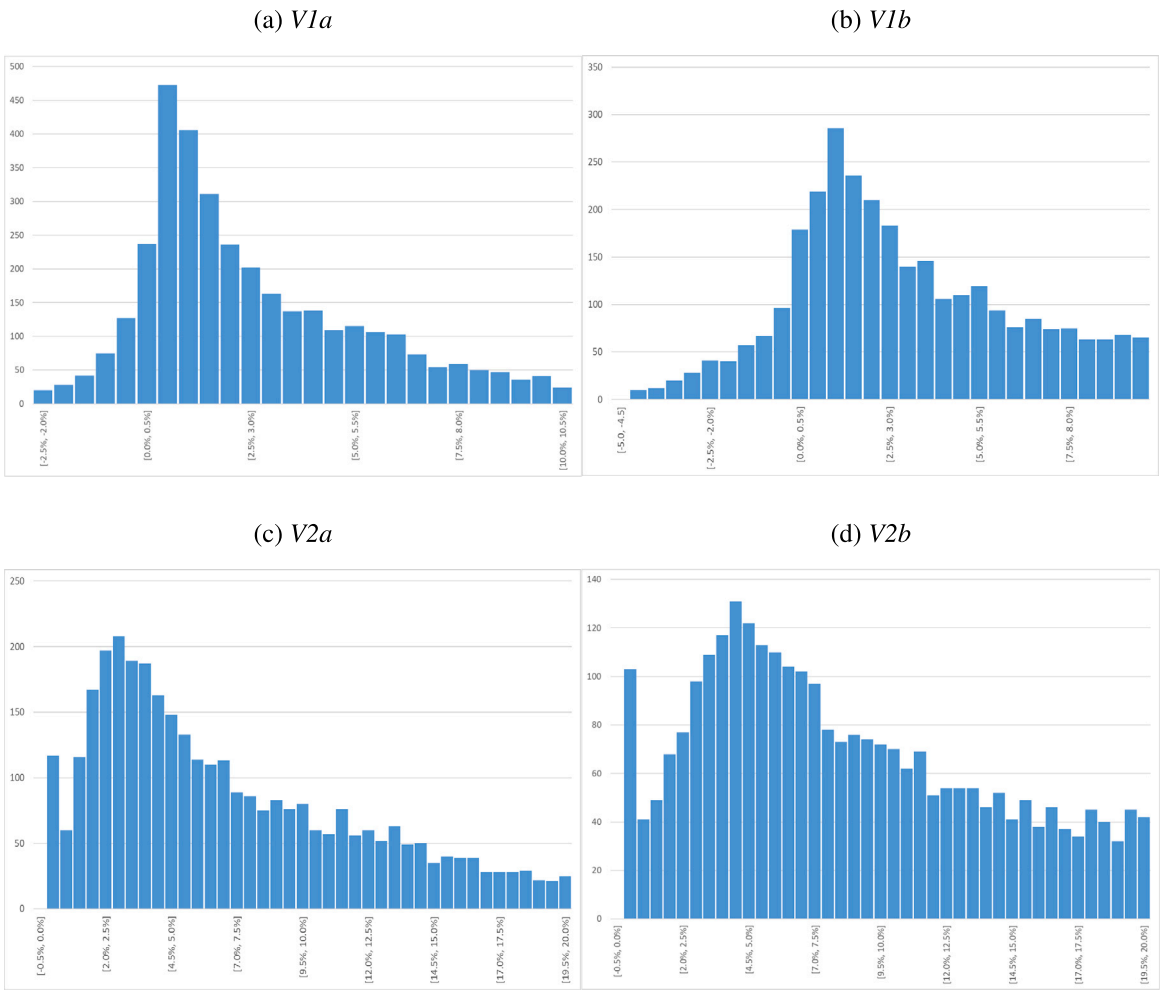

Fig. 2. Distribution of welfare effects (Y-axis: number of households, X-axis: welfare change (%)).

at retirement. Contrasting variant $V1a$, we observe somewhat more extreme welfare gains and losses in variant $V1b$. This is reasonable as $V1a$ and $V1b$ are similar variants, with $V1b$ being the more extreme variant. The bulk of the households face a welfare gain close to 2%. 10.8% of households face a welfare loss in variant $V1b$. Although $V1b$ can be considered the more extreme variant of $V1a$, the welfare gains from $V1b$ are not always larger than the welfare gains from $V1a$. So, variant $V1b$ does not dominate $V1a$ in terms of welfare gains.

Contrasting variants $V1a$ and $V1b$, variant $V2a$ does not produce welfare losses. This is due to the fact that households do not have to sell their house, but have the option to borrow against their housing wealth instead. Hence, they do not miss out on real returns on their housing wealth. Many households face welfare gains between 2%–5%, but welfare gains are shown to be heterogeneous and can be as large as 20%. For 1.1% of the households welfare does not change in variant $V2a$ compared to $V0$. Although $V2a$ can be considered to be more flexible than variants $V1a$ and $V1b$, the welfare gains from $V2b$ are not always larger than the welfare gains from either $V1a$ or $V1b$. So, variant $V2ab$ does not dominate $V1a$ or $V1b$ in terms of welfare gains.

Similar to variant $V2a$, Fig. 2(d) suggests that most of the households face a welfare gain (and, hence, use the option) if they can use the option to borrow against 100% of their housing wealth (1.1% of households face a welfare loss of zero in variant $V2b$). Contrasting variant $V2a$, we observe more extreme welfare gains in variant $V2b$. This is reasonable as $V2a$ and $V2b$ are similar variants with $V2b$ allowing for more borrowing. Again, although many households face a welfare gain close to zero, welfare gains are largely heterogeneous. The welfare gains from $V2b$ are always at least as big as the welfare gains from $V1a$ for each household. So, variant $V2b$ dominates $V2a$ in terms of welfare gains.

Although Table 3 and Figs. 2(a)–2(d) show that different variants to treat housing wealth over the life cycle lead to different welfare gains, on average, the table and figures also show that the actual welfare gain is largely heterogeneous among households. This proves that focusing on a representative household only will lead to a substantial loss of information. In fact, our results show that it is important to take into account households' heterogeneity which cannot be obtained by assuming a single representative agent in the life cycle model. Even in the case we assume homogeneous parameters for all the different households, as we have shown in this section.

Welfare gains with heterogeneous preferences

In the previous section we have shown that welfare gains from the different variants to treat housing wealth over the life cycle are largely heterogeneous among a representative group of households. So far, we have assumed homogeneous parameters for these households. In this section, we analyze the importance of taking into account households' heterogeneity in preferences for consumption smoothing and time and see if this matters for our welfare effects. For details regarding the parameters, we refer to the column "*Heterogeneous preferences*" in Table 2.

In Table 4, we present the welfare consequences of variants $V1a$ – $V2b$ when we take into account households' heterogeneity in preferences for smoothing and time. Adding heterogeneity in preferences

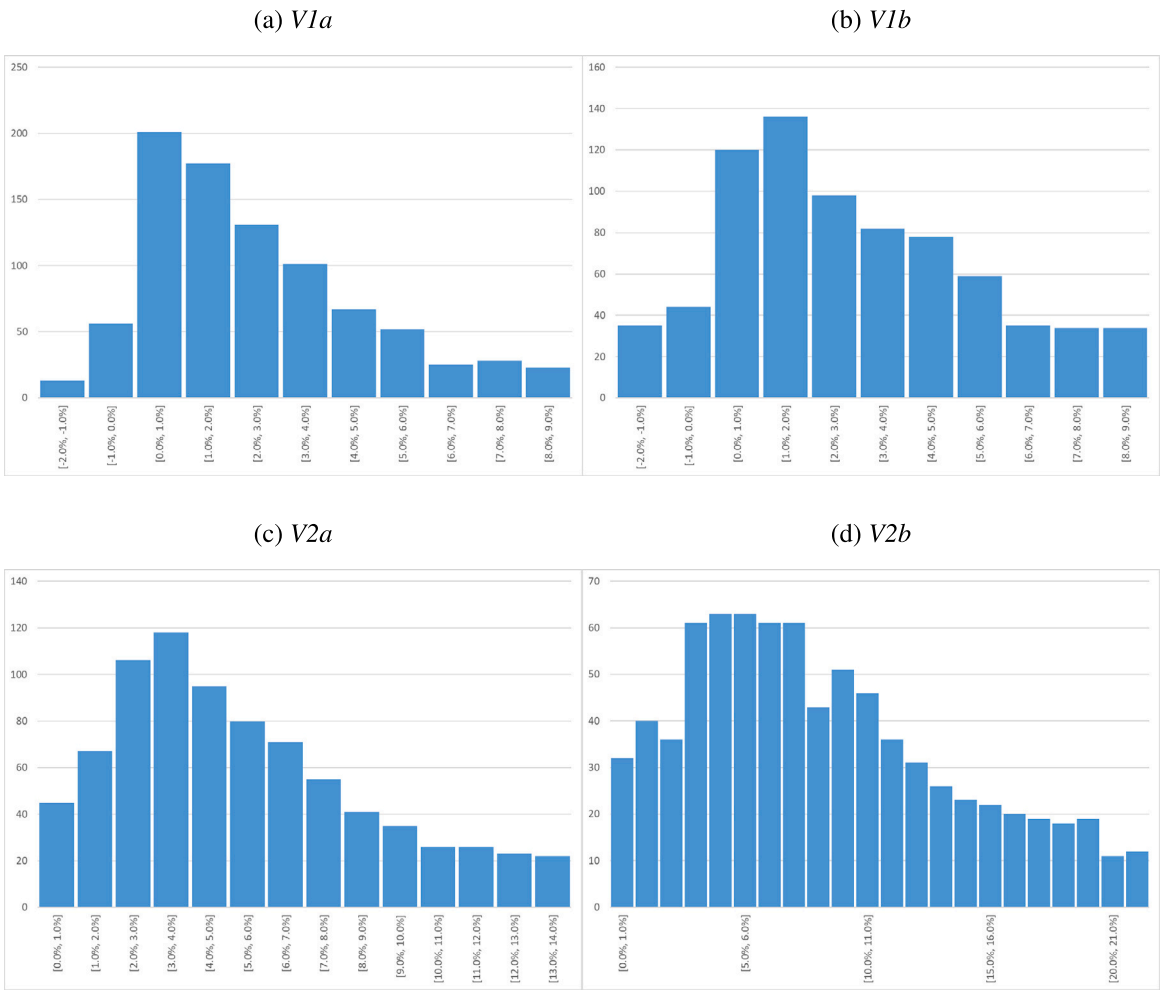

Fig. 3. Distribution of welfare effects (Y-axis: number of households, X-axis: welfare change (%)).

compared to homogeneous parameters decreases the size of the average welfare gain, but the differences with assuming homogeneous preferences is fairly small. If anything, allowing for heterogeneity in preferences for consumption smoothing and time slightly compresses the size of the welfare gains. An important takeaway for these results is that welfare gains with heterogeneous preference parameters are quite similar to the welfare gains with homogeneous preference parameters.[27] Hence, whereas allowing for heterogeneity in the financial situation of households appeared important, allowing for heterogeneous preferences regarding consumption smoothing and time seems less important.

Similar to Figs. 2(a)–2(d), we find substantial heterogeneity among the sample for who we calculate welfare gains based on heterogeneous parameters (see Figs. 3(a)–3(d)). Figs. 2(a)–2(d) primarily show more extreme cases in a larger sample.

Table 4
Welfare effects (%) of $V1a - V2b$ with heterogeneous risk and time parameters.

	$V1a$	$V1b$	$V2a$	$V2b$
Mean				
Heterogeneous	2.9	4.7	8.1	13.2
Homogeneous	3.2	5.0	9.4	14.6
Median				
Heterogeneous	2.0	3.1	5.4	9.0
Homogeneous	2.1	3.3	5.4	9.0
P25				
Heterogeneous	0.8	1.0	3.1	4.9
Homogeneous	0.9	1.2	3.2	5.0
P75				
Heterogeneous	4.1	6.6	9.4	15.7
Homogeneous	4.3	6.7	9.5	16.0

Sensitivity of welfare gains to γ, β, and θ

There has been no consensus in the literature on the size of the IES $(1/\gamma)$. The literature typically finds estimates of $0.4 \leq IES \leq 0.8$, but recent evidence from Rogerson and Wallenius (2016) suggests that these values of the IES are too low and that the IES is likely to be above unity. Empirical estimates for the Netherlands from Kapteyn and Teppa (2003), Been and Goudswaard (2023), Been et al. (2023) suggest that $0.5 \leq IES \leq 0.8$ (i.e. $1.25 \leq \gamma \leq 2$). To show the sensitivity of our welfare effects to the choice of γ, we present the welfare gains for $\gamma \in \{1, 2, 5\}$ in Table 5. Table 5 shows the sensitivity of our results to assuming $IES \in \{0.2, 0.5, 1.0\}$ which covers the range of commonly found values for the intertemporal elasticity of substitution of consumption and leisure. The sensitivity analyses show that welfare gains are larger with higher (lower) values of γ $(1/\gamma)$ in all variants considered, i.e. welfare gains of liquidating housing wealth are larger if more smoothing of consumption is preferred. That is because the different variants allow for more consumption smoothing which is more valued with a higher γ.

[27] In Appendix G, we show that these welfare gains are robust to using a sample of households aged 30+ only.

Table 5
Welfare effects (%) of $V1a$-$V2b$ for different values of γ, β, and θ.

	$V1a$	$V1b$	$V2a$	$V2b$
A. Homogeneous β&γ				
Baseline: $\beta = 0.97$&$\gamma = 2.26$&$\theta = 1.09$				
Mean	4.3	6.9	11.2	18.6
Median	2.3	3.7	6.6	10.9
P25	0.9	1.3	3.3	5.3
P75	5.6	9.0	13.1	20.1
$\beta = 0.97$&$\gamma = 1.0$&$\theta = 1.09$				
Mean	3.8	5.8	1.8	15.3
Median	1.9	2.7	0.0	9.0
P25	0.7	0.7	0.0	4.1
P75	4.7	7.5	0.0	18.4
$\beta = 0.97$&$\gamma = 2.0$&$\theta = 1.09$				
Mean	4.3	6.7	10.9	17.9
Median	2.3	3.5	6.5	10.4
P25	0.9	1.2	3.2	5.1
P75	5.6	8.9	13.0	21.7
$\beta = 0.97$&$\gamma = 5.0$&$\theta = 1.09$				
Mean	3.5	7.4	13.8	23.4
Median	1.8	3.9	7.1	12.8
P25	0.5	1.3	3.7	6.3
P75	4.5	9.6	14.0	25.8
$\beta = 0.92$&$\gamma = 2.26$&$\theta = 1.09$				
Mean	4.7	8.5	14.9	24.1
Median	1.7	3.3	8.9	15.0
P25	0.5	0.8	3.9	7.0
P75	6.1	12.0	17.5	28.7
$\beta = 0.99$&$\gamma = 2.26$&$\theta = 1.09$				
Mean	3.9	6.3	10.5	17.5
Median	2.1	3.4	6.2	10.3
P25	0.8	1.0	3.3	5.1
P75	5.1	8.4	12.4	20.9
$\beta = 0.97$&$\gamma = 2.26$&$\theta = 0.25$				
Mean	2.2	0.5	8.4	11.0
Median	0.7	−0.8	3.9	4.7
P25	−0.5	−2.2	0.0	1.6
P75	3.3	1.7	9.2	11.5
B. Heterogeneous β_i&γ_i				
β_i&γ_i&$\theta = 1.09$				
Mean	2.9	4.7	8.1	13.2
Median	2.0	3.1	5.4	9.0
P25	0.8	1.0	3.1	4.9
P75	4.1	6.6	9.4	15.7
β_i&γ_i&$\theta = 0.25$				
Mean	1.5	0.1	5.9	7.7
Median	0.5	−0.8	3.1	3.9
P25	−0.5	−2.2	0.0	1.6
P75	2.4	0.9	6.9	8.5

Similarly, we consider $\beta \in \{0.92, 0.99\}$ to test the sensitivity of our results to assumptions regarding the time preference. The sensitivity checks in Table 5 show that a higher value of β results in a relatively lower welfare gain. Hence, welfare gains from liquidating housing wealth are larger when households put less weight on future consumption and more weight on current consumption. Liquidating housing wealth allows households to take consumption from the future to the present which is only interesting for those with sufficiently strong preferences for current consumption.

Additionally, we analyze the sensitivity of our results to assuming $\theta = 0.25$, i.e. a larger marginal benefit from bequests. Following the most recent empirical evidence from Ameriks et al. (2020), we have assumed $\theta = 1.09$ which implies that the marginal utility of bequests are fairly small. Koijen et al. (2016), Nakajima and Telyukova (2017), Lockwood (2018), and Nakajima and Telyukova (2020) suggest $\theta < 1$ implying a larger marginal utility of bequests.[28] By assuming $\theta = 1.09$, we may overestimate the welfare gains compared to $\theta < 1$. However, Nakajima and Telyukova (2020) argue that the parameter values of the bequest motive are of little importance to their results. Most importantly, the bequest parameters should imply that bequests are a luxury good ($\kappa > 0$) which is the consensus in the literature.[29] Our sensitivity analysis in Table 5 shows that $\theta = 0.25$ results in smaller welfare gains in the variants considered due to a much higher marginal benefit from bequests. Our main conclusions that borrowing against housing wealth leads to larger welfare gains than selling the house at retirement and that welfare gains are largely heterogeneous are not altered because of $\theta = 0.25$. However, welfare gains are substantially smaller than with assuming $\theta = 1.09$ and can even lead to more substantial welfare losses in variants $V1a$ and $V1b$ because the bequest is smaller than preferred. Although different assumptions regarding γ and β lead to different sizes of the welfare gains, the sign of the welfare effect (gain/loss) is largely subject to the size of θ. Hence, the strength of the bequest motive is an important factor in determining the welfare gains and their size from liquidating housing wealth for consumption.

Table 5 shows three interesting patterns that make economically sense when assuming different parameters in the welfare analyses of

[28] Lockwood (2018) finds $\theta = 0.95$. Nakajima and Telyukova (2017) and Nakajima and Telyukova (2020) even find $\theta = 0.22$ and $\theta = 0.38$, respectively.

[29] See, among others, Dynan et al. (2002), De Nardi (2004), Kopczuk and Lupton (2007), DeNardi and Yang (2014), Gan et al. (2015), Lockwood (2018), Ameriks et al. (2020).

the four aforementioned variants. Firstly, the sensitivity analyses show that welfare gains are larger with lower values of β in all variants considered, i.e. welfare gains of liquidating housing wealth are larger if more weight is given to current consumption. Secondly, the sensitivity analyses show that welfare gains are larger with higher values of γ in all variants considered, i.e. welfare gains of liquidating housing wealth are larger if more smoothing of consumption is assumed. Thirdly, welfare gains are larger if the marginal benefits from bequests are smaller, i.e. those with little preferences to bequeath can liquidate their housing wealth and use this to finance consumption at the cost of wealth at the end of life. However, regardless of the exact parameters values, we find (1) largest welfare gains in the scenario in which households can borrow against their housing wealth over the life-cycle and (2) substantial heterogeneity in welfare gains among households.

Heterogeneous welfare gains by groups

In the remainder of this section, we analyze the heterogeneity in welfare gains for different socio-demographic groups. More specifically, we estimate an OLS model to present the correlation between households' characteristics and their calculated welfare gains based on homogeneous parameters.[30] The estimated coefficients should be interpreted as: coefficient × 100 = Δ welfare (%). For a univariate analysis of the heterogeneity in welfare gains, we refer to Appendix F.

Table 6 shows that welfare gains are especially present among those households with higher net housing wealth and lower current income and projected pension income. These are the households whose consumption is most constrained by their income and illiquid wealth and who can substantially increase consumption by making housing wealth liquid. We find little to no effects of households' characteristics and preferences for consumption smoothing and time in the multivariate analysis. This is consistent with our other analyses to address the importance of preferences regarding consumption smoothing and time[31]: estimated welfare effects are relatively insensitive to different parameter values of consumption smoothing and time. From this we can reasonably conclude that the insensitivity of welfare effects to heterogeneity in preference parameters is unlikely to be driven by a possible lack of variation in responses in the reduced sample.

Table 6
Estimation results of the welfare gains (fractions) by variant $V1a - V2b$.

	$V1a$	$V1b$	$V2a$	$V2b$
Female	0.000	0.002	−0.001	−0.001
	(0.002)	(0.003)	(0.008)	(0.009)
Immigrant (1st gen.)	0.003	0.003	0.002	0.003
	(0.006)	(0.006)	(0.010)	(0.011)
Immigrant (2nd gen.)	0.011	0.012	0.006	0.006
	(0.008)	(0.010)	(0.014)	(0.017)
Couple	0.011*	0.026***	−0.002	0.010
	(0.004)	(0.006)	(0.021)	(0.022)
Age	−0.001	−0.003*	−0.018	−0.021*
	(0.001)	(0.001)	(0.009)	(0.010)
Age sq.	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Number of children	0.000	0.000	0.004	0.005
	(0.001)	(0.001)	(0.004)	(0.004)
Gross HH inc. (log)	−0.028**	−0.040**	−0.046	−0.066*
	(0.009)	(0.011)	(0.024)	(0.026)
Housing value (log)	0.025***	0.048***	0.076***	0.128***
	(0.004)	(0.006)	(0.007)	(0.009)
LTV	−0.027***	−0.054***	−0.050**	−0.072***
	(0.006)	(0.011)	(0.016)	(0.020)
Pension accruals (log)	−0.002	−0.007	0.092	0.086
	(0.014)	(0.015)	(0.067)	(0.070)
Proj. pension inc. HH (log)	−0.009	−0.021*	−0.114	−0.148*
	(0.008)	(0.009)	(0.064)	(0.066)
Risk preference	0.002	0.001	0.006	0.007
	(0.001)	(0.002)	(0.003)	(0.004)
Time preference	0.001	−0.001	0.005	0.006
	(0.001)	(0.002)	(0.004)	(0.005)
Const.	0.136*	0.237**	0.334**	0.397**
	(0.068)	(0.079)	(0.109)	(0.127)
N	923	923	923	923
Adj. R-sq.	0.362	0.529	0.258	0.408

Robust standard errors are reported in parentheses.
* Significant at the 10% level.
** significant at the 5% level.
*** significant at the 1% level.

Discussion

Our model identifies clear welfare effects of alternative options for liquidating housing wealth and shows that welfare effects are heterogeneous for a representative sample of households. These results are based on several simplifying assumptions. In this section, we explain how enriching our model with more realistic assumptions can affect the calculated welfare effects.

Firstly, except for mortality risk, our model abstracts from stochastics in income,[32] financial markets, and housing markets. Hence, we assume deterministic income growth (and, therefore, deterministic pension accumulation), deterministic returns on financial assets, deterministic returns on housing, deterministic mortgage interest rates, and deterministic rental rates. Including one or more of these stochastic elements substantially complicates the model, but combining population-wide heterogeneity with uncertainty is an interesting direction for future research.

Introducing these types of uncertainty in the model can have two opposing effects on our welfare gains. On the one hand, it implies that households need more precautionary savings. Especially, if they are relatively risk averse. Therefore, households may consume less of the increased consumption potential in the four variants we presented. Our sensitivity analysis suggests that introducing precautionary savings (by assuming $\theta = 0.25$ instead of $\theta = 1.09$ thereby effectively increasing preferences for holding wealth at the end of life) compresses the welfare gains from liquidating housing equity. This approach is in line with Hurd (1989) who finds that bequests are largely unintended 'leftovers' from precautionary savings. Therefore, without making a fully stochastic model, we conclude that introducing precautionary savings decreases the welfare gains from liquidating housing equity. On the other hand, introducing uncertainty might also imply more positive welfare gains, as households can benefit from liquidating housing wealth after an adverse income shocks (such as unemployment).

Secondly, except for mortality, our model abstracts from household transitions such as marriage, separation, and children. Introducing children in the household most likely increases the consumption needs during the prime age of the parents. Therefore, we would expect that introducing children in the model would increase the demand for liquidating housing wealth before retirement and increase the welfare gains from variants $V2a - V2b$. Compared to a model with children, our current model is likely to underestimate the welfare gains from variants $V2a - V2b$. Marriage and separation have less clear effects *a priori*. Introducing marriage and separation would add another channel of uncertainty in households' income, both positive and negative uncertainty. Marriage and separation might also imply the need for additional spending throughout the life-course which would increase the demand for more liquid wealth. Nonetheless, our current analysis

[30] The results with heterogeneous preference parameters are similar and can be found in Appendix H.

[31] This is also consistent with the analysis of Scholz et al. (2006), who find no significant correlations between households' characteristics, such as having (grand)children, and optimal wealth holdings. Similarly, regression analyses of Scholz et al. (2006) do not show strong correlation between planned bequests and optimal wealth holdings.

[32] This includes abstracting from uncertainty in human capital accumulation. This may be important for portfolio decisions (Benzoni et al., 2005).

has shown that single households and couple households do not differ a lot in their welfare effects from variants $V2a - V2b$.

Thirdly, we have assumed exogeneity in housing choices in our model following (Yogo, 2016). Especially, because we specifically focus on homeowners who can use their housing wealth to finance consumption over the life-cycle. In contrast, Nakajima and Telyukova (2017) allow homeownership versus renting to be endogenous in their model. Given the high subsidies and regulation in Dutch housing market that we outlined in Section "Institutional framework", households are inclined to buy a home if they can and we expect that homeowners are on average more affluent households than renters. Since our results indicate that welfare gains are particularly large among households with a high housing value and low LTV, i.e. more affluent households, we expect that welfare gains would have been lower among renting households if they would have had the opportunity to buy.

Fourthly, the absence of house price risk in our model means that welfare gains should be interpreted as an upper-bound, particularly if home equity can be fully collateralized to boost consumption (variant $V2b$). In the presence of house price risk it is typically in practice not possible to fully decumulate housing wealth by using a reverse mortgage. This would introduce a probability that the issuer of a reverse mortgage product is left with a residual loss if a decumulation of all housing wealth is followed by a house price decline (that the household cannot compensate with non-housing wealth). The risk of such a residual loss may be difficult to insure or mitigate in practice. Therefore, it is often observed that real-world reverse mortgage products allow homeowners to extract the value from their home equity only partially but not fully. As a result, the welfare gains from reverse mortgages in our paper are likely to be an upper-bound of what is feasible in real-world solutions.

Finally, we have assumed a common parameterization of the CRRA utility function. However, households may have preferences that are not fully captured by the utility function assumed. One such preference that is not taken into account is habit formation in consumption. Evidence on the existence of habit formation is mixed (Havranek et al., 2017). For example, Dynan (2000) find no evidence for habit formation among US households. In contrast, Carrasco et al. (2005) and Guariglia and Rossi (2002) find evidence in favor of habit formation in Spain and the UK, respectively. Alessie and Teppa (2010) find empirical evidence in favor of habit formation among Dutch households. However, they also find that the magnitude of habit formation coefficient is small. This makes it unlikely that allowing for habit formation alters the main results of our analysis.

Conclusions

This paper analyzes the extent to which different variants to liquidate home equity leads to welfare improvements for households by solving liquidity constraints for consumption. Moreover, the paper analyzes the welfare effects for a representative sample of the population and investigates the welfare effects for particular subgroups. To analyze such heterogeneity in welfare effects, we use a Life-Cycle Model (LCM) with two sources of heterogeneity: (1) we use administrative data for a representative sample of households from the Netherlands and (2) we allow for heterogeneous preferences for smoothing and time in the LCM elicited in survey data from the Netherlands. These sources of heterogeneity enrich the LCM beyond heterogeneous-agents models and allow us to study the population-wide distribution of welfare effects.

To analyze the welfare effects of liquidating housing wealth, we consider four variants in which households either sell (50% of) their house at retirement or borrow against (50% of) households' housing wealth over the life-cycle. Our results suggest that borrowing against households' housing wealth over the life-cycle leads to larger welfare gains than selling the home at retirement. We consider the option to borrow against 50% of households' housing wealth over the life-cycle as the most feasible option, compared to borrowing against 100% of households' housing wealth, that leads to the largest welfare gains: Median (average) welfare gains are about 7% (11%). However, we find substantial heterogeneity in welfare gains among households with a welfare gain between 3% and 13% for half of the households. Nonetheless, welfare gains can be as large as 20%, although the bulk of the welfare gains is around 2%.

Regressing the welfare effects on households' characteristics indicates that much of the heterogeneity we find among households is explained by heterogeneity in households' income and (housing) wealth. Our analyses indicate that allowing for heterogeneity in preferences for consumption smoothing and time is relatively unimportant in explaining households' heterogeneous welfare effects. This is confirmed by the relatively small effects of assuming different values for consumption smoothing and time on estimated welfare effects. The distributions of welfare effects are very similar for homogeneous and heterogeneous preferences in consumption smoothing and time. However, our results do suggest that households' bequest motive is an important factor in determining the sign and size of welfare effects.

Academically, our results are interesting as they outline a road map to further increase heterogeneity in LCM's and welfare analyses. Furthermore, we pose several potentially important improvements for future models, which mostly includes allowing for more stochastics. However, the combination of more stochastics and population-wide data is computationally challenging. Moreover, our results suggest that heterogeneity in consumptions smoothing and time parameters in the LCM may be of less importance than allowing for income and wealth information from actual households. This, however, should be further corroborated by future models using more detailed quantifications of preferences. For policy, our results are interesting as they suggest that (most) households will be better off with less illiquid and more liquid wealth. Based on this result, policy makers need to rethink the role of mandatory pension savings combined with mandatory mortgage repayments whilst keeping in mind issues regarding myopia to avoid undersaving. More tailor-made policy regarding mandatory savings and mortgage repayments could avoid problems with oversaving which has been widely documented across countries, including countries with lower levels of mandatory retirement savings than in the Netherlands, such as the UK and the US.

CRediT authorship contribution statement

Jim Been: Conceptualization, Formal analysis, Project administration, Writing – original draft, Writing – review & editing. **Casper van Ewijk:** Conceptualization, Funding acquisition, Methodology, Validation, Writing – original draft, Writing – review & editing. **Marike Knoef:** Conceptualization, Funding acquisition, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing. **Roel Mehlkopf:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Sander Muns:** Conceptualization, Data curation, Formal analysis, Investigation, Software, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

Jim Been, Casper van Ewijk, Marike Knoef, Sander Muns, Roel Mehlkopf have nothing to disclose.

Supplementary data

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