

# Retirement Savings Adequacy Across the Population:

Evidence from Population-Wide Administrative  
Asset Records in the Netherlands

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Cindy Biesenbeek  
Jim Been  
Marika Knoef  
Koen Caminada  
Kees Goudswaard

# Colophon

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Netspar Industry Paper 2025-32, December 2025

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## **Affiliations**

Cindy Biesenbeek - Economic Policy and Research Division, De Nederlandsche Bank;

Department of Economics, Leiden University

Jim Been - Department of Economics, Leiden University

Marike Knoef - Department of Economics, Leiden University; Tilburg School of Economics  
and Management, Tilburg University

Koen Caminada - Department of Economics, Leiden University; Faculty of Governance and  
Global Affairs, Leiden University

Kees Goudswaard - Department of Economics, Leiden University

## Abstract

Using administrative data on 4.3 million households, we evaluate retirement savings from all four pension pillars in the Netherlands. State pensions constitute relatively equal amounts across the population, occupational pensions provide earnings-related benefits to employees, and non-pension assets lead to significant pension supplements at higher income levels. While the Dutch systems deliver high median adequacy, the range is substantial. Using linear and quantile regressions, we find that households with a migration background, renters, women, the self-employed, and employees with flexible jobs and at small firms have on average lower expected pensions, indicating that income differentials of vulnerable labor market group are persistent in retirement.

## Samenvatting

Dit onderzoek biedt de meest complete analyse tot nu toe van de pensioentoeikendheid in Nederland, op basis van administratieve gegevens over 4,3 miljoen huishoudens (2022). Daarbij worden alle vier pijlers van het Nederlandse pensioenstelsel meegenomen: AOW, aanvullend pensioen, vrijwillige pensioenopbouw en niet-pensioengebonden vermogen (zoals spaargeld en woningbezit). De onderzoekers vinden dat een doorsnee huishouden circa 60% van het inkomen voor pensionering kan vervangen via de eerste drie pijlers en 70% wanneer ook privévermogen, waaronder de huurwaarde van de eigen woning, wordt meegerekend. Toch is de spreiding groot: de verschillen in verwachte pensioeninkomens zijn substantieel en hangen sterk samen met arbeidsmarktpositie en woningbezit. Kwetsbare groepen zijn met name huishoudens met een migratieachtergrond, huurders, vrouwen, zelfstandigen, flexwerkers en werknemers in kleine bedrijven of sectoren met beperkte pensioenopbouw (zoals horeca en handel). Zelfstandigen bouwen nauwelijks tweede pijler op, en compenseren dit slechts deels met eigen vermogen. Huishoudens met een migratieachtergrond hebben vaak onvolledige AOW-rechten en lopen verhoogd risico op pensioenarmoede.

## Introduction

The Netherlands is internationally recognized as a country with a relatively generous pension system. However, the composition of pension assets varies, and heterogeneity is substantial. This study evaluates the adequacy of retirement savings in the Netherlands using population-wide administrative microdata on 4.3 million households in 2022. We estimate expected retirement income across all four pension pillars—state pensions, occupational pensions, voluntary private pensions, and financial assets plus the rental value of the home. We use the method developed by Knoef et al. (2016) to annuitize asset elements and calculate expected pension income.

This paper answers several key questions related to pension adequacy. First, we examine the importance of the four pension pillars for the full distribution of Dutch households. We provide descriptive tables and graphs of expected pension incomes, plus replacement rates for multiple definitions of pension income and for all income percentiles of the population. We find that low-income households rely mostly on first pillar pensions, while the second and fourth pillar are increasingly important for higher-income households. Second, we examine the effect of the four pension pillars on income inequality by comparing Gini-coefficients and find that state pensions are distributed relatively equally. Third, we use OLS and quantile regressions to find household and job characteristics that correlate with lower expected pension incomes.

Our paper contributes to the literature in three ways. First, we use quite recent and high-quality data. We employ administrative population-wide data for the year 2022, whereas Knoef et al. (2016) used a representative selection of 1 percent of Dutch households in 2008. Using administrative data that reflect all retirement income sources accurately is essential for assessment of the adequacy of retirement savings (Rauh, 2025; Dushi et al., 2025). An advantage of population-wide data is that it allows detailed heterogeneity analysis and focus on potentially relevant subgroups. Second, our analysis offers new insights into how expected pension incomes vary across different income percentiles. This gives a comprehensive view of the adequacy of retirement income. Third and most important, we improve the understanding of why certain households have inadequate retirement savings. More specifically, we analyze to what extent the adequacy of pension income is affected by individual, household, and job characteristics, using regression models. Moreover, by using linear and quantile regression models we get more detailed knowledge of what characteristics are associated with the level of affluence in the distribution of pension income.

The remainder of this paper is structured as follows. The literature on pension adequacy is discussed in Section 1. We present the data in Section 2 and describe the methods used to estimate expected pension incomes and the regression models in Section 3. The results are presented in Section 4. Finally, Section 5 contains our conclusions.

## 1. Literature

Population aging has placed considerable strain on pension systems worldwide. Policy-makers therefore increasingly consider trade-offs between the sustainability and adequacy of pensions, with many reforms leading to lowering of pension benefits. Adequate retirement savings are essential for ensuring financial security in old age, enabling individuals to maintain their standard of living after exiting the labor force. Hence, the adequacy of retirement income is important for the well-being of households. That applies in old age but also earlier in the life cycle, when households accumulate savings. The Life Cycle Hypothesis (LCH), originally formulated by Modigliani & Brumberg (1954), provides a theoretical foundation for understanding such retirement savings behavior. According to this model, individuals smooth their consumption over their lifetime, by accumulating assets during their working years and decumulating them after retirement. Empirical analyses have used the LCH to assess the adequacy of retirement savings. The literature on these analyses consists of three approaches to assess the adequacy of pension assets.

Firstly, there are structural models to assess savings adequacy, by either comparing optimal asset holdings to actual asset holdings, such as in Scholz et al. (2006), Crawford & O’Dea (2020), and Ciurila et al. (2020), or by comparing optimal to actual asset decumulation, such as in De Nardi et al. (2014). As such, this strand of literature is very much theory-driven. Secondly, there is the predominantly empirical approach of estimating the effects of retirement on spending: the literature on the “Retirement-Consumption Puzzle”. The “puzzling” result is that individuals are unable to save sufficiently over a long time horizon to optimize consumption over the lifecycle (Banks et al., 1998; Miniaci et al., 2010; Smith, 2006; Haider & Stephens, 2007; Battistin et al., 2009; Aguila et al., 2011; Hurd & Rohwedder, 2013; Moreau & Stancanelli, 2013; Been & Goudswaard, 2021). This has been viewed as the inability of households to save sufficiently for retirement. The related literature largely depends on the availability of spending information in survey data. Only recently has the literature shifted towards using (restricted) administrative spending data from, for example, banks (Koopmans et al., 2025). Thirdly, previous empirical work assesses the adequacy of retirement income by employing replacement rate benchmarks (Banks et al., 2005; Haveman et al., 2007; Hurd & Rohwedder, 2008; Love et al., 2008; Borella & Fornero, 2009; Buetler, 2009; Brady, 2010; Binswanger & Schunk, 2012; Burnett et al., 2013; Dudel & Schmied, 2023). This strand of literature starts from the data instead of from the theory, unlike the literature that starts from life cycle theory. This allows using population-wide administrative microdata to detect interesting patterns in retirement savings adequacy. Our analysis fits in this data-based strand of literature and exploits population-wide information on a rich set of asset elements, including traditional pension assets, but also detailed information on non-pension assets.

In light of the availability and comparability of numerous data, the latter approach, which uses replacement rate benchmarks, has also been most frequently used in cross-country comparative analyses as they make clear that the adequacy of retirement savings depends on the generosity of public pensions, the coverage of occupational pensions, and the availability of private savings mechanisms (OECD, 2014; Knoef et al. 2015). Such analyses can provide empirical evidence on which pension system characteristics are important in providing an adequate retirement income (Been et al. 2017). A pension system that is consistently lauded for its adequacy, ranking highly in international pension comparisons (Mercer, 2024), is the Dutch system.<sup>1</sup> The Dutch pension system is successful in combining a basic minimum income with substantial replacement rates for higher incomes through mandatory occupational pensions (Knoef et al., 2015; 2016; 2017). While the state pension lifts households above the poverty line, occupational pensions allow households to sustain their living standard during retirement.

Knoef et al. (2016) are the first to show that a full assessment of pension adequacy requires analyzing all elements of pension assets, including private assets, such as savings accounts, stocks/bonds, business ownership, and home equity. Home equity can be a substantial source of income after retirement (Suari-Andreu et al., 2019; Nakajima & Telyukova, 2020; Ciurila et al., 2020; Been et al., 2024). Assuming that home equity only leads to reduction of spending needs compared to renting (i.e. using the renting value and no depletion of home equity), Knoef et al. (2016) concluded that two-thirds of future retirees had sufficient income in the Netherlands in 2008. This means that most households have sufficient pension savings.<sup>2</sup> However, Knoef et al. (2016) also show that a substantial number of households may not save sufficiently. However, they conclude that only 3% of all Dutch households are at risk of falling below the poverty line.

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1 In Mercer (2024), the degree of adequacy of pension systems is partly based on the cross-country comparable replacement rates from the OECD Pensions at a Glance series.

2 This is in line with Been & Goudswaard (2023) and Koopmans et al. (2025), who find that there is no substantial drop in spending at retirement (in contrast with evidence from Anglo-Saxon countries that often find consumption drops of 10-15 percent at retirement), Suari-Andreu et al. (2019) who shows that there is no decumulation of savings after retirement, and Ciurila et al. (2020) who show that most household save more than optimal according to the life cycle model.

## 2. Data

We use confidential microdata from Statistics Netherlands for the year 2022. These data contain linkable data at the individual level from multiple sources such as the Dutch tax authority, the municipal records database, employers, banks, and pension funds.

Our methodology is aligned with that of Knoef et al. (2016), unless stated otherwise. For details on our method, we refer to Section 3 and Appendix A. Since Knoef et al. (2016), the datasets have been enhanced. A key difference is that full population data are now available, rather than a 1% sample. Previously, approximately 70% of pension funds provided data on pension entitlements, while for the remainder of the population, Statistics Netherlands estimated these entitlements. Moreover, more recent data are now available for 2022 instead of 2008. The recent data also include assets accrued in tax-facilitated savings mortgages, which were previously unavailable.

Our dataset includes 4.3 million Dutch households. Expected pension income is presented at the household level, as assets are only registered at that level. In addition, partners are generally entitled to all or part of each other's pension assets. We consider all households with a Dutch residential address where the main earner is aged 35 or older. Households with a main earner under the age of 35 are excluded, as their incomes tend to fluctuate significantly and their future pension income is difficult to predict. We calculate household income by adding the income of the main earner and that of any partner. To ensure comparability between single-person and two-person households, pension incomes for two-person households are equivalized using the equivalence factor developed by Statistics Netherlands of 1.40. According to research by Statistics Netherlands, a two-person household requires 40% more income to achieve the same standard of living as a single-person household. Households with children usually have lower living costs when children move out of the house. We do not correct expected income for the number of children in a household since the amount of support to children varies by household, but we do note that a replacement rate lower than one is usually sufficient to maintain the standard of living after retirement for those households.

### 2.1 Household characteristics

We observe a set of household characteristics and use them to examine heterogeneity in pension adequacy. These characteristics are summarized in Table 1. For households with multiple persons, gender, migration and age refer to the main earner of the household. Demographic information is available for the full sample of 4.3 million households from the municipal records database. The main earner is male for 67% of the households. Moreover, 26% of households in our sample has a migration background, implying that the main earner of the households was either born abroad (first generation) or was born in the Netherlands

Table 1. Summary statistics of households and job characteristics

	Percentage	Median	Mean
<b>Household characteristics</b>			
Gender			
Male	67.1%		
Female	32.9%		
Migration background			
None (Dutch)	74.3%		
Western	11.1%		
Non-western	14.7%		
Age (years)			
35-39	14.7%		
40-44	14.6%		
45-49	15.5%		
50-54	18.5%		
55-59	18.3%		
60-66	18.5%		
Housing type			
Homeowner	63.7%		
Renter	34.1%		
Household type			
Couple	55.9%		
Single	44.1%		
Gross annual household income (in euros)		62,225	70,224
Total net household assets (in euros)		175,403	346,257
Bank and savings accounts (in euros)		21,025	49,945
Home equity (in euros)		133,504	177,863
Socioeconomic status			
Employee	66.0%		
Self-employed	11.3%		
Other	22.0%		
Observations of household characteristics		4.3 million	
<b>Job characteristics</b>			
Sector of employment			
Agriculture	1.1%		
Manufacturing	13.7%		
Electricity, gas, water supply	1.4%		
Construction	6.1%		
Wholesale and trade	12.9%		
Transportation and storage	6.2%		
Hospitality and food service	1.9%		
Information and communication	4.3%		
Financial and insurance services	4.6%		
Business services	15.5%		
Public administration	9.9%		
Education	6.7%		
Human health and social work	12.8%		
Other service activities	2.8%		
Company size			
Very small (<10 employees)	12.8%		
Small (10-49 employees)	14.9%		
Medium (50-249 employees)	19.6%		
Large (>=250 employees)	52.7%		
Contract type			
Permanent	79.9%		
Temporary	9.6%		
Agency work	2.4%		
Flexible hours	1.5%		
Director shareholder (DGA)	5.8%		
Other	1.4%		
Observations of job characteristics		3.0 million	

Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

and has at least one parent who was born abroad (second generation). Housing type - renter or homeownership - is available for 98% of our sample.

Fifty-six percent of households in our sample form a couple. This variable is defined by Statistics Netherlands and includes couples that are married, form a civil partnership, are parents of the same child, or are a couple in fiscal terms. We link individuals who form a couple in our dataset, add up their individual incomes, and apply an equivalence factor to define household income. Income is available from the Dutch tax authority. The median gross household income within our sample of couples and singles was approximately EUR 70,000 in 2022. The median household has about EUR 175,000 in non-pension assets. Much of this comes from home equity (EUR 133,000). Note that we only have data on assets that

are accounted for in the Netherlands (see Table 1). Socioeconomic status refers to the main source of income of the main earner of the household.

In addition to household characteristics, we include job characteristics in our regression models, because second pillar pension enrollment is strongly related to work sector, company size, and contract type. Job characteristics are available for wage employees only and refer to the main earner of the household. The main sectors of employment are business services (16%) and manufacturing (14%). The majority of the employees has a permanent contract (80%), although it is common to start a new job on a temporary contract for usually one year as a form of extended probation period. Employees with a temporary agency work agreement or a flexible hour contract may have a different pension agreement than 'regular' employees. More than half of the employees in our sample work in a large firm (53%, see Table 1).

## 3. Method

### 3.1 Information on pension accrual and household assets

We consider the four pillars of the Dutch pension system. The first pillar consists of the state pension (AOW), which provides a basic income independent of employment history. The second pillar covers occupational pensions accrued via employers. The third pillar includes voluntary pension savings products such as annuity insurance. All other forms of saving—such as stock investments or home equity—are categorized under the fourth pillar. Below, we elaborate on the methodology used for each pillar. We follow the method developed by Knoef et al. (2016) to estimate expected gross pension income per household, unless mentioned elsewhere.

*First pillar - state pensions* - We examine individual state pension entitlements up to 2022. These entitlements are based on the number of years that a person has resided in the Netherlands in the fifty years preceding the statutory retirement age. We assume that all individuals residing in the Netherlands in 2022 will continue to accrue full public pension rights until retirement. The state pension benefit is based on household composition. The gross annual benefit was EUR 16,427 for singles and EUR 11,174 per person for couples in 2022. We assume that the household composition in 2022 will remain the same.

*Second pillar - occupational pensions* - We obtain anonymized data from the microdata of Statistics Netherlands. These contain the expected annual pension income from the statutory retirement age onward, as calculated by pension providers. These estimates assume that individuals remain employed in the same job until reaching the retirement age. We add up gross entitlements at multiple pension schemes for the same individual. For individuals who retired early and are not included in the pension registry, we use data from the most recent available year, adjusted to euros of 2022.

*Third pillar - voluntary private pensions* - We use the pension-related contributions recorded in the microdata of Statistics Netherlands from 2011 onwards, based on income tax filings. These premiums pertain to private pension insurance products. For the period 2011-2022, we aggregate annual contributions. We assume that individuals who made contributions in the past will continue to contribute annually until retirement, at a level equal to their average contribution in recent years. A real annual return of 2% is assumed, consistent with the return assumed for the fourth pillar. This assumption is discussed further in Section 4.2. We convert accumulated third-pillar assets into an annual gross pension benefit starting at the statutory retirement age, considering life expectancy by gender and year of birth. The expected retirement age depends on the individual's date of birth.

*Fourth pillar - household assets* - We consider two definitions of assets based on microdata from Statistics Netherlands: financial assets and the rental value of the house. We do so in order to distinguish between liquid and illiquid types of assets. Financial assets include

bank and savings deposits, as well as stocks and other marketable securities. The rental value of the house reflects lower housing costs in case the mortgage is partially paid off. In a robustness test, total private wealth includes other forms of equity such as business equity as well. The assets from the fourth pillar are annuitized over the expected remaining lifespan of either the single individual or both partners in a household. If one partner has reached the statutory retirement age while the other has not, the annual withdrawal from financial assets is set at half the amount relative to when both partners entered retirement. See Appendix A for a detailed explanation of this method as developed by Knoef et al. (2016).

Note that our approach only identifies the adequacy of retirement savings by financial factors. However, true retirement savings adequacy may also depend on factors such as continuation of work after retirement (Kantarci et al., 2025a), using additional available time to replace spending by home production (e.g. cooking replaces dining out, Been et al., 2021) and individual preferences (e.g. households that like to travel need additional retirement savings). These factors are not considered in our approach. Kantarci & Zweerink (2020) show that sustained labor supply through partial retirement can increase the adequacy of retirement savings in the Netherlands. Home production that replaces spending is most likely only marginal in the Netherlands (Been & Goudswaard, 2023).

### **3.2 Assumptions for expected income at the retirement age**

The results presented in this analysis depend on various assumptions regarding key parameters. For example, we assume that individuals retire at the statutory retirement age (i.e. AOW age). Below, we outline the principal further assumptions. The parameters are determined in a manner comparable to Knoef et al. (2016), although the actual values of the parameters can differ, in line with the most likely current situation. We discuss the robustness of our results to parameter assumptions at the end of Section 4.1.

In the baseline scenario, we assume a real annual return of 2% on net assets in the third and fourth pillars. We assume a uniform rate of return across all asset types, since assuming different returns without accounting for risk would be inappropriate. At the same time, the 2% return is below the historical average return on equities. Households keep at least part of their assets in low-risk accounts such as bank deposits or savings accounts. Since any assumption regarding real returns is inherently arbitrary, we conduct sensitivity analyses based on alternative return assumptions (see at the end of Section 4.1).

Future financial assets in the fourth pillar are projected on the basis of assets observed in 2022, plus returns. This is because it is difficult to predict future household savings or potential inheritances. We therefore assume no further accumulation of assets and no repayment of debts, including mortgage debt.

In line with Knoef et al. (2016) we assume that homeowners with a home that is fully or partly paid off have a financial advantage in the form of implicit savings on rent. In an alternative scenario (see end of Section 4.1), we estimate expected pension income under the assumption that all types of assets including home equity can be fully accessed, either by selling the home or by taking out a reverse mortgage. In practice, however, few households sell their home or utilize a reverse mortgage in the Netherlands.

For simplicity purposes, we assume a *status quo* in pensionable income. This implies that people will remain in the same job with the same (real) earnings from the last moment that we observe them in the data until their retirement. Previous research (OECD, 2014) indicates that relaxing this assumption has little effect on expected median replacement rates. When wage growth is simulated – resulting in higher pension accruals – both the numerator and denominator of the replacement rate increase. While wage growth is often observed in the early phases of the life cycle, income frequently declines later in life due to reduced labor force participation and, more specifically, full or partial early retirement.

We calculate gross pension income only and do not consider any government transfers or subsidies. Note that the income tax burden is generally lower after retirement. Furthermore, households with an incomplete public pension may be eligible for supplemental income support under social assistance schemes (the “AIO”). However, strict eligibility and travel restrictions apply, and non-takeup appears to be considerable (Lössbroek, 2024). In this analysis we do not include AIO, healthcare, and housing allowances. We are thus able to identify vulnerable groups and to present the lower bounds of their expected pension income.

### 3.3 Regressions

We present our results in the form of descriptive statistics and regression results. The descriptive statistics include tables with the mean, median, p25 and p75 values by household characteristic and identify vulnerable subgroups, unconditional on other observed characteristics. In addition, regression models provide further insights into the relationship between specific household and job characteristics and expected pension income, conditional on other characteristics.

Two types of regression are used in this paper. First, we use Ordinary Least Square (OLS) regression to estimate expected pension incomes. We estimate the following equation:

$$Y_i = \alpha + \beta X_i + \varepsilon_i$$

with  $Y_i$  an outcome variable,  $\alpha$  a constant,  $X_i$  a vector of household and job characteristics, and  $\varepsilon_i$  the error term. We estimate the following outcome variables: expected pension income in euros from the first three pillars, expected pension income in euros from the first

three pillars and liquid assets, and expected pension income in euros from the first three pillars and total assets. The model estimates these variables for the year 2022.

The control variables include gender, age, migration background, household type (single or couple), housing type (renter or homeownership), and current gross household income. Moreover, we control for job characteristics including contract type, sector of employment, and size of the employing firm. Such employer-related information is important because the generosity of occupational pension schemes is quite heterogeneous across employment sectors. Also, larger firms are often in a better position to provide generous occupational pension schemes (Kantarci et al., 2025b). In multiple-person households, job characteristics, gender, age, and migration background refer to the main earner of the household.

OLS is the best linear unbiased estimator in terms of standard errors if standard errors are homoscedastic. However, descriptive statistics show that the distribution of expected pension income is right-skewed, and OLS may provide biased results. Therefore, we additionally use a quantile regression (QR) model to examine differences in the determinants of pension income across the distribution of pension income. This method was first presented by Koenker and Bassett (1978).

QR has several advantages over OLS. The distribution of expected pension income is heavily right-skewed, as we will show in Section 4. Outliers can have a substantial effect on the estimation of the mean. We prefer to present median values, which are less sensitive to such outliers. Moreover, QR requires less strict assumptions than OLS. It is not necessary to assume homoscedasticity of the error terms in QR, while it is necessary for OLS. This assumption is more likely to be violated in case of right-skewed data. Finally, QR provides estimates across the distribution of expected pension income, while OLS only provides estimates for the mean.

We estimate the following equation with quantile regression:

$$Y_{i,q} = \alpha_q + \beta_q X_i + \varepsilon_{i,q}$$

This regression is estimated for quantiles  $q = (0.25, 0.5, 0.75)$  separately. Note that the value of the coefficients  $\beta_q$  can differ across quantiles  $q$ . Once again, the dependent variable is expected pension income in euros from the first three pillars, from the first three pillars plus financial assets, and from the first three pillars plus total assets. The regressors in  $X_i$  include the same household characteristics as in the OLS estimates. Job characteristics are not included in  $X_i$ . Since quantile regressions with many regressors are computationally complex and sensitive to dimensionality, we include a dummy variable on socioeconomic status as an alternative in order to account for differences in wage employment, self-employment, and other income sources. This dummy represents the largest income source of the main earner of the household, and it can be wage employment, self-employment, or other income (i.e. from assets, social benefits, etc.).

## 4. Results

### 4.1 Expected pension income

This section presents a detailed overview of descriptive statistics on expected pension income across Dutch households. Table 2 shows the mean income from each pillar of the pension system, as well as the 25th percentile (p25), median (p50), and 75th percentile (p75). These distributional statistics provide insight into typical outcomes and the spread around them. Given the right-skewed nature of the data—where mean values are often substantially higher than the median—our interpretation will primarily focus on medians.

The median annual combined income from state and occupational pensions is just over EUR 33,000. Half of Dutch households fall within the range of EUR 22,000 to EUR 47,000 per year. When voluntary third-pillar savings and financial assets are added, the median increases to EUR 34,000 and EUR 37,000, respectively. Including financial assets and the rental value of the house, the median gross pension income rises to almost EUR 42,000. One-quarter of households receive more than EUR 59,000, while another quarter receives less than EUR 26,000 annually.

Table 2. Expected gross pension income (in euros per year).

Expected pension income	mean	p25	p50	p75
Pillar 1 + 2	36,547	22,348	33,404	46,870
Pillar 1 + 2 + 3	36,980	22,457	33,922	47,427
Pillar 1 + 2 + 3 + Financial assets	41,249	24,338	37,027	51,997
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	46,039	26,296	41,678	58,788

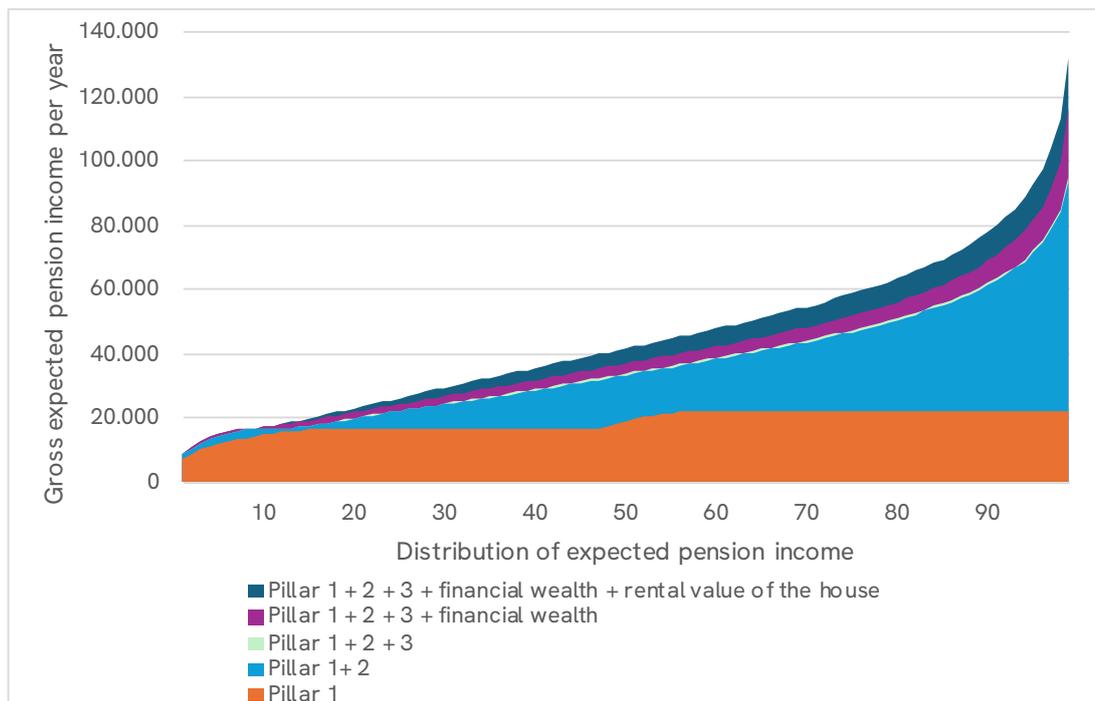
Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

In addition to Table 2, Figure 1 shows the distribution of expected gross pension income. It shows that pension assets are right-skewed for all four definitions of expected pension income. It shows that 10% of the households has an annual expected pension income of EUR 62,000 or more from the first two pillars, and EUR 78,000 or more when all pension pillars are included. For 5% of the households, expected pension income is EUR 72,000 or more from the first two pillars and EUR 92,000 or more from all pension pillars.

#### Robustness tests

We test the robustness of our estimates to assumptions by running scenarios with alternative parameters and assumptions. First, we change the real annual return, since the baseline of 2% is somewhat arbitrary. Median expected pension income from all pension pillars is EUR 42,000 in the baseline. This number increases to EUR 45,000 under the assumption of a 3% real annual return, and drops to EUR 38,000 under the assumption of a 1% real annual

Figure 1. Distribution of expected gross pension income (in euros)



Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

return. This finding indicates that our results are robust to changes in assumptions regarding the key parameter of real annual return.

The results change more substantially under alternative assumptions of asset depletion. The median expected pension income is EUR 50,000 per year under the assumption of total asset depletion. This is an upper bound of the expected pension income. It is in practice unlikely that households would fully deplete their assets, as predicted by the lifecycle theory. Remaining life expectancy is not known upfront. Moreover, a major part of assets consists of net home equity and cannot easily be liquidated (Been et al., 2024).

#### 4.2 Expected replacement rates

Replacement rates indicate the extent to which a household can replace its pre-retirement income. While we examined absolute pension income levels in Table 2, Table 3 analyzes replacement rates—defined as expected gross pension income divided by gross pre-retirement household income, equalized for household size.

The first and second pillars together replace approximately 59% of pre-retirement income for the median household. Table 3 shows replacement rates by pillar, including distributional statistics. The first two pillars offer a median replacement rate of 59%, below the 71% estimated by Knoef et al. (2016) who used 2008 data. The lower rate is attributable to several factors: previous assumptions of partial indexation in the second pillar (which did not materialize), the use of updated administrative data for the full population rather than a

sample, and demographic shifts. For example, the share of households with a non-Western migration background grew from 8% in 2008 to 18% in 2022—a group with significantly lower expected pension incomes (see Section 4.4).

Adding third-pillar income and financial assets increases the median replacement rate by only 0.4 and 4.3 percentage points, respectively. However, inclusion of assets, in particular non-financial assets, raises the replacement rate by 5 percentage points, to nearly 70%. Overall, half of households fall between 56% and 86%, with one-quarter below 56% and one-quarter above 86%.

Table 3. Gross replacement rates of expected retirement income (fractions)

Replacement rate	p25	p50	p75
Pillar 1 + 2	0.464	0.591	0.727
Pillar 1 + 2 + Pillar 3	0.470	0.595	0.732
Pillar 1 + 2 + 3 + Financial assets	0.510	0.638	0.787
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	0.561	0.699	0.861

Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

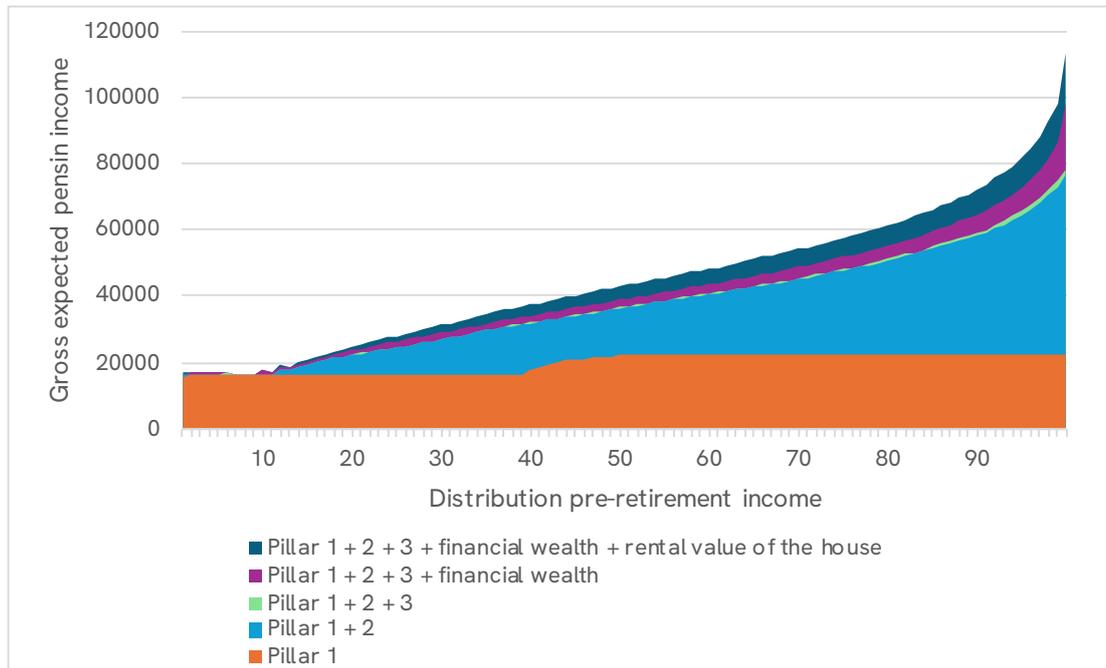
Haveman et al. (2007) show that a gross replacement rate of 70% is widely used as a rule of thumb in the literature. The 70% rule is based on the idea that while retirees may no longer incur certain work-related expenses, such as commuting or work attire, and may have less costs related to children, they still need to cover their basic living expenses, which are often similar to their pre-retirement expenses. Note that out-of-pocket medical expenditures are currently relatively low in the Netherlands, but they are likely to increase in light of ongoing reforms and tighter government budgets (Van Ooijen et al., 2022).

Based on this 70% rule, more than 70% of Dutch households with an expected pension income above the poverty line falls below this measure of adequacy when only state pensions, occupational pensions, and voluntary pensions are considered. When considering all asset elements, including non-liquid assets, about half of the households fall below the 70% rule.

### 4.3 Pension income and replacement rates across the income distribution

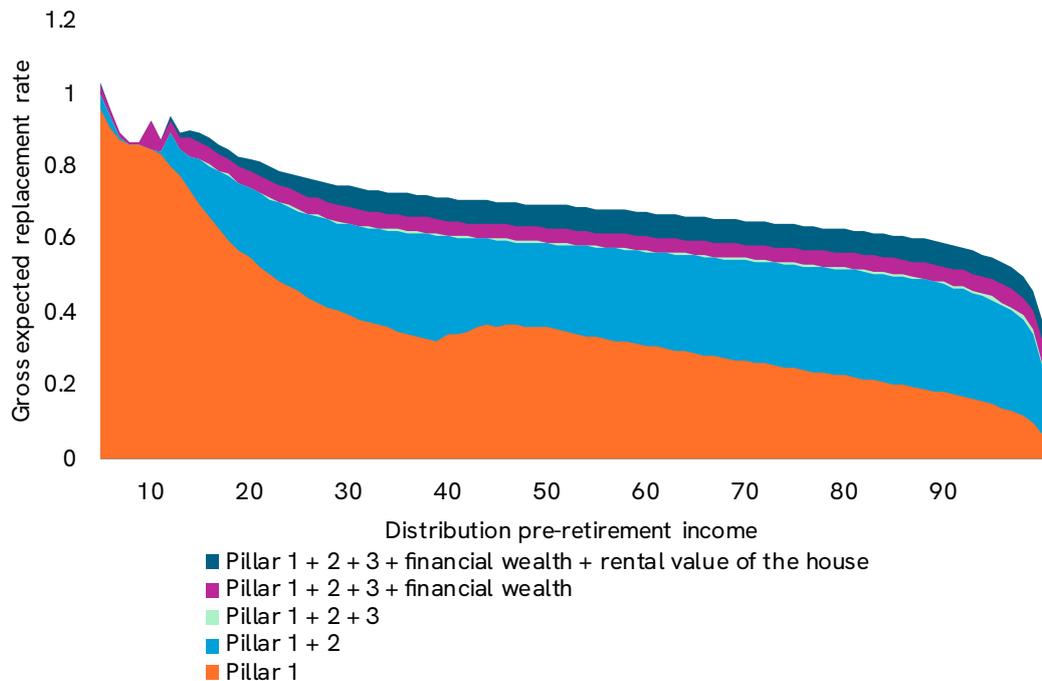
The main advantage of our population-wide data is that we get a complete picture of the distribution of income and assets across the population. In this section, we analyze the adequacy of pensions available at retirement, measured as pension income in absolute terms and as a replacement rate, across the distribution of current income of households. Aggregate pension income varies widely, from a gross amount of EUR 18,000 annually for the bottom 10% in terms of pre-retirement income to EUR 72,000 for the top 10%. Figure 3 illustrates the distribution of pension income across the current pre-retirement income distribution.

Figure 2. Household expected gross pension income (in euros) per year over household current total gross income percentiles



Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

Figure 3. Household gross replacement rates per year over household current total gross income percentiles.



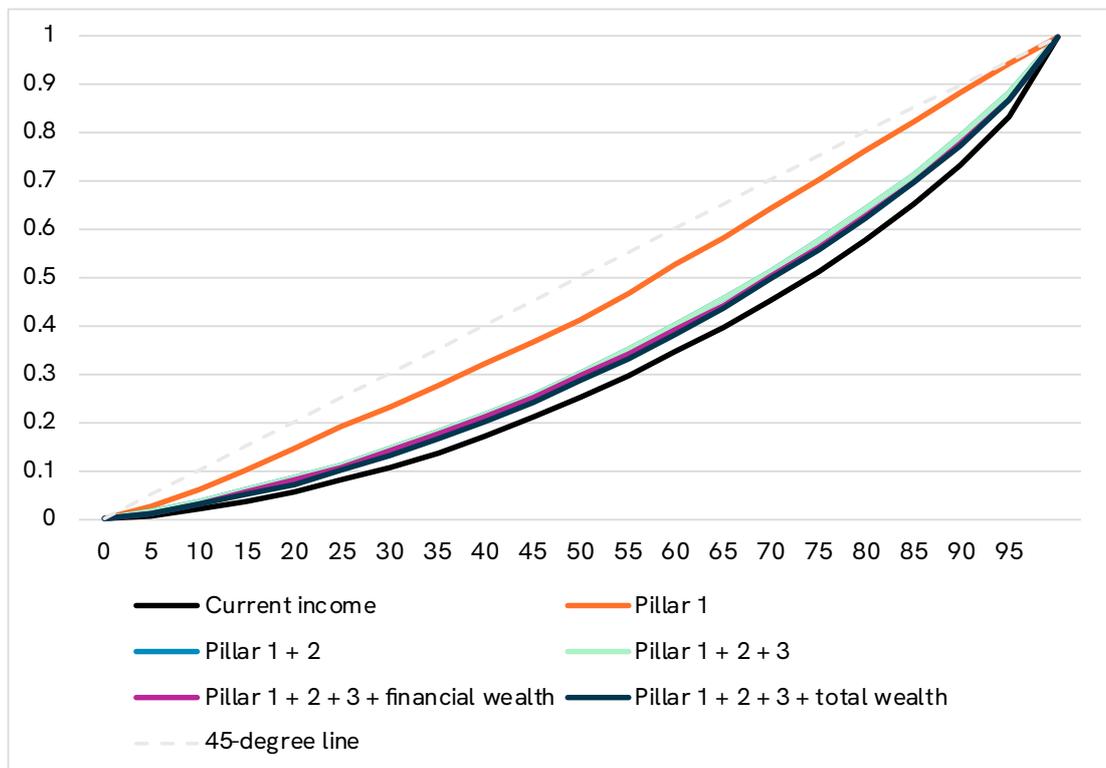
Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

Among low-income households, the first pillar state pension (in Dutch: AOW) plays a dominant role, while higher-income households rely more heavily on occupational pensions. The third pillar contributes relatively little to any income group. However, financial and total assets become increasingly important at higher income levels, especially when including assets such as housing and business assets.

The median replacement rate decreases with income. Figure 3 plots median replacement rates across the income distribution. For the lowest income decile, the first pillar alone is sufficient to replace 80-100% of pre-retirement income. Households with income above the median rely mostly upon the second pillar. Replacement rates from the first two pillars decline as pre-retirement income rises. Financial assets and other assets contribute a few percentage points to replacement rates throughout the income distribution, except for the first two income deciles.

In total, Figures 2 and 3 suggest that pension income is unevenly spread across the income distribution. Adding income from financial assets and the rental value of the house to state pensions, occupational pensions, and voluntary private pensions suggests that much of the additional pension income is especially relevant for households at the higher end of the income distribution.

Figure 4. Lorenz curves of different definitions of pension income.



Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

Figure 4 shows the Lorenz curves of the various pension income definitions. The 45-degree line represents a hypothetical fully equal distribution. The Lorenz curve for expected state pensions (first pillar only) is very close to the 45-degree line, indicating that the first pillar is relatively equally distributed. State pensions are flat-rate benefits, where the amount depends on household composition and years of residence in the Netherlands. Figure 4 furthermore shows that the distance from the 45-degree line increases substantially when occupational pensions are included. The Gini coefficient, a measure for inequality (i.e. the surface between the Lorenz curve and the 45-degree line in Figure 4), is 0.276 for expected pension income from state and occupational pensions. This coefficient does not change when third pillar pensions are added, and it increases slightly when financial assets (0.294) and the rental value of the house (0.305) are added.

#### 4.4 Pension adequacy across subgroups

In Table 4 we present both expected gross pension income and the associated gross replacement rate for different subgroups of the population. The subgroups we consider are men / women, singles / couples, no migration background / Western migrant / non-Western migrant, employed / self-employed, and homeowner / renter. We do not show results for differences between different age groups as these are relatively homogeneous: considering all pension pillars, financial assets and the rental value of the house, median pension income ranges from about EUR 40,000-EUR 43,000, and median replacement rates range from 68-72% across age groups.

*Gender* - The expected pension income of women is lower than that of men. Median expected pension income from the first three pillars amounts to approximately EUR 37,000 for men and EUR 28,000 for women. These figures refer to the main earner of the household. Much of this discrepancy can be traced to differences in occupational pension accumulation, a consequence of differences in labor supply between men and women. Nonetheless, we observe that replacement rates are about 10 percentage points higher among women. This result is driven by the denominator in the calculation of the replacement rate since women also have substantially lower pre-retirement income.

*Household composition* - The benefits received from the state pension depend on the number of accrued years (i.e. number of years living in the Netherlands) as well as household composition. The benefits of people in couple households are 37% lower than those for a single person because the benefit level takes into account the formal economies of scale calculated by Statistics Netherlands. This partially explains the differences in expected income from state pensions shown in Table 4. Next, single and couple households may differ structurally because of other observed and unobserved factors (the observed factors can be partialled out in our regression analysis below). Our results in Table 4 suggest that single households have substantially lower expected pension income (even when corrected for

household size) and substantially higher replacement rates. This combination suggests that single households have both a relatively low pre-retirement and post-retirement income in absolute terms. Additionally, they seem to struggle to continue their standard of living in retirement, with a median replacement rate of 67%, if the rental value of their property is not used.

*Migration* – A substantial share of individuals with a migration background have incomplete state pension entitlements. More than 86% of individuals with a Western migration background and 66% of those with a non-Western background have an incomplete state pension. The difference is probably due to the fact that individuals with a Western migration background, migrate to the Netherlands at a younger age on average, allowing them to accrue somewhat more state pension rights. After all, state pension entitlements are built up based on years of residence in the Netherlands. Missing years can, in principle, be purchased retroactively to supplement state pension entitlements, but this option is relatively costly and not widely known. For individuals who have incomplete public pension rights, their retirement income can be supplemented up to the public pension level through social assistance, provided that they meet the income and asset requirements. In this analysis, we assume that individuals currently residing in the Netherlands will remain in the Netherlands until retirement.

The expected median pension income of households with a migration background is substantially lower than that of a typical household without such background. This refers to households where the main earner was born outside the Netherlands (i.e., first-generation migrants). The difference originates in part from substantially lower income from the state pension (due to the state pension shortfall), but contributions from the second through fourth pillars are also relatively low. Individuals with a non-Western migration background have lower total pension income than those with a Western migration background: EUR 22,000 versus EUR 24,000 at the median.

Since the state pension is intended primarily to ensure that households do not fall below the poverty line during retirement, poverty is a serious risk for households with incomplete state pension entitlements. We find that 10% of the 4.3 million households analyzed can expect gross pension income from the first three pillars below the state pension benefit level. Due to the state pension shortfall, these percentages are substantially higher for households with a Western or non-Western migration background, at 38% and 34%, respectively.

As a result, one-quarter of households with a migration background are expected to have pension income below the AOW threshold. Specifically, total pension income of Western as well as non-Western migrant households in the lowest quartile is below the social minimum of EUR 16,427 per year. Table 4 also shows that the lower end of the pension income distribution has a longer tail for households with a Western migration background.

Individuals with a Western migration background have a relatively low replacement rate. A median household with a Western migration background can replace 47% of its pre-retirement income through the first three pillars, and 55% when financial assets and the rental value of the house are also included. This is substantially lower than the replacement rates from the first three pillars for individuals without a migration background (60%) and for those with a non-Western migration background (62%). Potential explanations are that households with a Western migration background tend to have higher pre-retirement income than those with a non-Western migration background, and that they migrated to the Netherlands at a later age.

It is possible that households with a migration background have accrued pension entitlements abroad. Unfortunately, no information on this is available in the dataset used. Other research shows that 46%, 46%, and 40% of retirees born in the United Kingdom, Germany, and Belgium, respectively, receive pension income from their country of birth (Lössbroek et al., 2024).

*Labor market* – Self-employed individuals tend to accumulate less pension assets, as they generally have no entitlements under the second pillar. For certain professions and sectors, participation in a pension scheme is mandatory, including for dentists, medical specialists, general practitioners, painters, and plasterers. However, these are exceptions; for most self-employed workers, no such obligation applies. Self-employed individuals may save for retirement through voluntary pension components, such as the third pillar, the value of their business, or owner-occupied housing. However, Zwinkels et al. (2017) and Biesenbeek et al. (2022) show that savings through these voluntary components are limited among the self-employed. In 2022, only 11% of self-employed workers accrued any pension rights in the third pillar.

For employees, pension income from the first and second pillars is substantially higher than for the self-employed. The difference in pension income between employees and the self-employed is entirely attributable to the far higher second-pillar pension income among employees. This gap narrows only marginally when third-pillar pension income is taken into account. Self-employed individuals do, however, derive significantly more pension income from financial assets and the rental value of the house. Nevertheless, total median pension income of the self-employed is clearly lower than that of employees: EUR 35,000 versus EUR 48,000.

The replacement rates of self-employed individuals across the first three pillars, are clearly lower than those of employees. This discrepancy becomes somewhat smaller but still exists when financial assets and the rental value of the house are considered. The distribution of replacement rates among the self-employed is considerably wider than among employees.

*Homeownership* – Homeowners and renters may structurally differ in terms of observed and unobserved characteristics, with homeowners most likely possessing more affluent characteristics (Been et al., 2024). This is confirmed by our results in Table 4. Homeowners are expected to receive more retirement income from state pensions, occupational pensions, voluntary pensions, and financial assets. On top of that, homeowners benefit from the rental value of their property assets. In total, the median homeowner can expect annual retirement income of EUR 51,000, which is more than twice that of the median renter (EUR 23,000). However, replacement rates are substantially higher for renters. This suggests that renters have both a relatively low pre- and post-retirement income in absolute terms, but they seem to be quite able to continue their standard of living in retirement according to the 70% rule. For homeowners it is crucial to be able to use the rental value of their property assets, as this increases the median replacement rate by 8 percentage points to 69%. Without financial assets and other types of assets – including the rental value of the home – the median replacement rate of homeowners falls well below the 70% rule of thumb for adequate retirement income.

Table 4. Expected gross pension income (in euros) and gross replacement rates (fractions) across different subgroups per year for remaining life after retirement

	Pension income (euro)			Replacement rate		
	p25	p50	p75	p25	p50	p75
<i>Men</i>						
Pillar 1	16,427	22,348	22,348	0.21	0.29	0.42
Pillar 1 + 2	24,581	36,141	48,991	0.45	0.58	0.70
Pillar 1 + 2 + Pillar 3	25,034	36,715	49,584	0.46	0.58	0.70
Pillar 1 + 2 + 3 + Financial assets	27,277	39,754	54,221	0.50	0.62	0.75
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	30,085	44,844	61,276	0.55	0.68	0.83
<i>Women</i>						
Pillar 1	16,427	16,427	21,206	0.23	0.35	0.62
Pillar 1 + 2	18,372	27,264	41,404	0.49	0.63	0.81
Pillar 1 + 2 + Pillar 3	18,490	27,550	41,811	0.50	0.63	0.81
Pillar 1 + 2 + 3 + Financial assets	20,252	30,627	46,436	0.54	0.68	0.87
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	21,205	34,071	52,431	0.59	0.74	0.91
<i>Single</i>						
Pillar 1	16,132	16,427	16,427	0.23	0.36	0.65
Pillar 1 + 2	16,735	22,906	33,790	0.48	0.62	0.82
Pillar 1 + 2 + Pillar 3	16,805	23,164	34,079	0.48	0.62	0.82
Pillar 1 + 2 + 3 + Financial assets	18,009	25,583	37,957	0.52	0.67	0.87
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	18,423	27,849	42,141	0.56	0.72	0.90
<i>Couple</i>						
Pillar 1	22,256	22,348	22,348	0.21	0.28	0.39
Pillar 1 + 2	30,769	41,303	53,849	0.45	0.58	0.68
Pillar 1 + 2 + Pillar 3	31,449	41,898	54,492	0.46	0.58	0.69
Pillar 1 + 2 + 3 + Financial assets	34,066	45,215	59,425	0.50	0.62	0.74
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	38,605	51,390	67,373	0.56	0.69	0.82

	Pension income (euro)			Replacement rate		
	p25	p50	p75	p25	p50	p75
<i>No migration background</i>						
Pillar 1	16,427	22,348	22,348	0.21	0.30	0.44
Pillar 1 + 2	25,312	36,599	49,377	0.47	0.59	0.72
Pillar 1 + 2 + Pillar 3	25,787	37,167	49,968	0.48	0.60	0.72
Pillar 1 + 2 + 3 + Financial assets	28,524	40,595	54,935	0.52	0.64	0.79
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	31,795	45,936	62,158	0.58	0.71	0.87
<i>Western migration background</i>						
Pillar 1	10,394	13,732	16,688	0.17	0.26	0.42
Pillar 1 + 2	13,165	20,142	33,590	0.32	0.47	0.62
Pillar 1 + 2 + Pillar 3	13,198	20,263	33,897	0.33	0.47	0.63
Pillar 1 + 2 + 3 + Financial assets	14,129	22,062	37,286	0.35	0.50	0.67
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	14,750	24,382	42,254	0.38	0.55	0.73
<i>Non-Western migration background</i>						
Pillar 1	12,726	15,961	19,020	0.27	0.44	0.72
Pillar 1 + 2	15,003	20,426	30,077	0.47	0.62	0.82
Pillar 1 + 2 + Pillar 3	15,016	20,467	30,187	0.47	0.62	0.82
Pillar 1 + 2 + 3 + Financial assets	15,481	21,402	31,968	0.50	0.65	0.84
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	15,606	22,156	34,674	0.52	0.68	0.87
<i>Employed</i>						
Pillar 1	16,427	21,683	22,348	0.20	0.27	0.37
Pillar 1 + 2	29,455	40,071	52,337	0.49	0.59	0.69
Pillar 1 + 2 + Pillar 3	29,641	40,329	52,690	0.49	0.59	0.69
Pillar 1 + 2 + 3 + Financial assets	31,763	43,296	57,319	0.53	0.63	0.74
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	34,327	48,168	64,253	0.57	0.69	0.81
<i>Self-employed</i>						
Pillar 1	16,427	22,101	22,348	0.22	0.33	0.51
Pillar 1 + 2	18,746	24,407	31,730	0.31	0.44	0.63
Pillar 1 + 2 + Pillar 3	19,274	25,306	33,597	0.33	0.46	0.64
Pillar 1 + 2 + 3 + Financial assets	21,941	28,647	38,611	0.37	0.51	0.72
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	24,471	34,602	47,100	0.43	0.60	0.83
<i>Homeowner</i>						
Pillar 1	16,427	22,348	22,348	0.19	0.26	0.35
Pillar 1 + 2	29,745	40,716	53,143	0.44	0.56	0.66
Pillar 1 + 2 + Pillar 3	30,480	41,299	53,765	0.45	0.56	0.66
Pillar 1 + 2 + 3 + Financial assets	33,954	45,144	59,197	0.49	0.61	0.72
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	39,888	51,832	67,356	0.56	0.69	0.83
<i>Renter</i>						
Pillar 1	15,866	16,427	16,427	0.32	0.49	0.77
Pillar 1 + 2	16,518	21,943	30,269	0.53	0.69	0.86
Pillar 1 + 2 + Pillar 3	16,530	22,009	30,398	0.54	0.69	0.86
Pillar 1 + 2 + 3 + Financial assets	17,166	23,067	32,224	0.56	0.72	0.90
Pillar 1 + 2 + 3 + Financial assets + rental value of the house	17,153	23,122	32,440	0.56	0.73	0.90

Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

#### 4.5 Regression results

We present the results of Ordinary Least Squares (OLS) regressions in Table 5 below.

The estimated relationship between household composition and migration background and pension income from OLS are in line with our findings from the descriptive statistics. For example, we find that singles and households with a migration background have lower expected pension income. After controlling for other household and job characteristics, being single reduces expected pension income by approximately EUR 8,000 per year, and having a migration background by approximately EUR 5,000 to EUR 9,000 per year (Table 5).

We find an opposite result for gender. Gender does not have a significant relation with pension income from the first three pillars, and only slightly reduces pension income from broader definitions. A potential explanation is that the 'raw' difference in expected pension income between males and females is driven by other characteristics. For example, women are more likely to work fewer hours, to have a lower income, and to work in sectors with less generous pension arrangements.

The expected pension income increases somewhat with age. Households in the age group 55-60 (60-66) have on average approximately EUR 4,000 (EUR 5,500) less annual pension income from the first three pillars than households in the 35-40 age group, after controlling for other household and job characteristics. A potential explanation is that households in these age groups reduce their working hours as they approach retirement.

Furthermore, expected pension income is positively correlated to current income, in line with our findings in Section 4.2. For every additional euro in current income, future pension income from the first three pillars increases by EUR 0.09, pension income from the first three pillars plus financial assets by EUR 0.17, and pension income from the first three pillars plus total assets by EUR 0.19.

In line with Section 4.4, we find that the expected pension of renters is substantially lower than that of homeowners, even if we disregard pension income from (housing) assets. An additional insight from our regression results is that the difference between homeowners and renters is not purely a selection effect; it is substantial even after correcting for differences in household income and other characteristics.

Job characteristics explain a substantial part of heterogeneity in expected pension income. Employees in flexible jobs have lower expected pension income than those with a permanent contract. Most notably, expected pension income of employees in temporary agency work is on average over EUR 10,000 per year less than that of employees on a permanent contract. Temporary agency workers have hardly any job protection, which leads to less bargaining power and lower wages (Biesenbeek and Volkerink, 2023; van der Wiel, 2010). Director / major shareholders have lower expected pension income from the first three pillars. This is likely because they can save for their pension within the firm, with fiscal opportunities (Biesenbeek et al, 2024).

We find heterogeneity across employment sectors as well. Workers in the hospitality and food service industries and wholesale trade can expect lower pension incomes. On the other hand, employees in education and public administration expect on average EUR 5,000 to EUR 6,000 higher pension incomes, in particular from the first three pillars. Workers in the financial sector not only have higher expected pension incomes from the first three pillars, but also from financial and other assets. Working the financial sector increases the expected pension income by approximately EUR 7,000 per year (first three pillars only) to EUR 9,000 per year (including financial assets and the rental value of the house).

Finally, we find a substantial relationship between firm size and expected pension income. Larger firms are more likely to offer secondary pension arrangements. This finding is correlated to the sector of work: the government is a very large employer and has good pension arrangements. The difference in expected pension income between employees at large to very large firms and smaller firms reduces somewhat when financial and other assets are included as an additional source of pension income (see Table 5).

Table 5. OLS results for expected pension income

	Pension income		
	Pillar 1 + 2 + 3	Pillar 1 + 2 + 3 + financial assets	Pillar 1 + 2 + 3 + financial assets + rental value of the house
<b>Gender (ref=male)</b>			
Female	-186.763 (164.098)	1,555.106*** (297.151)	2,514.546*** (322.593)
<b>Age group (ref=35-39)</b>			
40-44	-659.483*** (68.023)	-761.556*** (124.380)	-840.599*** (134.393)
45-49	-1,690.395*** (106.718)	-1,660.948*** (198.037)	-1,769.812*** (214.121)
50-54	-3,182.526*** (125.813)	-2,541.290*** (231.391)	-2,539.551*** (250.548)
55-59	-4,179.303*** (108.567)	-3,147.278*** (198.658)	-3,064.444*** (215.174)
60-66	-5,578.522*** (75.856)	-4,593.035*** (132.895)	-4,542.019*** (144.741)
<b>Household status (ref=couple)</b>			
Single	-8,817.853*** (143.770)	-7,131.073*** (260.199)	-8,197.769*** (282.330)
<b>Migration background (ref=none)</b>			
Western	-4,828.255*** (90.219)	-5,058.610*** (164.993)	-5,372.170*** (178.206)
Non-western	-8,263.408*** (114.088)	-8,548.250*** (205.122)	-9,451.416*** (222.393)
<b>Housing type (ref=homeowner)</b>			
Rental	-7,501.204*** (266.973)	-8,199.913*** (486.684)	-13,958.489*** (527.901)
Current household income (5y avg)	0.090*** (0.011)	0.169*** (0.021)	0.188*** (0.022)

	Pillar 1 + 2 + 3	Pension income Pillar 1 + 2 + 3 + financial assets	Pillar 1 + 2 + 3 + financial assets + rental value of the house
<b>Contract type (ref=permanent)</b>			
Temporary	-3,848.147*** (148.438)	-3,542.082*** (270.934)	-3,578.122*** (293.740)
Agency Work	-10,595.959*** (439.051)	-10,429.726*** (790.972)	-11,081.114*** (859.560)
Flexible hours	-6,672.442*** (261.238)	-5,299.971*** (477.518)	-5,007.025*** (517.647)
Director shareholder (Dga)	-9,924.380*** (105.898)	-5,967.421*** (236.035)	-3,110.681*** (252.410)
Other	-6,206.426*** (403.990)	-4,613.045*** (734.237)	-4,249.263*** (796.487)
<b>Sector of employment (ref=agriculture)</b>			
Manufacturing	-1,666.000 (82.317)	-935.429*** (128.468)	-1,570.446*** (140.183)
Electricity, gas, water supply	2,811.579*** (126.572)	1,559.971*** (201.468)	1,097,764*** (219.692)
Construction	-149.102 (80.269)	-1,255.928*** (120.625)	-1,613.278*** (132.619)
Wholesale and trade	-1,794.944*** (73.461)	-2,675.381*** (109.266)	-2,949.432*** (119.639)
Transportation and storage	74.107 (81.397)	-1,242.502*** (119.836)	-1,943.994*** (131.328)
Hospitality and food service	-1,974.572*** (152.196)	-2,156.170*** (322.004)	-2,405.106*** (341.391)
Information and communication	974.566** (326.161)	-40.677 (588.624)	150.856 (638.827)
Financial and insurance services	7,308.723*** (350.578)	8,285.287*** (660.344)	9,121.003*** (713.337)
Business services	1,315.420*** (181.142)	867.288** (314.569)	1,031.174** (343.064)
Public administration	6,384.172*** (100.357)	5,388.194*** (165.464)	5,065.080*** (179.972)
Education	5,030.918*** (81.044)	4,636.612*** (124.378)	4,568.178*** (135.883)
Human health and social work	1,714.258*** (81.265)	1,116.739*** (123.310)	827.506*** (134.878)
Other service activities	1,334.564*** (86.317)	1,126.061*** (147.389)	1,321.040*** (158.982)
<b>Company size (ref = very small, &lt;10 employees)</b>			
Small: 10-49 employees	2,824.422*** (60.794)	2,250.520*** (119.689)	2,114.966*** (129.176)
Medium: 50-249 employees	5,393.520*** (121.932)	4,570.523*** (229.624)	4,333.850*** (248.488)
Large: >=250 employees	7,926.112*** (169.292)	7,023.915*** (307.865)	6,914.477*** (334.080)

	Pension income		
	Pillar 1 + 2 + 3	Pillar 1 + 2 + 3 + financial assets	Pillar 1 + 2 + 3 + financial assets + rental value of the house
<b>Interactions</b>			
Female # Western	1,227.496*** (62.431)	1,166.587*** (122.877)	1,349.724*** (129.406)
Female # Non-western	1,553.399*** (74.226)	1,149.213*** (133.027)	1,055.265*** (142.729)
Female # Single	-3,096.283*** (38.020)	-3,889.288*** (82.097)	-4,240.423*** (86.457)
Single # Western	459.971*** (62.690)	127.718 (121.215)	215.303 (127.584)
Single # Non-western	3,123.780*** (77.064)	2,359.102*** (137.038)	3,088.307*** (147.421)
Constant	38,982.279*** (837.375)	37,174.231*** (1,523.815)	43,073.851*** (1,652.972)
r <sup>2</sup>	0.490	0.251	0.294
Observations	2,946,244	2,946,244	2,946,244

Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

Quantile regressions reveal substantial differences across the distribution of expected pension incomes, although the direction of the regressors is usually in line with the results from OLS. The QR results are presented in Table 6.

Most notably, we find that having a migration background has a much more closely related to expected income for households at the lowest quantile of the expected pension income distribution than for the mean and median households. For the 25th quantile, having a Western migration background reduces expected pension income from the first three pillars by approximately EUR 7,000. This is approximately EUR 4,000 for the median, EUR 3,000 for the 75th quantile and EUR 5,000 for the mean household (from OLS, see Table 5). Thus, QR results reveal that the negative effect of having a migration background on expected pension income is most pronounced at the lower quantiles of the pension income distribution. For non-Western migrants, the penalty is particularly severe at the 25th percentile, consistent with our earlier finding of incomplete buildup of state pension rights and lower occupational pensions (see Section 4.4). At higher quantiles the gap narrows somewhat, indicating that a subset of migrant households succeeds in building more substantial pension entitlements, although they remain below the native benchmark.

The correlations of age and household status from quantile regressions are in line with the results from OLS. We find somewhat larger negative correlations of being single and older on expected pension income for the lowest quantile, but the differences across the distribution are not as large as for migration background and self-employment.

Likewise, we find that the relationship between being self-employed and expected pension income is somewhat larger for the lowest quantile of the expected income distri-

bution than for the upper quantile (see Table 6). The expected pension from the first three pillars is EUR 10,000 lower than that of employees in the lowest quantile and at the median, and it is EUR 9,000 less for the highest quantile. The difference across the distribution increases when we take the fourth pension pillar into account. Using the broadest definition of pension assets, self-employees at the lowest quantile have approximately EUR 9,000 less pension income per year, and those at the highest quantile EUR 6,000 less per year. This indicates that some of the self-employed partly compensate a lack of pension income in the first three pillars with financial assets or income from home equity. However, being self-employed still has a strong negative relationship with expected pension income, even for the highest quantile and when financial assets and home equity are taken into account. Having income from a source other than self-employment or wage employment is negatively associated with expected pension income, but this relationship is smaller for individuals who are self-employed. This 'other' category includes unemployment, and may imply past pension buildup.

QR provides opposing estimates for women compared to OLS. Using QR, we find a small positive correlation of being female on expected pension income in all definitions of pension income (see Table 6). This contradicts with OLS, where we found a small negative but statistically insignificant relationship with being female and expected pension income from the first three pillars. There are several possible explanations. It could be that the QR model is subject to omitted variable bias, as job characteristics are not included, or that OLS provides biased estimates due to a violation of the homoscedastic error assumption.

Our QR findings on housing status are in line with those from OLS. Using both models, we find that renters have substantially lower pension income than homeowners. However, we find that the correlation of renting on expected pension income is larger for *higher* quantiles of the expected pension income distribution, contrary to other regressors such as migration background and self-employment. The relationship between housing status and expected pension income depends more on the definition of expected pension income than on quantiles. Expected pension income from the first three pillars is EUR 3,000 lower for renters than for homeowners in the lowest quantile and EUR 4,000 lower for the highest quantile. Expected pension income from the first three pillars and from total assets is EUR 9,000 lower for the lowest quantile and EUR 12,000 for the highest quantile. This indicates that non-financial forms of assets, most notably the rental value of the house, creates a substantial difference between renters and homeowners for all quantiles of the expected pension distribution. However, it is likely that homeowners are overrepresented in the highest quantile of the expected pension distribution.

The sign of the relationship between current income on expected pension income is in line with previous findings from OLS as well. The size of this correlation is higher for higher quantiles.

Table 6. Quantile regression results for expected pension income (part 1/3)

	Pillar 1 + 2 + 3		
	Q25	Q50	Q75
<b>Gender (ref=male)</b>			
Female	312.249*** (15.388)	1,079.165*** (13.935)	1,837.122*** (15.860)
<b>Age group (ref=35-39)</b>			
40-44	-236.851*** (24.983)	-561.419*** (22.624)	-1,025.292*** (25.749)
45-49	-641.630*** (24.651)	-1,381.488*** (22.323)	-2,177.966*** (25.407)
50-54	-1,252.244*** (23.717)	-2,144.421*** (21.477)	-3,171.369*** (24.443)
55-59	-1,572.956*** (23.809)	-2,341.845*** (21.560)	-3,105.223*** (24.538)
60-66	-2,158.058*** (24,089)	-2,307.046*** (21,814)	-2,385.499*** (24,827)
<b>Household status (ref=couple)</b>			
Single	-7,299.428*** (15.850)	-7,095.527*** (14.353)	-7,630.581*** (16.335)
<b>Migration background (ref=none)</b>			
Western	-6,527.314*** (22,095)	-4,050.080*** (20,008)	-2,819.406*** (22,772)
Non-western	-5,750.855*** (20.408)	-4,134.047*** (18.481)	-3,625.054*** (21.034)
<b>Housing type (ref=homeowner)</b>			
Rental	-3,124.279*** (16.801)	-3,755.648*** (15.215)	-4,170.179*** (17.316)
Current household income (5y avg)	0.129*** (0.000)	0.226*** (0.000)	0.316*** (0.000)
<b>Socioeconomic status (ref = employee)</b>			
Self-employed	-10,191.377*** (21,827)	-10,434.415*** (19,766)	-8,514.023*** (22,496)
Other	-6,018.531*** (17.825)	-5,513.550*** (16.142)	-4,217.258*** (18.372)
Constant	30,303.653*** (22.100)	30,095.325*** (20.013)	30,570.505*** (22.777)
Pseudo-R <sup>2</sup>	0.367	0.438	0.480
Observations	4,196,091	4,196,091	4,196,091

Table 6. Quantile regression results for expected pension income (part 2/3)

	Pillar 1 + 2 + 3 + financial assets		
	Q25	Q50	Q75
<b>Gender (ref=male)</b>			
Female	973.493*** (15.786)	1,772.736*** (15.095)	2,422.404*** (18.688)
<b>Age group (ref=35-39)</b>			
40-44	-317.605*** (25.629)	-584.682*** (24.508)	-1,049.056*** (30.341)
45-49	-730.555*** (25.289)	-1,331.621*** (24.182)	-2,122.565*** (29.938)
50-54	-1,100.189*** (24.330)	-1,947.176*** (23.266)	-2,793.451*** (28.803)
55-59	-1,299.864*** (24.425)	-1,999.189*** (23.356)	-2,475.165*** (28.915)
60-66	-1,732.621*** (24.712)	-1,891.796*** (23.631)	-1,676.767*** (29.255)
<b>Household status (ref=couple)</b>			
Single	-6,836.785*** (16.260)	-6,626.739*** (15.548)	-6,974.753*** (19.249)
<b>Migration background (ref=none)</b>			
Western	-6,739.967*** (22.667)	-43,67.635*** (21.675)	-3,387,895*** (26.833)
Non-western	-5,999.735*** (20.937)	-4,667,432*** (20.020)	-45,86.194*** (24.785)
<b>Housing type (ref=homeowner)</b>			
Rental	-4,292.874*** (17.236)	-5,107.685*** (16.482)	-5,887.144*** (20.404)
Current household income (5y avg)	0.173*** (0.000)	0.271*** (0.000)	0.368*** (0.000)
<b>Socioeconomic status (ref = employee)</b>			
Self-employed	-9,768.247*** (22.392)	-9,488.489*** (21.412)	-7,192.494*** (26.508)
Other	-5,331.647*** (18.287)	-4,758.800*** (17.486)	-3,277.099*** (21.648)
Constant	29,724.007*** (22.672)	29,836.951*** (21.679)	30,681.529*** (26.839)
Pseudo-R <sup>2</sup>	0.376	0.424	0.445
Observations	4,196,091	4,196,091	4,196,091

Table 6. Quantile regression results for expected pension income (part 3/3)

	Pillar 1 + 2 + 3 + financial assets + rental value of the house		
	Q25	Q50	Q75
<b>Gender (ref=male)</b>			
Female	1,420.250*** (16.888)	2,205.314*** (16.614)	2,851.483*** (21.083)
<b>Age group (ref=35-39)</b>			
40-44	-421.209*** (27.418)	-732.406*** (26.973)	-1,156.622*** (34.229)
45-49	-918.246*** (27.054)	-1,511.536*** (26.615)	-2,259.723*** (33.774)
50-54	-1,300.859*** (26.028)	-2,047.620*** (25.606)	-2,798.933*** (32.494)
55-59	-1,405.884*** (26.130)	-2,030.738*** (25.706)	-2,447.069*** (32.620)
60-66	-1,740.836*** (26.437)	-1,955.107*** (26.008)	-1,796.759*** (33.004)
<b>Household status (ref=couple)</b>			
Single	-7,211.819*** (17.395)	-7,114.404*** (17.112)	-7,523.655*** (21.715)
<b>Migration background (ref=none)</b>			
Western	-6,943.369*** (24.249)	-4,578.301*** (23.855)	-3,540.226*** (30.272)
Non-western	-6,206.988*** (22.398)	-4,920.014*** (22.034)	-4,870.840*** (27.961)
<b>Housing type (ref=homeowner)</b>			
Rental	-9,089.850*** (18.439)	-10,636.891*** (18.140)	-12,458.651*** (23.019)
Current household income (5y average)	0.199*** (0.000)	0.297*** (0.000)	0.395*** (0.000)
<b>Socioeconomic status (ref = employee)</b>			
Self-employed	-9,031.672*** (23.954)	-8,337.817*** (23.566)	-5,847.496*** (29.904)
Other	-4,411.688*** (19.563)	-3,737.775*** (19.245)	-2,223.982*** (24.422)
Constant	33,392.885*** (24.254)	34,351.833*** (23.860)	36,326.860*** (30.278)
Pseudo-R <sup>2</sup>	0.418	0.452	0.459
Observations	4,196,091	4,196,091	4,196,091

Source: Results based on own calculations in project number 3082 using non-public microdata from Statistics Netherlands.

## 5. Conclusion

This paper provides the most comprehensive assessment to date of the adequacy of retirement savings in the Netherlands, by combining population-wide administrative data on 4.3 million households with a multi-pillar perspective on pension and private assets. We show that the median household is able to replace 60% of pre-retirement income from the first three pillars, and 70% when private assets are included as well. For this median household, state pensions account for roughly EUR 19,000 annually – about 30% of pre-retirement income – while occupational pensions add another EUR 14,000, or 24%. Voluntary pensions contribute little on average, whereas assets, particularly lower housing costs resulting from a partially paid-off mortgage, play a crucial role in lifting retirement income above adequacy benchmarks. Replacement rates are strongly dependent on income level: low-income households have an expected replacement rate close to 1 because the flat-rate state pension replaces most of their previous earnings, while households with higher incomes usually have a replacement rate below the median rate.

Despite the overall strength of the Dutch system, the range of expected pension incomes is considerable. Regression analyses show that groups already disadvantaged in the labor market – households with a migration background, the self-employed, renters – can expect a lower pension income. The size of this relationship varies substantially over the range of expected pension incomes and is more negative for households at the lower end of the expected pension income range. Our findings furthermore show that labor market segmentation carries over into old-age income security: employees with a flexible job, in sectors such as the hospitality and food services industries and wholesale trade, and workers in small firms can expect substantially lower pension incomes.

Several limitations should be acknowledged. First, our results represent lower bounds for vulnerable groups, as we do not have data on the mitigating effects of taxes, transfers, and means-tested subsidies. Second, our analysis does not capture pension entitlements or assets accumulated abroad, which may be particularly relevant for households with a migration background. Finally, our adequacy assessment relies on financial measures alone, while broader concepts of well-being in retirement may also include health, housing quality, and personal preferences.

We point out a few avenues for future research. First, the relationship between income and retirement adequacy may be non-linear, and more refined econometric methods are needed to capture potential threshold effects or non-monotonic patterns. Second, while we employ quantile regression to explore heterogeneity, this method faces dimensionality challenges with a large number of regressors. Newer approaches – such as deep quantile regression or penalized quantile regression – could overcome these limitations and provide

richer insights into the drivers of adequacy across the income distribution. Applying these modern machine learning techniques offers a promising direction for future work.

Overall, our findings highlight both the strengths and the blind spots of the Dutch pension system. The combination of a relatively equally distributed first pillar and near-universal occupational pensions delivers high median adequacy, yet persistent heterogeneity underscores the need for policies that strengthen coverage and adequacy of labor market outsiders. Recognizing the role of housing and other assets when it comes to retirement preparedness is essential for designing sustainable pension and social policies in an aging society.

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## Appendix A – Annuitizing household assets

This appendix describes the process of converting financial assets into retirement income streams for singles and couples. For singles, the annuitization of assets is straightforward: we compute the annuity starting at the statutory retirement age ( $FRA$  — the retirement age applicable to individual  $f$  or  $m$ , depending on year of birth) that corresponds to the present value of the individual's assets. Formally, we annuitize the assets of single women as:

$$A = K / \sum_{n=FRA_f-a_f}^{99-a_f} \left( {}_n p_{a_f} \frac{1}{(1+r)^n} \right)$$

where  $K$  is the amount of capital required to fund annuity  $A$  from age  $FRA$  onward,  $a$  denotes age, and  ${}_n p_{a_f}$  is the probability that a woman aged  $a$  survives for  $n$  additional years. The maximum age in the mortality table of Statistics Netherlands is 99, and we therefore assume that no one lives beyond age 99. For single men, we use the same equation, but replace  ${}_n p_{a_f}$  with  ${}_n q_{a_m}$ , which is the probability that a man aged  $a$  survives  $n$  additional years. Annuitizing the assets of couples requires an additional assumption, since we observe assets at the household level and do not know how couples allocate their assets between the partners. We assume that couples smooth their resources both over time and between partners.

Typically, partners differ in age, may have different  $FRA$ 's, and will not die simultaneously. For example, in a household with a male and a female partner, we need to account for differences in the  $FRA$  and for differences in life expectancy by gender. We also account for household economies of scale, as multi-person households require fewer resources per person to achieve the same standard of living as a single-person household. To incorporate both economies of scale and age differences, we distinguish between the period when only the older partner has reached  $FRA$  and the period when both partners have reached  $FRA$ .

In households with an older male partner and a younger female partner, we compute the annuity as:

$$A = K / \left( \sum_{n=\max(FRA_m-a_m, 1)}^{(FRA_f-1)-a_f} \left( (1 - {}_n p_{a_f}) {}_n q_{a_m} + 0.5 \times E \times {}_n p_{a_f} {}_n q_{a_m} \right) \frac{1}{(1+r)^n} \right. \\ \left. + \sum_{n=FRA_f-a_f}^{99-a_f} \left( {}_n p_{a_f} (1 - {}_n q_{a_m}) + (1 - {}_n p_{a_f}) {}_n q_{a_m} + E \times {}_n p_{a_f} {}_n q_{a_m} \right) \frac{1}{(1+r)^n} \right)$$

where  $a_m$  is the man's age,  $a_f$  the woman's age, and  $E$  the equivalence scale (i.e., the factor that indicates how much more income a two-person household requires to achieve the same

standard of living as a one-person household). We standardize annuities to the one-person household level. The first part of the equation reflects the period during which only the man has reached  $FRA$ . If the woman is deceased, the man requires an annuity  $A$ ; if the woman is still alive, we assume he requires  $0.5 \times E$  due to economies of scale. The second part reflects the period during which both partners have reached  $FRA$ . If only one partner survives, the household requires annuity  $A$ ; if both survive, they require  $E \times A$ .

In an opposite case, where the woman is older than the man, we compute the annuity as:

$$A = K / \left( \sum_{n=\max(FRA_f - a_f, 1)}^{(FRA_m - 1) - a_m} \left( (1 - {}_nq_{a_m}) {}_np_{a_f} + 0.5 \times E \times {}_np_{a_f} {}_nq_{a_m} \right) \frac{1}{(1+r)^n} \right. \\ \left. + \sum_{n=FRA_m - a_m}^{99 - a_m} \left( {}_nq_{a_m} (1 - {}_np_{a_f}) + (1 - {}_nq_{a_m}) {}_np_{a_f} + E \times {}_np_{a_f} {}_nq_{a_m} \right) \frac{1}{(1+r)^n} \right)$$

When both partners are of the same age, we retain only the second part of the equation, since there is no period during which one partner has reached  $FRA$  without the other. When both partners are of the same gender,  $a_m$  is replaced by  $a_f$  or vice versa.

We assume that both partners retire at the same age, although not at the same time. Take, as an example, the case of an older man with an  $FRA$  of 66 and a younger woman with an  $FRA$  of 67. The woman continues working after the male retires, but she is likely to retire slightly before her official  $FRA$ , and retire at 66 as well.



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This is a publication of Netspar  
December 2025

T +31 13 466 2109  
E [info@netspar.nl](mailto:info@netspar.nl)

[netspar.nl](https://www.netspar.nl)