Projecting Households under the Shared Socioeconomic Pathways Using a Life Course Approach

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Abstract

The household is an important unit for analysis of greenhouse gas emission from the population. A large part of private consumption occurs at the household level such as housing, cars, household machines or even food. There are many different methods and approaches to project households. However, there is a lack of household projections that connect with population projections commonly used in climate change research, such as the Wittgenstein Center (WIC) global projections that correspond to the Shared Socioeconomic Pathways (SSP) scenarios. In developing a national level household projection model for Norway, using aggregated register data, the focus lies on how different life course events shape the likelihood of moving between household types. Changes in fertility, mortality and education attainment is reflected in the quantum and tempo of household formation and dissolution at different stages of the life course. Using the SSP scenarios and taking advantage of all the dimensions in the SSPs allow us to infer additional life events that has an impact on household status transitions, such as pursuing post-secondary education, that has not previously been considered in household projections.

Introduction

Globally the average household sizes have been steadily declining for many decades in particular in Europe, leading, in conjunction with a still increasing population, to an increase in the total number of households (Esteve et al., 2024). One critical aspect of the trend of the increasing number of households is in relation to climate change mitigation and adaptation. Population ageing and the increase of smaller households, such as one person households, in particular among the elderly population and the increased consumption of these households lead to an increase in greenhouse gas emissions (Ottelin, 2022; Zheng et al., 2022). Moreover, the increase of small households leads to an increase in resource consumption both because they are less energy efficient and because it often creates an increase in the total number of households (Keilman, 2003). The older population is also more vulnerable to climate change because they have less capacity to regulate extreme temperatures, both heat and cold (Chen et al., 2024). Therefore, the elderly population need to consume more energy both to heat up and cool down their homes (Estiri & Zagheni, 2019). Despite the increased attention to the interaction between population and climate change there are still a lack of household projections to adequately analyze how the future household composition might shape greenhouse gas emissions and climate change adaptation and mitigation goals. Household projections are still underdeveloped despite its relevance for modeling emissions at the household level.

Insofar the literature on household projections has largely focused on partnership formation and dissolution as two main events that change the composition of households (Keilman, 2019). However, there are several additional events that are of equal importance, for example leaving the parental home and ageing, that are also driving the creation and dissolution of new households. These two aspects are of high importance since the increase in single households among the young and elderly have been identified to drive the reduction in average household size in many counties in the world (Esteve et al., 2024)

Background

Official household projections for Norway have only been published once by SSB in 1995 and has not been updated since (Keilman & Brunborg, 1995). Household projections are needed as they are important for many applications when the process of interest is driven by the change in household composition rather than the population structure. For example, households are an important unit for modeling behavior such as living arrangements and consumption (Leiwen & O'Neill, 2004; Prskawetz et al., 2004) and many other types of models use the household as the unit of analysis when calculating the consumption of a good (Andarani & Goto, 2014; Ghani & Mahmood, 2023; Islam & Huda, 2019; Kytzia et al., 2004; Sandberg et al., 2017; Zhang et al., 2011).

However, some models use approximations of the future number of households based on assumptions on the average number of persons per household in the future or by simple forecasting and linear extrapolation (Sandberg et al., 2017; Zhang et al., 2011). It has been shown that using household projections with very crude assumptions and no information on the sizes of households which can have a large impact on subsequent analysis and lead to misleading results and conclusions (Prskawetz et al., 2004; Yi et al., 2006). There are several types of household or family projections as well as multiple methods, often restricted by data availability, to create these type of projections (Keilman, 2019). Household projections are often either by family type or size, however we are interested in both the family type and the size of families in the future, as both the composition of a household and size can affect the behavior of the household (Gatersleben et al., 2002; Man-Keun et al., 2018).

Life Course Approach

The life course approach is a theoretical and methodological framework that has been used in many areas of social sciences for studying lives (Elder et al., 2003). The life course approach examines life trajectories of individuals that are com-

posed of a series of transitions or life events with the aim of explaining their movements between statuses and roles during their life (Kulu & Milewski, 2007). In demography the life course perceptive have been used to for example examine how life course events affect fertility and mortality outcomes (Huinink & Kohli, 2014; Pensola & Martikainen, 2004).

Earlier life events affect future and this also applies to events related to household structure. Household formation is strongly related to events and transitions in the life course and these events changes how people organize in households in the course of their life. Life events such as transitioning into adulthood, pursuing higher education, partnership formation, childbearing, retirement and ageing, all might have an effect on the type and size of households. Extensive analysis how these life events affect household formations by cohort are therefore required. In line with demographic metabolism reasoning these preferences might be shaped by the experiences and cultural influences impacting each cohort, by the historical context and time through membership in a particular cohort (Elder & George, 2016).

Introducing concepts of the life course approach into household projections allows for the analysis of the future change in household based on demographic changes such as fertility, mortality and education attainment as these events can be considered as points that change the household structure and size in several ways and throughout the life course. Education attainment could have an impact on the timing of moving from the family home, start of cohabitation and time of having children. Fertility increases the household size while mortality reduces it. The usual timing of these events lets us identify periods in life when household transitions frequently occur. Furthermore, there might be differences between cohorts influenced by the social and cultural context that shape the different household trajectories throughout their lives changing the timing and patterns of cohabitation, separation and fertility. The concept of linked lives also enables us to extend our analysis from independent individual decisions of household formation to instead consider complex interlinked dynamics of households and social relations.

Data

The main data used in this project are data on household type, household size, family ties, education and other demographic variables from Norwegian registries. Register based household data is available in Norway annually from 2005 to 2024. The data is divided in the main household categories: living alone, couples without children, couples with children, single parents with children and multifamily households. Additional information is also available such as the household size and position of the individuals in the household, whether they are a parent or a child. The data is retrieved from the data portal *microdata.no* developed by the Norwegian Agency for Shared Services in Education and Research (Sikt) and Statistics Norway (SSB). This platform gives researchers access to anonymized microdata from the Norwegian registers in a contained environment. The availability of register data in Norway makes it possible to analyze the life courses of the Norwegian population in order to gain an insight in how the household dynamics change over the life course. Additional data will be obtained from open data provided by SSB.

Sample

Only household data from 2014 to 2024 is used due to changes in how the data is produced. From 2014 onward students' households are imputed when their registered primary address differs from their study location. The number of households are therefore underestimated, in particular the single households and the household data is therefore not comparable to the data from 2013 and earlier. The entire Norwegian population is included in the sample for each year, both individuals living in private households and non-private household. The non-private households are in many cases individuals living in different types of institutions.

Method

The household projection model is a cohort component model with the extension of household type specific fertility and mortality rates and transition rates between household types. Scenarios are built on assumptions of the future trends in the transitions between the different household types. Only the household classification by age and sex is projected, the population size, age and sex distribution are taken from an external population projection. In our implementation we use the Wittgenstein Center (WIC) global projections that correspond to the Shared Socioeconomic Pathways (SSP) scenarios and project the population of 200 world countries and regions by age, sex, and education from 2020 to 2100 (K. C. et al., 2024).

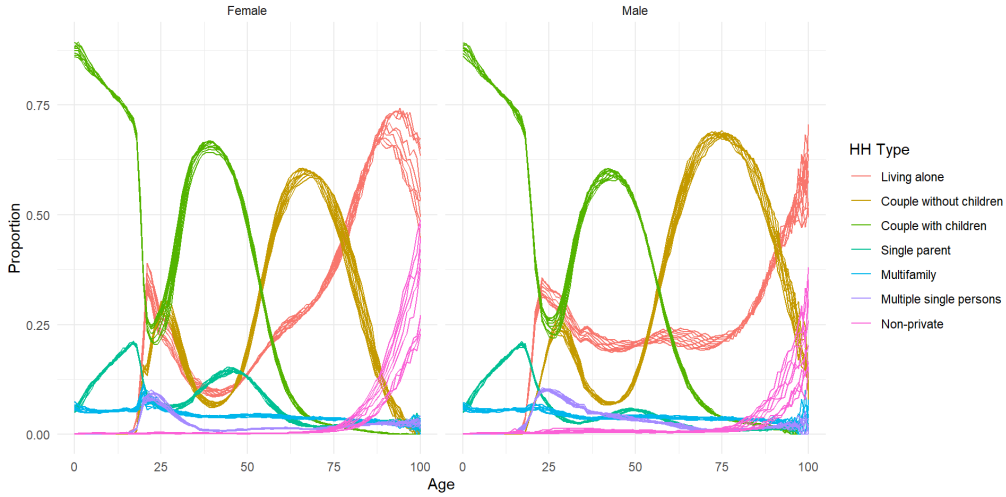
Transition rates between different household types are calculated from the historical data by age, sex, education and household size. From the historical transition rates the trend is extrapolated and used as a base for multiple scenarios of future household type shares. The households are then projected by applying the transition rate to initial type share and then adjusted to match the population projected at the same time step by the applied population projection.

Results

Extensive analyses of the Norwegian household data have been conducted, studying the age and cohort effects in household transition patterns. We have found generalizable patterns of household formation across the population by age, sex that are changing by cohort with new generation having different preferences and restrictions in terms of living arrangements and timing of leaving the parental home, partnership formation, childbearing and late age household arrangements.

Figure 1 shows the proportion of the population in each household type across all ages for each year of the data. Each line by household type represents one year. The proportions are for most household types and ages very close across all the years with notable exceptions for women living alone or in non-private households

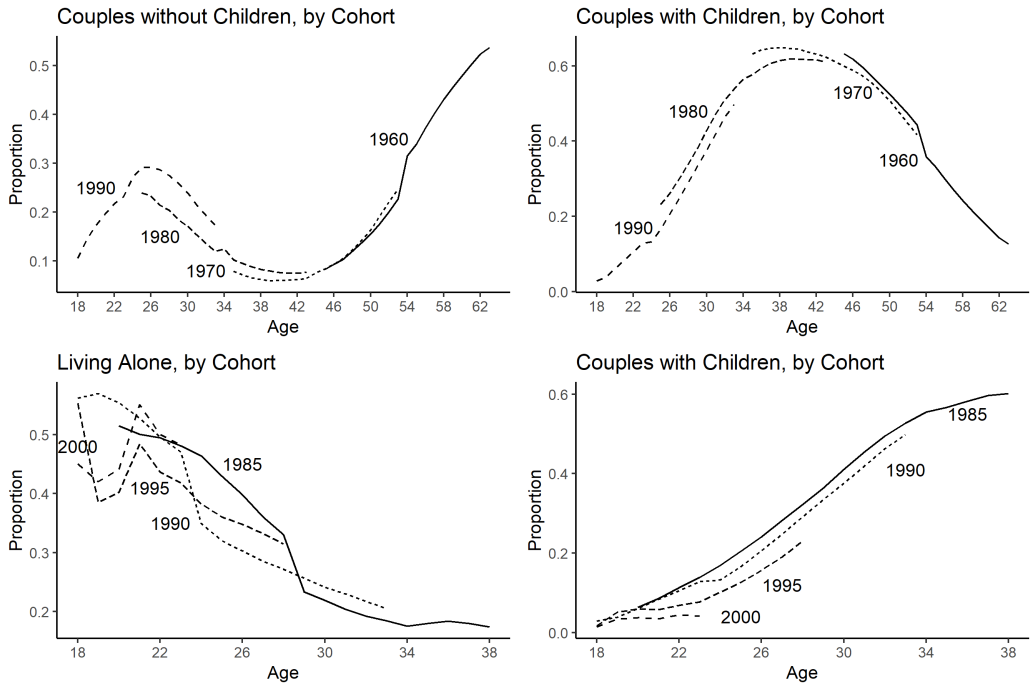
Figure 1: Proportion of population by age and sex in household type. All years 2014 - 2024



at age 90+, men aged 80+ in non-private households and men living alone between 25 and 75 years old.

In figure 2 the trajectories of eight different cohorts are presented for three different household types and at two different age ranges. Noticeable is how the trajectories across age differ between all cohorts and household types. The trend for partnership cohabitation, seen in the top left panel, seems to be delaying both cohabitation and childbearing as the peak of the curve for the 1990 cohort is seemingly later that of the 1980 cohort. This peak of the curve likely indicates the timing of when more couples are having children that new couples forming in a cohort. As seen in the two panels to the left in figure 2 the timing of couples having their first child seems to get increasingly delayed by younger cohorts. However, the proportion of couples with children is only marginally decreasing between cohorts. In the bottom left panel we can see a trend of increased single households that while gradually decreasing are sustained in the thirties. The variability of the data across cohorts is unclear but could be due to data quality issues, further investigations into this needs to be conducted.

Figure 2: Proportion of population by age in household type. Top row: Cohorts 1960 - 1990. Bottom row: Cohorts 1990 - 2000



Conclusion

The main contribution of our household projection model is the focus on household type specific transition rates and linking this with future estimates of fertility, mortality and migration from external population projections. In our case we are focusing on linking the household projection with the Shared Socioeconomic Pathways (SSP) population scenarios and build household scenarios aligned with the projected population in the SSP scenarios.

Next steps include the addition of an education dimension. Adding an education dimension in the projections would possibly improve the assumptions of the timing of leaving the parental home and also the timing of partnership formation and in turn fertility.

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