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Projections of demand for care among the elderly in Poland including health status and living arrangements

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Motivation

The most distinctive feature of demographic developments, debated increasingly since the 1960s, are changes in the age composition of populations. They are manifested by the increasing number of older people and their share in the total population and labelled as population ageing. One of the effects of population ageing is the increasing demand for care among older people - a subject of a scientific debate and public policy concerns (Agree and Glaser, 2009). Researchers conclude that requesting a care need by older persons is above all related with their health status (e.g., Czekanowski and Bień, 2006; Doblhammer *et al.*, 2008). Health together with income are also the most important factors determining the use of institutional forms of support (Gaymu *et al.*, 2006), while household composition is a predictor of receiving informal support (Wingard, Jones and Kaplan, 1987; Gaugler *et al.*, 2007). Meeting care needs of dependent older people is becoming more urgent as the pace of population ageing in many developed countries, including Poland, is accelerating. The essential ingredients of population ageing, i.e. the increasing number of older people and their proportion in the total population, can be considered as a challenge for care arrangements globally. In most countries worldwide, the supply of formal care services for older people is generally underdeveloped, coverage of not-for-profit organizations is limited while private markets usually cannot offer sufficient and affordable provision of help (WHO, 2011). That makes older people with functional limitations strongly rely on informal support from others, mainly from their family network members (both close members like spouses, children, siblings, but also more distant relatives), friends and neighbours (Colombo *et al.*, 2011; Błędowski, 2012). However, changes in family related behaviours, both demographic (associated with timing, frequency and sequence of family events) and organisational (connected with labour market involvement of men and women and patterns of housework division between them) call into question the traditional intergenerational care exchanges and their sufficiency to meet the augmented care needs in the future (Agree and Glaser, 2009; Dykstra, 2018). Changes in the family model, shrinking kinship networks as well as different modes of care provision with a dominance of informal supply of care by family members determine how the care needs of seniors are being met today and will be fulfilled tomorrow. Recognition of the future demand for care and its estimation is, therefore, a key priority for social policy considerations. Moreover, tracking changes in the prevalence of living alone among older people is particularly socially relevant as this living arrangement is becoming more and more widespread and potentially important for the health and wellbeing of seniors in single living as well as social policy in general (Reher and Requena, 2018).

Estimation of the future demand for care among older people in terms of the number of persons in need should be based on developments in the older population. However, the official population projections are traditionally available only by age and sex. Discussions how to satisfy the future care demand from older people should be based on population projections that go beyond the traditional breakdown. Ideally, they should account for indicators of care needs (e.g. dependency/health status) and care supply (e.g. kinship and social networks) measured at the individual level to grasp the scale of the aggregated demand for care and to understand how caring responsibilities could be shared between family members and professional carers. In practice, such projections are rarely prepared with data unavailability being the main limitation. Currently, there are limited examples of studies that would account for both dimensions simultaneously (e.g. Gaymu, Ekamper and Beets, 2008; Geerts, Willeme and Mot, 2012; Eggink, Woittiez and Ras, 2016; Kingston, Comas-Herrera and Jagger, 2018).

In Poland, the substantial increase in the absolute number of older people and their share in the total population in the coming decades is prominent which makes the country an interesting case study. In recent years Poland's population has been decreasing and ageing – both the natural and the real increase have been negative and the number of people aged 65+ in 2019 was more than 1.7 million higher than in 2010 (GUS, 2020). Along with the growth in the number of older people there is an accelerating increase in the proportion of older adults. It reached 12.4% and 13.5% in 2000 and 2010, respectively, and was already equal to 18.1% in 2019. While the more numerous cohorts will become older and their health will naturally deteriorate due to senescence, an inflated demand for care services among future older people can be expected. In the years 2018-2060 the number of people aged 65 and over will grow by 4.5 million with a simultaneous reduction of people in working age (15-64 years) by 7.9 million (Eurostat, 2019). It determines not only the change in the relation between the number of producers and consumers in the economy but also the shift between the number of potential caregivers and care recipients: the old-age support ratio, defined as the number of the population aged 15 to 64 per member of the population aged 65+ is projected to go down from 4.0 to 1.6 persons between 2018 and 2060.

Caring needs of older people are met mainly by informal caregivers who, first and foremost, are the family network's members. The institutional care supply fulfills just a very small fraction of older peoples' care needs (ca. 1% of the population in Poland according to the 2011 population census). Given the supply of informal care is predicted to diminish mainly due to changes in the family structures, it is crucial to

adequately estimate the future demand for care among older people taking into account the relevant context.

Aim of the dissertation

The aim of this thesis is to estimate future demand for care among people aged 65 years and over in Poland by preparing appropriate population projections. The demand for care is defined as the number of older people in need of care due to their health status. Predicting the number of older people in need of care rather than percentages is legitimate as the stock of middle-aged adults is already known, while percentages depend to a considerable extent on the future numbers of children yet to be born. For that purpose the following partial theses are formulated:

1. Despite the potential health improvement by age, an increase in the demand for care among older people is expected. This is due to the intensity of the population ageing process in Poland leading to a fast increase in the number of older people that are living longer than ever. Therefore, estimation of this demand requires to link changes in the population age structure with changes in the health status. Consequently, the changes in the individual health of older persons should be incorporated into the projection model.
2. The changes in the family model and living arrangements of older adults result in both shrinking (informal) family care resources and the increasing demand for formal care. In particular, the growing number of people living in one-person households is augmenting the demand for formal care among older persons. Therefore, to estimate the macro-level effects of these developments for care demand, the projection model should take into account changes in living arrangements of older adults observed at the micro-level.

To prepare population projections that would assess the number of people in care need I propose the analytical approach which integrates microsimulation of health and living arrangements changes with macro-level projections of the population by age and sex. The proposed approach is driven by the following main thesis:

> To estimate the future demand for care among older people changes in the age composition of the population should be linked with changes in the individual health status. In addition, developments of living arrangements of older people need to be accounted for. The projection tool with microsimulation modelling of individual-level behaviours incorporated in the population projections at the national level provides better predictions of the future care demand.

There are relatively few studies in the Polish literature dealing with the future demand for care among older Poles with activity limitations (Szukalski, 2004; Abramowska-Kmon, 2011; Bonneux and van der Gaag, 2012; Szweda-Lewandowska, 2016). This dissertation attempts to contribute to the field by performing a study that combines changes of the population age structure with changes in the health status and the living arrangements status in a dynamic setting using microsimulation methods. The goal of the dissertation is achieved through the following basic research tasks:

1. to explore the health and the family situation of older people in Poland and their changes over time based on the available empirical data;
2. to estimate the parameters reflecting the older peoples' dynamics of health and living arrangements for the population projection model;
3. to formulate a population projection model which accounts for the health status and the living arrangements of older people and aims to project the future demand for care among the older people in Poland.

The structure of the dissertation reflects the subsequent research tasks. In the first chapter I provide an overview of demographic change in developed countries and its consequences for care among older people. Its goal is to set the stage for the empirical part of the study. The second chapter is devoted to the family and health situation of older people in Poland and basically covers the first research task. In this chapter I provide detailed information on living arrangements and health status of older persons in Poland and put it in a comparative international perspective. The aim of the third chapter is to model the dynamics of health and living arrangements of older people in Poland using individual-level longitudinal data. This empirical part of thesis fulfils the second research task. The final chapter culminates the previous parts of the research as it serves for the preparation of projections of future demand for care among people aged 65 years and over in Poland.

Research methods and data

Population projections of people aged 65 and more by health status and living arrangements are achieved in a two-stage modelling procedure. At the first stage a micro-level study is conducted, while the second stage involves a macro-level analysis. This sequence of modelling is crucial as the results of micro-modelling are the input data to obtain the macro level output.

Health is operationalized with the concept of activity limitations measured via the Global Activity Limitation Indicator (GALI) which captures the presence of long-standing activity limitation due to health problems. The individual's health status is classified into two possible states of being healthy or functionally disabled

(unhealthy) based on the GALI question. To be classified into the unhealthy state one has to report severe limitation in activities. The healthy state is defined as being either not limited at all (no declared limitations) or limited but not severely in activities people usually do. The living arrangements are operationalised dichotomously and are split into living alone (single-person household) and living with others (not living alone/ two-or-more-persons household).

The first stage concerns modelling changes in health and living arrangements of older people as they age that requires individual-level longitudinal data. The main outcome of this stage are transition rates between the states defined for both processes. Transition rates are a summary description of the dynamics of health and living arrangements of older individuals derived from the use of multistate methods (Willekens, 2014; van den Hout, 2017). To estimate the multistate model the EU-SILC rotational panel data for the years 2005-2015 have been used. The EU-SILC panel offers annual data on individual's health and the household structure representative for the population residing in private households. The effects found in the estimated model are interpreted as average effects observed for the 2005-2015 period. The total number of respondents in the database was 43,962. In the final state space of the joint model defined by a combination of dichotomous health and living arrangements variables the total number of transitions between different states amounted to 10,235 out of the total of 99,182 observations.

The second stage of the projection procedure is based on two types of data. The transition rates estimated at the first stage are the elementary input information to be used in a microsimulation model. Another key information are the official population projections from Eurostat. Population projections determine the population's size and its composition by age and sex and their future developments. The initial data on transition probabilities together with prospective mortality rates according to the Eurostat's assumptions supply the microsimulation model to generate individual health and living arrangements life histories over the future. I simulate life trajectories of individuals who were between 50 and 90 years old in 2015. The simulation of the individual life histories was performed with *simmulti.msm* function in *msm* package (Jackson, 2011) which simulates a number of individual realisations from a continuous-time Markov process up to a given time. The simulated individual careers up to 2030 are aggregated into cohorts. Each synthetic cohort consists of 1,000 women and 1,000 men which gives a total sample of 41,000 women and 41,000 men. Individual trajectories are aggregated to redistribute the official population projections across health and living arrangements statuses. The final product of the modelling are the population projections by age, sex, health status and

living arrangements of people 65 years old or more up to 2030. Additionally, the study considers two types of scenarios that measure effects of changes in transition rates on the overall system. The first type assumes improvement in morbidity, while the second type looks into the potential effect of mortality improvements on population composition.

Modelling results and projections of care demand among the elderly

There are two types of results obtained throughout the dissertation that are connected to the stages of the projection procedure. The first one are transition rates estimated with multistate models. They summarise the collective experience of similar individuals under observation and describe the dynamics of the process under study. The results of separate multistate models of health and living arrangements confirm that the shape of the hazard functions of both health and living arrangements at ages above 50 is age-dependent. Moreover, they show that with age intensities of health deterioration are increasing, while chances for health improvement are decreasing. Education was found positively related with health as the better educated had higher intensities to recover and lower risks of becoming severely limited than the lower educated. Similarly, the probability of moving to living alone is rising with age, whilst turning to living with others is declining. The intensities to change health status at older ages are exceeding those of living arrangements status which reflects more frequent health transitions than living arrangements transitions. The intensity of moving from not living alone to solitary living was found significantly higher for women that for men, but no gender difference was found for the transition in the opposite direction. The state space of the final model combines health and living arrangements. The parameters estimated in the joint model reflect the age-dependecy revealed in the previous separate models. Consitently, the risk of transition to living alone was found higher for women.

The second type of results were directly linked with population projections that have been prepared in the second stage of modelling. Estimated parameters from the joint multistate model have been used as input to run microsimulations. The output of the microsimulation exercise, i.e. individual trajectories up to 2030 aggregated into cohorts (41 cohorts separately for men and women), allowed disaggregation of the official projections of population of people aged 65 and above by health and living arrangements statuses. The results show that the growth of the population aged 65 and above in Poland between 2015 and 2030 is expected to be mostly driven by the subpopulation of functionally independent older adults. That will lead to an increase in the proportion of healthy persons in the total older population. However, the

subpopulation of unhealthy older adults is predicted to grow as well. The number of older people requiring care who live with others in 2030 is projected to be in the 95% confidence range from 1,335 to 1,744 thousand people (compared with 1,405 thousand in 2015 – i.e. the starting year of the projection interval). The number of older people requiring care and living alone – potentially the most demanding group for institutional care – falls in 2030 into the 512 to 918 thousand range (versus 474 thousand in the starting year 2015). The results of the projection are also presented in the form of life expectancies that include both the health and the living arrangements dimensions. The projected increase in extra life years for women will be slightly lower than for men. Life expectancy at age 65 years for women in Poland will increase between 2015 and 2030 by 2.1 years. Women will gain 3.1 years in good health and 0.3 years in *Unhealthy & Living alone* state, but time spent in *Unhealthy & Not living alone* state will decrease by 1.3 years. These changes will affect the proportion of the total life expectancy spent in functional states for both sexes. Relatively more years will be spent living alone (the stronger effect for men) and in good health (the stronger effect for women).

Moreover, the use of microsimulation model allowed checking the effects of alternative assumptions on morbidity as well as the potential effect of mortality improvements on the redistribution of the older subpopulation into the functional states. The performed sensitivity analyses show that – conditional on keeping the survival probability constant – lowering chances of health deterioration would reduce the proportion of the years lived in bad health from age 65, while the proportion of years spent in good health would be increasing. At the same time relatively more years would be spent living alone. Microsimulation proved to be an effective tool for combing the results of modelling of individual behaviours that generate demographic processes with a detailed disaggregation of population projections.

Contribution

My dissertation contributes to the scientific discussion regarding the future demand for care among older people and to methods of its assessment. The current knowledge regarding the effects of demographic developments defines the background for my discussion on care needs of older people in Poland and their appropriate assessment. Demographic developments are expressed mainly in terms of the evolving age structure of the population and changes in the family model generated by transformations of fertility and family formation and dissolution. The study is not restricted to debating population ageing and its consequences only with traditional measures of ageing, but it includes also more comprehensive measures

(prospective and adjusted for the economic life cycle) that broaden the scope of the discussion. It gathers facts and figures about the population of older people in Poland, especially with respect to health, living arrangements and organisation of care toward older adults, and puts them in a comparative, international perspective. My study continues this stream of population research that concentrates on population projections and consequences of population ageing. It also fits into the research direction that has been undertaken by the Institute of Statistics and Demography several years ago. Particularly, my work has been inspired and draws on the PhD dissertation by Anita Abramowska-Kmon (2011) on projections of care demand among older people as well as the PhD dissertation by Paweł Strzelecki (2012) with respect to microsimulation and population projections. My dissertation builds on both studies with some novel elements that should be treated as my proposal to extend the research.

My exploration of health and living arrangements of seniors in Poland is based on multiple data sources that describe and confront a variety of aspects related to both analysed categories. I critically evaluate datasets that could be potentially useful for modelling purposes. The results of the multi-state model used to estimate transition rates between health and living arrangements states among people aged 50 years and more contribute to existing literature on the dynamics of health and living arrangements of older people in Poland. In particular, they extend our understanding of the age dependency as well as potential effects of sex and education for health and living arrangements. The dynamic approach used to include additional measures of health and living arrangements is novel in Polish studies on projecting care needs among older persons.

The microsimulation projection model proposed makes it possible to obtain results consistent with the official population projections (at the macro level, here the Eurostat's EUROPOP2015 figures) and to account directly for the micro-level analyses relevant for the projection purpose. Using multi-state models in projections is advantageous: *„Because of the pivotal role of transitions, multistate models picture more closely the mechanism of demographic change taking place in the real world. As a result, they are better suited for integrated population projections in which functional states and interactions between functional states play a crucial role. In addition, the transitions provide a way to assess the impact on population dynamics of behavioural changes brought about by technological, economic or cultural change, or policies. The transitions are age-specific. As a result the multistate model gives at each age the distribution of cohort members among functional states."* (Willekens, 2007, p. 11). The agility of microsimulation due to relative easiness of representation of the current knowledge

about demographic processes shaping human life course may contribute to the improved accuracy of population projections. Adding extra variables into projections provides more information valuable for all the stakeholders. The flexibility of both tools, i.e. the multistate model and the microsimulation model, does not restrict the state space to the one used in that particular application. The states of interest can be easily replaced or extended with other attributes, and more categories can be specified within the selected attributes depending on research questions and data availability. The results of the study are primarily expressed in the number of people in a certain state being an indication of demand for some services, e.g. demand for care. Even though not a part of the study, it can easily be extended into the financial dimension by applying cost measures related to individuals.

My study is consistent with the paradigm shift in demography, and social sciences in general, that brings the adoption of the life course perspective to the forefront of the research (Willekens, 1999). Firstly, it tries to explain (and eventually predict) population changes as outcomes of individual agents' actions and interactions. Here, I represent the individual-level survey data on changes in health status and living arrangements status in terms of transition rates that are later used in microsimulations to generate cohorts' trajectories. As a result, the population composition by variables of interest is simulated. This way I follow the advocated moves from macro to micro and from micro to macro via integration of the observation of processes at the micro level with the macro level outcomes – in line with the so-called *methodological individualism* that views population dynamics as the composite effect of individual life courses (Willekens, 1999). Next, thanks to microsimulations I was able to link multiple processes that are intertwined at the micro-level level, i.e. individual ageing, evolution of health and living arrangements moves, to generate trajectories that built up to a comprehensive picture of the projected population of older people by health and living arrangements over the appointed time horizon.

Additionally, the methods used in the study, especially estimation of transition rates that reflect the risk of moving between the predefined statuses, allow the effects of chance (uncertainty) on change to be captured. Next to the estimated transition rates used for simulations, the uncertainty was incorporated into the study by comparing different mortality scenarios prepared by Eurostat and by offering my own scenarios on morbidity compression. Incorporating uncertainty into the model generates results that reflect it directly. It is important to demonstrate the necessity to associate the results with some variation to the projection users. Placing the output in adequate confidence intervals helps to grasp its magnitude.

The importance of the topic as well as the approach to address the research tasks can be valued as significantly contributing to the development of the discipline. The identification and formulation of the research problem is definitely embedded in the mainstream of research and is addressing the actual research needs and challenges in Poland. It presents the novel analytical tool to meet some of them. However, the extended analytical approach requires appropriate data. Their lack is the main source of some limitations of this study. Conceptually, the dichotomous operationalisation of living arrangements in the model and its interpretation in the study could be extended and more comprehensive in the context of the potential of family care supply. The information on age in the EU-SILC is restricted to the last open age group of 80 years and above which hinders learnings from the dynamic individual-level analysis. It also has to be kept in mind that the study's results refer only to persons living in private households. Also, duration dependence, which is a relevant predictor of health and living arrangements transitions, is not addressed in the study because of the limited time period of longitudinal data used in the analysis.

Conclusions

The study provides relevant insights into the discussion about the future demand for care among older people in Poland. It offers an extension of traditional population projections which provides added value for both researchers and policy makers, but also may perform an important educational function for other non-specialised audience.

The dynamic approach used in the proposed two-stage modelling procedure to produce projections of older people makes it possible – as the main thesis states – to produce better predictions of the future care demand among the older people. They combine both the indepth insight into interrelations between individual-level health and living arrangements trajectories and macro-level outcomes related to care demand and care supply. The study also adds to the field by investigating the dynamics of health and living arrangements of people aged 50 and more and their relationship with selected demographic variables.

The microsimulation model is relatively easy to be updated with the most recent findings on the relevant micro-level dynamics after translating them into parameters of the model. Additionally, the model offers flexibility in formulating assumptions and, therefore, is an efficient tool for conducting sensitivity analyses which is clearly advantageous in the context of possible (abrupt) changes in demographic and social processes over time. Importantly, it provides results that are consistent with the population projections published officially by the authorised agencies which is an

important argument for their accessibility and usability. Various types of population ageing measures shed different light on the consequences of population ageing, but changes in the demographic structures undoubtedly translate into the increasing size of the older population which is the most affected by the loss of independence. Repeating the analysis with the most recent data, both from the perspectives of population projections and the individual-level parameters' estimates, would provide actual projections that would foster both scientific discussions and policy decision-making processes.

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