The changing balance between formal and informal old-age care in Spain. Results from a mixed microsimulation-agent-based model

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Abstract

All developed countries have seen life expectancy improve at old ages, accelerating the process of population ageing associated with low fertility. In Spain this process has been especially fast, to the extent that in the last 30 years the number of people aged over 65 has doubled. This change in demographic structure is increasing the demand for health and social care for old-age persons, which today is still largely provided by family, typically by spouses and adult children. Concurrently, family structures are also rapidly changing due to reductions in fertility, the delay in family formation and rising divorce rates. Moreover, an increasing proportion of women have entered the labour force. Together, these factors affect the availability of family, i.e. informal, care for people of old age.

To study the supply and demand balance of informal care and quantify the needs for formal care when there is a deficit we have developed a mixed model that uses two different simulation techniques: microsimulation and agent-based-modelling (ABM). Based on current nuptiality, fertility and mortality levels, the model starts with a micro-simulation of the lifecycle of a cohort of individuals and their close relatives until death. The ABM then determines the amount of time available or needed for caring for

family members over their lifecycle, starting at age 50. Data on dependency risks, labour force participation and time available or required for care are estimated from Spanish surveys.

Surprisingly, results show that family care deficit was higher in older cohorts due to the higher mortality and thus greater impact of widowhood. However, for future generations we foresee that fertility decline and, paradoxically, the prolongation of couples' lifespan will augment the demand for formal care as there will be more couples with both members disabled but without children to take care of them.

Keywords: Old-Age Care, Formal Care, Informal Care, Agent-Based Modelling, Ageing

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Introduction

The combination of increasing life expectancies and falling fertility rates in all developed countries lead to an increase in the share of older persons in the population. As a result, the population as a whole is ageing. In Spain, which is the focus of this paper, the process of population ageing has been particularly rapid with a doubling of the number of persons aged 65 years and older in the last of 30 years to 19% of the total population and a four-fold increase among the 80+ to 6%. Moreover, among the oldest-old about half encounter difficulties to carry out one or more (instrumental) activities of daily living (Spijker and Zueras 2016). Population ageing is also accelerated by the low fertility levels over the past decades, aprocess that started in the mid-1970s when the average number of children per woman was close to 3, while today it isjust above 1.3 (www.ine.es). Official population projections highlights the fact that Spain, that already is one of the oldest populations in the world, will continue to age in the future. As a matter of illustration, in year 2031 there will be 11.3 million persons aged 65+ (which will represents 26% of the total population, an increase of 3.0 million (+35%) compared to 2016), and will reach 14.2 million by 2066 (35% of the total population, an increase of 62% in relation with 2016) (Instituto Nacional de Estadistica 2016). This rapid population ageing is also accompanied by other significant changes in the age structure. If the current demographic projection holds, the age group 30-49 years will decrease 28% over the next 15 years and 40% by 2066 (ibid.).

This rapid population ageing has raised concern for policy makers on how the future provision of elderly care can be met by both informal care (i.e. unpaid and mainly family-based) and formal care (i.e. home-based professional care and institutions). In Spain, studies on old-age care have shown that informal care is the most common source of support received by older people. For instance, according to studies by Spijker and Zueras (2016) and Durán-Heras (2000), Durán-Heras (2002), 80-90 per cent of people aged 65 years and older who obtained care at their own home relied on informal care and for the remainder on formal care. Other studies that focused on Spain have identified a mixed care pattern that combines any type of formal care and informal care at the same time (Rodríguez 2013, Rogero García 2009, Rogero García, Prieto-Flores, and Rosenberg 2008). However, the supply of informal caregivers may decline in

future due to changes in the age composition of the population as well as for other reasons, including the effect of having smaller families (Clarke 1995), the rising incidence of childlessness (Evandrou and Falkingham 2000), increasing female labor force participation (Allen and Perkins 1995) and rising rates of divorce and remarriage (Albertini and Saraceno 2008, Ganong and Coleman 2006, Ganong, Coleman, and Rothrauff 2009, Glaser et al. 2006, Lin 2008, Van Der Pas and Van Tilburg 2010, Wells and Johnson 2001). The way in which family structures and family relations are likely to evolve in the future may have direct implications for the level and type of informal old-age care. Any reduction in informal care could have a substantial influence on the demand for formal care. A better understanding of formal and informal care dynamics is therefore clearly an issue of great importance.

This paper has two purposes. First, to examine the effects of demographic trends that include low birth rates, increasing life expectancy and changing family structures on the kin network of elderly in Spain. Second, to estimate the demand and supply of informal old-age care in Spain on the basis of the kin network as well as changing educational and labour force participation. Specifically, our research question is to estimate how the needs for care of the old-age population will be shared between formal and informal care during the next 30 years in Spain.

In the next section, we briefly describe the effect that demographic change has had on elderly kinship networks. This is followed by a summary of how care dynamics have changed in Spain during this century. We subsequently present DemoCare, our care supply and demand model and provide estimates of care that could potentially be devoted to egos by partners and children, taking into account the level of fertility and nuptiality and the limitations imposed by mortality and infertility. We conclude by discussing possible future care supply-demand dynamics for elderly dependents in Spain in the context of the family environment.

The efect of demographic change in the kinship network of elderly

The demographic regime is an essential determinant of the patterns of coexistence of the elderly. In the coming decades, the effect of declining fertility and the rise of people without children in the generations

born during the baby boom years will restrict the ability of family networks to take care of dependent elderly people. As shown in Table 1, women born in 1938 (who are aged 81 years today) had borne an average of 2.6 children, a figure that dropped to 1.5 for the 1968 cohort, who are now 51 years old. At the same time, a much higher proportion of younger generations do not or will not have children (21%, compared to 14% of current octogenarians). The change in survival has also been very important, with an increase in life expectancy at birth of 36 years between the 1908 and 1968 cohorts, including a considerable lengthening of life after 65 years. The reduction of the risk of dying has a positive effect for families, as widowhood decreases, which is why, among those born in 1968, the proportion of people without a partner at age 50, due to the combined effect of singleness and widowhood, is around 10% for women, when it reached 37% for those born in 1908. Improvements in especially male survival have contributed to postpone widowhood among the most recent generations, although the widow population of 80 years or more is still very feminized (Spijker 2011). However, the increase in divorce rates will condition the availability of a partner in old age, especially in the generations born after the 1970s.

< Insert Table 1 about here >

The availability of potential family caregivers is not only affected by demographics. The greater incorporation into the labor market of the female cohorts has also meant a lower availability of daughters to take care of their parents as well as a lower disposition to do so. Regarding the latter, research has shown that higher educated and economically active women aged 45-54 are least likely to be of the opinion that the elderly care burden should fall on the shoulders of the family, despite the fact that precisely 45-64 year-old women, not men, are the ones providing such care (Zueras, Spijker, and Blanes 2018). On the other hand, pension reform and the extension of working life beyond the age of 65 could penalize women's access to full and larger pensions if they have had to reduce or abandon their employment in their last years of working life (Evandrou and Glaser 2003).

Living arrangement patterns also condition the provision of informal care. In Mediterranean countries

including Spain, older people live more often with others than in Nordic countries where they are more likely to live alone or in retirement or nursing homes, with Central and Eastern European countries in intermediate positions (De Jong Gierveld, De Valk, and Blommesteijn 2001, Delbès, Gaymu, and Springer 2006, Fernández Carro 2013, Gaymu, Ekamper, and Beets 2008, Laferrère et al. 2013, Tomassini et al. 2004, Zueras and Miret-Gamundi 2013). The number of offspring also matters. For example, elderly who only have one son or daughter are more likely to live with him or her than those who have more children who have a higher probability to live alone. This is for different reasons, including not showing a preference for one of the children or not needing to coreside as they have several children who live nearby. Differences within Southern Europe have also been observed. For instance, the proportion of older people who live with others but not their partner is higher in Spain than in Italy, Greece or Portugal (Zueras 2014b, Zueras and Miret-Gamundi 2013). At the same time, coresidence with children in old age has decreased among younger generations (Zueras 2014a), while oneperson households of nonmarried adults have increased, particularly among those over 75 years of age. The latter is due, in part, to the greater access to pensions (Zueras and Miret-Gamundi 2013), which favours and facilitates the preference for living independently (López Doblas 2005). Nevertheless, residing with children or relatives continues to be the preference of older Spaniards when suffering a functional loss that hinders or impedes their residential independence (Fernández Carro 2013).

These living arrangement patterns show great geographical and time differences and it is very likely that they will continue to change in the future as they depend on social norms and the availability of living relatives, aspects that have undergone substantial changes in recent decades. In particular, a greater shortage of family members is expected due to the growing proportion of older people without children, especially women, who will be forced to live alone, regardless of their residential preferences (Reher and Requena 2017). But coresidence is a complex function of the density of the kinship network, since it depends not only on the number of own children, but also the age difference between parents and children (Table 1) and the family situation of the latter.

For the remainder, greater female survival establishes sex differences in living arrangments and care

demands in old age. While men generally age while living as a couple with their spouses becoming the main care providers in case of dependence, women mostly age as widows (Delbès, Gaymu, and Springer 2006, Spijker 2011). They are therefore more vulnerable and needy of the support of persons external to the conjugal nucleus (descendants, siblings, other relatives or non-relatives).

These two factors together, the demographic regime and forms of coresidence, determine the offer of family members capable of helping or caring for the elderly.

The dynamics of caring for the elderly in Spain

In Spain, support and care for dependent seniors are mainly organized within the family, with formal care complementing informal care (Rogero-García 2010). Generally, in the southern countries the care falls on a few people within the family, with greater participation of the daughters, while in northern and central European countries, other components of social networks, such as friends or neighbours, also participate in the informal support and care mechansisms (Attias-Donfut, Ogg, and Wolf 2005). Previous work has highlighted that coresidence is one of the mechanisms of intergenerational solidarity that is more common in southern Europe (Albertini and Kohli 2012), where social policies have made households responsible for the welfare of its members (Flaquer 2004).

At the same time, increasing life expectancy at older ages has led to greater heterogeneity of elderly health profiles in Western countries (Riedel-Heller, Busse, and Angermeyer 2006, Rockwood and Mitnitski 2007). This is due to both to increasing prevalence of certain diseases and larger proportions of elderly accumulating diverse disabilities.

The massive incorporation of women into the labor market, together with transformations in family systems and living arrangements, were arguments used to implement the so-called "Dependency Law" in Spain (Spijker and Zueras 2018). It was an important step towards the development of a new System for Autonomy and Care for Dependency (SAAD), through the promotion of personal autonomy and the care of people who depend on others for their physical and/or mental limitations, recognizing the universal nature of benefits and the right to access them under equal conditions for all dependents (Martínez-Buján

2011). This meant ensuring an adequate amount of resources and services —including the prevention and promotion of personal autonomy, remote assistance, day/night centers and residential centers— to meet the growing demand due to population ageing (Spijker and Zueras 2018).

The new SAAD was also designed to reduce the burden of family members who assume the role of primary caregiver. As caregivers are predominantly women, the implementation of the law also respresented a step forward in reducing gender differences in both personal care and employment, as it would encourage women to continue working (full-time) despite having a family member with care needs. However, in practice, the new SAAD did not seem to have contributed to outsourcing the care of the family environment, since close to half of the economic benefit for care had been used to compensate informal carers (Consejo Territorial del SAAD 2012).

On top of that, there were severe budgetary adjustments in 2012 that transferred the burden of care back again to the dependent persons and their families, implying a refamiliarization and re-privatization of what had been achieved during the previous five years (Rodríguez Cabrero 2012). Despite of this, Spijker and Zueras (2018) showed that between 2006 and 2013 multiple attention strategies had become more common and that care was outsourced from the domestic domain in several ways. For example, among 65-79 year olds, care from multiple sources increased, as well as informal care exclusively from people outside the home, suggesting that spouses (usually the main caregivers in this age group) are being aided by social services and other workers and alludes to a possible effect of SAAD.

Method: DemoCare—a model to estimate the supply and demand for informal and formal care

In order to comprehensively study the demand and supply of care for the elderly in situations of dependence based on their available network of relatives, we have developed a model called DemoCare (Calduch et al. 2017). It uses two different simulation techniques: on the one hand, a kinship microsimulation based on the basic indicators of the demographic characteristics of a cohort; on the other, an Agent Based Model (ABM). The model simulates the life of representative individuals of a certain cohort (called “Egos”) and that of their close relatives. They are followed until death. Each year, these

agents are subject to the risk of entering more or less severe states of dependency, to which a demand for hours of care is associated. Specifically, the model estimates the demand for care of these Egos that could be satisfied by their kin network (spouse, (in-law) children. In the event that it is not partially or totally possible, it calculates the proportion of the care demand that cannot be assumed by informal family resources and that should, therefore, be externalized, presumably to the formal sphere. The model allows estimating and projecting the demand for elderly care in Spain and the distribution of care of a formal (professional) or informal type (by family members) according to the demographic characteristics of each birth cohort and comparing the different Spanish generations born during the 20th century[1].

With the objective of only identifying the impact of demographic change, the current model is based on health conditions and employment status that are invariable for all generations. More specifically, the model follows a group of approximately 10,000 people from different birth cohorts, whereby the demand for care is studied from the age of 50 until death. The kinship network of these Egos is reconstructed, limiting it to their spouse, children, children-in-law and grandchildren. For this article, we compare seven different generations, born at intervals of 10 years, between 1908 and 1968. The egos of these birth cohorts as well as their kin are exposed to the risk of falling into a specific dependency level. The exact risk depends on the Ego's sex, age and educational attainment. This has been estimated from the Survey on Disabilities, Personal Autonomy and Situations of Dependency (EDAD) of 2008. For example, Figure 1 shows that lower educated women are more vulnerable to have a high degree of dependency that would require full-time care, while people with a higher educational level have a lower risk. These risks are derived from age-specific transition probabilities between the initial situation of good health and the three dependent states of increasing severity. These probabilities are used in the simulation model, both for Egos and their relatives, with the objective of determining which part of our virtual populations requires care

[1] For the reconstruction of the kinship network, the Pascal language is used, as described in Devolder (2002, 2004). Regarding the ABM used to estimate the supply and demand of hours of care throughout the Ego's life the NetLogo software is used, a programming environment especially designed for the development of ABM and the simulation of natural and social phenomena. In Calduch et al. (2017) a more detailed description of the DemoCare model is given but we envisage making both programs available to other researchers so that DemoCare can be applied to other countries that have the necessary data.

and to what degree.

< Insert Figure 1 about here >

The same logic is used to determine if Egos and their relatives work, based on activity tables that are a function of sex, age, educational level and level of dependency. These tables are also obtained from EDAD (2008), while the probabilities of transition from one employment status to another are estimated from longitudinal data from the Spanish Labour Force Survey (EPA). Table 2 presents a summary of this information. As can be observed, labour force participation varies significantly by sex and educational level, as expected, while dependent people with a high educational level do not reduce their activity to the same degree compared to counterparts with a lower educational level. This justifies taking education into account in our modelling.

< Insert Table 2 about here >

In the simulation model, the survey information is also used to determine the number of hours that family members can offer to dependents, that is, the informal care offer (Table 3). The amount is mainly a function of the kin's age and their employment situation as well as their own health situation (level of disability or dependence). In turn, the demand for hours of care in the model is estimated from the hours of care received according to the EDAD (2008) survey.

< Insert Table 3 about here >

The ABM determines, at each moment of the Ego's life their situation of disability and dependence, the number of hours of care they can receive from their closest relatives who remain alive, that is, their partner, their children and children-in-law (from hereon referred to as children). These relatives will be

able to take care of Ego as long as they have free hours, which can be limited by their work and also by the needs of the rest of the family. For example, if Ego has a partner in good health who does not work, this person can take care of Ego if he or she has no children who require X hours of care based on their level of dependency or young age. On the other hand, Ego's children will be able to dedicate care time to the extent that their own children do not require their time, again because of their age or because of a possible disability situation. That is to say, the hours of care Egos can obtain from their relatives are in competition with the needs of the other family members. The algorithm of distribution of available hours of care is based on simple rules, which are applied in a hierarchical way to determine the amount of hours of care that family members can offer to Egos:

1. Members of unmarried siblings help each other.
2. Parents have preference to help their children before helping their partner or their own parents, in the event that the siblings have a positive net demand for hours of care.
3. An Ego's son or daughter will help his/her partner before, if he/she needs it, his/her parents.
4. If Ego and her partner are both in a situation of dependency, the hours of care for their children will be divided equally between the two, i.e. proportional to the demand of each.
5. The care of an Ego with a partner will be carried out first and foremost by the partner and Ego's children will only contribute if the partner's offer of hours is insufficient to cover the demand.

In other words, in the event that a person from the reference group (Egos) is in a situation of dependency, the hours of care offered by their family members will be limited by the situation of these. This is first by their level of labour force participation and own dependency status, which reduces their availability, but also by the demand for hours of care from other family members.

Results

The effects of the increase in life expectancy on the number of dependents

The model allows, in the first place, to examine the effects of mortality decline and the lengthening of life on the number of dependents in the population. For this, we calculate the probability of being in a state of

dependence at each exact age from birth for the seven simulated cohorts (Figure 2). As the risks of falling into dependence in each age interval are the same for all cohorts, the only differential factor lies in the mortality trend from cohort to cohort. Thus, for those born in 1968 the probability of being in a situation of dependency at the age of 85 will be 22%; that is, 22% of those born reach this age and have a disability that requires care from other people. On the other hand, the probability is 2% for a person born in 1908. Therefore, if the number of births in both generations were to be equal, the number of dependents at age 85 would be ten times higher among those born in 1968 than among the 1908 birth cohort. This difference is explained by the higher infant, child and premature mortality of people born at the beginning of the century.

< Insert Figure 2 about here >

Yet, the biggest difference is between the two most recent birth cohorts, as the same probability at age 85 is 13% for the cohort born in 1958, where the difference in life expectancy with the 1968 cohort is just over seven years. This rapid increase in the proportion that will reach old age is due to the predicted decline in mortality at advanced ages for the youngest cohorts. In general, this means that the lengthening of life causes a much greater than proportional increase in the total number of dependents, despite assuming constant dependency conditions as those observed in 2008.

Family care deficit

The main type of results obtained by our simulation model refers to the balance between the demand for hours of care by dependents and what can be offered by their families. Figure 3 presents the overall result in terms of the proportion of the dependent ego's care demand that can be potentially covered by their family (or informal care, according to the terminology used in this type of studies). It is generally observed that, for all simulated cohorts, families with dependent egos present a deficit of care hours. Both overall and for all ages that egos are in a situation of dependence it is necessary to resort to caregivers not

related to the families, which in practice means to resort to people who are remunerated for their services (i.e. formal care).

< Insert Figure 3 about here >

However, there are important differences between birth cohorts. The deficit of hours of family care was much greater in the past. It decreased until the 1948 birth cohort who have around 15 percentage points less throughout their dependent life compared with the 1908 cohort. As is detailed below, this is mainly explained by the reduction in mortality and widowhood. Conversely, however, the deficit of hours of family care will increase for the 1968 birth cohort compared to those born in 1948, reaching levels that are observed for the 1928 cohort. This change can be basically explained by the decrease in fertility that reduces the average proportion by 8 percentage points for all ages from the age of 50.

The distribution of informal care between parents and children

The informal family care of the dependents is assumed by the co-resident couple (wife or husband), the children or by both simultaneously. Obviously, if ego does not have a partner or is widowed, the children have to assume this role and if ego is childless or the children have died, it will need caregivers external to the family nucleus, which usually means from the formal or professional care sector.

Figure 4 provides more detailed information regarding figure 3, distinguishing what part of the informal care corresponds to the ego's couple or their children. One can observe the growing role of the couple across generations as for dependents aged 70 and born in 1968 they still cover, on average, half of their demand compared to just 23% for the 1908 cohort. This increase in the couple's survival has led to a delay

in the age at which children become the main caregivers[2]. This increase in the survival rates of the ego's partner is able to compensate the effects of the decline in fertility, which in turn explains the reduction in the proportion of care provided by children that is predicted for the 1968 generation.

< Insert Figure 4 about here >

Informal care for men and for women

It is interesting to note that the situation of dependent men is not overall better than that of women (Figure 5). Certainly, the combined effect of greater survival of women and older age of their male partners contributes to the fact that wives are the main caregivers of their dependent husbands until the husbands turn 84, while, conversely, husbands of dependent women are the primary caregivers only up to age 73. In fact, globally, the situation of dependent men is worse than that of women, as they have a greater care deficit than women throughout life, especially before the age of 60 and after 90. The reasons are multiple. Before age 60, there is a lack of caregivers for male dependents, because their wives are still working or because a higher proportion of their children are still young and need to be cared for, thus taking potential hours of care away from the mother. Conversely, for dependent men older than 85 years, the informal care deficit with respect to women at the same age is explained, paradoxically, by the greater survival of their wives. This magnifies the risk that the two are dependent and compete equally for the hours of care that their children can provide. Yet, this situation is more favorable for dependent women, as a large proportion of their spouses have died, meaning that the few husbands that do survive only slightly reduces the available set of hours of care that women can obtain from their children.

< Insert Figure 5 about here >

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[2] To provide another example, for the 1908 cohort it is at age 60 when the proportion of the care assumed by the children exceeds the proportion that corresponds to the partner; for the 1938 generation this occurs at age 65 and for the 1968 cohort at age 77.

Factors that cause the informal care deficit

As the comparison between dependent men and women shows, the offer of informal care depends on a complex set of factors. Figure 6 separates some of them and measures their respective importance. Specifically, it estimates what part of the theoretical offer of care could be devoted to egos, taking into account the level of fertility and nuptiality and the limitations imposed by mortality and childlessness of the ego, as well as the restrictions owing to the dependence (i.e. care needs) of the ego's direct kin (e.g. spouse) as well as that of the potential carer (e.g. non-adult children and the (degree of) labour force participation. In these graphs, hours of potential care are not counted, but the maximum number of kin that the ego has available. This corresponds to the level of fertility and nuptiality, i.e. the total number of relatives that can potentiall take care of ego throughout their life. At interest here are only those families who have an ego with a certain level of disability that requires personal care.

The upper part of each graph corresponds to the potential offer of care by the ego's partner. For example, for egos born in 1908, the main factor that limits this offer is mortality, since from the age of 90 basically all egos are wodows or widowers. As the bottom part of the graph shows, mortality also significantly limits the supply of child care for the 1908 generation (and more so among women than men), especially when compared to the 1968 generation.

Another important condition is the fact that a significant part of the egos have no direct relatives who can take care of them, either because they did not form a union, or because they did not have children. To estimate the effect of this lack of children who can be potential caregivers, we use a "counterfactual" reasoning that consists of assuming that all egos have formed a union, and those that do not have children, have the same parity structure as those that did. This allows estimating the total effect of not having children, i.e. because ego has no partner as well as despite having one. We have labelled this "childlessness".

The fourth factor that limits the supply of relatives susceptible to caring for egos corresponds to the time they spend working ("work"). The proportion is remarkably similar for both generations. One gender

difference that can be noted is that the proportion of potential partner carers lost due to work is expectedly higher among female egos, but that particularly given the spousal age difference, male egos may be effected by this until they are in their early 70s.

The fifth and final factor is caring for other relatives, including the ego's partner (labelled "competition"). It can be seen that for the 1968 generation, the situation of dependence of couples limits the availability of care time for egos due to a double effect: couples with a severe disability cannot be carers, but in turn their needs limit the offer of care that their children can provide in case they have to care for both parents simultaneously. Given the increase in longevity during the course of the 20th century, this effect is still quite strong at older ages, while among the 1908 generation it was stronger among those aged 75 and younger.

Finally, if we compare the egos of the two generations, we observe that the offer of kin carers is actually smaller for the generation of 1908, particularly in the case of women. This is mainly due to the effect of (male) mortality that does more than compensate the higher fertility, especially for egos who are at least 55 years old.

< Insert Figure 6 about here >

Limitaciones e interés del modelo de simulación

What distinguishes our model from a survey? ABM modeling is a powerful technique that facilitates the understanding of how biological, social and other complex systems emerge from the characteristics and behaviors of the agents that make up these systems. While surveys provide a cross-sectional view, modeling allows to see how social changes affect a long-term phenomenon, both in time and across generations. Another difference between our DemoCare model and surveys or censuses is that while the latter allow quantifying the current demand and supply of informal and formal care, our model is dynamic, permiting both cohort-specific current and future estimations of the potential supply of infomal care according to different kinship contexts.

The model is based on reliable data sources. Our input is obtained from demographic estimates derived from data from the Spanish National Statistics Office, the 2008 Survey on Disabilities, Personal Autonomy and Situations of Dependency and the Spanish Labour Force Survey, which has allowed a recreation of the universe as close to reality as possible. The objective of the model in its current version is to estimate the impact of demographic change on the evolution of dependence and the potential demand for formal care, and, therefore, working and health conditions remain stable for all generations, according to what was observed in 2008, the year of the health survey.

Despite its potential applicability for social and health policy, the model also has limitations that we outline below.

- First, the model is still relatively simple. At the moment it only takes into account the demographic change between cohorts. A possible extension would be to formulate hypotheses of change in health conditions (for example, playing with factors of expansion or compression of morbidity or the impact of a global improvement of health, or with the timing of transitioning into (and out of) dependency). Another factor of change that could be introduced is that related to labour force participation, for instance, by taking into account the growing female participation among the youngest cohorts, or the possible effect of an economic crisis and the subsequent increase in unemployment, which, in turm, yields a greater availability of hours of care.
- In addition, our ABM model does not include complex interactions between agents as the social network beyond the immediate family (partner and children) does not enter the model. Neither does it consider that the supply of hours of care by family members could depend on factors other than purely quantitative ones. For example, the effect of peer influence could be studied, based on the hypothesis that the willingness to help depends on having friends who care for older parents. Nor does it take into account feedback effects, which, in the context of the model, would be the effects of situations of dependence on demographic behavior. For instance, the fact of having dependent parents can condition the behavior of the children when seeking a partner or having children. In the same way, having dependent relatives can alter the activity of the potential caregiver.

- Other relevant factors that the model does not consider and that could affect the results are:
    - The effect of divorce and separation, although we believe that the increase in divorce rates since it was legalized in 1981 would only condition, to an important degree, the availability of a coresiding partner in old age in cohorts born since the 1970s, but it would have an effect on the potentially reduced availability of care time by divorced children who themselves have children under their care.
    - The possibility of health improvement, i.e. from a high to a medium level of dependency (or even completely reverting back to no dependency).
    - The physical distance between children and parents. As was shown by Spijker and Zueras (2017) with data from the 2013 wave of the Survey of Health, Ageing and Retirement in Europe (SHARE), not living with children significantly increases the probability of only receiving formal care. Unfortunately, the 2008 EDAD survey does not contain information on the distance between the non-resident children and their dependent parents.

On the other hand, one of the benefits of the model lies precisely in its simplicity, which makes it possible to identify the effect of the most important demographic factors in recent decades: the increase in life expectancy and the decline in fertility. The inclusion of numerous hypotheses would increase its complexity, at the same time that it would complicate the interpretation of the results in the identification of the factors and the dynamics that produce them. Simplicity, or parsimony in hypotheses, is, therefore, a virtue of the model.

Finally, it should be remembered that, in the real world, some of the attention needs are simply not satisfied at all, which give rise to serious effects for the quality of life of the person. Thus, lacking informal care does not automatically mean that the person who requires care will receive it. As Noble et al. (2012) suggested, not all older people will have savings to pay for private care services. In addition, currently in Spain there are insufficient resources for this demand to be covered by social services, a problem that was exacerbated after the adoption of austerity measures implemented by the government concerning health care provisions that had been stipulated by the 2006 Dependency Law (Correa and

Jiménez-Aguilera 2016, Deusdad, Comas-d'Argemir, and Dziegielewski 2016).

8. Conclusiones

The fundamental role of demographic change in the balance between the demand and supply of care for dependent elderly people is undeniable. The demographic change observed since the beginning of the 20th century would imply a greater demand for care, caused by the increased survival of younger cohorts to older ages. In turn, improvements in mortality at older ages -and, especially, that of men- favours the role of spouses as primary caregivers through the reduction or delay of widowhood. There is, however, a deficit in the ability of the nuclear family to provide the care demanded by the dependent elderly, which, although it reduces between the 1908 and 1948 cohorts, it increases again as a result of the decline in fertility. This results in a need to resort to caregivers outside the family network.

Contrary to expectations, the situation of the male-dependent older population is not better than that of the female population. The age difference between spouses contributes to the deficit of hours of care available for men who entre into a situation of dependency at younger ages, because their younger wives still dedicate to productive or reproductive work (caring for the shared children), thus reducing their potential dedication to the care of the dependent spouse. Paradoxically, elderly dependent women benefit from the mortality of their spouses, who are older and probably with some degree of dependence and, as a result, competed with their wives for informal care, rather than acting as primary caregivers.

Our results suggest that specific policies should be oriented to the reconciliation of paid work with informal care work for those with parents with a high degree of dependency, especially considering the increase in female labor participation. What, then, will be the fiscal burden of social assistance financed by the State? We have not proceeded to estimate the possible financial repercussions brought on by the increase in the demand for caregivers. However, according to a British study (Noble et al. 2012), demographic changes would double the cost per taxpayer between 2000 and 2050, due to the greater demand for social care and the reduction in the offer of informal assistance.

The next step in the development of our model will be the inclusion of some scenarios of change in the

variables of economic activity and dependency that pose more realistic situations and allow testing "what if" hypotheses. In particular, we are interested in analyzing the impact of changes in the health of the population. For example, what would happen if there was a reduction of 2%, 5% or 10% in the prevalence of all types of dependency? Or what would happen if entry into dependency states was delayed for two years?

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Table 1. Demographic trends in Spanish cohort born in 1908, 1938 and 1968

Cohort	**1908**	**1938**	**1968**
e_0 (life expectancy at birth, women)	49 años	63 años	85 años
e_{65} (life expectancy at age 65, women)	11 años	14 años	23 años
Proportion of survivors at age 65, women	40%	63%	95%
Definite singlehood, women	14%	8%	8%
Male widowhood at age 50 (%)	12%	5%	3%
Female widowhood at age 50 (%)	23%	15%	1%
Total fertility rate (TFR)	3,0	2,6	1,5
Childlessness (% of women)	26%	14%	21%
Age at first motherhood	27 años	26 años	30 años
Women who have had 1 child (%)	74%	86%	79%
2 children (%)	66%	77%	57%
3 children (%)	47%	43%	13%
4 children (%)	33%	24%	3%
5+ children (%)	24%	13%	1%

Source: Own calculations based on data from the National Institute of Statistics (INE, www.ine.es) and estimates obtained from the simulation model.

Table 2. Distribution of the population by labour force participation according to sex, educational level and level of dependency (2008)

Sex	*Men*			*Women*		
Educational level	*High* **%**	*Medium* **%**	*Low* **%**	*High* **%**	*Medium* **%**	*Low* **%**
Disability with high dependency						
Inactive	80	89	95	81	94	95
Part-time employed	6	3	2	7	2	2
Full-time employed	13	8	3	12	4	3
Disability with medium dependency						
Inactive	68	76	94	70	84	94
Part-time employed	11	9	2	10	6	3
Full-time employed	21	14	5	20	10	3
Disability without dependency						
Inactive	44	65	77	54	76	90
Part-time employed	21	13	9	20	11	4
Full-time employed	35	22	14	26	13	6
Without disability						
Inactive	23	29	46	38	60	77
Part-time employed	3	3	2	13	13	9
Full-time employed	74	69	52	49	28	14

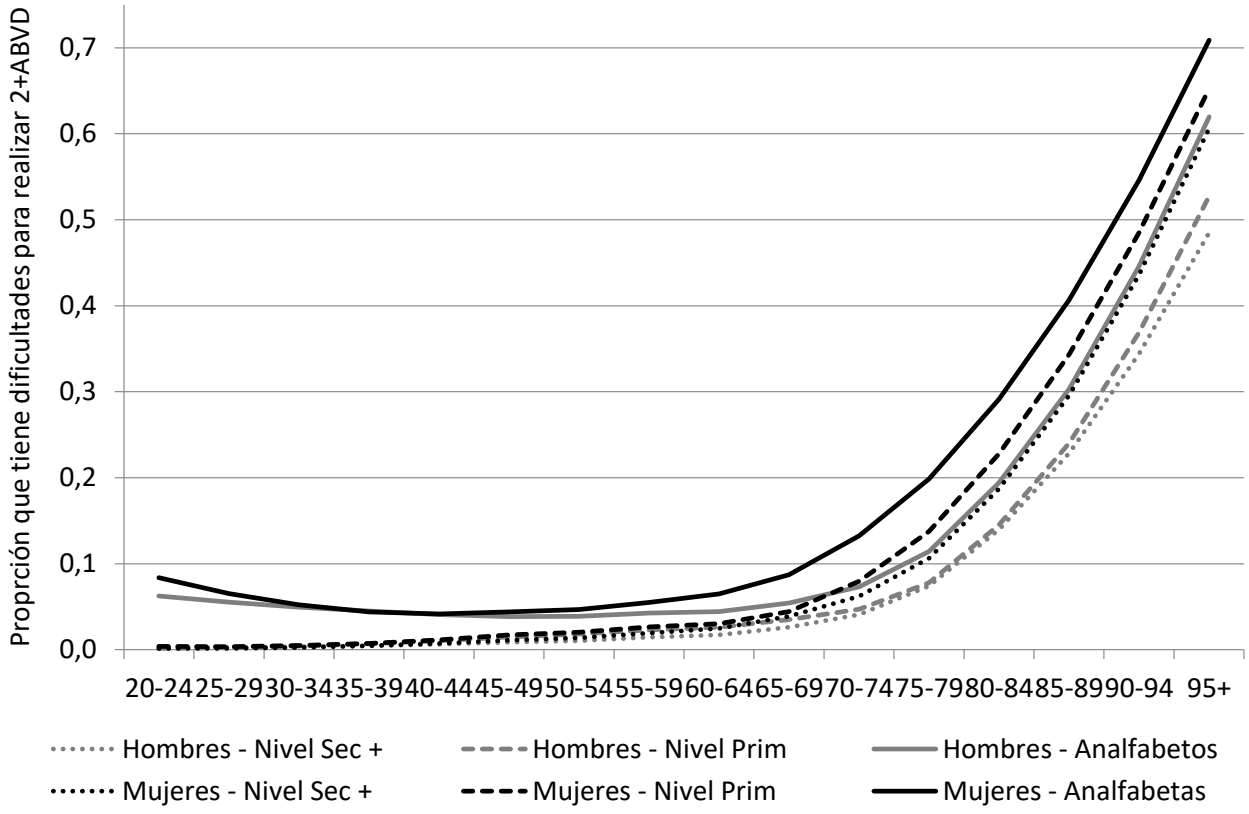
Source: Own calculations base on data from the EDAD (2008) Survey.

Table 3. Weekly hours of care, according to age, labour force participation (LFP) and dependency status. Demand (negative values) and supply (positive values) used in the ABM model

Age group	*LFP*	*Good health*	*Dependency status*		
			Low	Medium	High
Less than 5 years	Inactive	-20	-20	-30	-80
5 to 11 years	Inactive	-10	-18	-30	-80
12-16 years	Inactive	-5	-16	-30	-80
Adults	Inactive	60	30	-30	-80
	Part-time	45	22.5	-30	-80
	Full-time	30	15	-30	-80

Source: Own calculations base don data from the EDAD (2008) Survey.

Figure 1. Proportion of the population in the highest dependency state* by sex, age and educational level (2008)

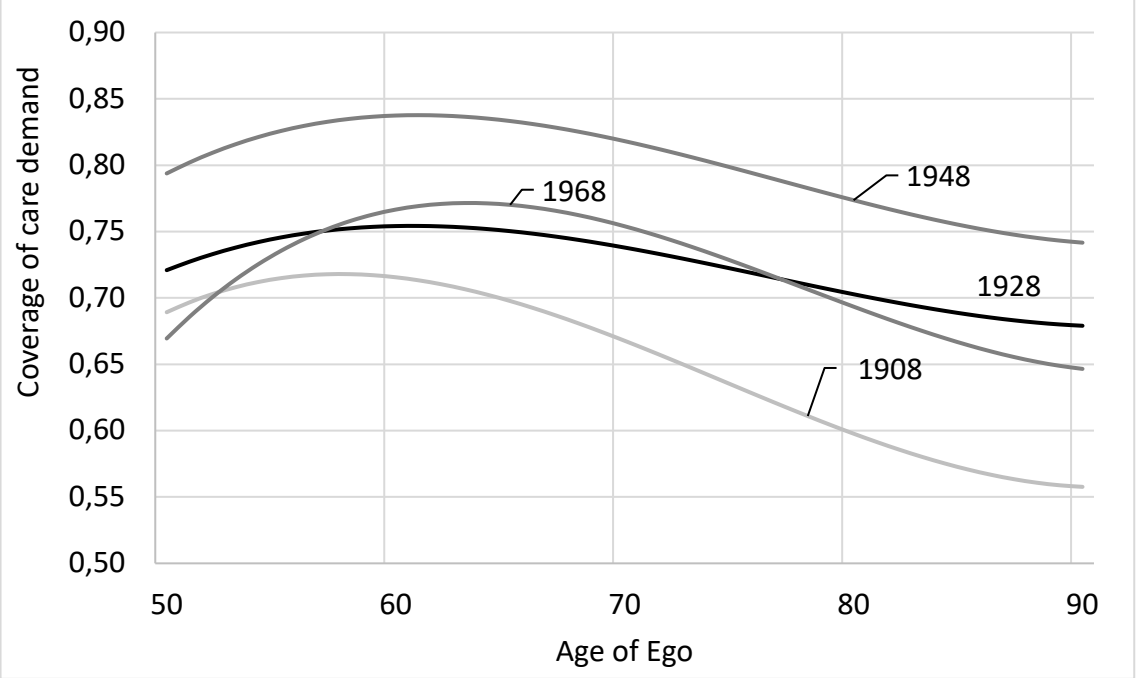


* With difficulties to perform two or more basic activities of daily living (ADLs).
Source: Own calculations based on data from EDDES (2008).

Figure 2. Probability of the 1908 to 1968 birth cohorts to live in a situation of dependency from age 50, counting since birth

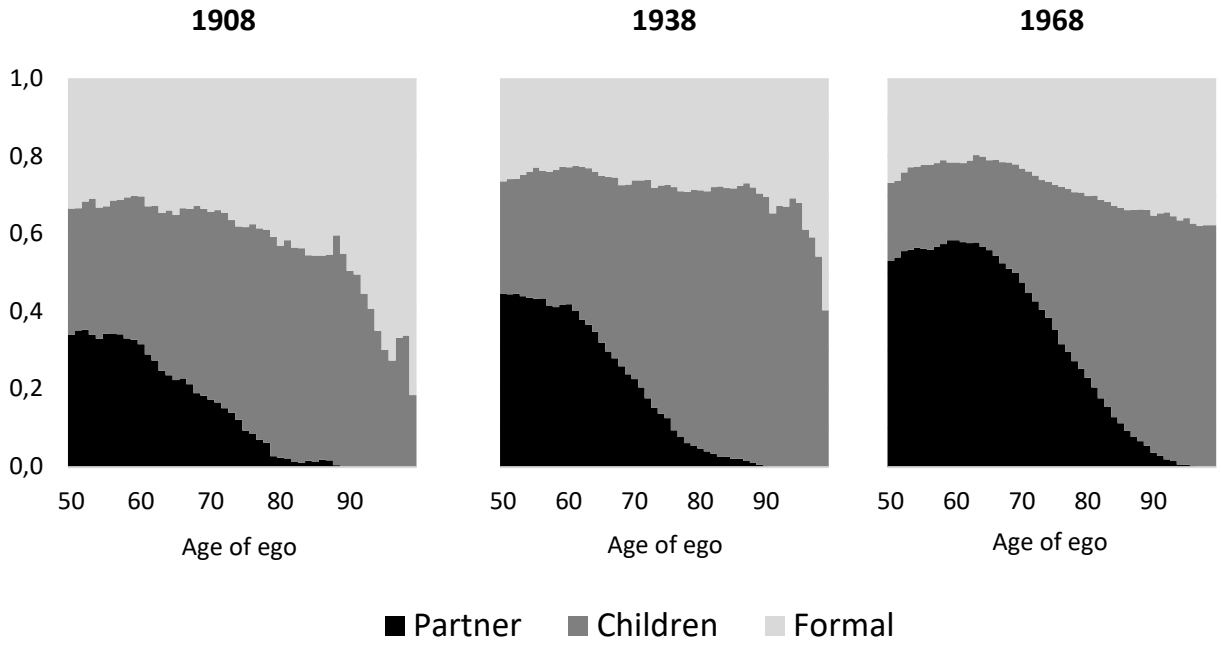
Source: Own calculations based on the results of the simulation model DemoCare.

Figure 3. Proportion of the care demand covered by the family, according to the age of the dependent persion (Ego) and his/her birth year (1908, 1928, 1848, 1968)



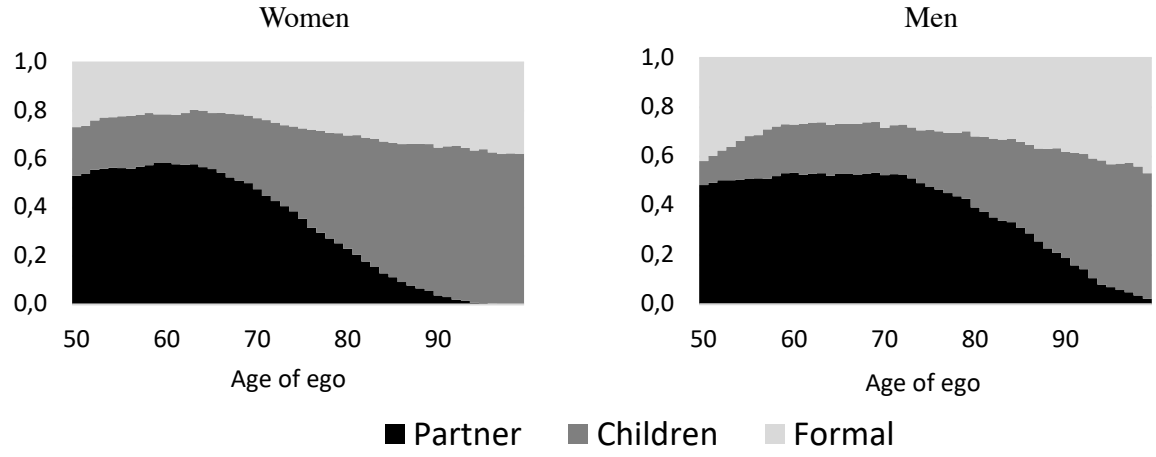
Source: Own calculations based on the results of the simulation model DemoCare (data smoothed with a grade 3 polinomial function).

Figure 4. Proportion of care covered by the partner and children of the dependent person (ego), according to the age and year of birth of the ego (1908, 1938 and 1968)



Source: Own calculations based on the results of the simulation model DemoCare.

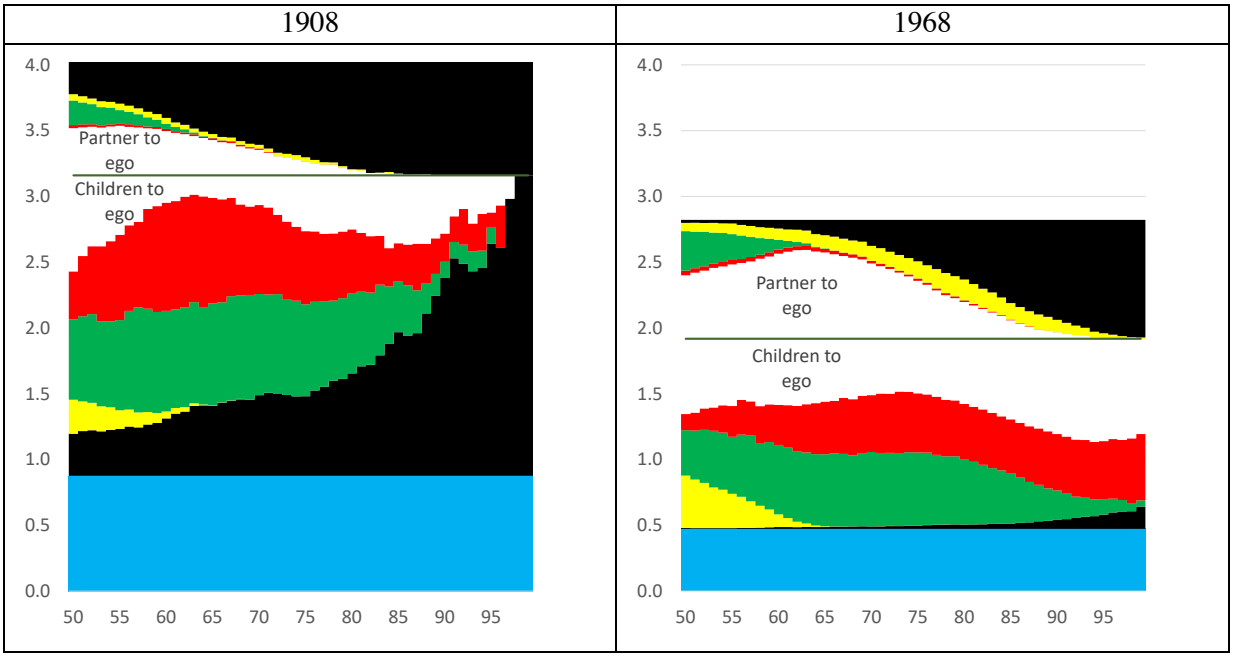
Figure 5. Proportion of informal care, according to the sex and age of the dependent person (ego), born in 1968



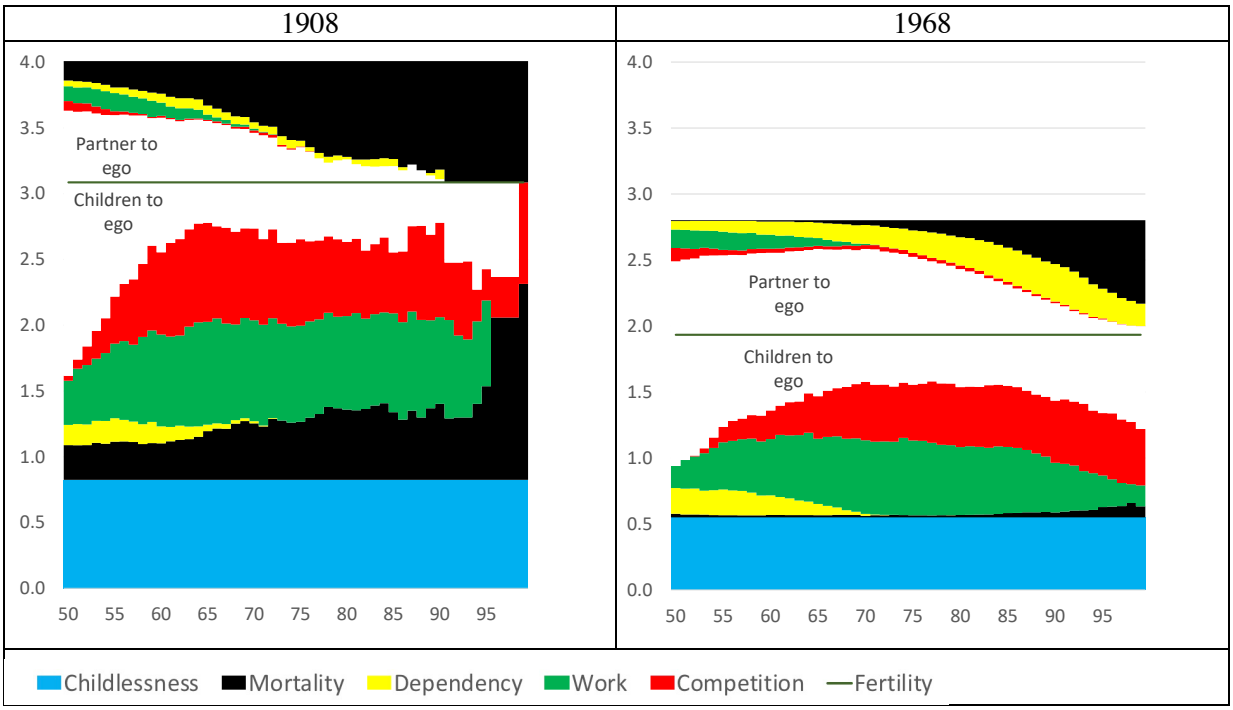
Source: Own calculations based on the results of the simulation model DemoCare.

Figure 6. Decomposition of care supply according to number of kin and factors associated with loss of potential care: comparison between 1908 and 1968 birth cohorts for dependent egos, by sex

a. Women



b. Men



Note: The label "childlessness" refers to the effect of never having had children as well as never having been in a union on the number of kin. "Mortality" relates to ego who have lost their partner (top part of graphs) or their children (bottom part). "Dependency" refers to the situation of dependence of ego's partner (top) or children (bottom), prevents the ego from being cared for and "competition" to the reduction in the offer of care. "Work" assumes that the ego's partner or child employment reduces their possibility to care.

Source: Own calculations based on the results of the simulation model DemoCare.