European Commission

JRC TECHNICAL REPORTS

Survey of Simulation Models of Long-Term Care Use and Expenditure

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2012

Report EUR 25535 EN

Joint Research Centre

European Commission
Joint Research Centre
Institute for the Protection and Security of the Citizen

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This publication is a Reference Report by the Joint Research Centre of the European Commission.

JRC74332
EUR 25535 EN
ISBN 978-92-79-26740-6 (pdf)
ISSN 1831-9424 (online)
doi:10.2788/52537

Luxembourg: Publications Office of the European Union, 2012

Printed in Italy

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Abstract:

The objective of this study is to provide a technical overview of the main simulation tools that are used for the projections of future developments in long term care systems in developed countries. The main thrust of the present analysis is that aging and uncertainties with respect to future trends in disability across individuals, and in costs required to cater to future needs, are likely to raise significant challenges both for individuals and for policy makers in the not-so-distant future, and that the supply of long-term care (LTC) is unlikely to match future demand. The main concepts used in the long term care literature are illustrated, and modelling strategies employed by different investigators are reviewed. Each of the simulation models discussed in this survey is presented in detail in the Appendix together with the relevant references. Both macrosimulation models primarily based on aggregate data at country level and microsimulation models based on individual and household survey data are considered in the present study.

1. Introduction

Ageing and uncertainties with respect to future trends in disability across individuals, and in costs required to cater to future needs, are likely to raise significant challenges both for individuals and for policy makers in the not-so-distant future. The supply of long-term care (LTC) is unlikely to match future demand. Projected trends around the world illustrate potential increases in the number of elderly people with disabilities in the range of 50 to 100% (Lafortune et al. 2007), while expected increases in the workforce in the long-term care sector are rather modest (Colombo et al. 2011). Similarly, projected increases in total expenditures with the provision of long term care services are routinely estimated far beyond 100%. As a result, the prospects of a widening "care gap" and its catastrophic budget consequences have spawned a large body of policy-oriented research efforts designed to grasp both the magnitude and the possible solutions to this LTC conundrum.

Projections of future trends in the long term care sector usually rely on simulation models designed to replicate a given policy environment. Most of the these tools are suitable for ex ante analyses of alternative policy options identified in terms of key parameters that characterise long term care issues such as the prevalence of disability in the population, the use of formal and informal long term care services, and the costs incurred with the provision of these services. In terms of data requirements, the LTC models can be broadly classified into two types: 1) macrosimulation models primarily based on aggregate data at country level, and 2) microsimulation models based on individual and household survey data.[1]

Our objective in this study is to provide a technical overview of the main simulation tools that are used for the projections of future developments in long term care systems in developed countries.[2] All these models are used to project future rates of use of long term care services mainly for elderly population and, in some cases, to analyse the financial aggregate effects of a higher aggregate demand for long term care assistance.

The structure of the study is the following. In the next section we introduce briefly the main concepts used in the long term care literature. In section 3, guided by a structure of a generic LTC model, we discuss the modelling strategies employed by existing studies for each of the model components. The discussion includes data, assumptions and sensitivity analysis. Each of the simulation models discussed in this survey is presented in detail in the Appendix together with the relevant references.

2. Overview of long term care systems

Long-term care includes medical, social and personal care services provided on a recurring basis to individuals with a chronic mental or physical disability, and is usually classified into two main categories: 1) assistance with activities of daily living (ADLs), including bathing, bed mobility, personal

[1] For a comparative discussion of macro- vs. microsimulation models in the LTC context see Wiener et al. (2007).

[2] This survey is by no means exhaustive. Rather, it is limited to models for which we could find easily accessible documentation for the model structure.

care, eating, medication etc, and 2) assistance with instrumental activities of daily living (IADLs), including routine activities such as meal preparation, housework, shopping, travel to medical services and telephone use. All these services are typically provided in private homes or in institutional settings (such as nursing homes).

Individuals' costs and access to LTC assistance are largely dependent on the country-specific features of the LTC systems, the two most important dimensions being the extent of coverage and types of LTC benefits provided. Based on OECD data (Colombo et al. 2011), in Table 1 we summarise the grouping of countries according to the comprehensiveness of LTC systems and the benefits provided. Comprehensiveness of LTC schemes helps distinguish three main types of LTC systems: 1) LTC systems providing universal public coverage, 2) public systems with means-tested benefits, and 3) mixed systems of universal and means-tested public coverage. The benefits provided could be in cash or in-kind, and typically they cover both home and institutional care.

Systems with universal coverage provide LTC services to all individuals who are eligible due to their care-dependent status, financed through taxes (as in the Nordic countries), or through compulsory public insurance (as in Germany, the Netherlands, and Luxembourg). While these systems are comprehensive with respect to access to LTC services covered and costs incurred by users, they require a significant amount of public investment (for example, 3.5 % of GDP in the Netherlands, and 3.6% of GDP in Sweden). In most cases, though not absent, users' out-of-pocket expenses are not burdensome.

Means-tested safety net schemes, on the other hand, focus on individuals who do not have sufficient resources to cover LTC expenditures on their own. In these systems, access to LTC benefits is conditioned on strict means and asset testing to ensure that individuals first exhaust private resources before relying on public LTC support (for example, the Medicaid system in the US). Given that they require people to sell their homes before accessing LTC support, however, these systems can exclude a significant number of disabled people in need of assistance, or they can render the LTC users impoverished before they can access public support.

Finally, systems with mixed public coverage combine universal benefits with means-tested support (such as universal benefits for disability and means – tested social care services in the UK). The disadvantage of these schemes is that they do not cover the full costs of LTC, leaving a significant share of these costs to be covered by users out-of-pocket. In Switzerland, for instance, the users end up paying 60% of the total LTC related costs.

In terms of financing, LTC schemes are funded primarily from public resources, through taxes (Nordic countries), or based on compulsory public LTC insurance schemes (Germany). Increasingly however, private LTC insurance is factored in as an additional source of funding, although comprehensive markets for private LTC coverage are still difficult to develop. Highest prevalence of private LTC insurance is recorded in the US and Japan (with up to 7% of the total LTC expenditures).

Table 1: LTC systems in OECD countries (2009 – 2010)

		Public Coverage		
		Universal	Means tested	Universal & means tested
Type of benefits	Mainly in-kind benefits	Australia (0.8%) Japan (1.4%)	United States (0.6%)	Canada (1.2%) Greece (0.3%) Hungary (0.3%) Mexico (n.a.) New Zealand (1.3%) Portugal (0.1%)
	Cash and in-kind	Belgium (1.7%) Denmark (1.8%) Finland (1.8%) Germany (0.9%) Korea (0.3%) Luxembourg (1.4%) Netherlands (3.5%) Norway (2%) Poland* (0.4%) Sweden (3.6%)	Slovenia*(0.8%)	Austria** (1.1%) Czech Republic (1.4%) France (1.7%) Ireland (n.a.) Spain (0.6%) Switzerland (1.3%) United Kingdom (0.96%)

The share of LTC expenditure in GDP (%) in parantheses. Health insurance scheme with no separate LTC system. ** Regional in-kind benefits.*

Based on: Colombo et al. (2011)

3. Structure of long term care simulation models

From the policy perspective, there are four main aspects that are critical in defining the sustainability of LTC systems: 1) the demand for long term care defined in terms of the number of individuals with disabilities and the extent of care required, 2) the supply of LTC services, including aspects of the availability of informal carers, formal workforce in the LTC systems, and charges/costs of LTC assistance, 3) LTC funding schemes and total LTC expenditures, and 4) the distributional effects of LTC policies. The LTC simulation models discussed here mainly focus on the demand for LTC services and on total expenditures incurred with the provision of these services. When accounted for, aspects of supply and funding schemes are addressed as exogenous changes in the sensitivity analysis. The analysis of distributional issues, on the other hand, is a relatively new development of research in the field. As described below, distributional impacts of LTC financing regimes are investigated by two of the models included in this survey.

The generic structure of a typical simulation model of long term care issues is illustrated in Figure 1. Structured in modules, the simulation exercise first requires data on the reference population groups, which are then used to identify (groups of) individuals with disability who are potential users of LTC services. Subsequently, the frequency and intensity of use of LTC services is combined with estimates of costs of service provision in order to determine the total public and private expenditures incurred in the sector. The type of data and the assumptions implemented for each model component, as well as the analysis of model sensitivity to baseline assumptions are described below.

Reference population

Empirical analyses of long term care issues require detailed data on groups of elderly individuals (65+) by age, gender, degree of disability, and other socio-economic characteristics. The reference groups in macrosimulation models are modelled as "cells" representing subpopulations defined by demographic, social and sometimes economic characteristics. Models differ in the details implemented. The European macrosimulation models for EU Member States, for example, rely on groups of elderly individuals classified by age, gender and dependency (see A2 and A3 in the Appendix). The PSSRU model in the UK, on the other hand, operates with a more detailed classification of elderly population by marital status, household type, housing tenure, and institutionalisation (A1 in the Appendix). Future trends are estimated based on official population projections.

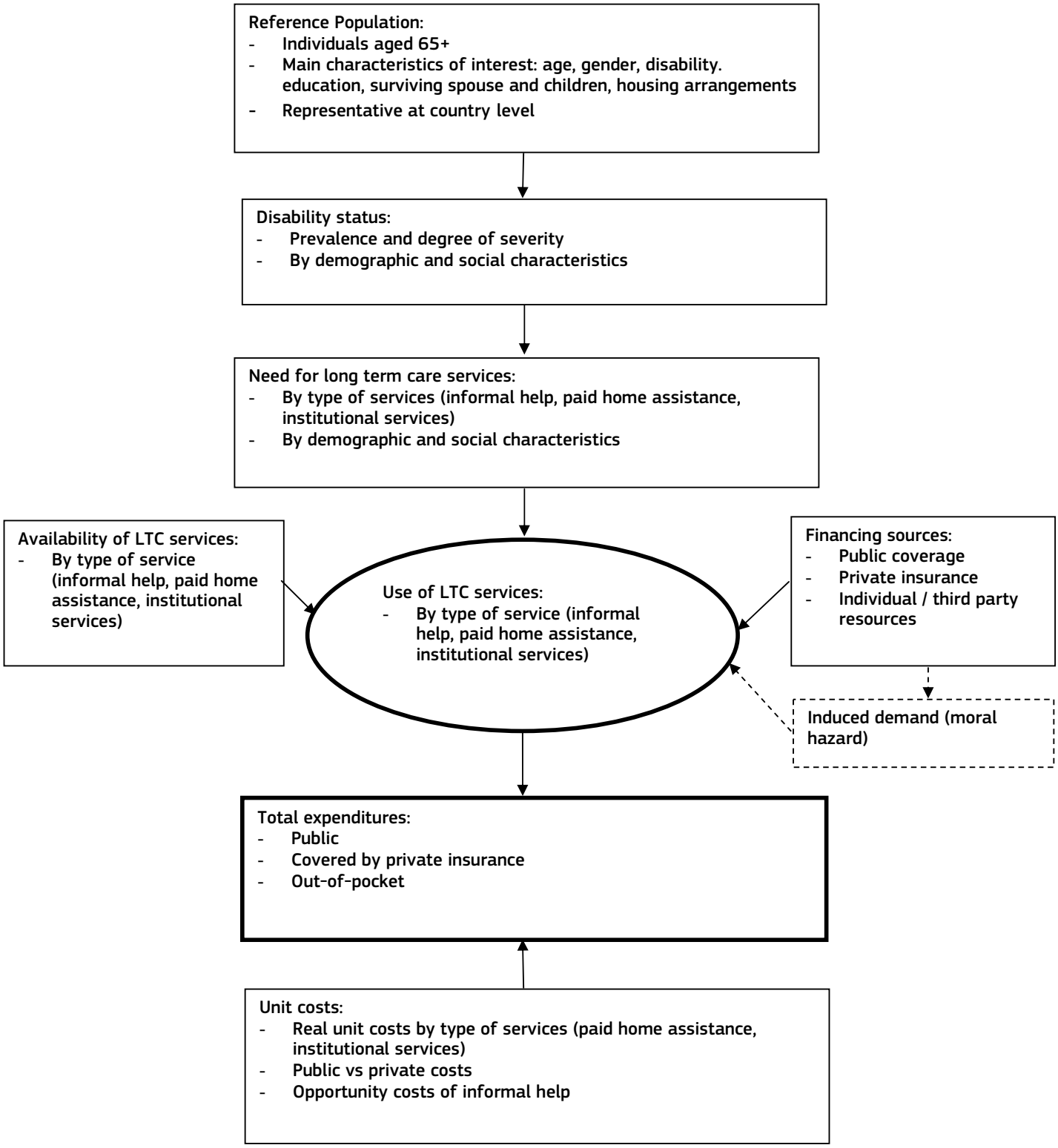
In contrast with models based on aggregate data, the microsimulation models use nationally representative samples of individuals of all adult ages, as in the Brookings analysis (A4 in the Appendix), or of older ages (65+), as in the APPSIM-ACM model in Australia and in the Urban Institute model in the US (A5 and A6 in the Appendix). Subsequently, future characteristics of individuals in the sample are simulated with other microsimulation models of population dynamics, such as PRISM for the Brookings analysis, DYNASIM3 for the Urban Institute model, and LifePaths for the Canadian analysis (A7 in the Appendix). Future population projections typically rely on assumptions on future fertility, mortality, and immigration rates, as well as other individual life events such as enrolment in education, marriage/divorce, having children, labour market participation etc.

Disability and dependency

Ideally, the demand for LTC services should be based on the number of individuals in need of such services. In the modelling context, this implies a definition of disability-related dependency and the identification of individuals in the population to whom this definition applies.

Having a disability, however, does not automatically imply dependency and the need for long term care assistance. Disability is defined in terms of limitations in performing some types of daily activities, while dependency requires that individuals with disability also need help with performing those activities. In the Canadian analysis of LTC, for instance, the survey data used allows for the classification of individuals with disability who need assistance on a daily basis (Table A7.1). In the German model, on the other hand, the recipients of LTC services are identified based on the national definition of dependency in terms of need for assistance with at least two ADLs for 90 minutes a day (Table A2.1). Finally, when the need for assistance cannot be identified based on the available data, the LTC models rely on the assumption that all individuals with disability require some form of formal or informal assistance with daily activities. Examples include the PSSRU model in the UK (Table A1.1), Brookings/ ICF Model of LTC Financing for the US (Table A4.1), and the Australian Model APPSIM – ACM (A6.1) – all models that rely on 4-5 categories of disability defined in terms of limitations with daily activities.

Figure 1: Simulation models of long term care use and expenditures



In the macro models, the initial distribution of individuals in dependency groups is estimated by age and gender based on survey data on limitations with daily activities (Table A1.1), or based on national official data on groups of individuals with dependency by age and gender (Table A2.1). The microsimulation models, on the other hand, usually estimate the probabilities of disability states based on survey data as functions of individual demographic and socioeconomic characteristics. For subsequent years, in both types of models, the baseline scenario typically relies on the assumption of constant dependency/disability rates by age and gender, and alternative scenarios of expansion or compression of dependency in elderly population are analysed as part of the sensitivity analysis exercise.

Use of LTC services

The use of LTC services is reflected by two main indicators: a) the number of recipients of LTC services, and b) the intensity of use of such services.

In all existing models of LTC, it is assumed that only individuals with need for assistance (or with disability) can receive some type of care services. Once the need for care assistance is assumed or determined based on the prevalence of disability in the population, the initial distribution of users of long term care services is estimated only for dependent individuals, and by type of service (informal help, paid home services, and institutional services), based on national official data (in macro models), or based on survey data (macro or micro models). When data allow, the probability of use is estimated as a function of individual demographic and socio-economic characteristics, and disability levels by type of service. Some degree of substitutability between services can be modelled by including an alternative type of service among the driving factors of the probability of use. For example, in the PSSRU model (Table A1.1) the probability of use of formal care services is modelled as a function of the receipt of informal help. Finally, the number of recipients of care services is obtained for each type of service by applying the probabilities of use to the number of individual with long term care needs.[3]

Often, however, it is the case that there is no data available for the direct estimation of the probability of receiving specific types of care services. For example, household survey data usually do not cover individuals in institutions. Then, the proportions of the elderly population in long term care institutions at country level, by age and gender, are used as proxies for the probability to receive institutional care conditioned on a severe disability state. Informal care, on the other hand, is determined indirectly as a residual category based on the assumption that all elderly individuals with disability receive some type of LTC service. In the analysis of LTC expenditures of EU27 Member States (Table A3.1), for example, the recipients of informal care services are defined as individuals with disability who do not use any type of formal care services.

[3] In macrosimulation models the probabilities of use are replaced by proportions of recipients of LTC services.

The intensity of use of services is estimated in terms of number of visits and hours per week based on survey data. Examples include the PSSRU model in the UK (Table A1.1), and the Brookings / ICF LTC Financing model and the Urban Institute LTC analysis in the US (Tables A4.1 and A5.1).

As emphasised above, the main challenge in modelling the use of LTC services remains the link between the severity of disability and the need for specific care assistance. Individuals with more severe disabilities, for instance, are more likely to use institutional services, while other forms of light to moderate disability may translate into less or even no need for care assistance. Detailed differentiation of needs for specific services according to the degree of disability, however, is likely to be highly data intensive.

Real costs of LTC services

The real unit costs associated with the provision of LTC services are necessary for the calculation of total expenditure with these services both at the individual and aggregate level. These costs are likely to differ by type of service (institutional, community based home care, private help at home, opportunity costs of informal help), and by source of payment (public vs. private insurance, out-of-pocket payments).

The way these costs are included in the LTC analysis depends on data availability. Typically, the sources of data used to estimate LTC unit costs include official statistics at national level, or survey data on individual expenses incurred with LTC services. In the PSSRU model in the UK, for example, the unit costs of formal care services include the opportunity costs of capital, overheads, and travel costs, and are estimated based on survey data (Table A1.1). The German model, on the other hand, uses federal data on daily rates for institutional care services, and survey data for paid home care assistance (Table A2.1). The Italian analysis of LTC relies on data collected from local studies for estimates of costs of formal care, and on survey data for estimates of costs of private care services received at home (Table A2.2). Finally, the Brookings model in the US includes daily charges for institutional services and average program costs for paid home services, with all costs varying by source of payment (Medicare, Medicaid, private).

Long Term Care Expenditures

Total expenditures with long term care services include all direct and indirect costs, both private and public, incurred with the provision of these services. Ideally, apart from the direct costs with labour and capital associated with the provision of services, LTC expenditures should also include the opportunity costs of provision of informal help by family members, friend and neighbours, as well as other costs to the society associated with health hazards of domestic carers (Colombo et al (2011)).

In most of the existing LTC models the calculation of total LTC expenditures is limited to total direct costs of the service provision. Depending on data availability, aggregate LTC expenditure is determined by multiplying the real unit costs by the estimated use of care services, such as in the PSSRU model (Table A1.1), or by summing up total public and private expenditures derived from aggregate statistics and survey data, such as in the German model (Table A2.1). None of the surveyed models, however, include the opportunity and social costs of informal care.[4]

Financing sources

Generally, financing schemes for LTC expenditures include three main sources: 1) public subsidies (universal coverage or mean-tested insurance), 2) private insurance, and 3) out-of-pocket private payments. In the macrosimulation models, the distribution of total LTC expenditures by source of financing is typically calibrated based on national-level data on institutional and community-based services, and on survey data for private out-of-pocket payments. This is the case, for example, in the German model (Table A2.1) which uses federal data from the Department of Health and from the Association of Private LTC Insurance for expenditures with formal LTC services, and survey data for additional services acquired privately.

The microsimulation models, on the other hand, can offer the advantage of a more detailed analysis of sources of coverage of LTC expenditures and their sustainability over time. When combined with projections of individuals' income and wealth, these models can be used for the analysis of the distributional impacts of LTC policies. Of the models surveyed here, the Brookings model in the US is the only microsimulation model that uses individual incomes and assets simulated with the PRISM model[5] in order to project the extent to which individuals with disability can sustain out-of-pocket LTC payments over time.

Finally, an innovative analysis of individuals' ability to cover LTC costs from private resources is included in Hancock et al (2007), a study that combines the demand for LTC services projected with the PSSRU model (A1 in the Appendix) with results from the CARESIM microsimulation model used for the simulation of individuals' income and assets. By merging the predictions of the two models, the authors analyse the distributional effects of alternative LTC charging schemes.

Availability of LTC services

Projections of the availability of LTC services would require simulations of future trends in labour and capital resources employed in the sector. Given the focus on projecting the use of long term care service, however, the simulation models for LTC use and expenditure are usually demand-driven and do

[4] The opportunity cost of informal care is included in the LTC analysis of the Urban Institute in the US (A5 in the Appendix), but it is used to estimate the probability of use of each type of service, and not for the calculation of costs associated with care provision.
[5] PRISM = Pension and Retirement Income Simulator Model

not include any module for endogenous adjustments in supply. They operate on the assumption that the supply of care services adjusts automatically to current demand levels. In most analyses, changes in supply are implemented in the sensitivity analysis by assuming exogenous changes in the demand (and, implicitly, availability) of certain types of services (see, for example, the A2 models in the Appendix). An alternative approach, as implemented in PSSRU (A1 in the Appendix), is to model the use of a certain type of care service as a function of the use of another (possibly substitute) service. In the UK analysis, the probability of use of paid home services is modelled as dependent on the receipt of informal care. Finally, a straightforward implementation of the supply of LTC services is attempted in the APPSIM-ACM model for Australia (A6 in the Appendix), whereby the future supply of formal services is projected based on national data, and the future trends in informal care are estimated based on survey data on determinants of having a carer. Then, the unmet demand for LTC services is determined as the difference between the number of elderly individuals with disability and the number of available LTC services.

Sensitivity analysis

The general objective of all the models surveyed in this study is to project future trends in the demand for LTC services and in total associated expenditures, and to investigate the impact of various changes in the main parameters of the model such as the size of the elderly population, disability/dependency rates, real unit costs of services, availability of supply of various types of services, and financing regimes. The analyses typically start with a baseline scenario, and then include comparisons with alternative scenarios formulated by changing the model assumptions one at a time.

Across models, the projections of the future use of LTC services are most sensitive to changes in the projections of the elderly population (and, in particular, the very elderly aged 85+), and to changes in disability/dependency rates. With respect to population, for instance, in the European study of LTC expenditures, simulation results for Italy are markedly different when national official projections are used instead of the Eurostat projections, presumably due to a larger pool of elderly individuals projected based on national data (Table A2.2). Assumptions on future disability rates, on the other hand, are modelled in relation to life expectancy. Generally, alternative scenarios assume either a compression in disability (with gains in life expectancy spent in good health), or an expansion of disability (with additional life years associated with more severe disability). Predictably, the LTC models project sizeable direct effects of changes in disability rates on the number of individuals in need for care services, but they are less suitable to account for uneven dynamics across the spectrum of services unless they take into account the degree of substitutability between services and the elasticity of LTC supply. Nevertheless, the main challenge in the analysis of alternative disability scenarios remains the lack of associated solid empirical support for future trends in the prevalence of disability.

With respect to LTC expenditures, the model projections are highly sensitive to assumptions on future trends in the real unit costs of services. The baseline scenario usually relies on the assumption that real costs of services change in line with trends in productivity at the country level. Alternative scenarios

are defined based on assumptions of faster/slower/no growth in real costs relative to productivity. Uniform changes in real costs are assumed for all types of services. As a result, the models can account for aggregate changes in LTC expenditures but, given the absence of associated empirical evidence on cross-elasticities of the demand for LTC services with respect to prices, they cannot be used to analyse nonlinear dynamics in the use of services generated by uneven price changes.[6]

Finally, an issue generally disregarded by most models, but included in the Brookings analysis of LTC in the US (A4 in the appendix) is the moral hazard associated with changes in financing schemes of LTC. Ideally, the modelling of changes in demand as a result of policy changes require behavioural models that can describe the incentive mechanisms associated with the use of specific types of services. In absence of a module of incentive mechanisms, however, an empirical solution is to adjust the probability of service use by a growth factor set exogenously in proportion to the hypothesised change in demand as a result of moral hazard, as implemented in the Brookings model.

4. Summary and conclusions

In this study, we survey several simulation models used for the analysis of future trends in the demand for long term care assistance and, in some cases, of total public and private expenditures required for the provision of these services. We identify the main model components, the data used for each of the components, and the main assumptions on which LTC projections are based.

Depending on the availability of country-specific data, we find that the LTC simulation models are informative for ex ante policy analysis especially with respect to issues such as future trends in the size of elderly population with disability. We learn, however, that the accuracy of projections of future use of LTC services depends on the model's ability to distinguish between disability and dependency and on the assumptions on future trends in dependency. With respect to LTC expenditures, models differ in their implementation of financing regimes. Some models focus on public expenditures, while others also include private resources spent with LTC assistance. Overall, all models predict significant increases in LTC expenditures as a result of ageing population, although the precise magnitude of the effects is highly sensitive to assumptions on future real unit costs in the sector.

Although much can be learnt from these analyses already, the empirical modelling of long term care assistance still remains challenging for a number of reasons. First, stronger empirical support for assumptions on future trends in disability and dependency is still needed. Although all of the studies surveyed include alternative scenarios of developments in the prevalence and intensity of disability, these are not usually accompanied by country-specific supporting evidence. Furthermore, no study differentiates trends in disability by age groups, gender, and other demographic and social characteristics as part of the sensitivity analysis exercise. Second, most of the models use the elderly population (aged 65 and over) as a reference group, although disabilities can affect even individuals of

[6] Another aspect that should be considered when projections indicate a need for higher aggregate public LTC expenditure is the deadweight loss of additional taxation required to finance this expenditure.

younger ages. Given that these individuals would require long term care assistance for a much longer period of time, analyses looking at the older population only are likely to underestimate the future demand for LTC services. Third, we would argue for a much clearer definition of the link between disability and dependency. Understanding what types of disabilities are most likely to lead to dependency and need for assistance would enable a more detailed analysis of the future demand by type of service. Fourth, issues regarding the supply of LTC services are either not addressed, or introduced to a limited extent. Given the dramatic expected changes in demand, the availability of supply in general (and of informal help in particular)[7] remains a critical issue for a complete analysis of LTC coverage in the future. Finally, as illustrated by the spatial analysis of LTC in Lymer et al. (2009), the balance between demand and supply of LTC service is likely to differ across regions and territories within countries. As a result, a mapping of gaps in LTC provision across the country over time is likely to require an analysis that adds a spatial dimension to projections over time.

[7] Examples of studies of future trends in the supply of informal care services include Jenkins et al. (2003) for Australia, Carriere et al. (2008) for Canada, and Pickard (2008) for the UK. Such results, however, are not yet included in large – scale simulation models of LTC.

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Appendix: Simulation Models of LTC Demand and Expenditure

A1. PSSRU (Personal Social Services Research Unit UK)

Objective

The objective of the PSSRU model is to make projections of the demand for LTC for elderly individuals up to year 2030, and to assess the financial impact of different LTC policies and approaches.

Model structure

PSSRU is a macro-simulation model structured in four modules designed to simulate the following: 1) the structure of the elderly population, 2) the use long term care services, 3) real unit costs of services, and 4) sources of LTC financing. The model components and sources of data are described in Table A1.1.

Table A1.1: PSSRU model structure and data sources

Module	Description and assumptions	Data sources
Population data base	The reference population includes individuals age 65 and over. Population projections are defined by age and gender for five age intervals: 65–69, 70–74, 75–79, 80–84, and 85+. Additional characteristics include: marital status, household type, housing tenure, and institutionalisation.	Office for National Statistic (ONS) population estimates for England for 1995 by age group and gender Government Actuary's Department (GAD) 1996 population projections for England 1994/1995 General Household Survey 1991 Census data PSSRU Residential Care Survey
Pension and retirement income	The model accounts for the effects of changes in individuals' income and assets only indirectly, through their correlations with the probability of use of care services. For instance, it is assumed that the ratio of privately funded to socially funded occupancy of nursing homes will rise in line with the ratio of home owners living alone to the rest of the elderly household population.	1994/1995 General Household Survey
Disability	Disability rates are estimated by age and gender based on survey data for four disability levels: IADLs1+, ADL1, ADLs2+ and None).[8]	1994/1995 General Household Survey
Use of institutional care services	Institutional care services include residential, nursing home and hospital care services. Probabilities of use of institutional care services are estimated based on survey data as a function of age, gender, and household type. Institutionalisation is treated as an additional category of disability.	Department of Health Data for residential care homes and nursing homes (1996) NHS Hospital Episode Statistics (HES) 1994/1995 for hospital care of elderly patients 1994/1995 General Household Survey 1995/6 PSSRU survey of publicly funded admissions
Use of formal non - residential care services	Probabilities of use of non-residential (paid) care services are estimated based on survey data as a function of receipt of informal care and other large number of other characteristics (including household type, disability level etc.). Projections are	1994/1995 General Household Survey

[8] IADLs1+ = deficiency in at least of instrumental activity of daily living, ADL1 = deficiency in one activity of daily living, ADLs2+ = deficiency in two or more activities of daily living, and None = no disability. Activities of daily living (ADLs) include: personal body care (washing, bathing, using the toilet, etc.), eating/ drinking, going to bed, dressing, walking, climbing stairs etc. Instrumental activities of daily living (IADLs) include housekeeping, using the phone, and managing money.

	made for the number of elderly recipients and the intensity of services received per week (number of hours/visits)	
Use of informal care services	The model reflects the use of informal care through two variables: household composition and receipt of informal care with domestic tasks. The probability of use of informal care by dependent individuals is estimated based on survey data as a function of age, gender, disability, and household type. Individuals with no disability are treated as if they do not receive any informal care.	1994/1995 General Household Survey
Induced demand	Not included in the model.	
Prices / unit cost of services	The model uses estimates of unit costs of formal (paid) care services based on survey data. These costs include the opportunity cost of capital, overheads and travel. The baseline total expenditure with LTC services is determined by multiplying the unit costs by the estimated use of care services (in weeks, hours, number of visits).	Unit Costs of Community Care Survey (1996)
Sources of financing of LTC services	For both institutional care services, the model accounts for the following sources of funding: 1) social services, 2) social security system funds, 3) private pay, and 4) the National Health Service (NHS). Funding of non – residential care services rely on: 1) NHS funds for community services, 2) social services for home care, 3) local authorities funds, and 4) private funding.	Department of Health data for gross expenditure on care services 1994/1995 General Household Survey
Supply of LTC services	The base case in the analysis is demand led: as the number of elderly individuals increases in the future, the amount of formal non-residential care services adjusts accordingly. The effects of changes in the supply of LTC are included in the sensitivity analysis which allows for changes in the availability of formal care services. Similarly, for informal care, the supply is also constrained by demand.	
Unmet LTC demand	Not included in the model	

Main results and sensitivity analysis

Wittenberg et al (1998) first analyse a baseline scenario based on official population projections, constant age-specific disability rates, mildly increasing real unit costs of services, and demand-led supply of care services. The authors then explore the implications of a variety of alternative scenarios implying different model assumptions with respect to population growth, future trends in marital status, household composition, housing tenure, disability rates, the supply of specific services, in LTC real unit costs, and changes in the LTC funding policies. The assumptions and results for each of these scenarios are included in Table A1.2.

Table A1.2: Sensitivity analysis with PSSRU model (selected)

Scenario	Assumptions	Results
Baseline scenario	Official population and marital status trends based on Government Actuary's Department (GAD) projections. Housing tenure rates change in line with Anchor Housing trust projections.	Predictions for England, period 1995–2013: • a 64% increase in the use of institutional care, a 56% increase the use of formal

	Constant age-specific disability rates. Real unit costs of social care will rise by 1% per year, and of health costs by 1.5% per year. The ratio of privately funded to publicly funded residents of care homes change in line with the ratio of elderly home owners relative to the total number of elderly individuals in private households. The rate of recovery of costs of social care in user charges remains constant.	home care, and a 61% increase in the use of private domestic help • a 153% increase in total expenditure with LTC services • projected structure of LTC funding: 25% NHS, 36% social services, and 39% private expenditure by service users
Faster population growth	This scenario assumes that the population of very elderly individuals (85+) will increase with 1% per year faster than GAD's official projections.	This scenario implies a much higher increase in the number of users of all LTC services (in the range 77–101%), and in total LTC expenditure (201%).
Higher disability rates	Disability rates are assumed to rise by 1% per year when the rise applies either a) only to the non–institutionalised individuals, or b) to the whole elderly population.	Higher disability rates for non–institutionalised individuals imply a higher number of individuals with dependency (125% relative to 57% in the base case), and a significantly higher demand for LTC services, with a maximum of 124% for informal care. Total LTC expenditure is expected to rise by 168%. In variant b), the projected increase in total LTC expenditure is 248%.
Lower disability rates	Age-specific disability rates are assumed to decrease by 1% per year, with two variants: a) the fall applies to non – institutionalised individuals, and b) the fall applies to the whole population.	In variant a), the projected number of elderly individuals with disability would increase by 9% (against the baseline change of 57%), but total expenditure would still increase by 142%. Variant b) projects a slightly higher change in the number of individuals with disability (32%), and a significant reduction in the rise of LTC expenditures (85% against the 153% baseline change).
Constant real unit costs of care services	Real costs of care services remain constant.	The projected increase in total LTC expenditure is 62%, relative to the 153% projection in the baseline scenario.
Lower increases in real unit costs of care services	The real unit costs rise by 1% less than in the baseline case, implying constant real unit costs of social care, and 0.5% increase in health care costs.	A projected increase in total LTC expenditure by 77%.
Higher increases in real unit costs of care services	The real unit costs rise by 1% more than in the baseline case, implying a rise of 2% for social care costs, and 2.5% increase in health care costs.	A projected increase by 260% in total LTC expenditure.

Reference for the model structure

Wittenberg, R., Pickard, L., Comas-Herrera, A., Davies, B., and Darton, R. (1998) – *Demand for long-term care: projection of long-term care finance for elderly people*, PSSRU, London School of Economics,

Related references

Hancock, R., Comas-Herrera, A., Wittenberg, R., and Pickard, L. (2003) – *Who Will Pay for Long-Term Care in the UK? Projections Linking Macro- and Micro-Simulation Models*, Fiscal Studies 24 (4), 387 – 426

Wittenberg, R., Comas-Herrera, A., King, D., Malley, J., Pickard, L. and Darton, R. (2006) – Future Demand for Long-Term Care, 2002 to 2041: Projections of Demand for Long-Term Care for Older People in England, PSSRU Discussion Paper 2330, March 2006

A2. European Models of Long-Term Care Expenditures (Germany, Spain, Italy, United Kingdom)

Objective

The overall objective of these models is to explore key factors that are likely to have a significant impact on long-term care expenditures in Germany, Italy, Spain and the UK.

Model structure

Comas-Herrera et al (2003) use cell-based macrosimulation models of LTC demand in order to project the aggregate LTC expenditures in four European countries (Germany, Italy, Spain and the UK) over the period 2000–2050. The four models are similar in structure, but they differ with respect to the definition of dependency categories, the use of informal care, as well as other assumptions on the use of LTC services. Notably, the model for Italy is used to project LTC demand at sub-national level, for the three main geographical areas of Italy (North, Centre and South). Overall, the models are used to project the number of elderly individuals with disability, the frequency and intensity of use of LTC paid and unpaid services, the real unit costs of services, and the total public and private LTC expenditures. In the following tables (Tables A2.1 to A2.3) we summarise the structure of each of the models for Germany, Spain and Italy. For the UK projections, the authors use the PSSRU model with updated data (see A1).

Table A2.1: Model for LTC demand in Germany

Module	Description and assumptions	Data sources
Population data base	The reference population includes individuals age 65 and over, grouped by age and gender	Eurostat 1999-based population projections
Pension and retirement income	Not included in the model.	
Disability	The model uses the national definition of dependency, i.e. individuals that need help with at least two ADLs[9] for about 90 minutes a day on average. The dependency rates are calculated according to age intervals and gender based on national official data.	German Department of Health Data Data from the Association of Private LTC Insurance
Use of institutional care services	The distribution of elderly individuals with dependency into nursing home care, formal care services, and informal care is calculated by age and gender based on national official data. Recipients who receive cash benefits are assumed to use informal care.	German Department of Health Data Data from the Association of Private LTC Insurance
Use of formal non - residential care services		
Use of informal care services		
Induced demand	Not included in the model	
Prices / unit cost of services	For nursing homes, daily rates are used as unit costs of service, while unit costs of home care are estimated based on survey data.	Federal Office of Statistics data on nursing home rates (1999) Infratest survey for out-of-pocket payments for additional services in nursing homes and private co-payments (2000)
Sources of financing of LTC services	Public and private national insurance, and out of pocket payments for additional services.	
Supply of LTC services	Demand-led model: the supply adjusts to current demand.	
Unmet LTC Demand	Not included in the model	

Source: Comas-Herrera et al (2003)

[9] ADLs = Activities of Daily Living (see footnote 8).

Table A2.2: Model for LTC demand in Spain

Module	Description and assumptions	Data sources
Population data base	The reference population includes individuals age 65 and over, grouped by age, gender and dependency.	Eurostat 1999-based population projections
Pension and retirement income	Not included in the model	
Disability	The model uses three dependency levels: independent, moderately dependent, and severely dependent. Prevalence rates are determined based on survey data.	Survey on the loneliness of the elderly (ESPM – Encuesta soble la soledad de las personas mayores) (CIS, 1998)
Use of institutional care services	The distribution of elderly individuals in care homes and day centres is calculated based on national official data.	National Statistics Institute (1996) IMSERSO, MTAS (Ministry of Labour and Social Services) (2000)
Use of formal non - residential care services	Use of formal care services is calculated by age, gender and dependency based on survey data.	Survey on the loneliness of the elderly (ESPM – Encuesta soble la soledad de las personas mayores) (CIS, 1998)
Use of informal care services	Dependent individuals reporting no receipt of formal care are included in the category of recipients of informal care. Informal care services are accounted for individuals who receive only informal care. Prevalence rates of informal care are calculated based on survey data.	Survey on the loneliness of the elderly (ESPM – Encuesta soble la soledad de las personas mayores) (CIS, 1998)
Induced demand	Not included in the model	
Prices / unit cost of services	Real unit costs are assumed to be the same for public and private home care services, and are estimated based on national official data. Unit costs are proxied by a weighted average of hourly costs for residential, home and day care services for all the Autonomous Communities.	IMSERSO, MTAS (Ministry of Labor and Social Services) (1998 - 2000)
Sources of financing of LTC services	User charges for publicly subsidised social services and out of pocket payments for private services.	
Supply of LTC services	Demand-led model: the supply adjusts to current demand.	
Unmet LTC demand	Not included in the model.	

Source: Comas-Herrera et al (2003)

Table A2.3: Model for LTC demand in Italy

Module	Description and assumptions	Data sources
Population data base	The reference population includes individuals age 65 and over, grouped by age, gender and dependency.	Eurostat 1999-based population projections
Pension and retirement income	Not included in the model	
Disability	The model uses two dependency groups: individuals with no dependency, and individuals unable to perform at least one ADL. Prevalence rates are based on survey data.	ISTAT Survey data
Use of institutional care services	Institutional care services in the model include residential care, nursing home care, long stay hospital care, and residential rehabilitation. Prevalence rates are determined based on national official data on the number of recipients of such services and the number of hours by type of service.	ISTAT Survey of Residential Care for Older People Department of Health data Local studies
Use of formal non -	The model includes data on formal non –	ISTAT Survey data

residential care services	residential health and social services. It is assumed that all recipients of such services have at least one ADL dependency. For social services, prevalence rates are estimated based on data for Rome, Naples, and other municipalities from North Italy. Data on private help at home is based on survey data.	Local studies (see Comas-Herrera et al (2003) for details)
Use of informal care services	Prevalence rates of informal care are determined based on survey data assuming that individuals who do not receive any formal service are recipients of informal care.	ISTAT Data (2000)
Induced demand	Not included in the model	
Prices / unit cost of services	Daily costs with institutional care are determined based on estimates of average daily costs reported in local studies. Similarly, estimates of unit costs of formal care services at home are collected from local reports. Costs with private help at home are calculated based on survey data. Except for private domestic help, all the costs are calculated at the national level.	Local studies (see Comas-Herrera et al (2003) for details) ISTAT Data (2000)
Sources of financing of LTC services	Both public and private LTC expenditures are included in the model. The public expenditures cover health and social services, but they do not include the national or local cash benefits.	
Supply of LTC services	Demand -led model: the supply adjusts to current demand.	
Unmet LTC demand	Not included in the model	

Source: Comas-Herrera et al (2003)

Main results and sensitivity analysis

Baseline scenarios in all the four models implement a common core of assumptions on population growth, trends in dependency rate, the number of elderly individuals in a household, and real unit costs of services. Alternative scenarios are formulated based on different assumptions with respect to population growth, trends in dependency rates, reduced availability of LTC services, by type of services, and trends in real unit costs of LTC assistance.

Table A2.4: Sensitivity analysis with models of LTC demand for Germany, Italy, Spain and the UK

Scenario	Assumptions	Results
Central baseline scenario	iorostat 1999-based population projections at country level. Constant dependency rates by age and gender. Constant household composition with respect to elderly population by age and gender. Constant use of care services by type of service, and age, gender and dependency status. Unit costs of services rise in line with productivity changes in each country.	Simulated initial shares of LTC expenditure in GDP in year 2000 are the following: 1.24% in Germany, 0.65% in Spain, 0.99% in Italy, and 1.36% in the UK. In the central baseline scenario, these shares are projected to double in most countries by year 2050 (2.72% in Germany, 1.39% in Spain, 1.94% in Italy, and 2.75% in the UK).
Eurostat high population growth	The high scenario includes high migration rates, fertility rates and life expectancy	With high population growth, the models project significant increase in the number of people with disabilities, and thus higher expenditures. By 2050, shares of LTC

		expenditures in GDP reach the following levels: 3.23% in Germany, 1.69% in Spain, 3.23% in Italy, and 3.46% in the UK.
Eurostat low population growth	The low scenario includes low migration rates, fertility rates and life expectancy	With low population growth, the rate of change in dependency rates reduces by more than half relative to the baseline scenario in all countries. Total LTC costs as % of GDP by 2050 reach the following levels: 2.18% in Germany, 1.13% in Spain, 2.06% in Italy, and 2.27% in the UK.
National official population projections	For the UK and Spain, the national official projections are roughly similar to the central Eurostat projections, while for Germany and Italy the differences are substantial.	Significant increases in dependency rates relative to the baseline scenario are projected especially for Italy (244% relative to107%) and the UK. (175% relative to 87%). The shares of total LTC costs in GDP are projected to reach the following levels by 2050: 2.66% in Germany, 1.37% in Spain, 2.72% in Italy, and 2.86% in the UK.
Delayed dependency	Dependency rates are delayed by the number of years by which life expectancy is assumed to increase in the Eurostat projections. Thus, adjustments in dependency rates are country specific, as they depend on projected changes in life expectancy at birth.	In this scenario, the models simulate significantly lower rates of growth in dependency in all four countries. The shares of total LTC costs in GDP are projected to reach the following levels by 2050: 1.58% in Germany, 1.06% in Spain, 1.26% in Italy, and 1.98% in the UK.
Slightly delayed dependency	Dependency rates are delayed by half the number of years by which life expectancy is assumed to increase in the Eurostat projections.	The growth rates in dependency are two times higher than in the previous scenario of delayed dependency for most countries. The shares of total costs in GDP reach the following levels by 2050: 2.11% in Germany, 1.23% in Spain, 1.53% in Italy, and 2.36% in the UK.
Reduced informal care and increased institutionalisation	A reduction in informal care by 0.5% with a corresponding increase in the use of institutional care.	Decreases in the use of informal care are accompanied by a higher use of institutional care. The highest increase in the demand for institutional care is projected in Spain (from 120% baseline to 260%). The shares of LTC costs in GDP by 2050 are: 3.07% in Germany, 2.18% in Spain, 2.55% in Italy, and 2.99% in the UK.
Reduced informal care and increased home formal care services	A reduction in informal care by 0.5% with a corresponding increase in the use of formal home care.	Projections for changes in the demand for informal care are the same as in the previous scenario. The highest increase in the demand for home care services is projected in Spain (from 99% baseline to 186% in this scenario). Total LTC costs as % of GDP in 2050 are: 2.81% in Germany, 1.52% in Spain, 2.07% in Italy, and 2.82% in the UK.
Reduced informal care with increased institutionalisation and home formal care services	A reduction in informal care by 1% with a corresponding increase (equally distributed) in the use of formal home care and institutional care	The shares of total LTC costs in GDP by 2050 become: 3.11% in Germany, 2.20% in Spain, 2.60% in Italy, and 3.03% in Germany.
Higher increases in real unit	Real unit costs increase 0.5% per year	Shares of total LTC costs in GDP are

costs	faster than country-specific productivity growth	projected to reach the following levels by 2050: 4.24% in Germany, 2.06% in Spain, 3.02% in Italy, and 3.69% in the UK.
Lower increases in real unit costs	Real unit costs increase 0.5% per year more slowly than country-specific productivity growth	Shares of total LTC costs in GDP are projected to reach the following levels by 2050: 2.59% in Germany, 1.26% in Spain, 1.85% in Italy, and 2.26% in the UK.
Constant real unit costs	0% growth in real unit costs of care services	Shares of total LTC costs in GDP are projected to reach the following levels by 2050: 2.74% in Germany, 1.39% in Spain, 1.94% in Italy, and 2.75% in the UK.

Source: Comas-Herrera et al (2003)

Reference for the model structure

Comas-Herrera (DGEMPL2003) – *European Study of Long-Term Care Expenditure*, Report to the European Commission, Employment and Social Affairs DG, PSSRU Discussion Paper 1840

Related references

European Commission (2008) – The 2009 Ageing Report: Underlying Assumptions and Projection Methodologies, European Economy 7, Brussels
European Commission (2011) – The 2012 Ageing Report: Underlying Assumptions and Projection Methodologies, European Economy 4, Brussels

A3. European Commission Model of Long-Term Care Expenditures (EU 27)

Objective

The objective of the LTC analysis in the European Commission's Ageing Report 2012 is to generate comparable projections of public LTC expenditure for the EU 27 Member States plus Norway over the period 2010–2060.

Model structure

The EC model is based on the framework defined in Comas-Herrera et al. (2003) (see A2 above), and it simulates the number of dependent elderly individuals and the total public expenditures with long term care services at country level.

Table A3.1: European Commission LTC model structure and data sources

Module	Description and assumptions	Data sources
Population data base	The reference population includes individuals aged 15+, grouped by age, gender, and dependency	Eurostat, EU SILC
Pension and retirement income	Not included in the model	
Dependency	Dependency refers to the subjective assessment of the inability to perform at least one ADL.[10]	EU SILC 2009
Use of institutional care services	The use of formal LTC services is defined as the probability to use a given type of formal LTC service (institutional or at home) derived based on national data. The dependent population is split by age and gender into three main groups: recipients of institutional care, recipients of home care, and recipients of informal care. It is assumed that all dependent individuals receive some form of care services.	Data provided by Member States
Use of formal non - residential care services		
Use of informal care services	Use of informal care is determined as a residual category as the difference between the total number of dependent individuals and the number of recipients of formal care services.	EU SILC, Member States Data
Induced demand	Not included in the model	
Prices / unit cost of services	The long –run cost of care services is assumed to equal the average formal LTC expenditure per user of formal care services. There is no differentiation between the unit costs of institutional and home care services. Average expenditure with formal LTC services is calculated by age and gender.	OECD / Eurostat System of Health Accounts (SHA) Data from Member States
Sources of financing of LTC services	The model accounts only for public expenditure with formal LTC services, including the total costs of in – kind services (institutional and home care) and cash benefits received by individuals with disability.	OECD / Eurostat System of Health Accounts (SHA) Eurostat Cronos Data from Member States
Supply of LTC services	Demand – led model: the supply adjusts to current demand	
Unmet LTC demand	Not included in the model	

Main results and sensitivity analysis

[10] ADLs = Activities of Daily Living (see footnote 8)

Table A3.2: Sensitivity analysis with the European Commission LTC model

Scenario	Assumptions	Results
Demographic scenario	The shares of dependent individuals who receive a given type of LTC service (institutional, home – based, informal) are constant (at the 2010 level) over the projection period. The dependent population evolves in line with the total elderly population. All types of LTC expenditures evolve in line with the growth rate of GDP per capita.	Highest increases in public LTC expenditure as % of GDP are projected for Denmark (from 4.5% in 2010 to 8.2% in 2060) and the Netherlands (from 4.1% in 2010 to 7.7% in 2060). The EU27 average share of LTC in GDP increases from 1.8% in 2010 to 3.4 in 2060.
Baseline scenario	Formal LTC (in kind) age-gender expenditure per capita evolves in line with GDP per hour worked (i.e. productivity).	Results are rather similar to the previous scenario. The EU27 average share of LTC in GDP reaches 3.6% by 2060.
High life expectancy	Life expectancy at birth is assumed to be one year higher than in the baseline scenario. This assumption implies an increase in the total number of dependent individuals.	The EU27 average share of LTC in GDP increases to 3.8% by 2060, with highest shares projected in Belgium, Denmark, the Netherlands and Nordic countries.
Constant disability	This scenario assumes healthy ageing. All gains in life expectancy are spent without disability. As in the baseline scenario, total public LTC costs evolve in line with productivity, while cash benefits are assumed to evolve in line with GDP per capita	Healthy ageing implies a significant reduction in the projected number of dependent individuals. Even in countries with highest long term care expenditures, their shares in GDP reach at most 3.8% by 2060 (as in the Netherlands, for instance).
Shift to informal care	Based on the assumption that 1% per year of the dependent individuals who so far received only informal care would gradually shift towards formal care during the first 10 years of the projection period. This implies a total shift of 9.6% from informal to formal care, of which 50% is allocated to institutional care, and the other half to home care services.	In this scenario, larger increases in the LTC shares in GDP are expected in countries with marked ageing trends. The highest LTC shares in 2060 are projected for France (5.5% in GDP), Belgium (5.9% in GDP), Denmark (9.1% in GDP), and the Netherlands (9.1% in GDP)
Coverage convergence	This scenario assumes that all EU countries with below – average coverage will converge to the 2010 EU 27 average level by 2060. The convergence is calculated by age and gender, with the relative proportion of each type of formal care being kept constant.	Significant changes in LTC shares in GDP are projected for Latvia (from 0.7% in 2010 to 4.4% in 2060), Germany (from 1.4% in 2010 to 5.9% in 2060), France (from 2.2% in 2010 to 6.9% in 2060) and Slovenia (from 1.4% in 2010 to 4.2% in 2060).
Cost convergence	An upward convergence of the relative age-gender specific expenditure per user as percentage of GDP per capita for all countries below the corresponding EU27 - average . Convergence is calculated for services in kind only. All other baseline assumptions are maintained.	Significantly high shares of LTC in GDP by 2060 are projected for Belgium (6.2%), Denmark (8.5%), the Netherlands (8.5%) and Lithuania (4.7%).
Healthy ageing – AWG reference scenario	It is assumed that half of the projected gains in life expectancy are spent in good health.	Results are broadly similar to the baseline scenario. The EU27 average LTC share in GDP increases to 3.4% in 2060.
Healthy ageing – AWG risk scenario	This scenario combines the AWG reference scenario with the cost convergence scenario. It is assumed that dependency rates change by half the change in age-specific life expectancy and country level expenditure per user converge to the EU average.	Results are broadly similar to the AWG reference scenario. The EU27 average share of LTC in GDP reaches 3.6% in 2060.

Reference for the model structure

European Commission (2012) – The 2012 Ageing Report: Economic and budgetary projections for the 27 EU Member States (2010 – 2060), European Economy 2 (provisional version)
European Commission (2011) – The 2012 Ageing Report: Underlying Assumptions and Projection Methodologies, European Economy 4, Brussels

Related references

European Commission (2008) – The 2009 Ageing Report: Underlying Assumptions and Projection Methodologies, European Economy 7, Brussels

A4. Brookings / ICF Long-Term Care Financing Model (US)

Objective:

The objective of the model is to simulate policy options for private and public coverage of LTC expenditures, with a focus on catastrophic out-of-pocket costs for LTC users in the US, for the period 1986–2020.

Model structure

The Brookings/ICF LTC Financing model is a dynamic microsimulation tool developed in the 1990s by researchers at the Brookings Institute in the US. The model is designed to project the number of individuals in need for long term care, the frequency and intensity of use of long term care services, and individual expenditures with these services by source of financing.

Table A4.1: Structure and data sources of the Brookings / ICF LTC Model

Module	Description and assumptions	Data sources
Population data base	A database of nationally representative sample of 28000 individuals of all adult ages in 1979 in the US	Special Pension Supplement of the May 1979 Current Population Survey (CPS) Social Security Administration (SSA) earning history data from 1951 to 1977 1984 Survey of Income and Program Participation (SIPP)
Pension and retirement income simulator (PRISM)	The module simulates the income and assets of elderly individuals. PRISM also simulates individual life events (retirement, mortality, disability, child bearing, changes in marital status).	
Disability	Individuals aged 65 and over are assigned one of four levels of disability: IADLs1+, ADL1, ADLs2+ and None).[11] In each simulation year, the module simulates transitions between disability levels for non–institutionalised elderly individuals.	1982–1984 National Long Term Care Survey (NLTCS)
Use of nursing home services	Probabilities of entry and length of stay in a nursing home are estimated based on survey data, and they differ by age, gender, marital status, disability levels, and prior admission to a nursing home. The predictive accuracy of these estimations is compared with a synthetic annual admission cohort estimated based on national survey data on nursing home discharges. The model assumes constant rates of nursing home admission over time.	1982–1984 National Long Term Care Survey (NLTCS) 1985 National Nursing Home Survey
Use of formal home care services	The model determines the non-institutionalised individuals aged 65 and over who are likely to use formal (paid) home care services. The probabilities of use of these services are estimated based on survey data, and they differ by age, gender, and disability level. The model determines the number of visits received and the period of use of these services.	1982–1984 National Long Term Care Survey (NLTCS) Medicare program data
Use of informal care services	Non-institutionalised individuals aged 65 and over can also receive informal (non-paid) home care services. The prevalence rates of these services are estimated based on survey data.	1982–1984 National Long Term Care Survey (NLTCS)

[11] ADLs = Activities of Daily Living, IADLs = Instrumental Activities of Daily Living (see footnote 8)

Induced demand [12]	Incremental increases in the demand for LTC services due to new financing programs are exogenous in the model. The probability of use of LTC services is adjusted by a growth factor calculated based on user – specified levels of induced demand.	
Prices / unit costs of services	For nursing home services, the model assumes that daily charges vary by source of payment (Medicaid, Medicare, private) and, after 1988, they increase at 5.5% per year (including 4% CPI annual increase, 1.3% annual increase in real wages, and 0.2% annual increase in fringe benefits). Total expenditure for nursing home services is calculated as the number of days in the nursing home multiplied by the daily charge. For formal home care services, prices vary by source of payment. Medicare and Medicaid visit rates are calculated as average program costs, while out-of-pocket price per visit is estimated based on survey data. Total expenditure with home care services is calculated as the number of visits multiplied by the price per visit.	1982–1984 National Long Term Care Survey (NLTCS)
Sources of financing of LTC services	Expenditure with LTC services are financed based on Medicare, Medicaid, and private sources (income, assets, third-party pay). The model assumes that a share of individual's income and assets can be used to cover part of the LTC costs. Individuals paying out-of-pocket for home care, for instance, are simulated to use up to 30% of their disposable income for services, while some single institutionalised individuals are simulated to sell their homes to pay for care.	
Supply of long term services	Implicitly assumed to adjust to the current level of demand of LTC services	
Unmet LTC demand	Not included in the model	

Main results and sensitivity analysis [13]

An updated version of the Brookings/IFC Long Term Care Financing model, called the Lewin Long Term Care Financing Model, is used in Wiener et al (1994) in order to project the use and expenditures of long term care services for the analysis of various options for LTC insurance schemes. This study compares a baseline case of current use of LTC services with alternative scenarios defined in terms of higher/lower disability rates, faster/slower price dynamics, and expanded public insurance coverage.

Table A4.2: Sensitivity analysis with the Brookings / IFC / Lewin LTC Model

Scenario	Assumptions	Results
Baseline scenario	The 1993 system of LTC financing and service delivery will continue into the future. Prices of long term care services	LTC use and expenditures increase substantially over the projection period.

[12] Also called moral hazard, the induced demand for LTC services is the increase in demand (including frequency or intensity of use of services) due to the introduction of third – party new financing programs.
[13] This presentation is based on Wiener et al.(2007).

	increase by 5.5% annually.	
High disability scenario	People live longer but more disabled lives. Elderly disability rates gradually increase so that the disability rate in 2020 is the same as the disability rate for people 5 years older in 1986.	In all scenarios related to disability levels, LTC use and expenditures increase substantially over the projection period.
Low disability scenario	People live longer and less disabled lives. Elderly disability rates decline such that the rate of impairment in 2020 is the same as the disability rate for people 5 years younger in 1986.	
High inflation scenario	Prices of LTC services increase by 6.5% annually.	In all scenarios related to inflation, total and Medicaid expenditure increase substantially over the projection period. Assumptions about inflation have a very large impact on the projected expenditures.
Low inflation scenario	Prices of LTC services increase by 4.5% annually.	
Policy options of LTC insurance	The study analyses various options that promote private LTC insurance or would establish a public LTC insurance scheme, including tax incentives or public – private partnerships.	Simulation results indicate that private long term insurance could grow, but it would not become a dominant source of funding under any of these options. Private insurance schemes, however, could help contain the effects of catastrophic out of pocket expenditures in nursing homes if individuals buy policies at younger ages.
Expanded public insurance programs	These options include liberalising Medicaid and LTC public insurance programs by types of services. These schemes, by definition, provide universal coverage.	Unlike the private insurance schemes, public insurance programs are unlikely to insure mainly upper – income individuals and can generally reduce catastrophic out-of-pocket costs to a larger extent.

Reference for the model structure

Kennell, D.L., Alecxih, L.M.B., Wiener, J.M., and Hanley, R.J. (1992) – *Brookings / ICF Long-Term Care Financing Model: Model Assumptions*, report prepared for the US Department of Health and Human Services, February 1992

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Kemper, P., Komisar, H.L., and Alecxih, L. (2005/ 2006) – *Long Term Care Over an Uncertain Future: What Can Retirees Expect?*, Inquiry 42, Winter 2005 / 2006, pp. 335 – 350

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Wiener, J.M., Freiman, M.P., and Brown, D. (2007) – *The NIC Compendium Project. A Guide to Long Term Care Projection and Simulation Models*. Washington DC: RTI International

Wiener, J.M., Illston, L.H. and Hanley, R.J. (1994) – *Sharing the Burden: Strategies for Public and Private Long-Term Care Insurance*. Washington DC: The Brookings Institution.

A5. The Urban Institute LTC Analysis (DYNASIM3 + LTC Module) (US)

Objective

The objective of this analysis is to project the number of elderly individuals with dependency and their use of long term care services in the US, over the period 2000-2040. The model predicts how changes in the socio-demographic characteristics of the elderly population will impact on the future demand for formal and informal long-term care services.

Model structure

The LTC projections are generated by adding a module of long term care to the DYNASIM3 model of population dynamics. DYNASIM3 is a major revision of the US based Urban Institute's dynamic microsimulation model created in the 1970, and it is used to simulate the demographic, economic and distributional consequences of retirement and ageing in the US population. The LTC module of the Urban Institute uses the demographic and socio-economic projections produced by DYNASIM3 in order to project the number of disable elderly individuals and the demand for formal and informal care services over a 40 years period. The strength of the study is the explicit estimation of the demand for informal long term care based on, among other factors, the opportunity cost of informal care proxied by the hourly wage of the child with the lowest wage.

Table A5.1: The structure and data sources of the Urban Institute Model for LTC Demand

Module	Description and assumptions	Data sources
Population data base	The reference population includes adults aged 65 and older. Future socioeconomic characteristics of individuals in the population are projected with DYNASIM3.[14]	1980 – 1982 National Longitudinal Mortality Studies 1982 – 1997 Vital Statistics Social Security Disability Insurance Social Security actuaries for the 2002 Trustees Report
Pension and retirement income	Not included in the model.	
Disability	Disability is defined as any difficulty an individual has with at least one ADL or IADL.[15] A distinction is made between moderate and severe disability. Disability rates among elderly individuals are estimated with ordered probit models applied to the HRS longitudinal survey data. The probability of a given disability status is modelled as a function of age, gender, education, race and ethnicity, marital status, household income, and mortality. The number of elderly individuals with disability is determined by applying the estimated probabilities to the DYNASIM3 population projections.	Health and Retirement Study (2000) of the Urban Institute
Use of institutional care services	Distinction is made for paid home services, any nursing home services, informal help received from biological children and informal help from other sources. The probability of use of each type of care service is estimated based on logit models applied to HRS longitudinal data. Separate models are run for dependent individuals with and without surviving children. Explanatory factors include the opportunity cost of informal care (hourly price of children's time) and number of children (if applicable), age, disability status, gender,	Health and Retirement Study (2002) of the Urban Institute
Use of formal non - residential care services		
Use of informal care services		

[14] For details on DYNASIM3 see Favreault and Smith (2004)
[15] ADLs= Activities of Daily Living, IADLs= Instrumental Activities of Daily Living (see footnote 8)

	race and ethnicity, marital status, education, and the ratio of income in poverty level. Intensity of use of care services (in terms of monthly hours of paid/unpaid care) is estimated based on OLS applied to the HRS data, with similar explanatory factors. The future demand for LTC services is determined by applying the estimated probabilities to the DYNASIM3 population projections.	
Induced demand	Not included in the model	
Prices / unit cost of services	Not included in the model	
Sources of financing of LTC services	Not included in the model	
Supply of LTC services	The model is demand-led.	
Unmet LTC demand	Not included in the model	

Main results and sensitivity analysis

Table A5.2: Sensitivity analysis with the Urban Institute Model for LTC Demand

Scenario	Assumptions	Results
Intermediate disability scenario	This scenario does not assume any particular trend in disability rates. Projected disability depends on the socio-economic characteristics of the population.	• Disability rates among elderly individuals are projected to decline during the period up to 2020, and to rise thereafter. Overall, the share of disabled individuals in the elderly population is projected to decline from 30% to 28% by 2040. In absolute terms, however, the number of disabled individuals is likely to more than double, reaching the level of 21 million by 2040. • The share of elderly individuals with disability who use paid help will increase from 22% to 26 %, while the share of unpaid help from children will decline from 28% to 24%. In absolute terms, the number of those receiving paid help will more than double between 2000 and 2040. • The average number of hours of paid care will increase by 36%, and the total paid home care hours will increase threefold.
High disability scenario	It assumes that disability rates increase by 0.6% per year from 2000 to 2014, and remain constant thereafter.	• The total paid home care hours will increase almost four times.
Low disability scenario	It assumes that disability rates decrease by 1% annually over the whole projection period.	• The size of the disabled elderly population is projected to increase by 50% over the projection period. • The projected increase in the number of elderly individuals

		using paid services is by three fourths in the case of home care, and by two-thirds in the case of institutional care.

Reference for the model structure

Johnson, R.W., Toohey, D., and Wiener, J.M. (2007) – *Meeting the Long-Term Care Needs of the Baby Boomers: How Changing Families Will Affect Paid Helpers and Institutions*, Discussion Paper 07-04, The Urban Institute, Washington DC

Related references

Favreault, M. and Smith, K. (2004) – *A Primer on the Dynamic Simulation of Income Model (DYNASIM3)*, Discussion Paper 02-04, The Urban Institute, Washington DC

A6. Australian Population and Policy Simulator – Aged Care Module (APPSIM-ACM)

Objective

The objective of this analysis is to project the need and use of LTC services by elderly individuals in Australia over the period 2001–2051.

Model structure

APPSIM is a dynamic microsimulation model used to project future demographic, social and economic characteristics of the Australian population over a period of 50 years (2001-2051). The model includes a module for aged care (ACM) designed to simulate the expected need and use of formal and informal care services for the Australian elderly population. Notably, the model accounts for future trends in the supply of LTC services, and it is used to determine the excess demand for LTC services by type of service.

Table A6.1: APPSIM-ACM model structure and data sources

Module	Description and assumptions	Data sources
Population data base	The reference population for the Aged Care module of APPSIM are individuals aged 65 and over. Data used by APPSIM is based on a 1% random sample from census data. The ACM Module uses demographic and socio economic projections simulated by other modules of APPSIM.	Census of Population and Housing (2001)
Pension and retirement income	Not included in the analysis	
Disability	Disability is defined in terms of limitations in four dimensions: physical, medical, social and psychological. The measurement of disability is used as a proxy for the need for LTC, i.e. each person with at least one of the four limitations is assumed to need some form of aged care. There are five states of disability (from low to profound), and disability rates are estimated based in survey data.	ABS Survey of Disability, Ageing and Carers (SDAC) (2003)
Use of institutional care services	Given their need for LTC (the demand) and the availability of LTC services (the supply), eligible individuals are randomly allocated to LTC services until the current projected supply is exhausted.	
Use of formal non - residential care services		
Use for informal care services		
Induced demand	Not included in the analysis	
Prices / unit cost of services	Not included in the analysis	
Sources of financing of LTC services	Not included in the analysis	
Supply of LTC services	The supply of informal care is estimated based on survey data on determinants of having a carer such as age, gender and living arrangements. The future supply of formal care services is projected based on national statistics.	ABS Survey of Disability, Ageing and Carers (SDAC) (2003) Australian Institute of Health and Welfare data (AIHW) Government Department of Health and Ageing data(DoHA)
Unmet demand for LTC	The excess demand for LTC services is determined as the difference between the number of elderly individuals with disability and the number of available LTC services.	

Main results and sensitivity analysis

Table A6.2: Sensitivity analysis with the APPSIM model

Scenario	Assumptions	Results
Baseline scenario	The share of elderly individuals with disability in the population remains constant.	The number of elderly individuals with some form of disability is projected to increase three times by 2051. The excess demand for informal care is expected to increase more than twofold, and the projected increase in the excess demand for formal home services is expected to reach 50% by the end of the projection period.
Liberal scenario	It assumes that an elderly individual with some form of disability (mild or moderate), and with access to informal care, may need formal home care.	These assumptions have an effect on the demand for formal home care, and can be viewed as providing lower and upper bounds for the demand for paid home care in a sensitivity analysis exercise.
Conservative scenario	It assumes that an elderly individual with some form of disability (mild or moderate) and access to informal care may not need formal home care.	

Reference for the model structure:

Nepal, B., Brown, L., Kelly, S., Percival, R., Anderson, P., Hancock, R. and Ranmuthugala, G. (2011) – Projecting the need for formal and informal aged care in Australia: A dynamic microsimulation approach, National Centre for Social and Economic Modelling (NATSEM) Working Paper 11/07, Canberra

A7. Canadian Demand for Home Care Services (LifePaths + LTC)

Objective

The objective of the analysis is to generate projections of the demand and supply of formal and informal home care for the elderly population in Canada over the period 2001–2051. The model helps project the supply of informal care in private households, the number of elderly individuals with some form of functional limitations, and the number of elderly individuals with disability who require home assistance.

Model structure

This analysis of long-term care demand and supply is structured in two parts. The first step entails the identification of individual demographic and socio – economic factors associated with disability and need for assistance, and the use of formal and informal care services. Subsequently, the estimated probabilities of use of formal and informal care are combined with population projections generated with the Canadian model LifePaths, a dynamic microsimulation model used to reproduce the demographic and socio-economic characteristics of the Canadian population for each province and territory. Distinguishing features of the LifePaths model include the following: 1) it is a longitudinal dynamic model that generates synthetic life histories for individual and families, 2) it is an open model with new individuals being generated over time, depending on contingent events such as marriage, 3) individuals' current behaviour is simulated as dependent on their respective recent past life events, 4) simulations are performed in continuous time, and 5) the model estimates standard errors for all the simulated results. The strength of the study is the analysis of future availability of informal care based on projected changes in the family structure and living arrangements.

Table A7.1 Canada demand and supply of home care – model structure and data sources

Module	Description and assumptions	Data sources
Population data base	Synthetic overlapping cohorts of the Canadian population. The individual characteristics of interest include age, gender, education, region of residence, marital status, age of spouse, place of birth and number of surviving children. The reference group for the LTC analysis includes individuals aged 65 and over.	LifePaths population projections
Pension and retirement income	Not included in the model	
Disability	Disability is defined in terms of functional limitations in mobility, dexterity, cognition, pain and discomfort based on survey data. Individuals are classified in four groups of disability: 1) none, 2) mild, 3) moderate, and 4) severe. Probabilities of having a disability are estimated with multinomial logistic regressions including demographic and socio economic characteristics of individuals aged 45 and older, and living in private households.	1996/1997 National Population Health Survey
Use of institutional care services	Not included in the model	
Use of formal non-residential care services	The model distinguishes between disability and need for assistance. Probabilities of needing home assistance are estimated with logistic regressions including demographic and socio economic characteristics of individuals aged 65 and older. Home assistance received by individuals with no disability is not considered. The use of home services (formal, informal or mixed) is estimated with multinomial logistic	1996 General Social Survey 1996 Census
Use of informal care services		

	regressions run for individuals who expressed a need for home assistance. Subsequently, these probabilities are combined with LifePaths population projections.	
Induced demand	Not included in the model	
Prices / unit cost of services	Not included in the model	
Sources of financing of LTC services	Not included in the model	
Supply of LTC services	The supply of informal services is projected in terms of the availability of spouses and children for providing assistance.	1996 General Social Survey
Unmet LTC demand	Not included in the model	

Main results and sensitivity analysis

Table A7.2: Sensitivity analysis for the Canadian demand and supply for home care

Scenario	Assumptions	Results
Baseline scenario	Probabilities of disability levels are constant (at the 1996 level).	The proportion of elderly individuals in need of assistance is projected to remain relatively constant, in the range 15-18% during the whole period. In absolute terms, however, the number of dependent elderly individuals is projected to more than double by 2031. The projections for the period 2001–2031 indicate a relative and absolute increase in the use of formal home services, with an annual growth of 2.7%, accompanied by a relative decrease in the use of informal care services, with an annual growth of 2.2%
Compression scenario	Probabilities of disability decrease gradually over a 15-years period. It is assumed that any given individual has a disability level of an individual 5 years younger.	Projections indicate an annual growth of 2.2% in the use of formal care services.
Expansion scenario	Probabilities of disability increase gradually over a 15-years period. It is assumed that any given individual has a disability level of an individual 5 years older.	Simulation results indicate an annual growth of the use of formal care services of 3.4%.

Reference for the model structure

Carriere, Y., Keefe, J., Legare, J., Lin, X. and Rowe, G. (2007) – Population aging and immediate family composition: implications for future home care services, Genius, LXIII (1), 11-31

Statistics Canada (online 2012) – *The LifePaths Microsimulation Model. An Overview*, downloaded from http://www.statcan.gc.ca/microsimulation/lifepaths/lifepaths-eng.htm, 16/08/2012

Related references

Carriere, Y., Keefe, J., Legare, J., Lin, X., Rowe, G., Martel, L. and Rajbhandary, S. (2008) – *Projecting the Future Availability of the Informal Support Network of the Elderly Population and Assessing its Impact on Home Care Services*, Research Paper, Statistics Canada, Ottawa

A8. CAPP_DYN – Long Term Care Policies in Italy

Objective

The overall objective of the analysis is to project the number of disabled elderly individuals and the public expenditures with long term care services in Italy over the period 2005–2050.

Model structure

Projections of prevalence of disability and trends in public expenditures with long term care in Italy are simulated with the CAPP_DYN microsimulation model. The model helps simulate the distribution of demographic and socio-economic characteristics of the Italian population over a period of 45 years. The CAPP_DYN model is dynamic in that it simulates changes in individuals' characteristics over time. For the LTC analysis, the main model of population projections is complemented with a module that is used to simulate changes in disability status for all individuals in the population.

Table A8.1: CAPP_DYN model structure and data sources

Module	Description and assumptions	Data sources
Population data base	The initial distribution of demographic and socio economic characteristics of the Italian population is based on survey data.	Survey of Households' Income and Wealth (SHIW) 2002 ISTAT census on population and households
Pension and retirement income	The labour income is simulated with CAPP_DYN based on survey data. Pensions, disability benefits and social assistance allowances are also simulated in the model.	ISFol PLUS 2004
Disability	Three groups of disability are defined based on survey data: 1) low, 2) medium, and 3) severe. Probabilities of transitions to given disability states are estimated with ordered probit models based on survey data.	ISTAT survey on public health and the use of national health services (2005)
Use of institutional care services	Not included in the model.	
Use of formal non - residential care services	Not included in the model.	
Use of informal care services	Not included in the model.	
Induced demand	Not included in the model.	
Prices / unit cost of services	Not included in the model.	
Sources of financing of LTC services	The level of LTC expenditure per capita is set exogenously, guided by official estimates of LTC shares in GDP.	Minister of Economy and Finance data
Supply of LTC services	Not included in the model.	
Unmet LTC demand	Not included in the model	

Main results and sensitivity analysis

Table A8.2: Sensitivity analysis with CAPP_DYN model

Scenario	Assumptions	Results
Baseline scenario – pure ageing	The prevalence of disability classes is estimated, by age and gender, based on survey data. It is assumed that gains in life expectancy are spent with disability.	Projections indicate that the number of individuals with disability is likely to more than double over the period 2005 – 2050 (from 4.6% to 9.5%). The trend is stronger for individuals with more severe disability. In absolute terms, the number of individuals with disability is

		projected to increase by 115%.
Compression of disability	The disability status changes with the individual socio – demographic characteristics over time. It is assumed that the increases in life expectancy are not associated with disability.	In this scenario, the growth in the prevalence of disability is significantly lower by the end of the projection period (from 4.5% to 7.8%). In absolute terms, the number of individuals with disability is projected to increase by 77%.
Constant LTC expenditures	It is assumed that public expenditures with the disabled individuals remain constant at the current level (0.9% of GDP in 2005).	Given the projected trends in disability in the pure ageing scenario, total public LTC expenditures are likely to increase from 0.9% in GDP to 1.7% in GDP by 2050. In the compression scenario, total public LTC expenditures are projected to increase to 1.5% in GDP by 2050.
High LTC expenditures	It is assumed that total public expenditures with disabled individuals increase to the level of the LTC fund in Germany.	In the case of pure ageing, LTC expenditures are likely to reach 3.5% of GDP by 2050. With compression of disability, the LTC share of GDP is projected to be at the level of 2.7% of GDP by the end of the period.

Reference for the model structure

Baldini, M., Mazzaferro, C., and Morciano, M. (2007) – *Assessing the Implications of Long Term Care Policies in Italy: A Microsimulation Approach*, Dipartimento di Economia Pubblica e Territorial, Universita di Pavia

Mazzaferro, C. and Morciano, M. (2008) – *CAPP_DYN: A Dynamic Microsimulation Model for the Italian Social Security System*, CAPPaper n.48, Centro di Analisi delle Politiche Pubbliche, September 2008

European Commission

EUR 25535 – Joint Research Centre – Institute for the Protection and Security of the Citizen

Title: Survey of Simulation Models of Long-Term Care Use and Expenditure

Author(s): Violeta Piculescu, Leandro Elia, William Becker

Luxembourg: Publications Office of the European Union

2012 – 37 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424

ISBN 978-92-79-26740-6 (pdf)

doi:10.2788/52537

Abstract

The objective of this study is to provide a technical overview of the main simulation tools that are used for the projections of future developments in long term care systems in developed countries. The main thrust of the present analysis is that aging and uncertainties with respect to future trends in disability across individuals, and in costs required to cater to future needs, are likely to raise significant challenges both for individuals and for policy makers in the not-so-distant future, and that the supply of long-term care (LTC) is unlikely to match future demand. The main concepts used in the long term care literature are illustrated, and modelling strategies employed by different investigators are reviewed. Each of the simulation models discussed in this survey is presented in detail in the Appendix together with the relevant references. Both macrosimulation models primarily based on aggregate data at country level and microsimulation models based on individual and household survey data are considered in the present study.

LB-NA-25535-EN-N

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ISBN 978-92-79-26740-6

Publications Office