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DEVELOPMENT OF HOUSING WITH CARE IN AGEING CITIES USING MULTIPLE DECREMENT APPROACH

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DEMOLITION IN GROWING AND SHRINKING CITIES

INTRODUCTION

Examine demand of housing units

It is influenced by changing ageing dynamics and population structure

We have to examine

- the drivers,
- outcomes and
- modelling of European demographic ageing, population decline – **Is the current database for planning and decision making adequate?**

Why?

Influencing housing stock in shrinking cities

What to do?

Considering possible impacts of ageing on housing stock and housing stock management. To remodel housing stock or to demolish and to build new .

Examine demand of housing units
It is influenced by changing ageing dynamics and population structure while spatial planners do not change their norms and standards

- **Evidences from OECD and European Union reports, <u>should</u> motivate discussions about the likely long-run effects of demographic change on the housing stock.**
- **Until now there has been relatively very little analytical interest in these demography-related issues facing many cities**

(McCann, 2017).

- **Since recently, there did not appear to be a single paper which aims to track the links analytically between population decline, population ageing, housing stock and the long-run financial viability of the city**

(Carbonaro et al., 2016).

- One of the first such papers have been presented at ISIR and published in IJPE

(Bogataj et al., 2016).

HOUSING STOCK CONSTRUCTION, REMODELING AND DEMOLITION IN GROWING AND SHRINKING CITIES

INTRODUCTION

As it is highlighted in the paper of McCann, all of the ongoing efforts in developing model-based analytical frameworks in urban economics are focused on growing cities and construction of new buildings. McCann argue that the lack of any formal analysis of housing stock in shrinking cities also regarding the long-run financial positions of cities may well be related to the fact that the field is dominated by North American issues, and as he highlighted, North America is a continent facing ongoing national and urban population growth. But his remark is wrong. Typical example of shrinking city is Detroit.

McCann, P. (2017). Urban futures, population ageing and demographic decline. Cambridge Journal of Regions, Economy and Society, 10, pp. 543–557

Building stock of Social infrastructure

* Kindergatens
* Schools
* Universities
* Hospitals
* Nursing homes
* Social housing
* Assisted-living facilities
* Retirement communities

HOUSING STOCK CONSTRUCTION, REMODELING AND DEMOLITION IN GROWING AND SHRINKING CITIES

Europe: Population structure by age (in % of population)

AGE	1950	1970	1995	2025	2050
0-14	26.2	25.3	19.2	14.7	14.4
15-64	65.6	64.2	66.9	64.3	58.0
65+	**8.2**	**10.5**	**13.9**	**21.0**	**27.6**
75+	2.7	3.5	5.2	9.1	14.6
TOTAL	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

(Source: http://www.iiasa.ac.at/Research/ERD/DB/data/hum/dem/dem_2.htm

Demographics driving development of social infrastructure

* 1950-2007 development of housing stock for production and service workers
* 1950-2007 development of health, care and educational services for production and service workers and their children

Eurobarometer 283

* Aging of population
* Deinstitutionalisation
* Eurobarometer 283, EC 2007

European Summit on Innovation for Active and Healthy Ageing, Brussels, 9-10 March 2015 Final Report

The building stock in Europe today is not fit to support a shift from institutional care to the home-based independent living model. Some 70-80 % of houses in the UK and 90 % in Germany are not suitable for independent living **as they contain accessibility barriers for people with emerging functional impairments and chronic conditions**.

HOUSING STOCK CONSTRUCTION, REMODELING AND DEMOLITION IN GROWING AND SHRINKING CITIES

KEY DEMOGRAFIC DATA - SLOVENIA

(thousands)	2013	%	2060	%
No. of people in Slovenia (mio)	2.060		2.040	
65 years old and more	356	17.3 %	599	29.4 %
80 years old and more	95	**4.6 %**	254	**12.4 %**
Life expectancy – 65 y (m/f)	16.3 / 20.1 (2009)		21.4 / 24.9	
GDP (+1,8194)	36.144		65.760	
Expenditure (2014: 487):	471 mio €	**1.3 % GDP**	1.853 mio €	**2.8 % GDP**
- nursing care	314 mio €	67 % LTC		
No. of beneficiaries/users (institutions - at home - money)	22-21-17/60 18-16-7/41		120-140	

Source: SURS, Ageing report

OBJECTIVE

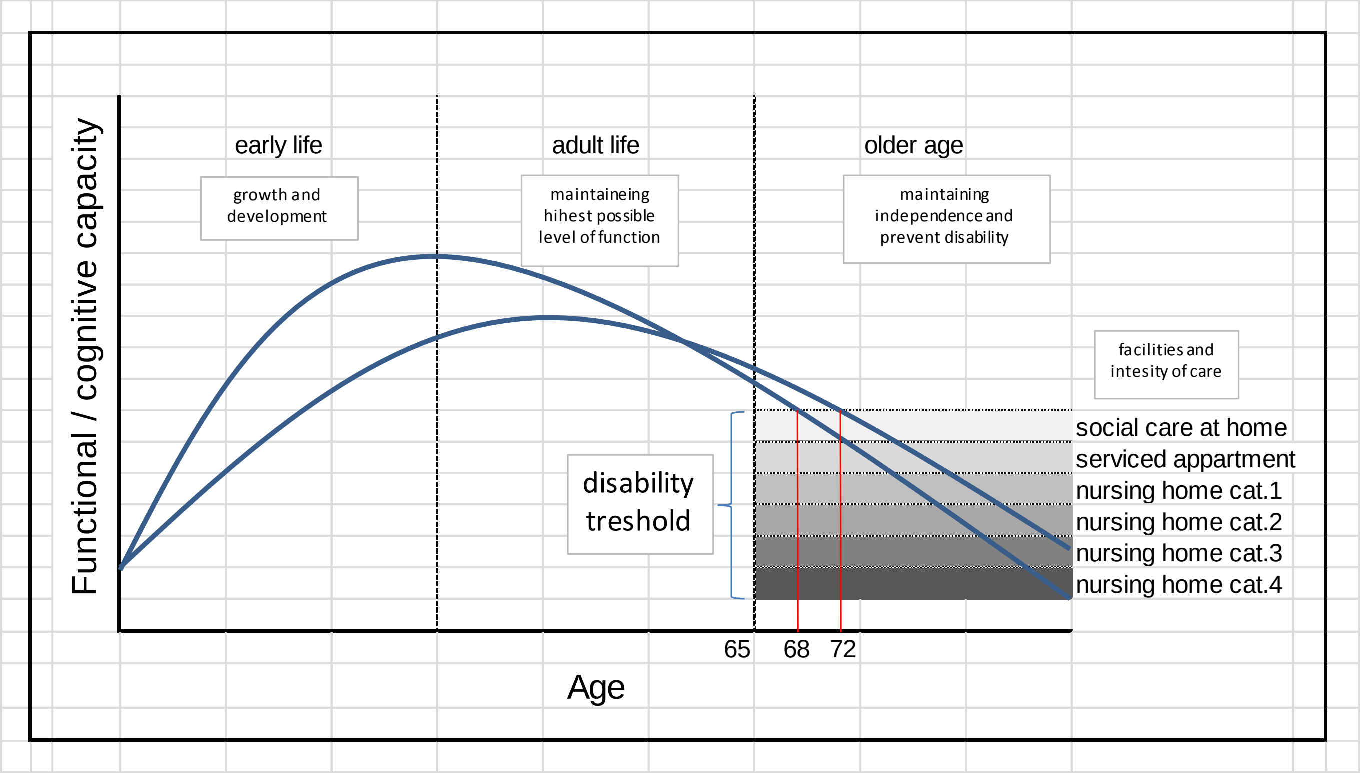
- **To introduce the model of multistate transitions in housing for ageing population.**
  - **The model shows how we can plan dynamics of needed investment in facilities and human resources based on forecast and**
- **suggests to optimise it regarding much lower health costs, social care costs,**
  - **which results creation of the social value of adaptation of the housing stock to needs of ageing population**

NOVELTY OF THE PAPER

The actuarial present value
of lifetime housing and care costs
is a subject
of criterion function
at a known variation of the life expectancy.
(Claudia Wood, 2017)
Premium size could be one of important constrains.
What about the social value?

MAINTAINING FUNCTIONAL CAPACITY OVER THE LIFE COURSE

by adapting the housing units to older users, reducing the needs of care and also reducing the health costs



Implementation in Slovenian housing stock remodeling and deinstutionalisation

NUMBER OF USERS AND APPLICATIONS OF LTC IN SLOVENIA

AGE 65-100	Independent	Homecare users (4)	Applicants (3)	Nursing homes residents (2)	Population in Slovenia (1)
		31.12.2015	**12.9.2017**	**31.12.2016**	**2016**
Male	151,255	1,781	1,609	4,460	157,527
Female	203,933	5,319	4,808	13,323	222,575
Total	**355,188**	**7,100**	**6,417**	**17,783**	**380,102**

Sources:

- (1) SURS – National Statistical Office (data of population od Slovenia)
- (2) ZZZS – National Health Insurance *Institute (data of Nursing homes residents*
- (3) SSZS – Assocation of Social institutions (*data of Applicants)*
- *(4) NIJZ – National Institute for Public Health (data of Homecare users)*
- MDDSZ – Ministry of Labour, Family, Social Affairs and Equal Opportunities
- UMAR – Institute of Macroeconomic Analysis and Development
- MZ – Ministry of Health, Directorat for LTC

GROWTH OF HOME CARE USERS
frequency of care depends also on accessibility

Year	Home care users
1998	3,909
2002	4,590
2004	4,732
2007	5,595
31. 12. 2011	6,624
31. 12. 2014	6,888
31. 12. 2015	7,100

Sources: - *NIJZ – National Institute for Public Health (data of Homecare users)*

RESEARCH CHALLANGE

* At the time of our collecting data in Slovenia there were 6,417 persons on waiting list for NH.
* The question is what policy of construction and remodeling of housing for all generations, also focusing on older adults Slovenia should develop.
* Also in other EU countries the question remains the same.

QUESTION – CRITERION FUNCTION

When to enable (<u>also with possible subventions</u>) a move from one type of housing unit to another

- **that actuarial present value of dwelling investments and care is minimum at longevity which does not fall under a certain value?**

Or

- **At known longevity in a certain type of dwelling the total longevity is maximum at given constrains of financial resources?**

DEFINITIONS

Primary care		accommodation and organized meals, technical support
Social care	BADL	bathing, dressing, feeding, positions in bed and getting up from it, movement, using the lavatory and interventions by doctor orders - such as: wound wrapping, pain relief therapy, a distribution of medication, monitoring vital functions, and more
	IADL	food preparation, laundry, transportation, and cleaning
Nursing service		ZN1 - cat1, ZN2 – cat2, ZN3-cat3

Creating Social Walue with Sheltered Housing Woods (2017)

Claudia Woods has been undertaking research into the social value of sheltered housing by bringing together all the qualitative data relating to the savings generated to health and social care services.

The Social Value of Sheltered Housing Woods (2017)

The report, which is a review of existing evidence, found that sheltered housing saves the UK's cash-strapped NHS and social services at least £486m per year.

The Social Value of Sheltered Housing

Claudia Woods has been undertaking research into the social value of sheltered housing in UK by bringing together all the data relating to the savings generated to health and social care services.

The Social Value of Sheltered Housing Wood (2017)

Sheltered housing provides independent, self-contained housing for older people, with wardens, alarms or other on-site staff to provide 24-hour support and security.

Created Social Value of Sheltered Housing in Uk

Wood identifies the savings to NHS and emergency and social care services from sheltered housing as at least:

* £300m per year from reduced length of in-patient hospital stays
* £12.7m per year from fall prevention by residents of sheltered housing
* £156.3m per year from prevention of falls which result in hip fractures
* £17.8m per year from reduced loneliness experienced by residents

KEY ISSUE
HOW TO ADAPT THE HOUSING STOCK TO THE AGEING POPULATION SO THAT THE ACTUARIAL INVESTMENT IN HOUSING STOCK AND CARE IS MINIMUM

we use **a model of long-term care insurance**

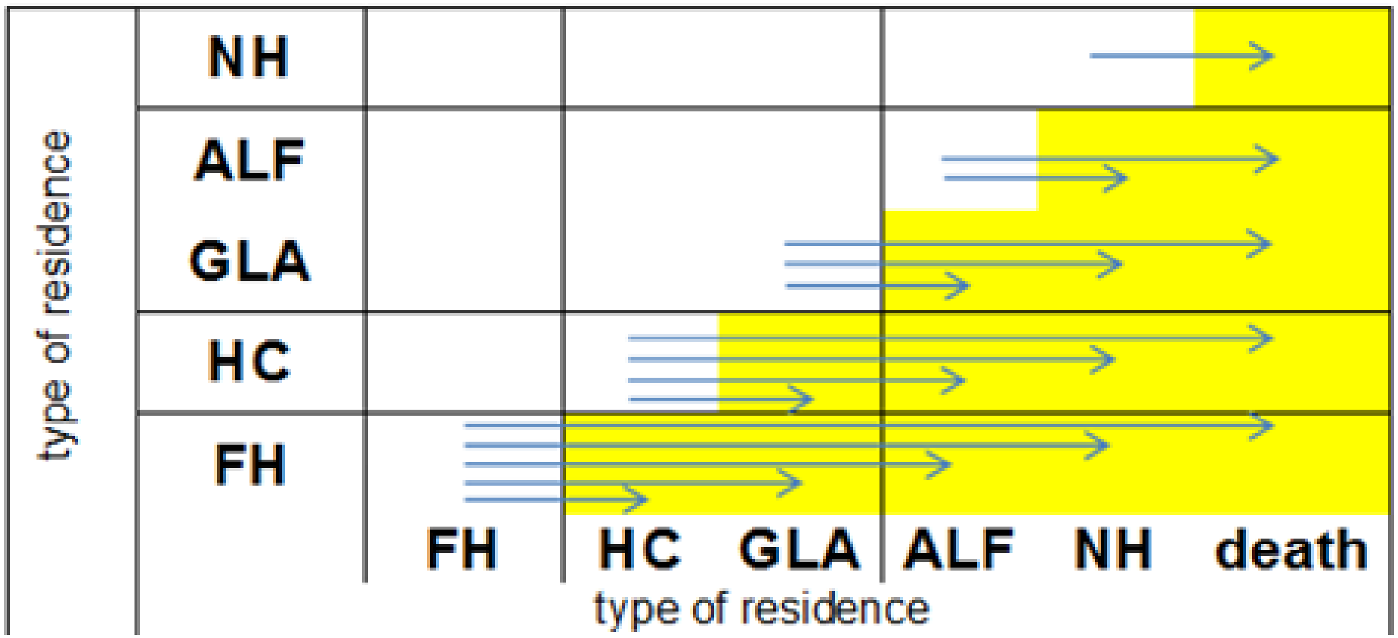
- life time care annuity,

where disbursement of benefits depends on functional capacities of older adults and type of dwelling, where they live.

***

Actuarial present value of long-term care $LTCa_x$ is subject of criterion function of suitability of the social infrastructure.

Possible transitions among different types of housing units adapted to functional capacities of older residents with declining functional capacities in multiple decrement model (i→j; i∈H, j∈H)



Types of dwelling: FH- Family Home (in existing home), HC Home care, GLA Ground Level Apartments ,ALF Assistance Living Facilities ,NH Nursing Home

MULTI-STATE FUNCTIONAL CAPACITIES MODEL

Possible transitions in the multiple decrement model:

TRANSITIONS			TO (j)					
			TYPE OF RESIDENCE					D
			EH	HC	RCIL	RCAL	NH	
FROM (i)	TYPE OF RESIDENCE	EH		X	X	X	X	X
		HC			X	X	X	X
		RCIL				X	X	X
		RCAL					X	X
		NH						X

Multiple decrement transition matrix

$$\mathbf{P}_{x,\tau} = \begin{bmatrix} p_x^{(0)} & q_x^{(0,1)} & q_x^{(0,2)} & q_x^{(0,3)} & q_x^{(0,4)} & q_x^{(0,5)} \\ 0 & p_x^{(1)} & q_x^{(1,2)} & q_x^{(1,3)} & q_x^{(1,4)} & q_x^{(1,5)} \\ 0 & 0 & p_x^{(2)} & q_x^{(2,3)} & q_x^{(2,4)} & q_x^{(2,5)} \\ 0 & 0 & 0 & p_x^{(3)} & q_x^{(3,4)} & q_x^{(3,5)} \\ 0 & 0 & 0 & 0 & p_x^{(4)} & q_x^{(4)} \end{bmatrix}_\tau$$

Numerical example

According to the general demographic data, mortality tables and data reported from nursing homes the transition matrix could be written. Let us say that structure of residents 80 years old by type of facility for each cohort (x years old; x=80) is written by the following vector S_x as sum of internal reallocations and the net migrations of cohort:

$$S_x = \begin{bmatrix} S_x^{(0)} & S_x^{(1)} & S_x^{(2)} & S_x^{(3)} & S_x^{(4)} \end{bmatrix} = \begin{bmatrix} 21.510 & 390 & 230 & 436 & 71 \end{bmatrix} +$$

$$+ \begin{bmatrix} 20 & 19 & 13 & 102 & 60 \end{bmatrix} = \begin{bmatrix} 21.530 & 409 & 243 & 538 & 131 \end{bmatrix}$$

Multiple decrement transition matrix

$$\mathbf{P}_{80}^{2015} = \begin{bmatrix} p_x^{(0,\tau)} & q_x^{(0,1)} & q_x^{(0,2)} & q_x^{(0,3)} & q_x^{(0,4)} & q_x^{(0,5)} \\ 0 & p_x^{(1,\tau)} & q_x^{(1,2)} & q_x^{(1,3)} & q_x^{(1,4)} & q_x^{(1,5)} \\ 0 & 0 & p_x^{(2,\tau)} & q_x^{(2,3)} & q_x^{(2,4)} & q_x^{(2,5)} \\ 0 & 0 & 0 & p_x^{(3,\tau)} & q_x^{(3,4)} & q_x^{(3,5)} \\ 0 & 0 & 0 & 0 & p_x^{(4,\tau)} & q_x^{(4,5)} \end{bmatrix}_{2015} = \qquad (1)$$

$$= \begin{bmatrix} 0,98164 & 0,00162 & 0,00167 & 0,00172 & 0,00176 & 0,01159 \\ 0 & 0,83415 & 0,04867 & 0,05111 & 0,05355 & 0,01252 \\ 0 & 0 & 0,9035 & 0,03993 & 0,04405 & 0,01252 \\ 0 & 0 & 0 & 0,76037 & 0,22711 & 0,01252 \\ 0 & 0 & 0 & 0 & 0,8344 & 0,16560 \end{bmatrix}$$

Numerical example: Allocation of residents of age x+1 by type of dwelling in year τ+1

$$\mathbf{S}_{81}^{2019} = \mathbf{S}_{80}^{2018}\mathbf{P}_{80}^{2018} =$$

$$= \begin{bmatrix} 21.530 & 409 & 243 & 538 & 131 \end{bmatrix} \cdot$$

$$\begin{bmatrix} 0,98164 & 0,00162 & 0,00167 & 0,00172 & 0,00176 & 0,01159 \\ 0 & 0,83415 & 0,04867 & 0,05111 & 0,05355 & 0,01252 \\ 0 & 0 & 0,9035 & 0,03993 & 0,04405 & 0,01252 \\ 0 & 0 & 0 & 0,76037 & 0,22711 & 0,01252 \\ 0 & 0 & 0 & 0 & 0,8344 & 0,16560 \end{bmatrix}$$

$$\begin{bmatrix} 21135 & 376 & 275 & 476 & 302 \end{bmatrix}$$

Allocation of residents by type of facility for studied cohort in the following year (when they are x+1 year old) we can calculate:

$$\mathbf{S}_{81}^{2015} = \mathbf{S}_{81}^{2015}\mathbf{P}_{81}^{2015} = \begin{bmatrix} S_{81}^{(0)} & S_{81}^{(1)} & S_{81}^{(2)} & S_{81}^{(3)} & S_{81}^{(4)} \end{bmatrix}_{2016}$$

Norms and standards of required human resources for elder care for each type of facilities is describe by vector H:

$$\mathbf{H} = \begin{bmatrix} H^0 & H^1 & H^2 & H^3 & H^4 \end{bmatrix}^T = \begin{bmatrix} 0 & 0.1 & 0.2 & 0.3 & 0.5 \end{bmatrix}^T$$

The require human resources for eldercare in studied urban area we calculate according following formula:

$$HR(80) = S_x.H = \begin{bmatrix} S_x^0 & S_x^1 & S_x^2 & S_x^3 & S_x^4 \end{bmatrix}_{\tau+1} \cdot H$$

$$= \begin{bmatrix} 21135 & 376 & 275 & 476 & 302 \end{bmatrix}\begin{bmatrix} 0 & 0.1 & 0.2 & 0.3 & 0.5 \end{bmatrix}^T = 387$$

It means that in such case 387 workers in EC will be needed for 80 years old inhabitants in the municipality. Summarizing the results for all age cohorts we can also calculate total number of required human resources for the next year and further gradually for all time horizon.

MULTI-STATE FUNCTIONAL CAPACITIES MODEL

Probability that older person will be in a certain category of care in nursing home and probability that older person will be dependent on the help of others and will need care in certain category.

Age M	Inde-pend	Estimate demand for LTC						Nursing home*		
		HC cat I	HC cat II	HC cat III	WL cat I	WL cat II	WL cat III	cat I	cat II	cat III
65	0.9885	0.0005	0.0002	0.0019	**0.0005**	**0.0002**	**0.0017**	0.0013	0.0005	0.0046
75	0.9624	0.0021	0.0005	0.0059	**0.0019**	**0.0004**	**0.0054**	0.0052	0.0012	0.0149
85	0.8595	0.0071	0.0017	0.0231	**0.0064**	**0.0015**	**0.0208**	0.0178	0.0043	0.0577
95	0.5747	0.0241	0.0027	0.0697	**0.0218**	**0.0024**	**0.0630**	0.0604	0.0067	0.1745

**Sources:* - ZZZS – National Health Insurance *Institute (data of Nursing homes residents)*

MULTI-STATE FUNCTIONAL CAPACITIES MODEL

Simulation of the model:

Age M	Independ	HC cat I-III	WL and NH cat I-II	WL and NH cat. III
65	0.9885	0.0026	0.0025	0.0063
75	0.9624	0.0085	0.0088	0.0203
85	0.8595	0.0319	0.0301	0.0786
95	0.5747	0.0965	0.0913	0.2375

Age W	Independ	HC cat I-III	WL and NH cat I-II	WL and NH cat. III
65	0.9905	0.0022	0.0015	0.0059
75	0.9554	0.0101	0.0085	0.0260
85	0.7606	0.0543	0.0522	0.1329
95	0.1977	0.1820	0.1717	0.4486

the dynamics of needed investments in facilities and human resources based on the forecasted structure of care dependency categories

ACTUARIAL MODEL OF LTC INSURANCE

We use the following notation:

Notation	Description of notation
P_x^{LTC}	single premium for LTC insurance for person x years old
$LTC\ddot{a}_x$	actuarial present value of lifetime expenditures for LTC services for person x years old
γ_2	percentage of the administrative fee that insurance company charges at each payment of premium
γ_1	percentage of the administrative fee that insurance company charges for each payment of benefit
${}_jp_x$	the probability that person x years old will survive j years
$p_x^{ltc(i)}$	the probability that person x years old is in the category of care i
c_i	yearly expenditure for LTC services in the category of care i
i	the interest rate
$\vartheta = \frac{1}{1+i}$	the discount rate

ACTUARIAL MODEL OF LTC INSURANCE AND ADAPTATION TO HOUSING

Single insurance premium for older adult at age *x* for long term care insurance:

$$P_x^{LTC} = (1+\gamma_2)\cdot LTC\ddot{a}_x$$
$$= (1+\gamma_2)\cdot \sum_{j=0}^{100-x} {}_jp_x \cdot \vartheta^j \cdot \left(p_{x+j}^{ltc\,I}\cdot c_1 + p_{x+j}^{ltc\,II}\cdot c_2 + p_{x+j}^{ltc\,III}\cdot c_3\right)$$

ACTUARIAL MODEL OF LTC INSURANCE AND ADAPTATION TO HOUSING

Yearly expenditure for LTC – based on intensity and expenditure for social care

Category	Intensity of care		Amount in EUR per			
	h/day	min/day	h*	day	month	year
I	0.75	45	16	12	360	4,320
II	1.25	75	16	20	600	7,200
III	1.75	105	16	28	840	10,080

Sources: - * SSZS – Assocation of Social institutions (*data of Applicants*)

ACTUARIAL MODEL OF LTC INSURANCE AND ADAPTATION TO HOUSING

The single premium for the adult (male) which will cover expenditures of LTC in the category of required intensity of care for a person who is dependent on the help of others.

$$P_{65}^{LTC}$$

$$= (1 + 0.05) \cdot \sum_{j=0}^{100-65} {}_{j}p_{65} \cdot \vartheta^{j}$$

$$\cdot \left(p_{65+j}^{ltc\ I} \cdot 4{,}320 + p_{65+j}^{ltc\ II} \cdot 7{,}200 + p_{65+j}^{ltc\ III} \cdot 10{,}080\right)$$

$$= 1.05 \cdot 6{,}426.57 \ = 6{,}747.90$$

ACTUARIAL MODEL OF LTC INSURANCE AND ADAPTATION TO HOUSING

The single premium for the adult (male) which will cover expenditures of LTC in the category of required intensity of care for a person who is dependent on the help of others.

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$$= (1 + 0.05) \cdot \sum_{j=0}^{100-65} {}_{j}p_{65} \cdot \vartheta^{j}$$

$$\cdot \left(p_{65+j}^{ltc\ I} \cdot 4{,}320 + p_{65+j}^{ltc\ II} \cdot 7{,}200 + p_{65+j}^{ltc\ III} \cdot 10{,}080\right)$$

$$= 1.05 \cdot 6{,}426.57 \ = 6{,}747.90$$

Multiple decrement matrix

$$\mathbf{P}_{x,\tau} = \begin{bmatrix} p_x^{(0)} & q_x^{(0,1)} & q_x^{(0,2)} & q_x^{(0,3)} & q_x^{(0,4)} & q_x^{(0,5)} \\ 0 & p_x^{(1)} & q_x^{(1,2)} & q_x^{(1,3)} & q_x^{(1,4)} & q_x^{(1,5)} \\ 0 & 0 & p_x^{(2)} & q_x^{(2,3)} & q_x^{(2,4)} & q_x^{(2,5)} \\ 0 & 0 & 0 & p_x^{(3)} & q_x^{(3,4)} & q_x^{(3,5)} \\ 0 & 0 & 0 & 0 & p_x^{(4)} & q_x^{(4)} \end{bmatrix}_\tau$$

Distrubution of residents x years old in year τ in diffetent types of dwellings

$$\mathbf{S}_{x,\tau} = \begin{bmatrix} S_x^{(0)} & S_x^{(1)} & S_x^{(2)} & S_x^{(3)} & S_x^{(4)} \end{bmatrix}_\tau = \begin{bmatrix} ZS_x^{(0)} & ZS_x^{(1)} & ZS_x^{(2)} & ZS_x^{(3)} & ZS_x^{(4)} \end{bmatrix}_\tau +$$

$$+ \begin{bmatrix} NM_x^{0} & NM_x^{(1)} & NM_x^{(2)} & NM_x^{(3)} & NM_x^{(4)} \end{bmatrix}_\tau$$

Distrubution of residents x+1 years old in year τ+1 in diffetent types of dwellings

$$\mathbf{S}_{x+1,\tau+1} = \mathbf{S}_{x,\tau}\mathbf{P}_{x,\tau} =$$

$$= \begin{bmatrix} S_x^{(0)} & S_x^{(1)} & S_x^{(2)} & S_x^{(3)} & S_x^{(4)} \end{bmatrix}_\tau \cdot \begin{bmatrix} p_x^{(0)} & q_x^{(0,1)} & q_x^{(0,2)} & q_x^{(0,3)} & q_x^{(0,4)} & q_x^{(0,5)} \\ 0 & p_x^{(1)} & q_x^{(1,2)} & q_x^{(1,3)} & q_x^{(1,4)} & q_x^{(1,5)} \\ 0 & 0 & p_x^{(2)} & q_x^{(2,3)} & q_x^{(2,4)} & q_x^{(2,5)} \\ 0 & 0 & 0 & p_x^{(3)} & q_x^{(3,4)} & q_x^{(3,5)} \\ 0 & 0 & 0 & 0 & p_x^{(4)} & q_x^{(4)} \end{bmatrix}_\tau =$$

$$= \begin{bmatrix} S_{x+1}^{(0)} & S_{x+1}^{(1)} & S_{x+1}^{(2)} & S_{x+1}^{(3)} & S_{x+1}^{(4)} \end{bmatrix}_{\tau+1}$$

Multiple decrement transition matrix where housing system does not include housing with care

$$\mathbf{P}_{x,\tau} = \begin{bmatrix} p_x^{(0)} & q_x^{(0,1)} & 0 & 0 & q_x^{(0,4)} & q_x^{(0,5)} \\ 0 & p_x^{(1)} & 0 & 0 & q_x^{(1,4)} & q_x^{(1,5)} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & p_x^{(4)} & q_x^{(4)} \end{bmatrix}_{\tau}$$

Allocation of residents x+1 years old in year τ+1 in diffetent types of dwellings – facilities for seniors are not available

$$\mathbf{S}_{x+1,\tau+1} = \mathbf{S}_{x,\tau}\mathbf{P}_{x,\tau} =$$

$$= \begin{bmatrix} S_x^{(0)} & S_x^{(1)} & 0 & 0 & S_x^{(4)} \end{bmatrix}_\tau \cdot \begin{bmatrix} p_x^{(0)} & q_x^{(0,1)} & 0 & 0 & q_x^{(0,4)} & q_x^{(0,5)} \\ 0 & p_x^{(1)} & 0 & 0 & q_x^{(1,4)} & q_x^{(1,5)} \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & p_x^{(4)} & q_x^{(4)} \end{bmatrix}_\tau =$$

$$= \begin{bmatrix} S_{x+1}^{(0)} & S_{x+1}^{(1)} & 0 & 0 & S_{x+1}^{(4)} \end{bmatrix}_{\tau+1}$$

Long term care annuity where housing with care is not included in the housing systems

$$LTC\_WHWC\ddot{a}_x =$$

$$= \sum_{j=0}^{100-x} {}_j p_x \cdot \upsilon^j \cdot \left(s_{x+j}^{hc} \cdot chc + s_{x+j}^{nh1} \cdot cnh_1 + s_{x+j}^{nh2} \cdot cnh_2 + s_{x+j}^{nh3} \cdot cnh_3 \right)$$

Long term care annuity where housing with care is included in the housing systems

$$LTC\_HWC\ddot{a}_x = \sum_{j=0}^{100-x} {}_j p_x \cdot \upsilon^j \cdot$$

$$\left(s_{x+j}^{hc} \cdot chc + s_{x+j}^{rvil} \cdot crvil + s_{x+j}^{rval} \cdot crval + s_{x+j}^{nhcI} \cdot cnh_1 + s_{x+j}^{nhc2} \cdot cnh_2 + s_{x+j}^{nhc3} \cdot cnh_3 \right)$$

Notation:

$$LTC\_HWC\ddot{a}_x = \sum_{j=0}^{100-x} {}_j p_x \cdot \upsilon^j \cdot$$

$$\left(s_{x+j}^{hc} \cdot + s_{x+j}^{rvil} \cdot crvil + s_{x+j}^{rval} \cdot crval + s_{x+j}^{nhc1} \cdot cnh_1 + s_{x+j}^{nhc2} \cdot cnh_2 + s_{x+j}^{nhc3} \cdot cnh_3 \right)$$

s_{x+j}^{hc}	**Share of population living in their own home receiving homecare**
chc	Cost of care - homecare
s_{x+j}^{rcil}	Share of population in independent units of retirement comunities
$crcil$	Cost of care in indep. units of retirement communities
s_{x+j}^{rcal}	Share of population in assisted living units of retirement communities
$crcal$	Cost of care in assisted-living units of retirement communities
s_{x+j}^{nhci}	Share of population in nursing home in category of care i
cnh_i	Cost of care in nursing home in category of care i

Social value created by including housing with care in housing system

$$SV_x = LTC\_WHWC\ddot{a}_x - LTC\_HWC\ddot{a}_x$$

FURTHER RESEARCH

Posible financing sources for development of retirement communities as social infrastructure:

- Municipal taxes
- Health and LTC insurance fund
- European Investment Bank
- Housing Equity Withdrawal – Reverse Mortgage

FURTHER RESEARCH

Development of regional risk management mechanism for financing development of

THE ADEQUATE HOUSING for all generations.

Thank you for your attention!