THE IMPACT OF THE DEMOGRAPHIC AGING ON THE HEALTH SYSTEM IN GERMANY - SIMULATIONS ON THE BASIS OF THE IBS-POPULATION MODEL*

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The demographic aging of the population has a serious impact on the (old age) pension system as well as on the health (insurance) system. The aim of this project is the simulation of the impact of changes in the age structure on expenses and revenues of health insurance within the coming decades. Per capita expenses of health insurance rise with the age of the population. Through multiplication of projected numbers for each single age with the age specific Per capita health expenses the effect of changes in age structure on the health system can be computed. The purely demographic effect on the expenses of health insurance (K_t) and the revenue received from contributions for a given personal income and a constant premium rate are derived from the results of the demographic simulations. The expense-revenue-relation reveals how much the premium rate has to be increased to maintain equilibrium between expenses and revenue. An increase in the expenses-revenue-relation is based on two counter-developments: the health insurance revenue is decreasing due to the lowering number of contributors (people of working age between 20-60) and at the same time the expenses are rising because the number of people over 60 is increasing.

The demographic aging of the population has a serious impact on the (old age) pension system as well as on the health (insurance) system. The aim of this project is the simulation of the impact of changes in the age structure on expenses and revenues of health insurance within the coming decades.

Per capita expenses of health insurance are closely related to the age of the population. If the Per capita expense of legal health insurance for young people under 10 is standardized as 1, then the Per capita expenses for age 55 is 3 while for age 83 it is 7. The age specific profile of Per capita health expenses was computed on the basis of data for services, medical treatment and pharmaceutical expenses of legal health insurance (Figure 1)[1].

The simulations of the author on the development of the population in the federal states in eastern and western Germany during the 21st century show that both median age and old age quotient will rise strongly until 2040/2050. Between 1996 and 2050 median age rises from 38 to 52 and old age quotient (number of people over 60 as a percentage of people aged 20-60) rises from 37,5 to 87,9. (=Variant 4)[2]. Through multiplication of projected numbers for each single age with the age specific Per capita health expenses the effect of changes in age structure on the health system can be computed. Furthermore the size of the working population and the (insurance) premium rates are also effected by changes in the age structure. The purely demographic effect on

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[1] Ministry of Labour, Health and Social Services, NRW (Ed.): Health Report NRW 1994, Office of Public Health Services, NRW State, Bielefeld 1995, p.174

[2] H. Birg, E.-J. Flöthmann, Th. Frein and K. Ströker, Simulationsrechnungen zur Bevölkerungsentwicklung in den alten und neuen Bundesländern im 21. Jahrhundert, Bd. 45 der Materialien des Institutes für Bevölkerungsforschung und Sozialpolitik, Universität Bielefeld, 1998.

the expenses of health insurance (K_t) and the revenue received from contributions for a given personal income and a constant premium rate can be derived from the results of the demographic simulations as follows:

Expenses

(1) $$K_t = \sum_x \left(\alpha^m_{t,x} B^m_{t,x} + \alpha^w_{t,x} B^w_{t,x}\right) = \sum_x \alpha_{t,x} B_{t,x}$$

Revenue

(2) $$E_t = \sum_x \left(\beta^m_{t,x} B^m_{t,x} + \beta^w_{t,x} B^w_{t,x}\right) = \sum_x \beta_{t,x} B_{t,x}$$

Expense-Revenue-Balance

(3) $$\sum_x \alpha_{t,x} B_{t,x} = \gamma_{t,x} \sum_x \beta_{t,x} B_{t,x}$$

For $\gamma_{t,x}=1$:

Expense-Revenue-Relation (4) $$X_t = \frac{K_t}{E_t}$$

Expense-Revenue-Relation (indexed for 1996=100)

(5) $$Y_t^* = \frac{X_t}{X_{1996}} * 100 \qquad \text{for } t=1997,\ldots,2100$$

Definitions:

B = Population (m = male, w = female)

x = age

α = Per capita expenses

β = Per capita revenue

γ = level factor

X = expenses Per DM revenue

Y = expenses Per DM revenue (indexed as 100 for 1996)

For the simulations to determine the effects on expenses, alternative profiles of age specific Per capita expenses have been assumed (variants A to D). The five particular expense variants were combined with 4 out of 36 simulation variants of the demographic projections. Out of 20 combinations 12 final variants were selected for monitoring the impact on the revenue and expenses of the health (insurance) system (Table 1). The expense-revenue-relation reveals how much the premium rate has to be increased to maintain equilibrium between expenses and revenue.

Figure 1

Alternative Forms of the Relation between Age and Per Capita Health Expenses

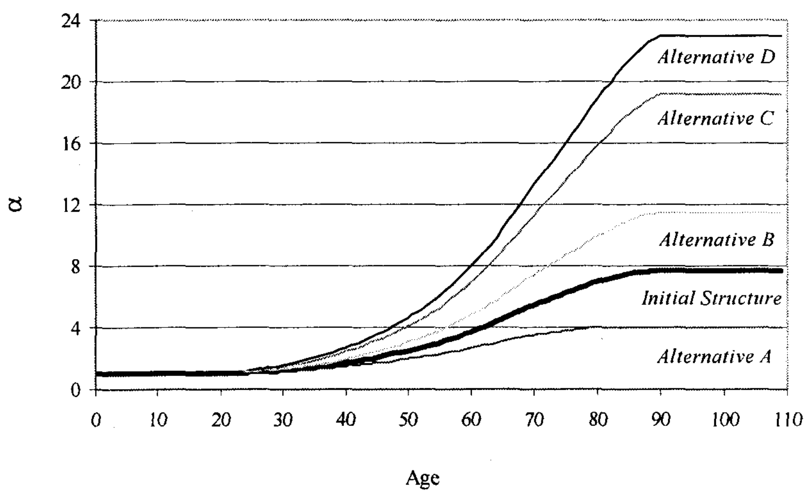


Table 1

Comparison of Variants of Demographic Simulations and Alternative Age Structures of Per Capita Expenses in Relation to the Revenue and Expenses of Legal Health Insurance

			Variants of age structure of expenses				
			Alternative forms of Per capita health expenses				
			Alternative **A**	Initial structure **G**	Alternative **B**	Alternative **C**	Alternative **D**
Variants of population simulations *	Net migration = 150.000	**Variant 4** (= low life expectancy, M=81, F=87)	4/A	4/G	4/B	4/C	4/D
		Variant 5 (= medium life expectancy, M=84, F=90)	X	5/G	X	X	X
		Variant 6 (= high life expectancy, M=87, F=93)	X	6/G	X	X	X
	Net migration = 300.000	**Variant 10** (= low life expectancy, M81, F=87)	10/A	10/G	10/B	10/C	10/D

*for constant total fertility rate (1,4 live births Per woman)

Refinement of the analysis of the rise of health expenses Per DM revenue from contributions ($=X_t$) in relation to the demographic development and the age structure of the Per capita health expenses can be done in two ways. First, the age structure of the Per capita health expenses (variants A, B, C and D) can be set constant throughout the period. Second, a shift from the initial age structure (initial profile G) to the structures A, B, C and D can be arranged. Consequently the index of the increase of the expense-revenue-relation can be computed in two ways:

a) for a constant age structure of Per capita expenses from the year 1996 (initial profile G):

X_t = expense-revenue-relation ($X_t=K_t/E_t$)

Y = index of X_t while $X_{1996}=100$

$$Y_t = \frac{X_t^G}{X_{1996}^G} 100 \qquad t = 2035;2050;2080$$

The result of this method is presented in Table 2.

b) in case when the initial age structure of the Per capita expenses from the year 1996 (initial profile G) gradually changes and converts to one of the alternative age structures A, B, C, and D:

$$Y_t^A = \frac{X_t^A}{X_{1996}^G} 100 \qquad Y_t^B = \frac{X_t^B}{X_{1996}^G} 100$$

$$Y_t^C = \frac{X_t^C}{X_{1996}^G} 100 \qquad Y_t^D = \frac{X_t^D}{X_{1996}^G} 100$$

The result of this method is presented in Table 3.

The main results of the increase in the expense-revenue-relation are given in Figure 2. The following points can be stated:

1) If the age structure of the Per capita expenses remains constant, the index of the expense-revenue-relation increases from 100 in 1996 to 164 in 2035 and to 177 in 2050. This implies that the premium rate of health insurance of, for example, 12% has to be increased by a factor of 1.64 to 19.7% until 2035 (to 21.2% by a factor of 1.77 until 2050). The possibility of an increase in costs (or a theoretically imaginable decrease in costs) due to technological

innovation is excluded; in other words the pure demographic impact on the premium rate is taken into consideration.

2) If technological innovation is thought to cause a rise in age specific Per capita expenses (variants B, C and D in Figure 2) the angle of the increase in the expenses-revenue-relation would be much steeper. The joint impact of demographic and medical developments on the expenses of the health system would cause an increase in the premium rate by a factor of 2 to over 3 according to the variant of the medical-technical development (Table 3).

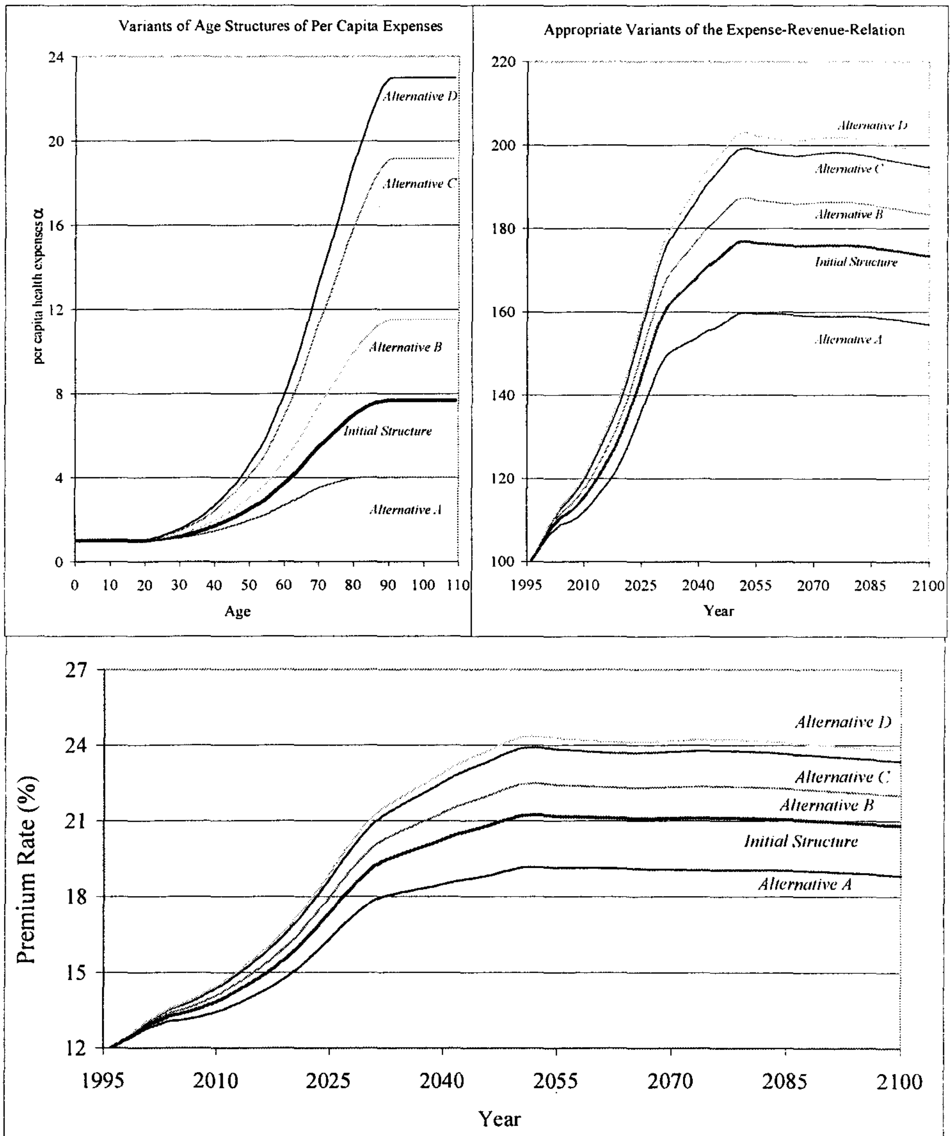
3) An increase in immigration of young people has only a marginal, muting effect on the increase of the expenses-revenue-relation; the same is true for various suggestions on the increase in life expectancy.

4) The increase in the expenses-revenue-relation is based on two counter-developments: the health insurance revenue is decreasing due to the lowering number of contributors (people of working age between 20-60) and at the same time the expenses are increasing because of the number of people over 60 which will rise until 2035/40 (and only begin to decrease after 2040). Given a constant age structure of Per capita expenses, the index of expenses increases from 100 to 122.4 between 1996 and 2040, while simultaneously the index of revenue decreases from 100 to 72.4. Consequently the index of the expense-revenue-relation rises from 100 to 168.8 (Figure 3).

The following results are valid for age structure C instead of initial profile G for Per capita expenses: The index of expenses increases from 100 to 136 between 1996 and 2040 and simultaneously the index of revenue decreases from 100 to 72.4 so that the relation of expenses and revenue rises from 100 to 187,8 (Figure 4).

Figure 2

Simulations on the Demographically Caused Increase in Health Expenses and the Effects on the Premium Rate of Health Insurance in the 21st Century



Assumptions: Smooth increase of life expectancy for males from 73 years to 81 years and for females from 80 years to 87 years until 2080. Live births Per woman 1,4 . Yearly Net Migration 150.000.

Source: see variant 4 in: H. Birg, E.-J. Flöthmann, Th. Frein u. K. Ströker, Simulationsrechnungen zur Bevölkerungsentwicklung in den alten und neuen Bundesländern im 21. Jahrhundert, Bd. 45 der Materialien des Institutes für Bevölkerungsforschung und Sozialpolitik, Universität Bielefeld, 1998.

Source of data of Per capita health expenses (Initial Structure): Ministry of Labour, Health and Social Services NRW (Ed.), Health Report 1994, Bielefeld 1995, p. 174.

Table 2

Rise of Health Expenses of Insurance Per Collected (DM) Premium in Relation to the Demographic Development and the Age Structure of Per Capita Health Expenses – for Constant Age Profile of Expenses

<table>
<tr><td colspan="3" rowspan="3"></td><td colspan="5">Variants of age structure of expenses</td></tr>
<tr><td colspan="5">Alternative Forms of Per capita health expenses
initial profile G constant over time</td></tr>
<tr><td>Alternative
A</td><td>Initial structure
G</td><td>Alternative
B</td><td>Alternative
C</td><td>Alternative
D</td></tr>
<tr><td rowspan="4">Variants of population simulations *</td><td rowspan="3">Net migration = 150.000</td><td>Variant 4
(= low life expectancy, M=81, F=87)</td><td>1996: 100
2035: 152
2050: 160
2080: 159</td><td>1996: 100
2035: 164
2050: 177
2080: 176</td><td>1996: 100
2035: 172
2050: 187
2080: 186</td><td>1996: 100
2035: 181
2050: 199
2080: 198</td><td>1996: 100
2035: 184
2050: 203
2080: 202</td></tr>
<tr><td>Variant 5
(= medium life expectancy, M=84, F=90)</td><td>X</td><td>1996: 100
2035: 171
2050: 188
2080: 192</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Variant 6
(= high life expectancy, M=87, F=93)</td><td>X</td><td>1996: 100
2035: 178
2050: 201
2080: 209</td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>Net migration = 300.000</td><td>Variant 10
(= low life expectancy, M81, F=87)</td><td>1996: 100
2035: 144
2050: 150
2080: 150</td><td>1996: 100
2035: 155
2050: 165
2080: 164</td><td>1996: 100
2035: 162
2050: 174
2080: 173</td><td>1996: 100
2035: 169
2050: 183
2080: 183</td><td>1996: 100
2035: 172
2050: 187
2080: 186</td></tr>
<tr><td colspan="8">*for constant fertility (1,4 live births Per woman)</td></tr>
<tr><td colspan="8">Source of demographic variants:
H. Birg, E.-J. Flöthmann, Th. Frein u.K. Ströker, Simulationsrechnungen zur Bevölkerungsentwicklung in den alten und neuen Bundesländern im 21. Jahrhundert, Band 45 der Materialien des Institutes für Bevölkerungsforschung und Sozialpolitik, Universität Bielefeld, 1998.</td></tr>
</table>

Table 3

Rise of Health Expenses of Insurance Per Collected (DM) Premium in Relation to the Demographic Development and the Age Structure of Per Capita Health Expenses – for Changing Age Profile of Expenses

			Variants of age structure of expenses				
			Alternative Forms of Per capita health expenses – initial age profile G is converting to one of the alternatives A to D over time				
			Alternative A	Initial structure G	Alternative B	Alternative C	Alternative D
Variants of population simulations *	Net migration = 150.000	**Variant 4** (= low life expectancy, M=81, F=87)	1996: 100 2035: 113 2050: 119 2080: 119	1996: 100 2035: 164 2050: 177 2080: 176	1996: 100 2035: 216 2050: 235 2080: 234	1996: 100 2035: 319 2050: 351 2080: 349	1996: 100 2035: 371 2050: 409 2080: 407
		Variant 5 (= medium life expectancy, M=84, F=90)	X	1996: 100 2035: 171 2050: 188 2080: 192	X	X	X
		Variant 6 (= high life expectancy, M=87, F=93)	X	1996: 100 2035: 178 2050: 201 2080: 210	X	X	X
	Net migration = 300.000	**Variant 10** (= low life expectancy, M81, F=87)	1996: 100 2035: 108 2050: 112 2080: 112	1996: 100 2035: 155 2050: 165 2080: 164	1996: 100 2035: 203 2050: 218 2080: 217	1996: 100 2035: 298 2050: 323 2080: 322	1996: 100 2035: 346 2050: 376 2080: 375
*for constant fertility (1,4 live births Per woman)							
Source of demographic variants: H. Birg, E.-J. Flöthmann, Th. Frein u.K. Ströker, Simulationsrechnungen zur Bevölkerungsentwicklung in den alten und neuen Bundesländern im 21. Jahrhundert, Band 45 der Materialien des Institutes für Bevölkerungsforschung und Sozialpolitik, Universität Bielefeld, 1998.							

Figure 3 A

Index-Series for Expenses (=K), Revenue (=E) and Expense-Revenue-Relation (K/E=X) in Relation to the Demographic Development*

- Initial Profile G -

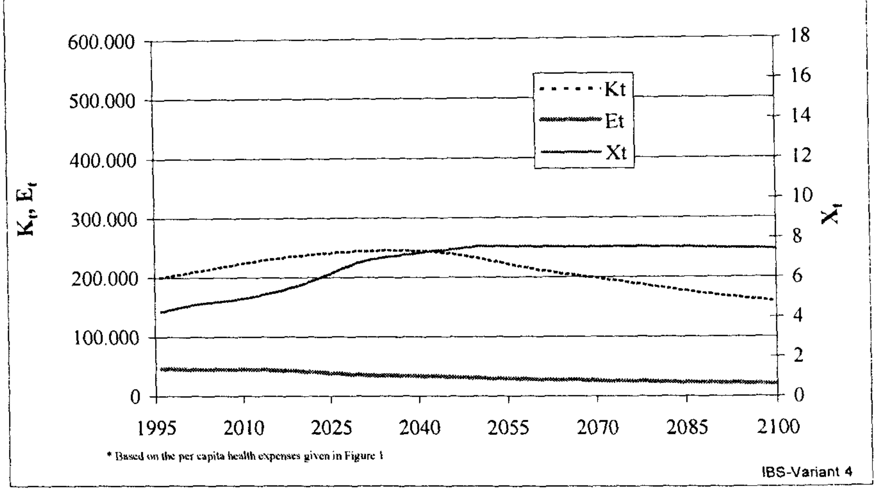


Figure 3 B

Index-Series for the Initial Value = 100

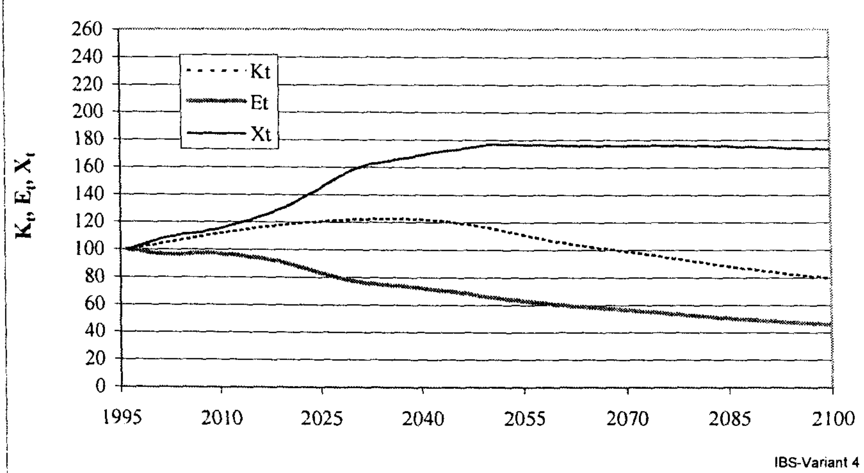


Figure 4 A

Index-Series for Expenses (=K), Revenue (=E) and Expense-Revenue-Relation (K/E=X) in Relation to the Per Capita Health Expenses
- Alternative Profile C -

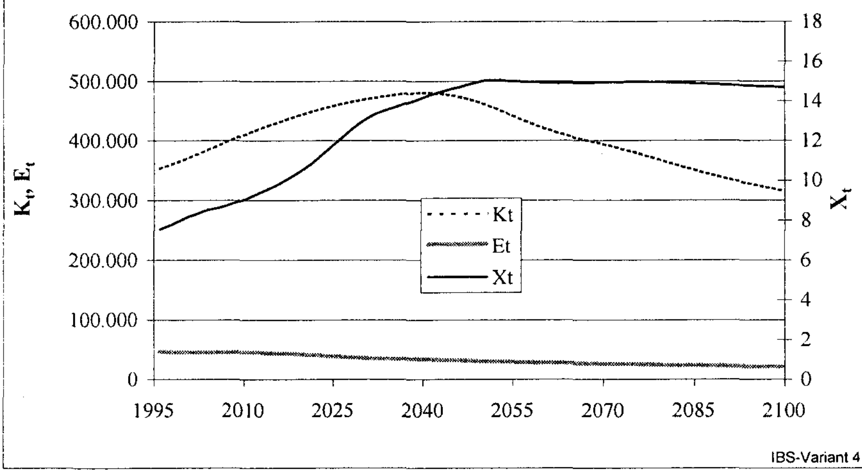
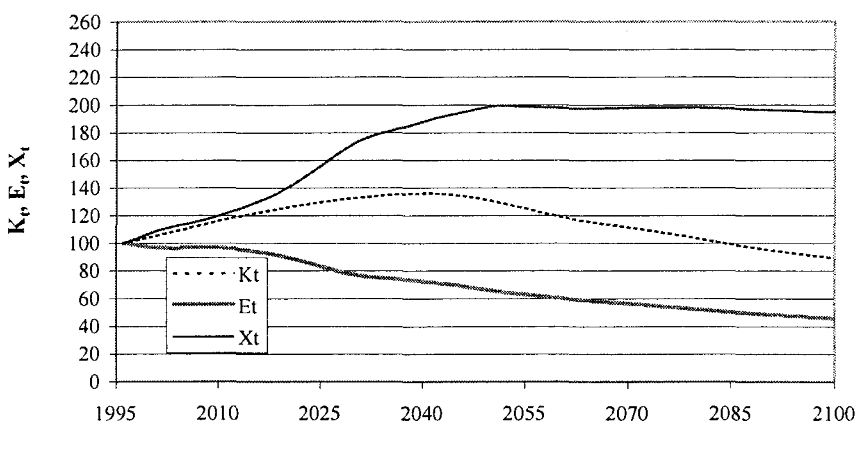


Figure 4 B

Index-Series for the Initial Value = 100



ÖZET

DEMOGRAFİK YAŞLANMANIN ALMANYA'DAKİ SAĞLIK SİSTEMİ ÜZERİNDEKİ ETKİSİ-IBS NÜFUS MODELİNE DAYALI SİMULASYONLAR

Toplumdaki (demografik) yaşlanma emeklilik sistemini olduğu kadar sağlık sistemini de derinden etkilemektedir. Projenin amacı yaş yapısındaki değişimin önümüzdeki onyıllarda sağlık sigortalarının gelirleri ve giderleri üzerindeki etkisinin simule edilmesidir. Kişi başına sağlık giderleri (buradaki örnekte sağlık sigortasının kişiler için yaptığı harcama) nüfusun yaşı ile bağlantılıdır. Zorunlu sağlık sigortasının 10 veya daha düşük yaştaki kişiler için kişi başına sağlık giderleri 1 olarak standardize edilirse, halihazırda 55 yaşındakiler için kişi başına giderler 3, 83 yaşındakiler için ise 7 olmaktadır.

Nüfusun 21. yüzyıldaki gelişimi ile ilgili simulasyon hesaplarından 2040/2050 yıllarına kadar medyan yaş ve yaşlı oranının (60 yaş üstü nüfusun 20-60 yaş nüfusun yüzdesi olarak ifadesi) çok yükseleceği anlaşılmaktadır. Yaşa özel kişi başına sağlık giderlerinin tek yaşlar için projekte edilmiş nüfuslarla çarpılması durumunda yaş yapısındaki değişimin toplam sağlık giderleri üzerindeki etkisi hesaplanabilmektedir. Öte yandan çalışan insanların sayısı ve sağlık sigortalarına ödedikleri primler de yaş yapısı ile ilintilidir. Belirli bir maaş ve sabit bir prim oranı varsayıldığında sağlık sigortasının giderleri (Kt) ve prim kaynaklı gelirleri (Et) üzerinde saf demografik etkiden kaynaklanan değişme hesaplanmaktadır.

Giderler üzerindeki etkinin hesaplanması için kullanılan simulasyon hesaplarında kişi başına sağlık giderlerinin yaş yapısında 4 farklı alternatif de kullanılmıştır (Grafik 1'de A-D Varyantları). Söz konusu 5 gider varyantı toplam 36 demografik projeksiyondan 4'ü ile eşleştirilmiştir (Tablo 1). Sağlık sisteminin gelir ve giderleri üzerinde etkilerin gösterilmesi için toplam 20 kombinasyon arasından 12 sonuç varyantı seçilmiştir. Gider-Gelir-Oranı, gider gelir eşitliğinin devamının sağlanması için sağlık sigortalarına ödenen prim yüzdesinin hangi oranda arttırılması gerektiğine işaret etmektedir. Gider-Gelir-Oranı'ndaki artış ters yönde işleyen iki farklı gelişmenin sonucunda meydana gelmektedir. Toplumdaki yaşlanma ile birlikte prim ödeyenlerin (20-60 yaş arası çalışan insanlar) sayısı azalmakta, öte yandan yaşlılar için yapılan sağlık harcamalarının daha yüksek olması nedeniyle toplam sağlık harcamaları da artmaktadır. Sağlık harcamalarının yaş yapısının mevcut düzeyde sabit kalması durumunda 1996 yılında 100 olan Gider-Gelir-Oranı 2050'de 177'ye çıkmaktadır. Söz konusu artış saf demografik etkiden kaynaklanmaktadır. Bunun yanında tıbbi-teknolojik gelişmenin sağlık harcamalarının mevcut yaş yapısında değişime yol açacağının varsayıldığı durumlarla ilgili hesaplamalar da Grafik 2 ve Tablo 3'te verilmiştir.