Does the ageing of the population have an impact on health care expenditure in Germany?

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1. Introduction

One of the biggest problems facing the German health care system is funding the cost of statutory health insurance (SHI). In this branch of social security about 90 percent of the German population is insured against the risk of costs incurred as a result of a medical condition. The cost of SHI for outpatient and inpatient services as well as for prescriptive drugs, other medication and medical aids are covered by split cost contributions, calculated as a product of contribution-eligible earnings and the proportional contribution rate of SHI. On the basis of this logic the contribution rates for SHI increase as soon as the rate of increase in spending is greater than the rate of increase in eligible earnings.

Studies on the future trends of these contribution rates forecast a further increase from the current 14 percent to about 25 percent in 2040 (Knappe 1995, Breyer/Ulrich, 2000). The major determinants which the rises in costs and contribution rates in SHI are usually attributed to are threefold: the growing income of the population, the technical advances in the health care sector and, last but not least, the ageing of the German population, calculated as the percentage of the total population which is over 65 years of age (according to Prognos, 1998).

However, whether or not an increase in the percentage of the total population which is over 65 will actually result in greater health care costs is a moot point in the literature on the subject. Getzen (1992), Barer/Evans/Hertzman (1995), Zweifel/Felder/Meier (1999) as well as Spilman/Lubitz (2000) have all investigated whether the relationship between the level of real per capita expenditure and the proportion of aged persons in the population could possibly be an illusory correlation. The reason for such an illusory correlation could be based on the fact that the last two years of life are generally associated with a marked rise in expenditure while, at the same time, older people obviously show a higher probability of mortality than younger people (Getzen, 2001, p 175). In this case it would not be age as such, but rather proximity to the point of death for the individual concerned which is the determining factor for health care expenditure.

Zweifel/Felder/Meier (1999) actually demonstrate such an illusory correlation in two data records from deceased individuals in Switzerland who were medically insured. Their results indicate that the two last years of life in general are associated with higher costs for health care, independently of whether the insured person is 60 or 90 years old. From this the authors conclude that an increase in the proportion of older persons in the population as a result of higher life expectancy is *not* directly related to an actual rise in per capita expenditure. Higher life expectancy simply shifts the point in time at which higher costs occur to a later date.

In his comments on the work of Zweifel/Felder/Meier, Getzen (2001) refers to two important factors which put these results into perspective. On the one hand higher costs occurring in the last two years of life of the insured in Switzerland are significantly determined by the institutional framework conditions which exist there (scope of medical insurance cover etc). On the other hand, the state of health of an individual, even in the case of being affected by age, is not by any means the major determining factor for health care expenditure. The actual per capital expenditure is to a much greater degree the result of individual consumer decisions *and* the relevant existing restrictions. These restrictions can result equally from the individual consumer's budget or from the state's budget ceiling for health care expenditure (Getzen, 2001, p 177). With this Getzen quite clearly points to the interrelationship between individual consumer factors and institutional framework conditions.

When, however, the influence of such framework conditions is strong, the differentiation between functionally separated rates of expenditure and the expenditure of certain insurance carriers within the health care sector becomes relevant (Sauerland, 2002). The latter reflect not just the decisions of those supplying and those using the relevant services but also, to a greater extent, the range of services which a given health insurance financial body is prepared to fund. Consequently, the costs in question are determined by the (political) decisions of the responsible insurance carriers themselves. In contrast to this, by means of an investigation of a functionally separate expenditure amount, such as the costs for medical treatment, the influence of the funding structure, i.e. individual financing bodies and insurance carriers, on the size of such spending can be analysed.

In order to isolate the influence of the institutional framework conditions on the size of costs, this study investigates the determining factors for costs in statutory health insurance between 1960 and 1997 as well as the determinants of expenditure for medical treatment in Germany between 1970 and 1997. The aim of the study is to ascertain the determinants of the relevant expenditure amounts and to investigate whether the age structure of the population can be established as an influencing factor on these amounts.

In the following ordinary least square estimations the relevant real per capita costs, as dependent variables, enter the estimations as level values. While both expenditure amounts are deflated with reference to the same price index for health care services, the reference value for treatment costs is the total population. The expenditure of statutory health insurance, on the other hand, is related to the number of people insured.

In order to obtain the best possible estimates the effect of a great number of dependent variables on the size of expenditure is investigated. Following up on the aforementioned studies on the trends in costs of statutory health insurance, the impact of income (actual per capita) and technical advances, which are approximated by means of a linear time trend in the estimating equation, are first assessed using a 'basis model'. Finally, further variables such as age structure and the structure of service providers - measured as the number of doctors and beds per 1,000 inhabitants - are included in the equation. Equally, the percentage which the private households must contribute towards those costs (out-of-pocket payments) is included as an additional variable in the analysis of expenditure on medical treatment as part of the estimation. An increasing percentage of contributions obtained from private households goes hand in hand with a decreasing percentage of costs covered by SHI, which is a consequence of budgeting requirements and restrictions in services on the part of SHI.[1]

Additionally, the impact of significant changes to compulsory health insurance such as the ones brought about by the Health Care Reform legislation of 1989 is taken into consideration by placing appropriate dummies. Since all the time series used refer to the former Federal Republic of Germany, another dummy has been placed for the 1991 German Re-unification.

All variables are included in the equation as actual expenditure levels. In order to take the problem of a possible spurious regression between non-stationary time series into account, all standard amounts are assessed for their degree of integration. The next step is to use the procedure suggested by Engle and Granger (1987) to check whether the resulting non-stationary time series are co-integrated so that the application of the ordinary least square estimation still produces valid results.

2. Determinants of statutory health insurance expenditure

On the basis of the funding logic employed by SHI as outlined in the introduction, the estimations of trends in expenditure use the gross income, which more or less equals the contribution-eligible earnings, as the level of income.

In the analysis of the time series for the whole of the former Federal Republic of Germany from 1960 to 1997 the gross income as well as the time trend, the latter of which is a possible yardstick for technical advancements, both have a significant impact on the overall development of SHI expenditure in the described 'basis model'. Additionally, in estimation 1 the dummies placed to simulate the legal changes in SHI in 1968 and 1989 show a significant impact. On the other hand the constant is not significant.

Further, in estimation 2 the age structure of the population has an impact. Besides the gross income (given as income variable 'gi'), the population's age structure measured as a percentage of retirees among members of the SHI ('pr') as well as the linear time trend (variable for technical advancements) all have a definitive impact on the level of SHI costs.

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[1] All data has been sourced from information provided by the German Federal Bureau of Statistics

The algebraic signs of all the variables correspond to theoretically plausible circumstances. This specification also shows the dummies for 1968 and 1989 having a significantly negative impact. Apart from this, the positive dummy for 1991 becomes significant.

Dependent variable	*Real per capita expenditure of SHI log(e_shi) from 1960 to 1997*			
Variable	Estimation 1	Estimation 2	Estimation 3	Estimation 4
C	-0.0372 (-0.0228)	-4.2798 (-3.51939)**	-4.3968 (-4.4917)**	-4.1812 (-4.0811)**
log(gi)	0.7524 (4.2815)**	0.8598 (5.8414)**	0.8571 (6.6613)**	0.7089 (4.6708)**
log(pr)		1.0916 (3.5139)**	1.1122 (3.7821)**	
log(doc)			0.3345 (3.4532)**	0.7917 (5.2077)**
log(beds)				1.8275 (4.5178)**
time	0.0195 (4.6134)**	0.0100 (2.7826)**		
d68	-0.0866 (-2.1756)**	-0.3610 (-5.3749)**	-0.3447 (-5.4362)**	-0.1782 (-4.9278)**
hr89	-0.1268 (-3.2233)**	-0.0811 (-2.2809)**	-0.0711 (-2.2268)**	
ru91		0.0878 (2.2414)**	0.1142 (3.5834)**	0.2055 (4.7692)**
ar(1)	0.7079 (5.3272)**			
Adjusted R-squared	0.9896	0.9891	0.9901	0.9889
Akaike info criterion	-3.652511	-3.495190	-3.597691	-3.554890
Schwarz criterion	-3.391281	-3.193529	-3.296030	-3.424275
Durbin-Watson stat	1.6047	1.4267	1.5544	1.6881
N	37	38	38	37
	** = significant at 5 percent-level * = significant at 10 percent-level t-statistics in brackets			

Table 1: Estimations of SHI expenditure in Germany

The relevance of other possible determining factors can also be shown. In this regard, it can be seen that in estimation 3, apart from the gross income and the ongoing dominant age structure factor, the proportional number of doctors has a significant effect on SHI expenditure. Apart from this, in this estimation the significance of the dummies from estimation 2 is retained. The coefficients of gross income, age structure and the dummies for 1968 and 1989 remain virtually unchanged compared to estimation 2. Only the dummy for 1991 shows an increased coefficient while the time trend becomes completely insignificant.

Estimation 4 also contains many revelations with respect to expenditure in statutory health insurance. Besides gross income and the proportion of doctors, it includes the number of hospital beds as a variable to account for the overall trend of expenditure. In this case the effect of gross income is reduced whilst the impact of the proportional number of doctors is much greater. In contrast, the impact of the dummy variable 'd68' shrinks drastically and the dummy for 1989 becomes insignificant. The proportional number of hospital beds is the dominant influence, while the time trend remains insignificant in this specification.[2] The results of the four estimations of expenditure levels described above are contained in Table 1.

In answering the question as to which model gives the best estimation results, it is shown that the adjusted R^2 as well as the values of the Akaike and the Schwarz information criterion are all nearly identical for the four estimations. Therefore, for the purpose of simplification only estimation 2 will be considered in detail in the following.[3]

At first glance the variation of the estimation time frame shows that the specification for estimation 2 is also valid for the period from 1960 - 1990 with all the parameters. However, on examining the period from 1970 - 1997 the impact of technical advances ('time') is no longer evident (p = 0.3475).[4] The actual and the estimated amounts as well as the progress of their related? residuals from estimation 2 are given in the following Chart 1.

The residuals from specification 2 display I(0) characteristics. [5]At the same time an analysis of the dependent variables shows that SHI expenditure and gross income (both actual per capita) as well as the time series of retiree quotients 'pr' in the period under scrutiny are integrated from grade 1. In this case at least one co-integration relationship between the I(1) level variables of estimation 2 can be assumed.[6]

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[2] A White Test, however, shows that the residuals of estimation 4 show heteroscedasticity. The values established in estimation 4 were therefore calculated with a standard deviation and covariance which are consistent with regard to the White heteroscedasticity test. The significance levels of the variables change only marginally in relation to an unadjusted ordinary least square estimation.

[3] Additionally the results for the error correction models on the basis of estimations 3 and 4 are briefly reported where relevant.

[4] Estimations 3 and 4 are also valid for the period 1960-1990. While estimation 4 also retains its validity for the period 1970 to 1997, the proportion of doctors in estimation 3 becomes insignificant. (p = 0.4757).

[5] The values from the ADF test for residuals from estimations 3 and 4 are -4.5522 and -3.4097. With a critical value of -3.34 each, both residuals are stationary (integrated from grade 0).

[6] The corresponding Johansen co-integration test shows with reference to the I(1) variables as well as the exogenous dummies d68, hr89 and ru91 that three con-integrational relationships exist. This does not mean that on the basis of the individual ADF test results a trend in the estimated amount or a constant in the dependent variable is assumed.

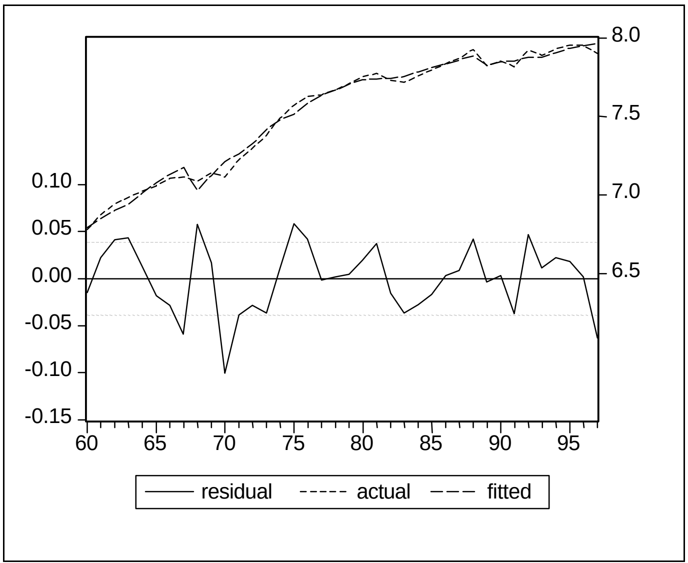

Chart 1: Estimation and residual of SHI expenditure

On this basis, according to the Engle-Granger procedure, the second step to be taken is to estimate a dynamic model in order to assess the impact of short term fluctuations on long term equilibrium values. In the error correction model the rate of change of gross income dlog(gi) and proportion of retired persons dlog(pr) (of the current and previous periods), the ratios of change of expenditures prior to measured period and the residuals which are delayed for one period ($resid\_ecm_{t-1}$) are included as dependent variables. The estimation results show for once that the delayed residuals with a negative sign have a significant impact on the change in SHI expenditure. This again confirms the assumption that at least one co-integration relation exists between the analysed I(1) variables.

Dependent variable: dlog(e_shi)
Sample(adjusted): 1963 1997
Included observations: 35 after adjusting end points

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$resid\_ecm_{t-1}$	-0.674871	0.192019	-3.514599	0.0014
dlog(gi)	0.492061	0.230835	2.131656	0.0413
dlog(pr)	-0.569480	0.247845	-2.297722	0.0287
$dlog(e\_shi_{t-2})$	0.365634	0.148769	2.457736	0.0200
C	0.012494	0.008537	1.463456	0.1537
R-squared	0.455871	Mean dependent var		0.027306
Adjusted R-squared	0.383320	S.D. dependent var		0.047959
S.E. of regression	0.037661	Akaike info criterion		-3.588803
Sum squared resid	0.042551	Schwarz criterion		-3.366610
Log likelihood	67.80405	F-statistic		6.283491
Durbin-Watson stat	1.829662	Prob(F-statistic)		0.000851

Table 2: Error correction model - SHI expenditure

In addition the results in Table 2 indicate that the change in gross income as well as the change in expenditure itself, which is delayed by two periods, affect the trends in SHI expenditure on a short-term basis. Further, changes in the retiree quotient have an identical effect.[7] It is noticeable that against expectations an increase in the retiree quotient has a negative short-term effect on the growth in SHI expenditure.

Chart 2 demonstrates the development of the relevant amounts in the error correction model as well as the relatively low explanatory value of the estimated error correction model.

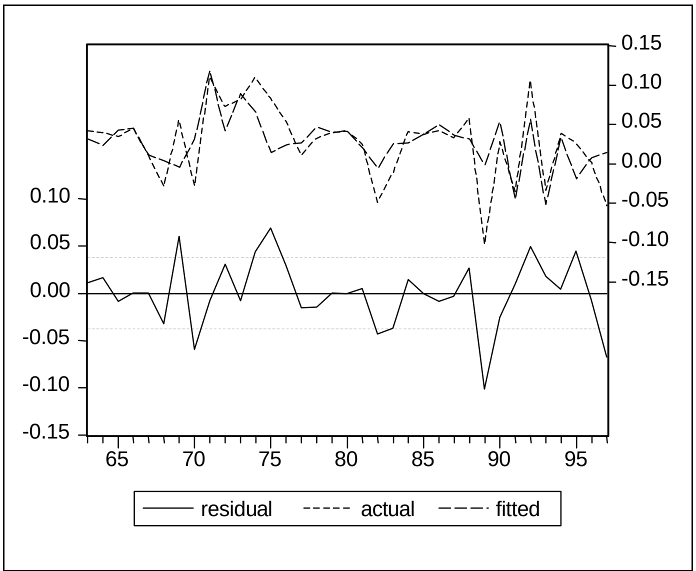

Chart 2: Error correction model and residual - SHI expenditure

3. Determinants of expenditure on medical treatment

In contrast to the case with SHI expenditure, it is the gross domestic product (GDP) rather than gross income which is used as an income variable in the functionally separate treatment expenditure.

The first step was to use the available data to ascertain whether the real per capita GDP and technical advancements actually had a significant effect on expenditure from 1970 to 1997. In this case the significant impact was restricted to the GDP. Also, in estimation 1 the dummy placed for 1989 still retains a significantly negative impact. While it is true that the trend in expenditure for medical treatment can be attributed to this estimation by more than 98 percent, the explanatory value of the regression can still be increased.

The highest adjusted R^2 with respect to the actual per capita costs for medical treatment is established using three explanatory variables: In this way GDP (as income variable), the share of out-of-pocket payments towards treatment expenditure (as financing variable) [8] and the

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[7] The error correction model based on estimations 3 and 4 yields a qualitatively identical result.

[8] It should be noted that the variable sh_oop in the estimations refers to figures from the Federal Bureau of Statistics regarding the share of out-of-pocket payments by private households in the treatment expenditure.

linear time trend (variable for technical advances) have a definite impact on the level of spending for treatment. The algebraic signs of the variables are in accordance with plausible, theoretically sound concepts. In this specification the dummy for the year 1989 also displays a significant and negative influence.

Dependent variable	*Real per capita expenditure for medical treatment* *log*(e_treat) *from 1970 to 1997*			
Variable	Estimation 1	Estimation 2	Estimation 3	Estimation 4
C	3.5626 (1.9269)*	2.2606 (3.4277)**	1.0301 (0.4695)	-6.0684 (-7.1758)**
log(gdp)	0.4416 (2.5342)**	0.3960 (5.9183)**	0.4928 (2.1797)**	
log(gdp_{t-1})				0.9076 (6.9162)**
log(sh_oop)		-0.5365 (-14.7419)**	-0.4957 (-10.2110)**	
log(doc)			0.7050 (4.8045)**	
log(age65)				1.6254 (4.7514)**
time		0.0236 (18.2005)**		
hr89	-0.0727 (-2.7192)**	-0.0616 (-5.5358)**	-0.0386 (-2.0283)*	
ru91			0.0773 (2.7829)**	0.0701 (3.0579)**
ar(1)	0.9226 (35.3035)**			
Adjusted R-squared	0.9851	0.9962	0.9936	0.9542
Akaike info criterion	-4.404354	-5.539380	-4.993151	-3.278390
Schwarz criterion	-4.212378	-5.301487	-4.707679	-3.086414
Durbin-Watson stat	1.9759	2.1246	2.2809	1.5067
N	27	28	28	27
	** = significant at 5 percent-level * = significant at 10 percent-level t-statistics in brackets			

Table 3: Estimations of treatment expenditure in Germany

A significant effect of the proportion of doctors on treatment costs can also be shown. In estimation 3 the GDP as well as the share of out-of-pocket payments are also included. In this specification the effect of the share of out-of-pocket payments in overall treatment expenditure falls slightly in relation to estimation 2. In contrast, the impact of GDP increases markedly. In addition to the dummy for 1989, the one for 1991 becomes significant with positive algebraic signs. A significant impact of technical advances (time trend) seen in estimation 2 is no longer evident in this specification. Furthermore the constant within the estimation is not significant.

Finally, estimation 4, which apart from the GDP delayed by one period (variable gdp_{t-1}) also factors in the proportion of over 65-year-olds in the population, shows the effect of the population's age structure on expenditure. In spite of the dominant and significant influence of the age structure, the impact of the delayed GDP increases markedly. In this specification the proportion of out-of-pocket payments by private households towards treatment expenditure, technical advances and the dummy variable for 1989 all become completely insignificant. The results of the described actual expenditure estimates are contained in Table 3.

As expected, the estimating equations 1 and 2 display a high and nearly equivalent adjusted R^2. With reference to both the Akaike as well as the Schwarz information criterion, estimation 2 represents the 'best' model. For this reason estimation 2 was selected as the basis for the error correction model which will be subsequently assessed. A careful analysis of estimation model 2 initially shows that this specification remains valid when the estimation period is reduced to 1970 to 1990.[9] The estimated values and the progress of the corresponding residuals from model 2 are reflected below in Chart 3.

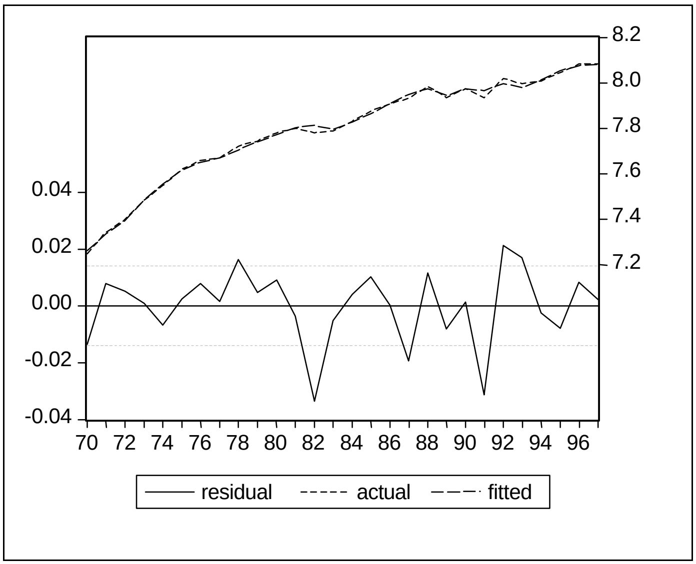

Chart 3: Estimation and residual of treatment expenditure

The test statistics of the residuals in this estimation indicate that this generated time series is stationary and shows the degree of integration l(0). At the same time an analysis of the dependent income variable shows that the GDP is integrated from grade 1. In contrast, the proportion of funding of treatment costs by out-of-pocket payments from private households is stationary.[10] Because of the stationary nature of the residuals it can therefore be assumed

[9] Variable ru91 does not apply to this reduced estimation time frame.

[10] Please compare to the test results in the attachment.

that both I(1) time series contained in the estimation of spending amounts are co-integrated and that as a second step a dynamic model can now be examined on the basis of the results obtained so far.[11] This dynamic model illustrates the short-term fluctuations around the long-term balanced value.

Only the growth rates of the income (continuing period and prior period), of the delayed expenditure variables, and the residual of the level-value estimation delayed by one measured period – as variable $resid\_ecm_{t-1}$ – are included in the dynamic model. The estimates are given in Table 4.

The estimation results show that the delayed residuals have a negative algebraic sign and that they have a significant impact on the change in the total health care expenditure. This confirms the assumption that a co-integration relationship exists between the I(1) variables which have been analysed. It is further shown that only the short-term fluctuations in the continuing gross domestic product – with the expected algebraic signs – have a significant impact on the short-term fluctuations of total expenditure.

Dependent variable: dlog(e_treat)

Sample(adjusted): 1972 1997

Included observations: 26 after adjusting end points

Convergence achieved after 7 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
$resid\_ecm_{t-1}$	-1.500335	0.365774	-4.101808	0.0005
dlog(gdp)	0.484849	0.154210	3.144087	0.0047
C	0.019690	0.010879	1.809977	0.0840
ar(1)	0.505048	0.181591	2.781238	0.0109
R-squared	0.486228	Mean dependent var		0.028468
Adjusted R-squared	0.416168	S.D. dependent var		0.034638
S.E. of regression	0.026466	Akaike info criterion		-4.285260
Sum squared resid	0.015410	Schwarz criterion		-4.091706
Log likelihood	59.70838	F-statistic		6.940189
Durbin-Watson stat	1.832072	Prob(F-statistic)		0.001851
Inverted AR Roots	.51			

Table 4: Error correction model - treatment expenditure

The autocorrelation of the residuals which is established using a Breusch-Godfrey test is factored in by including an ar(1) term in the error correction model. The trends of the relevant

[11] Since no more than two non-stationary time series are included in the estimating equation, establishing the number of the co-integration relationships by means of a Johansen co-integration test can be dispensed with.

amounts in the error correction model as well as their ability to adjust are again depicted in chart 4.

Chart 4: Error correction model and residual - treatment expenditure

4. Conclusion

If one considers the results arrived at in the preceding paragraphs some insights into the determinants of the expenditure contingents under review can be gleaned.

To begin with, the estimations of statutory health insurance expenditure largely confirm the determining factors that have also been identified in the studies cited above. There is conclusive evidence that factors such as the available income, technical advances, and also the population's age structure all have a significant impact on the expenditure level of statutory health insurance. It is remarkable, though, that the very factor of age structure as well as technical progress - measured as a time trend - do not have any significant impact whatsoever in estimation 4, while determinants shaping the supply side of health care, namely the proportion of doctors and hospital beds per inhabitant are actually highlighted. A possible explanation might be that for once the suppliers' structure more or less accurately reflects the technical advances in health care - if, for example, more doctors are required in hospitals to ensure that new equipment and treatment methods can be applied - and equally that demand increasing with the longevity of the population generates more suppliers. Such a causal relationship would, however, imply that the decision makers in health care policy, who at least in Germany largely determine the density of the network of health care service providers, actually succeeded in systematically catering for the needs of an ageing population within the context of planning the capacities required.

In contrast to overall statutory health insurance spending, the age structure ceases to be a determining factor of overriding importance in the estimations of functionally separated expenditure for medical treatment. In this context it is, above all, the share of out-of-pocket payments in the total treatment expenditure - and thus the form of funding - which moves into the foreground of the significant determinants. The best estimates are obtained by including such factors as income, the share of out-of-pocket payments in overall health care expenditure and technical advances. It is equally true, though, that the age structure may have an impact. Estimation 4, however, only draws upon the earnings delayed by one period and the dummy placed for German Re-unification. Hence the age structure is neither the only nor the best determining factor which can be held accountable for treatment expenditure levels. How can such varying results be reconciled and interpreted?

It should be pointed out that the time series available are relatively short, which in turn detracts from the reliability of the estimates. Yet if one accepts those results in spite of all the reservations, conclusions can be made from the various determining factors established as to the impact of institutional framework conditions governing the decisions taken on both the supply and demand sides of the health services under consideration.

In order to establish how the population's age structure influences statutory health insurance expenditure it is surely helpful to closely inspect the regulations that apply to this specific branch of German social security. A significant observation is that up to 1995 a health insurance fund reserved for aged pensioners (“Krankenversicherung für Rentner”, KVdR) existed alongside the General Health Insurance (“Allgemeine Krankenversicherung”, AKV), the German umbrella organisation of health insurance funds (Beske/Hallauer, 1999). One of the major characteristics of this sub-sector was that until 1987 the contribution rate was well below average. If services which are in all other respects identical to those rendered by the general health insurance are offered at a lower price, an increase in demand for aged pensioners health insurance services is at least a plausible consequence. However, then the increased demand cannot be solely attributed to age, but rather to institutional framework conditions existing within statutory health insurance.

Another possible cause for the impact of the age structure upon statutory health expenditure can be traced back to the remuneration scheme for medical service providers (panel doctors) in the outpatient sector. A system of point ratings codified in the Unified Standards for Assessment (“Einheitlicher Bewertungsmaßstab”, EBM) stipulates that the consultation index a doctor can claim on a flat rate basis for each patient treated during a given quarter will grant him a significantly higher number of points for retirees than all other patient groups. A privately practising GP, for example, is credited with 475 points for an old-age pensioner while only 265 points are given for all other patients. According to this specific billing item, a retiree consulting a doctor causes expenditures that exceed the ones incurred by non-aged pensioners by approximately 80 %. In this instance it is also the framework conditions that might lead to increased expenditure for pensioners rather than the patients' real age.

Even these two isolated examples suggest that the above-mentioned criticism put forward by Geltzen should be taken seriously, namely to focus more closely on the framework conditions in the analysis of spending patterns. The fact that the age structure obviously has an influence on the spending level of each individual health insurance carrier does not necessarily imply that the amounts spent on functionally defined health services also depend on the age structure. In order to be able to assess the possible influence of the age structure on long-term cost development, further research will be needed to explore the effects of the institutional framework conditions in health care in greater detail.

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