Modeling the Health Insurance System of Germany: A System Dynamics Approach

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Abstract

The German Health Insurance System is balanced on the edge. Decision makers seem not successful in developing and implementing sustainable health policies, which ensure at least a balanced health insurance fund. Highly dynamic factors influence the health insurance fund situation and complicate the decision making. The System Dynamics Methodology is used to examine first possible causes of the enduring problem. In the formal simulation model, we include among other variables the population dynamics, personal income, contribution fraction and health expenses per capita as well as behavioral states of the agents. Second, the model is used to conduct simulation-based policy testing to find improved decision rules. The policy 'expenses reduction pressure' forces the government to reduce health insurance expenses per request. It can improve the health insurance system situation best. The result will be a reduction of the health insurance fund shortfall. Other policies worsen the problem significantly due to increased oscillatory tendency in the health insurance system. As result of the study, the different policies are discussed separately.

Keywords: Soft System Dynamics, German Health Insurance, Sustainable Policy, Co-Payment Policy

1.   Introduction

1.1   Problem Context

In the 19th century, Industrialization gained momentum and automation forced mechanical thinking. The microeconomic production theory evolved, which supported the idea of human substitution by machine. Due to these facts, the employers considered employees as basic production factors, similar to financial funds and raw materials. As a result, production companies exploited their workers. This resulted in the deteriorating living circumstances, especially for the working class and most of these people lived under the poverty line. As a result, they did not have access to health insurance and other social security systems.

To overcome main social problems, the German Emperor Karl Bismarck established the first German State Social Security System in 1883. German citizens, with less income than a defined amount of money, automatically became a member of the Social Security System. One of Bismarck's main ideas was the 'Social Concept', where the peoples' contribution payments depended on the individuals' income situation rather than upon the individuals' requests

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(Lindner 2003). This policy ensured that the poor and the sick got adequate financial and medical support. The historical development in Germany shows the efficiency and success of this system during the early 20th century. The 1883 introduced Social Security System consisted of four pillars: Health Insurance, Pension Insurance, Unemployment Insurance, and Accident Insurance (AOK-BV 2004b).

A modern definition of the Social Security System confirms, in general, the concept mentioned above.

> "The Social Security System is a federal created, compulsive prevention system. The main task is both to avoid the occurrence of specific risks and, in case of occurrence of these risks, compensating unplanned expenditures and losses of income, under the consideration of social goals." (Görres-Gesellschaft 1989)

The general system structure of the Bismarck Social Security System still exists today. The government, however, has introduced additional nursing care insurance, as the fifth pillar in 1994. An overwhelming demand for health insurance, especially by retired people, has drained the health insurance fund drastically. Thus, this new pillar of the Social Security System was introduced to cover, in particular, nursing and nursing home expenses. Since then, these insurance efforts are no longer covered by the state health insurance (Schnabel 2004).

Figure 1 and Figure 2 show the development of income and expenditure situation for the State Health Insurance Fund, over the past eleven years. This situation is similar for the other insurance pillars.
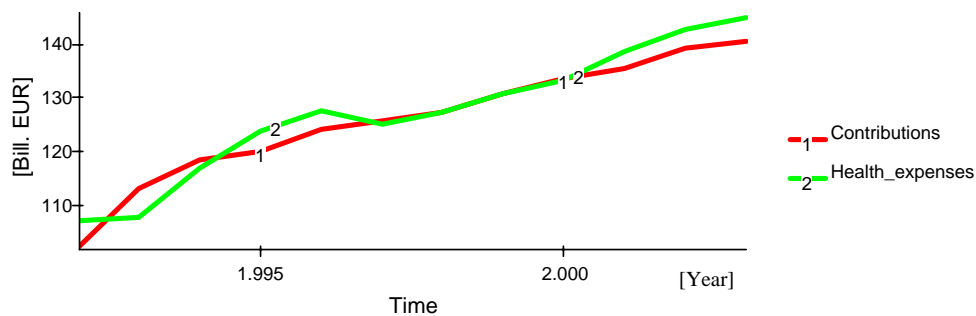

Figure 1:   Development of Contributions and Health Expenses over the past eleven Years

The graph shows a continuous growth both in contributions and health expenses, with an average growth rate of 2.8 %/year. In Figure 2, the graph shows the development of the profit and the contribution fraction. In general, both variables show a negative correlation. The higher the health insurance fund profit per year, the lower the contribution fraction will be and vice versa.
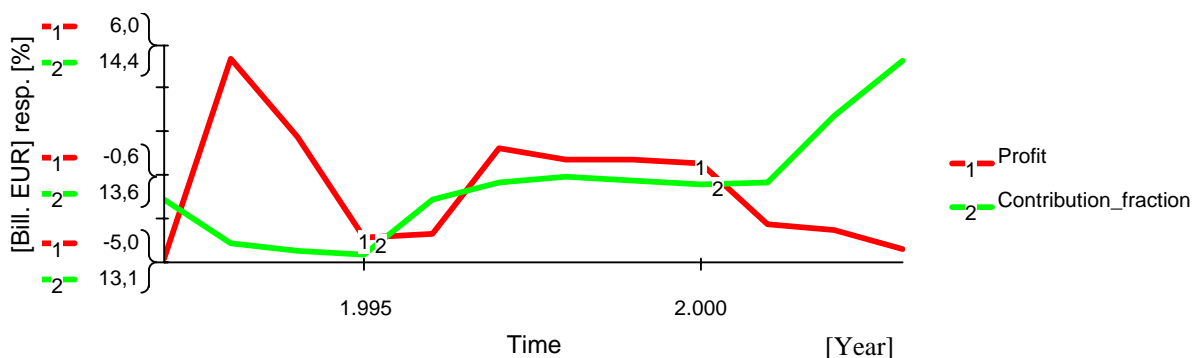

Figure 2:   Comparison of Profit and Contribution Faction over the past eleven Years
(Bundesministerium für Gesundheit und Soziale Sicherung 2003)

1.2   Problem Statement

The Social Security Fund has in average a lack of 1.3 billion Euros every year (Bundesministerium für Gesundheit und Soziale Sicherung 2003). A commission under the supervision of Roman Herzog, former President of Germany, concluded that the German Social Security System is balancing on the edge (dpa 2003). In order to preserve the social insurance principle on the one hand and maintain high service quality simultaneously on the other hand, a drastic intervention seems to be necessary. Several trials by the German Government to reduce the lack of money have not been successful, even though, they have changed the system parameters, mainly the contribution factor, in order to try to generate enough funds. With regards to Figure 1 and Figure 2, this shows that the policy changes have not to been successful. The question then arises, as to why it is not possible to stabilize the system and maintain zero profit equilibrium. Is the reason for the failure of the responsible institution founded in the system itself? Which intervention is then adequate to solve the lack of funding problem permanently? In order to find a solution to this question, this study was conducted.

We decided to work on this topic because problems in the Social Security Systems evoke serious side effects in other sectors of the economy. Germany faces the burden of high indirect labor costs, which reduce the global competitiveness of the German Industry. On a global scale, Germany is one of the countries with the highest labor costs (dpa 2003). A possible competition advantage shrinks remarkably. Less workforce demand, due to lower exports, will result in higher unemployment ratios. Smaller economic growth or even economic stagnation is highly possible.

The Social Security System, in general, and the Health Insurance System, in particular, is partially responsible for the higher indirect labor cost development. Because of the strong impact on several sectors within the country, it is worthwhile to supply in-depth research to find causes and improved policies. Each of the five sub-systems of the Social Security System has its own structure and characteristics, which differs from the other systems. On account of this, we decided to model one system in detail.

1.3   Adequacy of System Dynamics

Why is System Dynamics applicable to the problem? System Dynamics is applicable, because it and System Thinking are methodologies that can be used for solving real world problems, which highly depend upon feedback structure. System Dynamics includes concepts, which are mainly known in control theory as the mentioned feedback structure, variable interdependency and dynamic systems with strongly changing effects. In addition, System Thinking considers both long-term and short-term effects. System Dynamics is not applicable as a forecasting method, but it can be used to draw reasonable future behavior, depending upon the structure of the system. Because the German Health Insurance System structure has not changed significantly, the System Dynamics methodology was used firstly to replicate the structure and secondly to find optimal policies for solving the funding problem mentioned above. For replication of the system structure, feedback loops representing long and short-term behavior were considered. In addition, System Dynamics is helpful, because of its simulation-based theory. It is possible to evaluate simulation-based scenarios, in order to find better policies.

On the other hand exist weaknesses of System Dynamics, which can effect the applicability of the model outcome to the real world. The Social Security System, as well as the Health Insurance System, is managed by humans, who use a rather limited rational (Sterman 2000). It is

highly impossible to model irrational and sometimes arbitrary policies, because there is no structural foundation existent for this behavior. In summary, we think that the insights a System Dynamics model gives prevails the uncertainty due to the model structure.

1.4 Time Horizon

The time horizon, the period of time over which the study is accomplished, is set to be 100 years. The point of departure is the year 2001, because the needed data to build the system structure is available then. The study will range until 2101. The long time horizon period enables us to picture possible future scenarios, which include long-term dynamic effects like population development as well as short-term dynamics such as contribution adjustments.

1.5 Goals of the Study

The overall goal of this study is to find a sustainable policy for the health insurance system, considering specific factors for Germany, such as the unemployment ratio and the population development. The creation of a feasible model for the German Health Insurance System is the first step in achieving the goal. Secondly, the model should support decision makers in the fields of fund management and social health politics. Therefore, several scenario analyses will be conducted in order to find sustainable problem solving policies. A discussion of these policies and conclusions drawn from these discussions will conclude this study.

2. Dynamic Hypothesis

In the following, important feedback loops of the model will be represented as Causal Loop Diagrams. The purpose of a causal loop diagram is to expose significant feedback loops within the model boundary and plot chains of feedback (Wiener 1957). Compared with a stock and flow diagram, the causal loop diagram has the ability to show the overall inter-relationships between model variables and it can capture both short and long-term feedback loops. Feedback can be described with Wiener as: "To avoid the dangers inherent in this contingency, every effect, switch, or signal is attached to tell-tale back in the signal tower, which conveys to the signalman its actual states and performance"(Wiener 1957).

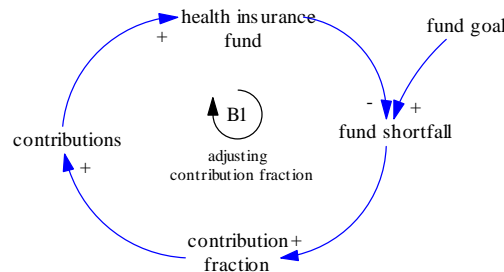**Balancing Loop B1 'adjusting contribution fraction'**

Figure 3: Loop B1 'adjusting contribution fraction'

The point of departure is a fund shortfall, which is calculated between the health insurance fund and the fund goal. A fund shortfall leads to an increase in the contribution fraction to minimize the shortfall and close a possible gap between the health insurance fund and the fund goal. The increase in the contribution fraction will consequently result in higher contri-

butions per year. Furthermore, the health insurance fund will receive additional funds and simultaneously the fund shortfall will be minimized (Figure 3).

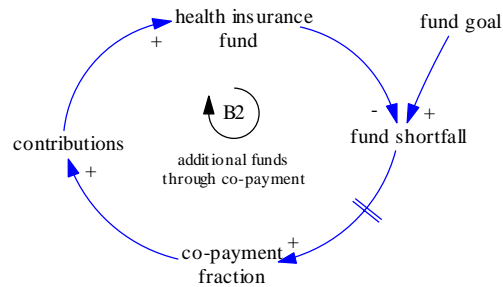**Balancing Loop B2 'additional funds through co-payment'**

Figure 4:   Loop B2 'additional funds through co-payment'

The balancing loop B2 tries to increase the contributions when there is a fund shortfall, by the means of a co-payment policy. A significant fund shortfall will cause an increase in the co-payment fraction, which will lead to higher contributions. If the contributions are higher, the health insurance fund will be supported with more financial means, which will in turn reduce the fund shortfall (Figure 4).

Balancing Loop B3 'pressure on government reduction health expenses'
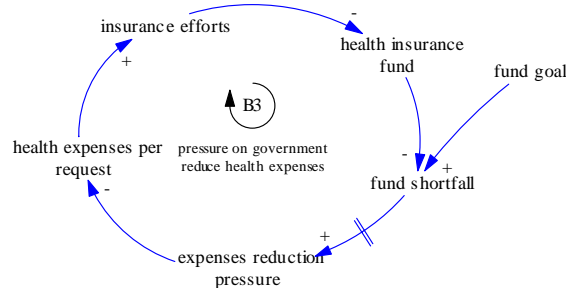

Figure 5:   Loop B3 'pressure on government reduces health expenses'

A permanent fund shortfall creates over time pressure on the government to reduce the shortfall. One possibility for the government is to reduce the health expenses by reducing the number of health requests. In Germany, we assume this alternative as not likely, because the direct reduction and denial of health insurance requests would not be considered politically acceptable. The pressure to reduce increased expenses will then result in a decrease of average health expenses per request. Consequently, the insurance effort will decline, which will shortly lead to an increase in the health insurance fund. The computed fund shortfall will decrease (Figure 5).

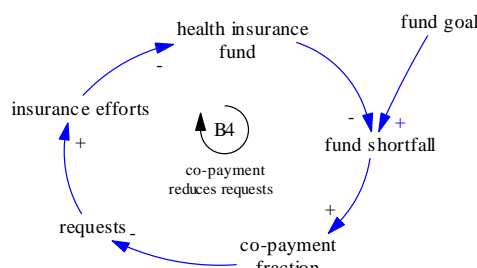**Balancing Loop B4 'co-payment reduces requests'**

Figure 6:   Loop B4 'co-payment reduces requests'

The co-payment policy variable has a second effect within the system. Figure 6 shows this effect. The already known causal relationship between the co-payment fraction and the fund shortfall is that the co-payment fraction will rise accordingly to the fund shortfall. A higher co-payment fraction will lead in turn to a decline in requests, because the co-payment fraction is a specific amount that the state insured people will have to contribute, when they utilize the health insurance system, i.e. when they visit the doctor or when they buy medicine using a prescription. If the requests are lowered, the health insurance expenses will also be less. This will immediately cause the health insurance fund to rise and the fund shortfall will be minimized.

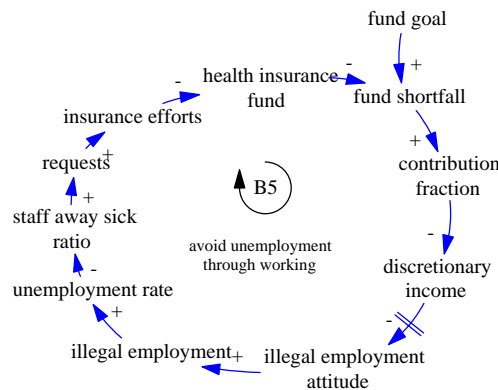**Balancing Loop B5 'avoid unemployment by working'**

Figure 7:   Loop B5 'avoid unemployment by working'

The fund management tries to cover a fund shortfall by increasing the contribution fraction. Otherwise, an increase in the contribution fraction will decrease the people's discretionary income, i.e. the part of their income they can spend voluntarily. It is assumed that people build an illegal employment attitude, when they have less discretionary income, which will in turn result in higher illegal employment. Illegally working people will fill normal job offerings, especially craftsmen activities. This will cause the unemployment ratio to rise. If the unemployment ratio is growing, people fear that they will loose their jobs and that they will have difficulties to find another job, due to the difficult economic situation. When jobs become harder to find, people tend to avoid sickness and try not to miss work. Therefore, the staff away sick work ratio, due to illness, will decrease and consequently the health requests will decrease as well. In time, the insurance efforts will decrease which will cause an increase in the health insurance fund. Finally, the fund shortfall will be reduced (Figure 7).

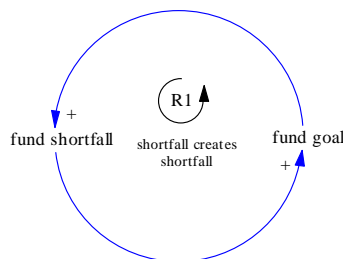**Reinforcing Loop R1 'shortfall creates shortfall'**

Figure 8:   Loop R1 'shortfall creates shortfall'

Reinforcing loop B1 shows the logic behind a fund goal policy, which considers the actual shortfall as well as the historic shortfalls. If there is a fund shortfall, the fund goal will be ad-

justed according to the fund shortfall. The result is a higher fund shortfall (Figure 8). This reinforcing loop destabilizes the system noticeably.

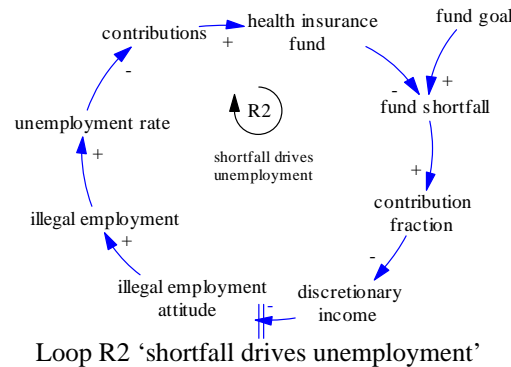**Reinforcing Loop R2 'shortfall drives unemployment'**

Figure 9:   Loop R2 'shortfall drives unemployment'

The fund management tries to lessen the fund shortfall by increasing the contribution fraction. This will, on the other hand, increase the labor costs, more precisely the indirect labor costs for the employers. As a result, the employer will have to pay more for each employee, which means that the employer will reduce or stop hiring work force. Nevertheless, we assume the referenced unemployment ratio includes the effect of rising indirect labor costs. It is therefore not shown in the above causal loop diagram. Furthermore, we assume the effect of small changes for indirect labor costs on the employment decision due to health insurance contributions as marginal. We consider more important the fact that people will decide to work illegally, when the contribution fraction rises and their discretionary income decreases. The illegal employment is building up, due to the decrease of the discretionary money. In the following, the illegal employment will rise, which leads to a higher unemployment ratio. The more people are unemployed, the fewer contributions the health insurance fund will receive. Therefore, the causal relationship between unemployment ratio and contributions is drawn negatively. Lower contributions will result in a lower health insurance fund and thus a larger fund shortfall will be created (Figure 9).

Reinforcing Loop R3 'contributions make it expensive'
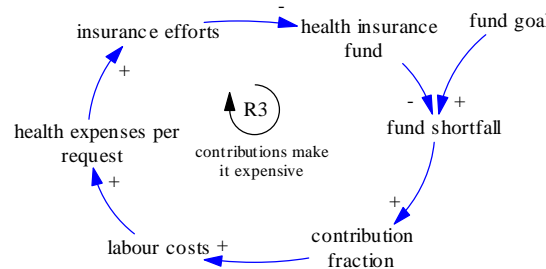

Figure 10:   Loop R3 'contributions make is expensive'

An increasing fund shortfall will drive the contribution fraction. Further, this will increase the labor costs of the employer. Higher labor costs lead to higher expenses per health request, because the salary for the employees will rise. The medical industry branch is thus directly responsible for the rise in health expenses per request. This will increase the insurance efforts and therefore drain the health insurance fund. Consequently, the fund shortfall will increase (Figure 10).

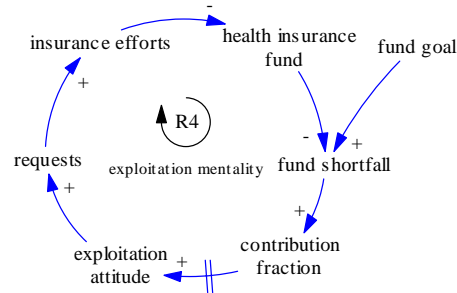**Reinforcing Loop R4 'exploitation mentality'**

Figure 11:   Loop R4 'exploitation mentality'

An elevated contribution fraction will form over time in humans an exploitation attitude, because they assume they have paid too much compared to their requests. This exploitation tends to result in a higher number of requests. A higher request number will lead to higher insurance efforts and the consequence will be a drain of the health insurance fund. To close the shortfall, the fund management will have to increase the contribution fraction even more (Figure 11).

2.2   Overview over the System Dynamics Model Structure

The model is divided into nine sectors, which are connected via several exchange variables. In the following, we describe the overall rational of each sector.

The 'contribution adjustment sector' uses 'health insurance fund' and 'actual fund goal' to compute the fund shortfall and adjust the contribution fraction, which will be fed into the 'contribution calculation sector'.

In the 'employees and retirees calculation sector', every figure regarding population is calculated. 'Total population', 'state insured employees' and 'state insured retirees' are derived from the population matrix. The last two mentioned variables, 'contribution fraction' and 'co-payment fraction' will be used in the 'contribution calculation sector' to calculate the total 'contributions' for the main sector and 'actual salary per employee'.

The 'human behavior sector' represents two human attitudes, which are depending on the 'actual salary per employee'. The 'illegal employment attitude' will affect the employees and retirees figures. The 'exploitation attitude' has an effect on the health insurance requests.

How many health insurance requests exist in Germany? This figure is calculated in the 'health insurance request calculation sector', by mainly using the effects of the co-payment, the unemployment ratio and the exploitation attitude.

In the 'health insurance expenses sector' the 'health insurance expenses' are calculated means the 'actual health requests', the 'actual salary per employee' and the 'expense reduction effect', through pressure on the government.

Finally, the 'government policy' sector introduces three governmental policies trying to stabilize the system. The first one is the 'fund goal' policy, which takes the 'debt due to support' into account. Another policy is introducing co-payment, which will increase contributions. The third policy is the 'expenses reduction pressure' felt by the government due to a fund shortfall. This will result in expense reduction.

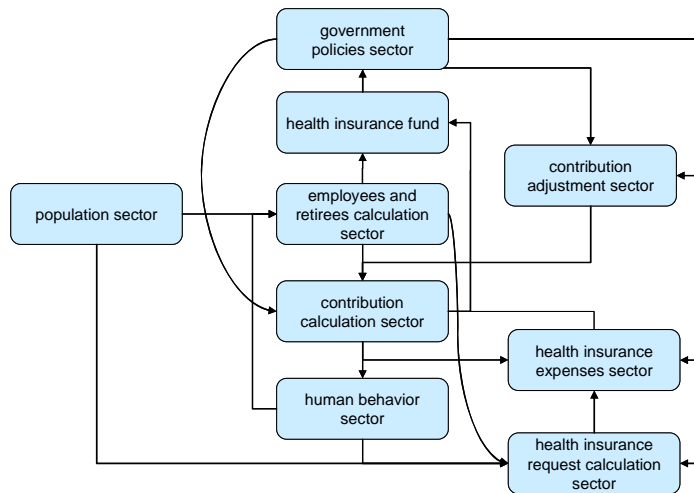Figure 12:   Overview of the Model Sectors

2.3   Model Assumptions

In order to create a functional and problem-oriented model, assumptions are needed, which limit the complexity of reality in order to receive insights. According to Forrester, it is necessary to draw a boundary chart defining endogenous, exogenous and not considered factors. Moreover, "the closed boundary concept implies that the system behavior of interest is not imposed from the outside but created within the boundary"(Forrester 1969). In order to produce the behavior being investigated, it is necessary to select relevant components. All other components are considered irrelevant for the study and are therefore outside the model boundary (Forrester 1969). Table 1 shows the model assumptions.

Endogenous variable	Exogenous variable	Excluded parameters	Policy variable
Health insurance fund	People leaving rate to private health insurance	Inflation rate	Fertility
Population	Net immigration probability per age	Population decimation by external effects	Normal net immigration rate
Employees	Initial population (both male and female)	Economic situation in Germany (GDP)	Administration expenses
Retirees	Death fraction	Effect of EU health politics on German government	Unemployment ratio
Contribution rate	Sex ratio of newborn	Technical and medical innovations	Co-payment fraction
Death rate	Birth probability over femal age	Effect of technical and medical innovations on life expectancy	
Average expenses per request	Staff away sick ratio	Reentry from private to state health insurance system	
Federal support	Autonomy ratio		
Health insurance fund goal	Direct labour costs		
Health requests			
Indirect labour costs			

Table 1: Boundary Chart

It appears in the assumptions of the model that hard and soft system thinking is used to formulate an insightful model. According to Checkland, hard system thinking is appropriate in well defined technical problems. On the other hand, soft system thinking is more appropriate in fuzzy ill defined situations, involving human beings and cultural considerations (Checkland

1999). In this elaboration, both perspectives are used to formulate a quantified simulation model (refer to chapter 3 and the simulation model in the appendix).

Exogenous Parameters

Leaving Rate to Private Health Insurance Company.
The leaving rate to private health insurance is depending on the salary per employee. In this model, the average salary per employee, rather than the exact salary distribution, is used, because the data was not available. Therefore, the private health insurance leaving rate is constant using the long-term average value.

Net Immigration Probability per Age
Net immigration probability per age is considered as exogenous parameter, as it seems highly improbable that people decide to immigrate to Germany only because of the provided health insurance, even if the health insurance in their country of origin is less comprehensive. We use a reasonable probability distribution over age to include the migration dynamics.

Initial Population (both Male and Female), Death Fraction, Sex Ratio of Newborn, Birth Probability of Females
These figures are according to actual statistical data from the German Federal Statistical Office and therefore represent the current situation in Germany. We do not consider the life expectancy explicitly, because it is inherent in the death fraction.

Staff Away Sick Ratio
We use the staff away sick ratio in the model as an exogenous, constant input, because we assume only a unidirectional relationship between the reference staff away sick ratio and health insurance requests. The higher the reference value, the more health requests there will be. On the other hand, the amount of health requests or actual contribution fraction does not affect the referenced staff away sick value.

Autonomy Ratio
The autonomy ratio is the ratio of self-employed people over employees. It is assumed constant, because no relationship between contribution fraction and the decision to work self-employed is seen.

Direct Labor Costs
We suppose no change of the direct labor costs due to the health insurance contribution fraction. However, changes in both health insurance contribution fraction and co-payment fraction will lead to higher indirect labor costs. This is explicitly modeled, contrary to the direct labor costs, which are assumed constant.

Parameters Not Considered in the Model

Inflation Rate
Inflation is not considered in the model, because the transactions between employees, respective retirees and the health insurance fund management, as well as the expenses for health insurance efforts all appear in the same year. The inflation rate would equally affect all agents. Due to this, a change in the system behavior, because of considering the inflation rate, is rather improbable. Only, if the "fund goal setting" policy were activated, would inflation influence the accumulated "debt due to support". For this case, we have considered the inflation rate to be negligible.

Population Decimation by External Effects
In the model, exceptional external effects, which could decimate or increase the population significantly, i.e. wars, terrorist attacks, atomic accidents, harm by environmental change, i.e. climate change, and deadly conterminous diseases, are excluded.

Economic Situation in Germany
We considered that the behavior of the system depended on the economic situation in Germany. However, in the model only the unemployment ratio as an aggregated variable of the economic situation in used. Other economic key values like GDP, exchange rate, import and export of commodities and services are not included.

Effect of EU Health Politics on German Government
In the European Union (EU), different approaches are followed to harmonize the independent national health insurance systems (Riesberg *et al.* 2003). Because these approaches are only momentarily discussed, no serious activities seem to have been undertaken, therefore we decided to exclude these probable effects on the German government and concentrate on the health insurance fund management.

Technical and Medical Innovations
Technical and medical innovations are not considered, because it seems to be obvious that innovative progresses, in both the technical and the medical field, can not cause the problem of fund shortfall. This is because the innovations are not available to the public, during the research stage, and are therefore relatively expensive. It is assumed that innovations will replace the existing technology, when they represent the same expense as the old technology. Thus, the health expenses, due to medical and technical treatment, will be constant over the time horizon.

Effect of Technical and Medical Innovations on Life Expectancy
It is supposed that the life expectancy is not changed by future technical and medical innovations. This does not seem to represent reality but estimations about the possible effects of innovations on life expectancy increment are highly uncertain. We found no statistical data to reasonably support any assumption.

Reentry from Private to State Health Insurance System
State insured people can leave the state system, if they earn more than a specific upper limit. They can then go to a private health insurance system. The re-entering of people from the private health insurance system to the state system is not modeled, because firstly, there is no reliable data about this issue available and secondly we considered this number as marginal, during the work life of the people. It is assumed that half of the employees will come back to the state health insurance, after their work life.

Policy Variables
In contrast to the exogenous variables, there are the policy variables considered as not constant over time. Furthermore, the chosen policy variables can be influenced directly by the government and fund management, through different political programs.

Fertility
The implicated fertility rate for Germany is according to the statistical data Zahn (2004). However, politicians have been discussing how to increase the birth rate per woman. Actual studies show that their attempts to increase the birth rate have not been successful (Rasche 2004).

Normal Net Immigration Rate
Current discussions in Germany concentrate on population development for the next century. Some activities are considered in order to stop the population from declining. Besides an increase in the birth rate per woman, immigration politics are getting more important. Several alternatives of the normal net immigration rate are discussed (Statistisches Bundesamt Deutschland (2003).

Administration Expenses
Administration expenses are important for the setting of the contribution rate, because the quota of administration expenses, regarding health expenses, reached 6% in the year 2001. Therefore, the contribution fraction is driven by the administration as well. A sustainable administration expense policy could help to decrease the contribution fraction permanently.

Unemployment Ratio
The unemployment ratio has an indirect effect of the contributions. Because the unemployment ratio is fluctuating in reality, with a small bandwidth, the contribution payment base is changing constantly.

Co-payment Fraction
Co-payment fraction is an additional and fast responding means of the government. The co-payment fraction will change both the contribution and expense side of the system very rapidly.

3. Model Validation and Analysis

The model validation process included both structural, behavioral and structural-behavioral analyses. Extreme tests with the policy variables Fertility, Unemployment ratio, contribution fraction, retirement age, labor market entrance age, and fund goal have been executed. Each run created reasonable model behavior.

3.1 Base Run

The model settings for the base run are briefly described in the following paragraphs. For the base run, all assumptions built in the model are activated. The administration expense fellows a continuous linear expense growth path. Furthermore, the actual unemployment ratio affects the staff away sick ratio and results in a decrease of health requests. In addition, adjustment of contribution fraction has also effects on the illegal employment attitude and the exploitation attitude. Besides, the employee and retiree number is computed from the population sector, meaning that actual and dynamic figures are used. A growth rate for employees' salary and retirees' pension is assumed. In the base run, no additional exogenous input is used.

The health insurance fund is the most important variable of the German Health Insurance System and is analyzed first. Compared to the reference mode, the base run shows fewer oscillations, but greater permanent fund shortfalls (Figure 13).

To understand this behavior, a detailed analysis is necessary. The population development can be seen from Figure 14. With an initial value of more than 82 million inhabitants, the number decreases, over time to around 58 million people. This is one of the major factors for the behavior of the total system. The amount of people, financing the health insurance fund, is eroding every year.
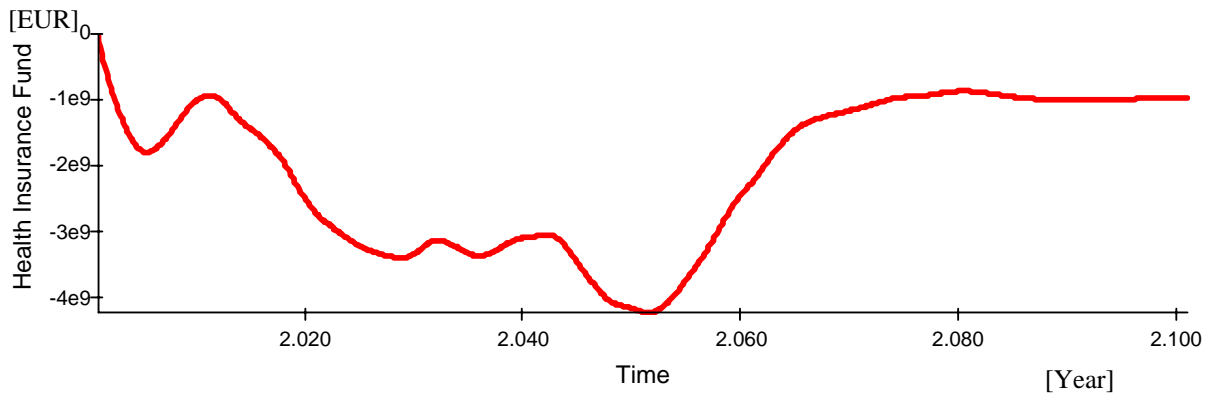
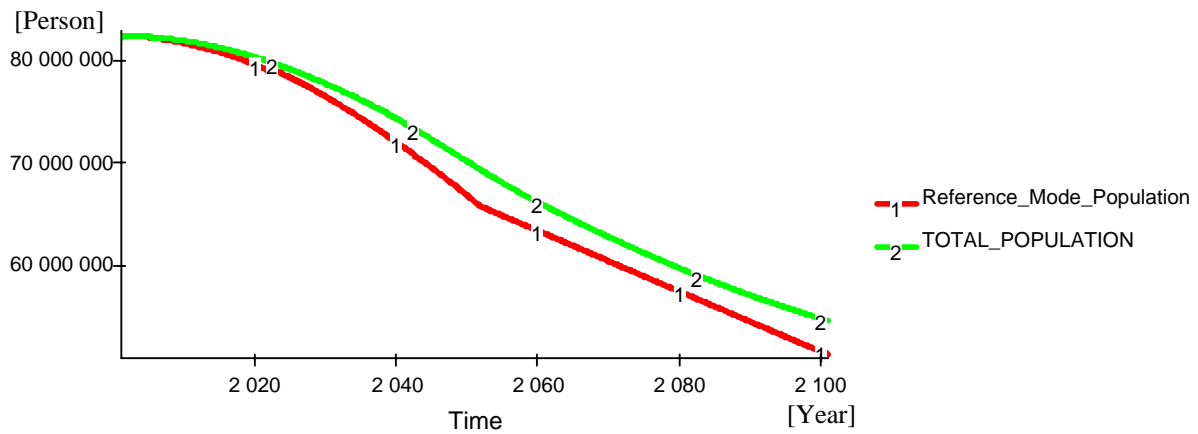Figure 13:   Base Run: Health Insurance Fund

Figure 14:   Population Development Compared to the Population Reference Mode

In addition, administrative expenses increase every year with a constant slope of 3.92 [fraction]. This second factor makes it, in combination with the population development, impossible to have a dynamic equilibrium, because the change in population figure causes a change in contributions and health requests. On the other hand, the rise of administration expenses affects only the expense side. Therefore, the inflow will not change according to the outflow. Thus, a mismatch of inflow and outflow exists. Consequently, the health insurance fund cannot be in dynamic equilibrium. Moreover, these dynamic effects cause the attached system to adapt.

In the following, each side of the health insurance fund is analyzed separately, in order to obtain an explanation for the health insurance fund behavior. With regards to the following analyses, in chapter four and five, the expense and contribution rates have dimensions of around 130 to 150 billion [euro]. The fund shortfall reference value is pushed to reality and set to a value of one billion [euro], which is approximately 0.75 per hundred of the rates dimension. Small changes of this size can't be seen in either the contribution graphs or in the health expense graphs.

Contribution Side
At year 2001, the contribution inflow exceeds the health expenses outflow. The administration expenses cause a found shortfall, which will cause a positive shortfall ratio. As result, the contribution rate will increase, whereby the contribution inflow rises. In addition, the actual salary per year will increase after a time delay of four years. This also causes an increased contribution inflow and the health insurance fund shortfall declines. Figure 15 shows parameters, which primarily influence the contribution fraction. For the first five years, the variable 'total retirees' grows stronger than the 'total employees' variable due to the initial values of

the population cohorts and depleted the employees. The fund shortfall rises, because the contributions paid by employees are higher than those paid by retirees. This causes lower contributions and leads to a greater fund shortfall. From year 2005 until year 2010, the total retiree number falls. At the same time, the variable 'total employees' rises causing more contributions. From year 2010 until year 2050, the total amount of employees steadily decreases whereas the amount of retirees increases until around year 2035. This leads to a reduced contribution growth rate. The contribution fraction adjustment, in the beginning of year 2030, is increased to compensate the reduction in employees. Furthermore, the contribution fraction adjustment is steeper, when the number of retirees reaches its maximum value around the year 2035.
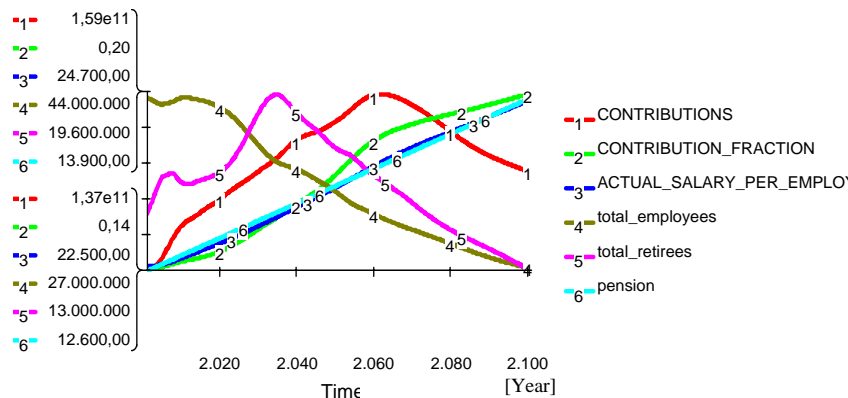
Figure 15:   Base Run: Contribution Side

Health Expenses Side

Figure 16 is explained as follows. The fund shortfall causes a rising contribution fraction. However, due to the rising contribution fraction, the exploitation attitude is building up. This leads, in general, to more health requests (curve 3). After year 2020, this effect is significant. It reaches the maximal value of 1.14 [dmnl] around the year 2060. This increases the health requests by 14 percent. Contrary, due to rising contribution fraction, the illegal employment attitude rises by 20 percent and leads to more unemployment (curve 4). The higher unemployment ratio will reduce the staff away sick ratio by approximately nine percent (curve 1). In consequence, the lower staff away sick ratio will reduce the request per capita by six percent (curve 2), meaning that employees do not try to miss work. In general, both of the human behavior effects have an asynchronous behavior. The result is an increase in health requests, because the exploitation attitude is more effective than the illegal employment and staff away sick effect on health requests. The result of both effects is the "multiplier request per capita" (curve 5).
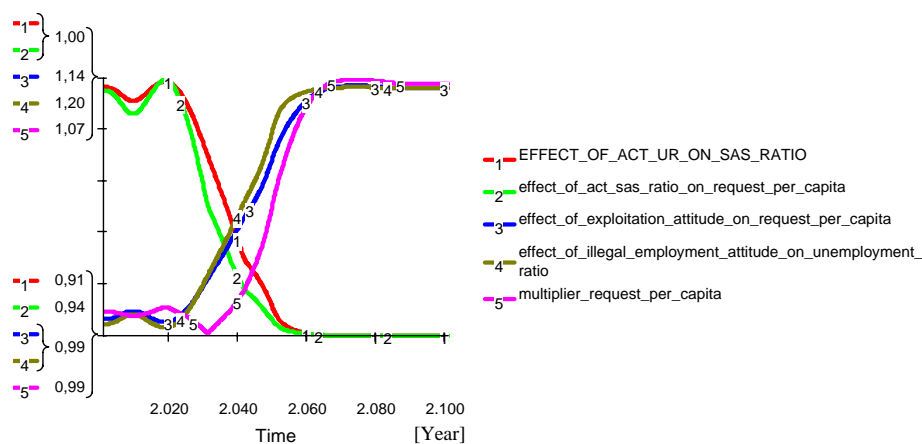

Figure 16:   Base Run: Effects on Request per Capita

The recently calculated 'multiplier request per capita' (curve 5, Figure 16 or curve 2, Figure 17) and the state insured population[2] is used to calculate the actual health requests (curve 1, Figure 17). Obviously, the amount of health requests depends strongly on the state insured population. The request multiplier has only marginal effects. However, a net effect of seven percent due to human behavior is considered significant. Because of the dependency of the actual health requests and the population, the actual request number mainly follows the population (curve 1 and curve 3).
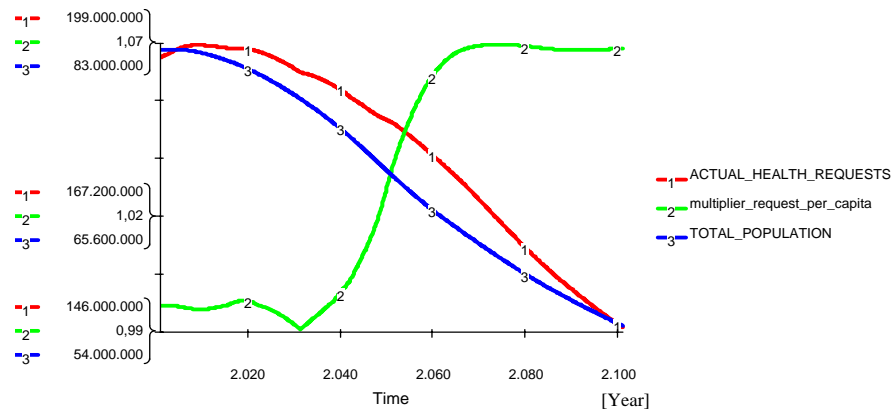
Figure 17:   Base Run: Calculation of Actual Health Requests

If the contribution rate is rising, so does the actual salary per employee. Figure 18 shows the effect of the contribution fraction (curve 1) on the actual salary per employee (curve 3). From year 2010 until year 2050, the actual employee salary is slightly less than the assumed constant salary growth. From around year 2060 until year 2090, the actual salary is then slightly higher, because of the growing contribution fraction. There is a lag time between both variables due to an information delay of four years.
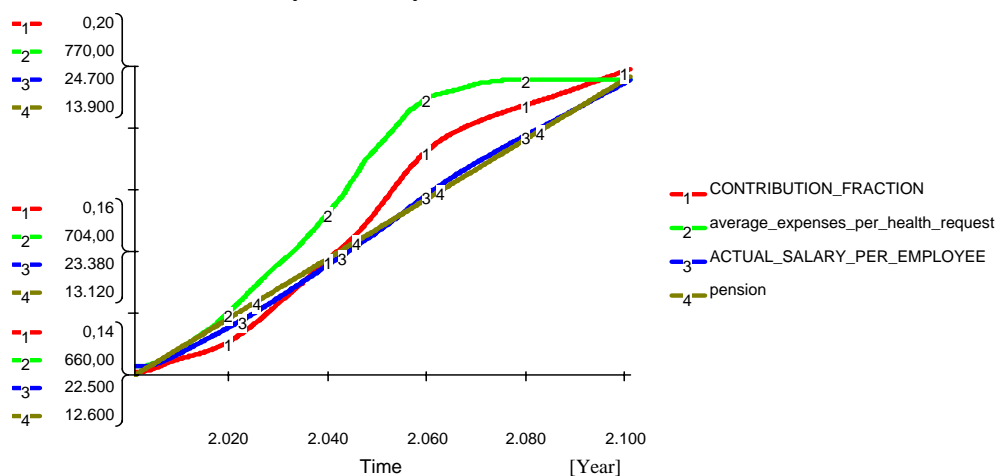

Figure 18:   Base Run: Calculation of Average Expenses per Health Request

Pension payments are not effected in value by changing the contribution rate. Therefore, pensions grow only with a constant slope, due to the salary and pension growth rate (curve 4).

In accordance with the actual salary per year, the average expenses per health request rise significantly from 660 [euro] to 770 [euro] and saturate around this level (curve 2). The satu-

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[2] The total population is shown as curve 3. The state insured population is simply the 0.75 percent fraction of the total population. We used the graph of the total population, because the state insured population is not available as a single value, only as an array. In addition, the behaviour, over time, is the same for both variables.

ration occurs less, because of a saturating contribution fraction, than the maximum increment in health expenses per health request of an assumed 10 percent.
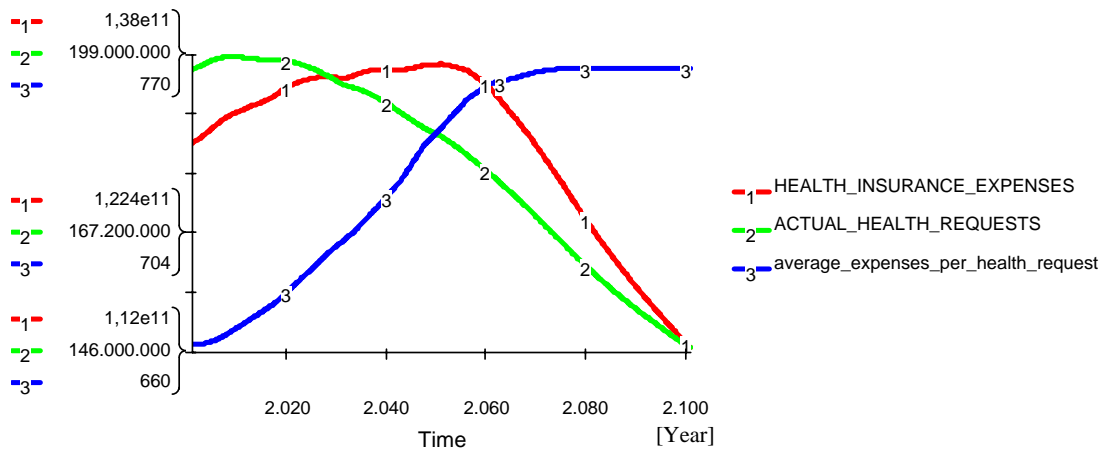

Figure 19:   Base Run: Calculation of Health Insurance Expenses

As result for the health expense side, Figure 19 shows the development of health insurance expenses (curve 1). Actual health request behavior (curve 2) depends mainly on the population development, with slight adaptations from several effects. The average expenses per health request (curve 3) have significance, especially during the period from year 2001 until year 2060. After year 2060, the further rising of the contribution fraction is not reflected in the average expenses per health request, due to the assumption of a maximum increase of 10 percent.

Figure 20 shows the contribution fraction development (curve 2) compared to the reference mode for the contribution fraction (curve 1). Obviously, the contribution fraction development does not depend on the contribution fraction adjustment delay as assumed. Therefore, the actual contribution fraction is smoothed. Nevertheless, the adjustment height of the fraction is similar in both cases. Thus, the long-term development is well captured by the reference mode.
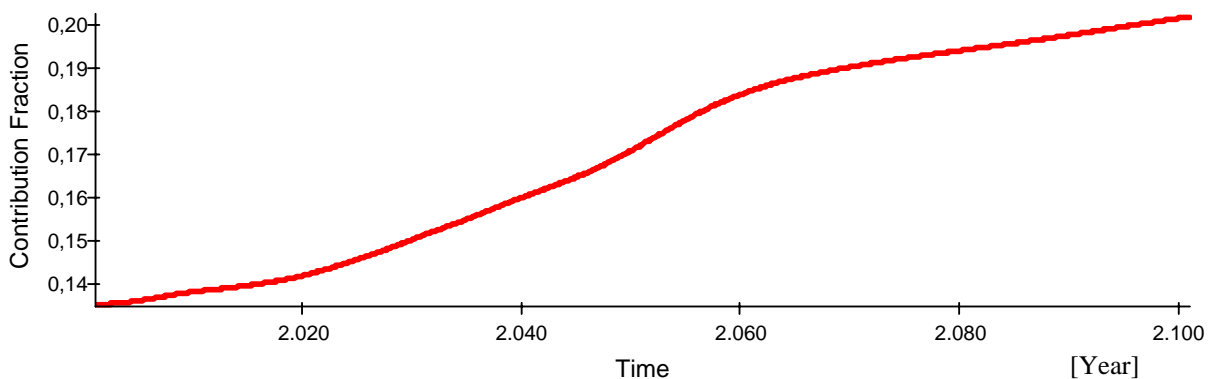

Figure 20:   Base Run: Contribution Fraction

3.2   Sensitivity Analysis

Sensitivity analysis comprises, in contrast to the extreme value analysis, moderate changes in specific variables, which are reasonable for the reality. Therefore, practical and graspable parameters are chosen and varied in feasible ranges. Policy improvements can also be derived from sensitivity analyses.

Fertility Rate

For this run, different fertility rates are used to analyze the sensitivity of the model to this variable.
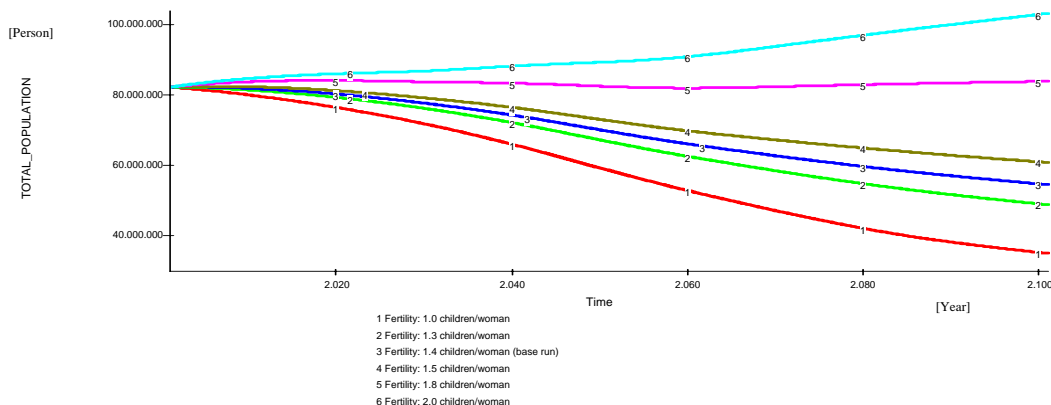

Figure 21:   Sensitivity Analysis: Fertility Rate

The variable 'fertility' is changed in the range from 1.0 to 2.0 [children/women]. The value of 1.4 [children/women] signifies the base run value, which is the actual statistical value in Germany (2001). Figure 21 and Figure 22 show the results for the population development and the health insurance fund. The fertility rate measured in children/woman for the different fertility rate assumptions are: 1.0 (curve 1), 1.3 (curve 2), 1.4 (curve 3), 1.5 (curve 4), 1.8 (curve 5) and 2.0 (curve 6.)

Figure 21 shows that a fertility of 1.8 is needed to stabilize the population development around the starting value of 82 million people. A fertility rate of 2.0 would lead to an increase in population near to 100 million people by the year 2101. Any value below the equilibrium value of 1.8 leads consequently to a decline of the population.

The result for each fertility assumption is shown in Figure 22. Apparently, a higher fertility ratio worsens the situation at the very beginning of the simulation. Curve 6 (2.0 children/woman), during the first 20 years, is permanently and significantly lower than curve 1 (1.0 children/woman). The following reasoning is behind the contra intuitive behavior: The average age entering the labor market is set to '18 [year]'. Therefore, the newborns can first enter the labor market after this 18-year period. Until then, they are consumers of health insurance efforts. This causes a stronger negative shortfall in the health insurance fund. After the year 2045, the situation is turned. The higher the fertility rate, the smaller the fund shortfall, because the higher number of employees and retirees contributes more contribution payments.
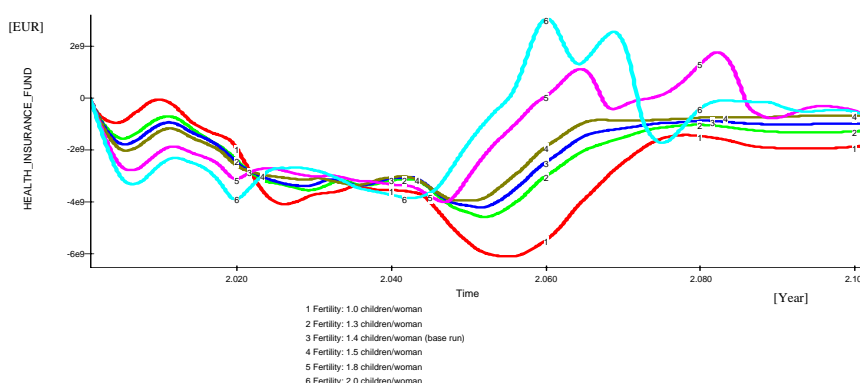

Figure 22:   Sensitivity analysis: fertility

This sensitivity analyses gives important insights. If the government is able to increase the fertility rate abruptly, it has to face the first 20 years of higher health expenses. The situation will be improved after a time period of around 45 years.

Net Immigration Rate

In the following, the sensitivity of the model regarding the net immigration rate is analyzed. The used values of 100.000 people/year (curve 1), 200.000 people/year (curve 2; base run) and 300.000 people/year (curve 3) are derived from a study of the German Population Development Office (Statistisches Bundesamt Deutschland (2003)).

Figure 23 shows the effect of the different net immigration rates on the total population. Evidently, the following relationship is valid: The higher the net immigration rate, the higher the total population. A change in the net immigration rate of 100.000 people/year will result in a 15 million people higher population after 100 years. In order to stabilize the actual population of Germany, a net immigration rate of around 400.000 people/year is needed.
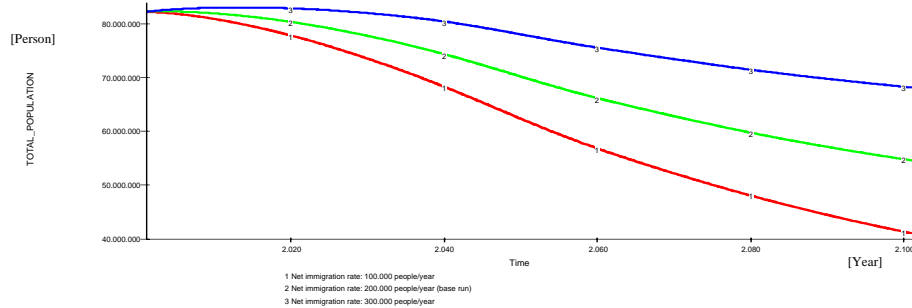

Figure 23:   Sensitivity Analysis: Net Immigration Rate

In Figure 24, the effect of increasing the immigration rate in contrast to the birth rate is seen. The higher the net immigration rate, the lower the fund shortfall on a permanent basis. This is contrary to the birth rate effect, which is shown in Figure 22.

This behavior is reasonable, because most of the immigrating people are older than 18 years of age. If they immigrate to Germany, they will immediately enter the labor market and pay contributions to health insurance fund. There is no childhood time delay, which causes health requests and expenses, but no contributions.

This analysis gives additional insights. By increasing the net immigration rate, it is possible to minimize the fund shortfall, because mainly adult people will immigrate, which can instantaneously start to work. Nevertheless, there is a very strong side effect, which decision makers must consider. By increasing the number of inhabitants only through net immigration, the national ability to sustain the population will be reduced. Consequently, the country would be depending on the immigration.
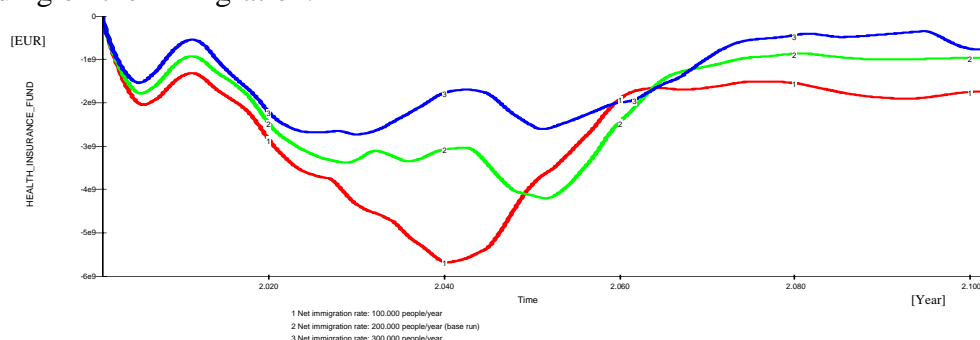

Figure 24:   Sensitivity Analysis: Net Immigration Rate

Reference Contribution Fraction

As a third sensitivity variable, the reference contribution fraction is selected, because we assume a strong sensitivity of this variable on the health insurance fund. To test the sensitivity five different values are used. Figure 25 shows the different developments of the contribution fraction for the runs (starting value of 0.12 percent, curve 1; 0.13 percent, curve 2; 0.1358 percent, curve 3; 0.14 percent, curve 4; 0.15 percent, curve 5).

The following development can be seen: If the reference contribution fraction is higher at the beginning than the actual reference contribution fraction (0.1358 [fraction]), an adjustment process will reduce the fraction (curve 4 and 5).
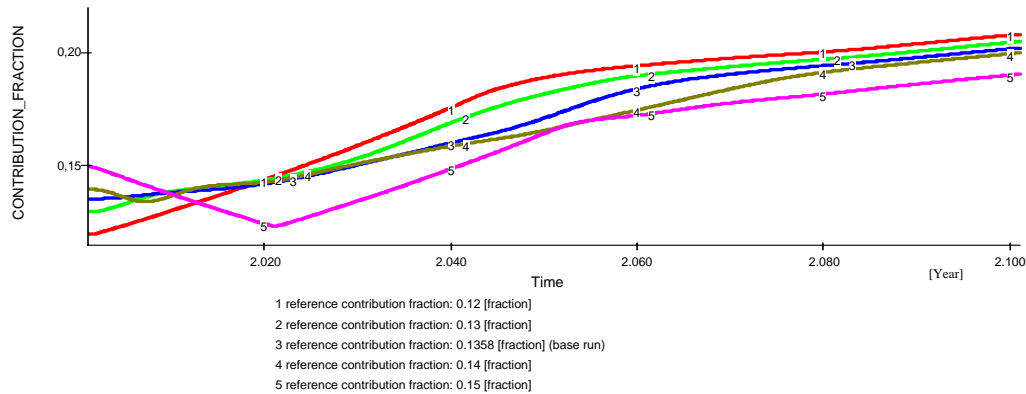

| Figure 25: | Sensitivity Analysis: Reference Contribution Fraction |

This leads to a permanent lower contribution fraction due to the first correction. For this case, the reference contribution fraction is set lower than the actual reference value. In the long run, the fraction will increase steadily with higher values for the contribution fraction (curve 1 and 2).

The effect of the different reference contribution fractions on the health insurance fund is shown in Figure 26. If the reference value is either higher or lower than the reference contribution fraction for the base run (0.1358 [fraction]), a positive or negative health insurance fund will appear, which will lead to the contribution fraction adjustments. Curve 4 and curve 5 show positive, whereas curve 1 and curve 2 shows negative, adaptation processes. In the end, the health insurance fund reaches, in either case, a steady state value in a bandwidth of one million Euros.
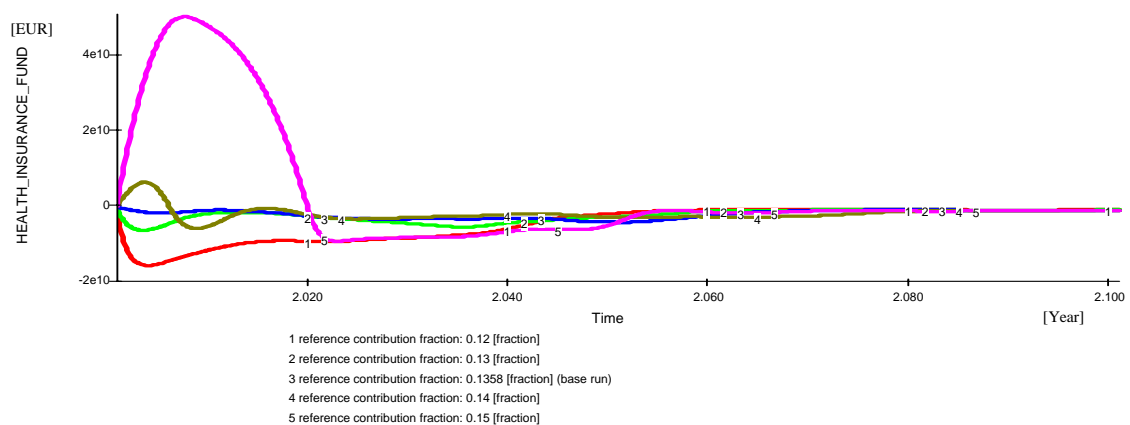

| Figure 26: | Sensitivity Analysis: Reference Contribution Fraction |

Recapitulate, the initial value of the reference contribution fraction is the point of departure for the behavior of the total system. The health insurance fund will reach in the end nearly the

same value for different starting values, even thought, the single contribution fractions are different for each starting value.

Contribution Fraction Adjustment Effect
For this sensitivity analysis, the nonlinear relationship 'effect of shortfall ratio on contribution adjustment fraction' is slightly changed. This relationship is assumed to be strong sensitive parameter. Small changes in the contribution fraction lead to larger changes in the contributions due to the large total income figures.

Four different runs are conducted. The first run is the base run, with the nonlinear relationship seen in. Figure 27 shows the impact of the different relationships on the contribution fraction, whereas the curve represents the base run, curve 2 to curve 4 represents the different variations of the nonlinear relationship. The chosen assumptions about the relationships cause slightly different contribution fractions, especially during the years between 2040 and 2070. Moreover, the lower the slope of the nonlinear relationship is, the fewer the adjustments of the contribution fraction (curve 2 compared to curve 1).

Figure 28 shows the effects of the accomplished changes on the health insurance fund. Changes with only 0.01 - 0.02 [fraction] in magnitude, causes an additional fund shortfall of one million at its maximum difference around the year 2055.
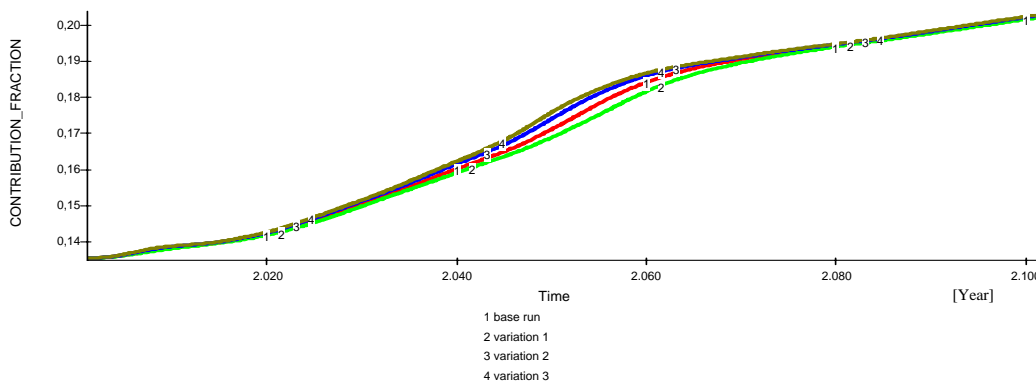

Figure 27:   Sensitivity Analysis: Contribution Fraction Adjustment Effect
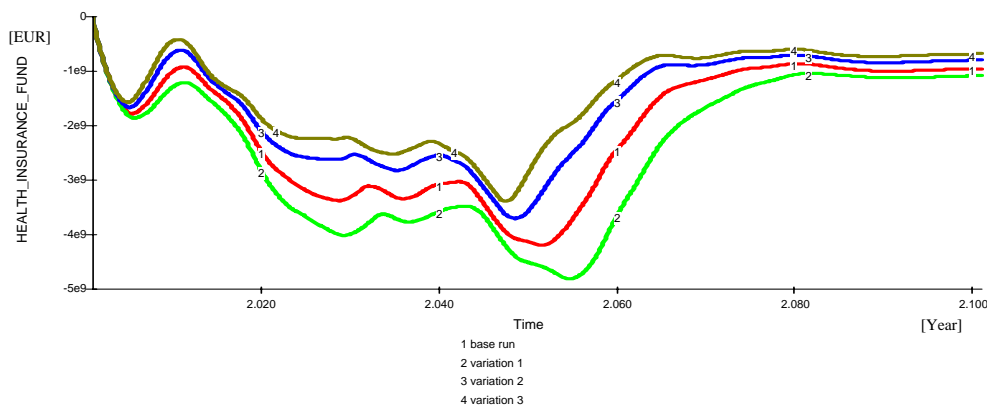

Figure 28:   Sensitivity Analysis: Contribution Fraction Adjustment Effect

In conclusion, the health insurance fund, as one of the most important entities of the model, is highly dependant on the effect of the shortfall on the contribution adjustment. This effect represents the policy of the fund management and how to adjust the contribution according to a fund shortfall. In the sensitivity analysis, a higher slope of the contribution adjustment effect seems to be preferable in order to close the fund shortfall. However, a higher slope means

stronger adjustment effects, if there are greater shortfalls. The system tendency to oscillate is strengthened by stronger contribution adjustment effects.

4.   Policy Testing

Policy testing can be done by two different approaches. The first approach is by changing parameters that already exist in the model. We consider this as soft policy testing, because the model remains the same structure while it is tested.

The second approach is changing the structure of the system, by introducing new feedback loops, by means of a new system structure. This is considered structural policy testing.

4.1   Soft Policy Testing

In chapter 3.4, 'sensitivity analysis', we have already analyzed the effects of several changes of model parameters, such as the fertility rate, net immigration rate and contribution fraction. The main insights are summarized in this chapter. Further soft policy testing runs are possible, i.e. for retirement age and average age entering the labor market.

The fertility rate policies face a time delay of about 20 years until the effects can be seen. This means that the situation during the first 20 years will be worsened rather than improved. In terms of the legislation period, it is impossible to build party politics only on this parameter, because almost five legislation periods are needed to see the results. However, after this policy delay period a sustained improved situation is present.

The net immigration rate policies show results in the short and long-term perspective. However, it is necessary to challenge one underlying assumption. The preferred net immigration rate is a demanded amount. In this model, it is assumed that the demand will be fulfilled permanently. Over a time horizon of one century, it is highly improbable that in reality the demand will be fulfilled constantly.

Contribution fraction changes are the easiest way of changing the system behavior. Therefore, the health insurance fund management mostly uses this type of adjustment. But, as the sensitivity analyses shows (Figure 25 till Figure 28), the contribution fraction is a highly effective leverage in this system. It is very easy to cause oscillatory behavior, due to over adjustments.

4.2   Structural Policy Testing

'Health Insurance Fund Goal Adjustment' Policy
The 'health insurance fund goal adjustment'-policy considers the fund debt, which is created due to federal support. In the stock and flow diagram of the main sector, the stock 'debt due to support' represents the accumulated federal support.

This policy uses the created debt to formulate the actual fund goal for the health insurance fund. The stock and flow diagram for this policy is included in the 'government activities' sector).

Figure 29 represents the system behavior, with and without the described policy. If the policy is inactive, the actual fund goal (curve 1) is zero due to the fact that the support (curve 3) rises according to the fund shortfall (curve 1, Figure 30).

If the policy is switched on, the actual fund goal (curve 2) is a time-delayed blueprint of the 'debt due to support' variable.
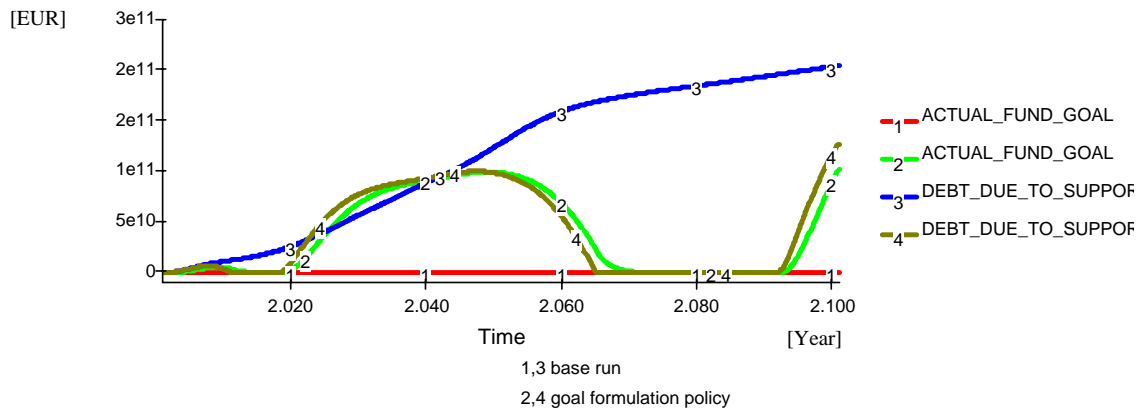

Figure 29:   Health Insurance Fund Goal Adjustment Policy: Debt and Actual Fund Goal

Figure 30 shows the result for the health insurance fund. The health insurance fund, without the 'goal setting'-policy shows small negative values (curve 1, figure 64 or more detailed: curve 2, Figure 13). The health insurance fund with active policy, shows, especially during the years from 2065 to 2092, strong overreactions due to strong contribution fraction adjustments.
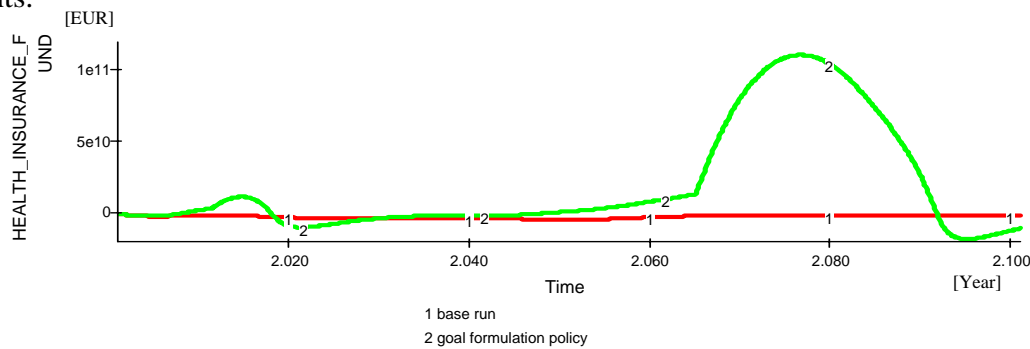

Figure 30:   Health Insurance Fund Goal Adjustment Policy: Health Insurance Fund

This policy is not adequate to improve the health insurance system, because a possible fund shortfall will increase the "debt to due support" variable, which causes a larger fund shortfall and thus stronger adjustments in the contribution fraction. This reinforcing loop leads to over-reactions in the contribution fraction adjustment, due to the delayed adaptation process and the repayment condition. Only if the health insurance fund has a positive balance, can repayments be made. Because the system is highly sensitive to the contribution fraction, the over adjustments occur and will destabilize the system.

'Corner Cutting Pressure on Government' Policy
If the prices for health products grow either to fast or to high, the government must take actions to contain these expenses by increasing the effects on the health insurance system (Bundesministerium für Gesundheit und Soziale Sicherheit 2004). This assumption underlies the 'corner cutting pressure on government' policy. The pressure on the government occurs, because of a shortfall in the health insurance fund and the government has to support the health insurance fund. The governmental budget is limited, meaning that a reallocation of the financial means, is needed in order to support the fund. This means that budget reductions will be necessary in other sectors of the national economy. These other sectors will create pressure on the government to reduce the lack of money that the health insurance fund needs, in order to avoid budget reallocations.
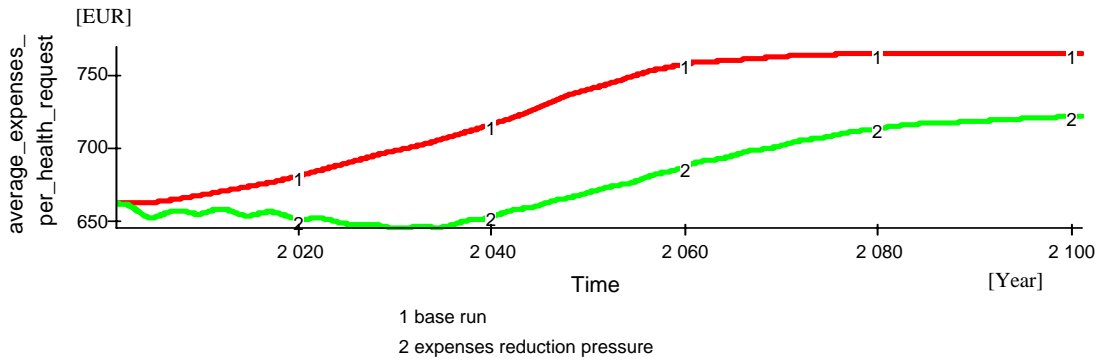
Figure 31:   Corner Cutting Pressure Policy: Average Expenses per Health Request

Figure 31 shows the successful reduction of the average health expenses per health request (curve 2) compared to the average expenses per health requests during the base run (curve 1). If the policy is activated the fund shortfall will create expense reduction pressure, which will result in a health expense reduction effect. As a result, the health insurance expenses will decline (curve 4 compared with curve 3). Because of lower health expenses, the contribution fraction can be lower than in the base run, where the policy deactivated. Figure 33 represents the described behavior of the contribution fraction. Lower contributions will follow in sequence with the lower contribution fraction (Figure 32, compared curve 1 and curve 2).
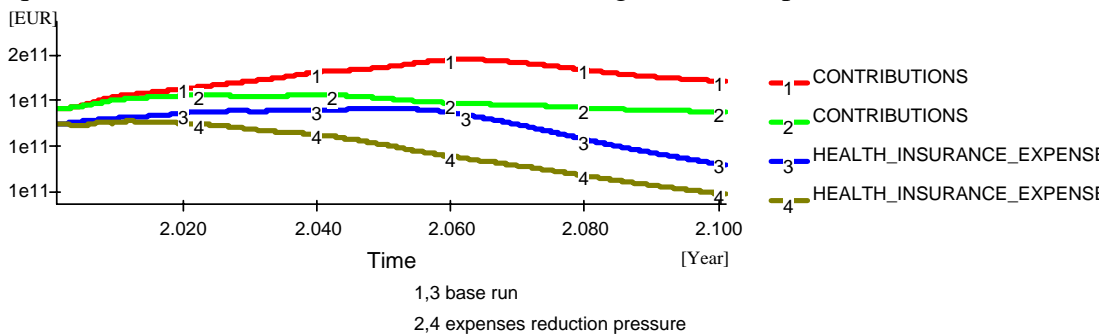

Figure 32:   Corner Cutting Pressure Policy: Contributions and Health Insurance Expenses
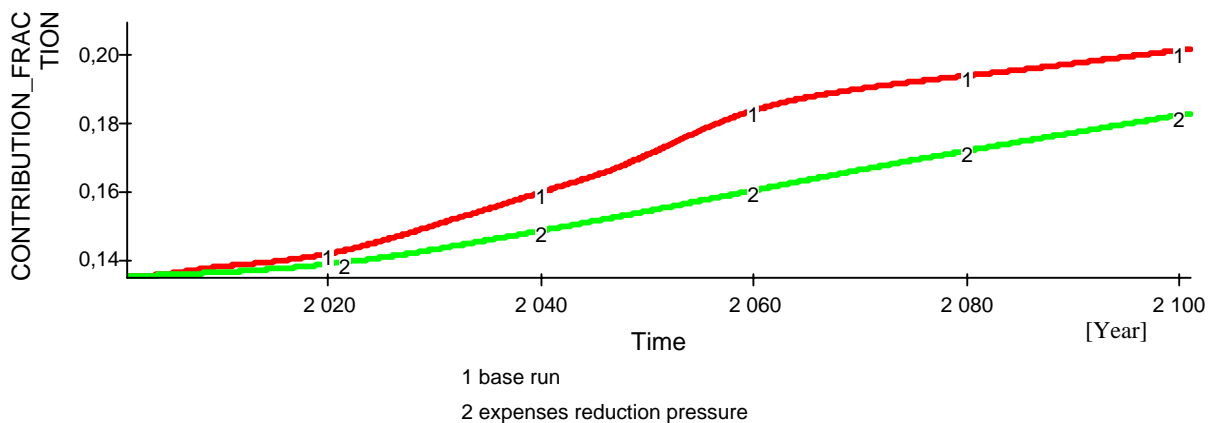

Figure 33:   Corner Cutting Pressure Policy: Contribution Fraction

The resulting effect of the 'expense reduction pressure' policy on the health insurance fund is shown in Figure 34. Due to lower health expenses, the fund shortfall is lower until year 2060. Because of the permanent lower contribution fraction, the fund shortfall cannot be reduced as quickly as without the policy.
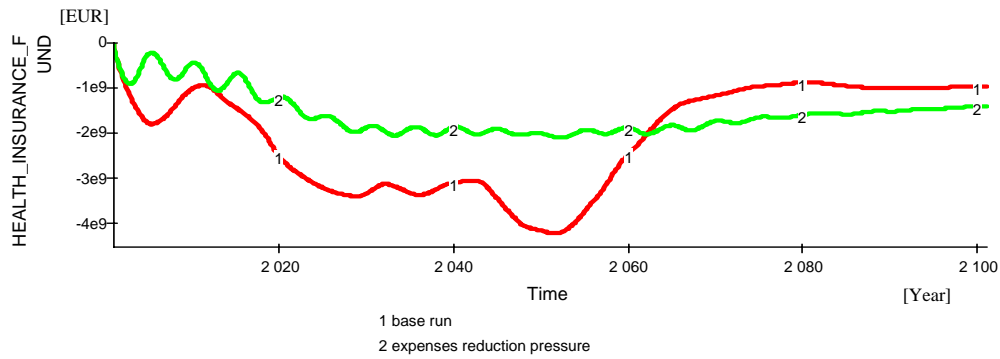
Figure 34:   Corner Cutting Pressure Policy: Health Insurance Fund

'Co-Payment' Policy

Another answer from the government on a fund shortfall could be the introduction of a co-payment policy. People have to pay additional contributions to the fund, which are independent from the original contribution fraction, when there is a fund shortfall. The stock and flow representation of this policy is in the 'government activities' sector. The reference co-payment fraction is set to 0.01 [fraction].

If the policy is active, the original contribution fraction (Figure 35, curve 1) is reduced (curve 2), because the co-payment fraction, as an additional inflow to contributions, partially substitutes the contribution fraction. The variable 'sum of contribution fraction' (curve 3) represents both inflows. Due to the higher adjustment rate, of the co-payment fraction, the contribution fraction of the system begins to oscillate, because even a small shortfall ratio leads to quick and over adjusting responses. After the year 2040, the damped oscillations find a steady state around a small negative shortfall with oscillations small in amplitude and long in frequency (Figure 36).
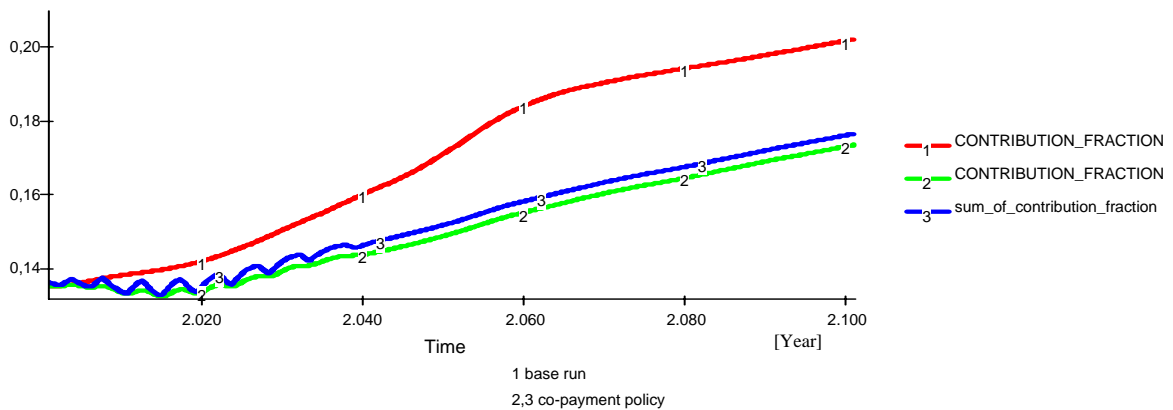

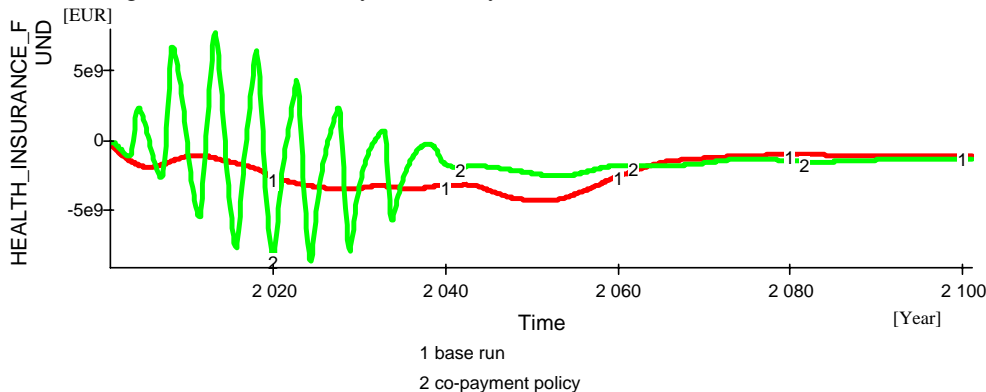Figure 35:   Co-Payment Policy: Contribution Fraction

Figure 36:   Co-payment Policy: Health Insurance Fund

By introduction of a co-payment fraction, the oscillatory tendency of the system is amplified. If the system is exposed to an external shock, the probability to oscillate is higher with the co-payment fraction policy than without it. Therefore, the policy is not considered as useful to stabilize the system and strengthen its shortfall behavior.

'Fixed Contribution' Policy

The fixed contribution policy is yet to be discussed between the German Government and the opposition. The major idea is not to determine the contribution payments based on the fund shortfall, since the introduction of the health insurance system by Bismarck (AOK-BV 2004a). The parties discuss whether the contributions should be a constant amount of money per employed capita, therefore the name 'Capitation' is used. To model this, we use the existing circumstances in the model that represent an average employee salary income. A constant contribution fraction combined with an average constant salary is equal to a constant amount of money for each employee, i.e. 'The Capitation'. However, to maintain a constant salary, it is necessary to change the model structure. The "salary and pension growth rate" is no longer directly connected to the actual salary per employee. In order to obtain a constant salary value, this link has to be erased. The switch "sw_contribution_policy" can activate the "fixed contribution"-policy. A constant contribution fraction of 0.15 [fraction] is assumed.

Figure 37 shows the result of the "fixed contribution"-policy for the contributions and the health insurance expenses. The contributions, with the fixed contribution fraction (curve 2), are from 2001 until 2040 and are higher than the contributions collected in the base run with the flexible contribution fraction (curve 1). This is simply because the fixed contribution fraction is set to 0.15 [fraction], whereas the base run contribution fraction starting value is set to 0.1358 [fraction]. After the year 2035, the "flexible contribution" policy causes more contributions, because the contribution fraction increases to values higher than 0.15 [fraction] (Figure 38, curve 1 compared with curve 2). Instead, contributions due to the fixed contribution fraction decline due to the population development.

A comparison of average expenses per health request shows that at the beginning a nearly identical development. After the year 2040, the difference becomes significant. The health insurance expenses produced by the base run (with flexible contribution fraction, curve 3), exceed the health expenses for the system with a fixed contribution fraction (curve 4).
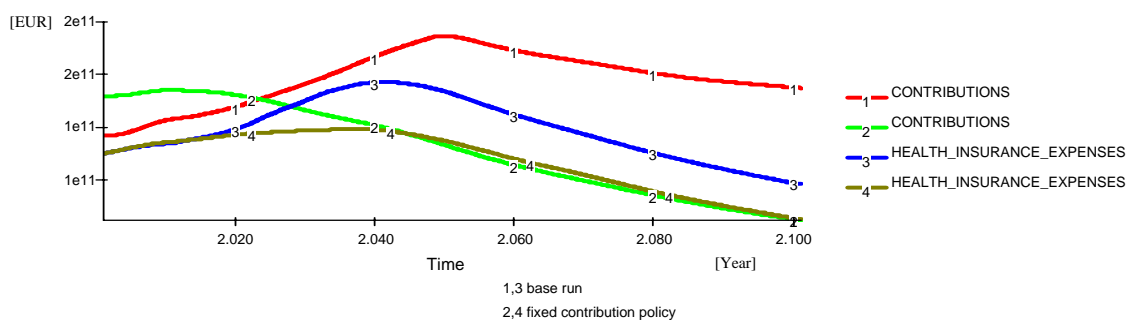

Figure 37:   Fixed Contribution Policy: Contributions and Health Insurance Expenses
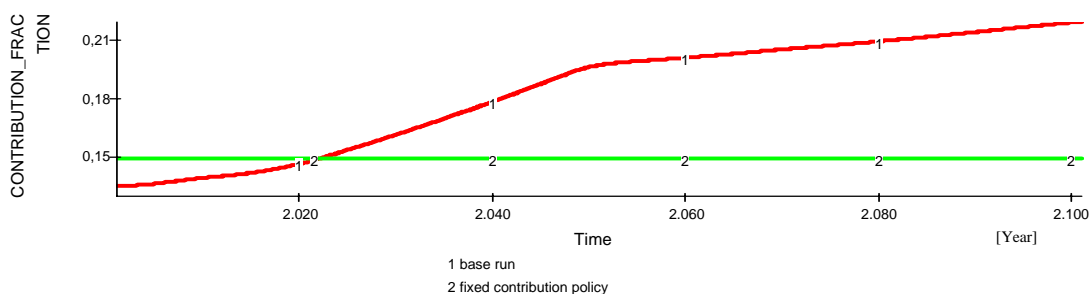

Figure 38:   Fixed Contribution Policy: Contribution Fraction

The reason for fewer health expenses is the reduced effect of the contribution fraction on the average expenses per health request (Figure 39). However, in both cases, the average expenses per request reach its maximum value of around 770 Euros. Nevertheless, a difference exists in the total health expenses between the two policies. This is due to the lower health requests with a constant contribution fraction, because the lower contribution fraction causes a lower exploitation attitude and fewer health requests. Therefore, the total amount of health request and health expenses is reduced, when the 'fixed contribution'-policy is activated.
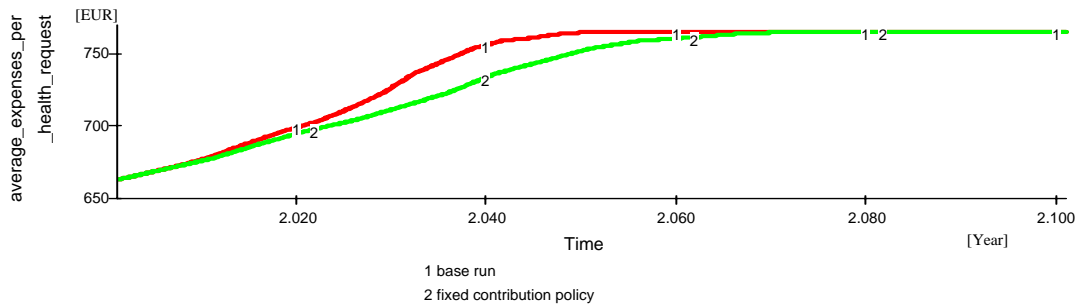

Figure 39:   Fixed contribution policy: average expenses per health request

Figure 40 shows the effect of the discussed policy regarding the health insurance fund. Several effects cause abrupt change. Firstly, the population development curve shows the time of its inflection point (Figure 14, curve 1). Secondly, the fraction of retirees declines faster than the fraction of employees due to the initial population values. Consequently, the amount of requests is reduced and the contribution inflow is increased.
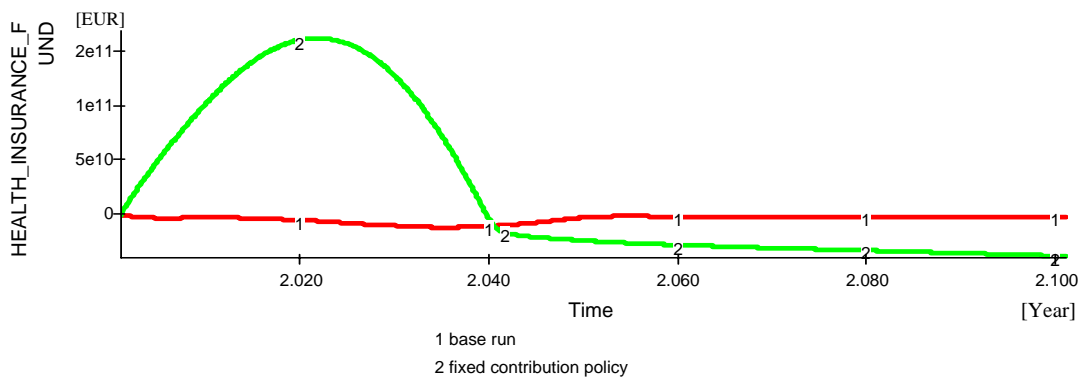

Figure 40:   Fixed Contribution Policy: Health Insurance Fund

The result of this policy is simply the cancellation of the balancing feedback loop B1 "adjusting contribution fraction". By this means, the oscillatory tendency of the system can be reduced. However, any chosen fixed contribution fraction will not be lasting or correct of ever. Figure 40 shows that the incipiently contribution fraction is higher than the actual necessary value. Circumstances change and make contribution adjustments necessary, especially because of the population development. It is highly uncertain that with incomplete information the chosen fixed contribution fraction can fulfill the demand.

'Per Capita Administration Expenses' Policy
The fifth discussed policy stresses the administration expense development. The administration costs rise with an almost constant slope every year. In the base run model, it is assumed that a permanent development of the expenses is used in the same manner. A more realistic assumption takes the amount of state insured people in account. The amount of administrated people acts as cost driver.[3] The more people that are insured, the more expenses are generated

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[3] This is an application of the activity-based-costing theory.

and vice versa. Administration expenses per capita are calculated and multiplied with the actual population figure. [4]
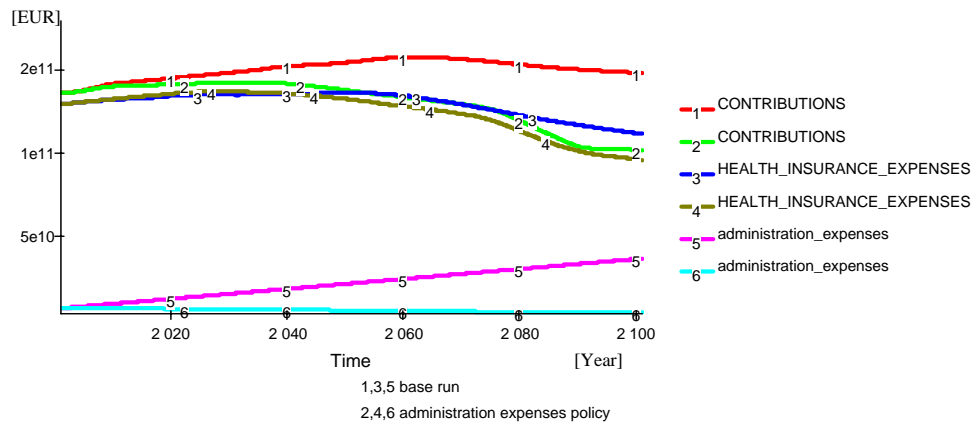

Figure 41:   Per Capita Administration Expense Policy: Contributions and Expenses

As seen in Figure 41, the administration expenses in the base run grow constantly with a fixed slope (curve 5). Contrary, the population dependant administration expenses (curve 6) follow the population development. The lower administration expenses lead to a lower shortfall and therefore to lower contribution fractions (Figure 42, curve 2) than the contribution fraction in the base run (curve 1). Consequently, the health expenses will decline and in sequence the total health requests will decline, too (Figure 41, curve 4 compared with curve 3).
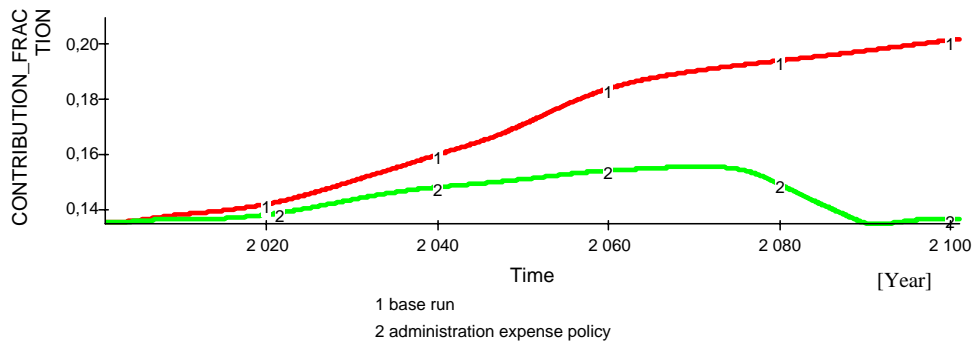

Figure 42:   Per Capita Administration Expense Policy: Contribution Fraction

Figure 43 shows the effect of these developments on the health insurance fund. From year 2001 until approximately year 2072, the behavior is satisfying from a fund management perspective. In the following year, the total population decline causes less administration expenses, which lead to an increase in the health insurance fund. Consequently, the contribution fraction decreases. Because of the falling contribution fraction, the effect of exploitation attitude on requests per capita declines, which reduces the number of requests. Therefore, a surplus in the health insurance fund is created, which will be reduced by the contribution fraction adjustment (curve 2).

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[4] Calculated expenses per capita per year by mean of data (2001): 7.640.000.000 [euro/year]/ 70.994.000 [insured people] = 107.61 [euro/year/people].
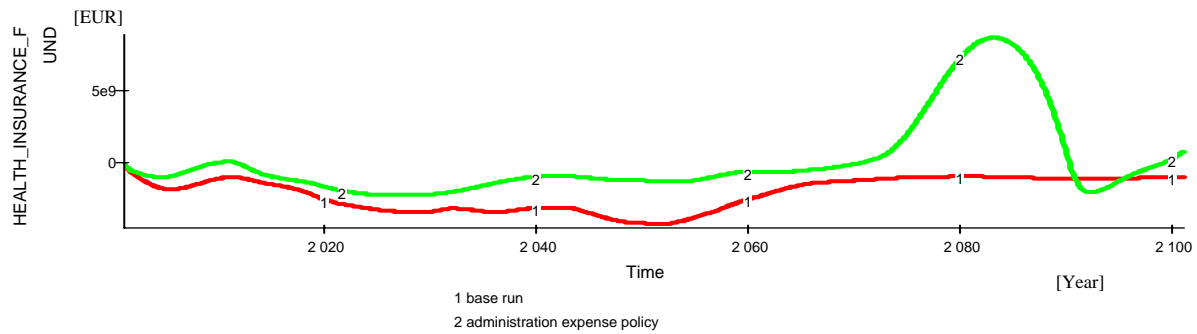
Figure 43:   Per Capita Administration Expense Policy: Health Insurance Fund

6.   Conclusion

The German Health Insurance System seems to be, on one hand, a very rigid and apathetic system (Lindner 2003). On the other hand, it responds to shortfalls with large changes in the contribution fraction, which causes instabilities and oscillations. We have analyzed the health insurance structure by means of different analysis methods, with the goal to identify system behavior and find sustainable policies.

Sensitivity testing or soft policy testing has shown that the system is sensitive to changes in the fertility rate and the net immigration rate. However, changes of these entities, corresponding to reality, are long-term projects. Especially a change of the fertility rate depends highly on other politic sectors and is not easy accomplished.

In contrast, changing of either the reference contribution fraction or the contribution fraction adjustment effect is easily done, because both variables are policy variables. However, as the sensitivity analyses show, these variables are at the same time high leverage points of the system. Drastic changes of these variables will lead to unpredictable outcomes. The sensitivity analysis shows improvement potential for the contribution adjustment effect. Therefore, finding an optimal contribution adjustment policy remains an important task.

Besides sensitivity analysis, several policy analyses have been performed in order to firstly relate the model more to reality and secondly to improve the model outcome, according to a permanent zero health insurance fund perspective. The introduced 'goal adjustment' structure has not improved the behavior of the health insurance fund, because of additional shortfall, which is caused by the debt due to support, which causes large contribution fraction adjustments. As mentioned in the previous paragraph, the contribution fraction adjustment effect is the strongest leverage in the system. Therefore, a policy, which strengthens the adjustment effect, is not applicable to stabilize the system.

The 'corner cutting pressure on government' policy seems to be effective in stabilizing the system. The effect occurs, if there is a shortfall of the health insurance fund, and reduces the average expenses per health request. This policy is suitable to lower the system oscillatory tendency, due to its damping effect on health requests.

The 'co-payment' policy affects the health insurance fund as the 'goal adjustment' policy. In general, the adjustment effect due to a shortfall is increased. Consequently, the system oscillatory tendency is increased as well. However, if the adjustments are within certain boundaries, the system is able to find a sustained equilibrium.

In Germany, they have discussed the possibility to change the contribution charging method from the old Bismarck's system to a fixed amount of money per capita and year and this is modeled by the 'fixed contribution' policy. First, the fixation of the contribution fraction is a means to stabilize the system. However, the process of choosing the constant contribution fraction must be uncertain, because the future development of both the total population and the health requests are unknown. Therefore, is it impossible to choose an adequate contribution fraction, which ensures at least a zero health insurance fund situation over a long time period.

Another policy, which makes the model more related to the reality, is the change of the administration expense assumption. The 'per capita administration expenses' policy denies the permanent growth of the administration expenses and substitutes this assumption by a 'fixed amount per capita' assumption. Then, the administration expenses behave in accordance with the population development. This will lead to a more stabilized system, because the unrealistic assumption regarding the administration growth causes high changes in the system.

In conclusion, the model regarding the German Health Insurance System represents the general structure of the system. The most difficult task for the fund management is to maintain a contribution fraction policy, which is suitable to the demands of the population development. At the same time, the fund management has to consider the effects of the contribution fraction on the human behavior.

7.   Further Research

For further research, the model can be improved to include more accurate figures, especially regarding the contribution adjustment policy that is actually used by the fund management. This would give additional insights and would strengthen the explanatory power of the model.

Furthermore, a healthiness measurement ratio could be introduced. In our model, we have this figure calculated (average health state of inhabitant), but it is not shown and discussed in the report, because we consider the performed calculation as too simple and therefore too inaccurate to represent reality. The explanations derived from the variable are not very meaningful. Despite this, future research could improve the model by introducing a reliable health measurement system. In addition, as Lindner has pointed out, the existing German Health Insurance System is rather concentrated in curing diseases than in preventing them (Lindner 2003). This issue is a worthwhile subject to be studied. The existing model can be improved to cover this topic.

Moreover, the model should be integrated in a comprehensive model to cover more side effects and gain more insights. A possible model is the Threshold 21 (cf. www.threshold21.com). We have discovered following possible interfaces to the T21-model: population, income distribution, employment, government debt, household and life expectancy.

To conclude, we hypothesize that the topic of the Social Security System, especially the Health Insurance System, will become more important in Germany, as with the rest of the world, over the next decades. Research in this field is therefore needed and worthwhile to accomplish.

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