Working Paper

A SIMPLE SICK-LEAVE MODEL USED FOR INTERNATIONAL COMPARISON

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International Institute for Applied Systems Analysis
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FOREWORD

The principal aim of health care research at IIASA has been to develop a family of submodels of national health care systems for use by health service planners. The modeling work is proceeding along the lines proposed in the Institute's current Research Plan. It involves the construction of linked submodels dealing with population, disease prevalence, resource need, resource allocation, and resource supply.

One of these submodels, SILMOD (Sick-Leave Model) is used to derive morbidity indicators from sick-leave statistics. With it, the number of sick days, hospital stays, and resources needed can be determined on the basis of a definite demographic structure and fixed labor participation rates. The model is presented in this paper, and interesting camparisons are made using data from Austria, the German Democratic Republic, and England and Wales.

Related publications in the Health Care Systems Task are listed at the end of this report.

Andrei Rogers
Chairman
Human Settlements
and Services Area

ABSTRACT

This paper describes a simple sick-leave model and its application to data from Austria, the German Democratic Republic and the U.K. With this model, not only present resource requirements can be estimated, but also forecasts for future requirements can be predicted from knowledge of the country's demographic structure and change. Also included in the paper are possible extensions of the model.

CONTENTS

A SIMPLE SICK-LEAVE MODEL USED FOR INTERNATIONAL COMPARISON

1. INTRODUCTION

The usual way to measure morbidity is to record general prevalence and general incidence of illness within a population. Unfortunately, however, this is difficult in practice because in most countries the high costs of this type of survey prevent the appropriate data base from being set up. For this reason, techniques have been developed at IIASA to derive morbidity indicators from mortality data: data which is usually well documented (Klementiev, 1977. See also Shigan, et al., 1979, for a complete description of the Health Care Systems Modeling Task at IIASA). However, as shown by Shigan (1977), there are many other possible ways to approximate morbidity.

In countries where public health insurance covers a high proportion of the population against the risk of illness, sick-leave statistics are very often published regularly. This paper describes a model that estimates morbidity from such statistics.

Since the employed population is one third to one half of the total population of developed countries, its illnesses can be expected to be a considerable part of the total morbidity. Of course, one should not forget that sick leave is not just an indicator of morbidity in the narrow medical meaning of this term. Sick leave deals as well with problems of social stress (e.g. if an employed person must remain at home to be responsible for a sick member of the family). In addition, sick leave reflects the behavior of the individual within the framework of the firm. An employee, although ill in clinical terms, may prefer to stay at work during economic recessions or periodic unemployment because of the fear of losing his job. Furthermore, sick-leave figures depend partly on the reporting behavior of employees and employers and on the requirements to certify illness officially. Each of these factors influences the reported statistics on sick leave.

So far, the discussion has considered the properties only of aggregate sick leave indicators. As shown later, sick leave is not equally distributed over either the sexes or the social strata. Sick leave varies widely over these dimensions, both with respect to the frequency of occurrence and with respect to the duration of the partial disability (Fleissner, 1977).

From the point of view of economics, sick leave is used as a measure of loss of production. The economist measures this loss by the average percentage of disability days per year per employee. This figure is important for a number of reasons. On the one hand, sick leave is one part of the cost of production, irrespective of whether the firm, health insurance, state, individual employee, or group with which he works has to pay for it or not. On the other hand, sick leave often incurs costs to the health care system. A sick employee must usually visit the doctor, if only to testify the absence from work. At the same time the health care system may provide some treatment to the sick person as an in-patient or out-patient, and in some cases this leads to early retirement. In general, "sick leave" consumes resources. Medical, professional, and paraprofessional manpower must be paid for. Hospital care and drugs could be needed as well and must also be provided.

Following these considerations, it is not surprising that sick leave is an increasingly important phenomenon in the struggle for higher productivity. Instead of emphasizing treatment, the majority of health care institutions are encouraging preventive strategies. The growing influence of occupational health, work-related health studies, screening programs, and "Humanisierung der Arbeitswelt" in the firm, demonstrates progress along this path in Western Europe, although there remain numerous problems (Novak, 1976). [In Austria only 9% of the employed people are supervised by a medical doctor in the firm (Moritz and Walla, 1977)]. Despite growing academic interest in this field of health care, the implementation of preventive measures is in an early stage (Wintersberger, 1976, Fleissner, 1978).

The model presented cannot handle all aspects of sick leave mentioned above. It is restricted to a very simple structure that allows one to determine the number of sick days, the hospital stays, and the resources needed, on the basis of a definite demographic structure and fixed labor participation rates (see Figure 1).

The model can be used in three ways. Implicitly, it gives an incentive to organize existing data in a more useful way. Secondly, its straightforward accounting can assess approximately the resources needed and/or consumed by the employed population. Thirdly, in combination with data from different countries, it can be a tool for international comparison. Section 4 shows how these three uses of the model can be applied in Austria, the German Democratic Republic, and England and Wales.

The model was programmed in a simple subset of FORTRAN so that no major difficulties would arise when implementing it with other computers. The program uses only those statements that are commonly available. It is flexible and can easily be modified or extended. Although the presented version does not show this property at first glance, the computer program can be adapted to account for different social strata, professional groups, and/or diagnostic groups. The parameters of the model are assumed constant over time, which is not true in reality.

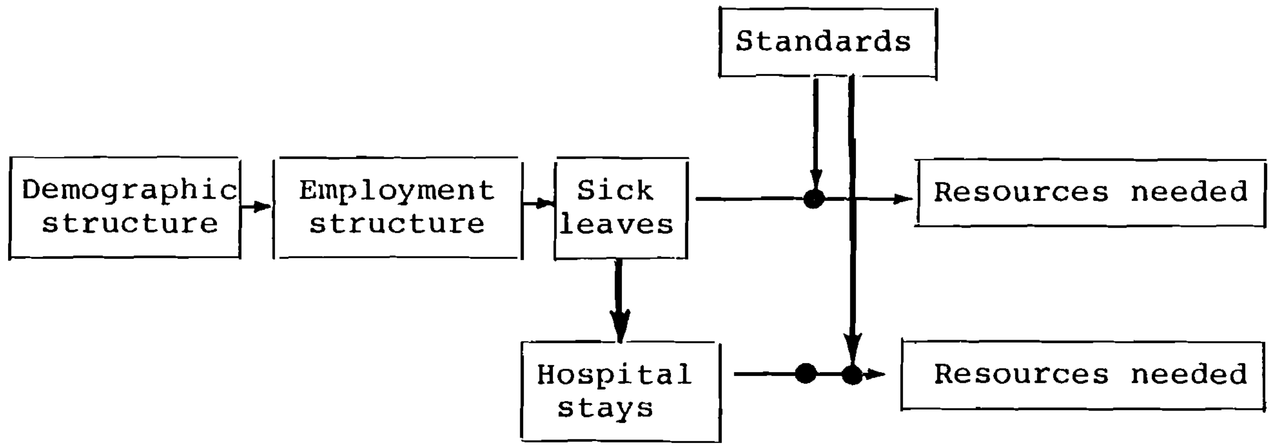

Figure 1. Basic structure of the process.

This restriction can be removed by introducing trend functions or regression equations in order to give the model a more dynamic behavior, and further possible extensions of the model are discussed in Section 3.

Because social and economic influences on sick leave vary from country to country and depend on its social and economic structure, links to these influences should perhaps have been established within the model. However, a mathematical description of these links would be difficult. Our way of taking into account these qualitative differences has been to ask each of the authors of this paper to comment on the data of his country from his own point of view. The reader who ignores these comments in favor of the tables of quantitative data may discover fallacies.

2. THE SICK-LEAVE MODEL (SILMOD)

The version of the model presented below is called SILMOD (Sick-leave-model). It transforms a set of input variables by means of simple mathematical procedures and certain parameters into a set of output variables. On the basis of population forecasts, the model performs the computation of economic losses and resources needed for the treatment of disabled employees. As an intermediate result, the number of employees, as well as the cases and days of sick leave and hospital stay are determined. The model is linear and static. But there is a built-in feature to produce forecasts of the output variables for the years

$$T_O + 5T \quad (T = 0,1,2...,T_O = \text{Starting year})$$

on the basis of population forecasts.

This section defines the variables, parameters, and the structure of the mathematical model in detail.

2.1. Variables, Parameters, Equations

The variables, parameters, their symbols, and the mathematical formulas used in the computer program (see Appendix) are given below. The order of the variables and parameters correspond to the computation process (see Figure 2). Input variables are underlined.

POP(J,K)..... J = 1,18 K = 1,2	Population structure divided by age group J (five-year groupings) and sex K. The DIMENSION statement provides 19 rows in the POP matrix. The last row of the matrix is reserved for the sum of certain average-measures of the previous rows: e.g. POP (19,2) contains the total female population as computed by the program.
RPART(J,K)... J = 4,16 K = 1,2	Labor-participation-rate matrix by age group and sex. The last row gives the average participation rate of the population from the age of 15 up to 65. Several definitions of this variable are possible, depending upon the meaning of "employment". One could include or exclude self-employed people, farmers, entrepreneurs, etc.
WORK(J,K).... J = 1,18 K = 1,2	Number of employees by age group and sex. WORK(J,K) = POP(J,K)*RPART(J,K) (1)
RSIL(J,K).... J = 4,16 K = 1,2	Sick-leave-rate matrix describing the average number of sick leaves per employee of age group J and sex K per year.
CASIL(J,K)...	Number of sick leaves in age group J and sex K. (For CASIL and the following variables and parameters, J = 4...16 and K = 1,2) CASIL(J,K) = WORK(J,K)*RSIL(J,K) (2)
DRSIL(J,K)...	Average duration of sick leave in age group J and sex K in days.

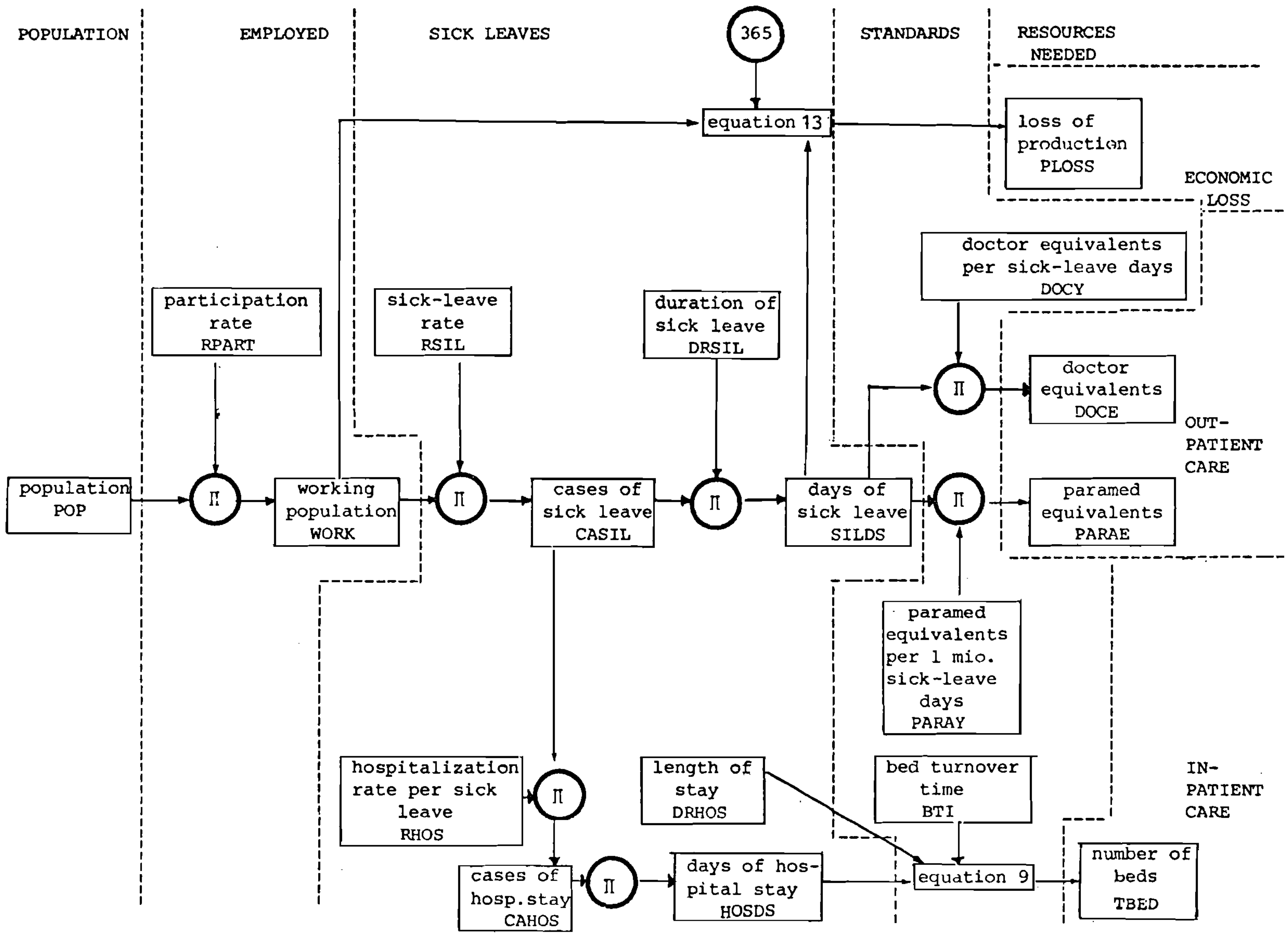

Figure 2. SILMOD - Structure of the sick-leave model.

SILDS(J,K).....Number of sick-leave days in age group J and sex K.

$$SILDS(J,K) = CASIL(J,K)*DRSIL(J,K) \quad (3)$$

<u>RHOS(J,K)</u>......Hospitalization-rate matrix by age group and sex.

CAHOS(J,K).....Number of hospital stays in age group J and sex K.

$$CAHOS(J,K) = CASIL(J,K)*RHOS(J,K) \quad (4)$$

<u>DRHOS(J,K)</u>.....Average length of hospital stays in days.

HOSDS(J,K).....Number of hospital stay days

$$HOSDS(J,K) = CAHOS(J,K)*DRHOS(J,K) \quad (5)$$

Next, numbers of sick leaves and hospital-stay days are determined. By setting standards, the corresponding resources needed can also be computed. For out-patient care there are two standards which are assumed constant over age and sex:

<u>DOCY</u>.....doctor equivalents per 1 million sick-leave days per year.

<u>PARAY</u>....paramedical equivalents per 1 million sick-leave days per year.

In order to characterize the efficiency of the hospital, we use:

<u>BTI</u>......Bed turnover time in days.

Immediately, the resources needed can be computed:

DOCE.....Doctor equivalents per year

$$DOCE = TSILDS*DOCY/10^6 \quad (6)$$

PARAE....Paramedical equivalents per year

$$PARAE = TSILDS*PARAY/10^6 \quad (7)$$

TSILDS...Total number of sick-leave days

$$TSILDS = \sum_{J,K} SILDS(J,K) \quad (8)$$

TBED.....Number of beds needed

$$TBED = \frac{ADRHOS + BTI}{ADRHOS} * \frac{THOSDS}{365} \quad (9)$$

THOSDS...Total number of hospital days

$$THOSDS = \sum_{J,K} HOSDS(J,K) \quad (10)$$

TCAHOS.....Total number of hospital stays

$$TCAHOS = \sum_{J,K} CAHOS(J,K) \qquad (11)$$

and

ADRHOS.....Average length of hospital stay

$$ADRHOS = THOSDS/TCAHOS \qquad (12)$$

PLOSS......Percentage loss of production

$$PLOSS = 100*TSILDS/(365*TWORK) \qquad (13)$$

where

TWORK......Total number of employees

$$TWORK = \sum_{J,K} WORK(J,K) \qquad (14)$$

2.2. Inputs and Outputs

In order to use the model, one must establish three groups of data in an input file. The program associates this file with internal file number 4, and the relevant FORMAT statements can be found in the program listing (see Appendix).

The first group of input data comprises parameters that define the dimensions of the problem:

- II - defines the forecasting interval in years
- JJ - defines the number of age groups (plus 1 to include a summary line)
- KK - defines the number of sub-groups into which the population is partitioned (e.g. male and female)
- LL - defines the number of diagnostic groups for which data is available
- JR - is the starting year of the simulation. The model calculates forecasts for the years

  JR, JR + II, JR + 2II, ...

The resource standards DOCY and PARAY must be defined in the second group. These standards can express ideal or actual standards depending upon the user's preference. The third group of input data comprises RPART, RSIL, DRSIL, RHOS, DRHOS, and POP. Population data must be placed in the input file by sex and age (five-year groupings) in five-year intervals. It is the last variable in the input file to enable easy inclusion of data from many years. For each point in time, the male population by age should be given first, followed by the female population.

In addition to reproducing the data in the input file, the first page printed by the program also shows the loss of production by sex and age as an output variable. This invariably shows that the percentage of lost working days is higher for men of all ages than for women.

The output of SILMOD is divided into two parts. The first part gives detailed information on:

-- numbers of employees (WORK),
-- cases and days of sick leave (CASIL, SILDS), and,
-- cases and days of hospital stays (CAHOS, HOSDS).

Each of the variables is disaggregated by sex and age. The last two rows of each column give sums or averages of the rates for males and females separately and together. The second part of the output gives summary information about sick-leave morbidity, the resources needed to handle it, and the consequent economic loss.

Both parts of the output can be produced by SILMOD for each year for which demographic forecasts are available. Table 1-9 show results from SILMOD for Austria, the German Democratic Republic, and England and Wales. These figures are discussed in more detail in Section 4.

2.3. Formal Characteristics

The formal structure of SILMOD is simple. The model does not have any lagged variables or any memory. It consists of a simple causal chain (see Figures 1 and 2) and no feedback loops are incorporated. The model is quasistatic. Dynamic behavior depends on changes in exogenous variables, primarily in changing populations.

This simplicity should enable the user to understand the logic of the model immediately, and to implement the model in a relatively short time on his computer. On the other hand,

Table 1. Input data for Austria.

DATA-INPUT

II	JJ	KK	LL	YR	BED TURN.	DOC.EQUIV	PARAM.EQUIV
4	19	2	0	1975	2.500	50.000	100.000

AGE	SICK-LEAVES PER HEAD		DURATION OF SL		LOSS OF PRODUCTION	
15-19	1.28369	0.94528	12.00	11.50	4.22035	2.97829
20-24	1.08250	0.82058	12.90	12.50	3.82582	2.81021
25-29	0.97872	0.77652	13.20	13.50	3.53948	2.87206
30-34	0.87087	0.73643	14.40	14.90	3.43576	3.00625
35-39	0.84339	0.72770	15.50	16.10	3.58150	3.20985
40-44	0.88969	0.77534	17.60	17.80	4.29001	3.78112
45-49	0.85666	0.75471	19.90	20.30	4.67056	4.19743
50-54	0.85284	0.78096	23.50	22.80	5.49089	4.87830
55-59	0.87842	0.79265	28.60	28.80	6.88296	6.25434
60-64	0.77434	0.60657	48.50	50.40	10.28918	8.37567
65-69	0.50839	0.39839	65.60	61.70	9.13709	6.73443
70-74	0.39680	0.30086	50.20	59.30	5.45736	4.88794
75-79	0.28797	0.18590	55.40	77.10	4.37086	3.92682

AGE	HOSP-STAYS PER SL		DURATION HOSP.STAY		PARTICIPATION RATE	
15-19	0.07380	0.08050	18.02	13.55	0.54940	0.48070
20-24	0.08440	0.11070	19.60	17.08	0.71741	0.62476
25-29	0.09340	0.11690	19.60	17.08	0.80427	0.50274
30-34	0.10080	0.13630	20.19	13.71	0.72411	0.42076
35-39	0.10410	0.13800	20.19	13.71	0.77737	0.42673
40-44	0.11710	0.11200	21.93	20.07	0.70489	0.38890
45-49	0.12160	0.11500	21.93	20.07	0.68709	0.38707
50-54	0.15220	0.11060	23.15	19.27	0.60805	0.37546
55-59	0.14700	0.10900	23.15	19.27	0.54636	0.28549
60-64	0.12900	0.14740	24.27	20.66	0.19118	0.07367
65-69	0.19650	0.22440	24.27	20.66	0.05340	0.02497
70-74	0.00000	0.00000	0.00	0.00	0.02436	0.00997
75-79	0.00000	0.00000	0.00	0.00	0.01490	0.00628

Table 2. Input data for the German Democratic Republic.

DATA-INPUT

II	JJ	KK	LL	YR	BED TURN.	DOC.EQUIV	PARAM.EQUIV
4	19	2	0	1975	7,200	148,000	200,000

AGE	SICK-LEAVES PER HEAD		DURATION OF SL		LOSS OF PRODUCTION	
15-19	1,91060	1,82070	10,90	12,50	5,70563	6,23527
20-24	1,91060	1,82070	10,90	12,50	5,70563	6,23527
25-29	1,36690	1,47180	12,40	14,30	4,64371	5,76623
30-34	1,08480	1,20430	14,80	16,90	4,39864	5,57607
35-39	1,08480	1,20430	14,80	16,90	4,39864	5,57607
40-44	0,91710	1,04410	19,00	21,30	4,77395	6,09297
45-49	0,91710	1,04410	19,00	21,30	4,77395	6,09297
50-54	0,85310	0,97360	25,80	26,90	6,03013	7,17530
55-59	0,85310	0,97360	25,80	26,90	6,03013	7,17530
60-64	0,89550	0,89300	34,80	30,40	8,53792	7,43759
65-69	0,72050	0,58330	37,50	34,00	7,40240	5,43348
70-74	0,72050	0,58330	37,50	34,00	7,40240	5,43348
75-79	0,72050	0,58330	37,50	34,00	7,40240	5,43348

AGE	HOSP-STAYS PER SL		DURATION HOSP.STAY		PARTICIPATION RATE	
15-19	0,03893	0,09139	18,60	11,80	0,31060	0,28580
20-24	0,03936	0,16738	17,80	10,30	0,86930	0,74567
25-29	0,05240	0,15540	18,30	10,90	0,97110	0,79280
30-34	0,06832	0,14188	20,50	12,70	0,98810	0,79610
35-39	0,07455	0,12248	20,40	14,50	0,98810	0,79610
40-44	0,10092	0,13089	21,00	17,20	0,98030	0,79820
45-49	0,12049	0,13741	21,40	18,60	0,98030	0,79820
50-54	0,15550	0,14936	23,20	20,30	0,93900	0,66950
55-59	0,18027	0,13465	24,00	24,40	0,93900	0,66950
60-64	0,19342	0,13080	25,00	27,00	0,90000	0,14000
65-69	0,23044	0,21768	25,50	28,80	0,26000	0,14000
70-74	0,25291	0,24413	25,10	30,40	0,00000	0,00000
75-79	0,27010	0,26551	24,20	32,40	0,00000	0,00000

Table 3. Input data for England and Wales.

DATA-INPUT

II	JJ	KK	LL	YR	BED TURN.	DOC.EQUIV	PARAM.EQUIV
4	19	2	0	1973	2.500	50.000	100.000

AGE	SICK-LEAVES PER HEAD		DURATION OF SL		LOSS OF PRODUCTION	
15-19	0.53500	0.62300	28.87	28.05	4.23163	4.78771
20-24	0.53200	0.60900	24.03	28.30	3.50245	4.72184
25-29	0.47300	0.51300	26.48	31.36	3.43152	4.40758
30-34	0.47900	0.55000	30.49	38.47	4.00129	5.79685
35-39	0.47800	0.56400	34.96	38.35	4.57832	5.92586
40-44	0.45700	0.55600	34.98	40.41	4.37969	6.15561
45-49	0.43200	0.49600	39.21	44.40	4.64075	6.03353
50-54	0.44900	0.49700	46.68	48.63	5.74228	6.62167
55-59	0.43600	0.41500	51.43	55.04	6.14342	6.25797
60-64	0.43900	0.35300	60.69	45.74	7.29943	4.42362
65-69	0.32200	0.00000	59.79	0.00	5.27462	0.00000
70-74	0.00000	0.00000	0.00	0.00	0.00000	0.00000
75-79	0.00000	0.00000	0.00	0.00	0.00000	0.00000

AGE	HOSP-STAYS PER SL		DURATION HOSP.STAY		PARTICIPATION RATE	
15-19	0.02360	0.01530	7.80	6.30	0.46000	0.44800
20-24	0.01150	0.03770	7.30	5.70	0.84900	0.63400
25-29	0.02060	0.03490	7.80	6.50	0.86600	0.47300
30-34	0.02030	0.03250	7.80	6.50	0.84600	0.44500
35-39	0.02030	0.03190	9.80	9.40	0.85900	0.51700
40-44	0.02130	0.03250	9.80	9.40	0.86700	0.55300
45-49	0.05410	0.03280	4.30	14.30	0.87100	0.55500
50-54	0.05210	0.03280	4.30	14.30	0.86000	0.52600
55-59	0.05720	0.03960	4.30	14.30	0.84200	0.45300
60-64	0.13910	0.12460	4.30	14.30	0.78300	0.18600
65-69	0.18950	0.00000	9.00	25.40	0.22800	0.00000
70-74	0.00000	0.00000	9.00	25.40	0.00000	0.00000
75-79	0.00000	0.00000	9.30	49.40	0.00000	0.00000

Table 4. SILMOD results for Austria in 1975.

YEAR 1975

AGE	POPULATION		WORKERS		PARTIZIPATION RATES	
0- 4	256256.	244282.	0.	0.	0,00000	0,00000
5- 9	311590.	297231.	0.	0.	0,00000	0,00000
10-14	328573.	314191.	0.	0.	0,00000	0,00000
15-19	293013.	280990.	160981.	135073.	0,54940	0,48070
20-24	258588.	253181.	185514.	158177.	0,71741	0,62476
25-29	259767.	251633.	208923.	126506.	0,80427	0,50274
30-34	265719.	260775.	192410.	109724.	0,72411	0,42076
35-39	234846.	230865.	182562.	98516.	0,77737	0,42673
40-44	208912.	207732.	147260.	80787.	0,70489	0,38890
45-49	217263.	234531.	149279.	90780.	0,68709	0,38707
50-54	195523.	274696.	118888.	103137.	0,60805	0,37546
55-59	123475.	175830.	67462.	50197.	0,54636	0,28549
60-64	171631.	243169.	32812.	17914.	0,19118	0,07367
65-69	162194.	238238.	8661.	5950.	0,05340	0,02497
70-74	129090.	201863.	3145.	2013.	0,02436	0,00997
75-79	75096.	143533.	1119.	901.	0,01490	0,00628
80-84	51634.	123981.	0.	0.	0,00000	0,00000
SUM	3543170.	3976721.	1459015.	979676.	0,41178	0,24635
TOTAL	7519891.		2438691.		0,32430	

AGE	SICK-LEAVE CASES		SICK-LEAVE-DAYS	
15-19	206650.	127682.	2479802.	1468347.
20-24	200819.	129797.	2590559.	1622467.
25-29	204477.	98234.	2699096.	1326165.
30-34	167564.	80804.	2412920.	1203977.
35-39	153970.	71690.	2386542.	1154209.
40-44	131016.	62638.	2305877.	1114950.
45-49	127882.	68513.	2544843.	1390804.
50-54	101392.	80546.	2382718.	1836443.
55-59	59260.	39789.	1694830.	1145915.
60-64	25408.	10866.	1232273.	547660.
65-69	4403.	2370.	288853.	146255.
70-74	1248.	606.	62639.	35906.
75-79	322.	168.	17851.	12919.
SUM	1384410.	773702.	23098804.	13006016.
TOTAL	2158112.		36104820.	

AGE	HOSPITAL STAYS		HOSPITAL DAYS	
15-19	15251.	10278.	274819.	139273.
20-24	16949.	14369.	332202.	245415.
25-29	19096.	11484.	374324.	196140.
30-34	16890.	11014.	341018.	150996.
35-39	16028.	9893.	323612.	135636.
40-44	15342.	7015.	336449.	140799.
45-49	15550.	7879.	341020.	158130.
50-54	15432.	8908.	357248.	171664.
55-59	8759.	4337.	202762.	83573.
60-64	3278.	1602.	79547.	33091.
65-69	865.	532.	20999.	10990.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	143442.	87311.	2984000.	1465707.
TOTAL	230753.		4449708.	

SUMMARY TABLE IN THE YEAR 1975

LOSS OF PRODUCTION	NUMBER OF BEDS	DOCTOREQUIV	PARAMED.EQUIV
4,05616	13771,480	1805,241	3610,482

DURATION SL		DURATION HOSP.STAY	
16,68494	16,81011	20,80277	16,78727
16,72982		19,28341	

Table 5. SILMOD results for Austria in 1990.

YEAR 1990

AGE	POPULATION		WORKERS		PARTIZIPATION RATES	
0- 4	274349.	254200.	0.	0.	0.00000	0.00000
5- 9	262980.	244619.	0.	0.	0.00000	0.00000
10-14	246772.	230237.	0.	0.	0.00000	0.00000
15-19	250979.	240875.	137888.	115790.	0.54940	0.48070
20-24	306485.	295408.	219875.	184559.	0.71741	0.62476
25-29	321220.	311783.	258348.	156746.	0.80427	0.50274
30-34	285386.	278335.	206651.	117112.	0.72411	0.42076
35-39	251133.	250136.	195223.	106740.	0.77737	0.42673
40-44	250027.	247341.	176242.	96191.	0.70489	0.38890
45-49	251175.	254089.	172580.	98350.	0.68709	0.38707
50-54	215802.	221833.	131218.	83289.	0.60805	0.37546
55-59	183803.	195283.	100423.	55751.	0.54636	0.28549
60-64	178344.	212764.	34095.	15674.	0.19118	0.07367
65-69	142693.	234588.	7620.	5859.	0.05340	0.02497
70-74	74093.	134805.	1805.	1344.	0.02436	0.00997
75-79	75352.	152893.	1123.	960.	0.01490	0.00628
80-84	41891.	98009.	0.	0.	0.00000	0.00000
SUM	3612484.	3857198.	1643090.	1038365.	0.45484	0.26920
TOTAL	7469682.		2681455.		0.35898	

AGE	SICK-LEAVE-CASES		SICK-LEAVE-DAYS	
15-19	177005.	109454.	2124063.	1258722.
20-24	238015.	151446.	3070395.	1893071.
25-29	252850.	121716.	3337620.	1643169.
30-34	179966.	86245.	2591511.	1285050.
35-39	164649.	77674.	2552053.	1250554.
40-44	156800.	74581.	2759686.	1327541.
45-49	147842.	74226.	2942061.	1506786.
50-54	111908.	65045.	2629845.	1483034.
55-59	88213.	44191.	2522898.	1272693.
60-64	26401.	9508.	1280471.	479183.
65-69	3874.	2334.	254123.	144014.
70-74	716.	404.	35953.	23978.
75-79	323.	178.	17912.	13762.
SUM	1548564.	817003.	26118592.	13581557.
TOTAL	2365567.		39700148.	

AGE	HOSPITAL STAYS		HOSPITAL DAYS	
15-19	13063.	8811.	235395.	119390.
20-24	20088.	16765.	393734.	286347.
25-29	23616.	14229.	462877.	243025.
30-34	18141.	11755.	366258.	161164.
35-39	17140.	10719.	346055.	146958.
40-44	18361.	8353.	402664.	167646.
45-49	17978.	8536.	394249.	171317.
50-54	17032.	7194.	394301.	138629.
55-59	13038.	4817.	301828.	92820.
60-64	3406.	1401.	82659.	28953.
65-69	761.	524.	18475.	10821.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	162624.	93104.	3398494.	1567069.
TOTAL	255728.		4965564.	

SUMMARY TABLE IN THE YEAR 1990

LOSS OF PRODUCTION	NUMBER OF BEDS	DOCTOREQUIV	PARAMED,EQUIV
4,05629	15355,849	1985,007	3970,015

DURATION SL		DURATION HOSP,STAY	
16,86633	16,62364	20,89781	16,83139
16,78251		19,41733	

Table 6. SILMOD results for the German Democratic Republic in 1975.

YEAR 1975

AGE	POPULATION		WORKERS		PARTIZIPATION RATES	
0- 4	506.	480.	0.	0.	0.00000	0.00000
5- 9	631.	600.	0.	0.	0.00000	0.00000
10-14	732.	697.	0.	0.	0.00000	0.00000
15-19	678.	644.	211.	184.	0.31060	0.28580
20-24	672.	638.	585.	476.	0.86930	0.74567
25-29	465.	450.	452.	357.	0.97110	0.79280
30-34	586.	579.	579.	461.	0.98810	0.79610
35-39	659.	651.	651.	518.	0.98810	0.79610
40-44	528.	524.	518.	418.	0.98030	0.79820
45-49	445.	529.	436.	423.	0.98030	0.79820
50-54	340.	550.	319.	368.	0.93920	0.66950
55-59	221.	372.	208.	249.	0.93900	0.66950
60-64	349.	585.	315.	82.	0.90000	0.14000
65-69	378.	598.	98.	84.	0.26000	0.14000
70-74	320.	496.	0.	0.	0.00000	0.00000
75-79	185.	351.	0.	0.	0.00000	0.00000
80-84	128.	281.	0.	0.	0.00000	0.00000
SUM	7823.	9027.	4370.	3620.	0.55867	0.40104
TOTAL	16850.		7991.		0.47423	

AGE	SICK-LEAVE:CASES		SICK-LEAVE-DAYS	
15-19	402.	335.	4387.	4186.
20-24	1117.	867.	12174.	10834.
25-29	618.	525.	7660.	7508.
30-34	628.	555.	9292.	9386.
35-39	707.	624.	10459.	10550.
40-44	475.	437.	9023.	9305.
45-49	400.	441.	7595.	9396.
50-54	272.	359.	7021.	9649.
55-59	177.	243.	4571.	6526.
60-64	282.	73.	9801.	2223.
65-69	71.	49.	2654.	1659.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	5148.	4508.	84637.	81222.
TOTAL	9655.		165860.	

AGE	HOSPITAL STAYS		HOSPITAL DAYS	
15-19	16.	31.	291.	361.
20-24	44.	145.	782.	1494.
25-29	32.	82.	592.	889.
30-34	43.	79.	879.	1001.
35-39	53.	76.	1075.	1109.
40-44	48.	57.	1006.	984.
45-49	48.	61.	1031.	1127.
50-54	42.	54.	982.	1088.
55-59	32.	33.	767.	797.
60-64	54.	10.	1362.	258.
65-69	16.	11.	416.	306.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	429.	637.	9184.	9414.
TOTAL	1065.		18598.	

SUMMARY TABLE IN THE YEAR 1975

LOSS OF PRODUCTION	NUMBER OF BEDS	DOCTOREQUIV	PARAMED.EQUIV
5.68671	71.969	24.547	33.172

DURATION SL		DURATION HOSP.STAY	
16.44095	18.01940	21.42163	14.78430
17.17782		17.45495	

Table 7. SILMOD results for the German Democratic Republic in 1990.

YEAR 1990

AGE	POPULATION		WORKERS		PARTIZIPATION RATES	
0- 4	496.	468.	0.	0.	0.00000	0.00000
5- 9	504.	477.	0.	0.	0.00000	0.00000
10-14	482.	456.	0.	0.	0.00000	0.00000
15-19	497.	475.	154.	136.	0.31060	0.28580
20-24	622.	597.	541.	445.	0.86930	0.74567
25-29	719.	692.	698.	549.	0.97110	0.79280
30-34	664.	638.	656.	508.	0.98810	0.79610
35-39	657.	631.	649.	502.	0.98810	0.79610
40-44	451.	442.	442.	353.	0.98030	0.79820
45-49	559.	564.	548.	450.	0.98030	0.79820
50-54	613.	625.	576.	418.	0.93900	0.66950
55-59	471.	491.	442.	329.	0.93900	0.66950
60-64	369.	477.	332.	67.	0.90000	0.14000
65-69	249.	464.	65.	65.	0.26000	0.14000
70-74	131.	276.	0.	0.	0.00000	0.00000
75-79	149.	343.	0.	0.	0.00000	0.00000
80-84	140.	347.	0.	0.	0.00000	0.00000
SUM	7774.	8464.	5104.	3823.	0.65655	0.45165
TOTAL	16237.		8926.		0.54974	

AGE	SICK-LEAVE;CASES		SICK-LEAVE-DAYS	
15-19	295.	247.	3215.	3068.
20-24	1034.	811.	11268.	10135.
25-29	954.	808.	11833.	11554.
30-34	712.	612.	10539.	10336.
35-39	704.	605.	10421.	10223.
40-44	406.	369.	7706.	7853.
45-49	503.	470.	9548.	10018.
50-54	491.	407.	12668.	10956.
55-59	377.	320.	9731.	8614.
60-64	297.	60.	10348.	1814.
65-69	47.	38.	1750.	1287.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	5819.	4746.	99027.	85877.
TOTAL	10566.		184904.	

AGE	HOSPITAL STAYS		HOSPITAL DAYS	
15-19	11.	23.	214.	266.
20-24	41.	136.	724.	1398.
25-29	50.	126.	915.	1369.
30-34	49.	87.	997.	1102.
35-39	52.	74.	1071.	1074.
40-44	41.	48.	860.	830.
45-49	61.	65.	1296.	1202.
50-54	76.	61.	1771.	1235.
55-59	68.	43.	1632.	1052.
60-64	58.	8.	1438.	211.
65-69	11.	8.	274.	237.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	517.	678.	11192.	9976.
TOTAL	1195.		21168.	

SUMMARY TABLE IN THE YEAR 1990

LOSS OF PRODUCTION	NUMBER OF BEDS	DOCTOREQUIV	PARAMED.EQUIV
5.67515	81.567	27.366	36.981

DURATION SL		DURATION HOSP.STAY	
17.01638	18.09345	21.63009	14.72323
17.50022		17.71377	

Table 8. SILMOD results for England and Wales in 1973.

YEAR 1973

AGE	POPULATION		WORKERS		PARTIZIPATION RATES	
0- 4	1917.	1816.	0.	0.	0.00000	0.00000
5- 9	2069.	1967.	0.	0.	0.00000	0.00000
10-14	1968.	1866.	0.	0.	0.00000	0.00000
15-19	1754.	1669.	807.	748.	0.46000	0.44800
20-24	1742.	1707.	1479.	1082.	0.84900	0.63400
25-29	1827.	1799.	1582.	851.	0.86600	0.47300
30-34	1486.	1443.	1257.	642.	0.84600	0.44500
35-39	1431.	1387.	1229.	717.	0.85900	0.51700
40-44	1438.	1424.	1247.	788.	0.86700	0.55300
45-49	1485.	1498.	1294.	831.	0.87100	0.55500
50-54	1547.	1616.	1330.	850.	0.86000	0.52600
55-59	1315.	1419.	1107.	643.	0.84200	0.45300
60-64	1328.	5648.	1040.	1050.	0.78300	0.18600
65-69	2608.	0.	595.	0.	0.22800	0.00000
70-74	0.	0.	0.	0.	0.00000	0.00000
75-79	0.	0.	0.	0.	0.00000	0.00000
80-84	0.	0.	0.	0.	0.00000	0.00000
SUM	23916.	25259.	12967.	8202.	0.54218	0.32474
TOTAL	49175.		21169.		0.43049	

AGE	SICK-LEAVE:CASES		SICK-LEAVE-DAYS	
15-19	432.	466.	12463.	13064.
20-24	787.	659.	18909.	18654.
25-29	748.	437.	19816.	13692.
30-34	602.	353.	18363.	13587.
35-39	588.	405.	20540.	15513.
40-44	570.	438.	19929.	17694.
45-49	559.	412.	21912.	18306.
50-54	597.	422.	27877.	20540.
55-59	483.	267.	24826.	14687.
60-64	457.	371.	27706.	16961.
65-69	191.	0.	11450.	0.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM.	6013.	4229.	223792.	162699.
TOTAL	10243.		386490.	

AGE	HOSPITAL STAYS		HOSPITAL DAYS	
15-19	10.	7.	79.	45.
20-24	9.	25.	66.	142.
25-29	15.	15.	120.	99.
30-34	12.	11.	95.	75.
35-39	12.	13.	117.	121.
40-44	12.	14.	119.	134.
45-49	30.	14.	130.	193.
50-54	31.	14.	134.	198.
55-59	28.	11.	119.	151.
60-64	64.	46.	273.	661.
65-69	36.	0.	327.	0.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	260.	170.	1579.	1819.
TOTAL	430.		3398.	

SUMMARY TABLE IN THE YEAR 1973

LOSS OF PRODUCTION	NUMBER OF BEDS	DOCTOREQUIV	PARAMED.EQUIV
5.00197	12.252	19.325	38.649

DURATION SL	DURATION HOSP.STAY
37.21657 38.46845	6.08078 10.69907
37.73350	7.90777

Table 9. SILMOD results for England and Wales in 1988.

YEAR 1988

AGE	POPULATION		WORKERS		PARTIZIPATION RATES	
0- 4	2034.	1927.	0.	0.	0,00000	0,00000
5- 9	1762.	1667.	0.	0.	0,00000	0,00000
10-14	1530.	1446.	0.	0.	0,00000	0,00000
15-19	1899.	1808.	873.	810.	0,46000	0,44800
20-24	2065.	1888.	1753.	1197.	0,84900	0,63400
25-29	1930.	1893.	1672.	895.	0,86600	0,47300
30-34	1693.	1660.	1432.	739.	0,84600	0,44500
35-39	1672.	1662.	1436.	859.	0,85900	0,51700
40-44	1768.	1732.	1533.	958.	0,86700	0,55300
45-49	1424.	1386.	1240.	769.	0,87100	0,55500
50-54	1341.	1312.	1153.	690.	0,86000	0,52600
55-59	1293.	1322.	1088.	599.	0,84200	0,45300
60-64	1236.	5891.	968.	1096.	0,78300	0,18600
65-69	2935.	0.	669.	0.	0,22800	0,00000
70-74	0.	0.	0.	0.	0,00000	0,00000
75-79	0.	0.	0.	0.	0,00000	0,00000
80-84	0.	0.	0.	0.	0,00000	0,00000
SUM	24581.	25593.	13818.	8612.	0,56214	0,33649
TOTAL	50174.		22430.		0,44704	

AGE	SICK-LEAVE:CASES		SICK-LEAVE-DAYS	
15-19	467.	505.	13489.	14158.
20-24	933.	729.	22410.	20630.
25-29	791.	459.	20938.	14402.
30-34	686.	406.	20919.	15629.
35-39	687.	484.	24002.	18580.
40-44	700.	532.	24503.	21514.
45-49	536.	381.	21006.	16938.
50-54	518.	343.	24168.	16684.
55-59	475.	248.	24405.	13677.
60-64	425.	387.	25785.	17693.
65-69	215.	0.	12884.	0.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	6432.	4476.	234509.	169904.
TOTAL	10908.		404414.	

AGE	HOSPITAL STAYS		HOSPITAL DAYS	
15-19	11.	8.	86.	49.
20-24	11.	27.	78.	157.
25-29	16.	16.	127.	104.
30-34	14.	13.	109.	86.
35-39	14.	15.	137.	145.
40-44	15.	17.	146.	163.
45-49	29.	13.	125.	179.
50-54	27.	11.	116.	161.
55-59	27.	10.	117.	141.
60-64	59.	48.	254.	689.
65-69	41.	0.	368.	0.
70-74	0.	0.	0.	0.
75-79	0.	0.	0.	0.
SUM	264.	179.	1662.	1873.
TOTAL	443.		3535.	

SUMMARY TABLE IN THE YEAR 1988

LOSS OF PRODUCTION	NUMBER OF BEDS	DOCTOREQUIV	PARAMED.EQUIV
4.93981	12,718	20,221	40,441

DURATION SL	DURATION HOSP.STAY
36,45958 37,95929	6,29790 10,46395
37,07497	7,98177

the model structure might not be sophisticated enough for the problems he wants to investigate. Therefore, the next section deals with possible extensions of the model which could easily be added to SILMOD.

3. POSSIBLE EXTENSIONS

Extensions of the model by the user are possible in many directions. One could classify them as:

1. Disaggregation
2. Endogenization of exogenous variables
3. Inclusion of feedback loops and of additional variables

These formal dimensions correspond to different approaches of incorporating socio-economic influences into health care models (Fleissner, 1978).

3.1. Disaggregation

SILMOD categorizes the main variables of the model by sex and age only. In addition to these categories, dimensions of social strata, diagnostic groups, and the like could be easily included. The user could extend the parameters of the model in order to allow more than two (sex) categories and to interpret them as various social strata or different illness groups. This disaggregation process is restricted only by the available amount of data, and not by limitations of the model. Usually it is difficult to obtain separate data on sick leaves, for manual and non-manual workers or for civil servants and self-employed people, for example. More often data ordered by diagnostic groups are available. If there is only one indicator empirically available in disaggregated form, it seems to be useful to use this one and to take aggregated data instead of precise information for the other variables. For example, if one has data on the frequency of sick leave by diagnostic groups, sex, and age, but the average duration by sex and age only, one can take the average data and use them instead of the exact information. The same considerations hold for categories of resources (differentiated by kind of specialist, of paramedical staff, or by type of hospital beds, etc.). These various categories do not change the dynamic behavior of SILMOD. They only refine the mapping of the object under investigation.

3.2. Endogenization of Exogenous Variables

Another way to make the model more realistic is to widen the boundaries of the model. Variables that are not explained by the model but are used instead as parameters can be endogenized, i.e., be explained by other variables. Several ways of endogenization are possible.

a. Make time an explanatory variable (as in Figure 3):
This is the familiar case where linear or non-linear trends are included in the model, e.g., to "explain" labor participation rate, medical standards, duration of sick leave or hospital stay, etc. With this method, additional time dependencies are created, and the resulting model can behave "more dynamically": the variation of the main endogenous variables can be greater.

b. Use lagged values of the same exogenous variables (as in Figure 4):
Different tools are available to define the current value of a variable as a function of its past. Examples include moving average, autoregressive models. Once again, the new model behaves dynamically, not because of control loops, but because it has a memory of former exogenous variables.

c. Include other exogenous variables as explanatory variables (as in Figure 5):
This method reduces the degrees of freedom in the model so that two variables, exogenous in the original model, cannot be changed independently in the extended model. If, for example, the standard of bed turnover time is used to explain the average length of stay in hospital, the average length of stay becomes an endogenous variable which can change only with changes of bed turnover time. Once again the corresponding equation could

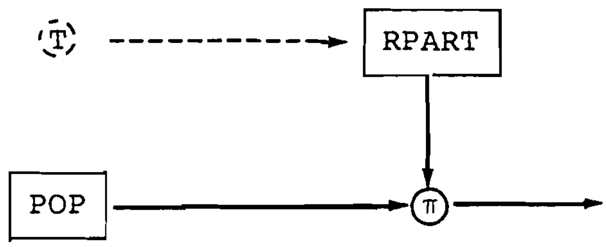

Figure 3. Participation rates can change with time.

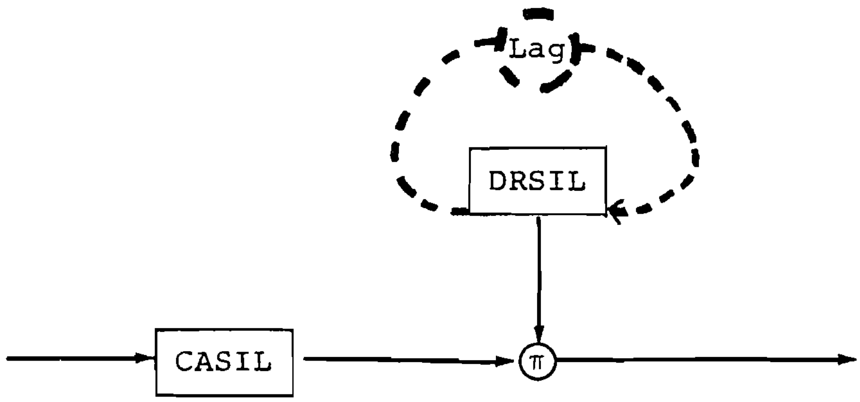

Figure 4. The duration of sick-leave can depend on past values.

be linear or non-linear. Lags are also possible and could lead to the endogenous variables having a more complex behavior.

d. Incorporate explanatory endogenous variables (as in Figure 6):
This type of extension is one way of bringing additional feedback loops into the model (see section 3.3). If there is no time lag between the endogenous and the former exogenous variables, a system of simultaneous equations will result, and will have to be solved by more complicated methods (matrix inversion, iterative methods, etc.). If there is a time lag, the model refers to its past and demonstrates a simple memory. The results of the model become dependent of the model's history.

3.3. Inclusion of Feedback Loops and Additional Variables

This is a very general procedure to bring more complexity (more connections between the variables and more variables) into the model. For example, a firm's policy might account for the influence that the labor participation rate has on the loss of production, or it might introduce a vaccination policy against influenza in order to reduce sick-leave rates or duration. If one adds costs to the list of variables, one could use the model as a tool for cost-effectiveness analysis. The same would be true if the model focused on measures to prevent accidents at work. Finally, sick leave is only the temporary part of the more general and serious state of invalidity. This model could be extended to include problems of total and/or partial invalidity, as well as rehabilitation.

4. APPLICATIONS

The first three sections below deal with comments on the input data, their sources, restrictions, pecularities, and range, for Austria, the German Democratic Republic, and England and Wales. Tables 1-9 show this data and the results from SILMOD for the three countries. Section 4.4 gives some tentative comparisons and conclusions.

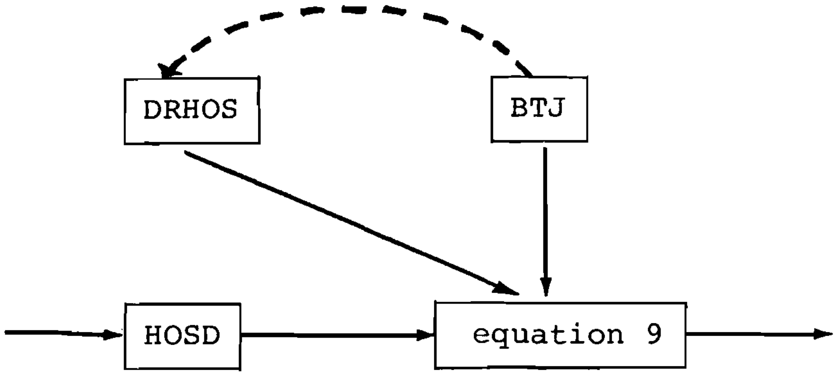

Figure 5. Length of stay in hospital can depend on bed turnover time.

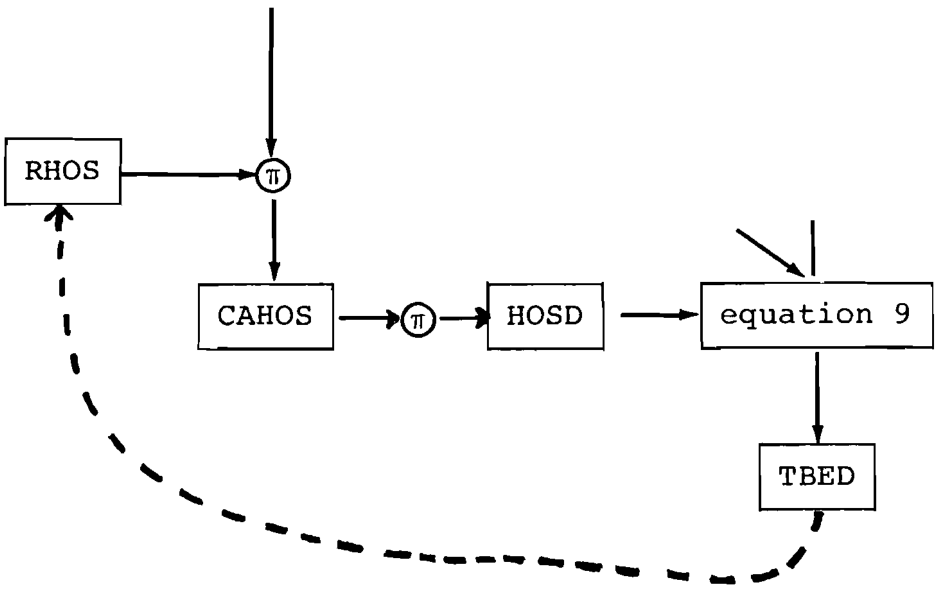

Figure 6. Numbers of beds can influence hospitalization rates.

4.1. Austria

RPART, the participation rates, refer to employed persons only when applied to Austria. Self-employed, farmers, entrepreneurs and persons not employed, such as students or housewives are excluded. Therefore, the rates shown in Figure 7 seem rather low (Austrian Central Statistics Office, 1976). Nevertheless, it can be seen that there is increasing male participation up to the 25-29 age groups, generated by the shift from the educational system to the labor market. From age 35-39 onwards, decreasing rates arise from invalidity and early retirement.

Female rates have their age-specific maximum in the 20-24 age group. The lower rates reflect the fact that married women are more likely to work as housewives and to be occupied with the task of child bearing until after the age of 35. Then some of them return to the labor market for the second time. To compare these figures with the total economically active population, a table of International Labor Office figures (1978) is included (Table 10).

In Austria, the legal age of retirement for men is 65 and 60 for women. But in private enterprises, it is possible to retire earlier after a minimum number of working years.

RSIL, the per capita rates of sick leave by age and sex, show a surprising behavior. Contrary to the belief which is commonly shared by Austrians, sick-leave rates for women are lower than those for men in every age group (see Table 1). However, a more detailed analysis shows that this difference can be explained partly by the different social composition of employed men and women, and by the different sick-leave rates corresponding to them. Sample Austrian data for 1971 (Fleissner, 1977, p.243) give the following rates of sick leave (Table 11). These should be related to the numbers of employed persons shown in Table 12. Most employed persons in Austria are included in this data.

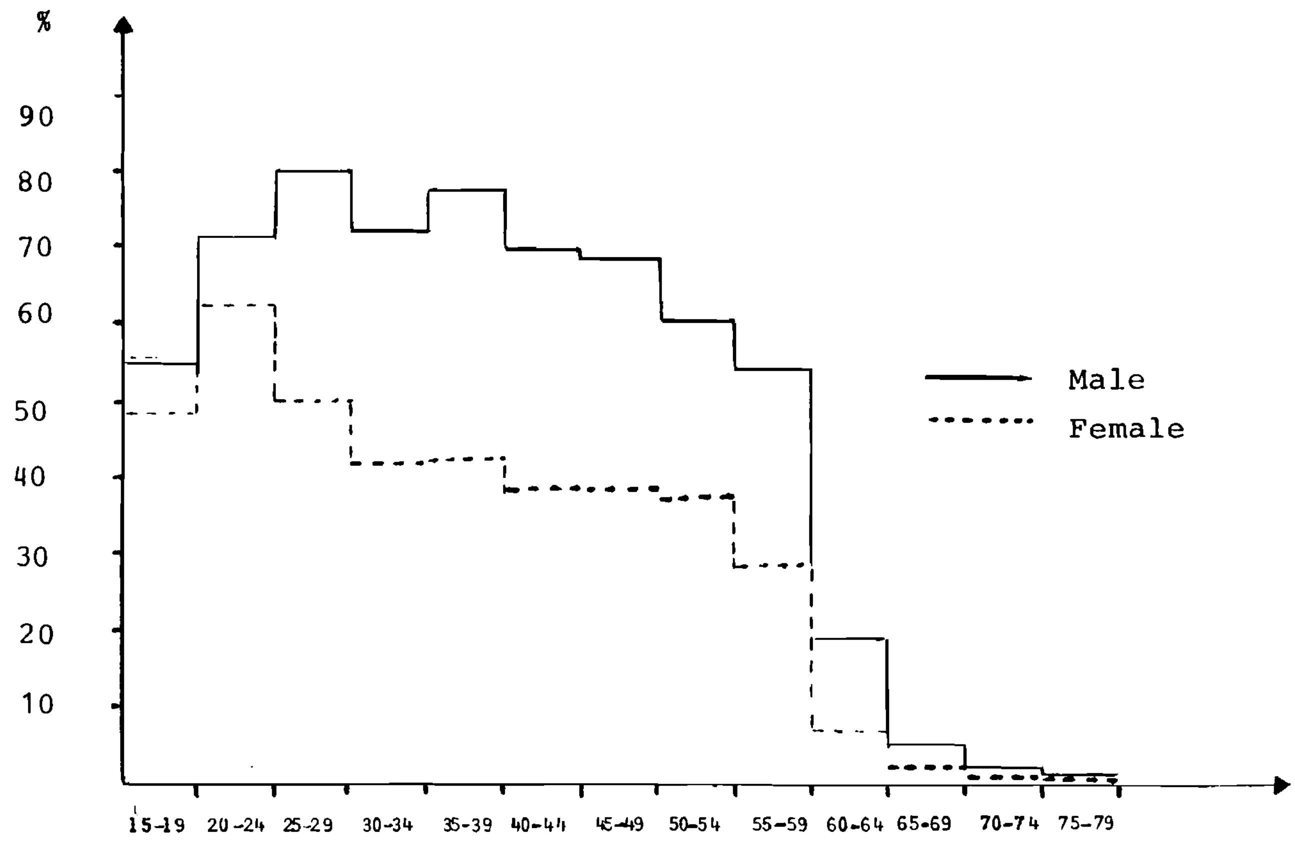

Figure 7. Participation rates by age and sex for Austria in 1975. (Exact data see Table 1).

Table 10. Economically active population by sex and age in Austria in 1975 (mid-year).

Age group	Male %	Female %
15 - 19	65.5	59.9
20 - 24	86.7	70.4
25 - 44	97.1	56.9
45 - 54	94.6	53.9
55 - 64	63.7	25.4
65+	8.0	3.3

Table 11. Per capita sick leave by social composition in Austria in 1971.

	Blue collar	White collar	Total
Male	1.04	0.54	0.89
Female	0.90	0.71	0.82
Total	0.99	0.62	0.89

Table 12. Numbers of employed persons in Austria in 1971.

	Blue collar	White collar	Total
Male	917.023	395.977	1.313.000
Female	408.366	378.515	858.881
Total	1.397.389	774.492	2.171.881

For blue collar workers, the sick-leave rates are higher for men than for women. The opposite is true for white collar workers. The summary lines show a greater variation with respect to social composition than with respect to sex. Table 12 shows that this surprising result arises from the fact that there is a higher proportion of male blue collar workers (with generally higher sick-leave rates) than female. The second unexpected finding can be seen in the variation of sick leave with respect to age. The highest sick-leave rates do not occur in older age groups but in the youngest. The rates decrease even faster for people older than 60. If they have not retired, older people have less temporary disabilities than younger people.

DRSIL, the average duration of sick leave (Austrian Social Security, 1978), rapidly increases with age and is not much affected by sex (see Table 1). In contrast to the rates of sick leave the length of sick leave is shortest in the youngest age groups (Figure 8*).

RHOS, the hospitalization rate per sick leave, and DRHOS, the average length of stay are available only in 10-year age groups, and not in five-year groupings. This data is found in a 1973 survey of health by the Austrian Central Statistics Office (1978). The data included in the model were compiled by aggregating the data about blue collar and white collar workers, including apprentices. They refer to individual sick leave cases and not to insured people.

The data reflect an increasing probability of hospitalization with age (up to 50-54 for men and 35-39 for women), although the per capita sick-leave rates decrease during these years. The data on the duration of stay are not very reliable.

---

*Per capita sick leaves are compiled by sick leave cases, (excluding special categories of employees working for the Austrian Federal Railways, civil servants and normal cases of maternity) divided by the number of insured persons. The under 15, 16-17, and 18-19 age categories were aggregated into one category.

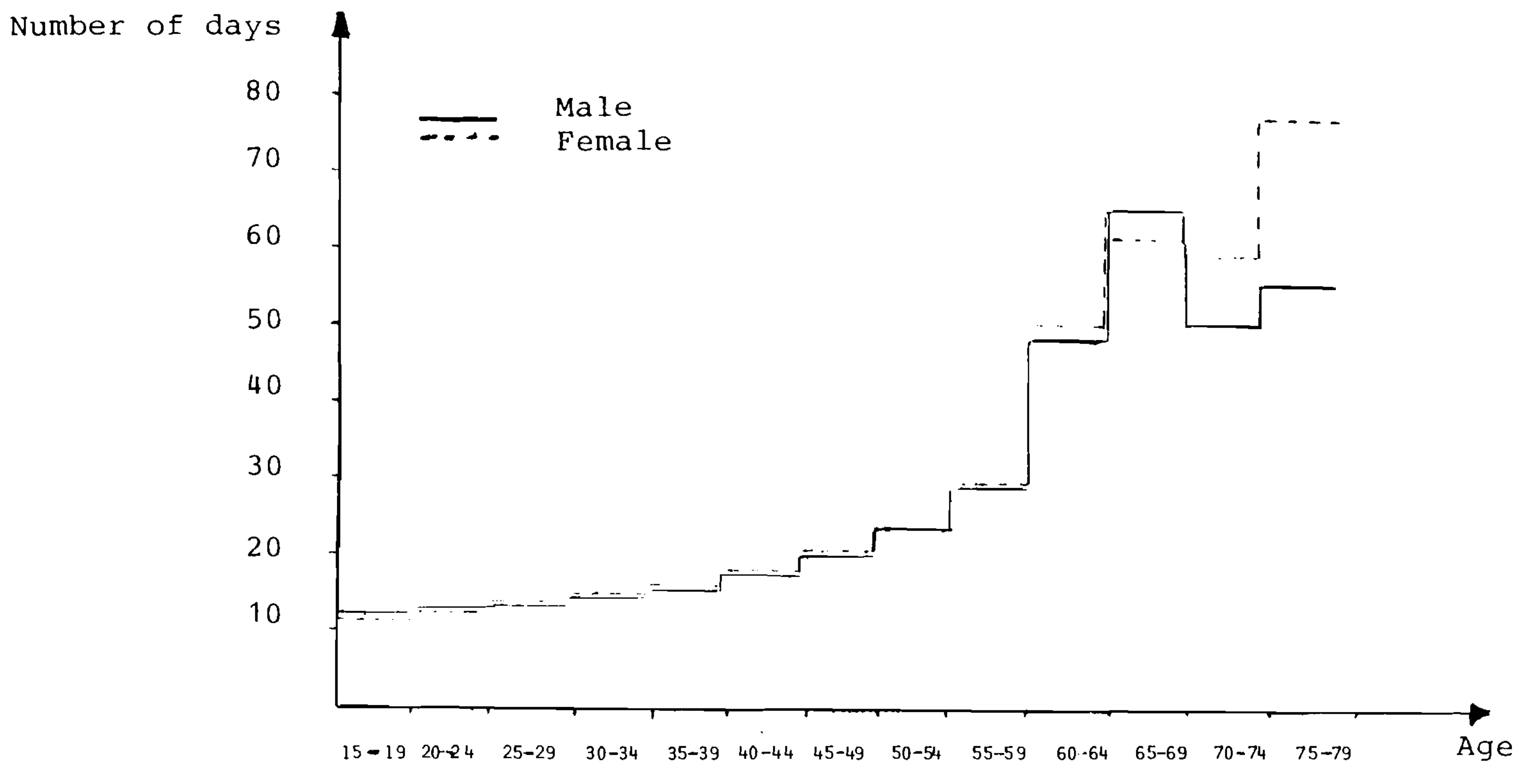

Figure 8. Average duration of sick leave by age and sex for Austria in 1975.

From what is available, however, we find that the length of stay increases with age for both men and women.

POP, the number of people by sex and age, shows a high proportion of elderly (Austrian Central Statistics Office, 1976) compared with the GDR and the UK.

4.2. German Democratic Republic

RPART, the participation rates, are high for both men and women (Freier Deutscher Gewerkschaftsbund, 1974) because of the constitutionally granted rights for equal wages and equal rights to work and education. In the GDR there exists a shortage of labor regardless of sex. Women in the GDR are more and more aware that employment helps them to develop their personality, and the high rates are achieved by different measures of social policy (maternity leave, a developed kindergarden system, etc.). The age of retirement is 60 for women and 65 for men. Employed persons can voluntarily stay at their work after this age without losing their pension. Special groups of workers (miners, etc.) enjoy earlier retirement possibilities.

RSIL, the sick leave rate, is lower for older workers. DRSIL, the average duration of sick leave, is longer because of the longer time needed to recover from more severe illnesses at this age (Mitteilungen Ambulante Betreuung, 1975). Younger people expose themselves more often to risk which results in higher sick-leave rates. Women between 25 and 34 have higher sick-leave rates because of additional stress (child bearing and household care), whereas older women have lower sick-leave rates than men. The usual higher life expectancy of women and their lower age of retirement correspond with low sick-leave rates in age groups over sixty.

The overall high sick-leave rates could be explained by two reasons in particular: there is (a) no decisive economic loss for individuals who become ill and (b) no risk of losing their jobs (Law Gazette of the GDR, 1977). From the first to the sixth week of illness employees are paid 90% of their average net salary (Nettodurchschnittsverdienst- "NdV"). From the seventh to the seventy-eighth week of illness there are different possibilities, shown in Table 13. There are separate settlements for

1. Employed persons suffering from tuberculosis
2. Antifascists and persons persecuted during fascism
3. Disablement through occupational accident or illness
4. Apprentices

For example, in categories 2, 3, and 4, the sick benefit is 100% of NdV. In addition, an employed person can insure himself against loss of income with the Public Insurance Institution of the GDR. Benefits of up to 90% of the gross average salary ("BdV") start with the seventh week of illness. Members of the labor union (Freier Deutscher Gewerkschaftsbund, 1972) receive additional support starting with the seventh week of illness. The amount depends on the monthly contribution and the the length of membership.

RHOS, the hospitalization rate for males, increases continuously with age. There is also an increased rate for women during their reproductive years and an increase at climacteric age. In the GDR, under current abortion laws, legal abortions are considered as cases of sick leave.

DRHOS, the average length of stay in hospital, is not governed by the patient's economic situation. However, people come to hospitals not only because of illness, but also for social reasons. They can, for instance, go to hospital if no care is available at home. In addition, the occupational health care system is very extensive, and allows immediate transfer to hospitals.

4.3. England and Wales

RPART, the participation rates, refer for England and Wales to employees and self-employed persons paying class I or II contributions to National Insurance. Some low-earning self-employed people are excluded, as also are most students and housewives. These figures, together with other statistics used below, are

Table 13. Sickness benefits in the German Democratic Republic.

With supplementary pension (with gross salary less than 600 Marks)		Without supplementary pension (gross salary higher than 600 Marks)	
By number of children	sick benefit (% NdV)	By number of children	sick benefit (% NdV)
1	70	1	50[a]
2	75	2	65
3	80	3	75
4	85	4	80
5 or more	90	5 or more	90

[a]The above percentages usually refer to the average net salary of the contributory average gross salary.

derived from Social Security statistics collected by the Department of Health and Social Security (1978) and unpublished supporting material. They show (see Figure 9) fairly constant employment through middle-age, with a dip for women of child-bearing age, and a decline toward the retiring ages of 65 and 60 for men and women. Officially retired people may continue to work and earn money up to a certain limit (£45 per week in April 1978) without losing their pensions. Most of them, however, are not liable to National Insurance contributions and hence are not included in the participation-rate figures.

RSIL, the per capita rates of sick leave by age and sex, is slightly misleading because it includes periods of sickness greater than six months. In the UK, such periods are treated as spells of invalidity rather than of sick leave. The true figures are therefore slightly lower. Women between 15 and 54 have higher sick-leave rates than men, but the limited information shown here does not reveal why. The rates for both men and women decline right up to retirement age, but the variation is small. In all groups the numbers of people "off sick" are gratifyingly small.

DRSIL, the average duration of sick leave, is surprisingly long in all age groups (see Table 3). This is partly because the distribution of sickness times is highly skewed towards shorter periods, and is therefore poorly characterized by the average. Furthermore, although sickness benefits require a certificate from a doctor, spells of less than three days attract no benefits and are often not reported. [More information about UK Social Security and sickness benefits is given in Willmott (1978)]. The figures do <u>not</u> include spells of invalidity.

As expected, older people are found to take longer periods of sick leave than younger people. The generally long periods in all age groups could arise through truly higher morbidity or because the system provides little financial incentive to return to work quickly. A third possibility is that most illnesses not requiring treatment are over in three days, and

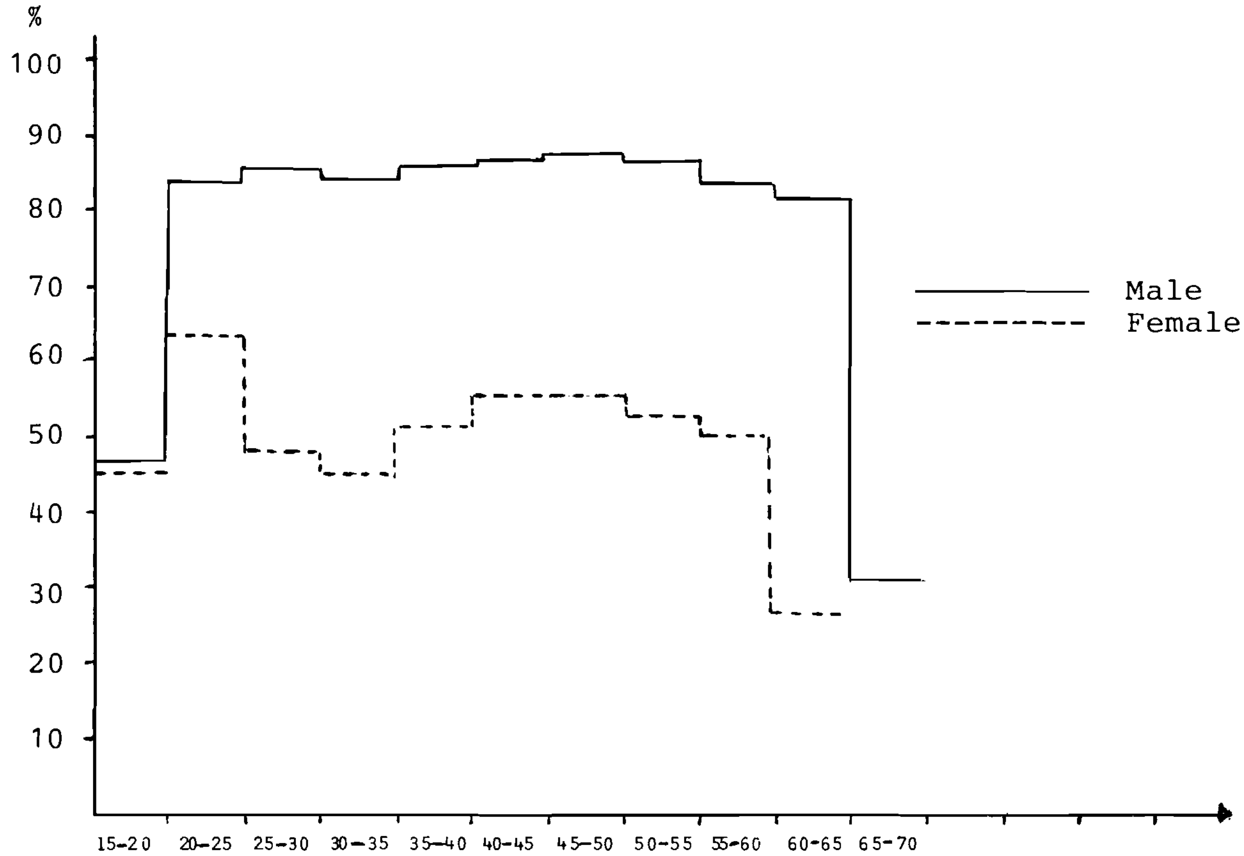

Figure 9. Participation rates by age and sex for England and Wales in 1976.

that other illnesses will require treatment in clinic or hospital and will necessarily take more of the patient's time. More information with which to test these hypotheses was not available. Whatever the reason, these long periods of sickness are highly likely to involve specialist medical resources: an assumption that SILMOD uses in estimating resource consequences.

RHOS, the hospitalization rate per sick leave, is a difficult statistic to extract and only very approximate estimates could be found. On the other hand, DRHOS, the average length of stay in hospital, is known by specialty, diagnosis, and age, through a nationwide hospital enquiry (Department of Health and Social Security, 1977). The figures given in Table 3 show the expected increase with age. Current statistics cannot distinguish the average length of stay for those who contribute to national insurance from those who do not. For ages below retirement, however, these are unlikely to be very different.

4.4. Conclusions

Making sense of international comparisons is notoriously difficult. All too often, differences in the way events are recorded, or differences in the events themselves, give erroneous results. The sections above mention some such difficulties about our data. Nevertheless, some results seem quite definite.

Through organizing the data from the three countries in this way, it is clear that the per capita rates of sick leave all decrease with age. Because general morbidity is usually agreed to increase with age, it follows that other influences must be at work. The way to reduce rates of sick leave may be to change social conditions rather than attack illness.

One of the outputs of SILMOD is the percentage loss of production in each age-group. Figure 2 shows how this measure of lost productive resources depends upon a long chain of calculations, the outcome of which would be difficult to predict in advance. In all three countries, the highest figures occur in the late fifties and early sixties. In many jobs, these are the ages at which employees might expect to attain senior managerial positions. The average loss of production across all age-groups is about 5%. The fact that it is similar in all three countries may suggest that it is a threshold value that can be reduced only with great difficulty.

However, Austria, the German Democratic Republic, and England and Wales are not similar in all respects. Using the model to make comparisons, we spot immediately the high average rates of sick leave in the German Democratic Republic and the long average lengths of sick leave in England and Wales. Some possible causes are suggested above. The evidence from the countries is that reductions are possible.

These three broad conclusions illustrate the three possible uses for a model of sick leave that were mentioned in Section 1: for organizing data, for estimating resources, and for making international comparisons. The computation of optimal solutions to known problems is <u>not</u> a feature of SILMOD. Instead, it shows the importance of social and economic factors in health care.

APPENDIX: COMPUTER PROGRAM LISTING (SILMOD)

```
C        DEFINITIONS
C        I...TIME INDEX,I=1,II
C        J...AGE INDEX,J=1,JJ
C        K...CATEGORY INDEX,K=1,KK
C        L...DIAGNOSTIC INDEX,L=1,LL
C        JR.....YEAR OF BEGIN OF SIMULATION
C
C
C        POP(J,K)...POPULATION
C        RPART(J,K)...PARTICIPATION RATE OF POPULATION IN WORK
C        WORK(J,K)...NUMBER OF WORKERS
C        RSIL(J,K)...RATE OF SICK LEAVE
C        CASIL(J,K)...CASES OF SICK LEAVE
C        DRSIL(J,K)...DURATION OF SICK LEAVE
C        SILDS(J,K)...NUMBER OF SICK LEAVE DAYS
C        PLOSS(J,K)...PERCENTAGE LOSS OF PRODUCTION
C        RHOS(J,K)...RATE OF HOSPITALIZATION PER SICK LEAVE
C        CAHOS(J,K)...CASES OF HOSPITALIZATION
C        DRHOS(J,K)...LENGHT OF STAY IN HOSPITAL
C        HOSDS(J,K)...NUMBER OF HOSPITAL DAYS
C
C
C        TPOP...TOTAL NUMBER OF POPULATION
C        TWORK..                WORKERS
C        TSILDS..               SICK LEAVE DAYS
C        TCASIL..               CASES OF SICK LEAVE
C.       THOSDS..               HOSPITAL DAYS
C        TCAHOS..               CASES OF HOSPITALIZATIONS
C
C
C        ADRSIL...AVERAGE DURATION OF SICK LEAVE
C        ADRHOS...AVERAGE DURATION OF STAY IN HOSPITAL
C        APLOSS...AVERAGE PERCENTAGE LOSS OF PRODUCTION PER YEAR
C
C
C        DOCE...DOCTOR EQUIVALENTS IN MENYEARS
C        PARAE...PARAMEDICAL EQUIVALENTS IN MENYEARS
C        DOCY...DOCTORYEARS EQUIVALENT PER 1 MIO SICKL.DAYS
C        PARAY...PARAMEDICAL EQUIVALENTS PER 1 MIO SIL.DAYS
C        TBED...TOTAL BEDS REQUIRED
C        BTI...BED TURNOVER TIME (DAYS)
C
C
```

```
      DIMENSION POP(19,2),WORK(19,2),RPART(19,2),RSIL(19,2),CASIL(19,2)
     *          ,DRSIL(19,2),SILDS(19,2),PLOSS(19,2),RHOS(19,2),CAHOS
     *           (19,2),DRHOS(19,2),HOSDS(19,2)
C
C     INPUT FILE NO. 4,NAME PARA
      READ(4,901) II,JJ,KK,LL,JR,BTI,DOCY,PARAY
901   FORMAT(5I5,6F10.3)
      WRITE(6,929)
929   FORMAT(1X,'DATA-INPUT',/)
C     OUTPUT FILE NO.6
      WRITE(6,930)
      WRITE(6,901)II,JJ,KK,LL,JR,BTI,DOCY,PARAY
930   FORMAT(1X,,'  II    JJ    KK    LL    YR',' BED TURN,',2X,
     *'DOC.EQUIV ','PARAM.EQUIV')
C
C     INPUT DATA FILE NO.4,NAME PARA
C
      READ(4,902)((RPART(J,K),J=1,JJ),K=1,KK)
      READ(4,902)((RSIL(J,K),J=1,JJ),K=1,KK)
      READ(4,902)((DRSIL(J,K),J=1,JJ),K=1,KK)
      READ(4,902)((RHOS(J,K),J=1,JJ),K=1,KK)
      READ(4,902)((DRHOS(J,K),J=1,JJ),K=1,KK)
      JJ2=JJ-2
      DO 250 K=1,KK
      DO 250 J=4,16
250   PLOSS(J,K)=100.*RSIL(J,K)*DRSIL(J,K)/365.
      WRITE(6,931)
931   FORMAT(/1X,5H AGE ,2X,20HSICK-LEAVES PER HEAD,9X,
     *14HDURATION OF SL,7X,18HLOSS OF PRODUCTION)
      DO 260 J=4,16
      JA=5*J-5
      JE=JA+4
260   WRITE(6,933)JA,JE,(RSIL(J,K),K=1,KK),(DRSIL(J,K),K=1,KK),
     *(PLOSS(J,K),K=1,KK)
      WRITE(6,932)
932   FORMAT(/1X,5H AGE ,3X,17HHOSP-STAYS PER SL,7X,
     *18HDURATION HOSP.STAY,7X,18HPARTICIPATION RATE)
      DO 270 J=4,16
      JA=5*J-5
      JE=JA+4
270   WRITE(6,933)JA,JE,(RHOS(J,K),K=1,KK),(DRHOS(J,K),K=1,KK),
     *(RPART(J,K),K=1,KK)
933   FORMAT(1X,I2,1H-,I2,2F10.5,5X,2F10.2,5X,2F10.5)
902   FORMAT(8X,8F8.4)
      DO 300 I=1,II
      READ(4,903)(POP(J,1),J=1,JJ)
      READ(4,903)(POP(J,2),J=1,JJ)
903   FORMAT(1X,8F10.0)
      TWORK=0.
      TPOP=0.
      TSILDS=0.
      TCASIL=0.
      THOSDS=0.
      TCAHOS=0.
      TPLOSS=0.
C
C
C
```

```
      DO 200 K=1,KK
      POP(JJ,K)=0.
      WORK(JJ,K)=0.
      CASIL(JJ,K)=0.
      SILDS(JJ,K)=0.
      CAHOS(JJ,K)=0.
      HOSDS(JJ,K)=0.
      DO 211 J=1,JJ2
      POP(JJ,K)=POP(JJ,K)+POP(J,K)
      WORK(J,K)=RPART(J,K)*POP(J,K)
      WORK(JJ,K)=WORK(JJ,K)+WORK(J,K)
211   CONTINUE
      DO 210 J=4,16
      CASIL(J,K)=RSIL(J,K)*WORK(J,K)
      CASIL(JJ,K)=CASIL(JJ,K)+CASIL(J,K)
      SILDS(J,K)=DRSIL(J,K)*CASIL(J,K)
      SILDS(JJ,K)=SILDS(JJ,K)+SILDS(J,K)
      CAHOS(J,K)=RHOS(J,K)*CASIL(J,K)
      CAHOS(JJ,K)=CAHOS(JJ,K)+CAHOS(J,K)
      HOSDS(J,K)=DRHOS(J,K)*CAHOS(J,K)
210   HOSDS(JJ,K)=HOSDS(JJ,K)+HOSDS(J,K)
      RPART(JJ,K)=WORK(JJ,K)/POP(JJ,K)
      DRSIL(JJ,K)=SILDS(JJ,K)/CASIL(JJ,K)
      PLOSS(JJ,K)=100.*SILDS(JJ,K)/(365.*WORK(JJ,K))
      DRHOS(JJ,K)=HOSDS(JJ,K)/CAHOS(JJ,K)
      TPOP=TPOP+POP(JJ,K)
      TWORK=TWORK+WORK(JJ,K)
      TCASIL=TCASIL+CASIL(JJ,K)
      TSILDS=TSILDS+SILDS(JJ,K)
      TCAHOS=TCAHOS+CAHOS(JJ,K)
200   THOSDS=THOSDS+HOSDS(JJ,K)
      APLOSS=100.*TSILDS/(365.*TWORK)
      ADRSIL=TSILDS/TCASIL
      ADRHOS=THOSDS/TCAHOS
      ARPART=TWORK/TPOP
      DOCE=TSILDS*DOCY/1000000.
      PARAE=TSILDS*PARAY/1000000.
      TBED=THOSDS*(ADRHOS+BTI)/(365.*ADRHOS)
911   FORMAT(1H1,5HYEAR ,I4,/)
      JAHR=5*I+JR-5
      WRITE(6,911)JAHR
913   FORMAT(1X,5H AGE 5X,10HPOPULATION,15X,10H  WORKERS ,13X,
     * 19HPARTIZIPATION RATES,/)
      WRITE (6,913)
      DO 400 JI=1,JJ2
      JA=5*JI-5
      JE=JA+4
912   FORMAT(1X,I2,1H-,I2,2F10.0,5X,2F10.0,5X,2F10.5)
      WRITE(6,912)JA,JE,(POP(JI,K),K=1,KK),(WORK(JI,K),K=1,KK),
     * (RPART(JI,K),K=1,KK)
400   CONTINUE
914   FORMAT(1X,5H SUM ,2F10.0,5X,2F10.0,5X,2F10.5)
      WRITE(6,914)(POP(19,K),K=1,KK),(WORK(19,K),K=1,KK),
     * (RPART(19,K),K=1,KK)
920   FORMAT(1X,5HTOTAL,5X,1F10.0,15X,1F10.0,15X,1F10.5)
      WRITE(6,920)TPOP,TWORK,ARPART
917   FORMAT(/,1X,5H AGE ,2X,16HSICK-LEAVE:CASES,9X,15HSICK-LEAVE-DAYS/)
      WRITE(6,917)
916   FORMAT(1X,I2,1H-,I2,2F10.0,5X,2F10.0)
      DO 410 JI=4,16
      JA=5*JI-5
      JE=JA+4
      WRITE(6,916)JA,JE,(CASIL(JI,K),K=1,KK),(SILDS(JI,K),K=1,KK)
```

```
410     CONTINUE
918     FORMAT(1X,5H SUM ,2F10.0,5X,2F10.0)
        WRITE(6,918)(CASIL(19,K),K=1,KK),(SILDS(19,K),K=1,KK)
919     FORMAT(1X,5HTOTAL,5X,1F10.0,15X,1F10.0,15X,1F10.5)
        WRITE(6,919)TCASIL,TSILDS
        WRITE(6,935)
935     FORMAT(/1X,5H AGE ,6X,14HHOSPITAL STAYS,7X,13HHOSPITAL DAYS,/)
        DO 420 JI=4,16
        JA=JI*5-5
        JE=JA+4
420     WRITE(6,916)JA,JE,(CAHOS(JI,K),K=1,KK),(HOSDS(JI,K),K=1,KK)
        WRITE(6,918)(CAHOS(19,K),K=1,KK),(HOSDS(19,K),K=1,KK)
        WRITE(6,919)TCAHOS,THOSDS
        WRITE(6,940)JAHR
940     FORMAT(1H1,'SUMMARY TABLE IN THE YEAR',I5)
        WRITE(6,944)
```

```
        WRITE(6,945)APLOSS,TBED,DOCE,PARAE
945     FORMAT(/1X,F20.5,3F20.3)
944     FORMAT(/1X,2X,'LOSS OF PRODUCTION',6X,'NUMBER OF BEDS',
     -  8X,'DOCTOREQUIV',7X,'PARAMED.EQUIV')
947     FORMAT(/1X,2F10.5,5X,2F10.5)
948     FORMAT(1X,5X,F10.5,15X,F10.5)
        WRITE(6,946)
946     FORMAT(/6X,'DURATION SL',13X,'DURATION HOSP.STAY')
        WRITE(6,947)(DRSIL(19,K),K=1,KK),(DRHOS(19,K),K=1,KK)
        WRITE(6,948) ADRSIL,ADRHOS
300     CONTINUE
        CALL EXIT
        END
```

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