Committee II
Theoretical Empiricism: A General
Rationale for Scientific Model-Building

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SOCIO-ECONOMIC PLS - SOFT MODEL OF POLAND: AN APPLICATION OF MODE D

by

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Discussion Paper

on

Richard Noonan's

EVALUATION OF SCHOOL SYSTEMS USING PARTIAL LEAST SQUARES (PLS): AN APPLICATION IN THE ANALYSIS OF OPEN SYSTEMS

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Summary

ROGOWSKI H

I am indepted to Profs. Herman WOLD and Richard NOONAN for help, the few hours' discussions and the fruitful advices.

0. Summary

In the paper a new weight-relation - MODE D - is introduced in Partial Least Squares Method. Usually all indicators of the given LV (latent variable) are the same type of weight-relations: MODE A (outward-directed) when these MV-s (manifest variables) are reflective and MODE B (inward-directed) when they are only formative. The proposed new mode D is that there exist formative and reflective variables simultaneously in the same block, so one LV can be connected with indicators having different modes. The estimation method for soft model with mode D is combined of the procedures for mode A and mode B.

In the second part of the paper an application of the new mode is described. The model (Socio-economic PLS - soft model of Poland) contains 75 indicators of 9 latent variables. 7 LV-s belong to the first and 2 LV-s - to the second level of hierarchy. It is estimated basing on realy data from 1950 to 1982. Additionally the SG test and Tukey's jackknifing are applied. Quality of the model isn't bad although it is a provisional version.

1. Mode D - an extension of PLS Method

All extensions of Wold's basic design of PLS method assume that an investigator has complete freedom to decide, among other things, whether the LV should be estimated PLS mode A or B (see [1] and [2]). It means that for given LV its block of indicators is outward-directed (mode A) or inward-directed (mode B). This decision is facilitated by the following rules (see [2]):

- if all indicators for the given LV are formative then it is choosen mode B, in the case of reflective indicators - mode B,
- if the given LV is exogenous then it is choosen mode B, in the case of endogenous LV - mode A (see also [1]),
- purely technical rule.

Sometimes we can obtain LV which one group of indicators is formative and the second one is reflective. In this case you can apply mode D - an extension of modes A and B. In the second part of the paper an application of the mode D is showed. It is Socio-economic PLS-soft model of Poland - 1950-1982. An example of arrow scheme of LV with mode D is exhibited in Fig. 1 .

The estimation of a model with LV-s having mode D is combining PLS - mode A and PLS - mode B. Assume that Fig. 1 shows a part of a soft model. Basing on that example it is described PLS - mode D.

The difference between this method and Wold's PLS (see [1]) is that in one and the same block some weights are computed Mode A, other weights are computed Mode B.

Assume that we have obtained new weights $w_{ij}^{(s)}$, $v_{ij}^{(s)}$ and new values of LV-s: $KSI_{jt}^{(s)}$ at s-th cycle. At the iteration no. s+1 inside estimation of LV-s - $A_{jt}^{(s+1)}$ (see [1]) - is calculated. Then we can estimate the new weights $\overset{\cdot}{w}_{ij}^{(s+1)}$ and $\overset{\cdot}{v}_{ij}^{(s+1)}$ in the following way:

(i) for $i=1, 2, \ldots, k_1$ $\overset{\cdot}{w}_{ij}^{(s+1)}$ are the OLS estimators of parameters of the following equation

$$(1) \qquad A_{jt}^{(s+1)} = \sum_{i=1}^{k_1} \overset{\cdot}{w}_{ij}^{(s+1)} x_{it} + \text{error} \quad (t=1, \ldots, T),$$

(ii) for $i=1, 2, \ldots, k_2$ $\overset{\cdot}{v}_{ij}^{(s+1)}$ are the OLS estimators of parameters of the following equations

$$(2) \qquad y_{it} = \overset{\cdot}{v}_{ij}^{(s+1)} A_{jt}^{(s+1)} + \text{error} \quad (t=1, \ldots, T).$$

Subsequently we standardize of the new weights like in Wold's PLS and calculate the new values of LV-s applying the following formula:

$$(3) \qquad KSI_{jt}^{(s+1)} = \sum_{i=1}^{k_1} w_{ij}^{(s+1)} x_{it} + \sum_{i=1}^{k_2} v_{ij}^{(s+1)} y_{it} \quad .$$

The remaining part of estimation process is the same like PLS - basic design.

Note that the formula (1) is the way of obtaining the new weights in PLS-mode B and the formula (2) - PLS-mode A.

2. Socio-economic PLS-soft model of Poland - 1950-1982#)

It is well known that the development of social sphere depends on the development of economy. This dependence is the main relation in the model. On the other hand economy depends on the development of industry and agriculture, and foreign trade and it is assumed that economy is the variable of higher level than others (in analogy to the social sphere). For details see Table 1, where the latent variables with levels of hierarchy and number of manifest variables are shown. So the model contains 9 LV-s.

It is assumed two types of inner relations - DESIGN 1 and DESIGN 2 (see Fig. 2 and Fig. 3). The first one is more complex. In economical sphere the level of development of agriculture is assumed to depend on industry, whereas the level of development of foreign trade depends on industry and agriculture (e.g. by demand on import goods like grain, oil, semi-finished products). On the other hand all social LV-s of the first level depend on the quality of life. The second type (DESIGN 2) is the simplest - there don't exist relations between LV-s of the first level of hierarchy. So e.g. the indicators of foreign trade depend on industry and agriculture but only by level of economy.

All indicators have efficiency character (e.g. production of some goods per capita, productivity of labour and fixed capital, new flats per capita ...). For details see Table 2, where all of the manifest variables are described. Additionally two kinds of

weight-relations are shown - MODE 1 and MODE 2. The second one means that the model has mode A (all indicators are outward-directed or in another words all indicators are reflective) and it is the simplest case. The MODE 1 is more complex and means mode D, where all indicators like production of some goods per capita or per 1 hectar, the value of sale and so on are outward-directed (mode A) and others are inward-directed (mode B). In another words all "resultant" manifest variables are reflective (mode A) and the remaining MV-s are formative (mode B).

Three models are estimated: 1-1, 2-1, 2-2, where the first digit means the MODE number and the second digit - the DESIGN number. For example the model 2-1 is the model with MODE 2 (mode A) and DESIGN 1 (more complex). The convergence of the estimation process is obtained after the 25-th, 9-th and 11-th iteration, respectively. It is interesting that the estimated weights and loadings of the two first models are practically equal pairwise. Note that this fact is true for the models 1-1 and 2-2 but only for latent variables with the same mode, for example F.TRADE and EDUCAT (see Table 3 and Figures 7 and 12).

The estimated weights and loadings with their standard deviations of the models 1-1 and 2-2 are presented in Table 3. In the Tables 4 and 5 you can see estimated parameters of the inner relations of the model 2-2 and the models 1-1 and 2-1, respectively. There exists high correlation between economical and social spheres

in all models (the highest and most accurate coefficient is obtained for the model 1-1). Note that the estimated parameters connected with LIFE in the three last equations are less than their standard deviations. On the other hand the economical part is more plausible in the model 1-1. Applying PLS method we have obtained the estimated values of LV-s, which are presented on the diagrams in Figures 4-12 (upper parts concern the model 2-2 and lower parts - the model 1-1). Observe that the level of development of industry from 1979 to 1980 increased in the model 2-2 and decreased in the model 1-1. Analogical observations you can do in the level of agriculture in the period 1976 - 1977 and in the level of social sphere in the years 1974 - 75. You can say that the model 1-1 is more realistic than the remaining ones.

Additionally the models 1-1 and 2-2 are tested by SG test and Tukey's jackknife (see [1], [2]). Speed of convergence of the testing process is shown in the Table 6 (one iteration is equivalent to one reestimation of parameters of the model). These models have similar predictive property - SG test Q^2 is equal to 0.7074 and 0.7146, respectively. The years predicted poorly are the same in both models - 1958, 1959, 1967-70. All indicators of blindfolded LV - LIFE - except 69-th MV are well predicted (the SG tests for the 69-th MV in the both models are equal to -0.0875 and -0.0795, respectively).

The models described above are provisional and the building

of new versions of the model will be continued as well as the building of new models applying PLS method.

#) The model is estimated basing on the realy data from Great Year-Book of Poland 1982 and 1981, Warsaw 1983 and Warsaw 1982, respectively.

FIG 1

Arrow scheme of Mode D

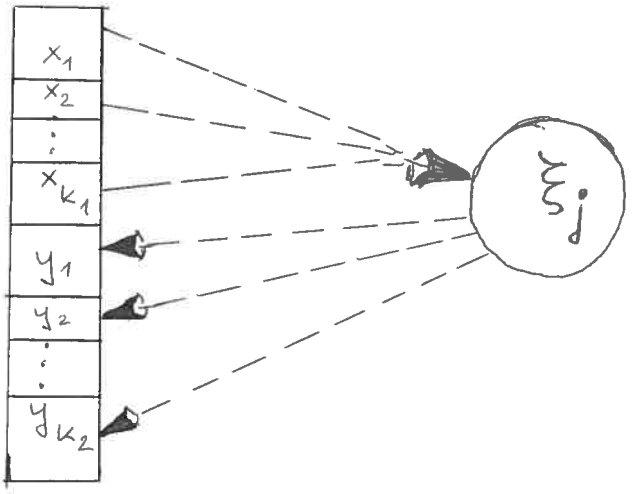


TABLE 1

Latent variables

No of LV	Name of LV	Meaning of LV	Level of hierarchy	Number of MV-s
1	INDUSTRY	Level of development of industry	1	24
2	AGRICUL.	Level of development of agriculture	1	17
3	F.TRADE	Level of development of foreign trade	1	2
4	ECONOMY	Level of development of economy	2	43
5	SOCIAL	Level of development of social sphere	2	32
6	LIFE	Quality of life	1	9
7	CULTURE	Level of development of cultural sphere	1	10
8	HEALTH	Level of development of medical service and health	1	7
9	EDUCAT.	Level of development of educational sphere	1	6

TABLE 2

Manifest variables with MODE 1 and MODE 2

No of MV	Meaning of MV	Indicator of LV (s)	MODE 1	MODE 2#)
1	Productivity of labour in industry	INDUSTRY ECONOMY	INWARD INWARD	OUTWARD OUTWARD
2	Added value in industry devided by output of industry	INDUSTRY ECONOMY	INWARD INWARD	OUTWARD OUTWARD
3	Fixed capital in industry devided by labour in industry	INDUSTRY ECONOMY	INWARD INWARD	OUTWARD OUTWARD
4	Productivity of electricity in industry	INDUSTRY ECONOMY	INWARD INWARD	OUTWARD OUTWARD
5	Productivity of fixed capital in industry	INDUSTRY ECONOMY	INWARD INWARD	OUTWARD OUTWARD
6	Coal production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
7	Oil transormation per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
8	Passangers cars production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
9	Lorries production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
10	Cement production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
11	Roll products per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
12	Electricity production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
13	Copper production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
14	Agricultural machines and installations production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD

(Continued)

TABLE 2 (Continued)

15	Elements of automatization production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
16	Computer systems production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
17	Semi-conducting elements production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
18	Sulphuric acid production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
19	Lime nitrogen production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
20	Phosphates production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
21	Plastics production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
22	Medicaments production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
23	Radio sets production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
24	TV sets production per capita	INDUSTRY ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
25	Added value in agriculture devided by agricultural outputs of goods	AGRICUL. ECONOMY	INWARD INWARD	OUTWARD OUTWARD
26	Global stock production devided by global plant production	AGRICUL. ECONOMY	INWARD INWARD	OUTWARD OUTWARD
27	Added value in agriculture devided by agricultural global production	AGRICUL. ECONOMY	INWARD INWARD	OUTWARD OUTWARD
28	Yield of grain per 1 hectar	AGRICUL. ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD
29	Yield of potatoes per 1 hectar	AGRICUL. ECONOMY	OUTWARD OUTWARD	OUTWARD OUTWARD

(Continued)

TABLE 2 (Continued)

30	Yield of sugar-beet per 1 hectar	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
31	Heads of cattle per 100 hectars	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
32	Heads of pig per 100 hectars	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
33	Agricultural final production devided by agricultural global output	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
34	Yield of grain per capita	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
35	Yield of potatoes per capita	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
36	Yield of sugar-beet per capita	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
37	Cattle for slaughter per capita	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
38	Meat from industrial slaughter per capita	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
39	Meat production per capita	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
40	Purchased cattle for slaughter per capita	AGRICUL.	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
41	Used fertilizers per 1 hectar	AGRICUL.	INWARD	OUTWARD
		ECONOMY	INWARD	OUTWARD
42	National income devided by import (productivity of import)	F.TRADE	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
43	Export devided by national income (export capacity of economy)	F.TRADE	OUTWARD	OUTWARD
		ECONOMY	OUTWARD	OUTWARD
44	Number of doctors per capita	HEALTH	INWARD	OUTWARD
		SOCIAL	INWARD	OUTWARD

(Continued)

TABLE 2 (Continued)

45	Number of dentists per capita	HEALTH SOCIAL	INWARD INWARD	OUTWARD OUTWARD
46	Number of nurses per capita	HEALTH SOCIAL	INWARD INWARD	OUTWARD OUTWARD
47	Hospitals cots per capita	HEALTH SOCIAL	INWARD INWARD	OUTWARD OUTWARD
48	1/being in hospitals per capita	HEALTH SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
49	Number of drug stores per capita	HEALTH SOCIAL	INWARD INWARD	OUTWARD OUTWARD
50	1/mortality of babies	HEALTH SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
51	Edition of books and brochures per capita	CULTURE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
52	Circulation of newspapers and magazines per capita	CULTURE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
53	Number of libraries per capita	CULTURE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
54	Number of books in libraries per capita	CULTURE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
55	Number of seats in theatres per capita	CULTURE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
56	Number of audiences in theatres per capita	CULTURE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
57	Number of cinemas per capita	CULTURE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
58	Number of audience in cinemas per capita	CULTURE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
59	Number of radio subscribers per capita	CULTURE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
60	Number of TV subscribers per capita	CULTURE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD

(Continued)

TABLE 2 (Continued)

61	Real wages in State-controlled economy	LIFE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
62	Number of new flats per capita	LIFE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
63	Average of living space in new flats	LIFE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
64	Average of number of rooms in new flats	LIFE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
65	Value of sale in shops per capita	LIFE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
66	Value of sale in restaurants per capita	LIFE SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
67	Number of shops per capita	LIFE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
68	Number of restaurants per capita	LIFE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
69	Number of workers' canteens per 1 worker	LIFE SOCIAL	INWARD INWARD	OUTWARD OUTWARD
70	Number of pupils of overprimary schools per capita	EDUCAT SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
71	Number of pupils of grammar schools per 1 pupil of technical school	EDUCAT SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
72	Number of alumnuses per capita	EDUCAT SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
73	Number of alumnuses of grammar schools per 1 alumnus of technical school	EDUCAT SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
74	Number of students of high schools per capita	EDUCAT SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD
75	Number of graduates of high schools per capita	EDUCAT SOCIAL	OUTWARD OUTWARD	OUTWARD OUTWARD

#) Note that MODE 1 and MODE 2 are equivalent with mode D and mode A, respectively.

FIG 2

Assumed inner relations - DESIGN 1

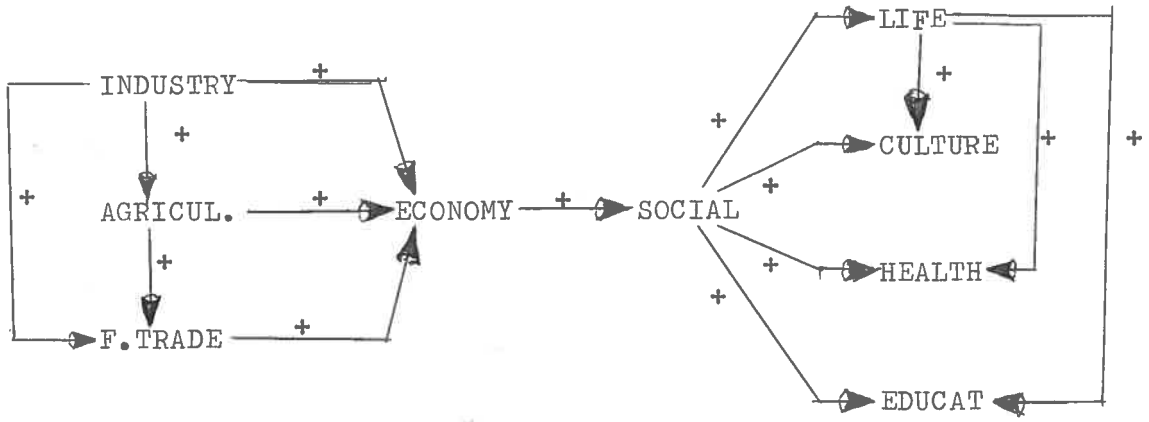


FIG 3

Assumed inner relations - DESIGN 2

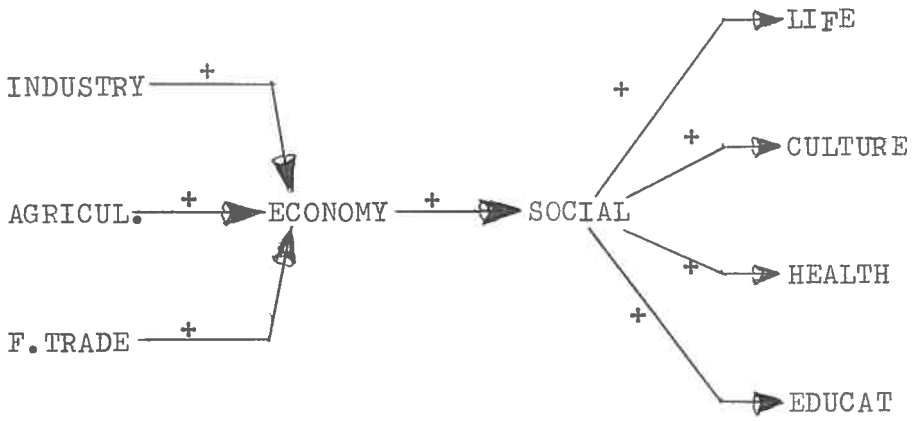


TABLE 3

Estimated outher relations of the models 1-1 and 2-2

Name of LV	No of MV	Mode	Model 1 - 1 weight (st.dev.)	Model 1 - 1 loading (st.dev.)	Model 2 - 2#) weight (st.dev)	Model 2 - 2#) loading (st.dev.)
INDUSTRY						
	1	INWARD	0.1257	0.9975	0.0497	0.9934
			(0.0015)	(0.0007)	(0.0000)	(0.0007)
	2	INWARD	0.0641	-0.6941	-0.0349	-0.7062
			(0.0005)	(0.0002)	(0.0000)	(0.0007)
	3	INWARD	0.2816	0.9366	0.0464	0.9492
			(0.0020)	(0.0006)	(0.0000)	(0.0007)
	4	INWARD	-0.0336	0.5279	0.0258	0.5543
			(0.0001)	(0.0002)	(0.0000)	(0.0003)
	5	INWARD	0.0970	0.0911	0.0053	0.0376
			(0.0006)	(0.0001)	(0.0000)	(0.0000)
	6	OUTWARD	0.0377	0.9879	0.0491	0.9875
			(0.0000)	(0.0005)	(0.0000)	(0.0007)
	7	OUTWARD	0.0379	0.9880	0.0492	0.9893
			(0.0000)	(0.0007)	(0.0000)	(0.0005)
	8	OUTWARD	0.0341	0.9341	0.0461	0.9516
			(0.0000)	(0.0006)	(0.0000)	(0.0005)
	9	OUTWARD	0.0369	0.9222	0.0465	0.9019
			(0.0000)	(0.0009)	(0.0000)	(0.0008)
	10	OUTWARD	0.0381	0.9745	0.0487	0.9589
			(0.0000)	(0.0006)	(0.0000)	(0.0005)
	11	OUTWARD	0.0384	0.9861	0.0494	0.9789
			(0.0000)	(0.0006)	(0.0000)	(0.0009)
	12	OUTWARD	0.0385	0.9952	0.0497	0.9941
			(0.0000)	(0.0008)	(0.0000)	(0.0005)
	13	OUTWARD	0.0350	0.9478	0.0469	0.9649
			(0.0000)	(0.0005)	(0.0000)	(0.0006)
	14	OUTWARD	0.0365	0.9463	0.0472	0.9392
			(0.0000)	(0.0004)	(0.0000)	(0.0006)
	15	OUTWARD	0.0348	0.9453	0.0467	0.9630
			(0.0000)	(0.0007)	(0.0000)	(0.0005)
	16	OUTWARD	0.0323	0.8915	0.0439	0.9155
			(0.0000)	(0.0008)	(0.0000)	(0.0006)
	17	OUTWARD	0.0330	0.9098	0.0449	0.9328
			(0.0000)	(0.0007)	(0.0000)	(0.0006)
	18	OUTWARD	0.0381	0.9677	0.0487	0.9624
			(0.0000)	(0.0005)	(0.0000)	(0.0007)
	19	OUTWARD	0.0381	0.9624	0.0484	0.9532
			(0.0000)	(0.0005)	(0.0000)	(0.0002)
	20	OUTWARD	0.0386	0.9823	0.0492	0.9734
			(0.0000)	(0.0007)	(0.0000)	(0.0010)
	21	OUTWARD	0.0382	0.9886	0.0494	0.9929
			(0.0000)	(0.0008)	(0.0000)	(0.0007)

(Continued)

TABLE 3 (Continued)

INDUSTRY (Continued)					
22	OUTWARD	0.0365	0.9620	0.0479	0.9741
		(0.0000)	(0.0005)	(0.0000)	(0.0005)
23	OUTWARD	0.0336	0.9233	0.0457	0.9409
		(0.0000)	(0.0006)	(0.0000)	(0.0008)
24	OUTWARD	0.0380	0.9428	0.0475	0.9224
		(0.0000)	(0.0007)	(0.0000)	(0.0007)
AGRICUL.					
25	INWARD	0.0862	-0.8168	-0.0788	-0.8122
		(0.0003)	(0.0008)	(0.0001)	(0.0005)
26	INWARD	0.0082	0.4946	0.0508	0.5342
		(0.0002)	(0.0006)	(0.0000)	(0.0005)
27	INWARD	-0.1495	-0.9507	-0.0869	-0.9479
		(0.0009)	(0.0002)	(0.0001)	(0.0006)
28	OUTWARD	0.0558	0.9644	0.0834	0.9560
		(0.0000)	(0.0005)	(0.0001)	(0.0006)
29	OUTWARD	0.0422	0.7671	0.0622	0.7572
		(0.0000)	(0.0006)	(0.0000)	(0.0003)
30	OUTWARD	0.0407	0.7295	0.0584	0.7229
		(0.0000)	(0.0005)	(0.0000)	(0.0000)
31	OUTWARD	0.0582	0.9911	0.0873	0.9905
		(0.0000)	(0.0005)	(0.0001)	(0.0006)
32	OUTWARD	0.0571	0.9738	0.0873	0.9810
		(0.0001)	(0.0003)	(0.0001)	(0.0010)
33	OUTWARD	0.0247	0.3519	0.0381	0.3579
		(0.0000)	(0.0005)	(0.0000)	(0.0005)
34	OUTWARD	0.0278	0.5487	0.0416	0.5431
		(0.0000)	(0.0003)	(0.0000)	(0.0004)
35	OUTWARD	0.0013	0.1190	-0.0001	0.1103
		(0.0000)	(0.0002)	(0.0000)	(0.0001)
36	OUTWARD	0.0434	0.7704	0.0632	0.7656
		(0.0000)	(0.0006)	(0.0001)	(0.0005)
37	OUTWARD	0.0550	0.9581	0.0843	0.9698
		(0.0000)	(0.0008)	(0.0001)	(0.0005)
38	OUTWARD	0.0554	0.9646	0.0850	0.9758
		(0.0000)	(0.0005)	(0.0001)	(.0007)
39	OUTWARD	0.0504	0.9035	0.0759	0.9074
		(0.0000)	(0.0007)	(0.0001)	(0.0006)
40	OUTWARD	0.0554	0.9558	0.0845	0.9673
		(0.0000)	(0.0006)	(0.0001)	(0.0008)
41	INWARD	0.4419	0.9795	0.0880	0.9709
		(0.0008)	(0.0008)	(0.0001)	(0.0000)

(Continued)

TABLE 3 (Continued)

F.TRADE					
42	OUTWARD	-0.5242	-0.9782	-0.5221	-0.9780
		(0.0005)	(0.0009)	(0.0005)	(0.0005)
43	OUTWARD	0.4992	0.9759	0.5014	0.9761
		(0.0004)	(0.0006)	(0.0003)	(0.0005)
ECONOMY					
1	INWARD	0.0691	0.9912	0.0303	0.9942
		(0.0091)	(0.0008)	(0.0000)	(0.0008)
2	INWARD	0.0493	-0.6870	-0.0215	-0.6992
		(0.0030)	(0.0009)	(0.0000)	(0.0007)
3	INWARD	0.1332	0.9156	0.0283	0.9285
		(0.0100)	(0.0006)	(0.0000)	(0.0009)
4	INWARD	-0.0419	0.4928	0.0145	0.5167
		(0.0010)	(0.0003)	(0.0000)	(0.0000)
5	INWARD	0.0318	0.1414	0.0037	0.1071
		(0.0031)	(0.0007)	(0.0000)	(0.0001)
6	OUTWARD	0.0228	0.9781	0.0299	0.9823
		(0.0000)	(0.0007)	(0.0000)	0(0.0005)
7	OUTWARD	0.0229	0.9813	0.0299	0.9844
		(0.0000)	(0.0005)	(0.0000)	(0.0008)
8	OUTWARD	0.0209	0.9031	0.0275	0.9229
		(0.0000)	(0.0007)	(0.0000)	(0.0007)
9	OUTWARD	0.0221	0.9427	0.0287	0.9311
		(0.0000)	(0.0008)	(0.0000)	(0.0007)
10	OUTWARD	0.0229	0.9812	0.0299	0.9755
		(0.0000)	(0.0007)	(0.0000)	(0.0007)
11	OUTWARD	0.0232	0.9895	0.0303	0.9896
		(0.0000)	(0.0005)	(0.0000)	(0.0003)
12	OUTWARD	0.02333	0.9930	0.0305	0.9953
13		(0.0000)	(0.0006)	(0.0000)	(0.0004)
13	OUTWARD	0.0214	0.9218	0.0281	0.9384
		(0.0000)	(0.0003)	(0.0000)	(0.0006)
14	OUTWARD	0.0221	0.9482	0.0288	0.9443
		(0.0000)	(0.0004)	(0.0000)	(0.0002)
15	OUTWARD	0.0212	0.9173	0.0280	0.9347
		(0.0000)	(0.0008)	(0.0000)	(0.0006)
16	OUTWARD	0.0198	0.8560	0.0262	0.8781
		(0.0000)	(0.0007)	(0.0000)	(0.0007)
17	OUTWARD	0.0202	0.8752	0.0268	0.8989
		(0.0000)	(0.0007)	(0.0000)	(0.0004)
18	OUTWARD	0.0229	0.9773	0.0298	0.9745
		(0.0000)	(0.0009)	(0.0000)	(0.0009)
19	OUTWARD	0.0229	0.9762	0.0298	0.9684
		(0.0000)	(0.0006)	(0.0000)	(0.0008)
20	OUTWARD	0.0232	0.9898	0.0303	0.9842
		(0.0000)	(0.0007)	(0.0000)	(0.0004)

(Continued)

TABLE 3 (Continued)

ECONOMY (Continued)					
21	OUTWARD	0.0231	0.9849	0.0302	0.9894
		(0.0000)	(0.0009)	(0.0000)	(0.0005)
22	OUTWARD	0.0222	0.9463	0.0292	0.9580
		(0.0000)	(0.0003)	(0.0000)	(0.0005)
23	OUTWARD	0.0206	0.8957	0.0272	0.9143
		(0.0001)	(0.0008)	(0.0001)	(0.0007)
24	OUTWARD	0.0228	0.9619	0.0296	0.9515
		(0.0000)	(0.0007)	(0.0000)	(0.0006)
25	INWARD	0.0534	-0.8674	-0.0268	-0.8856
		(0.0025)	(0.0009)	(0.0000)	(0.0005)
26	INWARD	0.0118	0.5335	0.0163	0.5710
		(0.0005)	(0.0012)	(0.0001)	(0.0007)
27	INWARD	-0.0254	-0.9699	-0.0298	-0.9759
		(0.0041)	(0.0007)	(0.0000)	(0.0005)
28	OUTWARD	0.0223	0.9490	0.0291	0.9366
		(0.0000)	(0.0004)	(0.0000)	(0.0006)
29	OUTWARD	0.0171	0.7275	0.0220	0.6987
		(0.0000)	(0.0006)	(0.0000)	(0.0006)
30	OUTWARD	0.0165	0.6872	0.0213	0.6562
		(0.0000)	(0.0008)	(0.0000)	(0.0005)
31	OUTWARD	0.0232	0.9873	0.0302	0.9807
		(0.0000)	(0.0007)	(0.0000)	(0.0007)
32	OUTWARD	0.0227	0.9767	0.0298	0.9808
		(0.0000)	(0.0000)	(0.0000)	(0.0008)
33	OUTWARD	0.0094	0.4054	0.0125	0.4277
		(0.0000)	(0.0006)	(0.0000)	(0.0005)
34	OUTWARD	0.0114	0.4861	0.0147	0.4670
		(0.0000)	(0.0006)	(0.0000)	(0.0006)
35	OUTWARD	0.0011	0.0395	0.0009	-0.0013
		(0.0000)	(0.0007)	(0.0000)	(0.0002)
36	OUTWARD	0.0176	0.7389	0.0226	0.7096
		(0.0000)	(0.0006)	(0.0000)	(0.0005)
37	OUTWARD	0.0219	0.9453	0.0287	0.9465
		(0.0000)	(0.0009)	(0.0000)	(0.0007)
38	OUTWARD	0.0221	0.9542	0.0290	0.9552
		(0.0000)	(0.0007)	(0.0000)	(0.0005)
39	OUTWARD	0.0204	0.8680	0.0264	0.8526
		(0.0000)	(0.0005)	(0.0000)	(0.0006)
40	OUTWARD	0.0221	0.9474	0.0289	0.9495
		(0.0000)	(0.0007)	(0.0000)	(0.0007)
41	INWARD	0.2431	0.9895	0.0303	0.9890
		(0.0045)	(0.0007)	(0.0000)	(0.0007)
42	OUTWARD	-0.0228	-0.9537	-0.0297	-0.9463
		(0.0000)	(0.0007)	(0.0000)	(0.0006)
43	OUTWARD	0.0220	0.9122	0.0287	0.9089
		(0.0001)	(0.0007)	(0.0001)	(0.0005)

(Continued)

TABLE 3 (Continued)

SOCIAL					
44	INWARD	0.2767	0.9609	0.0425	0.9643
		(0.1276)	(0.0024)	(0.0010)	(0.0013)
45	INWARD	0.0685	0.9116	0.0403	0.9159
		(0.0563)	(0.0050)	(0.0010)	(0.0031)
46	INWARD	-0.4553	0.9690	0.0430	0.9742
		(0.1732)	(0.0038)	(0.0010)	(0.0022)
47	INWARD	0.1218	0.9284	0.0411	0.9306
		(0.0773)	(0.0039)	(0.0010)	(0.0023)
48	OUTWARD	-0.0256	-0.9371	-0.0416	-0.9412
		(0.0003)	(0.0040)	(0.0010)	(0.0021)
49	INWARD	0.0162	0.9184	0.0410	0.9174
		(0.0325)	(0.0033)	(0.0009)	(0.0018)
50	OUTWARD	0.0279	0.9885	0.0439	0.9915
		(0.0002)	(0.0011)	(0.0010)	(0.0008)
51	INWARD	0.0222	0.5992	0.0271	0.5984
		(0.0093)	(0.0084)	(0.0005)	(0.0049)
52	INWARD	0.1357	0.8473	0.0377	0.8375
		(0.0451)	(0.0034)	(0.0008)	(0.0021)
53	INWARD	0.0024	0.7862	0.0346	0.7884
		(0.0194)	(0.0053)	(0.0009)	(0.0037)
54	INWARD	0.4504	0.9790	0.0435	0.9834
		(0.2257)	(0.0029)	(0.0010)	(0.0017)
55	INWARD	-0.0090	-0.6841	-0.0306	-0.6882
		(0.0077)	(0.0086)	(0.0004)	(0.0084)
56	OUTWARD	-0.0064	-0.2446	-0.0111	-0.2493
		(0.0002)	(0.0074)	(0.0001)	(0.0042)
57	INWARD	-0.0030	-0.4498	-0.0204	-0.4500
		(0.0291)	(0.0048)	(0.0004)	(0.0018)
58	OUTWARD	-0.0229	-0.8431	-0.0376	-0.8426
		(0.0001)	(0.0069)	(0.0007)	(0.0062)
59	OUTWARD	0.0248	0.9085	0.0402	0.9120
		(0.0004)	(0.0057)	(0.0010)	(0.0048)
60	OUTWARD	0.0270	0.9904	0.0440	0.9915
		(0.0002)	(0.0011)	(0.0010)	(0.0007)
61	INWARD	0.0249	0.9723	0.0431	0.9717
		(0.9757)	(0.0083)	(0.0006)	(0.0084)
62	OUTWARD	0.0244	0.8905	0.0394	0.8856
		(0.0005)	(0.0259)	(0.0007)	(0.0277)
63	OUTWARD	0.0203	0.7474	0.0333	0.7570
		(0.0020)	(0.0790)	(0.0025)	(0.0769)
64	OUTWARD	0.0265	0.9744	0.0433	0.9762
		(0.0001)	(0.0085)	(0.0006)	(0.0082)
65	OUTWARD	0.0268	0.9837	0.0437	0.9826
		(0.0001)	(0.0043)	(0.0008)	(0.0048)
66	OUTWARD	0.0266	0.9749	0.0432	0.9750
		(0.0001)	(0.0088)	(0.0006)	(0.0078)
67	INWARD	-0.0834	0.7737	0.0341	0.7768
		(0.0301)	(0.0771)	(0.0025)	(0.0746)
68	INWARD	0.1158	0.9557	0.0424	0.9568
		(0.8168)	(0.0128)	(0.0006)	(0.0122)

(Continued)

TABLE 3 (Continued)

SOCIAL (Continued)					
69	INWARD	0.0013	-0.0806	-0.0032	-0.0698
		(0.0059)	(0.1820)	(0.0115)	(0.2751)
70	OUTWARD	0.0233	0.8509	0.0376	0.8429
		(0.0001)	(0.0056)	(0.0007)	(0.0038)
71	OUTWARD	-0.0142	-0.5209	-0.0229	-0.5180
		(0.0001)	(0.0049)	(0.0004)	(0.0030)
72	OUTWARD	0.0255	0.9353	0.0416	0.9297
		(0.0001)	(0.0049)	(0.0008)	(0.0037)
73	OUTWARD	-0.0056	-0.2080	-0.0094	-0.2020
		(0.0003)	(0.0165)	(0.0002)	(0.0142)
74	OUTWARD	0.0266	0.9745	0.0433	0.9701
		(0.0002)	(0.0007)	(0.0010)	(0.0008)
75	OUTWARD	0.0244	0.8986	0.0402	0.8982
		(0.0002)	(0.0018)	(0.0009)	(0.0016)
LIFE					
61	INWARD	0.3723	0.9880	0.1429	0.9853
		(0.7175)	(0.0033)	(0.0072)	(0.0044)
62	OUTWARD	0.0454	0.9012	0.1302	0.9017
		(0.0007)	(0.0256)	(0.0056)	(0.0222)
63	OUTWARD	0.0371	0.7921	0.1113	0.8165
		(0.0036)	(0.0651)	(0.0029)	(0.0547)
64	OUTWARD	0.0496	0.9651	0.1436	0.9753
		(0.0004)	(0.0111)	(0.0072)	(0.0089)
65	OUTWARD	0.0500	0.9880	0.1445	0.9901
		(0.0006)	(0.0050)	(0.0077)	(0.0034)
66	OUTWARD	0.0495	0.9872	0.1434	0.9913
		(0.0004)	(0.0080)	(0.0073)	(0.0027)
67	INWARD	0.1642	0.7860	0.1142	0.7736
		(0.0323)	(0.0737)	(0.0031)	(0.0723)
68	INWARD	0.2916	0.9717	0.1407	0.9733
		(0.7217)	(0.0074)	(0.0070)	(0.0086)
69	INWARD	-0.0448	-0.0746	-0.0103	-0.0246
		(0.0177)	(0.1830)	(0.0343)	(0.2751)
CULTURE					
51	INWARD	-0.0476	0.5973	0.0995	0.7016
		(0.0344)	(0.0139)	(0.0006)	(0.0012)
52	INWARD	0.1150	0.8172	0.1393	0.8389
		(0.0107)	(0.0059)	(0.0003)	(0.0007)
53	INWARD	0.2134	0.7755	0.1311	0.6875
		(0.0301)	(0.0088)	(0.0008)	(0.0017)
54	INWARD	0.2985	0.9885	0.1635	0.9654
		(0.0171)	(0.0027)	(0.0005)	(0.0007)

(Continued)

TABLE 3 (Continued)

CULTURE (Continued)					
55	INWARD	-0.0217	-0.7022	-0.1145	-0.7637
		(0.0150)	(0.0096)	(0.0012)	(0.0010)
56	OUTWARD	-0.0348	-0.3023	-0.0415	-0.3847
		(0.0019)	(0.0084)	(0.0006)	(0.0020)
57	INWARD	-0.1324	-0.4751	-0.0748	-0.5688
		(0.0396)	(0.0087)	(0.0002)	(0.0016)
58	OUTWARD	-0.1247	-0.8590	-0.1401	-0.9129
		(0.0019)	(0.0084)	(0.0008)	(0.0009)
59	OUTWARD	0.1421	0.9044	0.1517	0.8427
		(0.0020)	(0.0067)	(0.0011)	(0.0014)
60	OUTWARD	0.1506	0.9934	0.1649	0.9929
		(0.0002)	(0.0011)	(0.0002)	(0.0009)
HEALTH					
44	INWARD	-0.1237	0.9767	0.1510	0.9897
		(0.0809)	(0.0025)	(0.0002)	(0.0007)
45	INWARD	-0.1807	0.9419	0.1434	0.9654
		(0.1125)	(0.0058)	(0.0003)	(0.0007)
46	INWARD	0.1941	0.9860	0.1525	0.9890
		(0.0350)	(0.0030)	(0.0002)	(0.0005)
47	INWARD	0.5716	0.9511	0.1457	0.9688
		(0.0653)	(0.0043)	(0.0002)	(0.0007)
48	OUTWARD	-0.1617	-0.9665	-0.1474	-0.9787
		(0.0011)	(0.0052)	(0.0002)	(0.0008)
49	INWARD	0.2604	0.8920	0.1437	0.8560
		(0.0170)	(0.0064)	(0.0005)	(0.0007)
50	OUTWARD	0.1688	0.9922	0.1553	0.9847
		(0.0003)	(0.0009)	(0.0002)	(0.0007)
EDUCAT					
70	OUTWARD	0.2233	0.9256	0.2225	0.9262
		(0.0006)	(0.0009)	(0.0003)	(0.0007)
71	OUTWARD	-0.1389	-0.5892	-0.1367	-0.5895
		(0.0014)	(0.0014)	(0.0004)	(0.0009)
72	OUTWARD	0.2454	0.9763	0.2454	0.9764
		(0.0005)	(0.0006)	(0.0002)	(0.0006)
73	OUTWARD	-0.0421	-0.3850	-0.0533	-0.3945
		(0.0066)	(0.0059)	(0.0035)	(0.0033)
74	OUTWARD	0.2589	0.9650	0.2561	0.9634
		(0.0019)	(0.0014)	(0.0011)	(0.0009)
75	OUTWARD	0.2366	0.8701	0.2371	0.8691
		(0.0010)	(0.0014)	(0.0007)	(0.0010)

#) All indicators have mode A at the model 2-2.

TABLE 4

Estimated inner relations of the model 2-2

	INDUSTRY	AGRICUL.	F.TRADE	
ECONOMY	0.5881 (0.0007)	0.3612 (0.0008)	0.0610 (0.0002)	R^2= 0.9999
	ECONOMY			
SOCIAL	0.9923 (0.0019)			R^2= 0.9847
	SOCIAL			R^2
LIFE	0.9845 (0.0043)			0.9693
CULTURE	0.9830 (0.0012)			0.9663
HEALTH	0.9856 (0.0014)			0.9714
EDUCAT	0.9586 (0.0025)			0.9189

TABLE 5

Estimated inner relations of the models 1-1 and 2-1#)

	Model 1 - 1			Model 2 - 1		
AGRICUL.	INDUSTRY 0.9789 (0.0005)			INDUSTRY 0.9698		
	R^2 = 0.9582			R^2 = 0.9405		
F.TRADE	INDUSTRY 0.3314 (0.0008)	AGRICUL. 0.6242 (0.0008)		INDUSTRY 0.3108	AGRICUL. 0.6418	
	R^2 = 0.9044			R^2 = 0.8955		
ECONOMY	INDUSTRY 0.5290 (0.0031)	AGRICUL. 0.4230 (0.0019)	F.TRADE 0.0555 (0.0015)	INDUSTRY 0.5999	AGRICUL. 0.3522	F.TRADE 0.0577
	R^2 = 0.9999			R^2 = 0.9999		
SOCIAL	ECONOMY 0.9956 (0.0013)			ECONOMY 0.9923		
	R^2 = 0.9912			R^2 = 0.9847		
LIFE	SOCIAL 0.9852 (0.0050)			SOCIAL 0.9850		
	R^2 = 0.9706			R^2 = 0.9702		
CULTURE	SOCIAL 0.9372 (0.2867)	LIFE 0.0589 (0.2868)		SOCIAL 1.5999	LIFE -0.6242	
	R^2 = 0.9906			R^2 = 0.9820		
HEALTH	SOCIAL 0.8500 (0.6866)	LIFE 0.1448 (0.6870)		SOCIAL 0.7250	LIFE 0.2644	
	R^2 = 0.9861			R^2 = 0.9731		
EDUCAT	SOCIAL 2.0206 (1.2809)	LIFE -1.0709 (1.2753)		SOCIAL 2.0463	LIFE -1.1012	
	R^2 = 0.9660			R^2 = 0.9610		

#) For the model 2-1- the jack-knifing measures are not calculated, whereas for the model 1-1 it is done and the standard errors are written in brackets.

TABLE 6

The convergence of missing data technique applied to the models 1-1 and 2-2 (number of iterations)

	Sample no						
	1	2	3	4	5	6	7
Model 1-1	9	9	9	12	10	19	17
Model 2-2	8	10	11	9	9	10	7

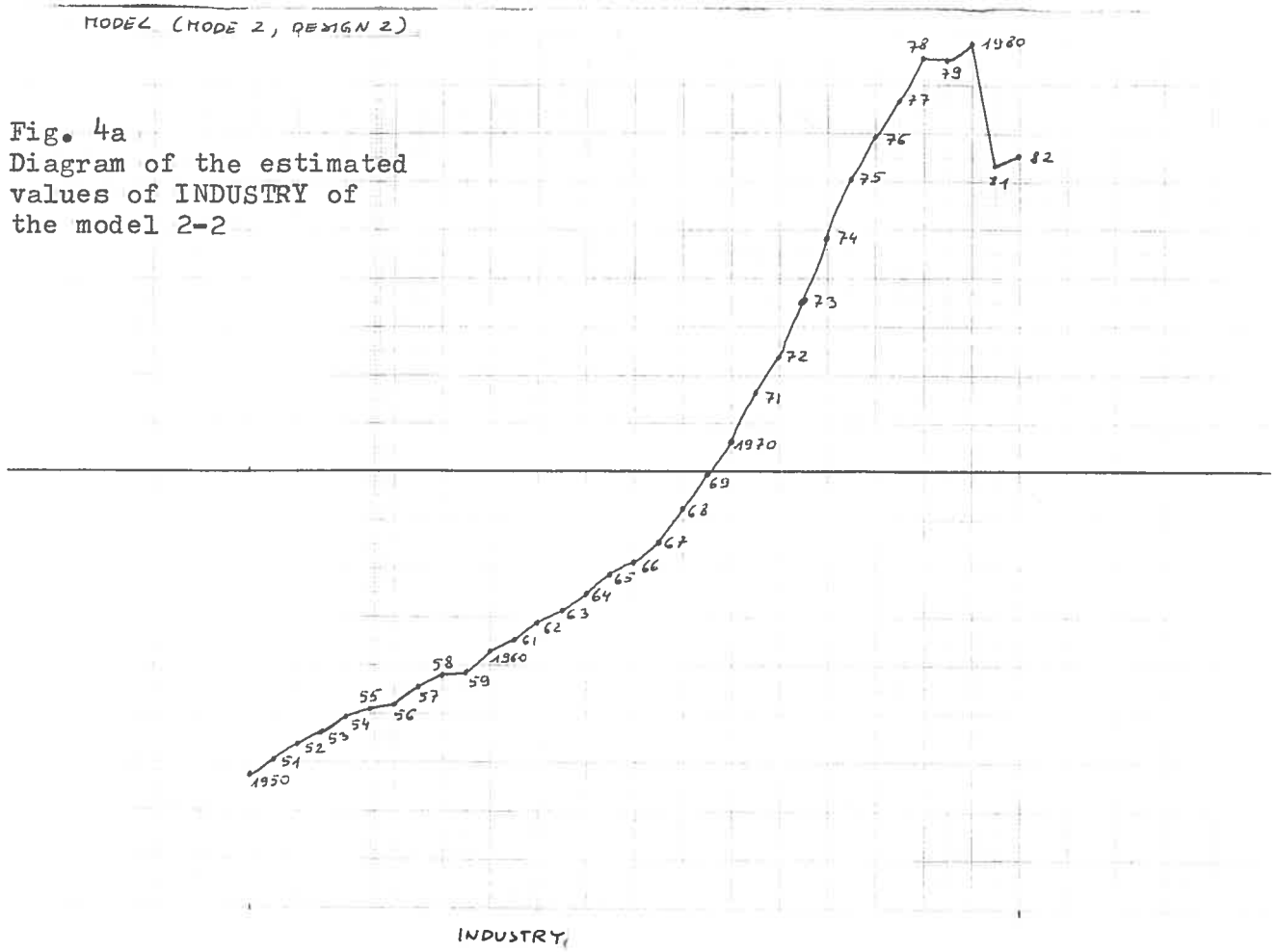


Fig. 4a
Diagram of the estimated values of INDUSTRY of the model 2-2

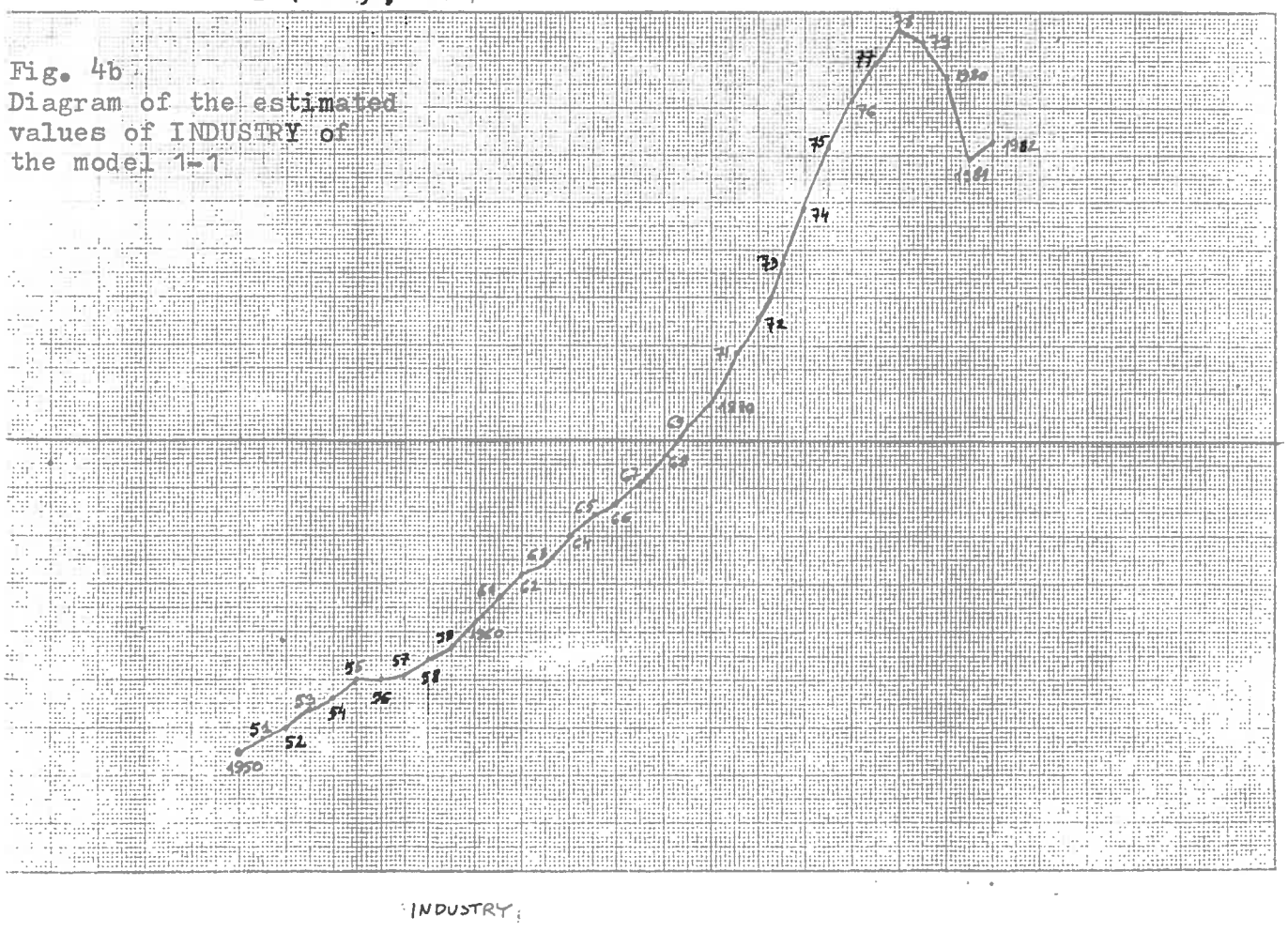
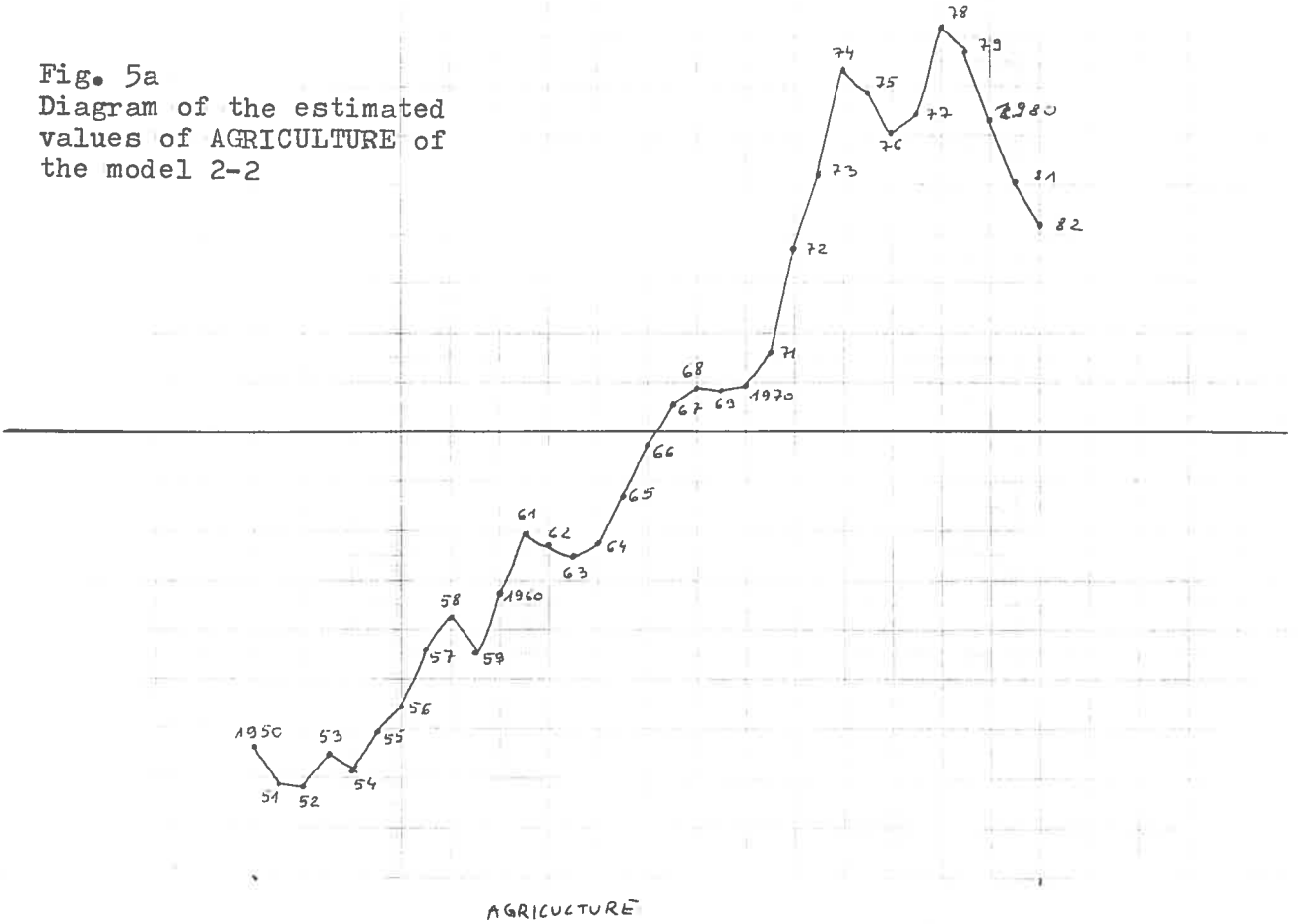


Fig. 4b
Diagram of the estimated values of INDUSTRY of the model 1-1

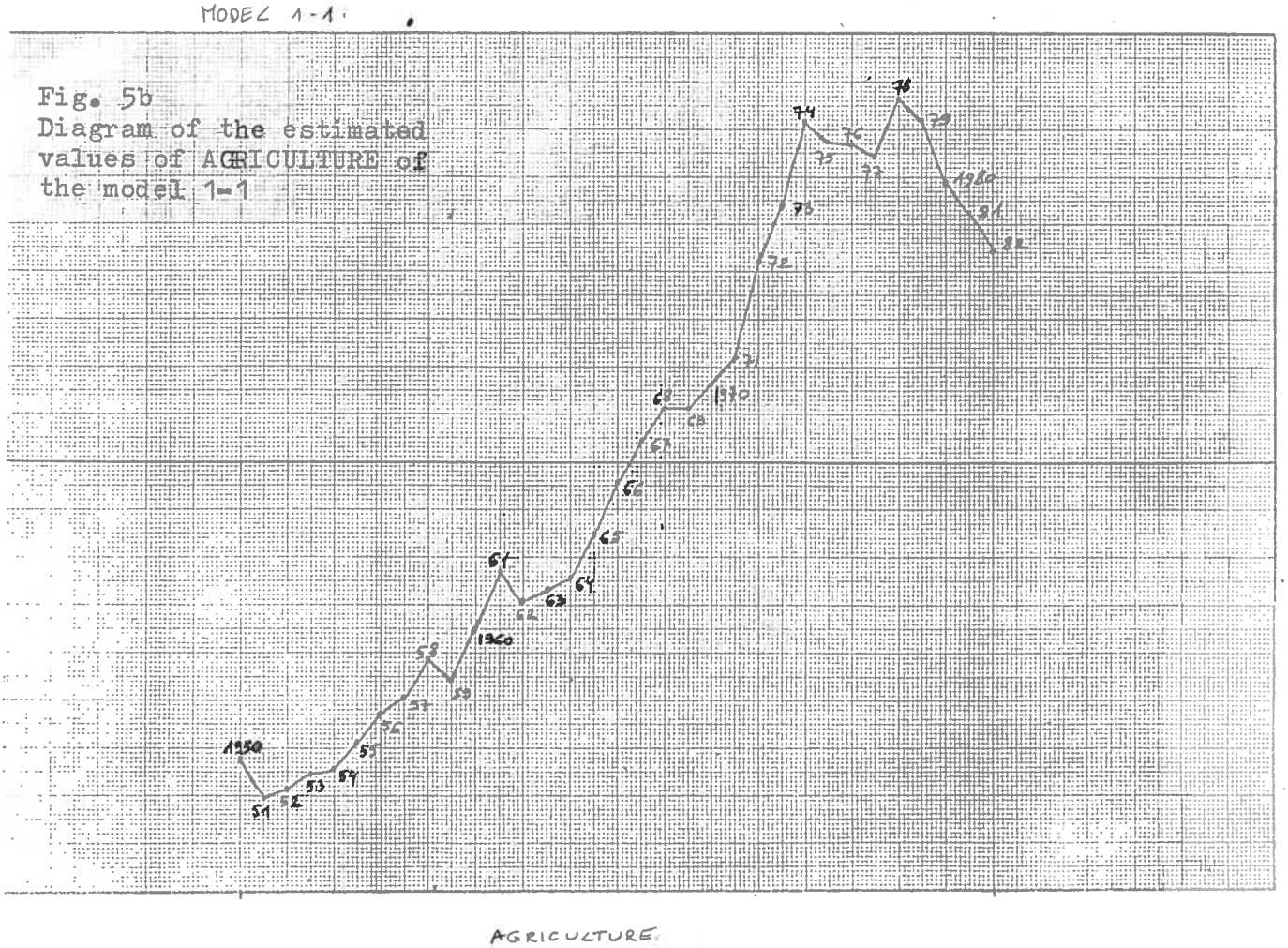
MODEL 2-2

Fig. 5a
Diagram of the estimated values of AGRICULTURE of the model 2-2



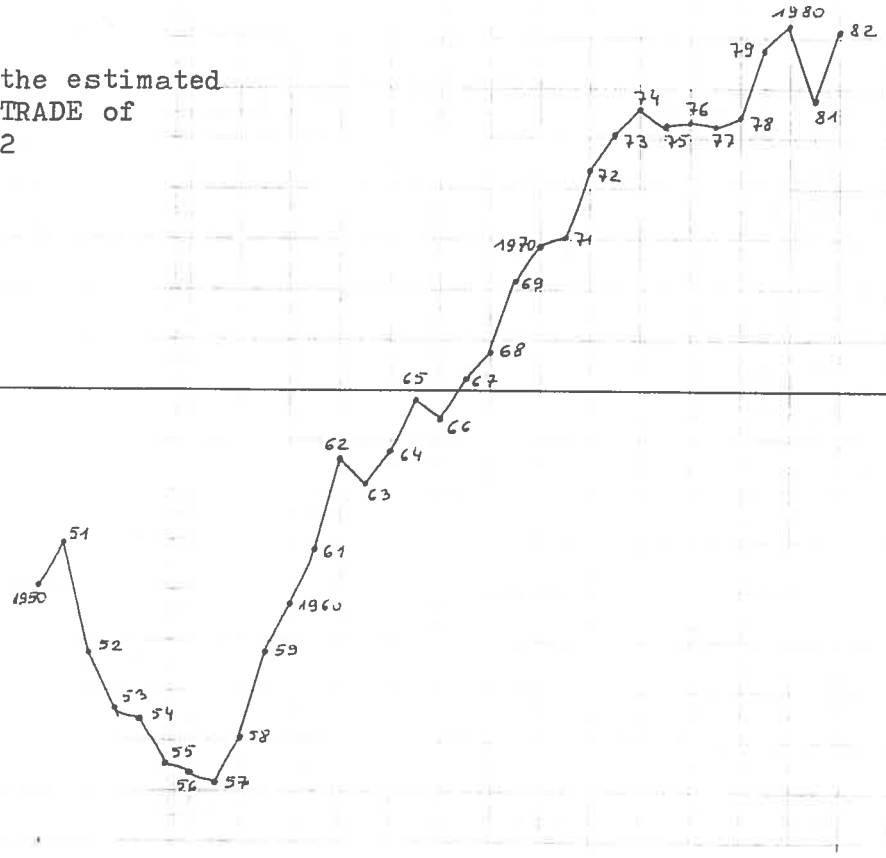
MODEL 1-1

Fig. 5b
Diagram of the estimated values of AGRICULTURE of the model 1-1



MODEL 2-2

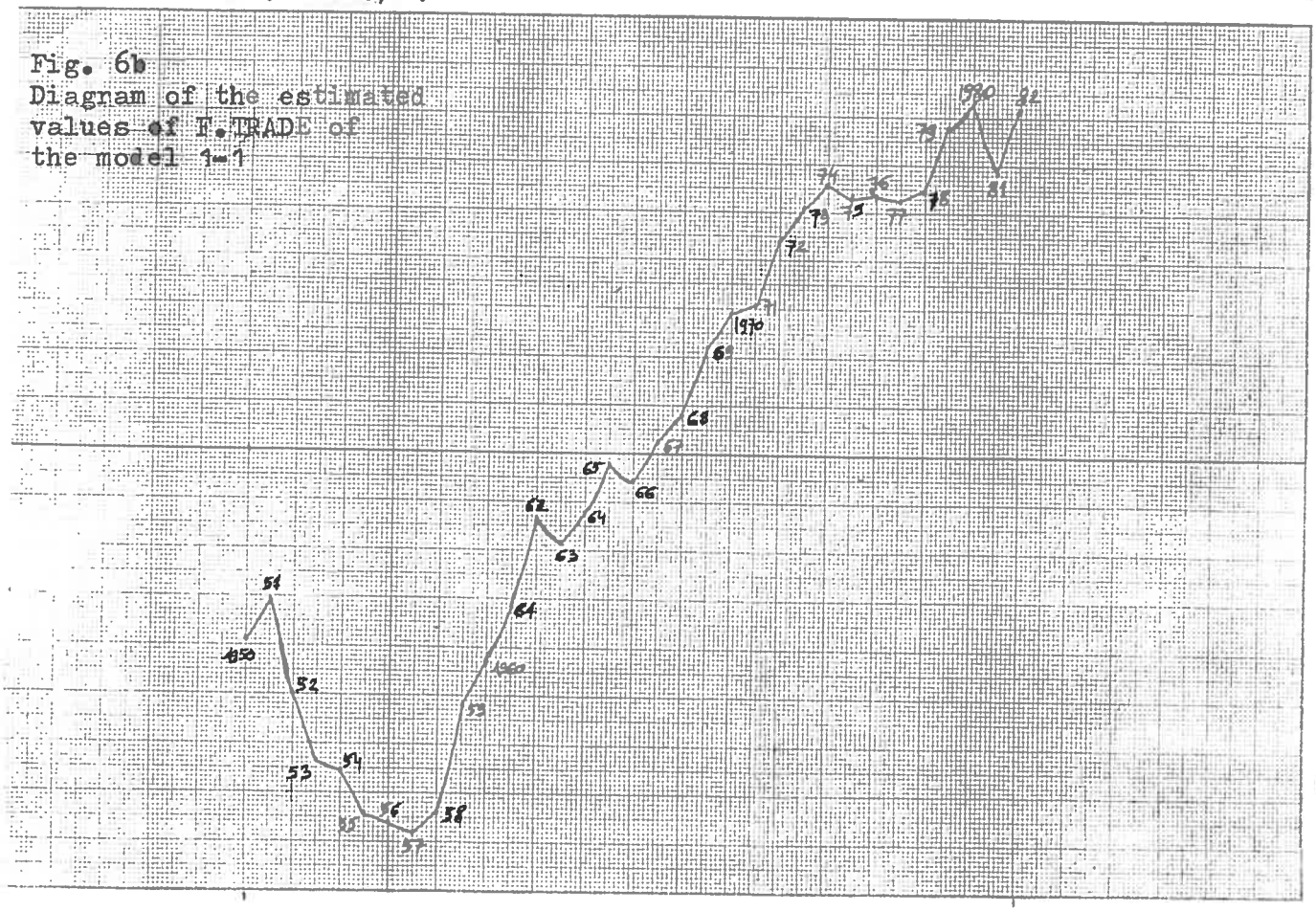
Fig. 6a
Diagram of the estimated values of F.TRADE of the model 2-2



F. TRADE1

MODEL 1-1

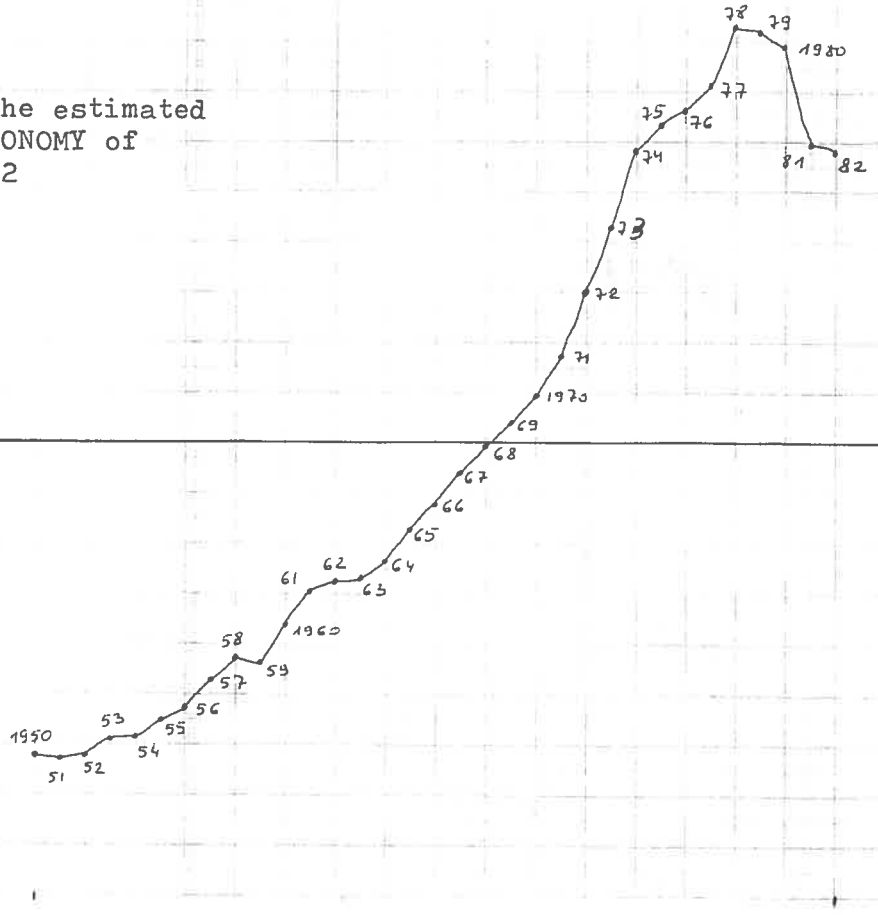
Fig. 6b
Diagram of the estimated values of F.TRADE of the model 1-1



FOREIGN TRADE1

MODEL 2-2

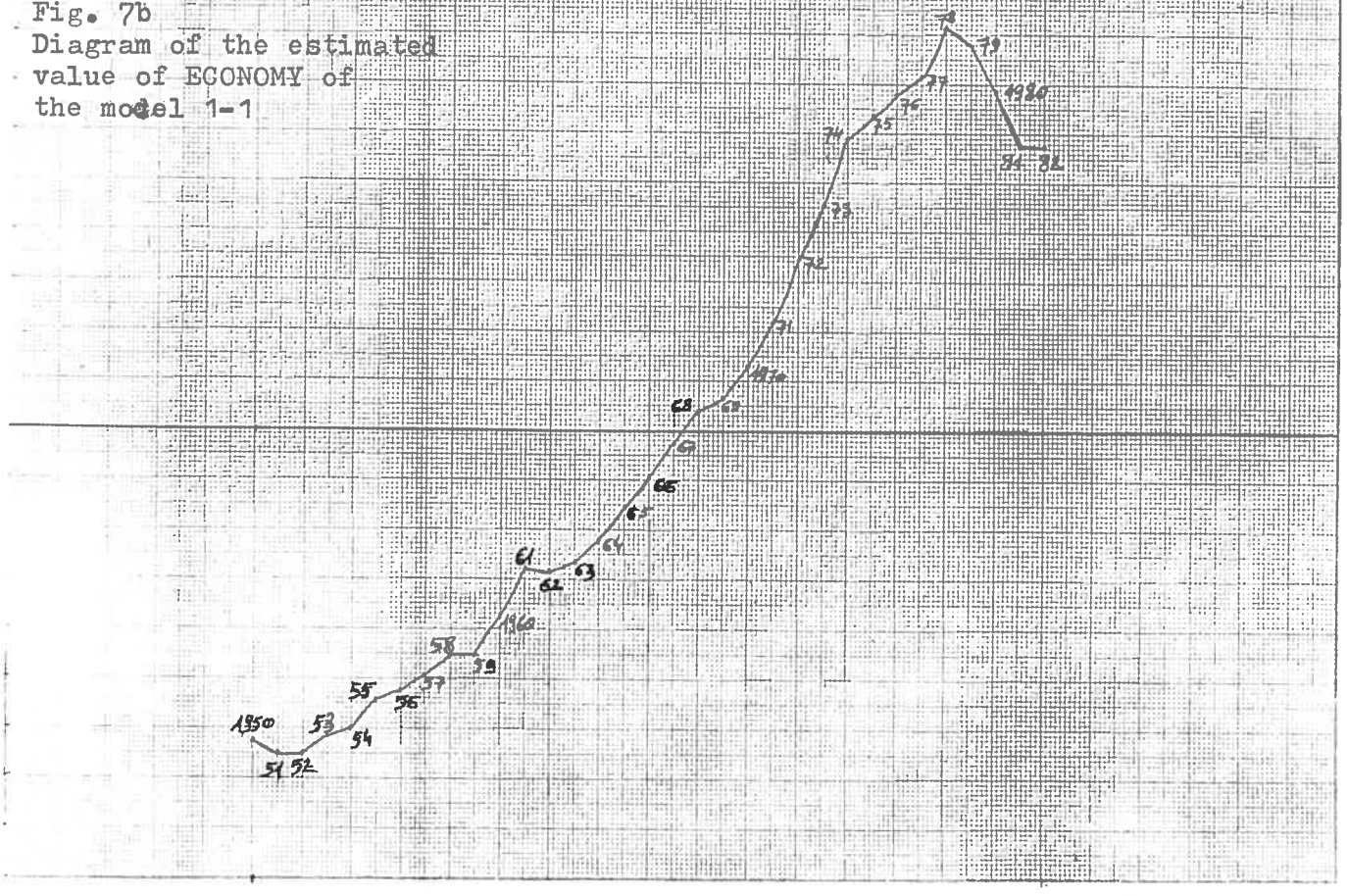
Fig. 7a
Diagram of the estimated values of ECONOMY of the model 2-2



ECONOMY

MODEL 1-1

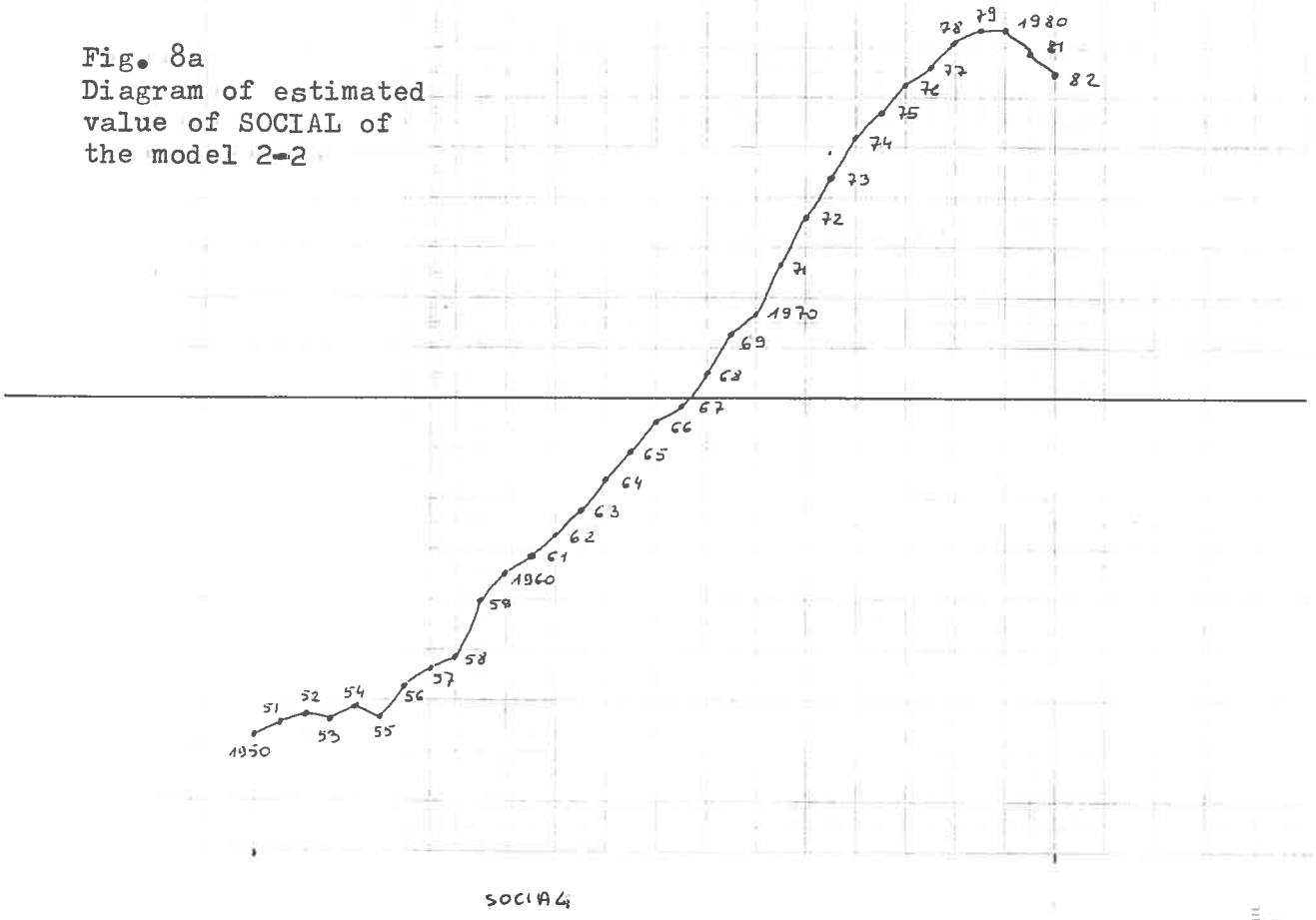
Fig. 7b
Diagram of the estimated value of ECONOMY of the model 1-1



ECONOMY

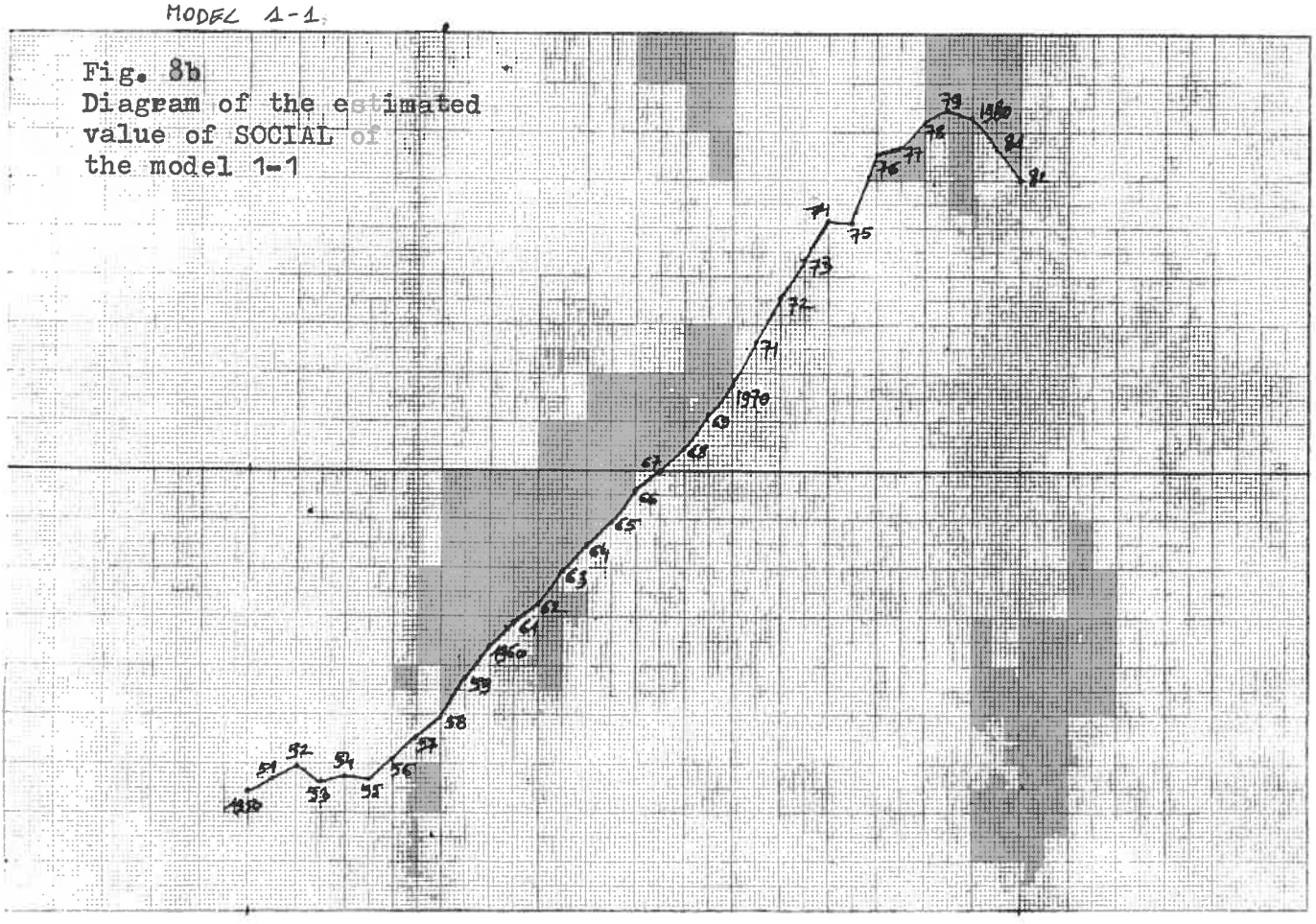
MODEL 2-2

Fig. 8a
Diagram of estimated value of SOCIAL of the model 2-2



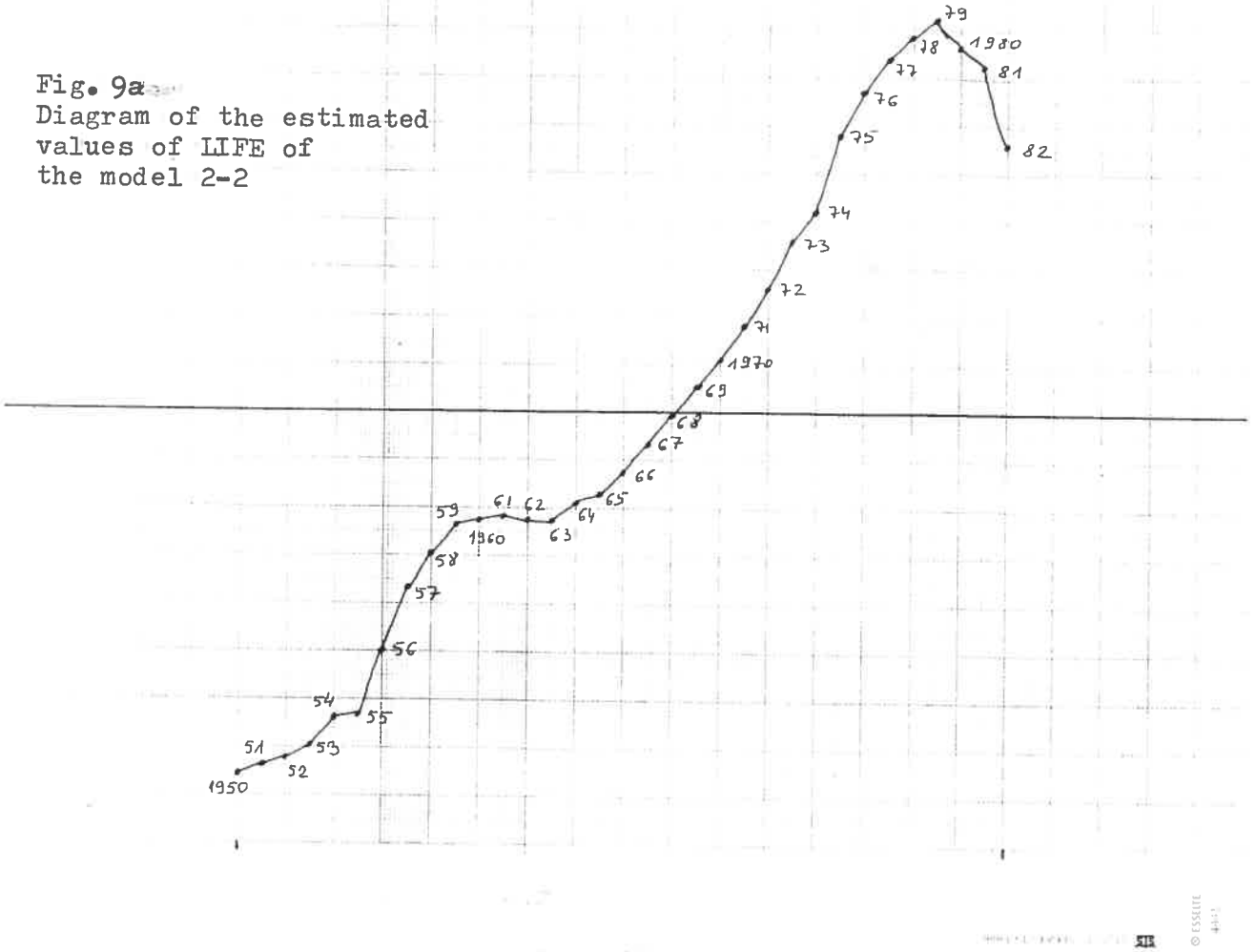
MODEL 1-1

Fig. 8b
Diagram of the estimated value of SOCIAL of the model 1-1



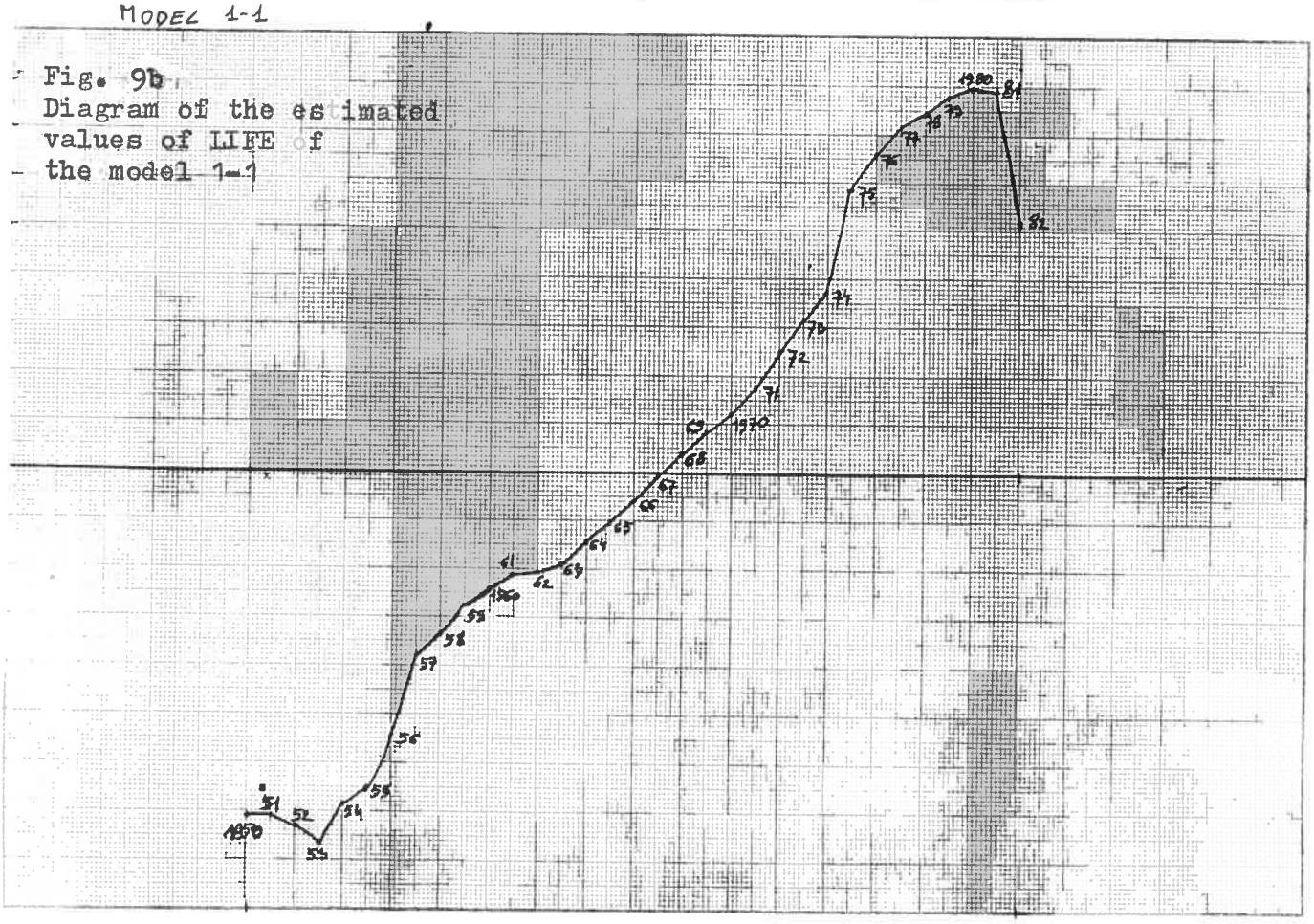
MODEL 2-2

Fig. 9a
Diagram of the estimated values of LIFE of the model 2-2



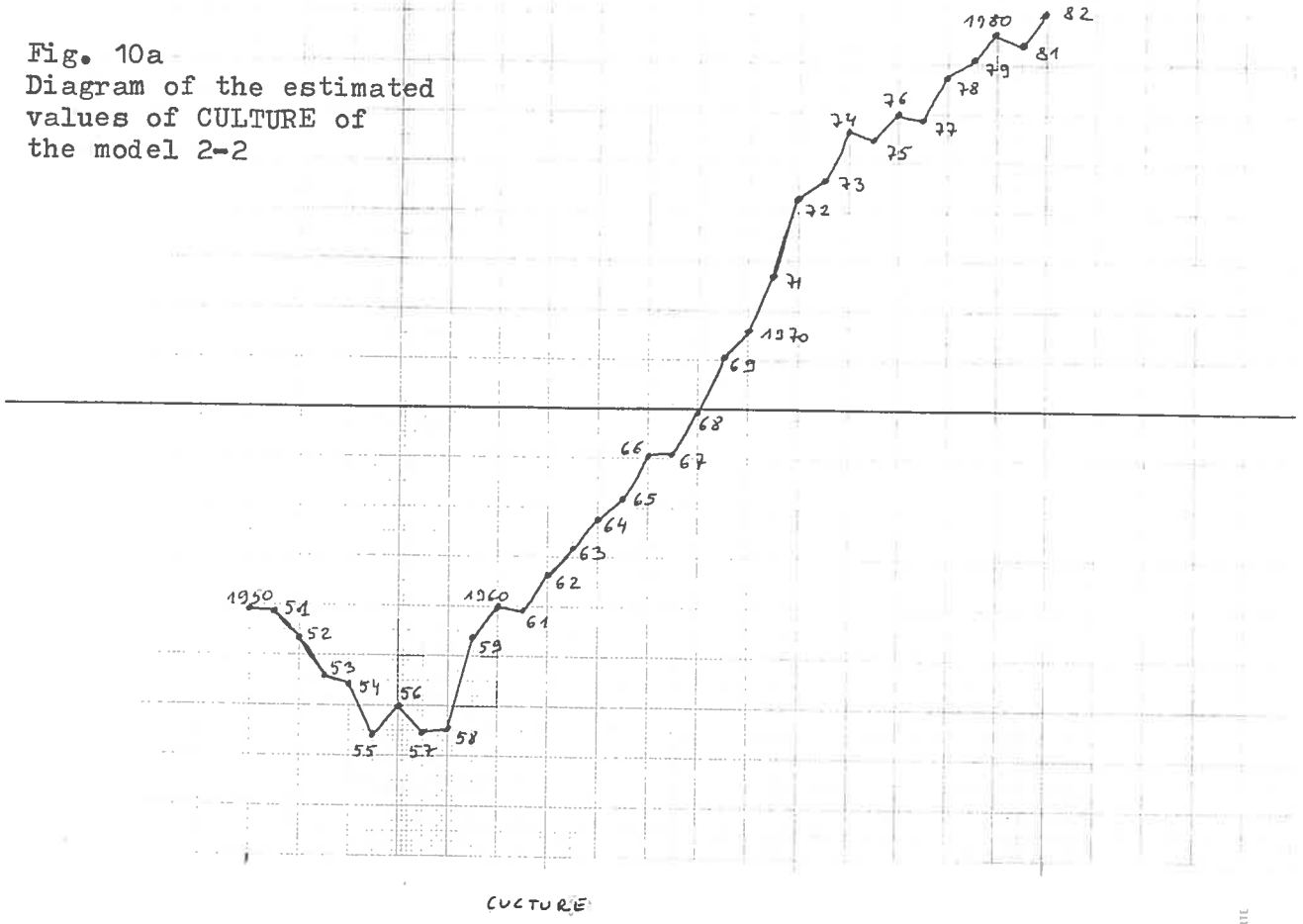
MODEL 1-1

Fig. 9b
Diagram of the estimated values of LIFE of the model 1-1



MODEL 2-2

Fig. 10a
Diagram of the estimated values of CULTURE of the model 2-2



MODEL 1-1

Fig. 10b
Diagram of the estimated values of CULTURE of the model 1-1

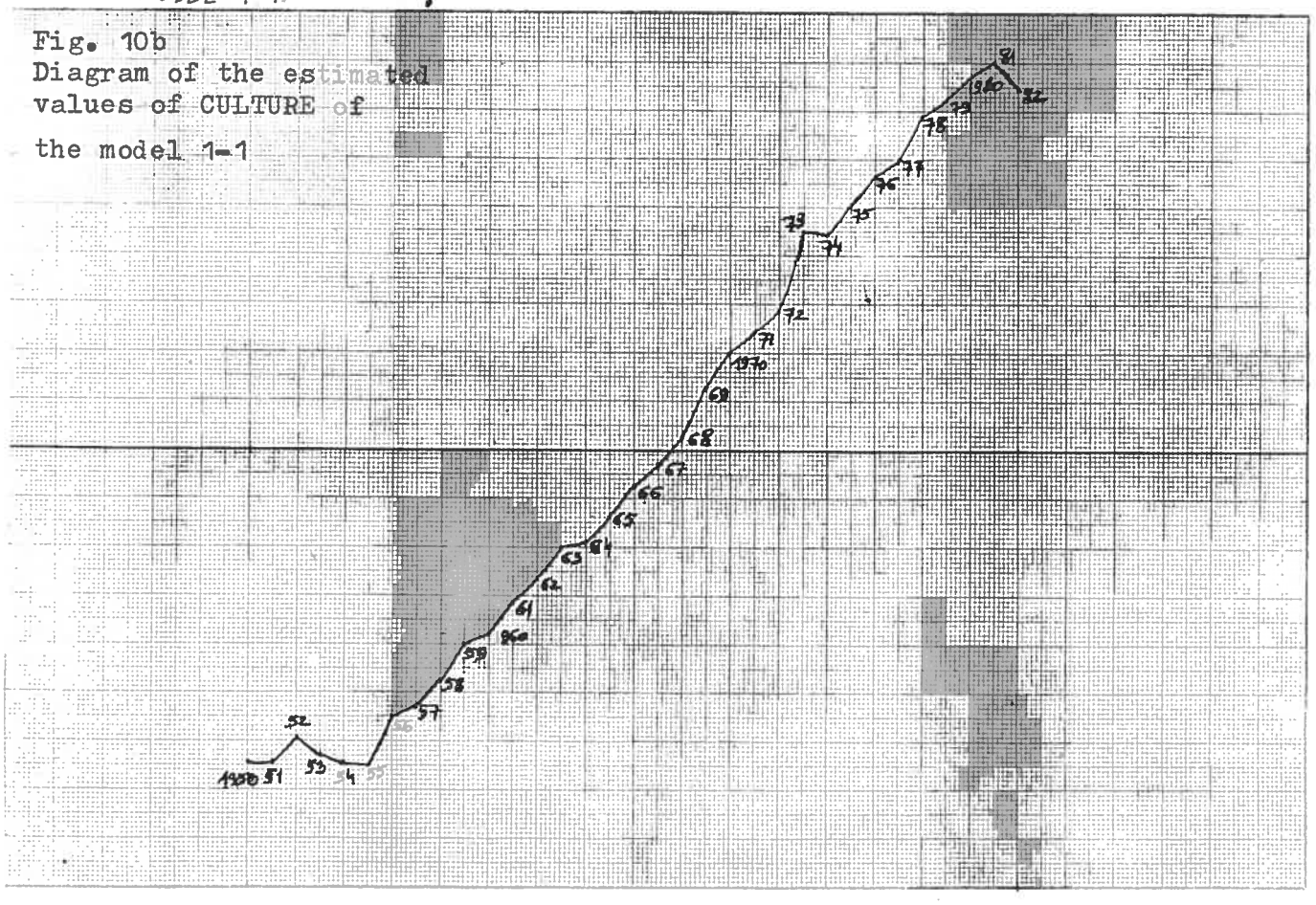
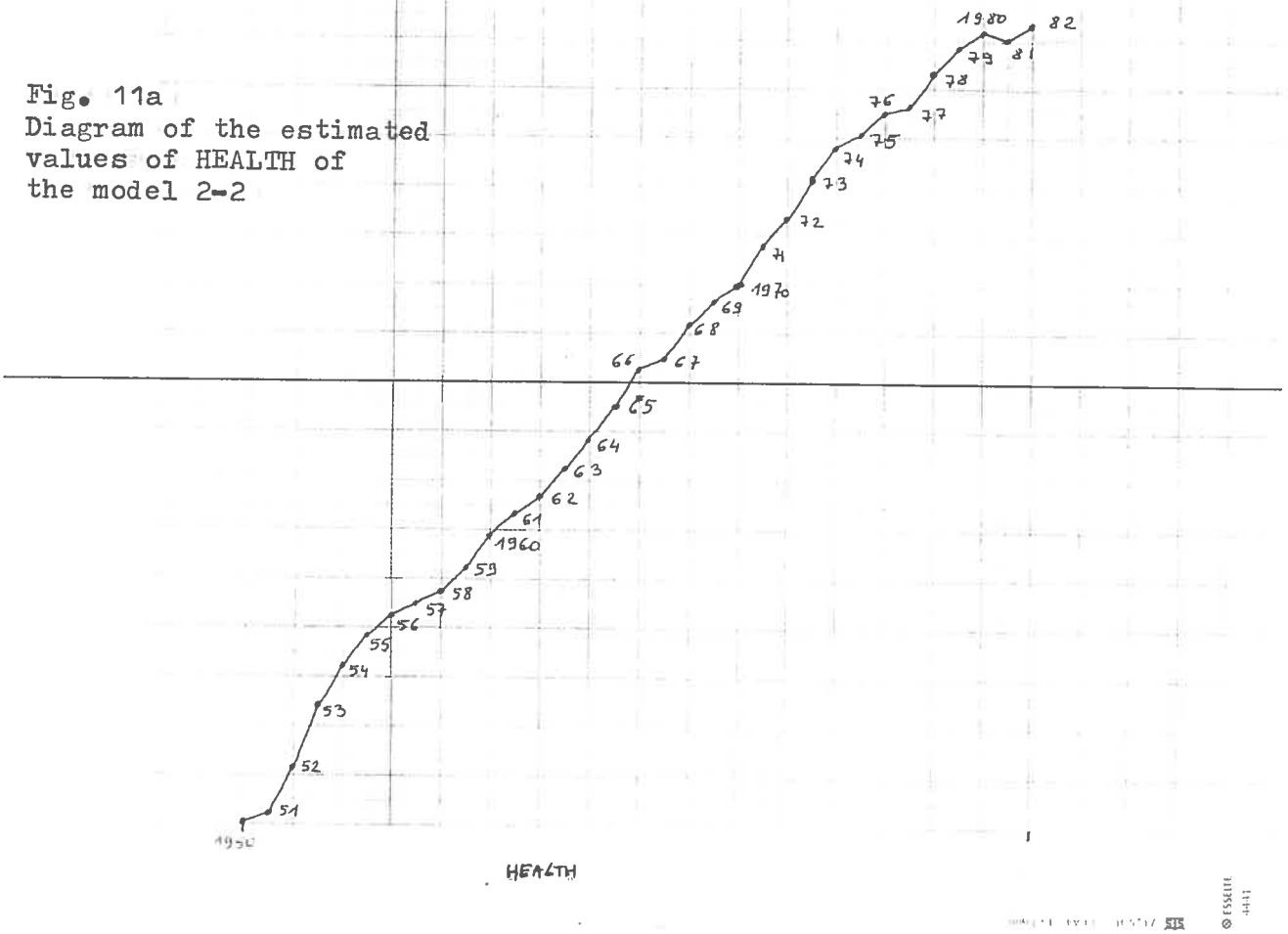
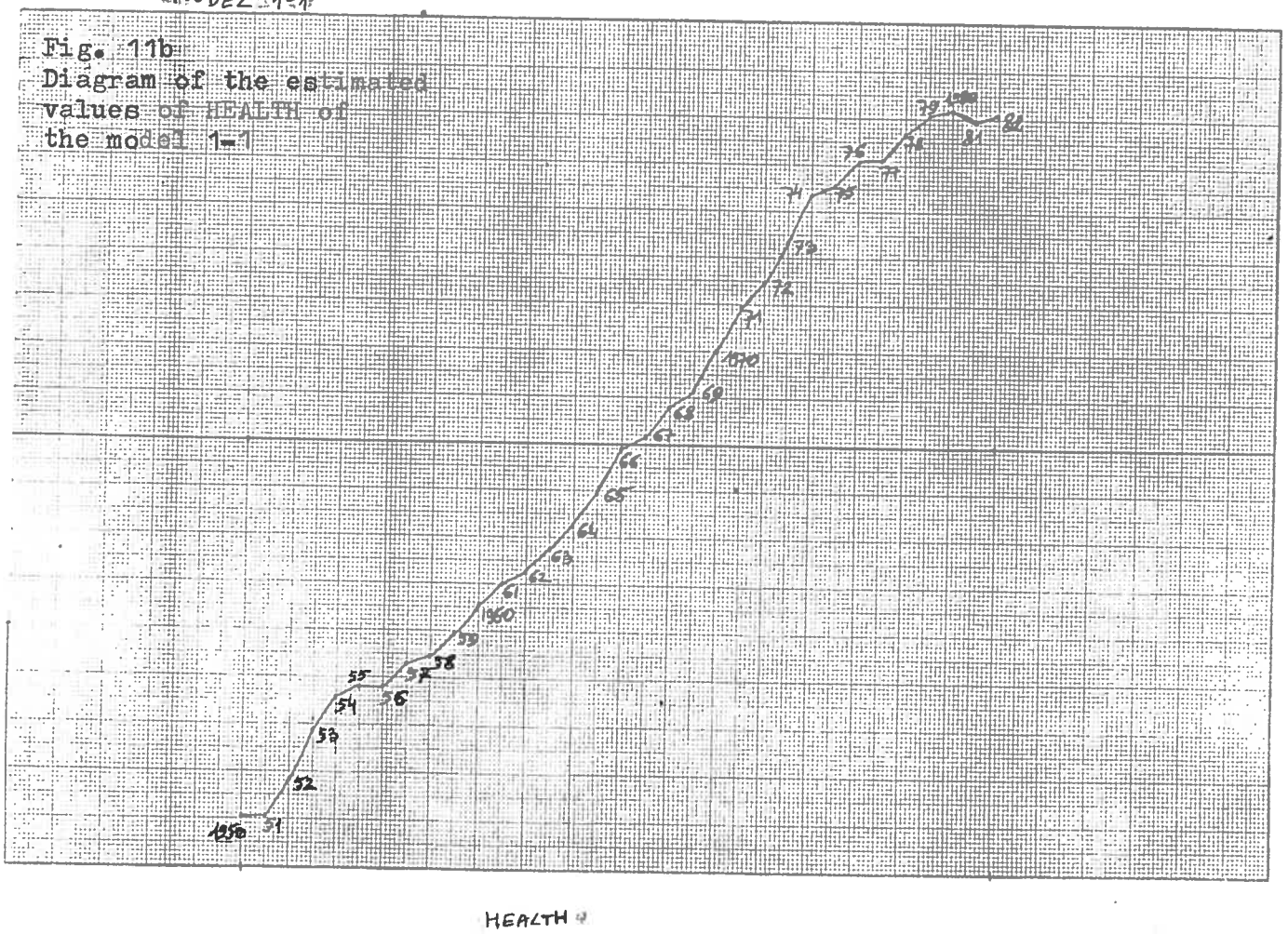


Fig. 11a
Diagram of the estimated values of HEALTH of the model 2-2



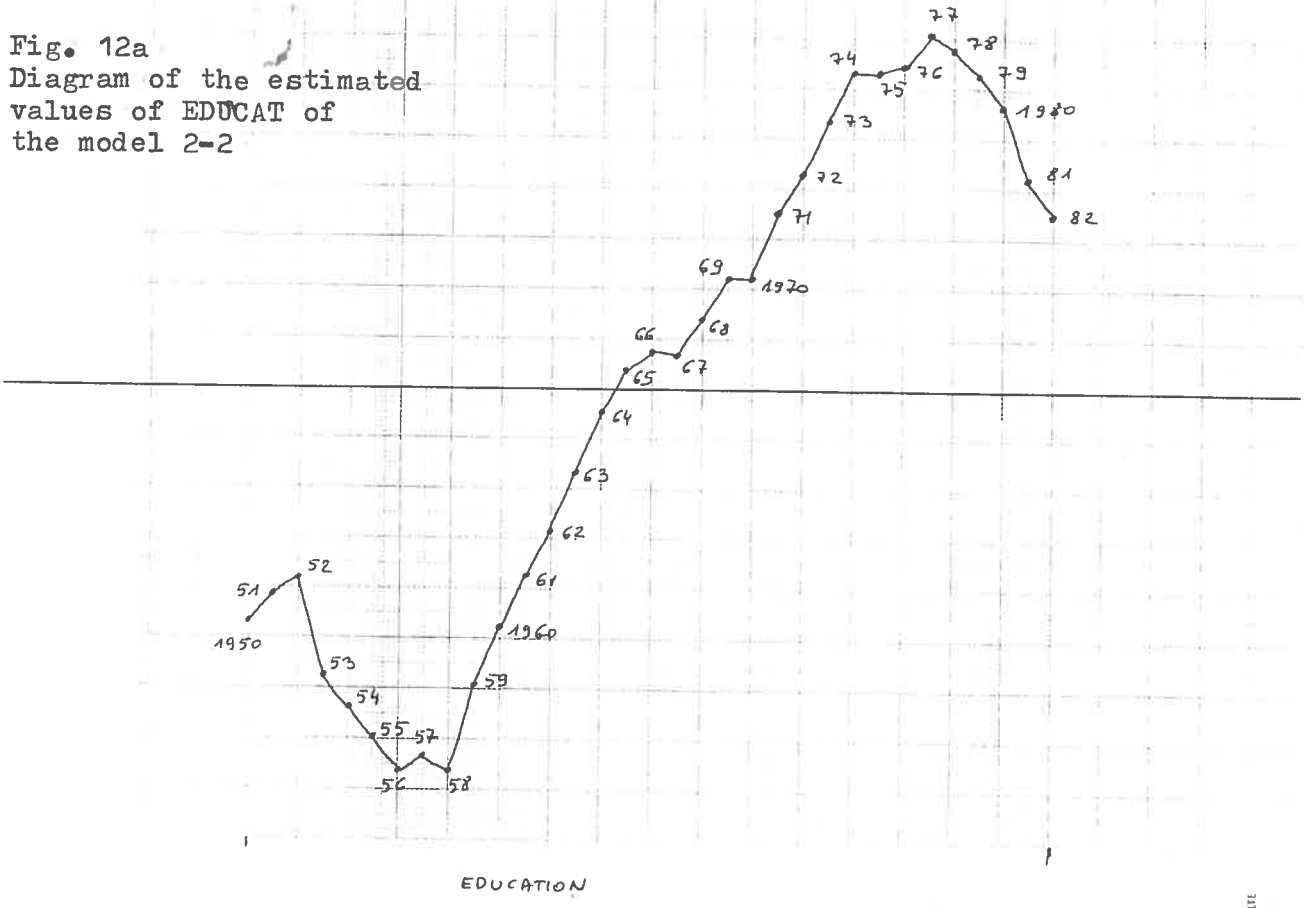
MODEL 1-1

Fig. 11b
Diagram of the estimated values of HEALTH of the model 1-1



MODEL 2-2

Fig. 12a
Diagram of the estimated values of EDUCAT of the model 2-2



MODEL 1-1

Fig. 12b
Diagram of the estimated values of EDUCAT of the model 1-1