

3.5 REAL-WORLD APPLICATIONS, INCLUDING SOLUTIONS IN ECOLOGY, ECONOMY, SOCIOLOGY, MEDICINE, TECHNOLOGY, BIOINFORMATICS

Estimation of Connections of Regional Indicators of Quality of Life Based on Structural Modeling

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Abstract. *Approaches to structural modeling are considered at an estimation of connections between the manifest and latent variables. These variables characterise efficiency of social and economic development of regions of Ukraine on the basis of criteria of quality of life of the population. Latent variables are presented as integrated indicators of quality of life. It is thus provided, that analyzed latent variables, in turn, can be connected among themselves. The process engineering of construction and the analysis of computer models is offered at an estimation of connections in indicators of quality of life of the population of regions of Ukraine with system STATISTICA are offered.*

Keywords

Regional synthetic indicators of quality of life, analysis of path diagrams, confirmatory factor analysis, analysis of structural equation.

1 Introduction

In article [1] approaches to modeling of complex estimations of efficiency of regional social and economic development on the basis of criteria of quality of life of the population are considered. The speech is about directions of use of the factor analysis, directed on a contraction of a certain gang of statistics to non observable or latent variables. We have to consider the multiple approaches to an object, to the data which provides set of alternative experiments on the one hand, and set in the answer of alternative actions with another. The important is to pay our attention on analysis of a latent variable, according to J. Loehlin [2]. This approach is successfully realised on the basis of *Structural Equation Modeling – SEM*.

Main objective SEM of the analysis consists in that on the basis of modeling of causal relationships between analyzed variables to check up different hypotheses concerning these connections or, in other words, to define degree according to which the theoretical model is supported by typical data. If typical data coincide with theoretical model then these models can be authentic, concerning practical applications. And if typical data do not support theoretical model, the primary model should be changed and checked up, otherwise other theoretical models should be developed and checked up.

Hence, SEM, using a scientific method of authentic check, can ensure check of our understanding of complicated connections in the constructed system of regional indicators of quality of life that is probable, can be connected in several ways.

The purpose of the article is to illuminate a process engineering of construction and the analysis of models of an estimation of connections in system of indicators of quality of a life of the population of regions of Ukraine. These are graphic (network) models, models of confirmatory factor analysis and structural equations models. They describe relationships between manifest and latent variables taking into account the supposition, that latent variables, in turn, can be connected among themselves. The structure of connections is supposed enough complicated, however its type has the a priori supposition are linear relationships which are described by simple equations.

2 Theoretical part

Reviewing of [1] synthetic components of a category defined in work “*quality of life*” is one of possible approaches to definition of system of indicators of quality of a life of the population of regions of Ukraine in its widest understanding. Among them:

(III) *Quality of a social orb (or social safety)* which maps in itself level of working conditions of the population, its employment, social protection, physical and property safety, level of corruption of characteristic structures etc.;

(V) *Quality of financial security* which maps data about incomes and expenses of local budgets, official transfers from state bodies and other.

Being repelled in the approach from certain system of indicators-indicators of quality of components (III) - (V), we try, using ideas SEM of the analysis, to check up theoretical model which describes association of quality of financial security on quality of a social orb of regions of Ukraine.

In a general view statement of a problem of structural modeling at an estimation of connections between regional indicators of the population’s quality of life looks thus. Let we observe statistical variables for which we have a matrix of selective coefficients of correlation or a covariance. These variables characterized some indications of quality of life of the population of regions of Ukraine and are called as manifest. Real relations between manifest variables can be complicated, however we have a hypothesis that there is some number hidden or latent variable (*regional synthetic indicators of quality of life*) which exactitudes with known degree explain structure of these connections.

For computer support of structural equation modeling use the applied programs presented, as a rule, in modern statistical packages. Most of all known among them are such: LISREL (SPSS), EQS (BMDP), CALIS (SAS), EzPATH (SYSTAT), and SEPATH (*STATISTICA*). Programs AMOS and COSAN are accessible in the FORTRAN version. Structural modeling at an estimation of connections in indicators of quality of life of the population of regions of Ukraine is supported by means of system *STATISTICA*.

The base technology of computer structural modeling at an estimation of communications in system of indicators of quality of life of the population of regions of Ukraine consists of such stages:

- It is represented with the help of the path diagrams (graphs or webs) model describing our understanding of communications between indicators of quality of components (III) - (V);
- It is defined with use of internal methods *STATISTICA* of a dispersion and covariance the variables which values turn out in analyzed model on the basis of entrance data;
- *STATISTICA* checks the how much well received dispersions and covariance satisfy our model;
- The system deduces results of statistical tests, estimations of parameters and standard errors for factors in the linear equations, and also the additional diagnostic information;
- On the basis of the initial information it is possible to solve, whether well current model is coordinated with analyzed data.

Let's consider realization of the basic stages of the specified computer technology of structural modeling on an example of authentic check of our understanding of connections between the constructed synthetic indicators of quality of a social orb and financial security of 27 regions of Ukraine and corresponding gangs of reduced statistics during 1999-2002. The list of analyzed variables which describe quality of a social orb and financial security of regions moves in table 1.

Let's notice, that in SEPATH distinguish four types of variables: *manifest endogenous; manifest exogenous; latent endogenous; latent exogenous*. At the first stage of structural modeling of a sheaf between these variables are formalized by means of the path diagrams which is under construction on the basis of a number of rules.

On fig. 1 the diagram which describes our understanding of connections in system of indicators of quality of components (III) - (V) is presented. It is similar in many respects about the block-chemo which is used at programming, very simple for reading and allows to present model clearly. On this path diagrams (graphs or webs) manifest variables are mapped by rectangles, and latent – ovals. Residual variables are mapped also by ovals. Direct connections between two variables are mapped by arrows. Indirect connections are mapped only by arcs (always without an arrow). Numbers of free parameters which are estimated by system, take places about arrows or arcs on their middle. Two parameters which have same number, have the same numerical value. If for latent exogenous variables of a variance and a covariance not presented on the path diagrams explicitly variances are considered equal 1.0, and covariance’s equal 0.

On fig. 1 it is visible, that the structural model consists of two models of measurement: one-factor model with five manifest variables and one general factor YIII and two-factor model with the general factors yV1 and yV2. In turn in an

average part of the diagram factors YIII, yV1, yV2 are connected among themselves by regression association, which it is formally possible to present the equations (1).

For support of the computer analysis the structural model presented on fig. 1, is described by means of the designer of ways in language *PATH1*. The entry of the constructed model in language *PATH1* moves on fig. 2.

To definition of unknown parameters of model it was applied *Generalized Least Square* (GLS) – estimation procedure by the generalized method of least squares. Outcomes of modeling are presented on fig. 3 and to tab. 2. We will analyzed the basic criteria of an estimation which move on fig. 3 in the upper informational part of a window:

- ✓ The constructed structural model is an invariant dial concerning a modification on the basis of values of two criteria ICSF Criterion and ICS Criterion (the more close an index to 0, the big degree of invariance of the constructed model concerning a dial modification, that is the model does not vary at multiplication of data to an identical constant or shift to the fixed magnitude);
- ✓ Chi-square Statistic will not have (chi-square) standard distribution, as special parameter Boundary Conditions is not equaled 0;
- ✓ Approach of an index of quality of trimming Steiger-Lind RMSEA to 0 specifies in good enough trimming taking into account lower and an upper bound of a confidential interval;
- ✓ Value of index RMS Stand. Residual (Root Mean Square Standardized Residual) which also specifies in quality of a trimming of model, signals about inadequate exposition given by model (value more than 0,1);
- ✓ The hypothesis about correspondence of data of regional statistics of analyzed theoretical model which describes our understanding of connections in system of indicators-indicators of quality of financial security and a social orb of regions of Ukraine, can be accepted.

Estimations of parametres of model which are presented to tab. 2, specify in insignificance of connections only between two latent variables yV1 and yV2, that is the hypothesis about association of quality of financial support of social and economic development of regions of Ukraine between organs state and local authorities does not start.

2.1 Tables

In tab. 1 such label of a code is applied $x(q.s.j)$: – the indicator j groups s an indication q ($q = \text{III}$ - quality of a social orb, $q = \text{V}$ - quality of financial security of regions).

Tab. 1. Gangs of indicators of quality of a social orb and financial security of regions of Ukraine.

<i>Indicators</i>	Code
<i>III.1. Indicators of employment and working conditions:</i>	
Population occupation level	xIII102
Particle of workers which were in the conditions of the forced partial employment	xIII105
<i>III.2. Indicators of social voltage:</i>	
Debts from wages payment counting on one occupied in economy branches	xIII201
Amount of victims from a traumatism connected with manufacture, on 1000 working	xIII204
<i>III.3. Indicators of territorial mobility of the population:</i>	
Balance of migration behind all streams on 1000 population	xIII303
<i>V.1. Indicators of the state financial support:</i>	
Official transfers from state bodies in local budgets on 1 person	xV101
<i>V.2. Indicators of financial support of local authorities:</i>	
Expenses of local budgets on formation counting on 1 person	xV201
Expenses of local budgets on public health services counting on 1 person	xV202
Expenses of local budgets on social protection and social security on 1 person	xV203
<i>Regional synthetic and group indicators of quality of components (III) - (V):</i>	
Regional synthetic indicators of quality of a social orb	YIII
Group indicators of the state financial support	yV1
Group indicators of financial support of local authorities	yV2

Tab. 2. Window with a fragment of estimations of parameters of analyzed model.

	Model Estimates (Cov-SEP-III-V.smx)			
	Parameter Estimate	Standard Error	T Statistic	Prob. Level
(YIII)-1->[xIII102]	-0,002	0,004	-0,581	0,561
(YIII)-2->[xIII105]	0,035	0,005	6,798	0,000
(YIII)-3->[xIII201]	0,033	0,004	8,571	0,000
(YIII)-4->[xIII204]	0,009	0,002	4,047	0,000
(YIII)-5->[xIII303]	-0,006	0,003	-2,291	0,022
.....				
(YIII)-19->(yV1)	-0,055	0,006	-9,431	0,000
(YIII)-20->(yV2)	0,010	0,002	4,745	0,000
(yV1)-21->(yV2)	0,007	0,021	0,344	0,731

2.2 Figures

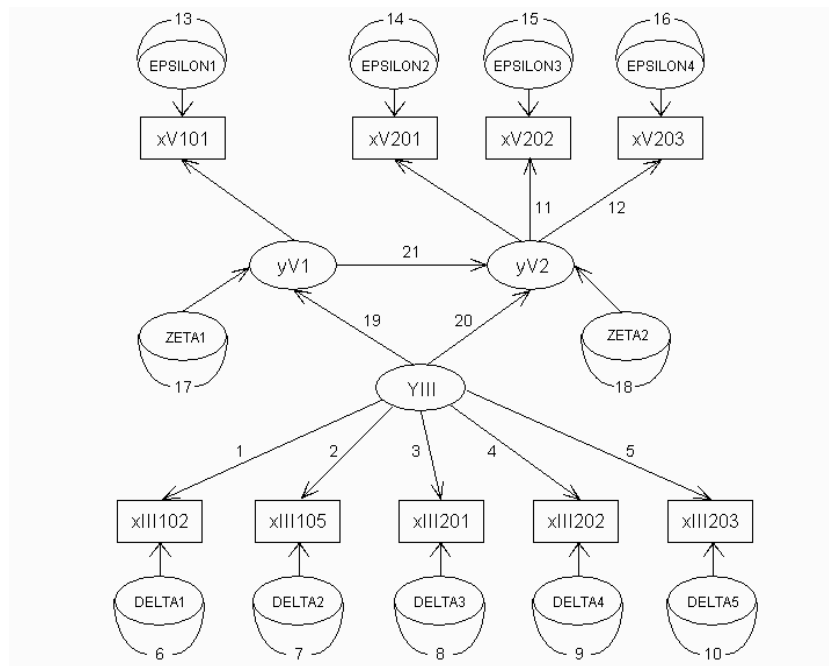


Fig. 1. The diagram of connections between indicators of quality of components (III) - (V).

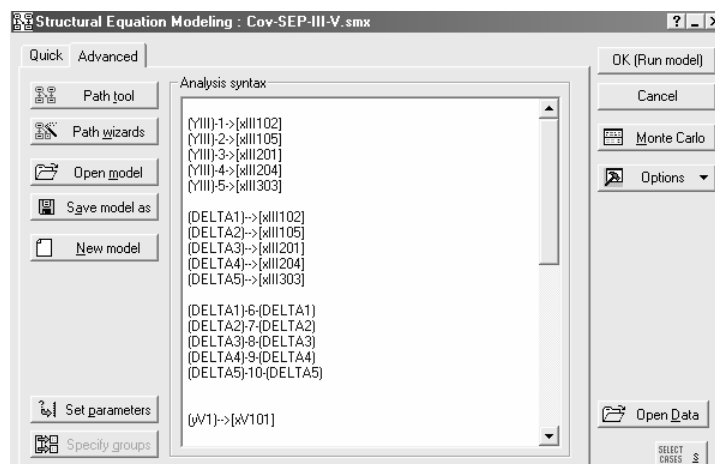


Fig. 2. Entry of the constructed model in language *PATH1*.

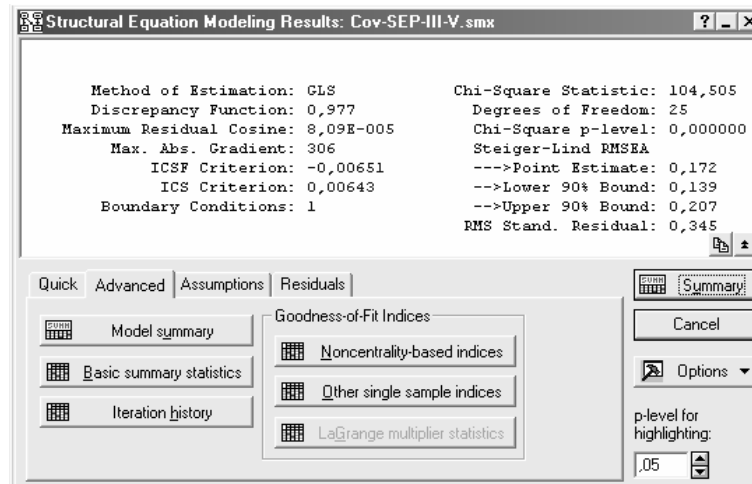


Fig. 3. Window of outcomes of structural modeling.

2.3 Equations

$$\begin{aligned} yV1 &= a19 * YIII + ZETA1, \\ yV2 &= a20 * YIII + a21 * yV1 + ZETA2, \end{aligned} \quad (1)$$

where $a19$, $a20$, $a21$ – model factors are unknown; ZETA1, ZETA2 – the errors which variances also are free parameters.

3 Conclusion

Let's notice, that in the course of structural modelling we did not expect ideal correspondence of model and data. The constructed computer models with a linear dependence is only approximations of real connections between manifest and latent variables. Actually, natural associations are far from the linear. Most likely, the valid associations between analyzed indicators are not linear. Moreover, the validity of some statistical suppositions which are imposed on checked models is under the big problem and requires the subsequent workings out.

The analysis of results of structural modeling allows drawing such conclusions:

- ❖ The answer to a question «ideally model is important not is coordinated with data?», whether and the knowledge «is coordinated it well enough to be useful to use and a reasonable explanation of structure of manifest data?»;
- ❖ If the system of the linear equations, isomorphic to the analyzed graph (path diagrams), is well coordinated with data, it allows to leave model for the subsequent analysis or practical use, but does not lead up its validity;
- ❖ Under condition of a raise of degree of correspondence of the constructed structural model to typical data it can be used for working out of compensatory mechanisms in financial security of social and economic development of regions of Ukraine.

References

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