STRUCTURAL EQUATION MODEL FOR THE MULTIDIMENSIONAL MEASUREMENT OF THE POVERTY IN MEXICO

[1]**Pedro Flores-Jiménez,** [2]**Oswaldo Morales-Matamoros,** [3]**Ricardo Tejeida-Padilla**

[1,2,3] Instituto Politécnico Nacional, México
pyterfj@hotmail.com, omoralesm@ipn.mx, rtejeidap@ipn.mx

ABSTRACT

This paper postulate that the poverty in Mexico can be determined analyzing different hypothetical constructs, just like the official measurements, that carry out several organisms of the Federal Government's, to effect of obtain an unique measurement. It postulate that the measurements of the levels of alimentary poverty, of capacities, of patrimony, the index of social backwardness, that obtains the Social Developmental Secretariat, they can integrate with other socioeconomic measurements such as the Marginalization index, that obtains the National Council of Population.
Given the subjectivity of the different hypothetical constructs, as poverty, social backwardness and marginalization, the only form of measuring them is indirectly, by using methods that use variables that they can be measured directly.
For the integration of the diverse official measurements proposes a method of multivariate analysis known as a Structural Equation Model. It develops a complete model of structural regression, compound by two sub models: the Measurement and the Structure models; which used *i* variables observed to define j variables latent hypothetical, both dependent and independent, to determinate an integrated measure of the poverty.

Keywords: Poverty, Structural Equations Model, general index of poverty.

INTRODUCTION

The poverty is a complex social phenomenon whose scope goes beyond of the income sufficiency. It can express that the poverty is a general phenomenon of insufficient development; in this way, it is considered that a person is poor when he is in a precarious situation in which lacks of abilities and/ or opportunities of development, which is manifested in situations of low- income, conditions of unhealthy life, malnutrition, vulnerability to the disease and to the environment inclemencies, that adversely affect their opportunities of surviving and improving his quality of life.
Measuring the poverty is not easy by the multiplicity of factors that make it up it. It is a complex system (Fan 2007; Yan 2007; Zhu, 2007.) The most extensively more accepted definition on poverty is that defines it as the incapacity of achieving a minimum standard of living. But, this requires that answered several questions:
How measures the level of wellfare?
What it understands for a minimum standard of living?
How measures the severity of the poverty?

Consequently, to obtain an index that it measures the poverty, is necessary to consider the poverty as a hypothetical construct and determine a measurement of indirect form building on direct measurements of variables that can quantify directly.

THE PROBLEM OF MEASURING THE POVERTY

The General Law on Social Development, in Mexico, instructs measure the poverty at national, states and municipal level, through the indicators of current income per capita, educational backwardness average at home, access to health services, access to social security, quality and spaces of the housing, accesses to the basic services in the housing, access to the alimentation and the degree of social cohesion.

This means previous it that the legislators have identified that the poverty is composed of multiple factors that define it of way Multidimensional. That is to say, the poverty is a hypothetical construct which only can be understood through the analysis at several manifestations of physical, economic, social, educational lacks and, surely, other more.

The ***Poverty*** concept is abstract; this is, not it can measure in a direct way for several reasons. First, because only it perceives for the severity of your effects in the people and not it counts at present with any standardized measurement and accepted by all world, in absolute terms. From the point to view of relative measurements, there is no consensus.

Second, it is a hypothetical construct who can mean diverse things for the people. Someone understand, as Poverty the lack of foods, or the absence of income, either not have studies, or the lack of access to health services. For others, the Poverty is related with the lowest strata in which it can classify to the society, according to the quantity of properties that possesses or the level of satisfactors to that has access or can acquire.

Third, the poverty is the effect that produce several tangible and intangible factors in a society and who affect direct or indirectly to the people. Human beings are seen as an element more than a global system. They separate several arguments that indicate that the poverty intangibility is the result of the interaction of the people with a set of internal and external factors those which, analyzed of form isolated, lose his context and individual value of contribution. Then ¿How one can measure this concept?

Several researchers (López Calva, 2006; Kakwani, 2007) have developed multiple methods to answer the previous question. In Mexico, the Ministry of Social Development (SEDESOL) uses an econometric procedure (Elbers, 2003) to measure the Poverty of income at three levels:

a. The food poverty: Incapacity to obtain a basket of basic food, still if use of all the income available in the home to buy only this basket goods.

b. The capacity poverty: insufficiency income to acquire the food basket and carry out the necessary expenses in health and education, even by using the total income of the households only for these ends.
c. The poverty of patrimony: Insufficiency of the available entrance to acquire the alimentary basket, as well as carrying out the necessary expenses in greetings, doting, housing, transport and education, although the totality of the entrance of the household is used to acquire exclusively these resources.

Given the General Law of Social Development sets that the measurement must consider his multidimensional character, the National Council of Evaluation of Politics of Social Development (CONEVAL) it formulated the Index of social backwardness, which is an indicator of shortages that values one at three levels of geographic junction: State, municipal and local. This measurement adds prompts of education, of access to health services, of basic services, of quality and spaces in the housing and assets in the home.

On the other hand, also Mexican government, through the National Council of Population (CONAPO), calculates that Index of Marginalization which is a measure-summary that it permits to differentiate the states and municipalities from the country according to the global impact of the lacks that suffers the population as result of the absence of access to education the residence in inadequate housings, the insufficient monetary income perception and the related with to the residence in small locations.

Other international indexes have been developed, as that Human development Index proposed by United Nations Program for the Development (UNPD) that aforementioned he combines three elements to evaluate the progress of the countries with regard to human development, the GDP by inhabitant, the health, and education; everyone it includes with the same consideration.

One can deduce that, someway, the different indexes measure diverse dimensions of a same complex problem. Besides, there are aspects that the indexes do not consider like that of utility, freedom or happiness and that in several positions, arrive at being fundamental in his conceptualization and inclusion in a poverty measurement model.

This document proposes a method of integrated measurement. The fundamental premise that is outlined is that the measurement of the poverty yes produces a certain general index, by considering the diverse dimensions in which it is conceptualize. The quantization of this index is can determine in an indirect way leaning in the direct measurement of diverse factors as number of illiterate peoples, percentage of the population that not has access to the services of health; percentage of housings without drainage, water, electricity, apartments; and other more.

Structural Equation Model Of Poverty

Formally, the problem that is outlined is: How to determine a general index of poverty in Mexico by considering the measurement of the different dimensions in which it is manifests the poverty?

This problem presents two sub problems. First, the realized measurements in Mexico, as well as your diverse used methodologies, hatch a heterogeneous quantity of factors, and the incorporation or your exclusion of each factor represent diverse advantages and handicaps, according to the focusing that you are had given to the study. Therefore, the indexes of social backwardness and of marginalization contemplate observable variables that it is duplicated or that could complement mutually. These indexes were obtained, in turn, for different institutions.

The second problem, represent it the own carried out inquiries. The instruments of collection of data, as the inquiries, were not designed specifically to measure the poverty, by not having a precise definition of how to measure her specifically. The questionnaires with the specific purpose of realizing counting to obtain proportions of population with lacks mainly of services elaborated one.

Applying Systems' General Theory, it is possible to integrate the diverse indexes and the official isolated measurements on the poverty, that permit carry out the multidimensional measurement of the poverty in Mexico, to determine a general index of poverty.

In an analytic way, if to a system it is not applied any stimulus then, cannot wait for no answer. On the other hand, if to a given system, he is applied some stimulus to the input (***c***), then for the law of cause and effect, that system will generate an answer (***e***), either visible or perceived, to the output, or maybe not an answer but yes an increase of your internal entropy.

If one it conceptualizes to society as a system, then his social interrelations economic; politics; cultural and others more, will modify his outputs:

$$de \propto dc \qquad (1)$$

Where:

dc = is the an entry continuous change (cause) or external stimulus that deposits a system.

de = is the output or answer of a system who results from an incremental change in an entry continuous change (effect.)

The way in which the systems postpone one of other gives through the proportionality or function of gain $g(e,c)$. With these concepts one that can set:

$$de = g(e,c)dc \qquad (2)$$

Where:

$$\lim_{\Delta \to 0} = \frac{de}{dc} = \frac{output\ differential\ change}{input\ differential\ change} = g(e,c) \qquad (3)$$

If the social system had only a change to the input, the answer will be considered:

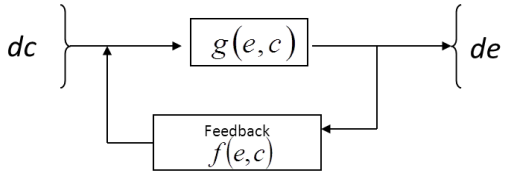


Figure 1. System with an entry, an output and feedback.

Besides, adding to the system's entry the feedback stimulus, he has one then: $dc + f(e,c)de$ The system's output will be given by:

$$de = g(e,c)[dc + f(e,c)de] \qquad (4)$$

Grouping common variables differentials, the output will be:

$$[1 - g(e,c)f(e,c)]de = g(e,c)dc$$

$$de = \frac{g(e,c)}{1 - g(e,c)f(e,c)}dc \qquad (5)$$

Following with this thought line and assuming that society does not have an only entry nor an only output, but multiple entries, internal entropy, gone out and feedback, then calculation complexity can enlighten one with the following figure:

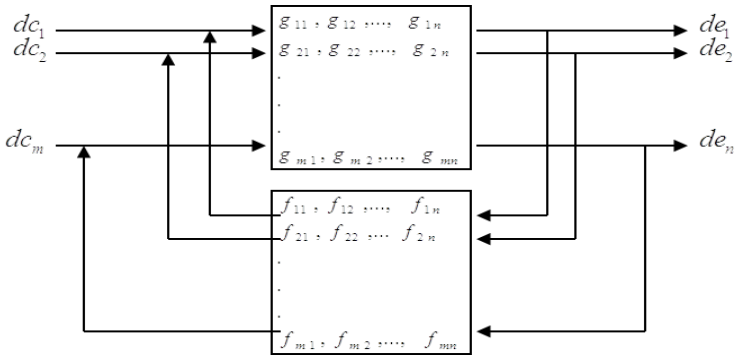


Figure 2. System with m Inputs and n Outputs.

The kind of systems of equations, because of his size and to the quantity from components, one more can represent of form simple using the matrix nomenclature. Then, the previous expression can represent one also as: $dE = [I - g(E,C)f(E,C)]^{-1} g(E,C)dC$ which represents a system of equations with feedback for ***m*** inputs and ***n*** outputs.
Trying to analyze such performance would generate several equation systems complex that may be is not worthwhile appraise. Above all, when it deals with people in poor situation. A way to synthesizing evaluation complexity is applying the concept of the *Black box* (Gigch 1987; Von Bertalanffi, 1984; Churchman, 1984; Klir, 1969; Klir, 1985) and applying other methodology of systems (Zhang, 2007.) Considering the previous, an alternative for evaluating complexity is the following one.

MODELING USING SEM

The model it defines considering that the general index poverty ($\boldsymbol{P_i}$) it is obtained from the hypothetical constructs: Indexes of more excluded, of social backwardness, of the measurements of the levels of alimentary poverty, patrimonial and capacities. However, each hypothetical construct is an abstract concept that it must possess some true value; but, to find it, is necessary that it appraises in an indirect way, using several variables observed.

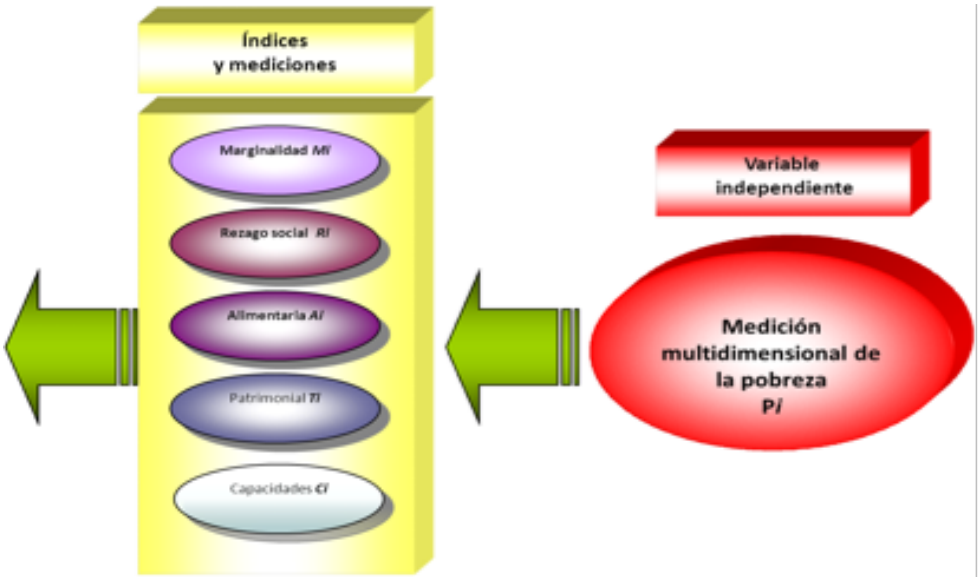


Figure 3. Hypothetical Constructers related to the general poverty Index.

To way of example, the index of marginalization ($\boldsymbol{M_i}$) It considers four socioeconomic sizes of the marginalization: Education, housing, monetary income, and population distribution that are, in his turn, also hypothetical constructs. The index position of more excluded I would become following form modeling:

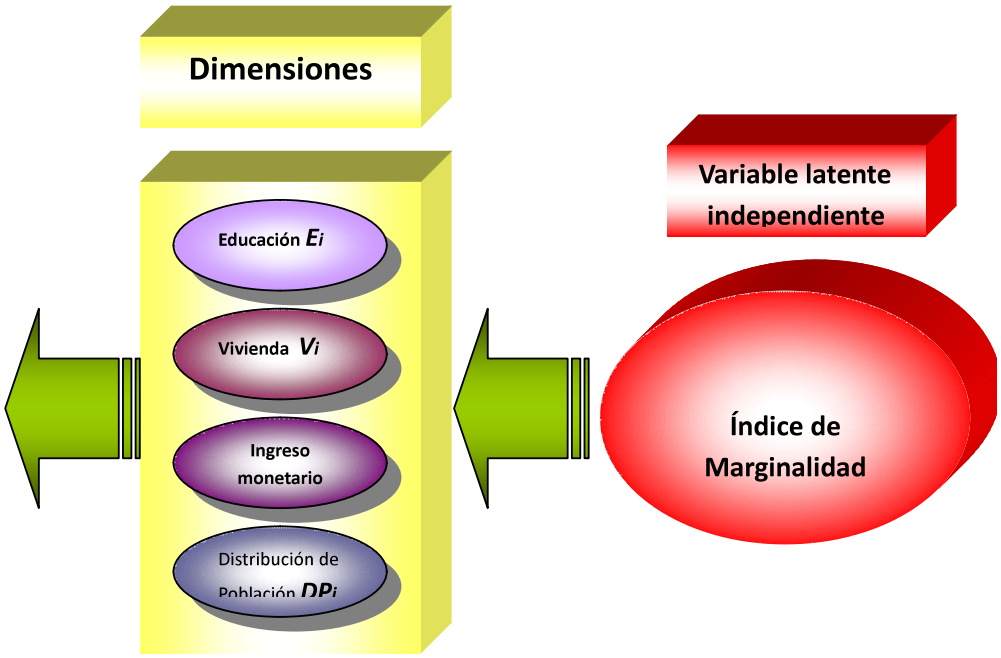


Figure 4. Hypothetical Constructers related to the Index of marginalization.

In his turn, each one of the four sizes identifies nine forms of exclusion that they measure his space intensity as percentage of the population that does not share the enjoyment of resources and essential services gives birth to the his basic capacity development: Illiteracy, population with complete elementary education, waterless particular housings intubated, particular housings without drainage nor sanitary service, particular housings with earthen apartment, particular housings without electrical energy, particular housings with some accumulation level, occupied population that perceives until two minimum wages, locations with minus than 5,000 inhabitants. These are variables that yes can measure in a direct way, because the data have obtained one by means of the national inquiries ENIGH 2005 and 2008; and the II Counting of Population and Housing.

MEASUREMENT MODEL

For example, a part of the model of measurement that is proposed, illustrated in the Figure 5. By convention, in the models' of structural equations also called, schematic representation trajectory diagrams each observed variable is represented with a rectangle, and each latent variable with a ellipse. For the residual values **E** and **D** not uses any geometric figure.

Structural Equation Model Of Poverty

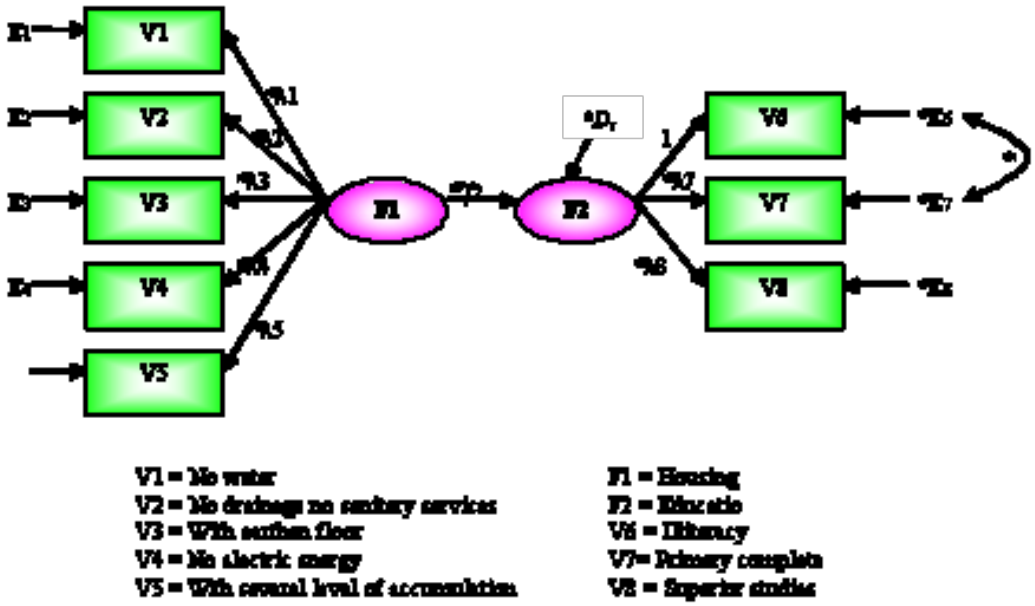


Figure 5. Example of structural modelling or Measurement Model.

All observed variables designated with a **V** and they set up the current data in study. The other variables are hypothetical and represent the structural network of factors and sizes under research.

The unidirectional arrows represent the structural coefficients of regression that indicates the impact of a variable on other. For the diagram of example, the five unidirectional arrows that it begin to appear of the Factor 1 (F1) towards each one of the five observed variables (V1; V2; V3; V5 V4,) indicate that the obtained measurements are caused by F1. In a similar form, the unidirectional arrow it begins to appear towards F2, imply contradiction that F1 causes to F2.

For the other side, the arrows that go out from the E's symbolize the impact of the random errors of measurement on the V's variables; and the arrows that go out of the D's towards the F's variables they indicate the impact of the random error of prediction.

Finally, the arrow curved bidirectional represents the covariance or correlation between pairs of variables. For the example, the bidirectional arrow that links to E6 with E7 sets that the associated errors of measurement with V6 are correlated with the associated errors of measurement with V7.

The well-developed statistical theory to justify this model can find one in published different works on modelling of structural equations, as Hayduk (1987), Bollen (1989,) Loehlin (1992) and in different reviews specialized as Multivariate Behavioral Research;

Psychometrika; Sociological Methods & Research; Journal of Educational Statistics; British Journal of Mathematical and Statistical Psychology; and Sociological Methodology.

In essence, the system of representation of Bentler-Weeks (1979) sets that all contained variables in a structural model can be classified in two categories: dependent variables and independent variables. Any unidirectional variable that has managed an arrow to her represents a dependent variable; if no has any unidirectional arrow to her then it considers as independent varible.

Usually, the dependent variables are Explained in function of the other variables contained in the model, whereas the independents variables are used as explicit variables. On the contrary, in the Bentler-Weeks representation system there is a great difference on the independent and dependent variable conceptualization. In this representation, any variable that is not dependent automatically as independent variable, without mattering if it is a observed variable, a factor or a residuel error. For the example that is exposed, the dependent variables are: V1; V2; V3; V4; V5; V6; V7, V8, F2; and the independent variables are: E1; E2; E3; E4; E5; E6; E7; E8; F1; D1.

Then, a dependent variable is any variable that can be expressed like a function of structural regression with other variables. This function of regression is expressed as an equation. The equations that generate this example and that define the Measurement Model are:

$$
\begin{aligned}
V_1 &= \lambda_1 F_1 + E_1 \\
V_2 &= \lambda_2 F_1 + E_2 \\
V_3 &= \lambda_3 F_1 + E_3 \\
V_4 &= \lambda_4 F_1 + E_4 \\
V_5 &= \lambda_5 F_1 + E_5 \\
V_6 &= \lambda_6 F_2 + E_6 \\
V_7 &= \lambda_7 F_2 + E_7 \\
V_8 &= \lambda_8 F_2 + E_8 \\
F_2 &= \gamma_2 F_1 + D_2
\end{aligned}
\qquad (6)
$$

Considering the simple regression notation, the prediction of V1 using F1 can define as:

$$V_1 = \lambda_1 F_1 + E_1 \qquad (7)$$

Where λ_1 represents the coefficient to be estimated.

The statistical theory indicates that a regression coefficient is compound, in two element reality: the true or structural coefficient between the dependent variable and independent, and the reliability of the variable predictor. The reliability is the grade in which the independent variable is free from error. From a so theoretic perspective as practical, one cannot measure a concept perfectly because some measurement error grade always exists. The answers offered by the people polled have certain error of measure that affect in a

direct form to the structural true coefficient.The impact of the measurement error and, consequently the reliability decrease, can be observed of a regression coefficient expression as in the previous equations. Assume the following equation:

$$\beta_{y\bullet x} = \beta_v \times \rho_x \qquad (8)$$

where β_{y*x} is the observed coefficient of regression, β_v is the true structural coefficient, and ρ_x is the reliability of the predictor variable. Unless the reliability is of the a hundred per cent, the observed correlation always underestimates to the correct relation.

The main task is to determine the goodness of the fit between the models proposed SEM and the gathered data; and after it carries out the necessary fits to achieve a more refined model of the measurement of the poverty. To carry out the previous process, in a general way applied the following scheme:

Data = Model + Residue

Where:

Data.- Represents the observed variable measurements.

Model.- Represents the hypothetical structure that links to the variables observed with the latent variables.

Residue.- Represents the existing discrepancy between the hypothetical model and the observed data.

The causal relations that it is set in a model SEM must have sustenance highly rational and based on a theory that it tries to explain a phenomenon. For this study, a series of appraisable variables that allowed several hypothetical constructs' conceptualization of diverse hypothetical constructs in order to derive a general index of poverty.

Bollen (1989) expresses three conditions that must be observed when causal relations between variables set one: isolation, association and address of cause. While that the association and address of cause can be clear and easy to browse, results difficult secure that a cause and an effect can be isolated of the other. This is the argument that exhibit several researchers to consider that the models SEM, and the raised causal relations in such models, are approaches that cannot be proven really. At the very most, they can be disapproved or without confirmation.

VALIDITY OF THE HYPOTHETICAL PROPOSED MODEL

A question that rises immediately when a suggested problem using SEM models one is: Given that he is applied a model which is more confirmatory than reconnaissance, what as good he is the proposed model?
The answer to this question is, by means of the measurement or evaluation of the existing difference between the matrixes ***S*** (with elements S_{ij}) and ***Σ*** (with elements $\hat{\sigma}_{ij}$). Naturally, a new question arises: How can one measure or evaluate this matrix difference?
To answer this second question he introduces the concept: The model's goodness of fit.
From general form, the model's goodness of fit refers to the existing difference between the covariance observed matrix S and the predicted matrix of covariances by the parameter estimation $\hat{\Sigma}$. If the difference value is small, it means that the proposed model represents reasonably well to the observed data. If the difference is big, one can conclude that the proposed model is not consistent with the observed data.
The inconsistencies can owe one to two possible causes (Raykov & Marcoulides, 2000):

1. To that proposed model can have deficiencies in his development in the sense of that is not able to emulate the data contained in the matrix he analyses one, although they count on the biggest quantity of suitable values of the parameters.
2. Or that the model is well expressed but that it fails in the compendium of the data and these contain erroneous values.

If the values that are been about to compare were scalar, then is necessary to apply a simple subtraction between both matrixes, using the absolute values of them inclusive then only resulting differences to evaluate the distance between them. However, this cannot directly apply one between the two matrixes ***S*** and ***Σ*** given that, it does not obtain a number, but a difference matrix is, the Residuel covariance matrix $S - \hat{\Sigma}$. The residual matrix elements are then $s_{ij} - \hat{\sigma}_{ij}$. The standardized residuum matrix contains the elements $r_{ij} - \left(\frac{\hat{\sigma}_{ij}}{s_{ii} s_{jj}} \right)$, where r_{ij} is the correlation observed between the variables ***i*** and ***j***; and $\hat{\sigma}_{ij}$ is the predicted covariance, and s_{ii}, and s_{jj} are the standard deviations observed. The standardized residue obtained from the correlations are easier to interpret than the not standardized residue, based on the covariances, because those do not depend of the used scale in the realized measurements of the observed variables.
For the difference evaluation they are applied several methods. The simplest form is to take the addition of the squares of the differences between the corresponding two matrix elements. Other method consists the multiply the squares of the differences with certain appropriate weights, and also obtain your sum. In both cases, the resultant sum is a number that it can correctly be interpreted since measure the difference found between the proposed model and the observed data. While major is this number, will exist a major difference between the matrixes. If is smaller, then the matrixes will be very similar.
Of the previous paragraph the concept of distance between the matrixes derives one then **S** and **Σ**, that is a number that results from the comparison between the elements of ***S*** with the

implied model's covariance matrix elements. This distance is, then, according to the parameters of the model and of the variances and covariances for the observed elements. When it talks with one another of the distance between forming with a die and the report between the parameters of the model and the s matrix, also it is almost lifelike of a function of fit denoted with the letter $\boldsymbol{F}$.

Because of which the function of fit analyses the distance between two matrixes, the value of $\boldsymbol{F}$ always is between zero and a positive value. If the value of $\boldsymbol{F}$ is similar to zero, then both matrixes $\boldsymbol{S}$ and $\boldsymbol{\Sigma}$ are identical. In the EQS calculation package to evaluate the model and the data, this calculation is realized by means of iterations (30 iterations it has usually defined by omission.)

VALIDITY OF THE HYPOTHETICAL PROPOSED MODEL

To integrate the complete latent variable model, the next graph define the model of structure, that have to see each other with the form in how mainly one they model the relations between latent factors.

Any latent variable that is influenced through other latent variable in a model is calls dependent latent variable. A dependent latent variable has at least, a directed arrow to her coming of other latent variable.

Any latent variable that is not influenced by no other latent variable in a model is known as independent latent variable.

In the following diagrams, each direct arrow that is drawn represents the following relations:

1 The structural coefficients it relates to some latent variables with other latent variables,
2 The loads of the factors they relate to the latent variables with the observed variables,
3 The existent relations between the errors of measure and your observed variables,
4 The relations between the equations of the errors of prediction and your respective latent variables employees.

The curved arrows that illustrate one in the charts represent the following covariances:

- The covariances between the latent independents variables
- The covariances between the prediction error equations
- The covariances between the measurement errors

From these charts one can model the structural equations. This modeling also is known with the Latent Variable analysis or Linear Structural relations (Loehlin, 1992). The generated equations specify the prediction of the latent independents variables on the dependent latent variables.

In this part it is necessary to make a major enlargement of the concepts of direct, indirect and total effect.

The strong evidences of inferences cause-effect only can be derived of experimental studies realized in a laboratory and below conditions controlled. Nevertheless, in the models SEM the Causal concept is used to refer to the direct relations in hints between latent variables.

A direct effect between two latent variables defines one by a direct unidirectional arrow that connects them. The direct effect measures through a structural coefficient.

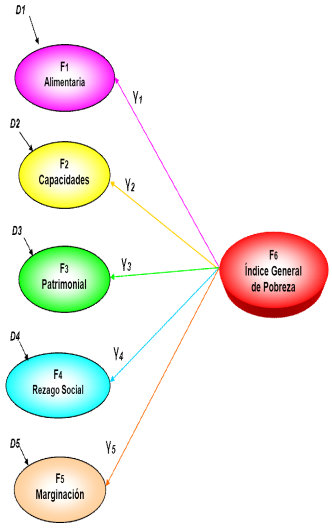


Figure 6. Relation of the latent dimensional Factors against the latent Factor general Poverty index.

In the structural diagram of the Figure 6, the construct general poverty index exercises one direct effect on the marginality, social backwardness, alimentary, patrimonial and capacities.

An Indirect effect between two latent variables defines one when direct lines between both do not exist but the latent first variable relates one to the second by means of the paths contained in other related latent construct. An Indirect effect is measured for the product of his involved structural coefficients.

When they remain established the two models, both them he distinguishes one with the noun of complete latent variable model. From this complete model, they set the suppositions that give sustenance to the paper and they theorize about the impact that each of the latent constructs has on the other ones constructs, and one develops a complete mathematical model. At the end, the numerical calculations were realized with the EQS calculation program.

Our model remains complete due of which this understands the two models: those of measurement and those of structure. Given that our complete model does not allow the

relations in leadership opposite to his causal flow (he is a unidirectional model) also he is of the kind Recursive model.

Map 1 . Marginalization grade.

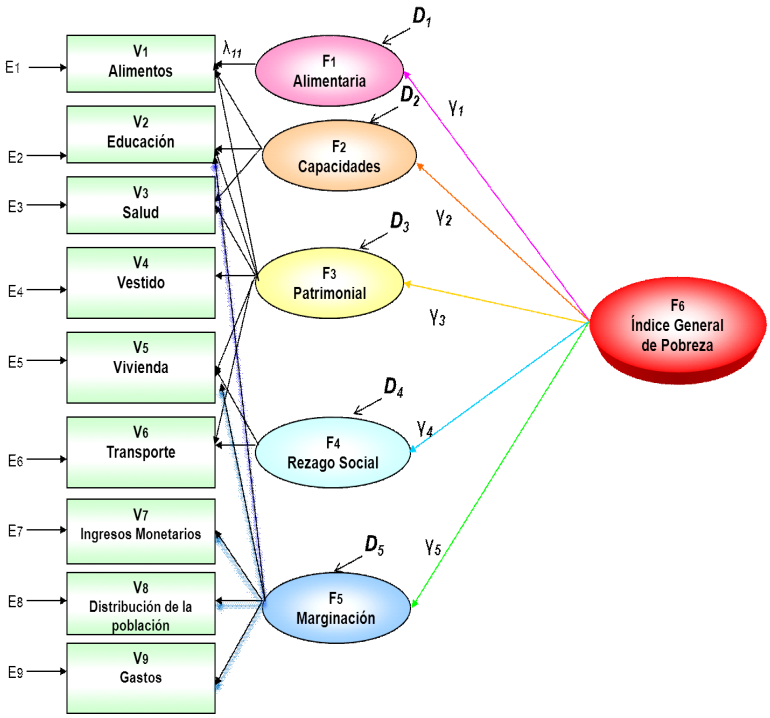
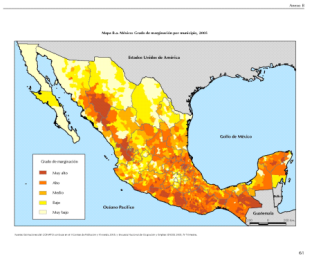


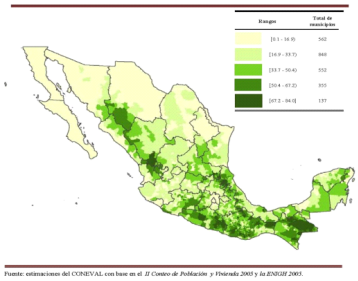
Figure 7. Complete latent variable model.

If he is considered the proposed model, several variables are redundant then because the Marginalization Indexes use observed variables that also are used in the alimentary poverty measurement and in the Index, of social backwardness. In the following maps one can see the results that obtain diverse federal departments, and it is concluded that are similar.

Map 1. Marginalization grade.



Map 2 . Grade of social backwardness social.



Map 3 . Alimentary poverty map.

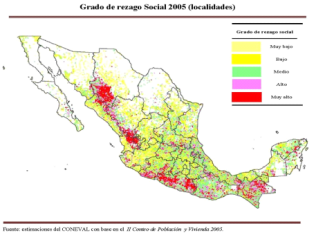


Figure 8. Maps of: (1) margination grade, (2) grade of social backwardness, and (3) alimentary poverty.

Therefore, results necessary integrate the diverse official measurements on the poverty effect does not duplicate to him efforts and unify to him the criteria.

CONCLUSIONS

The multivariate techniques have as fundamental objectives it increase so explanatory capacity of the researcher as the statistical efficacy of your analyses. The multiple regression, the factorial analysis, the multivariate analysis of the variance, the discriminate analysis and other powerful statistical techniques are tools with which count the researchers. Nevertheless, they have a limitation common: each technique can examine only a relation at the same time. Even the techniques ones that have account dependent multiple variables like the multivariate analysis of the variance and the canonical analysis, it follow representing single a unique relation between the dependent and independent variables (Hair et al, 1999.)

The proposed model, on the contrary, browses in a simultaneous way a series of relations of dependence, it who is fundamental due to that different dependent variables are converted, in turn, in free variable in different relations of dependence that it is outlined to measure the poverty in a multidimensional way. Each concept of backwardness or marginality serves as observed variable to lean the study of abstract concepts by means of a validity of hypothetical constructs.

The model values a series of equations of interrelated different, but multiple regressions by means of the specifications that they consider at one Structural model. This makes some dependent variables to turn into independents variables in posterior relations, generating with this interdependent nature of the structural model.

Moreover, the proposed model has the ability to add latent variables to the analysis. A latent variable is a supposed concept; hypothetical and not observed that it can be approximate by means of observable variables. The values of the observable variables are obtained of the national polls of population and housing.

The present research postulates that the diverse dimensions of the poverty are to variable observable by means of those which is possible to investigate the causal existent relations between hypothetical constructs. To validate these postulates, is necessary to develop a statement that permits parse such latent relations between observed variables and not observable. A model of structural regression is the appropriate thing for such end. All hypotheses that it is outlined have been appraised by means of a model with testing characteristic.

REFERENCES

Bentler, P. M. y Weeks, D. G. (1979). Interrelations among models for the analysis of moment structures. Multivariate Behavioral Research. No. 14, pages 169-185. E.U.A.

Bentler, P. M. y Weeks, D. G. (1980). Linear Structural equationswith latent variables. Psychometrika. No. 45, pages 289-308. E.U.A.

Bollen, Kenneth A. (1989). Structural equations with latent variables. New York Wiley Interscience, New York, E.U.A. April de 1989.

Churchman, C. West. (1984). El enfoque de sistemas. Editorial Diana, México, D. F.

Elbers, Chris, Lanjouw, J. O., and Lanjouw P. (2003). Micro-level estimation of poverty and inequality. Econométrica 71(1): pp 355-364.

Fan Dongping. (2007) Towards Complex Holism. Systems Research and Behavioral Science. No. 24, pages 417-430. Wiley InterScience. USA.

Hair Hair, Jr., J. F., R. E. Anderson, R. L. Tatham, y W. C. Black. (1999). Análisis Multivariante. 5a. Edition, Prentice Hall, Iberia, Madrid, Spain.

Hayduk, L. A. (1987). Structural equation modeling with LISREL: Essentials and advances. Edited by Johns Hopkins University Press. Baltimore, MD, USA.

Kakwani, Nanak y Jacques Silber. (2007). The many Dimensions of Poverty. First edition, Palgrave MacMillan, New York, USA.

Klir, George J. (1969). An approach to General Systems Theory. First edition, Van Nostrand Reinhold, New Cork, USA.

Klir, George J. (1985). Architecture of systems problem solving. First edition, Plenum Press, New York, USA.

Loehlin, J. C. (1992). Latent variable models: An introduction to factor, path & structural analyses. Second Edition, Lawrence Erlbaum Associates, Publishers. Hillsdale, NJ, USA.

López Calva, Luis F. y Miguel Székely. (2006). Medición del desarrollo humano en Mexico. First edition, Fondo de Cultura Económica, Mexico.

Raykov, Tenko y George A. Marcoulides. (2000). A first course in Structural Equation Modeling. First Edition, Lawrence Erlbaum Associates, Publishers, NJ, USA.

Sandquist, Gary M. (1985). System Science. First edition, Prentice Hall, New Jersey, USA.

Van Gigch, John P. (1987). Teoría general de sistemas. Second edition, Trillas. Mexico, Von Bertalanffi, Ludwig. (1984). Teoría general de los sistemas. Fondo de Cultura Económica, Mxico.

Yan Zexian. (2007). A new approach to studying complex systems. Systems Research and Behavioral Science. No. 24, pages 403-416. Wiley InterScience. USA.

Zhang Huaxia (2007) Soft methodology and 'soft' philosophy of science. Systems Research and Behavioral Science. No. 27, pages 156-170. Wiley InterScience. USA.

Zhu, Zhichang. (2007). Complexity Science, Systems Thinking and Pragmatic Sensibility. Systems Research and Behavioral Science. No. 24, pages 445-464. Wiley InterScience. USA.