

Sinergy among Engineering Techniques to Simulate a Socioeconomic System

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Abstract

Is necessary to build a model that describes the behavior of a socioeconomic system. This model will be carried out using systemic thought and will be based in revision of sources and authors, construction of Diagram of likeness among the factors, mensuration of the relative importance of the causes, elaboration of Ishikawa's diagram and Model of Causation, diagram of Forrester, validation of the model and know the behavior of the variables in different scenarios. We will end up suggesting modifications to the model, presentation of recommendations, possible government politicians and control to prevent and to mitigate Poverty

Keywords

Poverty, concentration of wealth, continuous simulation, public policy

1. Introduction

The poverty impacts in the way like the social and economic dynamics of a population are presented; this brings bigger vulnerability conditions for this population. The socioeconomic type dynamics, have propitiated such negative situations as consolidation of an unjust social structure, the urban segregation, the lack of spaces of sociability, the exhaustion of the resources and the growing vulnerability in great quantity of sectors; when the problem beyond being due to restrictions of resources or shortage, is based in inequity in the possession of these resources and in the distribution of the wealth. When approaching the problem of the poverty and of the distribution from a dynamic focus will be able to know the factors that determine it and in that magnitude, as well as the exit variables that will surely have again incidence in the system.

With this work it is sought to formulate an integral and strategic model that describes behaviors and dynamic of variables of type socioeconomic, useful to generate or to tune political and control measures guided to improve the conditions of people's life and in the redistribution of wealth; it is also sought him to be the sufficiently flexible thing to be validated in other contexts.

2. Reference Mark

It is sought to conceive the poverty and the concentration of wealth, problematic that impact directly in the population's well-being and cause another series of situations, as violence and illegality that alter the stability of the socioeconomic system; due to the complexity of the problem the dynamics of systems will be used like relating for the analysis of interactions, since it allows to know tendencies in the behavior of variables.

2.1 Systemic thought and dynamics of systems

The systemic thought is it emerged in like an answer to the flaws of the mechanical thought (that adhered to the reduction analysis, where all the objects, events and properties can be understood in terms of the last elements), to explain biological phenomena. The systemic perspective recognizes multiple interactions among all the elements in a complex situation. A related change gave reach to the idea of 'System'. In systemic thought, a 'System' it is a net of components, complex, highly interrelated that exhibit properties of synergy - the everything is bigger to the sum on its behalves - [1]. See figure 1 below.

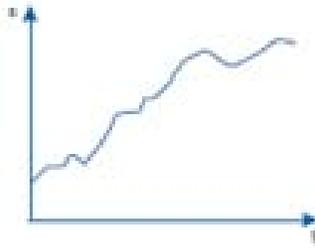


Figure 1: Behavior of a System

The term dynamics is used by opposition to static, and it expresses a changing character. When speaking of the dynamics of a system, reference it is made to that the different variables that can associate to their parts suffer changes along the time, as consequence of the interactions that take place among them. Their behavior will come given by the group of the trajectories of all the variables [2].

The dynamics of Systems leans on in three fundamental principles: Existence of feedback curls, non linear relationships between variables and Existence of delays in the relationships among variables [3, 4]. When building a model in the specialized software Stella (or I think), it is had the following elements that allow making a graphic recognition of the nature of the variables and relationships:

Rate: It is the quantity of something that flows in a period of time, Level: The accumulation of flows added to an initial, and Auxiliary condition: Are variable useful to adjust the dimensions in the equations.

2.2 Poverty

It is the main problem that motivated this study; diverse Organizations and Personalities at world level have elaborated conceptualizations around the Poverty; these are adjusted widely some of the following concepts:

The poverty is a state of privation of well-being, not only material (consumption of foods, housing, education, health...) but also referred in other spheres of the life: personal insecurity and of the goods; vulnerability (to the illness, to the disasters and the economic crises); social and political exclusion, among other factors; for it can be measured it in different forms that oscillate between the subjective ones and the objective ones. The objective ones can be classified in not monetary and monetary and these last ones in relative or absolute [5]. From another point of view, the poverty is a situation in which the person is not under conditions of not only satisfying her vital necessities in terms of physical survival (feeding, health and housing) but also in terms of her development as person: social insert, politics, identity, sense of ownership, access to the formation and the information, etc. Meantime the poverty is conceived as extreme poverty or misery; the inability of consenting to a minimum alimentary basket [6].

Amartya Sen, discovered that the famines in India have even taken place when the provision of foods was not different from previous years and that, in some areas affected by the hunger, foods had been exported; the above-mentioned takes to think that the problem of the poverty has a strong correlation with the way like is carried out the distribution and not only with the Shortage. For Sen, converge in the phenomenon "Poverty" social and economic factors that affect to the different groups of the society, and that influence on the election of opportunities [7].

The best classification and definition of concepts related with poverty, it has been achieved from the social sciences.

- **Poverty like a material concept:** The population doesn't have something that needs, or when lack the resources to consent to the things that she needs.
 - Necessity. Lack of goods or material services.
 - A pattern of privations. Perpetuation in the time of the necessities.
 - Limitation of Resources. Entrance lack, wealth or resources to acquire or to consume the things that they need.
- **Poverty like economic situation:** It is associated with lack of resources, mainly coming from Revenues.
 - Level of life. When the revenues or the consumption, it is below a specific standard.
 - Inequality. Some people are in disadvantage situation regarding others in the society.
 - Economic Position. The way like it is identified to what group a person belongs in a society.
- **Condition Social**
 - Social Class. It identifies the socioeconomic position with the socioeconomic status.

- Dependence. The individual that receives attendance because it lacks means of subsistence.
- Lacks of basic security. Vulnerability in the face of the social risks.
- Absence of ownerships. Inability of consenting to goods, services, opportunities, etc.
- Exclusion. It overcomes the privation idea, because it includes problems that are of stigmas and the social rejection.
- **Poverty like a moral trial:** The poverty is a severe privation and it is considered that people are poor when one judges that their material conditions are morally unacceptable [8].

As for the indicators or studies focused in determining the poverty, we find a wide variety that associates to the organizations that propose them and to the punctual priorities of the context where the mensuration is applied [9].

Table 1: Summary of the Poverty's mensurations

Mensurations of Poverty	Description or Equation
Coefficient of Engel	It is the % of Expense in foods $CE = \frac{GastosAlim\ entarios}{GastosTotales}$ (1)
Unsatisfied Basic Necessities or Necesidades Básicas Insatisfechas (NBI)	Is completed once or several of the following conditions: Inadequate housings, critical Accumulation, Services inadequate, High economic dependence or school Nonattendance
Incidence of the poverty	The % of homes, or of population that doesn't reach the level of the line of poverty (LP). The quantity of poor is q and the total population N. $H = \frac{q}{N}$ (2)
Integrated womb of Poverty or Matriz Integrada de Pobreza (MIP)	It keeps in mind NBI and LP, to segment: <u>Chronic poverty:</u> People are poor simultaneously for NBI and LP. <u>Recent poverty:</u> People are low the line of poverty and they don't have NBI. <u>Inertial poverty:</u> People are above the LP and they have NBI. <u>Non poor:</u> When people have enough revenues and they don't have NBI.
Breach or intensity of poverty	$I = \frac{1}{q} \sum_{i=1}^q \frac{z - y_i}{z}$ (3) where z denotes the value of the line of poverty, q represents the number of poor & and the Revenues of the home or person i.
Index of Sen	$P_z = H[I + (1-I) \times G_p]$ (4) where H denotes the proportion of Poor, I the breach of Poverty and Gp the inequality among poor
Index FGT (Foster, Greer and Thorbecke)	$P_\alpha = \frac{1}{N} \sum_{i=1}^q \left[\frac{(z - y_i)}{z} \right]^\alpha$ (5) where z denotes the value of the line of poverty, q represents the number of poor, N the population, and the Revenues of the home or person i, & a: ponderacion.
Multidimensional index of the Poverty or Índice Multidimensional de la Pobreza (IMP) - Oxford	It evaluates 10 indicators: Nutrition, infantile Mortality, years of study, the children's list, fuel to cook, toilet, water, electricity, floors and resources; contained in 3 dimensions: Health, Education and Standard of life.

According to the table 1 several ways exist of knowing of determining the magnitude of the poverty between people of any community; some of them are more concrete and have been used to evaluate the behavior of the poverty through the years or to carry out comparisons among diverse countries (as the incidence of Poverty), while other mensurations are relatively new and look for to include more approaches (Multidimensional Index of Poverty).

2.3 Poverty and Inequality in Colombia, last decades

During the first years of the decade of the ninety, were implemented in Colombia a series of economic and juridical reformations among which stand out the commercial and exchange opening, the labor reformation, the fiscal decentralization and the biggest independence in the Central Bank that affected the relationships and economic structures, producing adjustments in the markets and affecting the level of poverty, the distribution of the entrance and the sources of growth of the economy. In Colombia, the poverty measured with the index of Unsatisfied Basic Necessities, has come diminishing like consequence of the improvement in the access to the public services of education, health, housing and drinkable water; the poverty for revenues also reveals a tendency to lower from 1999 (see figure 2).

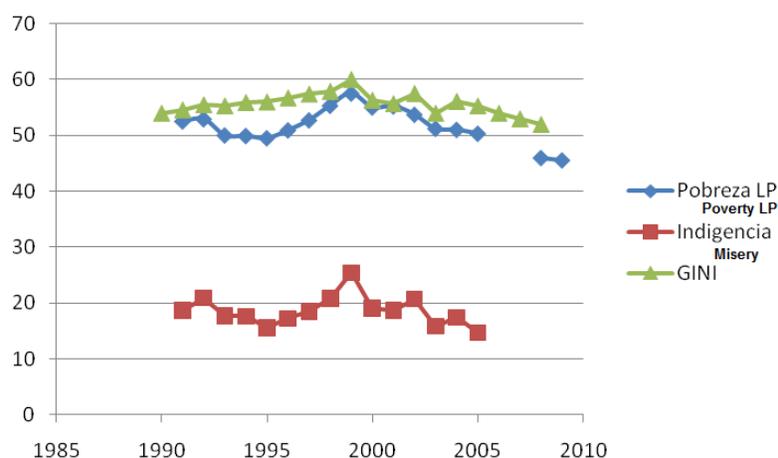


Figure 2: Poverty, misery and Gini in Colombia

The increment of the poverty and misery between 1995 and 2000 have been accompanied by more levels of entrance concentration (measured with the GINI), in the year 1999 a pick associated to the suffered economic recession that year it is evidenced. The biggest level of poverty is also related positively with the increments in the unemployment and the inflation, and with the biggest regressor in the distribution of the entrance; increments in the rate of real change and in the real minimum wage diminish the poverty [10].

3. Analysis of Experts and Variables

I take as main input the methodology proposed by the group of investigation Expert Systems and Simulation (Sistemas Expertos y Simulación -SES), of Distrital University -Bogota, Colombia, for the analysis of productive systems [11]:

3.1 Bibliographical sources and experts

With base in the reference mark an exhaustive search of dedicated sources began or related with Poverty that will allow to know elements, phenomena and in general. To the being the Poverty such a wide problem that affects in diverse grades each community and that it is conceived in different ways and from different focuses or disciplines, he/she tried to have representation of sources, of each possible focus: Politics, Economy, Social Sciences, Engineering, Statistic, etc. In total 202 bibliographical sources of diverse years of publication and contexts were consulted (authors' nationality or geographical scenario of analysis) [12, 16].

3.2 Analysis of Likeness and Pareto

The consultation of each one of the sources registered in a format that would allow know the relationships of causation among the diverse variables associated to Poverty. It was obtained that of a total of 1972 registrations, it had 1199 variables that impact in Poverty; after a couple of iterations to the exercise of Likeness the number of variables fell at 125. According to the classification for relative frequency, the variable Education is that that has the biggest weight in Poverty (with 5, 7%), continue in its order: Revenues (4,4%), economic Inequality (3,7%), Unemployment (3,2%), Health (2,6%), Social Capital (2,5%), Basic Services (2,4%), Actives (2,3%), Economic Growth (2,2%) and Exclusion (1,9%). These first 10 variables, represent 8% of the total of variables (125) and show an accumulated frequency of 30, 8%, that which reflective a good convergence level in the approaches of the authors.

3.3 Analysis Causes - Effect or Ishikawa.

Since variables exist with a very low participation and that to approach them in their entirety would be not very efficient, the best was to carry out a cut until that variable that contributes in the Explanation of the Poverty, completing an accumulated frequency of 80%; the variables or selected causes, grouped in 5 big groups: Economic effects, Effects Society, Effect Government, Factors of Well-being and Inequality.

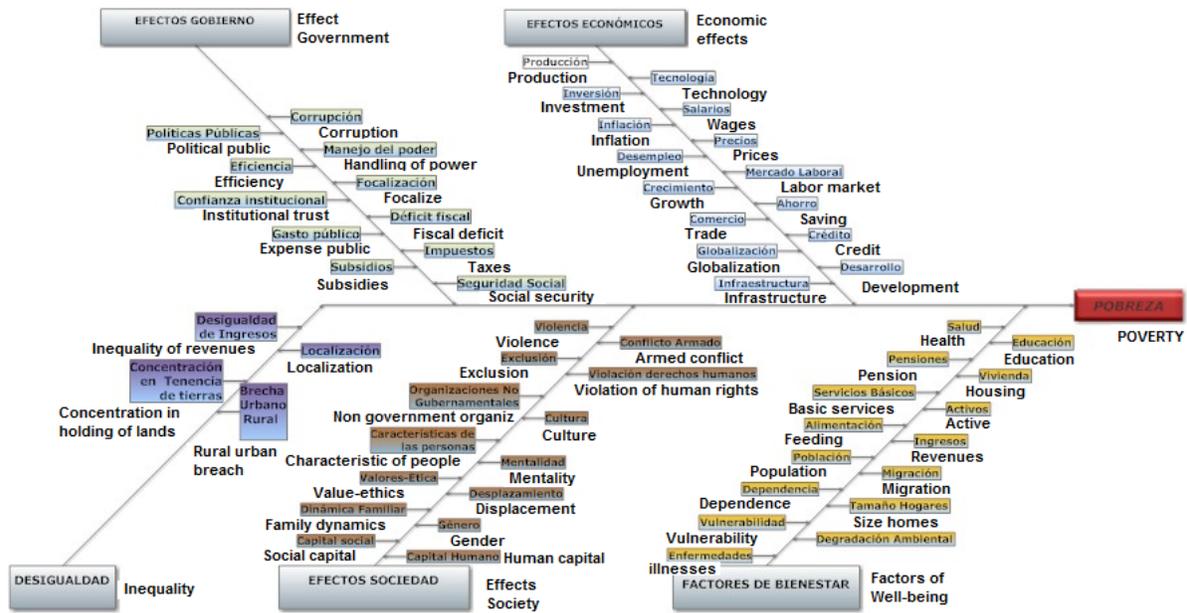


Figure 3: Diagram Ishikawa of Poverty

In Figure 3 the causes appear; was decided to include 5 variables more: Population, Rural Urban Breach, Displacement, Non government organizations and Fiscal Deficit, due to their impact in the Colombian environment.

4. Causal Model

Taking as main input the opposing relationships of incidence in the diagram of Cause Effect, was carried out the analysis of causation by means of Causal diagrams. To facilitate the understanding 5 detailed causal diagrams were elaborated starting from the big groups of factors established in the previous stage. The relationships in these diagrams are based in several studies consulted during the elaboration of the theoretical mark and the revision of experts. The figure 4 sample the causal diagrams.

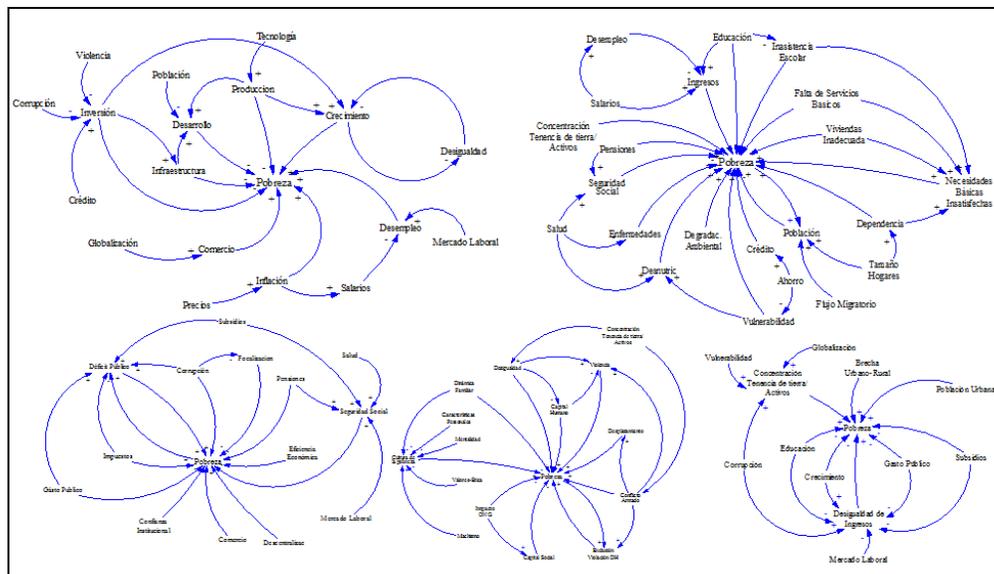


Figure 4: Causal diagrams for groups of Factors

5. Simulation Model

A model was elaborated by each group of factors, in which the variable of main answer in each one of the models was the number of poor people. The figure 5 sample the models elaborated in the software Stella, where multiple models and series of time are included; for the models of multiple variables it was looked for to have high values in the correlation Coefficients and determination, while the Significance of the statistical F would look for to show small values (smaller at 0.05). In the models, those variables that are preceded for 'MT', represent multipliers, while 'N' refer at Level and 'T' to Rate.

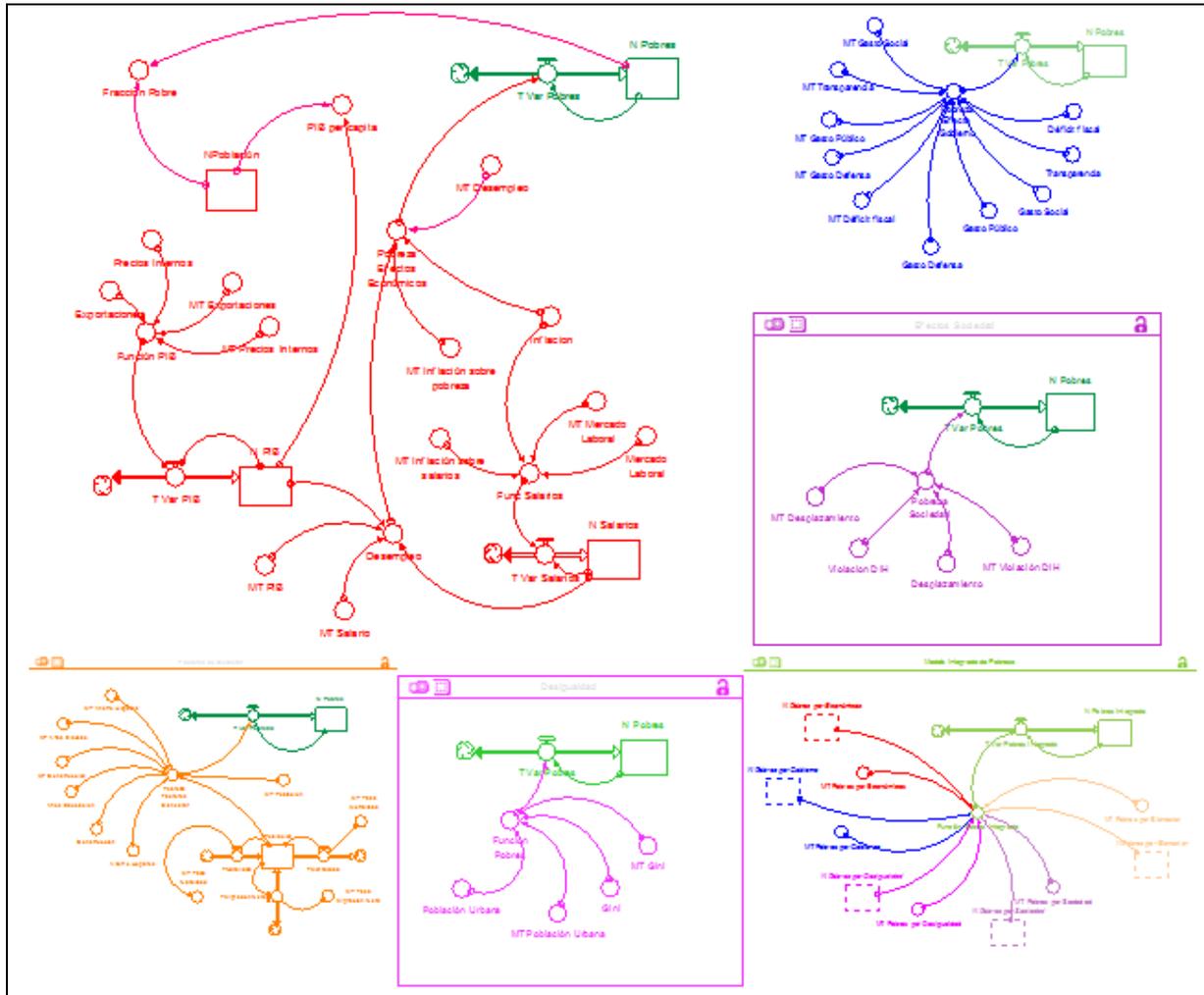


Figure 5: Continuous Simulation Model

It was necessary to have approaches to integrate those models in an unique model. The technical AHP (Analytic Hierarchy Process) was chosen, because it allows to pick up the approach of experts regarding a situation in which is required to ponder (or to assign the weight) of several elements - in this case the groups of factors - [17]. It was appealed to the approach of experts in the impact of the problem of poverty -, requesting that they qualified the preference of each group of factors of explanation of the Poverty, in front of the rest of groups. Of the 16 consulted experts, only took into account 10 qualifications (those whose Statistician of consistency went smaller at 0.1). With the consolidated weight of the acceptable qualifications, the total weight was determined: Effects government (32.4%), Economic (22.1%), Factors of Well-being (18%), Effects society (16,8%) and inequality (10, 7%).

6. Validation

The real annual values of the variables were compared for the period 1990 - 2009, in front of the exits of the used models. In the figure 6, the results of this comparison are appreciated for some variables.

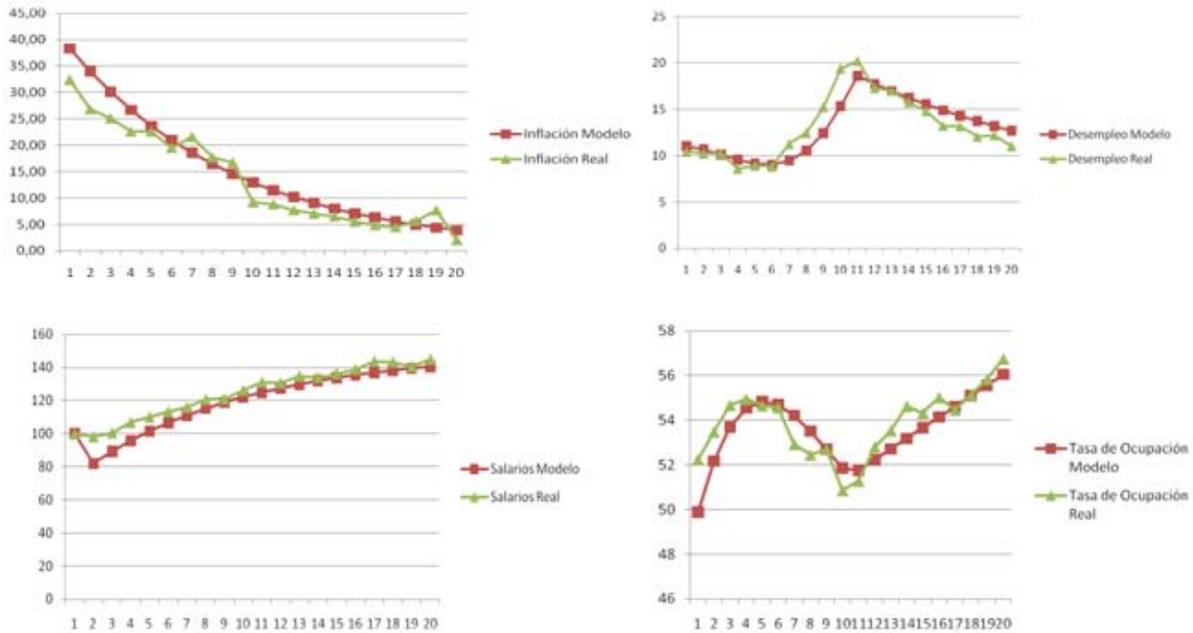


Figure 6: Examples of Validations

The above-mentioned was supplemented with the half relative error or Error Relativo Medio (ERM) of the mensurations of each variable (see equation 6).

$$ERM = \frac{\sum_{i=1}^n \left| \frac{Valor_Estimado_i - Valor_Real_i}{Valor_Real_i} \right|}{n} \quad (6)$$

The dear Value (Valor_Estimado) represents the exits of the pattern, real value (Valor_Real) the original data of the variable and n the number of observations to be compared. It is expected that the value of the ERM is maximum of 0,1 to guarantee validity of the estimates. Most of ERM was passable; some variables as Inflation, Exports, Saving Homes and fiscal Deficit, presented a superior value to the prospective one, reason why was carried out the same exercise with the Number of poor that generates the pattern of each group of factors and for the integrated pattern, finding that the evaluated indicator of error (ERM) has very low values - understood among 0,027 (or 2,7%), for the group Effects Society and 0,046 (or 4,6%), for the group Factors of Well-being -. The integrated pattern of Poor sample a half relative error of 4,2%.

7. Analysis of Scenarios

According to three possible scenarios to evaluate that it will happen in the following twenty years to the period of validation, that is to say how the behavior of the variables will be among the periods 2010 and 2029, if stay the tendencies that have prevailed in the last years (tendency scenario), if changes are supposed in the variables from 2010 that elevate the number of poor (pessimistic scenario), or changes that mitigate the number of poor (optimistic scenario). In the figure 7, see the behaviors that would have the variables of the models proposed for the tendency scenario.

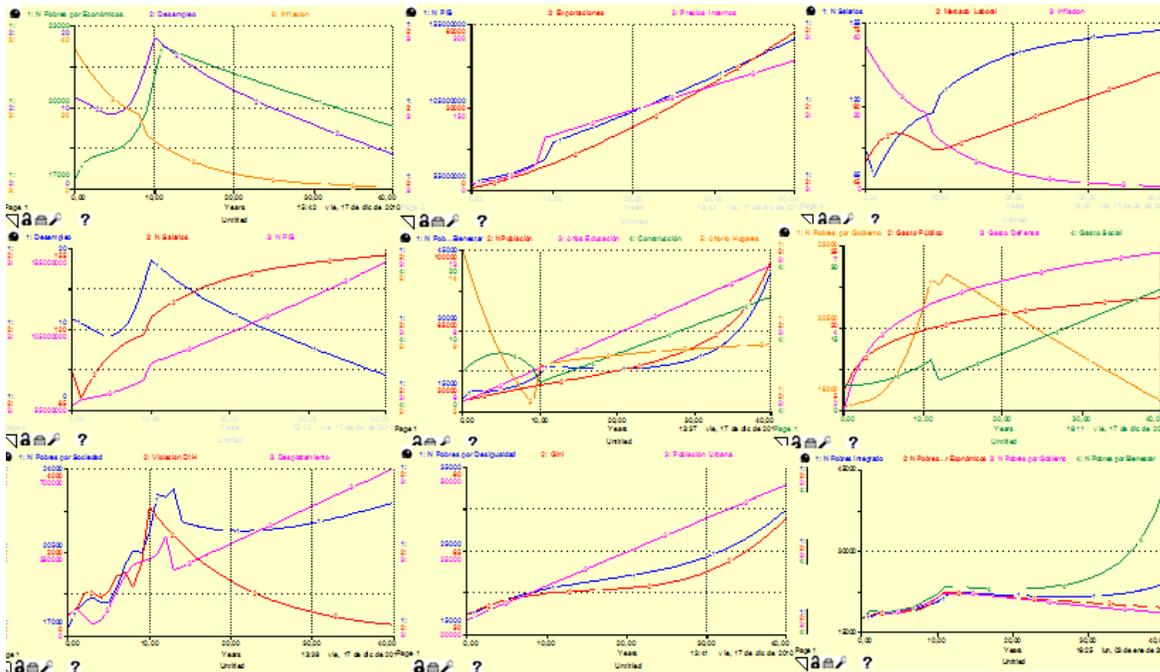


Figure 7: Results in Tendency scenario

Some unfavorable conditions for the Poverty (pessimistic scenario), it would take us to that in 20 years the country counts with more than 10 million poor people that at the present time, while if it is allowed that the conditions remain with its tendency, in 2029 we would count a little more than three million poor. Finally when evaluating a scenario in the which take measures to diminish the number of poor, between the present time and next twenty years the number of poor people would grow in something more than half million, that which is not completely bad if one keeps in mind that the population continues growing and that more children in poor homes than in homes non poor are born. The values can be seen in the table 2.

Table 2: Poor's number in 2029, according to scenarios

Poor's number	Value
Real - In 2009	20'478.373
According to Tendency scenario (2029)	23'768.610
According to Pessimistic scenario (2029)	30'493.660
According to Optimistic scenario (2029)	21'024.890

8. Conclusions and Recommendations

With this investigation was explored and consolidated a proposal for the study of the Poverty - as problematic complex and multidimensional -, that picks up the advances contributed in qualitative research, for a great diversity of authors of diverse disciplines and focuses it stops then to integrate this contributions in a model that reflects how elements and diverse variables are configured in the explanation of the number of poor people in Colombia and it allows to evaluate scenarios & political of prevention and mitigation. The successful use of methods as the diagrams: of pareto, Ishikawa and causal, the multiple models, the time series and Analytic Hierarchy Process, reinforce the impact of quantitative elements and of Industrial engineering in the study of a social problematic.

Is required a very clear conceptualization of the poverty and conscience that diverse mensurations exist, being so valuable the subjective measures as the objective ones. The Poverty has been broadly studied by heterogeneous focuses: Politics, Economy, Social Sciences, Engineering, Statistic, etc. The causes of Poverty were contained in Economic Effects, Effects Society, Effects Government, Factors of Well-being and Inequality. Some key variables as the social Capital, the mentality and all those associated to the culture of the poverty, didn't enter in the

mathematical pattern for lack of data or because the figures didn't help to improve the models. The following recommendations are presented, with base in the discoveries of the model:

It is high-priority an effort combined to solve the armed conflict, since an important quantity is invested in fighting against the groups to the margin of the law, giving up partly with it to invest in items related with the Social security, the infrastructure and everything that that redounds in more social well-being for the Colombian community. The solution to the conflict would cause the fall in the number of having displaced and in the number of violations to the Humanitarian International Right, that which is in the same address of reducing the number of poor. This requires political will to fix goals of agreements with the mediation of International Organisms. Is necessary diminishing the unemployment by means of incentives that reactivate the economy, as the development to the national production and the use of exporter potential. Likewise to promote in the managers the creation of vacant in the diverse links of the supply chains, to improve the occupation rate. Also, for the fixation of the wages a politics of annual increment should be implanted that it muffles the inflation at least.

A very strong politics is recommended for the abolition of the corruption, by means of formation, promotion of projects that have direct incidence in the mentality of collective thinking, fomenting to be associative, the social cohesion and the innovation. To include more effective mechanisms of control and more severe punishments to those who make acts of corruption in their different manifestations and to the media that promote and celebrate the culture of the trap. Next to the above-mentioned, it is urgent a politics and mechanisms with those which it is guaranteed that the items of the public expense, the subsidies and transfers, are channeled correctly, avoiding that it don't arrive to those who should benefit (exclusion errors) and avoiding that it stray to people that should not receive them (inclusion errors). In the sense of the inequality of revenues, a politics of maxims proportions among the wages of the different hierarchical and occupational levels, will allow to reduce social uneasiness and to homogenize conditions of life. It becomes necessary also a group of politicians to avoid the concentration of proprietors of the earth that incentives exist to live and to work in rural areas. Finally the country should bet to the development of the Education of its inhabitants, by means of the operation of politicians that facilitate the educational access in all the levels and the permanency in the diverse systems (public or private), this way the human capital would rise in general of the country, in such a way that would increase the capacity to generate people's revenues and would have bigger possibilities that novel and effective ideas will be generated for the solution of problems that concern us to all or whole communities and for the advance in the national and regional development. Also intends to establish a group of politicians to guarantee the saving of the homes that at the moment are not below the line of the poverty and to evolve promoting the change of cultural conditions that perpetuate the Poverty.

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