

Nuevo Leon's Public Debt: Analysis using Dynamic systems modeling

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Abstract:

Public finances in decentralized governments, specifically public debt and its implications in the development of one state as Nuevo Leon are the main objectives in this research study. Using system dynamics modeling to represent the public debt model, simulations are being generated to assess the main variables involved in the process of government debt and its impact on public policy.

Among the scenarios used in the simulations, the variables that represent the behavior of the indicators are: per capita public debt, government debt to gross domestic product (GDP) and public debt relative to income are evaluated until the year 2036. The main components of the system are normative, income and outcome, historical data is obtained from the Ministry of Finance and Public Credit of Mexico (SHCP), INEGI, and public accounts from Nuevo Leon state.

The system dynamics modeling allows representing public policy guidelines prior to implementation under the structure of documented historical assumptions.

Keywords: system dynamics; public debt; debt/GDP; Nuevo Leon México, Public Policy; escenarios.

Introduction:

Mexico is a country that has had several changes in his Laws of State Revenue, from being a centralized country in public funds to a decentralized country for the management of certain public resources, these changes have the flexibility to governments to obtain loans guaranteed by the State, in the role of making public spending for the benefit of citizens, various factors such as corruption, low incentive in punishment for officials who misuse credit, and little incentive to make transparent public spending, have created incentives perverse to debt make an issue of national interest.

The problems of national debt stems from the possibility of bankruptcy or risk of non-payment of financial obligations contracted by government entities in a given period of time, by which governments try to meet the needs of people risking the planning financial future. (Diaz Hernández, 1994).

Currently the non-inclusion of standardized parameters for granting new loans within state governments hinders the efficiency of fiscal policy. The possibilities that a higher level of government can, in principle, bailing out subnational entities facing financial problems, introduce negative incentives that can generate such governments engage in fiscal indiscipline.

To be included in further analysis is necessary to study the issue of public finances not only expenses, but also in three parts: income, expenses and debt, from a macroeconomic perspective: the public debt management should always be guided by a golden rule, save on the time of fat cows to have a financial cushion in the lean season. That is, fiscal policy should be counter-cyclical and pro-cyclical. The second most important reason: the amount of public debt can be so great for a country (or state, or municipality) that could jeopardize the financial viability to future generations. (Urzúa, Villarreal A. & Villarreal J., 2012).

The law of the state of Nuevo León until 2012 in its regulation does not contain a clear text about the fate of debts. Referred to as the destination of debts within the powers of the state executive, in which these new loans are intended "for the purpose for which they were hired and revenues generated and applied financial schemes provided in their payment" (Ley Estatal de Nuevo León, 2012).

In 2011 public debt relative to gross domestic product (GDP), in Nuevo León accounted for 3.5%, in 2008 to 2% and in 2004 to 1.5%, according to the Ministry of Finance and Public Credit. (SHCP, 2012). The indebtedness of the Mexican states between 2000 and 2011 grew 3.5 times, from 90,753 to 315,018 million pesos. In real terms, the growth level was 97.7% (ASF, 2011).

A dynamic model is a support tool for understanding social problems and formulating public policy solutions. Technological change has made available the dynamic study of social problems because advances in software and hardware allow performing the simulation of complex mathematical models (Sherwood, 2002).

System dynamics studies the characteristics of feedback information in the industrial activity to show how organizational structure, amplification and delays interact and influence the success of the company (Forrester, 1981). The data used in the model are governed under the assumptions described in the methods section. The research structure comprises context description, the dynamic model development, evaluation of the dynamic model, set design and development of conclusions.

The Dynamic Problem: current situation of public finances in Nuevo Leon

According to statistics of the Ministry of Finance and Public Credit (Secretaria de Hacienda y Credito Público, SHCP 2012), the credit history of the State of Nuevo Leon has an accumulated debt public of 37,937.9 million pesos in 2012, compared to the 32 States of Mexico, have the third position, and the ten states with more public debt are: 1. Distrito Federal, 2. Estado de México, 3. Nuevo León, 4. Coahuila, 5. Veracruz, 6. Jalisco, 7. Chihuahua, 8. Michoacán, 9. Chiapas and 10. Sonora. (SHCP, 2012). From the proposal of Blanchard (1990), the most widely used indicator for the analysis is the government debt to gross domestic product (GDP). This ratio measures the level of debt relative to the country's economic activity, in this case is used for the state Nuevo Leon, representing a way of assessing the creditworthiness (Intoinsai, 2010). States with a higher level of debt in relation to GDP are followed: 1. Coahuila, 2. Quintana Roo, 3. Nayarit, 4. Chiapas, 5. Michoacán, 6. Zacatecas, 7. Veracruz, 8. Chihuahua, 9. Sonora and 10. Nuevo Leon. (SHCP, 2012).

The balance of the public debt of all states equals 396,832.4 million pesos, between December 2000 and March 2012, the balance of the debt of states and municipalities nominally increased 4.4 times, from 90,731.3 million pesos to 396,832.4 million, with an

absolute variation of 306,101.10 million current pesos. Analyzing the evolution of public debt in Nuevo Leon from 1993 until 2012, there is an increasing exponential behavior in the annual totals.

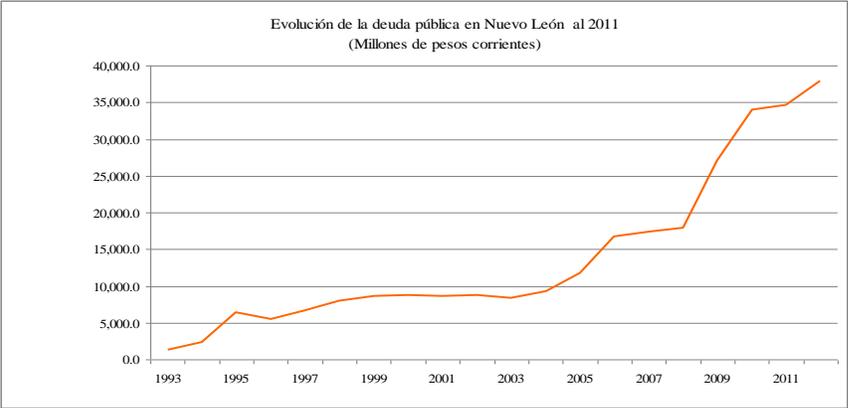


Figure 1: Public debt of Nuevo Leon- SHCP 2012

Annually authorized public accounts by the Congress of the State of Nuevo León reflected an increase in revenue collection for the state government. Budgeted revenues in 2012 were \$ 59.418 million, registering an increase of 4.6% over 2011. Total government revenue comprises 13% of own revenue, 38% of federal participation, 3% support for infrastructure and security and 46% of federal contributions labeled. From which only \$ 32.327 million pesos are run by the state government of Nuevo Leon, equivalent to 54% of the total (Gobierno de Nuevo León, 2012).

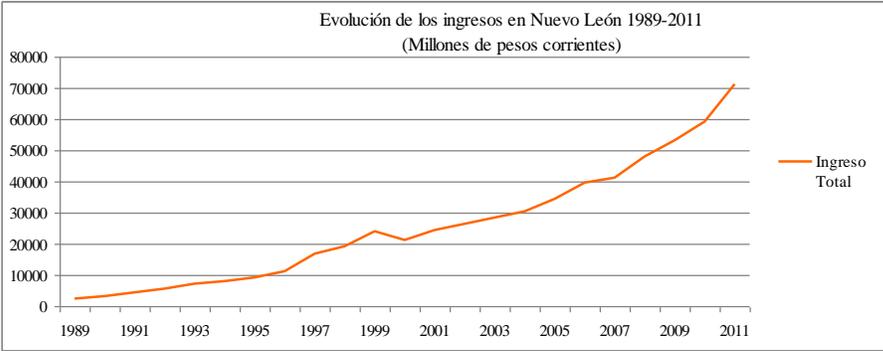


Figure 2: Total income of Nuevo León- INEGI 2012

The growth of total expenditures of Nuevo Leon has been consistent with the growth of public debt, the expenditure budget of Nuevo Leon in 2012 consisted of: 39% spending on education, 15 % in cities, 13% in social development, public safety 8%, 7% in public

works, government 6%, 4% on debt service, 4% for health, judiciary 2%, 1% in autonomous organizations, 1% in the judiciary (Gobierno de Nuevo León, 2012).

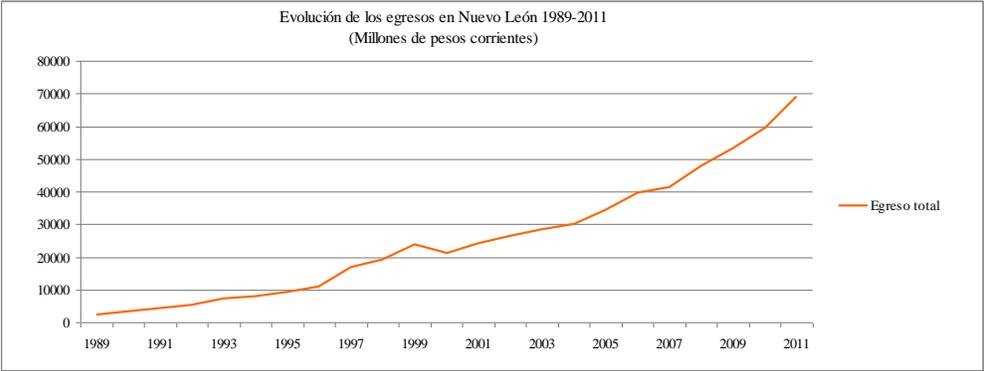


Figure 3: Total expenditure of Nuevo León- INEGI 2012.

The state of Nuevo Leon is listed as one of the states with the greatest capacity to generate income in Mexico, It is estimated that 18% of total revenues relate to taxes and other direct taxes from the federal finances are from Nuevo Leon, a figure which is higher when compared to the national average which is 6%.

Normative framework on public debt

One of the key components in order to explain the operation of the public claims to Nuevo Leon is the normative framework of the state, which is mainly governed by the Constitution of the United Mexican States, which sets the standard for financial prudence should governed public debt of subnational governments in fraction VIII, Article 117, which reads as follows: "States and municipalities may not incur obligations or loans except where intended for productive public investments, including those containing autonomous agencies and public companies, according to the foundation established by the legislature in a law and concepts and up to the amounts that they set annually in the respective budgets. " (Reformed as April 12, 1981). These guidelines law seeks to establish basic rules for handling loans. However, do not establish clear penalties to the breach of the law. State constitutions specify in some cases by public debt laws rules governing borrowing.

Research Methodology

The models are constructed with explicit assumptions and relationships are visible in system modeling. System dynamics combines systems thinking and mental models with the computing power of today (Jackson, 2000; Luna-Reyes and Maxwell, 2003). A

dynamic model is a support tool for understanding social problems and formulating public policy solutions.

Easton considered public policy as a political system in which requests are generated to solve problems in a given environment. The political system is a system in which the demands of citizens are entered, processed, and the result is a public policy that ensures system stability (Easton, 1990).

Public policy seen as a system output produced new demands on their time and may be a new entry to another system or feedback to it. The usefulness of seeing public policy as a system is analyzed as an aggregate to achieve a goal. The interaction between the various stakeholders and the context makes public policy analysis being considered more as an art than a science (Bardach, 2004). System dynamics is a valuable tool that allows data and information to assess the causes of the problem. Following the methodology of Bardach combined with Sterman summarizes the application of system dynamics in public policy methodology for this investigation of public debt analysis of Nuevo Leon.

Public policy (Bardach,2004)	System dynamic (Sterman,2000)	Analysis of public policy with system dynamics
1. Define the problema.	1. Define the dynamic problem	1. Define the dynamic problem.
2. Obtain data and information.	2. Dynamic hypothesis	2. Develop the model of simulation.
	3. Develop the model	
	4. Evaluate the constructed model.	3. Evaluate the model with real data.
3. Develop alternative solution.	5. Make the policy formulation and evaluation.	4. Scenarios of public policy.
4. Selection criteria.		
5. Projection effects or results.		
6. Review of costs and benefits.		
7. Choose a solution.		
8. Tell your story.		5. Develop the proposal of public policy.

Table 1: methodology (Easton, 1990)

Development of the dynamic model of public debt Nuevo Leon

Following the methodology proposed by Sterman, after the definition of the dynamic problem requires establishing a dynamic hypothesis, described below:

The increase of the public debt of Nuevo Leon is reinforced by insufficient financial planning in the destination of current expenditure.

A system is a set of components that interact to achieve a common goal; the system dynamics modeling allows representations of complex problems. The purpose of system dynamics is to obtain a better understanding of certain behaviors and thereby to develop strategies and policies to improve system performance over time (Kopainsky, Luna-Reyes). To evaluate the dynamic hypothesis proposed in this research, the structure of the subsystems is structured for: total income, total expenses and normative that are within the public finance system in Nuevo Leon.

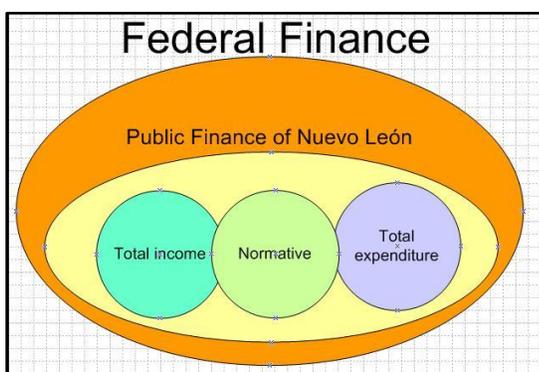


Figure 4: components of the model public debt Nuevo Leon

Among debt dynamics in the state of Nuevo Leon, was identified a supra-system: *Federal Finance*, which held public policy of the federal government in the matter of fiscal policy, income distribution, the rules for spending tagged resources and public policy guidelines for the management of federal taxes.

Public Finance of Nuevo Leon: in this system the expenditures occur under spending budget and to develop financial planning studies for government agencies and public account reports. The three interacting subsystems is total income, total expenses and normative.

Total Income: in this subsystem the compliance with the obligations of the fiscal coordination law, takes control of the funds raised by federal grants, own income, taxes and contributions of the habitants.

The second subsystem is the *total expenses*, the resources that governments dispense to cover the costs that arise in the performance of its functions and programs. Under the

terms set by their respective spending budget and other laws on the subject, the data is integrated in the amount of labor, materials and supplies: general services, subsidies, transfers and subsidies; acquisition of movable and immovable property; public works and social activities, financial investment, resources transferred to federal and municipal third parties and public debt payments.

The third subsystem is the *normative*: containing the elements governing the use of public resources in the state, the way that new loans are authorized according to the legislature established in the state of Nuevo Leon.

Causal Diagram-indebtedness of Nuevo Leon

The representation of the variables in a causal scheme symbolize the increasing or decreasing effect having one variable over another, R cycles between variables indicate that there is an exponential growth, B cycles are which balance the system.

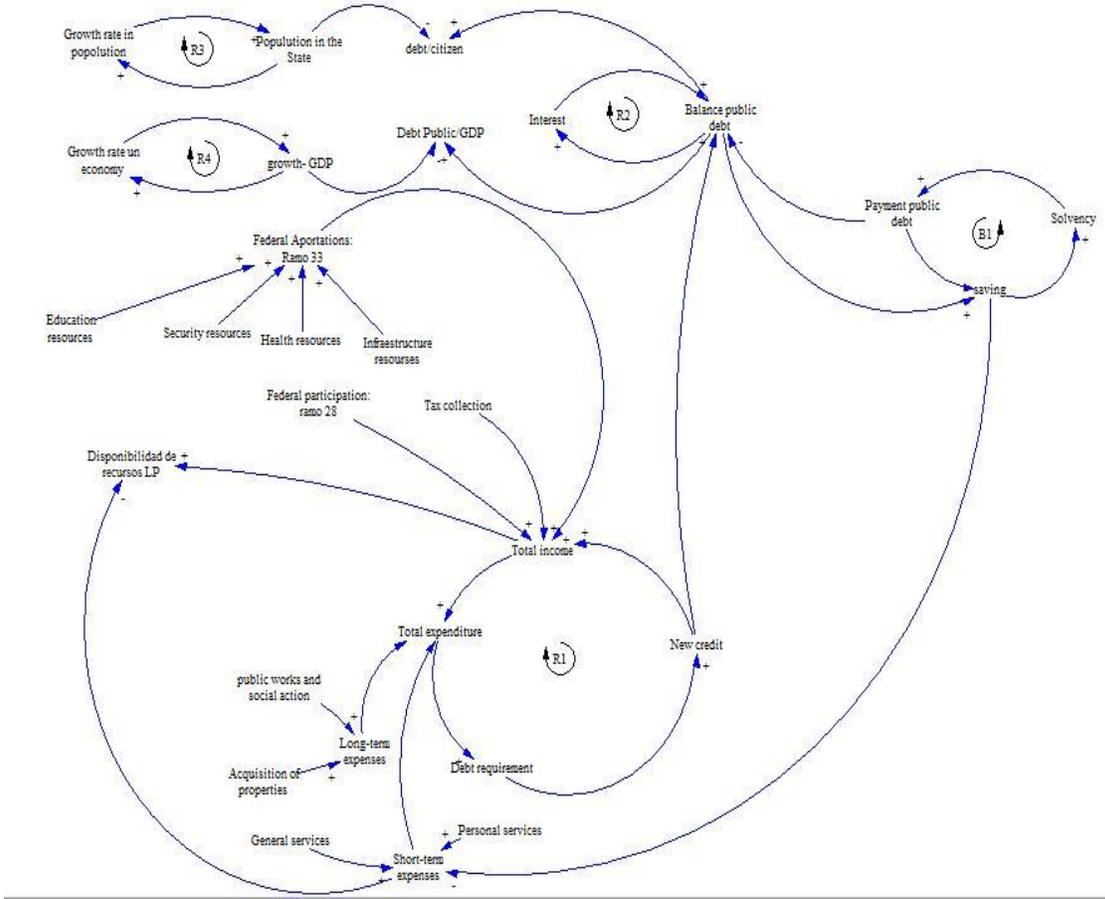


Figure 5: Causal diagram of the model public debt Nuevo Leon

R1- credit increase: the interaction of the variables that make up this cycle shows the effect that has increased the fiscal deficit in the application of new loans by the state of Nuevo Leon. The revenues, federal transfers and contributions generate the total income the deficit increases to incur further expenditure. Referring to state government accounts where it makes a balance in resources required annual spending by planning, the resources are listed in revenues and resources for new loans contracted by government performance and public debt.

B1- debt payment: the amount of available resources after the fiscal year is considered as savings by the government, so that the related variables represent growth. The fiscal deficit increases public debt, having a cumulative growing public debt, interest and payments do not go up as long as a new payment amount is negotiated.

R2- growing interest: the accumulated debt grows as new loans are contracted; the public accounts continue to record deficits, growing the amount of debt generates an effect on the accumulation of debt.

B2- Credit Balancer: Payments to debt repayments are considered in lowering the amount of debt accumulated.

R3- Population Snowball: represents the effect of the percentage of population growth in the state annually. It connects to the debt per capita indicator, the total public debt as credit history in the state of Nuevo Leon.

R4- Snowball GDP: represents the effect of the growth rate percentage of gross state domestic product growth variable and is connected with the variable of public debt as a percentage of GDP. Overall, the feedback loops allow the effects illustrate the causes of indebtedness of the state of Nuevo Leon. A low fundraising, high expenditures generate a deficit that needs to be offset by hiring new loans, part of the debt is paid annually but these resources are part of the expenses, which continues to generate growth in public debt accumulated.

Block Diagram the representation of the model

Through dynamic simulation software –iThink- a block diagram is built based on the relationships of variables set in the causal diagram, in the representation of the dynamic model are captured the values of variables from the model assumptions for simulations.

The debt level variables, financial balance, the state population and economic growth are represented as a stock whose role is to symbolize the accumulation of some state variable as shown in the following notation:

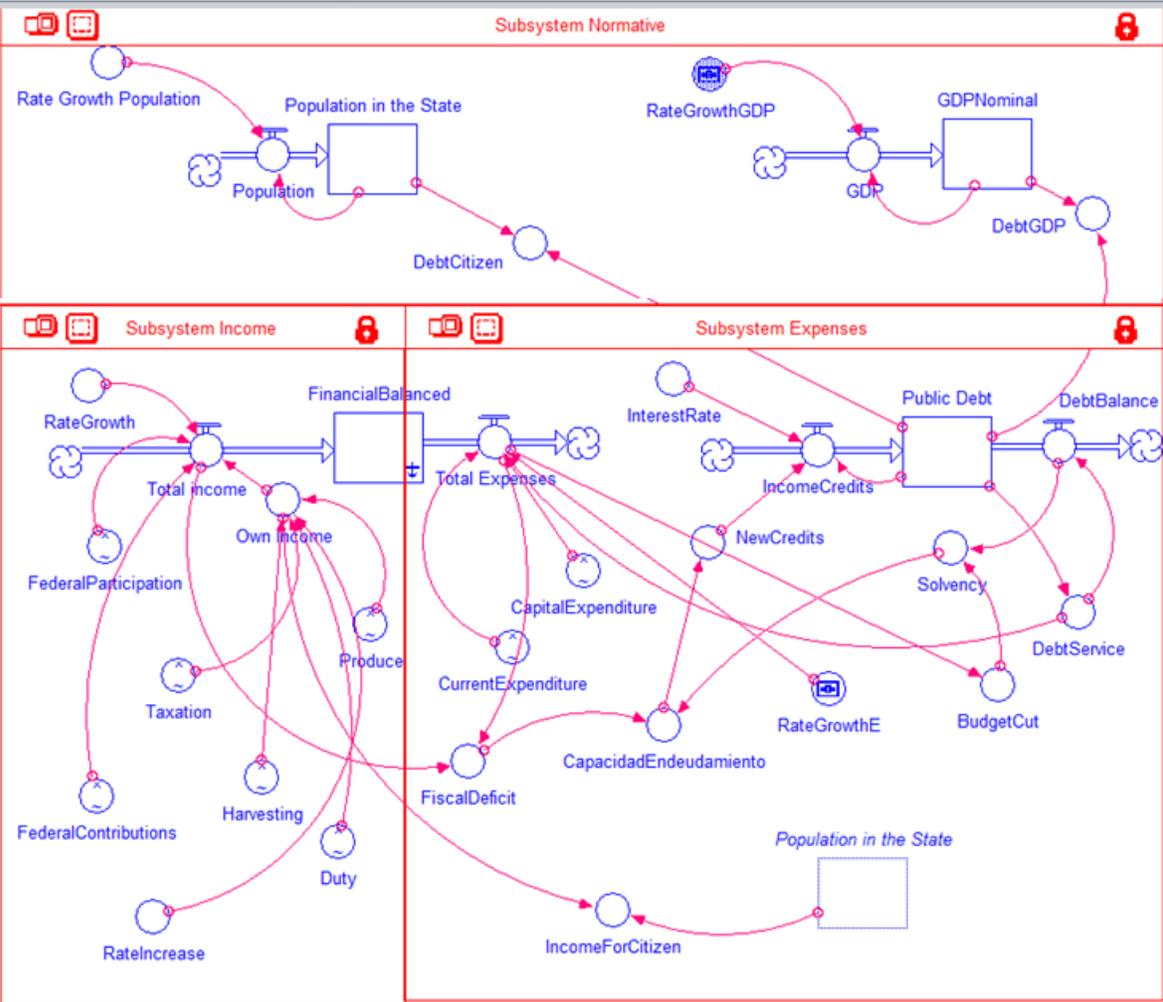


Figure 6: Representation of the model public debt Nuevo Leon in software iThink.

Model Assumptions:

The model assumptions enable us to establish the dynamic model behavior that, related with the variables in a systemic fashion, allow us to replicate the functioning of the analyzed system. To Michael Parking, the assumptions constitute the foundations on which the model is built. They are proposals about what is important and what can be ignored.

In the construction of the dynamic model proposed in this research, the subsystems previously discussed are considered in elements like: the structure of the public finances in

Mexico, the resource distribution that is established by the Fiscal Coordination Law (Ley de Coordinación Fiscal), and the statistics about the public expenses in the Government of Nuevo León.

The values of the variables that integrate the system are obtained from the National System of Public Finance from the States and Cities of the INEGI, and the Ministry of Finance and Public Credit (Secretaría de Hacienda y Crédito Público 'SHCP'), with data series from 1998 to 2012. In the variables of own income, federal transfers, federal participation, current expenditure, and capital expenditure, the data series are generated towards 2036. The public debt value is the balance calculated to date and the behavior of this variable will be depending on the interaction of all the variables in the dynamic of the systems. The base assumptions are:

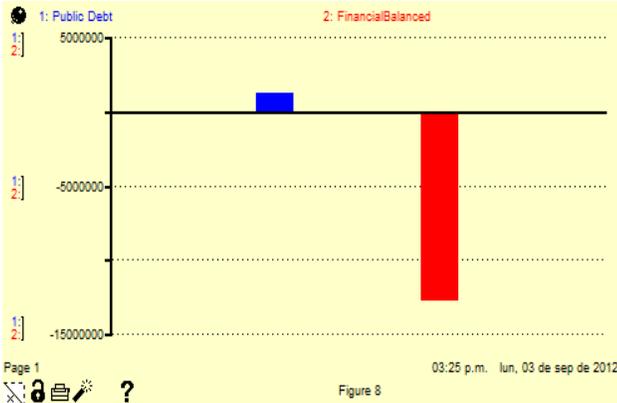
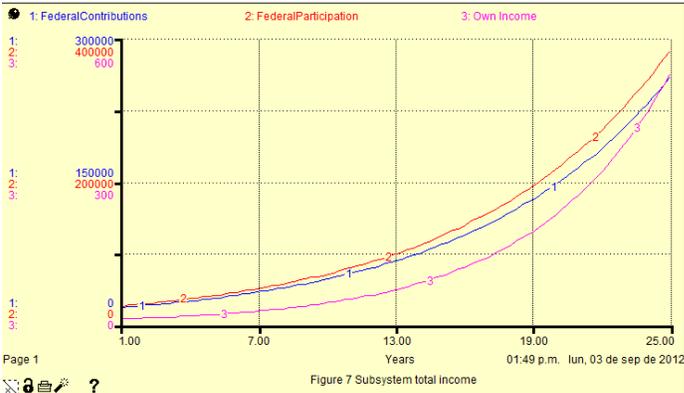
- The federal participation will have a growth of 12% yearly.
- The federal contributions will grow to a 12% annual.
- The own incomes will have a growth of 12% yearly.
- The low term expenditure will grow 14% yearly.
- The long term expenditures will grow 30% yearly.
- According to INEGI, the total population of Nuevo León is 4,653,458 of people with a growth rate of 1.9% yearly.
- The public debt accumulated in 2012 for Nuevo Leon is 37, 487.9 millions of pesos, according to the SHCP.
- The Gross Domestic Product of Nuevo León is one trillion of pesos to 2012, future plan made with INEGI information.
- The economic growth of Nuevo León will be 3% yearly.

Model Behavior

After consulting the dynamic system in the simulator, according to the represented problem, the equations of the described models in the first annex of this investigation are introduced. It is concluded that the model includes the elemental variables to realize the simulations with the projected series under the model assumptions.

Subsystem: total income: this subsystem is formed by the exogenous variables: federal participation and federal transfer; and the endogenous variables: own income composed by the rights, profits, products and taxes. All the yearly values are concentrated in the income flow. It has an exponential behavior, in which the positive growth of these variables

is reflected. The figure 7 exposes the behavior of the federal participation, federal contributions, and the own income during the period of 2012-2036, the figure 8 represents the comportment of public debt and financial balanced.

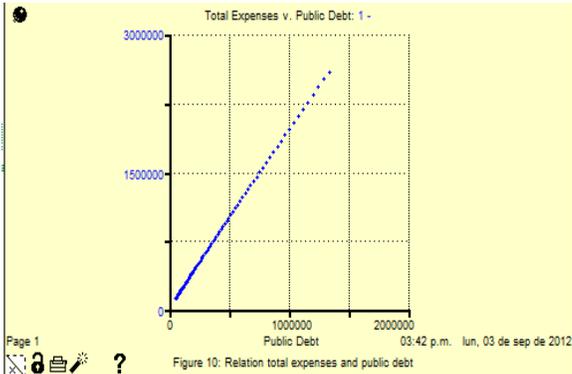
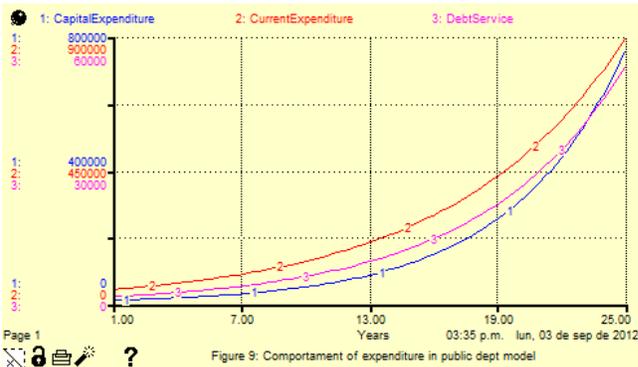


Within the subsystem of total income, the behavior of the federal contributions represents the 46% of the total income, according to the budget of 2012.

Subsystem: total expenditure

The subsystem of total expenditure includes the values of the amounts destined to the current expenditure, capital expenditure and the debt service that represents the yearly payment of the public debt. This is according to information obtained from the previously described assumptions about basic data from the public account of Nuevo León.

The dynamic of the new credits is determined by a variable of fiscal deficit that interacts with the flow variable and the cost cutting, which represents the internal savings, and it allows knowing if there is the possibility of public indebtedness to obtain new credits.

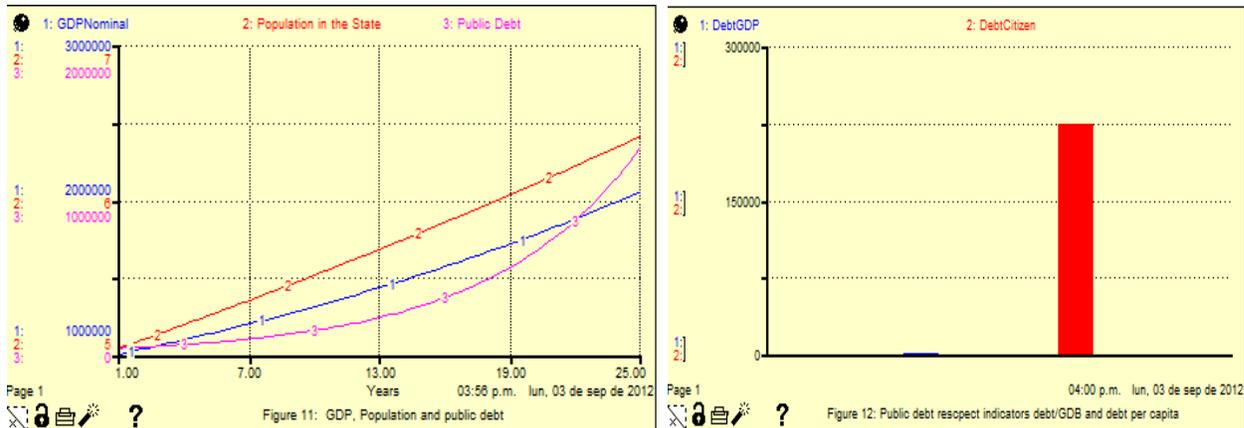


The debt payment is realized by deducting from the accumulated debt, in the public debt flow. The payment value is added to the total expenditure in the level variable. The addition of all these variables and their interactions form the subsystem 2. As it is appreciated on the figure 9, the total expenditure is feed in a dynamic fashion by the expenditures of the

current expenditure, capital expenditure and the debt service. The relation in total expenses and the total of public debt are represented in the figure 10.

Subsystem: Normative

This subsystem includes the public debt indicators regarding the state Gross Domestic Product (GDP debt), the public debt regarding the number of inhabitants in the state of Nuevo León (debt per capita) that are built based on the subsystems behavior (total income and total expenditure). Based on the current situation of 2012 and the dynamic model behavior, the debt per capita indicator will allow visualizing the impact of the public debt in future generations.



The figure 11 represents the level: public debt, economic growth and estate population, after executing the dynamic simulation of the model, the variables of economic growth and State population behave with a lineal growth according to the established assumptions and the public debt has an increasing and decreasing behavior. The dynamic of these flows will allow generating the scenario of public policy, in the case of the indicator public debt respect to GDP the growth is stable, and the indicator public debt per capita the growth is variable (figure 12).

Calibration and model characterization

In this section, the model testing realized according the methodology proposed by Sterman (Sterman, 2000), have the objective of validate the model behavior according to established parameters to represent the dynamic of the public debt.

Pertinence of the model border

This proof determines if the concepts and important variables for the purposes of the model are endogenous, if they are controlled internally. With the objective of clarifying the border limits, it is pertinent to use the definition of subsystem, system, and supra-system.

Also, a dynamic hypothesis is formulated to establish the possible effects derived from implementing the policies in the model. In addition, the variable processes and exogenous cycles that could affect the model behavior are identified.

Experiment results: Within the construction process of the dynamic model of the public finances of Nuevo León, the borderline was defined. Within these boundaries the addressed problem is developed. In this way, three subsystems were identified (total expenditure, total income and normative), as well as the State System of Public Finance of Nuevo Leon (Sistema Estatal de Finanzas Públicas de Nuevo León) and the supra-system of SHCP, not understood like a government institution but as a hierarchic superior jurisdictional space, which contains the State System of Public Finance of Nuevo Leon.

Structure assessment

In this model test we were looking to validate the model structure and that the variable behavior was attached to the real system representation. The experiment results are that, even the model was built based on a simplification process of the reality, the experiment takes in consideration the main elements that influence the dynamic of the public finances of the State. The model is consistent with the fiscal laws, having in consideration that the obtained values are consistent. In addition, it simulates a theoretical problem.

Dimensional Consistency

This proof determines the coherence of the units of measure in the used variables in the dynamic model. It allows identifying that the operation results are in real terms. Applying the dimensional consistency in the proposed model, the units of measure were configured for the monetary values in millions of Mexican Pesos (MPX) yearly. In case of the population variable, the unit of measure is inhabitants per year.

Parameter Assessment

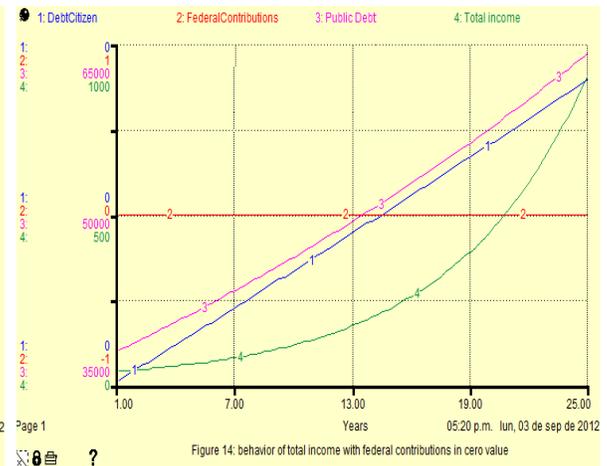
Feeding with real data the simulation model represents a very complex duty, given the conditions in which the public finance behaves. The proof consists in determining the parameters that are going to be used in different system variables. The idea is that those

parameters have to be consistent with the reality in which the problem operates and the identified system.

Proof result: A series of data, given by the State System of Public Finance of Nuevo Leon from INEGI, with public account history of Nuevo Leon, were employed. Also, we used some studies published by Risk qualifiers, who used themselves information from each variable based on the public statistics of states that presents the SHCP of Nuevo León. In consequence, it is not necessary to use numerical methods to determine the parameters.

Model proofs in extreme conditions

This model test consists in manipulate and designate the values that can take one or more exogenous variables from the model in an extreme way, allowing to validate the robustness and evaluate the coherence regarding the reality. In this dynamic model, it was decided to affect the value of the *federal contributions* inputs that, as it can be appreciated in the figure 13 has an increasing behavior.



Modifying the value of the federal input in all periods to a value of zero, the next results are obtained in the test: the complete system behavior that represents the dynamic model of the public debt, due to the fact that the modified variable is the biggest monetary exogenous entrance (income) in the system. This is portrayed on the on the image 14, which shows a significant increase on the low availability of resources. The model behavior was completely modified, which shows the variable importance with federal input for the system integrity.

Sensibility analysis

The sensibility analysis will allow us to know the variables with greater impact in the dynamic model, the selected variables to make sensibility analysis were the following:

- -Growth rate in federal input.
- -Growth rate in federal participation.
- -Growth rate in current expenditure.
- -Growth rate in capital expenditure.
- -Growth rate in tax collection.

The five variables were selected based on the theoretical framework of this research, as well as the empiric evidence that shows the importance of the variables within the dynamic of the public finance. From all the selected variables, three were endogenous; in consequence the government authorities of Nuevo León are in charge of deciding about their fate. The way in which the Government defines its public policy, in function of those variables, the expenditure control will vary as well as its effect over the deficit and the public debt.

The exogenous variables are controlled by the external environment of the State government. They correspond to a federal government level and to the country macroeconomic conditions: federal transfers, federal input that represents 84% of the total income that is available in Nuevo León. The sensibility experiments of the model were realized under the established assumptions in the dynamic model, a growth of 10%, 15%, 20% and 25% was evaluated on the five selected variables.

Scenarios of public policy

After analyzing the sensibility of the variables, extreme values proof and consistency proofs in the model, the next focus of analysis were determined the quadrants of the scenarios:

-Horizontal (*fiscal federalism competitive*): this focus refers to the way in which the government of the State achieves to earn the resources that come from the federation; the resources are assigned based on policies established by the Mexican Constitution. The government of Nuevo Leon has no authority on the decisions made over the distribution of the resources, which is why it is considered an exogenous focus. Within the dynamic model it is represented in the following variables: federal contributions and federal transfers in the subsystem of total income.

-Vertical (*financial planning of the current expenditure*): considered the current expenditure variable as endogenous because the government of the state has direct decisions over the implemented strategies in its financial planning.

The scenario description is made based on the obtained results after running the model, under the location assumptions of the horizontal and vertical quadrants. The assumptions used to evaluate the dynamic scenarios with values that are showed on the table 2. The scenarios are described quantitatively after realizing model test in the simulator, emphasizing the total public debt accumulated by 2036, the public debt per inhabitant and the solvency indicator (public debt regarding the GDP). The information used to run the model varies depending the position of the quadrant desired to evaluate. The results will allow us to analyze with tools the dynamic model of the possible futures in the public debt behavior of Nuevo León.

Scenario of public policy	Current expense	Federal participations	Federal contributions	Economic growth
Bigger planning with resources insufficiency.	-20%	-10%	-20%	3%
Successuf public policy	-60%	10%	20%	5%
Chaos in the public finance of the state	60%	-10%	-20%	1%
Tendency planning with more resources	20%	10%	20%	3%

Table 2: description of scenarios.

Scenario: bigger planning with resources insufficiency

In 2036, the public debt of Nuevo León has an accumulated \$578,974 million pesos, a debt per inhabitant of \$97,677 pesos, which represents 28% of the Gross Domestic Product. In average, from 2012 to 2036, the current expenditure from the Government increased 20%, the federal participation decreased 10%, due to the development of a variety of industries on the State, which also helped to an average economic growth of 3%. The finance strategic planning has played an important role during this time and it has been possible to expend best, but some regulations are still required for public debt and current expenditure.

Bigger planning with resources insufficiency		
Public Debt		
(millions of pesos)	2012	37,937.90
	2019	56,932.86
	2036	578,934.46
Public Debt per Capita		
(pesos)	2012	8,356.37
	2019	11,612.14
	2036	97,966.40
GDP respect the Public Debt		
	2012	0.04
	2019	0.05
	2036	0.28

Scenario: successful public policy

In 2036, the public debt of Nuevo Leon has an accumulated \$289,197.28 million pesos, a debt per inhabitant of \$48,937 pesos, which represents 9% of the Gross Domestic Product. In average, from 2012 to 2036, the current expenditure decreased 60%, the federal participation grew 10%, the federal participation increased too but only 20%, due to the industrial development on the state.

The economic growth of Nuevo Leon had an average growth of 5%. The financial strategic planning has played an important role during this time and it has been possible to expend best but there are some regulations that are still required for the public debt.

Successful public policy			
Public Debt			
(millones de pesos)	2012	37,937.90	
	2019	38,472.63	
	2036	289,197.28	
Public Debt per Capita			
(pesos)	2012	8,356.37	
	2019	7,846.96	
	2036	48,937.52	
GDP respect the Public Debt			
	2012	0.04	
	2019	0.03	
	2036	0.09	

Chaos in the public finance of the state			
Public Debt			
(millones de pesos)	2012	37,937.90	
	2019	98,546.08	
	2036	1,127,528.02	
Public Debt per Capita			
(pesos)	2012	8,356.37	
	2019	20,099.66	
	2036	190,798.57	
GDP respect the Public Debt			
	2012	0.04	
	2019	0.08	
	2036	0.89	

Scenario: chaos in the public finance of the state

In 2036, the public debt of Nuevo León has an accumulated \$1,127,528 million pesos, a debt per inhabitant of \$190,798 pesos, which represents 89% of the Gross Domestic Product. In average, from 2012 to 2036, the government current expenditure increased 60%, the federal participation decreased 10%, and the federal input also decreased 20%. Nevertheless, the economic growth of Nuevo Leon maintained an average growth of 60%.

Scenario: tendency planning with more resources

In 2036, the public debt of Nuevo Leon has an accumulated \$690,001 million pesos, a debt per inhabitant of \$116,761 pesos, which represents 34% of the Gross Domestic Product. In average from 2012 to 2036, the current expenditure increased 20%. The government current expenditure increased 20%, the federal participation grew 19% and also the federal participation increased 20%.

Due to the industrial development of Nuevo Leon, the economic growth of the estate maintained an increasing average of 3%. The financial strategic planning has played an important role during this time. It has been possible to expend best but there are some regulations that are still required for the public debt and the expenses made with the demanded resources.

Tendency planning with more resources		
Public Debt		
(millones de pesos)	2012	37,937.90
	2019	64,672.54
	2036	690,001.99
Public Debt per Capita		
(pesos)	2012	8,356.37
	2019	13,190.74
	2036	116,761.08
GDP respect the Public Debt		
	2012	0.04
	2019	0.05
	2036	0.34

Implications of public policy

Bardach defines the analysis of public policy as the way how we use the knowledge in other sciences to resolve fairly and efficiently concrete problems of public policy. Based on public policy definitions, the following are considered as the most relevant for this research:

“It is the norm or the group of norms that exist about a determined problem as well as the group of programs and objectives that a government has in a concrete field” (INAP, 1989).

“Government decisions that incorporate the opinion, participation, co-responsibility and money of the citizens, the electors and the contributors” (Aguilar, 1993).

“It is the group of objectives, decisions and actions that a government carries out to solve the problems that, in a determined moment, the citizens and the government itself consider a priority” (Bañon, Castillo, 1997)

Based on these definitions, *the public policies are conceptualized as the actions, programs, plans and strategies that a government realizes to solve and commit in a determined problem.*

Bardach points out that the on the eight steps road of the public policy analysis the sequence may vary, and not every step is necessary for a particular situation.

However, most of the time, the problem definition is the best point of departure and the argumentation of a proposal is almost always the ending. For this research, the next steps were followed for the construction of public policy proposals.

1. Problem definition

The public debt of Nuevo León has growth exponentially in the last two six-year Presidential terms of Mexico. To March 2012, the debt balance is \$37,578.4 million pesos. Half of the budget is given to public security and it is the equivalent to the public debt service in the 2012 budget.

Regarding the public debt per inhabitant, it is equivalent to 8,400 pesos. Considering that the legislation of the State of Nuevo León currently does not have in its regulation a clear text regarding the destination of the debts, and that the amount of the debt can be so big that it might risk that financial viability of the future generations, the public debt problem is considered as a relevant topic. According to information from the SHCP, the indebtedness of the Mexican states from 2000 to 2011 has increased 3.5 times, passing from 90.753 million to 315,018 million pesos. In real terms, that growth has reached a level of 97.7% (ASF, 2011).

2. Development of a simulation model

The dynamic simulation model that represents the public debt system is developed based on the normative system of the public finance of Nuevo Leon. The main elements, the cycles and the assumptions that conform the model are described. The data used to know the public finance current situation of Nuevo Leon was obtained from the given statistics from the SHCP in its web site.

3. Model evaluation with real data.

The public debt analysis was made towards 2036, which is why it was necessary to generate projects from the variables that interact with the model, based on the variables' behavior analysis in the period of 1998-2012.

4. Exploration of the public policy scenarios

The description of the dynamic scenarios depends on the indebtedness model of Nuevo León, proposed in this research. The percentages are an average of the variation in the variables from 2012 to 2036 under the described assumptions. The strategic variables are determined based on the consulted bibliography and the sensibility proofs realized in the model. The reduction of the current expenditure proposed on the scenarios depends on the public debt payment, high salaries of the public servants and the deviation of resources throughout the requirement of new public credits, assuming that within the current expenditure the municipal subsidies and transfers are also counted.

5. Public Policy Proposals

- I. Evaluate the public debt in the context of capacities of expenses destined to its payment, competitiveness of the tax collection and the percentage of public debt destined to the growth of the current expenditure on the budget.
- II. Establish the viable indebtedness limits from a state, regarding the own income, the state productivity and the saving capacity.
- III. Support the management of the public debt in systems and information technology that allow consulting the requirement and distribution of the public resources, to realize scenario analysis and improve the budget informs quality.
- IV. Reinforce the General Law of Public Debt in the state of Nuevo León, following the World Bank suggestions to optimize the sub national public debt handling, which includes: legislation of the indebtedness limit, establish the punishments for surpassing the limits and implementing transparent mechanisms for the public bankruptcy.
- V. Generate communication channels so the public debt information is not only understood by experts on the topic.
- VI. Enforce the use of studies on the state public finance in the government yearly and create an independent committee with authority to point out the non-fulfillment of the law and sanction the wrong use of the public resources in the corresponding institutions.
- VII. Train the public servants in topics of long term planning of public finance.
- VIII. Standardize and verify the quality of the published statistics on the government websites, throughout an independent commission that regulates and sanctions the unproven information.

Conclusions

The system dynamic model, developed in this research to represent the public debt behavior, allowed evaluate from quantitative indicators the future of the public debt in different scenarios of public policy with the objective of generate points of action.

It was determined that, regarding the total of hired financial obligations until March 2012, Nuevo Leon represents the third Mexican State with the biggest public debt, by making the comparison of the percentage of the Gross Domestic Product regarding the public debt, Nuevo Leon stands on the tenth place. This variable (public debt/GDP) allows to evaluating the long term sustainability of the public debt in Nuevo Leon.

Sensibility proofs were realized to the variables of the dynamic model and the variables effect was quantified: federal contributions, federal transfers, capital expenditure, current expenditure and tax collection. The current expenditure variable was the most significant in the accumulated public debt total.

The public finance in Mexico represents the great challenge that can change the destiny of the country. More studies are required in order to analyze the different problems under new perspectives and innovative tools, like the systemic modeling focus and simulations oriented to the formulation of public policy proposals. The dynamic modeling of systems allowed conceptualizing the indebtedness problem of the state regarding the causes that originate the problem growth.

The dynamic hypothesis was evaluated in relation to the variables that intervene directly or indirectly, which achieved to build dynamic scenarios that allow to visualize the possible futures under the established assumptions.

The public policy guidelines that are described in the research will allow to make more efficient the expense of the public resources in benefit of the citizens and the future generations of Nuevo León. The transparency plays an important role in the process of achieving a successful public policy scenario, where it is possible to reduce the public debt per inhabitant and increase the solvency lever regarding the GDP.

Based on the realized simulations on the proposed dynamic model, it is concluded that a tax increase does not have a significant effect on the public debt reduction, considering that a greater income on own resources would reduce the hiring of new credits.

In this sense, the variables with greater impact on the reduction of public debt are the effective handling of the current expenditure and the federal inputs. The state government only has faculties to control a current expenditure with a greater financial planning and using the resources with efficiency and more transparency.

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Appendix A: List of Equations and Documentation

$$\text{FinancialBalanced}(t) = \text{FinancialBalanced}(t - dt) + (\text{Total_income} - \text{Total_Expenses}) * dt$$

INIT FinancialBalanced = 0

INFLOWS:

Total_income = FederalContributions+FederalParticipation+Own_Income*RateGrowth

OUTFLOWS:

Total_Expenses = (CurrentExpenditure*RateGrowthE)+(CapitalExpenditure*1)+DebtService

GDPNominal(t) = GDPNominal(t - dt) + (GDP) * dt

INIT GDPNominal = 1000000

INFLOWS:

GDP = GDPNominal*RateGrowthGDP

Population_in_the_State(t) = Population_in_the_State(t - dt) + (Population) * dt

INIT Population_in_the_State = 4.54

INFLOWS:

Population = Population_in_the_State*Rate_Growth_Population

Public_Debt(t) = Public_Debt(t - dt) + (IncomeCredits - DebtBalance) * dt

INIT Public_Debt = 37937.9

INFLOWS:

IncomeCredits = (Public_Debt*InterestRate)+NewCredits

OUTFLOWS:

DebtBalance = DebtService

BudgetCut = Total_Expenses*.01

CapacidadEndeudamiento = IF FiscalDeficit< 0 AND Solvency>0 THEN FiscalDeficit*(-.1) ELSE 0

DebtCitizen = (Public_Debt/Population_in_the_State)*.000001

DebtGDP = (Public_Debt/GDPNominal)*.0000001

DebtService = Public_Debt* 0.02

FiscalDeficit = Total_income-Total_Expenses

IncomeForCitizen = Own_Income/Population_in_the_State

InterestRate = .042

NewCredits = CapacidadEndeudamiento

Own_Income = (Harvesting+Duty+(Taxation*RateIncrease)+Produce)

RateGrowth = 1

RateGrowthE = 10

RateGrowthGDP = .03

RateIncrease = 1

Rate_Growth_Population = .019

Solvency = DebtBalance/BudgetCut

CapitalExpenditure = GRAPH(TIME)

(1.00, 9507), (2.00, 11409), (3.00, 13690), (4.00, 16428), (5.00, 19714), (6.00, 23657), (7.00, 28388), (8.00, 34066), (9.00, 40879), (10.0, 49055), (11.0, 58866), (12.0, 70639), (13.0, 84767),

(14.0, 101720), (15.0, 122064), (16.0, 146477), (17.0, 175773), (18.0, 210927), (19.0, 253113), (20.0, 303735), (21.0, 364482), (22.0, 437379), (23.0, 524854), (24.0, 629825), (25.0, 755790)

CurrentExpenditure = GRAPH(TIME)

(1.00, 47605), (2.00, 53793), (3.00, 60786), (4.00, 68689), (5.00, 77618), (6.00, 87708), (7.00, 99110), (8.00, 111995), (9.00, 126554), (10.0, 143006), (11.0, 161597), (12.0, 182605), (13.0, 206343), (14.0, 233168), (15.0, 263480), (16.0, 297732), (17.0, 336437), (18.0, 380174), (19.0, 429596), (20.0, 485444), (21.0, 548552), (22.0, 619863), (23.0, 700446), (24.0, 791504), (25.0, 894399)

Duty = GRAPH(TIME)

(1.00, 2.68), (2.00, 3.16), (3.00, 3.73), (4.00, 4.40), (5.00, 5.19), (6.00, 6.13), (7.00, 7.23), (8.00, 8.53), (9.00, 10.1), (10.0, 11.9), (11.0, 14.0), (12.0, 16.5), (13.0, 19.5), (14.0, 23.0), (15.0, 27.2), (16.0, 32.1), (17.0, 37.8), (18.0, 44.7), (19.0, 52.7), (20.0, 62.2), (21.0, 73.4), (22.0, 86.6), (23.0, 102), (24.0, 121), (25.0, 142)

FederalContributions = GRAPH(TIME)

(1.00, 17.1), (2.00, 19.1), (3.00, 21.4), (4.00, 24.0), (5.00, 26.8), (6.00, 30.1), (7.00, 33.7), (8.00, 37.7), (9.00, 42.2), (10.0, 47.3), (11.0, 53.0), (12.0, 59.4), (13.0, 66.5), (14.0, 74.4), (15.0, 83.4), (16.0, 93.4), (17.0, 105), (18.0, 117), (19.0, 131), (20.0, 147), (21.0, 165), (22.0, 184), (23.0, 206), (24.0, 231), (25.0, 259)

FederalParticipation = GRAPH(TIME)

(1.00, 25.2), (2.00, 28.2), (3.00, 31.6), (4.00, 35.4), (5.00, 39.7), (6.00, 44.4), (7.00, 49.7), (8.00, 55.7), (9.00, 62.4), (10.0, 69.9), (11.0, 78.3), (12.0, 87.7), (13.0, 98.2), (14.0, 110), (15.0, 123), (16.0, 138), (17.0, 155), (18.0, 173), (19.0, 194), (20.0, 217), (21.0, 243), (22.0, 272), (23.0, 305), (24.0, 342), (25.0, 383)

Harvesting = GRAPH(TIME)

(1.00, 1.68), (2.00, 1.99), (3.00, 2.34), (4.00, 2.77), (5.00, 3.26), (6.00, 3.85), (7.00, 4.54), (8.00, 5.36), (9.00, 6.33), (10.0, 7.47), (11.0, 8.81), (12.0, 10.4), (13.0, 12.3), (14.0, 14.5), (15.0, 17.1), (16.0, 20.2), (17.0, 23.8), (18.0, 28.1), (19.0, 33.1), (20.0, 39.1), (21.0, 46.1), (22.0, 54.4), (23.0, 64.2), (24.0, 75.8), (25.0, 89.4)

Produce = GRAPH(TIME)

(1.00, 0.17), (2.00, 0.174), (3.00, 0.177), (4.00, 0.181), (5.00, 0.184), (6.00, 0.188), (7.00, 0.192), (8.00, 0.195), (9.00, 0.199), (10.0, 0.203), (11.0, 0.207), (12.0, 0.212), (13.0, 0.216), (14.0, 0.22), (15.0, 0.225), (16.0, 0.229), (17.0, 0.234), (18.0, 0.238), (19.0, 0.243), (20.0, 0.248), (21.0, 0.253), (22.0, 0.258), (23.0, 0.263), (24.0, 0.268), (25.0, 0.274)

Taxation = GRAPH(TIME)

(1.00, 5.52), (2.00, 6.51), (3.00, 7.68), (4.00, 9.07), (5.00, 10.7), (6.00, 12.6), (7.00, 14.9), (8.00, 17.6), (9.00, 20.7), (10.0, 24.5), (11.0, 28.9), (12.0, 34.1), (13.0, 40.2), (14.0, 47.4), (15.0, 56.0), (16.0, 66.1), (17.0, 78.0), (18.0, 92.0), (19.0, 109), (20.0, 128), (21.0, 151), (22.0, 178), (23.0, 210), (24.0, 248), (25.0, 293)

