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In Number 16 th is presented Mexico: Economic Performance of Local Economies. 2003-2013 by DÁVILA Alejandro & VALDÉS Miriam with adscription *Universidad Autonoma de Coahuila*, next article The importance of Social Networks in the savings decision of Mexican households: An agent-based model by AGUILAR-LUGO Jessica, QUINTERO-ROJAS Coralia and VIIANTO Lari, next article Multimedia animations of stories and legends of the Huasteca Culture by JIMÉNEZ-MALDONADO, Rosa María, HERNÁNDEZ-LÓPEZ, Dalia Rosario, PIEDAD-RUBIO, Ana María and ECHEVERRIA-MORALES, Karla Guadalupe, next article Economic Competitiveness: A Principal-Components Analysis for Latin America and Europe in a Comparative Perspective by MORENO-PLASCENCIA, Jorge Raúl & VÁZQUEZ-OLARRA, Glafira with adscription *Universidad Politécnica de Pénjamo*.

Content

Article **ECORFAN Journal-Mexico**
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Mexico: Economic Performance of Local Economies. 2003-2013

DÁVILA, Alejandro†* & VALDÉS, Miriam

Universidad Autonoma de Coahuila.

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Abstract

Siegel et al method (1995) was used to analyse the effects of changes in final demand structure of the Mexican economies, both national and local levels (32 states and 7 regions) on its economic performance. This method combines input output production model with portfolio theory in order to measure the economic performance in terms of expected growth in the gross production value and the stability of it (measured by its standard deviation). Sharpe ratio (1994) was used to assess the feedback between economic growth and stability. The study comprehends a span of time that runs from 2003 until 2013. The paper uses three national input-output tables (IOT), developed by the Mexican agency of statistic upon the SNA-UN (System of National Accounts-United Nations) methodology for 2003 and 2008, and a 2012 IOT made by a RAS actualization of 2008 table. The regionalization of IOT's was done using the FLQ method and the series of state gross domestic product produced by INEGI (Instituto Nacional de Estadística y Geografía). We work with 31 economic activities.
(150-200 words)

Input-output models; regional input-output models; regional economic performance.

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* Correspondence to Author (email: alejandro.davila@uadec.edu.mx)
† Researcher contributing first author.

Introduction

In the mid-eighties of the last century, Mexico undertook qualitative changes in its trade policy, moving rapidly from an internal market heavily protected by quotas and tariffs to a one of the schemes of international exchange of goods, services and capital more open of the world. [1]

During the thirty years following those decisions, gross domestic product (GDP) doubled in real terms and the share of exports in terms of GDP increased from 15.3 to 35.2 percent, while in the case of imports, the same indicator passed from 7.5 to 33.8. Consequently, the coefficient of openness of the Mexican economy, which was 22.8 in 1985, reached 69 percent in 2015. [2]

Throughout those years, the share of oil exports dropped from 68.2 to 6.2 percent, while non-oil exports reached a peak of 93.8 in 2015. Within this latter group, international sales of manufactured goods expanded their participation quota from 72.2 to 95.1 percent, the remainder being agricultural (3.6 percent in 2015) and mining exports (1.3).

In the specific case of manufacturing exports, its value in constant dollars multiplied 31 times, recording an average annual real growth rate of 12.1 percent, 5.2 times higher than that observed by GDP in the same period (2.3).

Perceived changes in the real value of goods exports were characterized by high variability and concentration. Three of the 97 chapters of the Harmonized System of Commodity Description and Coding accumulated 60.5 percent of its real value in 2015: chapter 87, Land vehicles and parts, with 23.7%; chapter 85, Machinery and electrical equipment, 21.3%; chapter 84, Mechanical appliances, boilers and parts, 15.5%.

At a specific level, 11 of the 599 tariff lines of the Harmonized System, 1.8 percent, accounted for 50.6 real value of goods exports in 2015: Automobiles (8.6); Vehicle parts and accessories (6.6); Vehicles for transport of goods (6.6); Crude petroleum (4.9); Machines for data process (4.8); Televisions (4.4).

Telephonic or telegraphic electrical equipment (4.2); Other machinery and electrical equipment (3.1); Insulated electric conductors (3); Other mechanical equipment and parts (2.9) and Tractors (2.3).

The dynamics of the GDP and foreign trade of the Mexican economy reveals substantial changes in the level, composition and the sectoral structure of final demand. In the first case, GDP as the main source of income that supports its absolute level; in the second case, because the dynamism of exports has strengthened the presence of this component of final demand to the relative detriment of other (private and government consumption and gross domestic investment) and finally; because the sectoral structure of exports of goods and services, has also changed significantly.

[1] The Ministry of Economy of the Federal Government reported the existence of 11 Free Trade Agreements with 46 countries, 32 Agreements for the Promotion and Reciprocal Protection of Investments with 33 countries and 9 limited reach agreements within the framework of the Latin American Integration Association. The Ministry notes that; "Mexico is actively involved in multilateral and regional organizations and forums such as the World Trade Organization (WTO), the Asia-Pacific Mechanism (APEC) Economic Cooperation, the Organization for Economic Cooperation and Development (OECD) and ALADI": http://www.gob.mx/se/acciones-y-programas/comercio-exterior-paises-con-tratados-y-acuerdos-firmados-con-mexico, visited on April 28, 2016.

[2] The indicators used in this section are calculated using data from the Bank of Electronic Information of INEGI, consulted on April 28, 2016.

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What have been the impacts of these changes on the performance of the Mexican economy? How have these effects manifested in their spatial and sectoral scope?

The standard model of foreign trade is built on four basic relations: 1. The link between the production possibility frontier and the relative supply curve; 2. Link between relative prices and demand; 3. Relationship between supply and demand, which determines the trade balance in the world economy, and; 4. The effect of trade terms[3] in the welfare of nations (Krugman and Obstfeld, 2001).

This theory postulates that the expansion of international trade produces overall benefits, allowing specialization and access to the benefits of economies of scale. This occurs even when there are absolute differences in productivity and wages, as long as countries specialize in the production and exports of goods and services whose manufacture requires factors that the country has relatively abundant and import goods and service that demand intensive use of relatively scarce factors in its territory (the principle of comparative advantage). However, within nations, international trade tends to produce different effects on income, on the dynamics of sectoral performance (Krugman and Obstfeld 2001) and, consequently, at the regional level.

The spatial and sectoral dimension of transformations linked to changes in trade policy in developing countries, was theorized by Krugman and Livas (1992).

According to their approach, the spatial location of productive factors is the result of a tension between centripetal and centrifugal forces. In the theoretical formulation, the centripetal forces are primarily determined by the interaction between economies of scale, market size and transportation costs, aspects linked with the backward and forward productive linkages. The model identifies the increased costs of urban mobility and the amount of land rent, as the main dispersion forces.

From their perspective, the formation of megacities in these countries is a byproduct of trade protectionism in relatively small domestic markets. Under these conditions, the balance between centripetal and centrifugal forces promotes a strong spatial concentration of productive factors. Trade liberalization and strengthening the external market alter this balance and allow a spatial relocation of economic activities.

The empirical evidence for the case of Mexico is consistent with this theoretical formulation, since trade liberalization led to a relative reallocating of industrial activities, from Mexico City, the megalopolis formed during the protectionist stage, towards twenty metropolitan areas located, all of them, to the north of Mexico City (Dávila, 2011).

Multiple research works has found that this relocation has not been homogeneous in space and sectors, as the growth dynamics has focused on the metalworking, iron and steel, electronics, textile and automotive industries. [4]

[3] It is the quotient resulting from dividing the exports price index over imports.

[4] The interested reader may consult: (Gutiérrez 1994), (Guillermo and Graizbord 1995), (Hiernaux-Nicolás 1995), (Hanson 1997), (Graizbord and Ruiz 1999), (Mendoza and Martínez 1999), (Dávila 2000, 2004, 2005, 2011 and 2015), (Chamboux-Leroux 2001), (Mendoza 2002), (OECD 2003) and (Félix 2005).

The economic rationality of these movements has to do with optimizing transport costs of inputs, goods and services to the external market, which is heavily concentrated in the United States of America (USA). But this movement of manufacturing activities to the north of the country tends to concentrate on a few metropolitan areas: The search for economies of agglomeration, especially scale and location economies, [5] as well as Marshallian externalities,[6] constitute the economic logic of these space relocation patterns.

These trends also suggest structural changes in the final demands of local economies (state and regional level). If this is so: What have been the effects on their economic performance?

Siegel et al. (1995) developed a model that allows to answer this question. The method combines the basic input output model of Leontief (1941) with analysis techniques proposed by Markowitz (1959) to evaluate investment portfolios.

This paper uses this methodology to evaluate the performance of the Mexican economy in three spatial areas: National; mesoregional (seven regions that cover the entire national territory), and for each of the 32 states of Mexico. Within this general framework, the objectives of the article are:

1) Analyze the evolution of final demand for state, mesoregional and national economies during the period 2003 to 2013;

2) Build input-output models for the national economy, as well as for its seven mesoregions and the 32 federal entities of Mexico, for the years 2003 and 2008 and 2012;

3) Use the model of Siegel et al. (1995) to assess, in each geographical area, the impact of the transformations observed in final demand on their respective economic performance. This will be for the period from 2003 to 2013, and;

4) Apply the Sharp ratio (1994) to evaluate, in each case, feedback between economic growth and volatility.

Diversity, diversification and economic performance

Most of regional economic analyzes focus on the magnitude of growth, underestimating or ignoring fluctuations (Brown and Pheasant 1985). However, the relationship between diversity and economic performance is quite old in the literature, reflection on the issue was driven by the catastrophic impact of the Great Depression of the 30s of last century in the US (Dissart 2003; Wagner 2000).

[5] Citing Ohlin (1933) Keilbach (2000) lists three types of agglomeration economies: 1) scale, which directly benefit the companies that generate them; 2) location, forged by the spatial concentration of establishments in the same industry, and 3) urbanization, derived from the size of the local economy.

[6] An externality, positive or negative, is generated when the production or utility function of an economic agent is affected by the action of external economic agents. They are classified in technological (when they are not necessarily transmitted through market mechanisms) and financial (those propagated via the price system). The distribution is imputed to spatial dissemination of knowledge (spatial spillovers of knowledge). Two types of externalities are identified: 1) Jacobs (1969, cited in Keilbach 2000), these result from the variety of products and technologies in a locality 2) Marshall (1920, cited in Keilbach 2000), attributed to the productive specialization of a city in a particular industry. Keilbach (2000) relates them to the localization and urbanization economies: Marshall type Externalities are external to the firm but internal to the industry, which links them with location economies. Meanwhile, urbanization economies may occur in a highly specialized or highly diversified local economy. Thus, although both agglomeration economies and externalities are related to the process of spatial concentration factors, they are different concepts.

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The starting point is a review of the concepts of diversity and diversification, as there is a recurring confusion. As Malizia (1990) observed, many of the indices created as indicators of diversification are actually measures of diversity. With the intention to clarify the meaning of these concepts, Siegel et al. (1995) propose the following definitions: "The noun diversity and the adjective diverse, related to a static and positive concept (state of, difference, variety, inequality). The verb diversify and the noun diversification, concern: 1) the process that makes things more different or varied (positive and dynamic concept) and; 2) the selection of assets (sectors) to minimize the risk (instability in output or employment) (dynamic and normative concept)."

Same authors conducted an extensive review of literature on the subject, identifying eight economic theories that address the topic: Industrial organization, economic base, regional economic cycle, commercial, portfolio, location and regional economy, economic development and the combination of two analysis techniques: portfolio and input-output models, the latter being proposed by the authors. In each case they describe the concept and measure of diversity, associated notions of diversification and economic performance as well as general comments and reviews of each approach (Siegel et al 1995).

Typology of diversity measures

Meanwhile, Wagner (2000) proposed a typology to classify and analyze the measures of economic diversity, grouping them into the following four sets:

Equiproportional measures

The first set is made up of indicators that Wagner called equiproportional.

They are based on the assumption of equal participation for all industries in an economy would achieve an optimal level of diversity. It is a derivative concept of entropy (a measure of disorder based on the second law of thermodynamics). Consequently, a greater concentration of economic activity in a few industries, causes less diversity or greater specialization.

In this set of indicators, the emphasis is on the greater or lesser variety of industries and not in the type of activities (Siegel et al 1995). It is about measures initially used in the industrial organization literature, which provide global indicators of concentration (Stigler 1968, cited in Wagner 2000). The best known are the Ogive, Herfindalh, National Participation and Logarithmic Participation indices. Their formulas are provided in Wagner (2000), and due to its ease of computation and smaller data requirements, have been the most used (Kort 1981, Attaran 1987, Smith and Gibson 1987, Deller and Chicoine 1989, Malizia and Ke 1993 Akpadock 1996; cited in Wagner 2000).

These indicators have been criticized in both terms; theoretical and empirical. There are two criticisms in the first group: 1) The criterion of equiproportionality is arbitrary (Conroy 1974 and 1975, Brown and Pheasant 1985), and; 2) Does not include intersectoral linkages and the number of sectors is usually fixed, so they do not include regional variations (Wagner and Deller 1998).

Empirical objections include: 1) Some regions identified as highly specialized based on these indicators, are relatively stable (Wasylenko and Erickson 1978, cited in Wagner, as the rest of references in this paragraph).

2) policy analysis results show sensitivity to entropy measure used (Kort 1981 Attaran 1987, Smith and Gibson 1987 and Malizia and Ke 1993); 3) the most specialized regions recorded higher growth and small relationship between levels of diversity and employment was observed (Kort 1981 and Attaran 1987); 4) (Smith and Gibson 1987 and Kort 1982) suggest the possibility of additional factors to diversity that influence the stability levels, and; 5) empirical studies on the subject have not been rigorous enough in modeling important economic regions (Malizia and Ke 1993).

Measures based on the type of industries

These measures emphasize the type rather than the variety of industries in an economy. In this set are listed: The percentage share of durable goods in regional exports, location coefficients, shift and share analysis and multi-model replicants technique (MMR).

We anticipate that this set of indicators receive some of the same questions targeted in the previous section for measures of entropy (Kort 1981, Smith and Gibson 1987, and Malizia and Ke 1993, cited in Wagner 2000. See also Wagner and Deller 1998).

In the first case, the stability of the regional economy is associated with their exports demand. Being durable goods sensitive to changes in income, the share of these goods in foreign sales of the region is used as a measure of diversity (Siegel et al 1995).

In the so-called export base theory, regional growth is driven by exports demand. Location coefficients have been used as a technique for estimating regional exports and as a manner to define their specialization patterns. This option has received three objections: 1) The assumptions for estimating exports are very restrictive (the same supply and demand functions at national and regional level).

2) Calculations are sensitive to sectoral disaggregation levels, and; 3) does not include intrasectorial trade and its effects on location quotients (Shaffer 1989, cited in Wagner 2000).

The shift and share analysis is another widely used technique to screen the evolution of regional employment or production. Changes in the studied variable are broken down into three elements; national share, sectoral mix, and residual or competitive element. The second one (the sectoral mix) has been used as a measure of diversity, and is the result of comparing variations of a sector in the reference area (often the country) with respect to those observed in the region of analysis. If the sum of the differences is positive, it is considered that the regional structure is diverse, otherwise, it is taken as an indicator of specialization. This technique has two basic shortcomings: 1) It does not explain the reasons for changes in the variable analyzed, therefore can not be used as a forecast tool, and; 2) the selection of the initial and final years may alter the results.

A fourth approach in this category is the technique of multi-replicants model (MMR), which combines three elements: 1) Analysis of shift-share, as described; 2) the Lorenz curve and 3; the Gini coefficient. Each component has its statistical interpretation and the results show the existence of diversification trends (Akpadock 1996, cited in Wagner 2000). In the previous paragraph the criticisms of MMR were stated, meanwhile the Lorenz curve measures inequality in income or employment distribution with respect to an ideal distribution (proportional), while the Gini coefficient is a scalar associated with the Lorenz curve (Nicholson 1978, cited in Wagner 2000). Therefore, they apply the same criticisms that those directed against entropy measures.

Measures based on portfolio theory

This approach is based on the financial portfolio theory (Markowitz 1959) to analyze regional economic growth. The seminal works are Conroy (1974 and 1975), who scan the regional diversity in a similar way applied for the process of selection of financial assets (which are replaced by economic activity sectors) to integrate an investment portfolio (a structure with sectoral participation in final demand). Considering the returns of individual industries (their expectations of economic growth), the stability and the covariance between net income of the regional portfolio, the model calculates a scalar measure of the portfolio variance (determined by the sectoral structure of final demand), which is used as a measure of economic diversity: A lower variance, the greater diversity of the regional economy and vice versa (Siegel et al 1995).

This approach has received three basic criticisms: 1) The financial portfolios are much more flexible than portfolios integrated by the sectoral share of final demand. The degree of control over them and the response time to change decisions in their integration, is much smaller and slower in the second case (Siegel et al 1995); 2) the expected performance of the industries and the variance covariance matrix are calculated using time series, for which the portfolio variance is dynamic and not static, unlike previous measurements of diversity (Brown and Pheasant 1985); 3) the variance of the regional portfolio is not weighted by interregional flows of intermediate inputs (direct, indirect and induced) (Siegel et al 1995 and Wagner 2000).

Measures using input-output models and indicators

By including intersectoral flows in the analysis of economic diversity, it is achieved a better perception of complexity, structure and performance of regional economies (Siegel et al 1995 and 1998 Wagner and Deller).

In this direction, we have explored two different ways: Wagner and Deller (1998) used the input-output matrix to estimate two diversity indices, which were combined with a third measure regarding the type of industry to build two composite indicators of diversity, one multiplicative and other additive. They analyzed the econometric relation of these indicators with stability indices. The results of their study showed a positive relationship between diversity, stability and economic growth (Dissart 2003).

Two relevant criticisms for this approach are: 1) It is insensitive to industry production levels (Wagner and Deller 1998); 2) It uses overall coefficients constructed from regional and national input-output (a density indicator, which is the ratio of the absolute value of the cells in the Leontief matrix and other regarding linear independence between rows and columns from the same matrix), whereby the sectoral detail of the structural interrelationships of economies is lost and it is unclear how changes in vector representations create changes in matrix interactions (Siegel et al 1995).

The second way (Siegel et al 1995), achieves a structural link between the portfolio theory and input-output model. A scalar, variance of gross production, is used as a measure of economic instability.

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As will be seen later, its computational formula relates the structure of final demand with the Leontief inverse matrix and variance covariance of expected returns in each sector (the latter measured by the average changes in the sectoral final demand throughout the study period). This methodology does not provide a direct measure of diversity, but provides an analytical framework to study "... the relationship between changes in the economic structure and performance, which is the basic purpose of the studies on diversity and economic diversification." Siegel et al (1995).

With this model it is possible to simulate the impact of economic diversification strategies on stability (measured by the variance of production) and economic growth (expected growth of output and/or employment). The most important policies to diversify the economy would be those capable of causing changes in: the level and structure of final demand, or increases of regional participation in the supply of intermediate inputs. Its effects can be analyzed separately or jointly, both globally and at sectoral level. Wundt and Martin (1993) formulated the model of Siegel et al as a constrained optimization problem, which allows assessing regional diversification strategies.

Like in the case of portfolio theory, methods using the variance covariance to assess economic performance are not independent of stability. Therefore, it is not possible to test statistical hypotheses linking diversity with growth and economic stability.

Similarly, this method combines dynamic analysis (for the portfolios variance covariance, which is calculated using time series) with a static (input-output model of fixed coefficients) (Wagner and Deller 1998). According to Dissart (2003), this may cause conceptual and empirical problems.

However, the author points out that these limitations can be solved by improving the generation of information systems, both for time series for the exogenous final demand variables, and for the updates of input-output matrices.

In the Mexico case, we see notable progress in the generation of economic information. This is combined with new and better indirect and hybrid methods for generating regional input-output matrices, as well as new techniques and resources for evaluate its performance (Dávila 2015).

In addition to integrating the concepts of stability, structure and economic growth if the basic model of Leontief is replaced by an expanded model built with social accounting matrices, it is possible to integrate the effects of diversity and diversification over income distribution (Dissart 2003).

In conclusion, of all the methods available to assess the relationship between diversity and economic performance, the one postulated by Siegel et al (1995) is the most suitable for the analysis proposed in this paper.

The method of economic performance analysis and information sources

The process of economic structure diversification of a region is based on the premise that establishes the negative relationship between diversity and volatility. This idea underlies the portfolio investment theory approach in the sense that diversification of financial assets that comprise it, can reduce risk (volatility performance).

In an analogous manner to financial assets, sectors of economic activity can register different evolution dynamics of production and employment over time.

Therefore, as in financial risk diversification strategies, it is possible to think of a transformation process of the economic structure as a way to boost stability (Essletzbichler 2007).

Empirical evidence from studies shows: 1) larger economies are more diverse and stable; 2) there is a direct relationship between diversity and stability, and 3) an inconclusive inverse relationship between diversity and employment growth (Dissart 2003).

The model for assessing economic performance

In Siegel et al (1995) proposal, the level of diversity attained by an economy is measured by calculating the variance of the gross production value and/or regional employment. Using matrix notation, the formula to get the first is:

$$V[\mathbf{x}] = \mathbf{w}\mathbf{R}Cov[\mathbf{F}]\mathbf{R}^T\mathbf{w}^T \quad (1)$$

Where:

$V[\mathbf{x}]$= Variance in the gross production value; $\mathbf{w}$ = Row vector of dimension *1xn* ($0 \leq w_i \leq 1$, $\Sigma w_i = 1$), with the participation of each sector in total final demand; $\mathbf{R}$ = Leontief inverse matrix, dimension *nxn* ; $Cov[\mathbf{F}]$ = Variance covariance matrix of the n sectors final demand, dimension nxn; $\mathbf{R}^T$ = Transpose of matrix $\mathbf{R}$; $\mathbf{w}^T$ = Transpose of vector $\mathbf{w}$.

Alterations in the weighted variance of different sectors in final demand of an economie, are transmitted to the employment or gross production value through regional intersectoral linkages. [7] In turn, regional production expected value, the other component of economic performance, is determined as follows:

$$E[\Delta\mathbf{x}] = \mathbf{R}E\mathbf{f}_{t+1} - \mathbf{R}E\mathbf{f}_t \quad (2)$$

Where: $E[\Delta\mathbf{x}]$ represents the expected growth in the sectoral production from period *t* to period *t+1*; $E[\mathbf{f}]$ represents the expected value vector of exogenous final demand by sector.

The advantage of this method is that it allows modeling, explicitly, economic performance (measured in terms of expected growth and stability) as a function of the economic structure. The interindustrial linkages determine regional input-output coefficients matrix, which, in turn, is the basic element for calculating the Leontief matrix and its inverse (matrix R). This way to incorporate local intermediate flows allows comprehensively analyze the structure and performance of the regional economy (Siegel et al.1995a and 1995b; Wagner 2000).

In this approach, production and/or employment volatility are related to the structural relationships underlying the supply and demand of the economy studied (Siegel et al 1995a), so the impacts of changes in the economic structure on its stability can be identified. When an economy records a diversification associated with the implementation of public policies with that purpose, we would be facing a normative phenomenon. If these variations occur regardless of public policy, it would be a positive process. Two would be the economic policy strategies implemented with the aim of achieving greater structural diversification and improve consequently the performance of an economy: 1) Promote actions to change the level and/or structure of final demand, so that a reduction is achieved in the gross production variance;

[7] It is input-output matrices in type B format, in which only intermediate and final transactions of national, state or regional origin are disaggregated (it depending of the spatial scope of analysis). International and interregional imports, both intermediate goods and final consumption are handled as rows at the bottom of the table and are not included in the computation of the inverse of Leontief matrix. For more details, see: Kronenberg 2011.

By implementing measures to achieve increase regional share in the intermediate inputs supply.

Information sources

In Mexico there are no state and mesoregional input-output tables built with the conventional methodology of the United Nations (UN). Therefore, these tables are to be estimated using national matrices of years 2003, 2008 and 2012 years, all of them prepared by the INEGI. The tables for 2003 and 2008 were built with the methodology of the System of National Accounts of the UN and the 2012 table was built through the RAS method. For the estimation of state and regional tables, it is used the indirect method best evaluated in the literature on the subject; this is the procedure formulated by Flegg et al. (1995 and 1997) [8] . For the construction of these models also we require information of gross domestic product for each state of Mexico, also generated by the INEGI. [9] It is annual series covering the period 2003-2013, which are being broken down into 31 economic activities.

The use of three input output tables to calculate production variances on the study period (2003-2013) provides two important advantages: 1) It allows to quantify the impact of regional trade coefficients changes over the gross production variance, and; 2) it reduce the possible discrepancies resulting from combining a dynamic analysis (variance covariance is calculated using time series) with a static one (input-output model).

By using the basic components of input-output model to calculate the portfolio variance, the Siegel et al method assumes its same assumptions; market structure, state of technology and relative prices are fixed. Furthermore, in regional models, because they are obtained by an indirect method of regionalization, each sector of the region has the same production technology as the reference region, in this case, the country.

Changes in level and structure of the final demands

Using regionalized matrices and series of gross domestic product for each of the mesoregions and states of Mexico, it was estimated the gross production value and the final demand. [10]

The criteria for the formation of the mesoregions were "geographical contiguity; exclusiveness; distance from the northern border and; relevant geographical conditions, specifically the relative location of the entities with respect to major mountain ranges and coastlines." (Dávila et al 2015).

Table 1 lists the states that integrate each region, as well as their respective shares in population, gross production and surface of the country. With shades of black to grey highlights the three regions with the largest share in each category. For its part, the map 1 defines the territories within the country.

[8] Dávila (2015, pp. 7-18.) provides a description of this input-output regionalization method, as well as the assessment of the relative performance in respect other indirect methods.

[9] The data are provided at basic prices, excluding transportation and trade costs and net indirect taxes less subsidies. These series considered imputed bank service payments.

[10] In the first case, the estimate is based on GDP data available (equivalent to value added, both at basic prices) and the ratio of value added relative to gross production value (obtained from the national input-output matrix). Knowing gross production values of each sector ($\mathbf{x}_i$), final demand ($\mathbf{f}_i$) is obtained by subtracting to the gross production value, the production value for the supply of intermediate demand.

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Evolution of final demand levels.

During the period of study, at national level, final demand grew at an average real annual rate of 2.5 per cent. At regional level, the Northeast and the Central-North Plateau registered the largest dynamism (3.5 and 3.3 percent, respectively), while in the Southeast-Gulf region, this single variable reached a rate of 0.9 percent.

REGION	STATE	Participation (%) on Surface	Population	Gross Production
1. Northwest.	Baja California; Chihuahua; Sonora; Baja California Sur; Sinaloa.	32.1%	11.1%	13.1%
2. Northeast.	Coahuila; Nuevo León; Tamaulipas.	15.1%	9.3%	15.6%
3.Center North Plateau.	Aguascalientes; Durango; Guanajuato; San Luis Potosí; Zacatecas.	15.1%	10.9%	9.2%
4. West.	Colima; Jalisco; Michoacán; Nayarit.	8.7%	11.9%	10.2%
5. Center.	Distrito Federal; Hidalgo; México; Morelos; Puebla; Querétaro; Tlaxcala.	5.1%	33.7%	34.8%
6. South.	Chiapas; Guerrero; Oaxaca.	11.8%	10.0%	4.7%
7. Southeast Gulf.	Campeche; Quintana Roo; Tabasco; Veracruz; Yucatán.	12.1%	12.4%	13.0%
TOTAL	MEXICO	100%	100%	100%

Table 1 Regions of Mexico: Participation (%) on the surface, population and national gross production, 2003. Source: (Davila et al. 2015)

In regards to states, and because of the abatement of the oilfields, Campeche was the only state that had negative growth annual rates (-3.2 percent). At the other extreme, seven states reached annual final demand real growth rate above four per cent during those years (2003-2013): Aguascalientes (5.2), Baja California Sur (5.1), Zacatecas (4.9), Sonora and Querétaro (4.7), Quintana Roo (4.5) and Nuevo Leon (4.3).

Changes in the final demand structure

Table 2 presents a summary of the major changes in the final demand structures during the period 2003-2013. The first two columns contain the concentration indices of the eight and four most important sectors in final demand for the year 2013. In the first three rows are the average for regions, states, and the nationwide. In the following two, are the maximum and minimum values registered by the regions, and in the last two rows, the values registered by the states. Columns three and four compute percentage changes observed in the concentration levels between the initial (2003) and the final year (2013). The last column calculates the participation of the four sectors with the most relevant change in concentration indices.

Figure 1 Mesoregions of Mexico
Source: (Davila et al. 2015)

At the national level, eight of the 31 economic activities have improved in terms of final demand level between 2003 and 2013. On the whole, they increased their participation in this variable in 9.7 points, from 34.2 percent of the final demand in 2003 to 43.9 in 2013. Four of these activities concentrated the 86.2 percent of the relative increase in final demand:

Machinery and equipment (333 to 336 subsectors according to NAICS classification - North American Industrial Classification System-); financial services and insurance; trade and; information in mass media. This select group of economic activities doubled its relative weight in the final demand during the period (from 8.4 to 16.8 percent).

	Final demand centration Inde 2013		Change on inal demand oncentration exes. 2003-2013		Total hange tribution
	8 ctors	4 ctors	8 ctors	4 ctors	4 /8 ectors
Average					
Regions	43.0%	29.0%	9.2%	7.6%	83.1%
States	44.5%	30.6%	10.7%	8.9%	82.9%
National	43.9%	32.1%	9.7%	8.4%	86.2%
Extreme values on ns					
Maximum a	50.8%	37.7%	10.2%	9.4%	91.5%
Minimum b	38.0%	23.4%	7.8%	6.7%	na
Extreme values on s					
Maximum c	67.2%	59.8%	18.9%	18.5%	97.7%
Minimum d	18.5%	6.6%	4.8%	4.0%	82.4%

a Northeast region in all cases
b South, West, Central-North Plateau, respectively
c Tabasco, Tabasco, Sonora and Sonora, respectively
d Campeche, Puebla, Guanajuato y Guanajuato, respectively

Table 2 Mexico, mesoregions and states of Mexico: Indices of sectoral concentration of the final demand in 2003 (%) and changes in concentration levels during the periods 2003-2013, 2003-2013, 2003-2013 (%)
Source: Regional input-output models. Developed by the authors based on the methodology described in this document with information from INEGI (Input Output Tables: 2003, 2008 and 2012m and statistics of the Gross Domestic Product of the Federal Entities)

This expansion greatly influenced the detriment of three industrial activities: oil mining; petrochemical, chemical and plastic and rubber industries (324 to 326 NAICS subsectors) and; the basic metal and the metal products manufacture (subsectors 331 and 332). This subset of activities lost more than one third (34.2 percent) of its relative weight in aggregated demand, moving from 15.7 percent of the total in 2003 to 10.4 ten years after (5.3 points less).

The state and regional patterns were very similar to the national, with concentration indices and changes slightly more pronounced in the federal entities.

The Northeast region is the one that reaches the maximum values about concentration levels of four sectors (37.7 percent) and eight sectors (50.8), as well as its variations over the years analyzed (9.4 and 10.2 percent, respectively). Three of the four sectors with the highest concentration levels in this region match with those sectors located in this same category at national level. The exception is the food industry in the Northeast region, which appears in this group in replacement of trade sector.

In the case of states, Tabasco reached the higher concentration indices, as the most significant increases during the period were recorded in the state of Sonora. In Tabasco, oil mining was the sector with higher specific weight in the final demand, the three remaining activities match the sectors located in the same group at national level (trade, financial services and information services). In the case of Sonora, non-oil mining is among the most important activities, the remaining three (machinery and equipment, financial services and information services) are also in this subset at national level.

Thus, data show changes in final demand structures and a deepening in sectoral specialization levels. How have these trends impacted the evolution of its economic performance?

Local economies performance

In the methodological framework adopted, the performance of an economy is a direct function of the average expectancy of growth in the gross production value, and inverse of the levels of volatility of the same variable.

Initially we will analyze the evolution of each one of these items separately, and subsequently we will observe both criteria simultaneously.

Expected growth in the gross production value

In line with the behaviour of final demand, the estimated growth of the gross production value in Mexico reached real annual rates of 2.5 percent between 2003 and 2013.[11] Also regional and state dynamics in the evolution of this variable are very similar to those already described for the case of final demand.

Performance of the gross production value variance

In the approach proposed by Siegel et al., (op. cit.), changes in the the gross production value (or employment) variance level can be explained by: 1) alterations in the level and structure of the final demand, or; 2) changes in regional intersectoral trade quotients. In order to identify the source of fluctuations in the stability, three series were calculated using observed annual variance between 2003 and 2013 with each of the three input-output matrices available, corresponding to the years 2003, 2008 and 2012. All these computations were made for each of the 32 federal entities of the Mexican Republic, for each of the seven mesoregions considered and for the country as a whole. The results are presented in Annex 1 of the work.

To illustrate the procedure, we will analyze the case of the North-Central Plateau region of Mexico (see Graph 1). The three lines in the graph measure the evolution of the variance in the gross production with each of the three input-output matrices employed.

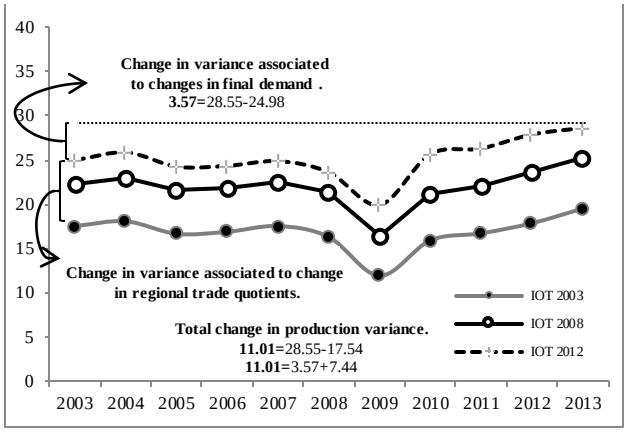
The total change (+11.01) results from subtracting to the level of variance quantified in 2013 with the 2012 matrix (28.55 units), the value of the variance registered in the initial year, 2003, obtained through the matrix of this same year (17.54).

Afterwards, variations associated with each of the two components mentioned above are calculated: The change in the absolute level of variance caused by alterations in the level and structure of the final demand (3.57 units) is obtained by measuring the difference between the values of the variance corresponding to the year 2013 with respect to the year 2003 (3.57 =28.55 -24.98), calculated both with the 2012 matrix.

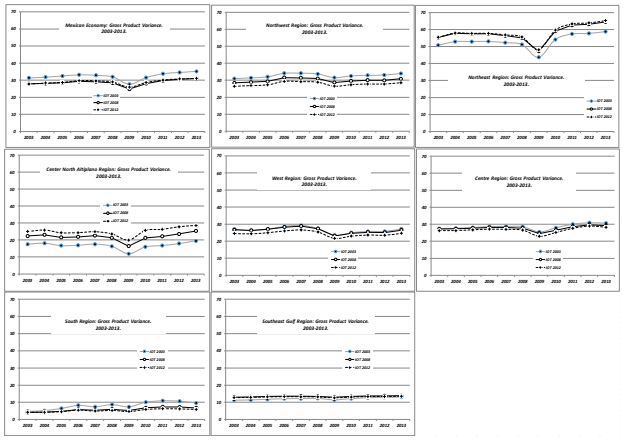
The impact over the production variance associated to changes in regional trade quotients; is estimated by the difference between the variance calculated for 2003 with the matrices of years 2012 and 2003. These values were 24.98 and 17.54, respectively, resulting in a variation of 7.44 units. Combining the two components yields the total change in variance (3.57 +7.44 =11.01).

Using the same scale to facilitate comparison, Graph 2 shows the behaviour of the gross production variance in the country and in each of its seven mesoregions. As indicated above, the results for the federal entities can be found in Annex 1.

[11] This value reflects the growth expentancy in the gross production value.



Graphic 1 North-Central Plateau region of Mexico. Variance of the gross production value. Period 2003-2013. Source: Regional input-output Models. Developed by the authors based on the methodology described in this document with information from INEGI (Input-Output Matrices: 2003, 2008 and 2012 and statistics of the Gross Domestic Product of the Federative Entities)

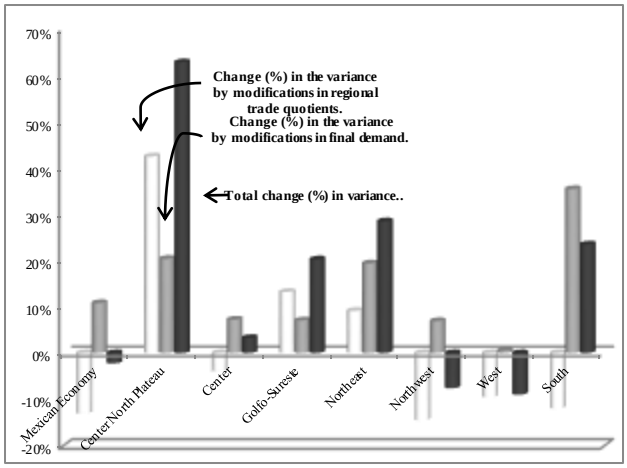


Graphic 2 Mexico and mesoregions of mexico. Variance of the gross value of production. Period 2003-2013

For the Mexican economy as a whole, even when the volatility associated with the structure of the final demand grew by 3.3 units (from 27.7 in 2003 to 31 in 2013), these changes were more than offset by the reduction associated with the regional trade quotients (-3.6). The net result was a slight decrease in the volatility indicator.

At mesoregional level, the Northeast region reached the highest levels of volatility, while the Northwest, North-Central Plateau, West and Center regions recorded similar amounts to those of the country as a whole. The lowest levels of instability were observed in the regions South and Gulf-Southeast.

The percentage changes of the gross production variance for the country as a whole, as well as for each of its seven mesoregions and its 32 federal entities were also computed. This information is detailed in Annex 2. The results at national and mesoregional level are presented in Graph 3.



Graphic 3 Mexico and mesoregions of mexico. Factors of changes in the variance of the gross production value. Period 2003-2013. (Percentage of the total)

Source: Regional input-output models. Developed by the authors based on the methodology described in this document with information from INEGI (2003, 2008 and 2012 Input-Output Tables and statistics of the Gross Domestic Product of the Federal Entities).

Changes in regional trade quotients helped to temper the gross production volatility in Mexico, as well as in the Northeast, South, Occident and Center regions. This same factor led to its greater instability in the Central-North Plateau, Southeast-Gulf and Northeast regions.

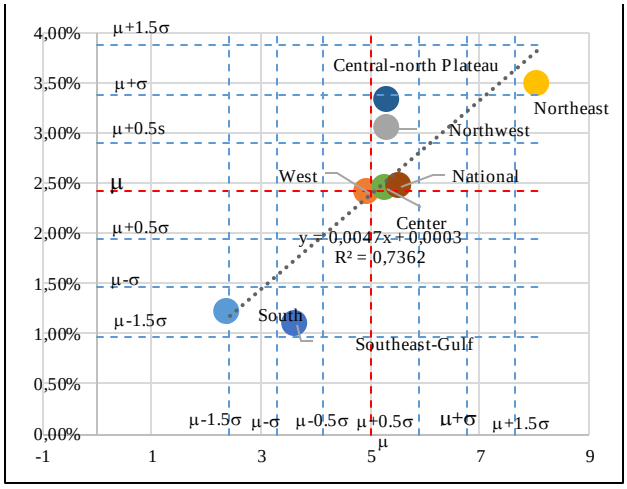
For its part, transformations in the final demand structure led greater volatility in the production level of the country, the seven regions and in 20 of 32 entities. The greater instability linked to this component was particularly important in the South, Central-North Plateau and Northeast regions. Combining both factors, the largest percentage increases in volatility levels were observed in the North-Central Plateau, Northeast and South regions.
In the case of the states, the behaviour can be summarized as follows: Total volatility increased in 19 of 32 states; changes in the final demand increased it in 20 entities and the local intermediate inputs coefficients reduced it in 17 entities.

Economic performance evaluation

Once the volatility is computed, the performance of an economy can be analyzed as a direct function of its expected growth (determined by the average rate of real growth in the gross production value) and as an inverse function of its instability (measured by the standard deviation of the gross production, which is obtained by calculating the square root of the variance).

The results are shown in Graphs 4 and 5. The first one contains information about regions, while the second one shows federative entities data. Both were evaluated using the input-output matrices of 2012[12] and have the same composition: the volatility indicator is located in the horizontal axis, i.e. the average standard deviation of the gross production during the period 2003-2013; as the vertical axis measures the other performance criteria , the gross production expected growth.

Using dispersion measures of every variable; mean, ranges of volatility and expected growth are identified, which are delimitated with dotted lines perpendicular to each axle.[13]



Graphic 4 Economic performance of the regions of mexico: average real growth rate of gross production (%) and average standard deviation (%). 2003-2013. The assessment with input-output matrices from 2012

Source: Regional input-output Models. Developed by the authors based on the methodology described in this document with information from INEGI (Input Output Matrices: 2003, 2008 and 2012, and statistics of the Gross Domestic Product of the Federal Entities).

The results show a trade-off between growth and volatility: A greater production dynamism, less stability or, equivalently, greater volatility. Similarly, a trend line is drawn, which identifies the average levels of correlation between growth and volatility.

[12] Same exercise was done with the matrices of the 2003 and 2008 years. Both are consistent with those observed in the 2012 matrix and show similar results.

[13] Five level ranges were defined in each of the two variables: very low (observations with a value lower than the average minus one and a half standard deviation; low (level between the mean minus one standard deviation); medium (values between the mean plus/minus half of the standard deviation); high (values located between the mean plus one standard deviation); and very high (values higher than the mean plus one and a half standard deviation).

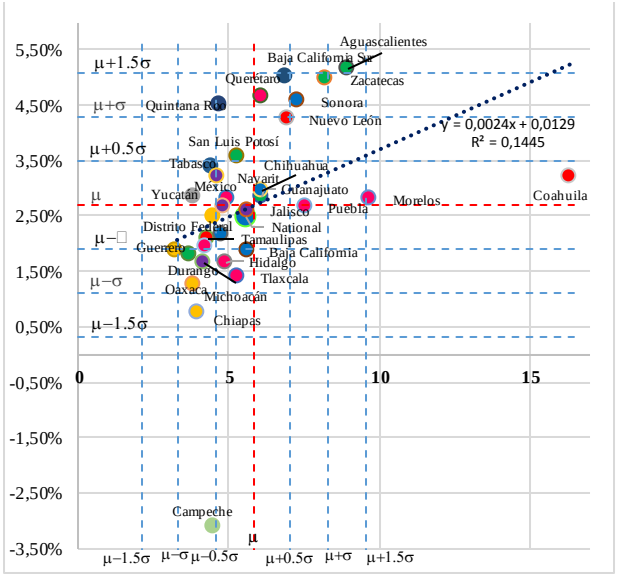
During those years, the Northeast was the region with the higher growth rate in gross production (3.48 percent per year), being located in the area "very high" in this aspect. Nonetheless, this region was also the one with the highest volatility (on average, the gross production standard deviation was 8.07), being the only mesoregion of the country located in the "very high" area of volatility. For its part, the Central-North Plateau achieved a high growth level (3.32), but unlike the Northeast, remained in a zone of average volatility (5.34). In the same strip of volatility were located three other regions; Northweast, Central and Occident (with deviations values of 5.35, 5.32 and 4.96 percent, respectively), but the last two remained in medium growth area, with rates of 2.44 and 2.41 percent, while the Northwest region is ranked in the range of high growth (3.05), but with a slower rhythm than Central-North Plateau region. Thus, it can be concluded that the Central-North Plateau region was the one that showed the best combination of growth and volatility, since it achieved an expansion of production slightly lower than Northeast, but much more stable. Similarly, with a level of stability similar to the one registered by the Northweast, Center and Occident regions, the region was able to achieve better rates of economic growth.

At the other extreme are the two regions with lower growth (Gulf-Southeast and South). Clearly the first one was the worst performer, because with higher levels of volatility to those registered in the South region, Gulf-Southeast obtained a lower growth rate (1.08 per cent, against 1.21).

The analysis of the economic performance of the federal entities shows two extreme values:

1) The state of Coahuila, with a volatility value (16.4) almost three times higher than the national average and an economic growth located at the top of the mid-range area (3.19 percent), and; 2) Campeche, the only state of the Mexican Republic with negative growth rates (-3.11 percent) of its gross production over the period 2003-2013.

Six states are located in a very high gross production growth area: Aguascalientes (5.17), Baja California Sur (4.99), Zacatecas (4.97), Queretaro (4.63), Sonora (4.57) and Quintana Roo (4.52). In this group, the lower volatility values were observed in Quintana Roo (4.73, low range), Queretaro and Baja California Sur (placed in a medium instability level, with standard deviations of 6.13 and 6.89, respectively). With the evaluation criteria employed, these entities attained the best economic performance during the period.



Graphic 5 Economic performance of the federal states of Mexico: average real growth rate of gross production (%) and average standard deviation. 2003-2013. Estimations with 2012 input-output matrices
Source: Regional input-output models. Developed by the authors based on the methodology described in this document with information from INEGI (2003, 2008 and 2012 Input-Output Tables and statistics of the Gross Domestic Product of the Federal Entities)

The reverse of the medal was occupied by nine states, located in the "low" (Tlaxcala, Oaxaca, Michoacán, Guerrero, Hidalgo, Durango and Baja California) and "very low" (Campeche and Chiapas) strata of gross production variation. Within this conglomerate, the standard deviations were highest in Baja California (5.64), Tlaxcala (5.28), Hidalgo (4.89) and Campeche (4.51), being the entities with the most precarious levels of economic performance.

In the Markowitz theory (1959), a portfolio is efficient when there is no someone else who can provide higher performance at the same level of risk, or; that a certain amount of "profits", guarantees the minimum standard deviation (lower volatility or risk). With these elements of valuation, it is clear that at the mesoregional level, the Central-North Plateau region is emerging as the top performer. However, at the state level, it is not possible to determine unambiguously the state with the best economic performance during the period.

In order to establish evaluation criteria, William F. Sharpe (1994) developed an indicator that bears his name, which allows to identify the portfolio with the best performance and risk combination. This index measures the performance per risk unit by estimating the difference between the expected benefit of a portfolio relative to a benchmark portfolio. The result is divided by the standard deviation of the portfolio examined. The formula is as follows:

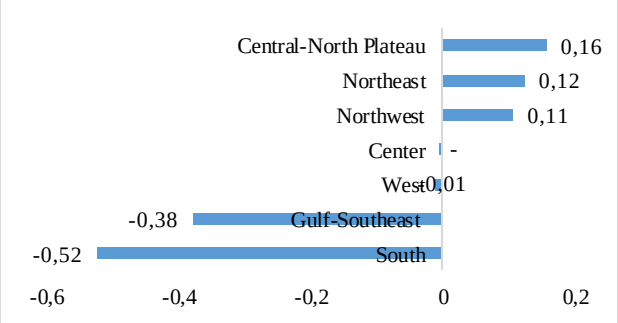
$$S = \frac{\mathrm{R[F]} - \mathrm{R[B]}}{\sigma[F]} \qquad (3)$$

Where: R[F] corresponds to the portfolio performance F, R[B] corresponds to the performance of the reference portfolio B, and σ[F] is the estimate of the standard deviation associated with the portfolio F.

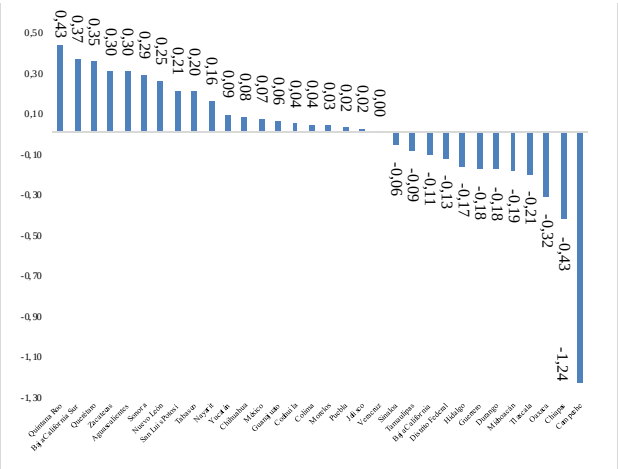
Originally, the reference portfolio was risk free. Subsequently applications emerged where the reference portfolio was similar of the examined, but with less risk. Even, in some applications the reference return is omitted, estimating only performance-volatility ratio for the option evaluated. The latter solution was questioned by Sharpe (1994).

Taking as reference the "national portfolio", whose performance (average annual growth rate) was 2.48%, the Central-North Plateau region reached the best performance, because in computing its growth differential compared to the national average and divided by the standard deviation, reached the maximum value of the Sharpe ratio (0.157). At the opposite, the South region (-0.524) stood. Two other regions (Northeast and Northwest) were placed in the second and third positions, respectively, with positive coefficients of 0.124 and 0.107. The places four, five and six were occupied by the Central, West and Gulf-Southeast regions (See Figure 6).

Analyzing federal entities, the results are presented in Figure 7, where Sharpe coefficient values of the five states located at the ends are displayed. With a ratio of 0.43, Quinta Roo ranked first, followed by Baja California Sur (0.37), Querétaro (0.35), Zacatecas and Aguascalientes (both 0.3). At the bottom they were placed Michoacán (-0.19), Tlaxcala (-0.21), Oaxaca (-0.32), Chiapas (-0.43) and Campeche (-1.21).



Graphic 6 Economic performance of the regions of mexico. Sharpe coefficient. Reference Portfolio Performance: 2.48%, National average real growth rate.
Source: Regional input-output models. Developed by the authors based on the methodology described in this document with information from INEGI (2003, 2008 and 2012 Input-Output Tables and statistics of the Gross Domestic Product of the Federal Entities)



Graphic 7 Economic performance of the federal entities of mexico. Sharpe coefficient. Reference Portfolio Performance: 2.48%, National average real growth rate
Source: Regional input-output models. Developed by the authors based on the methodology described in this document with information from INEGI (2003, 2008 and 2012 Input-Output Tables and statistics of the Gross Domestic Product of the Federal Entities)

Conclusions

The data reflect the deepening of local economies specialization as a result of the progress of foreign trade liberalization in Mexico. This trend is explained by the new balance between transportation and agglomeration economies fostered by access to foreign markets.

The effects on economic performance have been contrasting, although some local economies have reached acceptable rates of expansion in gross production, growth has been moderate in most federal entities. Moreover, the increasing productive specialization has increased instability levels, particularly in federal entities and regions in which industry of machinery and equipment has a preponderant weight.

With the dynamism of exports, changes in the amount and structure of the final demand of the Mexican economy deepened. Furthermore, its sectoral concentration was accentuated and the volatility levels of gross production associated with these transformations rose. This occurred in the three geographical levels: Country, mesoregions and federal entities.

The impact of changes in local intermediate inputs coefficients on volatility were differentiated: At national level, they had a positive contribution to offset the instability caused by changes in final demand, so the total variance recorded a slight net fall (-0.9%). Something similar happened in the Northwest and West regions. As well, Central and South regions also had a positive effect, but this was not enough to offset the increased instability related to structural changes in final demand, so the net variance increased. In the remaining three regions (North-Central Plateau, Gulf-Southeast and Northeast), both factors combined to accentuate the instability of gross production. Regarding federal entities, the overall level of volatility increased in 19 federal entities; changes in the final demand increased volatility in 20 federal entities and the growth of intermediate inputs coefficients produced a reduction on volatility in 17 federal entities.

By integrating the two indicators of economic performance (growth expectancy and standard deviation) with the Sharpe ratio, the North-Central Plateau region was the best evaluated (0.43), followed by the Northeast (0.124) and then Northwest (0.107). At the other end were the South (-0.524) and Gulf –Southeast (-0.379) regions. At the state level, Quintana Roo (0.43), Baja California Sur (0.37), Querétaro (0.35), Zacatecas and Aguascalientes (0.3 in both cases) achieved the best results. On the opposite side stood Campeche (-1.24), Chiapas (-0.43), Oaxaca (-0.32), Tlaxcala (-0.21) and Michoacán (-0.19).

By crossing these trends with previous research results, it can be concluded that the largest share of exports in gross production does not guarantee the best results. For example, in the mesoregional area, the Northwest and Northeast regions, both achieved export quotas higher than the Central-North Plateau region (22.7, 20.4 and 16 percent, respectively) (Davila et al 2015), nevertheless, the latter recorded a higher economic performance ratio. When considering the national content exported in gross production, Central-North Plateau outperformed the Northwest region (10.2 and 8.8 in each case) (Davila et al 2015). Therefore, in order to obtain better economic performance, it can be more relevant other factors like; the net exported content, sectoral diversity and highest density of local production chains.

We have identified the following two lines of research as relevant to deepen the study of performance of local economies in Mexico:

1. Apply the Siegel et al method, replacing input-output Leontief basic model for extended models built with social accounting matrices. This will facilitate the adequate integration of income effects and take account of the impact of exogenous changes on their distribution.

2. In the analytical framework described in the previous section, and applying constrained optimization techniques, it can be useful to run simulation exercises of different policy options impacts on economic performance, especially policies about diversification strategies based on innovation cluster approach.

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Annexes

	IOT 2003				IOT 2008				IOT 2012			
REGION	**2003**	**2008**	**2012**	**2013**	**2003**	**2008**	**2012**	**2013**	**2003**	**2008**	**2012**	**2013**
Total nacional	**31.32**	**31.90**	**34.49**	**35.14**	**27.86**	**28.37**	**30.56**	**30.93**	**27.71**	**28.91**	**30.70**	**31.04**
South	4.75	8.66	10.67	9.60	4.15	6.00	7.29	6.75	8.37	5.29	6.15	5.87
West	27.03	27.41	25.75	27.17	26.65	27.34	25.10	26.45	24.46	25.36	23.46	24.60
Northwest	30.94	33.76	33.08	34.01	28.45	31.04	29.98	30.83	26.45	28.86	27.79	28.59
Northeast	50.80	51.18	57.74	58.78	55.39	55.14	63.18	64.53	55.42	55.69	63.87	65.25
Southeast Gulf	11.25	12.28	12.90	13.04	13.02	13.49	13.73	13.85	12.73	13.16	13.42	13.52
Center	27.37	28.60	30.87	30.64	73.67	75.06	79.35	82.14	26.29	26.53	28.90	28.26
Plateau	17.54	16.30	17.87	19.52	22.34	21.29	23.59	25.27	42.73	38.87	54.42	50.10
Aguascalientes	40.91	60.21	66.45	76.47	47.02	68.29	75.07	85.46	42.81	63.60	70.09	80.07
Baja California	37.41	38.92	36.19	35.85	35.01	36.36	33.63	33.27	33.53	34.84	32.15	31.78
B.C. Sur	43.03	55.68	53.41	52.98	45.40	56.58	54.99	53.54	37.57	50.27	48.10	47.43
Campeche	24.57	22.58	20.99	21.23	24.41	22.48	20.34	20.71	23.53	21.85	19.99	20.35
Chiapas	20.22	57.43	46.95	32.84	22.01	34.05	28.38	19.60	21.44	21.92	21.04	15.85
Chihuahua	33.61	36.32	36.38	36.96	31.78	34.64	34.44	34.95	32.00	36.23	36.51	37.52
Coahuila	202.88	177.32	240.85	257.49	216.99	192.41	257.08	274.07	209.40	188.02	251.49	268.19
Colima	27.13	31.94	30.00	31.17	23.87	27.74	24.80	24.85	22.41	25.62	23.87	23.66
Distrito Federal	25.35	26.27	24.83	24.32	19.08	20.30	18.91	18.29	18.27	19.64	18.58	18.00
Durango	8.76	10.33	9.91	11.08	9.45	11.11	10.63	12.54	10.56	12.11	11.08	13.80
Guanajuato	37.48	29.59	32.22	33.28	42.16	34.48	36.74	37.81	40.47	33.83	36.17	37.14
Guerrero	13.07	15.70	17.45	17.30	9.70	12.63	12.43	12.30	8.55	11.20	10.79	10.68
Hidalgo	20.49	23.33	21.55	23.08	24.89	25.48	22.67	23.56	25.84	26.09	23.37	23.93
Jalisco	37.37	35.16	34.27	35.74	35.69	34.38	33.53	34.71	32.09	31.54	30.88	31.82
México	23.60	22.37	24.34	23.06	25.30	24.01	26.32	25.05	24.40	23.40	25.69	24.50
Michoacán	15.68	19.86	15.68	17.24	18.90	23.78	15.29	18.01	18.76	23.20	14.89	17.57
Morelos	35.10	39.06	89.63	87.75	38.17	43.26	100.48	98.40	37.30	42.45	95.99	94.42
Nayarit	24.41	55.92	30.85	32.17	17.87	40.53	23.41	24.48	15.52	29.72	20.78	21.61
Nuevo León	37.57	42.13	42.91	42.45	40.68	45.45	47.11	46.96	41.80	46.69	48.44	48.35
Oaxaca	8.29	7.03	12.28	11.63	9.31	7.81	10.60	10.62	9.20	6.91	14.70	15.00
Puebla	54.51	56.25	69.20	59.18	53.57	55.13	66.53	57.36	47.52	49.73	65.70	57.14
Querétaro	32.07	27.04	30.63	30.63	38.67	32.07	37.13	37.11	38.47	32.50	37.71	37.61
Quintana Roo	21.95	24.81	22.82	23.08	21.28	25.34	23.15	23.45	20.41	24.33	22.09	22.42
San Luis Potosí	32.00	30.06	31.15	30.38	41.75	39.60	42.14	41.52	31.70	31.40	27.60	27.84
Sinaloa	22.03	26.58	24.24	24.47	23.03	28.29	24.12	24.12	22.43	27.32	23.12	23.06
Sonora	72.01	83.06	78.31	89.56	35.37	55.83	48.09	60.55	33.89	49.75	43.11	53.30
Tabasco	16.99	16.07	15.78	16.36	26.02	21.82	19.95	21.05	24.46	20.49	18.67	19.77
Tamaulipas	19.81	22.01	20.06	19.03	20.41	22.34	20.15	19.40	19.46	21.40	19.34	18.56
Tlaxcala	34.98	23.76	25.46	24.13	45.16	28.16	31.02	29.03	43.33	27.10	29.60	27.92
Veracruz	15.41	16.51	17.05	16.54	20.48	22.95	23.14	22.57	17.58	20.32	20.85	20.19
Yucatán	13.90	17.33	18.53	18.36	11.89	14.62	15.49	15.36	11.61	14.10	14.97	14.96
Zacatecas	18.83	21.48	22.11	20.96	23.90	23.00	37.77	34.24	31.40	30.17	76.19	67.70

Annex 1. Production Variances. Years: 2003, 2008, 2012 y 2013.
Source: Regional input-output models. Developed by the authors based on the methodology described in this document with information from INEGI (2003, 2008 and 2012 Input-Output Tables and statistics of the Gross Domestic Product of the Federal Entities).

	Δ% VQ			Δ% VQ TQ			Δ% VQ FD		
REGION	**2003-2008**	**2008-2012**	**2003-2012**	**2003-2008**	**2008-2012**	**2003-2012**	**2003-2008**	**2008-2012**	**2003-2012**
Nationall	-9.20%	9.66%	-2.24%	-11.05%	1.93%	-13.04%	1.85%	7.72%	10.80%
South	69.54%	9.57%	16.72%	-12.65%	-11.87%	43.22%	82.19%	21.43%	-26.49%
West	0.01%	-15.41%	-14.59%	-1.42%	-7.22%	-10.48%	1.42%	-8.19%	-4.11%
Northwest	1.06%	-10.42%	-11.92%	-8.05%	-7.01%	-16.96%	9.11%	-3.42%	5.04%
Northeast	9.79%	15.58%	23.59%	9.04%	1.00%	8.34%	0.76%	14.58%	15.25%
Southeast Gulf	24.94%	-0.61%	17.10%	15.77%	-2.41%	11.65%	9.16%	1.80%	5.45%
Center	173.63%	-58.93%	5.81%	169.15%	-64.65%	-4.11%	4.49%	5.73%	9.92%
Plateau	20.27%	93.37%	86.31%	27.35%	82.56%	58.94%	-7.08%	10.81%	27.37%
Aguascalientes	62.09%	3.08%	68.16%	14.92%	-6.86%	4.44%	47.17%	9.94%	63.72%
Baja California	-2.37%	-11.68%	-15.69%	-6.41%	-4.19%	-11.57%	4.04%	-7.49%	-4.12%
B.C. Sur	34.93%	-13.98%	13.51%	5.52%	-11.16%	-14.54%	29.41%	-2.82%	28.05%
Campeche	-8.74%	-12.26%	-19.45%	-0.63%	-2.76%	-4.44%	-8.11%	-9.49%	-15.01%
Chiapas	192.79%	-52.29%	3.80%	8.82%	-35.62%	5.70%	183.97%	-16.67%	-1.89%
Chihuahua	2.61%	3.99%	9.07%	-5.45%	4.57%	-5.02%	8.06%	-0.58%	14.10%
Coahuila	-5.65%	31.32%	23.21%	6.95%	-2.29%	3.11%	-12.60%	33.61%	20.10%
Colima	5.73%	-18.28%	-14.56%	-12.01%	-7.66%	-21.09%	17.74%	-10.62%	6.52%
Distrito Federal	-21.10%	-10.11%	-37.06%	-24.72%	-3.26%	-38.77%	3.62%	-6.86%	1.71%
Durango	25.85%	4.62%	22.00%	7.92%	8.99%	17.01%	17.93%	-4.38%	4.99%
Guanajuato	-8.56%	4.66%	-3.22%	12.49%	-1.89%	7.39%	-21.06%	6.55%	-10.61%
Guerrero	-5.74%	-12.95%	-26.78%	-25.78%	-11.33%	-52.99%	20.04%	-1.61%	26.21%
Hidalgo	35.40%	-8.64%	11.16%	21.52%	2.39%	20.73%	13.88%	-11.02%	-9.57%
Jalisco	-10.40%	-10.73%	-20.21%	-4.50%	-8.26%	-16.43%	-5.90%	-2.48%	-3.78%
México	2.01%	7.08%	8.58%	7.21%	-2.55%	3.28%	-5.20%	9.63%	5.30%
Michoacán	47.22%	-38.15%	-4.21%	20.57%	-2.43%	16.45%	26.65%	-35.72%	-20.66%
Morelos	20.01%	130.42%	163.26%	8.73%	-1.86%	5.89%	11.28%	132.28%	157.37%
Nayarit	102.24%	-68.90%	-23.44%	-26.79%	-26.67%	-57.27%	129.03%	-42.22%	33.83%
Nuevo León	20.42%	6.36%	26.00%	8.27%	2.71%	10.12%	12.15%	3.65%	15.89%
Oaxaca	-2.85%	24.21%	69.66%	12.33%	-11.53%	9.91%	-15.19%	35.74%	59.75%
Puebla	1.46%	10.91%	23.54%	-1.73%	-9.79%	-14.72%	3.19%	20.69%	38.26%
Querétaro	4.91%	17.15%	14.65%	20.58%	1.36%	16.63%	-15.67%	15.79%	-1.98%
Quintana Roo	10.01%	-12.65%	0.69%	-3.04%	-3.99%	-7.57%	13.05%	-8.66%	8.26%
San Luis Potosí	24.45%	-14.30%	-13.86%	30.50%	-20.71%	-0.93%	-6.05%	6.41%	-12.93%
Sinaloa	25.22%	-18.23%	4.88%	4.55%	-3.46%	1.77%	20.67%	-14.77%	3.10%
Sonora	-35.55%	-24.76%	-85.30%	-50.89%	-10.89%	-112.50%	15.34%	-13.87%	27.20%
Tabasco	47.65%	-14.69%	6.85%	53.10%	-6.11%	30.54%	-5.45%	-8.58%	-23.68%
Tamaulipas	14.18%	-14.04%	-2.42%	3.04%	-4.22%	-1.79%	11.14%	-9.82%	-0.63%
Tlaxcala	-2.94%	6.35%	-12.42%	29.13%	-3.79%	19.28%	-32.06%	10.14%	-31.69%
Veracruz	39.93%	-10.60%	30.95%	32.85%	-11.46%	12.33%	7.08%	0.86%	18.62%
Yucatán	10.30%	2.40%	9.23%	-14.41%	-3.55%	-19.70%	24.71%	5.95%	28.93%
Zacatecas	41.01%	95.47%	182.69%	26.94%	31.21%	40.02%	14.07%	64.26%	142.67%

Annex 2. Percentage changes in variances (**Δ% VQ**)) due to changes in final demand levels (**Δ% VQ FD**) and changes in trade quotients (**Δ% VQ TQ**). Periods: 2003-2008, 2008-2012, 2003-2012.
Source: Regional input-output models. Developed by the authors based on the methodology described in this document with information from INEGI (2003, 2008 and 2012 Input-Output Tables and statistics of the Gross Domestic Product of the Federal Entities)

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The importance of Social Networks in the savings decision of Mexican households: An agent-based model

AGUILAR-LUGO, Jessica†*, QUINTERO-ROJAS, Coralia and VIIANTO, Lari

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Abstract

Saving is important for economic growth because it is one of the determinants of investment and productivity. However, at the micro level, the decision of individuals on the use of their remaining income after consumption expenditures is affected by various issues, both social and economic. In Mexico, there are millions of people who prefer to borrow from relatives or friends rather than from any banking institution. The objective of this work is to study the impact of family networks on private savings in Mexico. Given the socio-cultural context behind the saving decisions of individuals, we conduct the study from the perspective of Agent-Based Models (MBA). The analysis is done through a model that is built and simulated on the NetLogo platform. The parameters and target values correspond to the Mexican economy in 2012 and 2014. The results suggest that family relationships have an effect on savings in Mexico.

Agent Based Models, Family networks, Formal savings, Informal savings, NetLogo

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* Correspondence to Author (email: j.aguilarlugo@ugto.mx)
† Researcher contributing first author.

Introduction

From very old times humans know and practice the concepts of saving and credit. While saving refers to the difference between the disposable income of people and the consumption they make, the credit refers to those loans between people for a given period. At the national level, saving is an important variable for economic growth because it is one of the determinants of investment and productivity.

However, at the microeconomic level, individuals' decision about what to do with the remaining income from their consumption expenditures is affected by various social and economic issues. The customs, traditions, habits, economic and geographical characteristics of each region and country have been determinants of the savings mechanism chosen by households, which may be formal or informal. In Mexico, for example, both saving and personal credit are influenced by existing social relationships, so that millions of people prefer to apply for loans to relatives, friends, neighbors or acquaintances rather than to a banking institution (CONDUSEF, 2014).

Given the macroeconomic relevance of these variables, the objective of this study is to study the impact that family networks have on private savings in Mexico. Due to the socio-cultural context behind the saving decisions of individuals, it is considered opportune to carry out the study from the perspective of Agent-Based Modeling (MBA, onwards).

The MBA is a form of computer simulation that allows to create, analyze and experiment with models composed by agents that interact in an environment. Although simulation is an important research technique in the natural sciences, in areas such as biology, chemistry, physics, zoology, to mention a few, it has only been used in the social sciences (Wilensky & Rand, 2015).

This is largely due to the fact that with this approach it is possible to address real-world problems under a wide variety of possible circumstances. In addition, the simplified representation of social reality that can be created allows us to express in the simplest way possible the way in which reality is thought to be directed. However, the greatest advantage of the MBA is that it enables virtual social experiments without incurring the difficulties and ethical problems that would arise from carrying them out in reality (Gilbert, 2008).

In economics, there are several recent examples of the use of this model with favorable results (Fagiolo and Dosi, 2003, Deissenberg et al., 2008, Dosi et al., 2010, Martínez, Quintero and Viianto, 2015, among others). The present work is in addition to this aspect by developing an MBA that allows the evaluation of the impact of income and consumption levels of the country, and especially the family ties (friendship, neighborhood, etc.), personal savings decisions and the national savings.

The rest of this paper is organized as follows. Section 2 presents a brief review of previous work on the determinants of savings, in order to emphasize the added value of the present analysis. Section 3 deduces the concept of household savings. Section 4 presents the savings and credit landscape in Mexico in 2012 and 2014. Section 5 analyzes the determinants of saving. Section 6 presents the MBA approach. Section 7 develops and simulates a model for saving households in Mexico. Section 8 presents and discusses the results. Section 9 summarizes the conclusions of the present study

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Review of related literature

Emphasizing the socio-cultural issues behind individual savings decisions, the present analysis distances itself from a number of previous work on the determinants of saving in Mexico using more conventional tools and approaches and which, among other things, do not take Taking into account the interactions of individuals with the environment.

This is the case, to mention a few: Villagómez (1993), Attanasio and Székely (1999) and Montes and Villagómez (2002), who use, among other tools, the Life Cycle hypothesis with favorable results. However, Villagomez (1993) points out the need to "deepen work that analyzes the problem of saving from a microeconomic perspective, as well as those that study the behavior of this variable in informal markets." On the other hand, Attanasio and Székely (1999) conclude that:

"[...] When households are less likely to save during some phases of their life cycle, strong family ties may often replace the lack of savings at more advanced ages ... Policies to promote savings Must take into account that in Mexico the different sectors of the population may respond in a totally different way in the face of savings incentives ... "p. 334 and 335.

On the other hand, some recent econometric studies study a great variety of variables that determine saving. For example, Rodriguez (2015) uses partial equilibrium, general equilibrium, and econometric multinomial logit models and to explain the savings using macroeconomic variables.

The results highlight that the unemployment rate, annual general inflation and fiscal reform have a negative effect on the savings possibilities of Mexican consumers.

While the real ex-post interest rate and labor reform contribute positively to these possibilities. For their part, Bosch, Melguizo, Peña and Tuesta (2015) use a cluster analysis and a probit econometric model, and evaluate variables such as gender, educational level, self-confidence, motivation and employment in the formal and informal sector. One of its results is that informal work adversely affects savings decisions.

Therefore, the present study complements those mentioned above when taking into account the informal savings market and the influence of family and social ties in the decision making of heterogeneous agents.

From national saving to household saving

When talking about saving, there is a natural allusion to consumption since these concepts are the two possible destinations of the income of a person, household or society. On the other hand, the credit allows to extend the possibilities of consumption of the individuals. In sum, savings, credit and income have a close relationship capable of affecting the microeconomic decisions of current and future consumption of people. Moreover, viewed from a macroeconomic perspective, when saving is channeled as investment, it becomes a key element for long-term economic growth in the country.

According to conventional economic theory, a measure of the total income that the set of people obtains in the economy is given by the Gross Domestic Product (GDP), which is defined as:

'The market value of all final goods and services produced (legally in the market, including tangible and intangible goods) within a country in a given period".

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However, in an economy money flows continuously from households to businesses and then back to homes. While a significant part of this flow of money is measured by GDP, there are other sources of monetary income that are received by households, but by definition are not accounted for in GDP. For example, diverse incomes, dividends, interests, transfers, et cetera. As will be discussed below, these other sources of income induce a gap between savings, according to the National Accounts, and household savings, understood as the difference between the amount of all their monetary incomes (including or not in GDP) And its consumption.

Private savings according to National Accounts

According to the expenditure approach, GDP (denominated Y) is composed of the sum of the following elements: private consumption (C), private investment (I), government purchases (G) and net exports (XN). That is to say:

$$Y=C+I+G+NX \quad (1)$$

However, given the very small proportion of net exports in most countries, the simplified assumption is often made that it is a closed economy. This fact simplifies the identity of GDP, which can be rewritten as:

$$Y-C-G=I \quad (2)$$

The left side of the last expression represents national saving (or simply saving), since it is the remnant of total income in the economy that results from paying for consumption and government purchases. This equation reveals that, for the economy as a whole, savings must equal investment.

Therefore, according to conventional theory, saving has a key role in the development of countries as it constitutes the main source of funds for the financing of investment projects that promote economic and social development. It is important to emphasize that savings, channeled through an efficient and secure intermediation system, drive productivity and lay the foundations for sustained long-term growth (Rivera, 2014).

So, saving is the main constraint on investment spending and, therefore, plays a crucial role in the Mexican economy. Because investment provides a key link that leads to productivity and real income growth, an adequate supply of savings is required for the economy to progress at an acceptable pace (Huidobro, 1995). Thus, a greater effort is required to understand the determination and behavior of savings if the public policies are to be designed to achieve this objective (Villagómez, 2011).

The haushold saving

Denoting by A the savings and by T the net amount that the government collects from households in taxes, national savings can be broken down between private savings and public savings:

$$A = (Y – T – C) + (T– G) \quad (3)$$

Thus, public saving is the amount of tax revenue left to the government after covering its expenses, while private saving is the amount of income left to households after taxes and consumption. Although private saving results from household decision-making, it does not constitute all of its real or actual savings.

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The gap between private saving and real household saving is due, on the one hand, a part of the latter comes from unaccounted income in GDP and, on the other hand, that households use both formal and informal saving methods (CNBV and INEGI, 2016).

According to the above, the National Institute of Statistics and Geography (INEGI) defines savings simply as:

"Separate a part of the income or the money that is received to use it in the future. Saving can be achieved by saving a portion of income or by spending less. There are two forms of savings: formal and informal "(INEGI, 2016).

In turn, the income referred to by this definition is personal income or average current income. This indicator is made up of monetary and non-monetary inflows, divided into the following five categories: labor income, property income, transfers, housing rent estimation, and other current income (INEGI, 2016).

In other words, the effective saving of households depends on the total income they receive, which, by its composition, is greater than that recorded in GDP, that is, private saving according to the National Accounts. In sum, as Huidobro (1995) points out:

"[...] Most definitions consider savings as a residual concept, that is, income minus consumption, or in an international context, such as the demand for investments minus the net inflow of capital. Consequently, savings measures can vary significantly due to differences in both definitions and measurement of concepts difficult to quantify [...] "(p.1).

Such savings can also be made in a formal way (supported by the financial legislation system) or informal, which makes their quantification even more difficult.

These types of savings are defined by INEGI (2016) as follows:

Formal savings: "Money that is saved in some financial institution (bank or non-bank), through certain products such as savings accounts, investment accounts, among others, which may or may not, give a profit or performance depending on the conditions Of opening or characteristics of the product, with the advantage of providing security, because the money is protected by the IPAB (Institute for Protection of Bank Savings) and offers greater facility to obtain a credit. This type of savings does not have any risk, only in certain options like term deposits or promissory notes there is no immediate availability of money. "

Informal saving: "When money is stored in the house, with a relative or through mechanisms such as bundles, piggy banks or unauthorized institutions. You can dispose of the money immediately, but it has the risk of being stolen, there is the temptation to spend it by having it handy and make improper use of it. "

As a complement to savings, INEGI defines the loan as:

"Act through which a person (creditor) entrusts money to another (called debtor) for a certain period. After the deadline, the person who received the money returns it to the creditor. Usually the credits are not free, so the debtor, when returning the money to the creditor or before, must add an additional payment, which is called "interest" and is expressed or disclosed through the interest rate".

From the above, it follows that, like savings, credit can be channeled through formal or informal mechanisms. The definitions of formal and informal credit described by INEGI (2016) are as follows:

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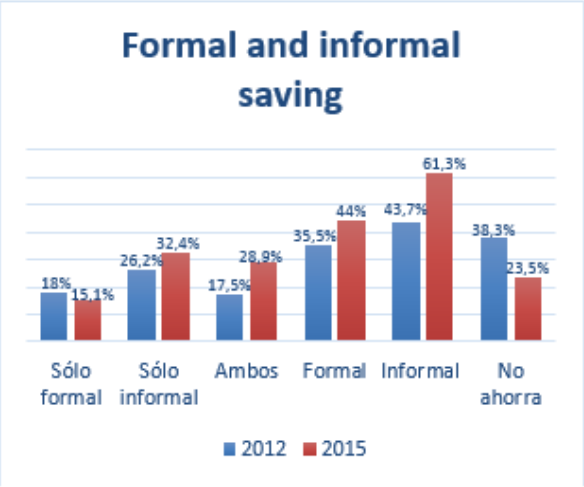
Crédito formal: "Préstamo solicitado a una institución financiera que se dedica, como parte de su actividad principal, a intermediar recursos económicos".

Formal credit: "Loan requested from a financial institution that is engaged, as part of its main activity, to intermediate economic resources".

Saving and credit in Mexico

In Mexico, the percentage of adults who save has increased in recent years. In 2012, 61.7% (43.4 million) declared savings, while in 2015 the percentage rose to 76.5% (58 million) (CNBV and INEGI, 2012 and 2016, page 35). However, as shown in Figure 1, the weight of informal savings has been greater than that of the formal one in both years and was also the one that experienced the greatest increase from 2012 to 2015.

The preference of Mexican households for informal savings mechanisms is mainly due to insufficient or variable national income (CNBV and INEGI, 2016), which makes it difficult to enter the formal financial market (Hoyo, Peña and Tuesta, 2013, Allen, Demirgüç-Kunt, Klapper and Martinez Pería, 2012, Djankov, Miranda, Seria and Sharma, 2008, and Cano, Esguerra, García, Rueda and Velasco, 2013). .



Graphic 1 Formal and informal saving
The sum of the percentages is greater than 100% since the informant could mention more than one option.

The situation of credit or loans in Mexico, as well as savings, has shown an increase in the percentages of use. The percentage of adults who applied for loans in 2015 was 54.4% (41.5 million), surpassing the 2012 credit of 51.4% (36 million) (CNBV and INEGI, 2012 and 2016). Similarly, Figure 2 shows that, like savings, the preferred mechanism for credit is the informal mechanism. The main barriers to not requesting formal credit products are: dissatisfaction with debts (39.5%), non-compliance (32.9%), lack of interest (19.3%), and high commissions and interest involved in a loan with some authorized institution (14.2%) (CNBV and INEGI, 2016, p. 92).

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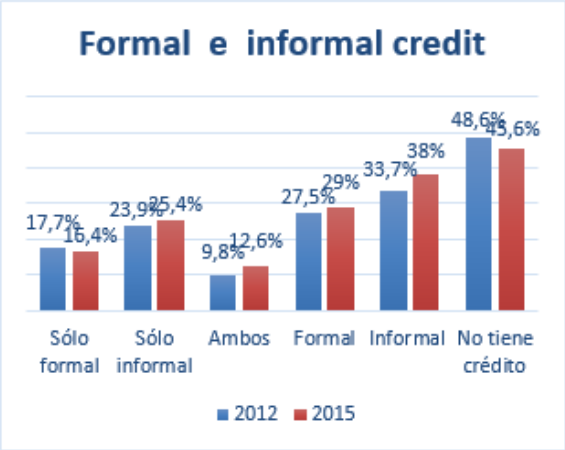

Graphic 2 Formal and informal credit
The sum of the percentages is greater than 100% since the informant could mention more than one option
Source: Own elaboration with information of the ENIF 2012 and 2015

From the above, it is concluded that in both cases the users of only formal mechanisms decreased while the users of only informal systems and those using both increased. For Peña, Hoyo and Tuesta (2014) this suggests that Mexico lags behind and with savings figures lower than what would correspond to its level of development.

The fact that at the national level there is a greater number of users of informal savings than formal savings reduces the efficiency of the formal market of loanable funds, the channeling of resources towards formal markets is less. This translates into fewer resources available in banks for the financing of investment projects, causing the increase of credit. This in turn limits the financing of capital creation projects that accelerate the country's economic growth (Rivera, 2014).

On the other hand, households deprive themselves of the various benefits derived from participating in formal financial systems, such as: access to credit on terms more favorable than those provided by the informal market.

Ssecurity offered by formal savings and The possibility of managing or mitigating risks through insurance (Peña, Hoyo and Tuesta, 2014).

Given this picture of savings and credit in Mexico, the following section will explore the factors that influence and determine people's savings and loan decisions.

Determinants of household savings and credit

Two crucial variables for decision making on saving and credit are personal income and consumption, since saving is a residual income variable after spending on consumption of goods and services.

In a country as Mexico, where there is a high poverty rate and a widespread informality, the main factor that determines the possibilities and decisions of savings and loans is income. According to Hoyo et al. (2013), the main barrier to saving and obtaining formal credit financing in Mexico is the insufficiency or the instability of income.

A relevant feature of loans at the national level is that they are mostly not solicited from authorized financial institutions, but rather from relatives, friends or acquaintances (see Figure 3). This suggests that another determinant of savings and credit is membership in family networks. That is, savers have part of their disposable income stored in the hands of one or more family members, friends or acquaintances who have applied for loans. For this to be possible, people create multiple types of links or ties based on mutual trust and at the same time this gives rise to social networks or "family networks". By maintaining expectations in these relationships with multiple interpersonal links, in addition to financial services, favors, information, goods, and others are exchanged (Vélez-Ibáñez, 2010).

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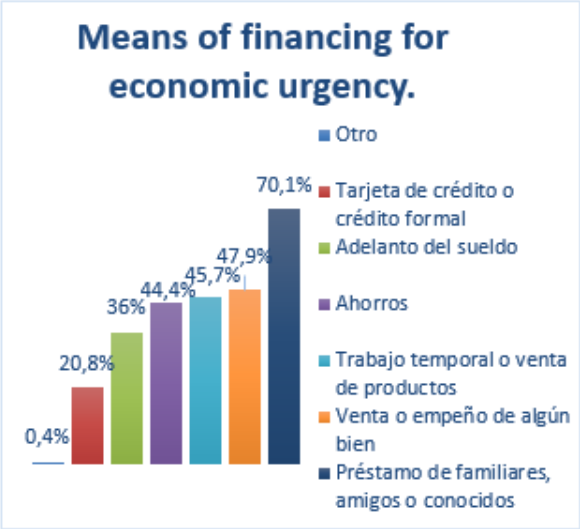
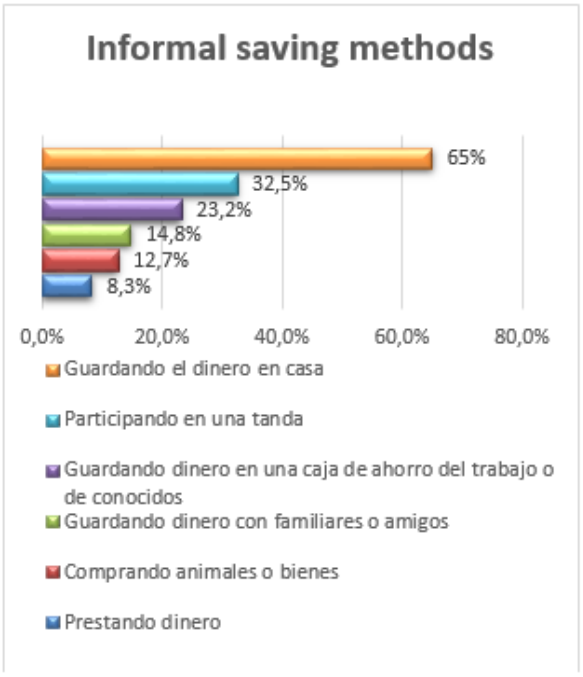


Graphic 3 Means of financing for economic urgency
The sum of the percentages is greater than 100% since the informant could mention more than one option.
Source: Own elaboration with information of the ENIF 2012 and 2015.

Thus, loans in the informal market are financed by the savings of other people who are part of their family networks, as shown in Figure 4. Note that all illustrated savings means money flows between members of family networks, being saving money at home the preferred saving mechanism.



Graphic 4 Informal saving methods
The sum of the percentages is greater than 100% since the informant could mention more than one option.
Source: Own elaboration with information of the ENIF 2012 and 2015.

Tamaño de la familia y el desempleo (Allen et al., 2012; Demirgüç-Kunt y Klapper, 2012); las regiones geográficas y nivel de desarrollo de los países (Demirgüç-Kunt y Klapper, 2012); la autoexclusión (Hoyo et al., 2013); el género, la educación, la ocupación, el tamaño de la comunidad donde habita el individuo, la preferencia por el mercado financiero informal (Peña et al., 2014); el empleo informal (Bosch et al., 2015), etcétera.

However, in this paper, the following factors will be retained, given their relevance in the savings and credit decisions of Mexicans: personal income, consumption and membership in a family network. In turn, as a determinant of income will be considered the employment status (employed or unemployed) of individuals.

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In other words, the effects of economic variables (income, consumption and labor status) on family savings will be analyzed in a social context where membership in a network may be the most important factor in savings and credit decisions of households. Households. Given the socio-economic nature of this study, we will resort to Agent-Based Modeling.

Agent-Based Modeling (MBA)

According to Ballot, Mandel and Vignes (2014), traditional economics is based on a reductionist approach in which, if one knows the basic elements of a system, it is possible to predict its behavior and properties. Thus, the tendency has been to consider as homogeneous the agents of the population of economic systems, with equal skills and rationality to process information. However, the markets and their dynamics are rather heterogeneous. Neither this feature nor the impact of institutions or social phenomena such as beliefs, imitation or loyalty has been incorporated into most microeconomic models.
In contrast, the MBA correspond to a view of socioeconomic dynamics driven by interactions between heterogeneous actors, so that individual knowledge is not sufficient to describe the overall behavior of the system. Unlike analytical models where it is not possible to differentiate individual behavior from agents, MBAs allow each agent to operate according to their own preferences or rules of individual action (even agents can learn from their past experiences in making Decisions), that is, it is heterogeneously modeled for individuals (Wilensky and Rand, 2015).

This is why the MBA plays a central role in the search for alternative economic models. In sum, it can be said that it is a valuable approach to economics for the following reasons (Gilbert, 2008; Ballot et al., 2014): (i) the importance of interaction in the economy can be addressed through the use of networks as a means to better understand and analyze economic dynamics. (Ii) It is possible to represent intangible but relevant factors such as family and social ties. (Iii) The inclusion of individual heterogeneity even allows agents to learn from their past experiences and use that information in future decision making. (Iv) Analysis can be performed at various scales. For example, from the results of the individual interactions it is possible to generate structures at the macro level. (V) It allows to understand the process and not only the final deductions. (Vi) It is possible to take into account imperfect information and limited rationality. (Vii) Provides a dynamic adjustment framework for public policy analysis and thereby facilitates the collection of predictions about the impact they may have on society. (Viii) Ensures that the mathematical and computational construction of the model is accurate, complete, consistent and unambiguous, as this is a necessary step in order to be properly programmed and executed.

Given the characteristics of the socioeconomic phenomenon of household savings, this paper will use the MBA in the analysis of the impact of family networks on the savings of Mexican households. In particular, the following section will develop and simulate an agent-based computational model.

MBA General Characteristics

A model is intended to facilitate understanding of the real world. Its main advantages are that they succinctly express the relationship between the explanatory variables and the phenomenon represented in the model, while at the same time making it possible to know better if it is possible to reproduce properly its characteristic pattern, or reference pattern. In the context of the MBA, this translates into finding a set of agents that, by providing them with certain rules, generate the underlying reference pattern of the phenomenon (Wilensky and Rand, 2015), which in this case is household savings.

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The following describes elements of the basic structure of an agent-based model.

Models under this approach are composed of agents endowed with four fundamental attributes: autonomy, social ability to interact, reaction to stimuli and pro-activation (goals to be established by the agents themselves). In addition to these attributes, we have the following: perception of the environment, memory to store perceptions and experiences, movement, execution of actions and rules or strategies that determine their behavior (Gilbert, 2008). In addition, agents have limited rationality (as a consequence of the complexity that heterogeneity and interactions) and their rules of the game are precisely modeled.

On the other hand, models incorporate randomness, since decisions can be made on the basis of probabilities (Wilensky and Rand, 2015). It is also possible to represent multiple scales of analysis, such as the emergence of structures at the macro level from individual actions. This global behavior or macro is revealed as a society, since in isolation, the facts (in the virtual and real world) would be completely different in the absence of the scenario of trust, communication and exchange of physical or intangible goods between the people. That is, the individual values are incorporated by mere summation to obtain aggregate values (Ballot et al., 2014).

The NetLogo simulation platform

The most popular agent-based simulation tool is the NetLogo free computing platform (Garcia-Valdecasas, 2016). According to Tisue and Wilensky (2004), NetLogo is a programming language environment where multiple agents and characteristics coexist that is useful to simulate natural and social phenomena.

It particularly adapts to models with complex systems that evolve over time and allows to give instructions to hundreds or thousands of independent agents, all operating simultaneously. This makes it possible to explore the connections and influence that exist between the behaviors of individuals at the micro level and the patterns at the macro level that arise from interactions. Even this program facilitates experimentation because experiments can be repeated to identify variations in dynamics and outcomes (Wilenksy and Rand, 2015).

In this computational platform, agents follow certain predetermined rules of behavior, both when isolated, and when they coexist and interact with other agents. The results of these interactions can be very diverse depending on how they are programmed both the environment and the rules of behavior of the agents (Fioretti, 2013).

The programs in NetLogo have three parts. First is the section that indicates the types of agents that will be there (called turtles) and the name of the variables that will be available for all the agents (global variables). Next, there is the so-called configuration procedure, which initiates the computational simulation. Finally the tracking procedure is found, which is repeatedly executed by the system in the order in which the simulation is executed (Gilbert, 2008). The following section presents the agent-based model for saving households in Mexico, based on the NetLogo language.

An agent-based model for household saving

Agents

The agents in this model of savings are the households, because it is within the same that give the fundamental decisions of work and consumption.

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The home is also a core of important social linkage, since the more links are with other households, the greater the sources of financing for tied agents. These ties will be called family networks.

Thus, unlike models where the location of agents plays a crucial role in the simulation of the program, in this model what is important is the representation of connections between agents.

The rules of household behavior on savings and savings are related to various explanatory variables such as employment status, income, consumption and the degree of solidity the connections between households, among others, described below.

Variables

The independent or explanatory variables that define the behavior of the agents in the system are the following:

- Members: average number of household members nationwide.
- Economically active members: number of household members who are able to work, regardless of whether they are employed or not.
- Members with work: number of household members with employment.
- Unemployment: difference between economically active members and members with work.
- Status: indicates the decile of income and expense to which each household belongs. This variable randomly distributes agents in deciles. Depending on the decile, the level of income and expenditure are then assigned.
- Income: constituted by ten deciles that represent the income of households..
- Expenditure: it represents the part of the income that is destined to the consumption of the households, which also is divided into ten deciles.
- Excess: remnant of income that has not been consumed by households. That is, it is obtained as the difference between income and expenditure, so that its value can be positive or negative. A positive value means that the household has savings, while a negative value means that you have incurred debt.
- Savings: collects the excess in each iteration. If such excess is greater than a certain number (called a limit), the household will decide whether to save it formally at the bank, or informally in the form of a loan to a member of its network that requires it. If the excess is less, use the informal mechanism to keep it at home.
- Limit: it is the reference value from which the household makes its saving decisions.
- Savings at home: the excess of income accumulated at home.
- Savings in the bank: it is the excess of income of the homes formally saved.
- Family loans: records all household savings that have been kept in the hands of some other agent who needed loans. Some agents borrow what they need to meet their spending needs, while others lend according to their savings situation available.

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- Extended family: counts the bonds that each household has with other households. These links form family networks and are so strong that, if an agent needs a loan, any member of your network can provide the loan, if your savings allow it.

- n: represents the number of agents or households in the environment, ready to interact. This variable can take values between 0 and 1000.

- gm: coefficient that indicates the strength of the family and social connections or connections in the environment. Their value is between 0 and 10. The smaller this value, the smaller the links between households, reducing the possibility of loans between relatives, friends or acquaintances. On the contrary, a high value translates into a great trust between the population and therefore a large amount of loans, links and networks in the environment.

Pseudo-codigo

This part presents the pseudo-code of programming of the household savings model, in order to facilitate their understanding. It consists of an informal blend of natural language and programming that clearly and simply shows the structure and flow of the developed program.
The programming pseudo-code has two parts, initialization (called setup in NetLogo) and execution (go in NetLogo). Initialization indicates the types of agents and global variable variables. In the execution, the simulation starts (configuration procedure) and the tracking procedure, which is everything that allows the interactions between the agents and the system to be repeated in the order of the simulation.
Initialization:

- Global variables that count the total income, the different types of savings and the deciles in which the income is divided are created.

- The class of agents "families", as well as their categories called "family" is created.

- Families are characterized: number of members, being economically active, having employment, income, expenditure, remaining income, saving, status of informal, formal savings, saving at home, saving at a bank, lending money to relatives or Friends, have family ties in addition to nuclear, review, belong to some decile of income and add.

Ejecution:

- The enviroment is cleaned.

- A grafic circle representation is asigned to family.

- Families are created and dstributed randomly in the enviroment.

- Families' size is adjusted and are distinguished by colors.

- Families' bounds are created and colors are asigned to them.

- Families with links are considered as extended family.

- Member number is randomly asigned to each amily.

- Those who are economically active are specified.

- Those who are employed are specified.

- Starts the status of the income deciles.
- Savings in banks and family loans are started at zero.
- Every tenth of the families are assigned a decile.
- Links are created between families, determined by the value of gm.
- The family income is added to the total income.
- Income is distributed by deciles.
- In each decile the income and expenditure are assigned according to the gamma distribution.
- Families with excess income are identified.
- Agents with excess income are given the ability to lend.
- Those who have excessive negative income are given the ability to borrow.
- If families have savings greater than a pre-set value, they will save it at a bank or lend it to a member of their network. If not, they will keep it at home.
- If the excess income is negative, borrow money from someone in your network with excess positive income.
- The formal savings are accounted for with the proceeds in banks, and the informal savings with the money borrowed and kept at home.
- The proportions of those who used both mechanisms, from those who only used formal savings and those who only used informal savings, are presented.
- Finish the simulation.

Parametrization

The model was simulated using the most recent official data published by INEGI in the National Household Income and Expenditure Survey (ENIGH) and in the National Financial Inclusion Survey (ENIF). Thus, the model is first simulated for 2012 and then for 2014-2015. This is because the ENIGH reports socio-economic data for 2012 and 2014, while the ENIF reports saving and credit data for 2012 and 2015.

The average value of the variable members was 3.7 members per household in 2012 and in 2014 3.8. Then in the program agents are initially provided with 2 members plus a random integer between 0 and 4 to generate households with an approximate amount to the national average.

The average value of the variable economically active members was 1.7 in 2012 and 2014, so the program is assigned a value close to 1 plus an integer random number between 0 and 3.

The average value of the variable members with work was 1.7 in 2012 and 1.6 in 2014. In the program it is assigned a random decimal number between 0 and 1.7 plus an inferred number of a Poisson distribution.

The variable unemployment is deduced from the previous two.

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The income variable is made up of ten deciles, as is its real counterpart reported by INEGI (2015): Average quarterly total current income per household (in millions of Mexican pesos and at constant prices in 2014). The INEGI data are quarterly, so they were divided between three to approximate them to monthly data. To divide the income by deciles was used the fact that income in Mexico had a Gini coefficient of 0.44 in 2012 and 0.438 in 2014. This translates into a positive asymmetry, so that the monthly values were adjusted a Distribution function Gamma: $\Gamma(k, \lambda)$, from which the distribution of income per deciles.

As income in Mexico reflects a great deal of inequality (CONEVAL, 2013), we chose k = 2. This generates a greater variance in the income distribution of the country's households. From this value and the average of the income we derive $\lambda = k /$ average. Finally, the variance is obtained as: variance $= k\lambda \wedge 2$. The values per decile of the mean of the income and of the parameter λ are shown in Table 3 (Annex).

For the estimation of expenditure per decile, the same procedure was used as for income, since it is also divided into ten deciles according to INEGI (2015): Quarterly average monetary expenditure per household. That is, quarterly data on household expenditure on final goods and services (variable in millions of pesos at constant 2014 prices) approximate monthly data. From these, a Gamma distribution function, with parameter k = 4, is estimated. This in order to reproduce a relatively soft household consumption. The values per decile of the expenditure average and the parameter λ are shown in Table 4 (Annex).

The excess variable is obtained as the difference between the income and the expenditure previously obtained. These values accumulate in the savings variable.

Depending on its value in each iteration, the household decides whether to save it using formal or informal mechanisms. For this he compares it with the limit. The rule is that if the excess of an agent is greater than that amount (which is set at 2200 pesos), you can choose to save it in the bank or informally in the form of a loan to an agent that requires it. If the excess is less, it will keep at home (variable savings at home).

Savings in banks is the variable where all the excess of income of the households is formally saved in the bank. Similarly, the family loans variable records the household surplus that has been kept in the hands of some other agent who needed loans.

The variable n of number of households living in the environment is assigned the value of 800.

The variable gm average grade for 2012 was assigned a value of 3.0 and 4.7 for 2014-2015, was assigned a higher value because in the two years that passed in this period of time increased the participation of Mexican households in saving Informal with loans between them, that is to say, the strength of the social bonds that allow the financing of loans grew.

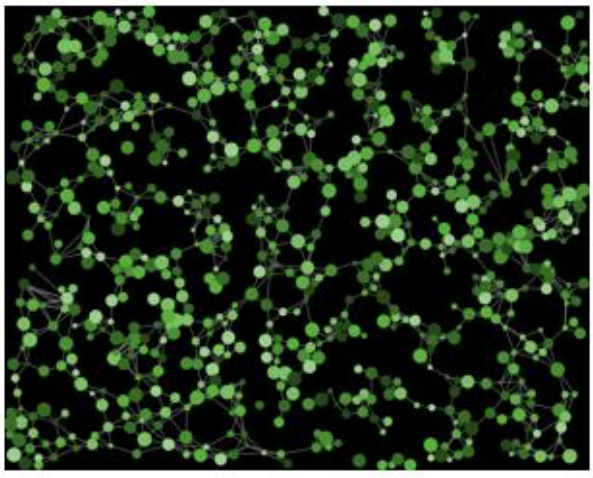
With these values, you can proceed with the simulation of the model for 2012 and 2014-2015. The results are presented in the following section.

Simulations results

The differences between the simulations for 2012 and 2014 are derived from the differences between the levels of income and expenditure of households in each year, as well as the random elements included to approximate the values of the model variables.

This randomness makes each simulation for a given year yield slightly different results, albeit with minimal variations. To reduce the effect of the random component, 100 simulations were performed for each year and the averages of the estimated variables were obtained.

The family networks created in one of the simulations for 2014 can be seen in Figure 5. The green circles represent the families and differ in size according to the members of each. Families belonging to the same network are linked with lines that reflect the various links.



Graphic 5 Family networks formed in a simulation for 2014-2015. Source: own elaboration through the simulation of the model

Table 1 reports the average values of the simulations along with the observed values. Three key parameters are also added in the definition of family networks (number of families and average grade) and savings decisions (limit), in order to facilitate the evaluation of the model.

Variable	Simulated values	Simulated values	Observed values	Observed values
	2012	2014	2012	2015
Informal savings only	28.7%	33.9%	26.2%	32.4%
Formal savings only	16.2%	16.1%	18%	15.1%
Both of them	14.1%	15.3%	17.5%	28.9%
Informal savings	42.8%	49.2%	43.7%	61.3%
Formal savings	30.3%	31.4%	35.5%	44%
Limit to decide to save on banks	*$2,200*	*$2,200*	--	--
Number of families	*800*	*800*	--	--
Average grade	*3.0*	*4.7*	--	--

Table 1 Simulated values and observed values for 2012 and 2014-2015. Source: Own elaboration based on the simulations of the INEGI model and data

Model evaluation

To determine if the implemented model explains the phenomenon of household savings in Mexico, it is necessary, among other things, that the individual and aggregate patterns deduced from the simulations correspond to the pairs reflected in the data. This comparison between the observed values and the values generated by the model is part of the validation process of the model (Wilensky and Rand, 2015).

The data in Table 1 show that the model is capable of reproducing the trends observed in both years in saving in Mexico. That is, from 2012 to 2014, in both simulated and observed data, the following is observed regarding savings preferences:

- The proportion of savers using only informal saving mechanisms increased (see first row).

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- On the contrary, the proportion of savers users only formal mechanisms decreased (see second row).

- The proportion of users of both mechanisms increased (see third row).

- The proportion of total users of informal savings increased (see fourth row).

- The proportion of total users of formal savings increased (see fifth row).

As in the data, there is an increase in the number of savers, both formal and informal. However, this increase is explained by the higher percentage of users of only informal mechanisms, at the cost of the reduction of users of formal mechanisms. In other words, savings increased, but their composition changed in favor of the informal sector.

On the other hand, most of the values generated by the model are very close to the observed values. This is best seen in Table 2, which shows a measure of the explanatory power of the model, given by the percentage proportion that represents the simulated value in the estimated value.

This table shows a better adjustment for 2012 than for 2015. This may be due to the fact that for that year the model was parameterized with both values of 2014 and 2015, due to the limitation in the data. Thus, in 2012 the explanatory power of the model is higher than 80% in the five categories of savings, although slightly overestimates the first. Its performance decreases in 2014, as it slightly overestimates the proportions of users of the first two mechanisms (only informal and only formal) and widely underestimates the proportion of users of both. However, its explanatory power is greater than 50% in all cases.

Variable	Simulated values Simulated values	Simulated values Simulated values
	2012	**2014**
Informal savings only	109.5%	104.6%
Only formal savings	90%	106.6%
Both of them	80.6%	52.9%
Informal savings	97.9%	80.3%
Formal savings	85.4%	71.4%

Tabla 2 Explanatory power of the model. Source: Made by myself

In sum, the previous results point to the validity of the model, since it succeeds in reproducing the underlying pattern of household saving in Mexico and its operation resembles that of the real world. This is, as in reality, in our virtual society, households have as main means of financing the informal sector, granting and borrowing from the members of the social networks to which they belong.

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Conclusions

In the present work, an agent-based model was constructed to study the effect of social networks on saving in Mexican households in 2012 and 2014. The simulations of the model allow us to conclude that the family networks stimulate the increase of informal savings, preferring to meet the needs of financing within them rather than using formal mechanisms.

Although the model can reproduce qualitatively the trends observed in the different types of savings, it is necessary to extend its scope to other years and variables to validate it satisfactorily also in a quantitative way. This would allow their use in the analysis and design of policies to stimulate savings, for example. However, it is a good starting point for a better understanding of saving in Mexico.

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Multimedia animations of stories and legends of the Huasteca Culture

JIMÉNEZ-MALDONADO, Rosa María†*, HERNÁNDEZ-LÓPEZ, Dalia Rosario, PIEDAD-RUBIO, Ana María and ECHEVERRIA-MORALES, Karla Guadalupe

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Abstract

This project aims to design and develop multimedia animations stories and legends of the Huasteca culture to language learning Tének, in order to change the conventional format ink and paper to digital format supported by graphics technology to create products. For the development of this training material a two-phase methodology was followed, first, target identification and choice of material to use, second, submission of scripts and audio sketches integration. As a result, four animated stories and legends of the culture with the main characteristic of deep cultural scenarios were obtained, nevertheless it introduces characters designed with a modern touch of the anime, allowing to bring to a current context and help to become popular among young internet users. The Tének, spoken in the region known as the Huasteca (Veracruz and San Luis Potosi), in the Gulf of Mexico (Ochoa, 1883). According to INEGI today, there are at least 174,000 speakers. Like most indigenous languages of Mexico the Tének subsists until today thanks to orality however according to the General Law of Linguistic Rights Tének have the right to communicate and become literate in their own language.

Didactic material, Language Learning, Rescue of Indigenous Languages

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* Correspondence to Author (email: rosa.jimenez@tecvalles.mx)
† Researcher contributing first author.

Introduction

The present project aims to design and develop multimedia animations of stories and legends of the Huasteca culture for learning the Tének language.

It is intended to change the conventional format of ink and paper to the digital format supported technology to create graphical products that at the same time show both the writing and the pronunciation of the Tének language, Promoting the learning of it through computer tools with which young people are acquainted and motivated by being digital natives and where the visual is imposed in support of intercultural education.

This work is a fundamental part of the development of learning activities for the Educational Platform Ka exla´ Designed to literate adult speakers of the Tének language to strengthen writing, helping to move from orality to written language in this way speakers will be able to perpetuate their knowledge and perspective of the world that surrounds them, besides supporting to diminish the digital divide in the communities where this platform is used.

The work was carried out in two phases, the first is to design didactic material and the second one in the elaboration of the contents.

As a result, we obtained four animations of tales and legends of the Tének culture, whose visual design it oscillates between cultural aspects very traditional in its scenes with touches of modernity in the illustration of the main personages.

Background of the Tének Language

At least 43% of the approximately 6,000 spoken languages in the world are in danger of extinction with the disappearance of unwritten and undocumented languages.

Humanity would lose great cultural wealth (UNESCO, 2015). One of the recurring reasons for the loss of a language, is its abandonment as a strategy of adaptation to a social context whose norms have radically changed (Grenoble/Whaley 1998). In Mexico there are 85 defined languages (INEGI, 2010), In addition, 25 indigenous regions are identified in 20 states of the country, mainly in the states Chiapas, Chihuahua, Guerrero, Hidalgo, Oaxaca, Puebla, San Luis Potosí, Veracruz and Yucatán Being 25% of the existing municipalities of the country of indigenous origin.(Official Journal of the Federation SEGOB, 2014), the survival of a language depends to a large extent on the desire, by its speakers, to maintain and transmit the language to the next generations (Fishman 1991).

The state of San Luis Potosí occupied for 2006 the seventh place in speakers of indigenous languages among which are: The Tének, náhuatl and Xi' úi (INEE, 2006). At present, at least 173,765 people in Mexico speak the Huasteco (INEGI, 2010), which is also called Tének, is a fundamentally oral language, of the family mayense that is in the region known as the Huasteca, In the Gulf of Mexico (Ramírez, 2003), population that is mainly located in the states of Veracruz and San Luis Potosí, the process of socialization in a culture is, to a large degree, to acquisition in and through the language (Ochs/Schieffelin 1987). A bilingual speaker can be identified by his linguistic traits, which can lead to attitudes of discrimination and exclusion on the part of the dominant group towards the minority group, or to feelings of familiarity, recognition and complicity among those who share the language (TabouretKeller 1997).

To this day many speakers stop teaching their children the language, they comment,

[…] Why teach them, if they are going to criticize them, they will no longer need it.

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Some bilingual teachers confront these mothers who demand that they no longer teach them at Tének and accuse them of reporting them to the authorities because of ignorance of current policies to revitalize native languages. The program for the revitalization, strengthening and development of the indigenous national languages 2008-2012 and that remained in previous policies of castilianization where children were prohibited from using their language in the classroom. (González, 2009)

In San Luis Potosí, great efforts have been made to promote the use of their native languages, mainly by the number of speaking population in the state, together each one, promotes that the Tének language creates bases rooted in the community and allows their users users exercise the right to communicate in their own language, considering that this language is only of oral tradition and that there are variants of the same, it has been difficult to define a standard for its writing, from which however there are already complete proposals that are taken as basis for this work, which identifies the importance of teaching reading and writing, because there are very few speakers who can make extensive use of written language, but it has been noticed the great interest that exists to know and learn from it.

Teaching materials

The teaching material is any instrument or support tool in the teaching-learning process.

The first teaching material recognized the Orbis Sensualim Pictus of J.A. Comenius of the seventeenth century, which did not contain the intention to ease knowledge with text and images according to apprentices.

Although it is not until the nineteenth century that this reaches its fullness, printed didactic material becomes a fundamental part of the teaching-learning process at any level.

However, at the end of the 20th century with the incorporation of Information and Communication Technologies (ICTs) in educational environments and in homes, didactic materials are also impacted and move towards the modernity of these environments.

Online education or e-learning is supported by the development of these materials to make meaningful learning for its users. However, the development of these materials also serves as a support in the classroom because in this environment of over visual stimulation students find them more attractive.

Preparation of Multimedia Didactic Materials

In order to facilitate the development of multimedia materials that comply with the stated objectives, the following steps were followed: Design of material and elaboration of contents.
In the material design, an analysis was made that defines the design that involves the thematic areas, how they are grouped and how to present it.

Meetings were held with an interdisciplinary group that collaborated in the development of this project comprised of bilingual teachers, application developers, teachers in educational technologies and designers. Ilustration 1

Figura 1 Work meetings

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Where it was determined that this material aims to strengthen teaching through reading practice and auditory registration and pronunciation of the Tének language, in addition to the material developed outside audiovisual, thus promoting two learning styles.

After that, we proceeded to the selection of teaching elements that could fulfill these objectives once incorporated multimedia, Cultural Tales and Legends were selected from a reading book that is used within bilingual school's and that others were written by children of several school's and compiled by Prof. Nefi Fernandez Acosta Mtro ethnolinguist collaborator of the project Ilustration 2

Figura 2 reading book

These books were evaluated by the collaboration group and later we requested an evaluation of the archaeologist Guillermo Ahuja who has a sufficient experience working for the Tének culture.

Content development

Once the material design is completed, went to the elaboration beginning by the writing of contents where it was decided to reduce the text of the stories and legends almost in 50% since in the computer one reads 25% slower than in paper, for this an adaptation was made to each story, in addition to include a dialogue between characters since in the written text this is an account. Ilustration 3

Figura 3 Text script

Later the script was done that describes each scene and include its dialogue for the work of sketches. After finishing the script with sketches, the scenarios were elaborated, using tablets converted to drawing tablets to digitize the sketches, as well as incorporating color and movement of each scene. Ilustrations 4, 5, 6, 7, 8, 9

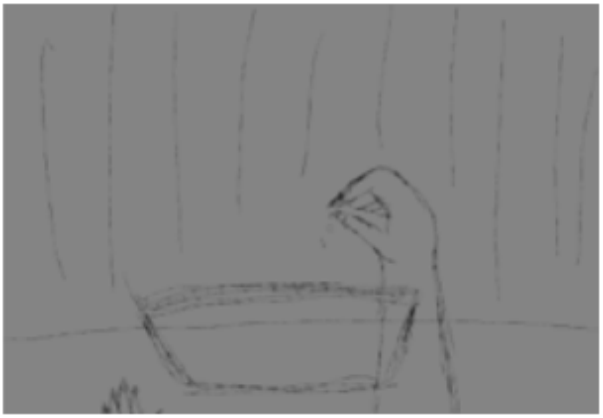

Figura 4 Drawing sketch

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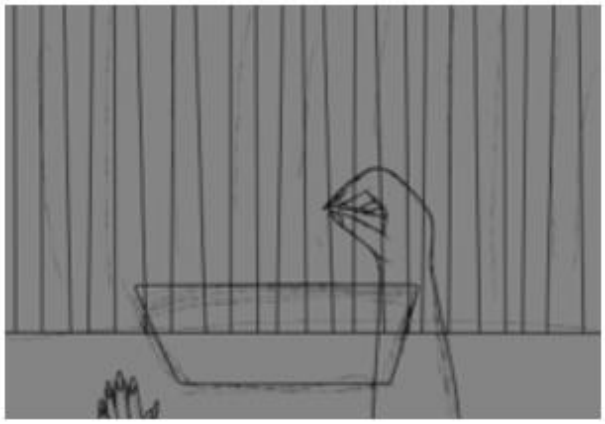

Figura 5 Drawing lines

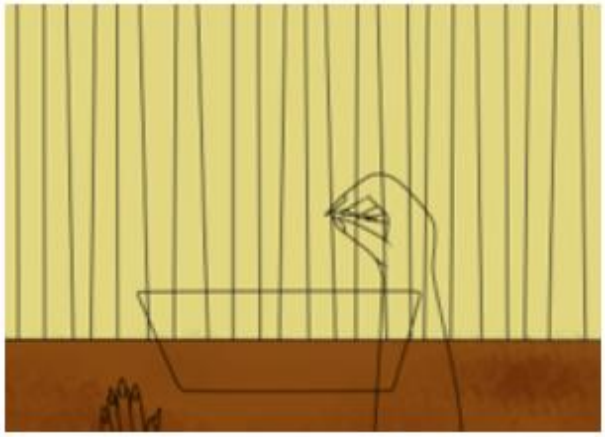

Figura 6 scenarios

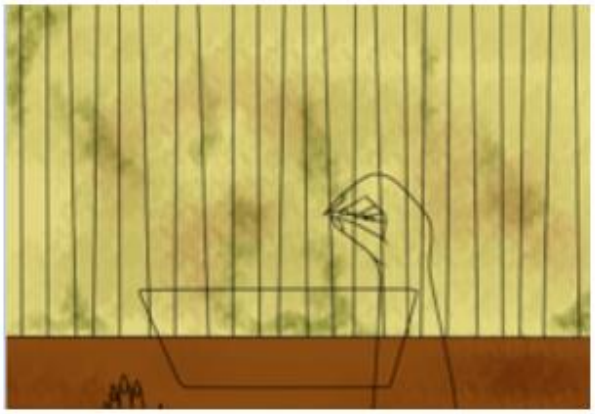

Figura 7 coloring scenarios

Figura 8 Incorporation of objects

Figura 9 Incorporation of characters

Finally, the audio and text are incorporated to each resulting material, this through the capture of readings of students speaking the Tének.

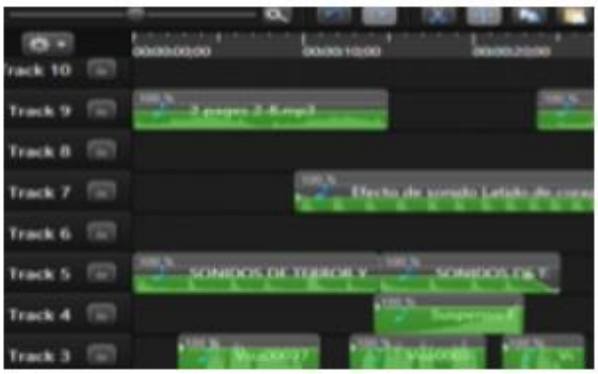

Figura 10 audio recording

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Figura 11 Incorporating audio to animations

Results

As a result, two stories and two legends of the Tének culture were developed, these animations have scenarios that describe very well the contexts of the indigenous communities that are in our region, the characters of each animation have modern roots that invite the viewer a little to contextualize them in the very famous oriental animations, however, the stories told date back to an oral tradition of culture, very old. Ilustraciones 12, 13, 14 y 15

Figura 12 The story of Musi'lam

Figura 13 The man and the ejénchix

Figura 14 The man and the buzzard

Figura 15 The story of the banana dog

This material is part of a module that integrates the Ka exla 'platform, which is dedicated to collecting texts from the community contexts and the memories within it.

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However, we believe that due to the excellent result we decided to present them in a particular way.

Annexes

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Economic Competitiveness: A Principal-Components Analysis for Latin America and Europe in a Comparative Perspective

MORENO-PLASCENCIA, Jorge Raúl†* & VÁZQUEZ-OLARRA, Glafira

Universidad Politécnica de Pénjamo. Carretera Irapuato - La Piedad Km. 44, Pénjamo, Gto., C.P. 36921. E-mail addresses of the authors: jmoreno@uppenjamo.edu.mx; gvazquez@uppenjamo.edu.mx.

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Abstract

We study economic competitiveness using principal-components analysis for Latin America and Europe. We construct an aggregate economic competitiveness index in order to measure fifteen dimensions related to endogenous and exogenous economic performance. Moreover, we analyze economic competitiveness behavior, per country, during the period 2001-2011. The results suggest that the most important variables related to economic competitiveness are the Exports of Goods and Services as a percentage of GDP, the Per Capita GDP; and the Commercial Sector. We conclude that in a globalized trade context, the strengthen of the markets, in terms of exportations, commerce, and its positive spillovers like the increase of the GDP per capita; would improve economic competitiveness of countries. We use annual data for twenty economies obtained from the World Bank, Cepalstat, and Eurostat database.

Competitiveness, Sectors, Principal Components Analysis (PCA), Europe, Latin America

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* Correspondence to Author (email: rosa.jimenez@tecvalles.mx)
† Researcher contributing first author.

Introduction

Paradoxically, there is no consensus to define competitiveness. According to the OECD (2001) economic competitiveness is the level in which countries can produce goods and services to preserve and increase the income of their populations on the long run. For the International Institute for Management Development (2013) competitiveness is a measurement of countries ability to create and maintain an environment that sustains value creation for its enterprises and prosperity for its people. The World Economic Forum (2013) defines competitiveness as a framework of institutions, policies and factors that determines countries´ productivity. For the World Bank (2014) competitiveness is related to the state regulations that conditionate firms´ performance and national competitiveness. In addition to the previous concepts, the European Union (2013) argues that the competitiveness of a territory is also a systemic concept.

We study competitiveness emphasizing a multidimensional analysis. A multidimensional approach generates accurate and specialize results. According to Bruneckiene and Paltanaviciene (2012) the competitiveness estimations produces several advantages: a) data analysis for investors that show, by socio-economic dimension, potential strengths and weaknesses. b) For governments, to offer crucial information in decision-making procedures. c) For companies, giving strong empirical evidence to measure economic factors and the specific subdivisions of development. d) For the academic field, to generate quantitative results which support scientific studies. And, e) for the society, doing evaluations for national economic performance and government intervention policies.

In this framework, we believe necessary the construction of an economic competitiveness index that can overcome the methodological limitations of other indices.

These limitations include the availability of comparable data, the complexity of the indicators, the use of quantitative and qualitative variables, etc. What we propose is to build such indices with basis on principal-components and panel-data. We aim at overcoming the limitations indicated above. We use this approach because it allows us to establish the main determinants of competitiveness with basis on statistical criteria. We build such indices under the consideration that competitiveness cannot necessarily be constrained to a single measure. Using World Bank, Cepalstat and Eurostat databases, we create our own information panel data according to statistical comparative equivalences.

Insofar to the design of our study, we present the results of our research according to the next order: First, we provide an academic context of the approaches to the study of competitiveness. Next, we explore the recent literature related to the measurement of competitiveness in a brief review. Then, we describe the methodology that we apply to estimate competitiveness. In addition, we present the results of our research in three subsequent parts: the descriptive statistics, the statistical analysis of the variables, and the ranking of the economic competitiveness with the annual analysis of the performance for the three top countries ranked. Finally, we show the principal components analysis results and posit our conclusions.

The Economic Competitiveness of Countries

Economic competition is a very important precondition that affects the effectiveness of development of national economy under the conditions of globalization (Stevans, Neelankavil, Mendoza and Shankar, 2012). Economists use to argue that economic globalization has the potential of increasing economic welfare for all.

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In traditional economics, the competitiveness of countries is determined through production inputs. Those inputs like labor, land, capital, and natural resources has been the measures of competitiveness mostly quantifiable factors that contributed to the gross domestic product of a country. In the era of globalization and the resulting interlink between countries and their economic interdependence, classical theories of competitiveness are no applicable due to modern dynamics of economic performance. Besides quantifiable factors, qualitative influences are equally important in determining competitiveness. Factors like public and private issues, institutional governmental actuations, extractive procedures and development subjects, among others (Tan, 2004).

An economic competitiveness index is a systematic instrument, which estimates the performance of a particular economy; it is strongly linked with a general evaluation using specific dimensions. An economic competitiveness index implies variables related with commerce, performance of firms, economic growth estimations, among others. In a quantitative way, an economic competitiveness index is calculated using econometric models for correlated variables of socio-economic data. There are a couple of economic competitiveness indices that are the most accepted of the market:

1. The World Economic Forum´s Global Competitiveness Index: Calculated every year since 1979, is an instrument that measures the ability of countries to supply high levels of prosperity to their population. It estimates the effectiveness of a country using their productive resources at short and long run. The calculus works using public information and the results of the executive survey to great businesspersons who participate at the World Economic Forum in Davos, Switzerland. The evaluation uses 140 world economies per annum (www.weforum.org).

2. The IMD World Competitiveness Yearbook (WCY): Elaborated for the IMD World Competitiveness Center. The study has been made since 1989. It measures the economic competitiveness of nations; in other words, produces a classification that shows how different economies managed their resources and competences to increase the quality of life of their population. It compares the competitiveness of 60 countries and uses at least 300 elements of analysis. The IMD World Competitiveness Yearbook is developed using four socio-economical dimensions. Those sectors are measured using top business executives survey and data from international institutions like World Bank, IMF, OECD, among others. They give variables weights in an arbitrary way according to preliminary sectors delimitation in order of importance. IMD World Competitiveness Yearbook is considered the most reliable instrument for economic performance comparisons and professional benchmarking (www.imd.org/wcc/).

Many other studies have been developing alternative models to determinate economic competitiveness. For instance, using firm's regulations as competitiveness main determinant (World Bank Doing Business Index, 2014). To rank international competitiveness according to a specific industry development (IMCO International Competitiveness Index, 2011). And even to measure regional competitiveness, in a comparative way for a unified market (EU Regional Competitiveness Index, 2013). Those studies are focusing on the solution of several problems from original sources: econometric (or statistical) modeling corrections, simplification in the presentation of results, optimal recollection of data, and other adjustment techniques (Oral and Chabchoub, 1996).

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Countries strive for competitiveness to attract foreign direct investments (FDI) and also to attract skilled work-force to their shores. Besides the quantifiable factors and the natural resources of a country, some qualitative variables are also important to achieve competitiveness. Competitiveness is a unit that can measure the relation between economic growth and national development. Furthermore comparisons between development platforms are possible using a competitiveness index (Ogrean, Herciu, 2012). Steve Lall demonstrated how important is competitiveness measuring for decision makers. His study suggests the necessity to coordinate competitiveness information with a precise analysis to launch reasonable platforms of development (Lall, 2001).

Literature Review

There are several proposals to establish rankings of economic competitiveness. For instance, The World Bank Doing Business Index (2014) uses firm´s regulations to establish the degree of competitiveness. The IMCO International Competitiveness Index (2011) considers the degree of industry development. The European Union Regional Competitiveness Index (2013) measure the degree of regional competitiveness.

Methologically, these indices are built using several techniques. However we should recognize that several problems exist to build adequate measures. These problems include econometric modeling problems, complex results, and data unavailable, among others.

Reiljan, Hinrikus and Ivanov (2000) state that economic competitiveness studies show the importance of having indices per dimensions. According to this idea, the complexity of competitiveness scrutiny can be reduced with multidimensional analysis.

Buracas, Zvirblis and Joksiene (2012) say that economic competitiveness can be interpreted as multidimensional phenomena; and because of that, should be measured using multicriteria methodologies. Jesionsky (1996) indicate that competitiveness indices as an overall ranking are not precise; and for that reason, competitiveness measurement should be differentiated. These kinds of results, the author concludes, can produce distinctive rankings that should be very useful for small and medium size economies.

Ogrean and Herciu (2012) admitted that a multidimensional study of competitiveness allows the structuration of competitiveness comparisons. Bruneckiene, Cincikaite and Kilijoniene (2012) add that according to national and international perspectives, multidimensional studies can measure public policies effectiveness for specific socioeconomic dimensions. Several studies and estimations prove that a multidimensional measurement of competitiveness implies more precise results and a necessary differentiated focus.

Methodology

The principal components analysis (PCA) is a method for re-expressing multivariate data. It allows reorienting the data so that the first few dimensions account for much as information as possible. The central idea is based on the concept of the proportion of the total variance (the sum of the variance of the p original variables) that is accounted for by each of the new variables. PCA transforms the set of correlated variables (x1... xp) to a set of uncorrelated variables (y1...yp) called principal components in such a way that y1 explains the maximum possible of the total variance, y2 the maximum possible of the remaining variance, and so on.

The aim of PCA is to interpret the underlying structure of the data in terms of the most important principal components.

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Usually, the first principal component may be interpreted as a measure of what is common to the set of correlated variables (x1...xp). Such interpretation relies on the fact that the first principal component is the best one-dimensional summary of the data. Particularly, for the aims of the analysis developed here, the first principal component may be interpreted as a scale index that summarizes the information contained on a particular set of variables.

Descriptive Statistics

According with our selection of variables, we use a sample of 220 observations for the 20 study countries. Variables listing in the economic competitiveness index construction are organize and describe as follows:

Variable	Description
ecppib	GDP at constant prices (dollars).
ecpibc	GDP per capita in constant prices
ectpib	Annual growth rate of GDP
eccpib	Annual growth rate of GDP per capita
ecahbr	Gross saving as a percentage of GDP
ecinve	Foreign direct investment (dollars)
ecbcbs	Trade balance of goods and services as a percentage of GDP
eccom	Commercial sector as percentage of GDP
ecebys	Exports of goods and services as a percentage of GDP
ecfbc	Gross capital formation as a percentage of GDP
ecggf	Final consumption expenditure of the federal government as a percentage of GDP
ecrese	Total reserves (dollars)
ecgnb	Gross national expenditure as percentage of GDP
ecibys	Imports of goods and services as a percentage of GDP
ecrrn	Total income from natural resources as a percentage of GDP

Source: Authors Elaboration.

Table 1 Variables Description

The descriptive statistics for the variables on the economic competitiveness index are expressed like:

Variable	Obs	Mean	Std. Dev.	Min	Max
ecppib	220	7.72E+11	8.35E+11	215900.1	3.05E+12
ecpibc	220	17774.07	16512.03	2089.79	55377.82
ectpib	220	3.125182	3.793696	-10.89	18.29
eccpib	220	2.077455	3.724217	-11.73	16.2
ecahbr	220	21.58077	6.143185	8.07	40.69
ecinve	220	2.29E+10	3.71E+10	-2.49E+10	2.62E+11
ecbcbs	220	1.402227	6.682388	-16.95	19.19
eccom	220	61.75632	23.82413	21.74	157.06
ecebys	220	31.5795	13.22574	10.87	83
ecggf	220	15.96118	5.635712	6.21	28.63
ecrese	220	6.43E+10	8.61E+10	2.61E+08	4.97E+11
ecgnb	220	98.59786	6.682322	80.81	116.95
ecibys	220	30.17714	11.45462	10.21	74.06
ecrrn	220	7.243455	10.1838	0.02	47.92

Source: Authors Elaboration.

Table 2 Variables Descriptive Statistics

Economic competitiveness index, variables pairwise correlations, provides the next results (significance levels):

	ecppib	ecpibc	ectpib	eccpib	ecahbr	ecinve	ecb
ecppib	1.0000						
ecpibc	0.5530***	1.0000					
	(0.0000)						
ectpib	-0.2932***	-0.3237***	1.0000				
	(0.0000)	(0.0000)					
eccpib	-0.1931***	-0.2337***	0.9844***	1.0000			
	(0.0040)	(0.0005)	(0.0000)				
ecahbr	-0.1189*	0.2461***	0.1136*	0.1633**	1.0000		
	(0.0785)	(0.0002)	(0.0928)	(0.0153)			
ecinve	0.5320***	0.3853***	-0.1128*	-0.0592	-0.0671	1.0000	
	(0.0000)	(0.0000)	(0.0952)	(0.3819)	(0.3215)		
ecbcbs	0.0034	0.2699***	-0.0318	0.0646	0.7560***	-0.0262	1.0
	(0.9596)	(0.0000)	(0.6386)	(0.3406)	(0.0000)	(0.6996)	
eccom	0.0527	0.6198***	-0.1205*	-0.0708	0.3573***	0.0581	0.274
	(0.4371)	(0.0000)	(0.0744)	(0.2957)	(0.0000)	(0.3909)	(0.0
	ecppib	ecpibc	ectpib	eccpib	ecahbr	ecinve	ecb

ecebys	0.0483	0.6264***	-0.1166*	-0.0475	0.5128***	0.0457	0.499
	(0.4760)	(0.0000)	(0.0844)	(0.4835)	(0.0000)	(0.4998)	(0.0
ecfbc	-0.1569**	-0.1182*	0.2914***	0.2662***	0.4811***	-0.0311	0.0
	(0.0199)	(0.0802)	(0.0000)	(0.0001)	(0.0000)	(0.6459)	(0.9
ecggf	0.5716***	0.6207***	0.3115***	0.2080***	0.0376	0.3906***	0.239
	(0.0000)	(0.0000)	(0.0000)	(0.0019)	(0.5791)	(0.0000)	(0.0
ecrese	0.3720***	0.1348**	-0.0618	0.0220	0.2150***	0.2423***	0.253
	(0.0000)	(0.0458)	(0.3613)	(0.7458)	(0.0013)	(0.0003)	(0.0
ecgnb	-0.0034	0.2699***	0.0319	-0.0645	0.7560***	0.0262	1.000
	(0.9594)	(0.0000)	(0.6385)	(0.3407)	(0.0000)	(0.6997)	(0.0
ecibys	0.0538	0.5658***	-0.1161*	-0.0925	0.1511**	0.0681	-0.0
	(0.4274)	(0.0000)	(0.0858)	(0.1716)	(0.0250)	(0.3148)	(0.9
ecrrn	0.3525***	0.4948***	0.3121***	0.3035***	0.5488***	0.1828***	0.449
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0066)	(0.00

	eccom	ecebys	ecfbc	ecggf	ecrese	ecgnb	ecil
eccom	1.0000						
ecebys	0.9701***	1.0000					
	(0.0000)						
ecfbc	-0.0542	-0.0480	1.0000				
	(0.4238)	(0.4788)					
ecggf	0.2921***	0.3236***	-0.1906***	1.0000			
	(0.0000)	(0.0000)	(0.0046)				
ecrese	-0.0732	-0.0019	0.0405	0.2391***	1.0000		
	(0.2795)	(0.9782)	(0.5506)	(0.0003)			
ecgnb	-0.2746***	-0.4999***	-0.0032	-0.2396***	-0.2538***	1.0000	
	(0.0000)	(0.0000)	(0.9620)	(0.0003)	(0.0001)		
ecibys	0.9599***	0.8630***	-0.0573	0.2339***	-0.1502**	0.0062	1.0000
	(0.0000)	(0.0000)	(0.3974)	(0.0005)	(0.0259)	(0.9277)	
ecrrn	-0.2015***	-0.0681	0.3629***	-0.2863***	0.1101	-0.4491***	0.3406***
	(0.0027)	(0.3147)	(0.0000)	(0.0000)	(0.1035)	(0.0000)	(0.0000)

	ecrrn
ecrrn	1.0000

Table 3 Variables Pairwise Correlations Analysis

Statistical Analysis

Economic competitiveness index principal components correlations and eigenvalues are expressed like:

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	4.4402	0.9652	0.2960	0.2960
Comp2	3.4750	1.2696	0.2317	0.5277
Comp3	2.2054	0.5493	0.1470	0.6747
Comp4	1.6561	0.6301	0.1104	0.7851
Comp5	1.0260	0.3474	0.0684	0.8535
Comp6	0.6785	0.1029	0.0452	0.8987
Comp7	0.5756	0.1604	0.0384	0.9371
Component	Eigenvalue	Difference	Proportion	Cumulative
Comp9	0.3218	0.1852	0.0215	0.9863
Comp10	0.1367	0.0714	0.0091	0.9954
Comp11	0.0653	0.0612	0.0044	0.9997
Comp12	0.0042	0.0042	0.0003	1.0000
Comp13	0.0000	0.0000	0.0000	1.0000
Comp14	0.0000	0.0000	0.0000	1.0000
Comp15	0.0000	.	0.0000	1.0000

Source: Authors Elaboration.

Table 4 Principal Components Eigenvalues Analysis

Eigenvalues are the scalar expression of the linear transformation of a vector space. In this case, eigenvalues reflect the variance or the information contained in the data (for each principal component). So, the component 1 has a proportion of 0.2960, this is that contains almost the 30% of the information data, and describes itself the 30% of the economic competitiveness index. The component 2 has a proportion of 0.2317, and in a cumulative with component 1, describes the 53% of the economic competitiveness index. And so on until get 100%.

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Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7
ecppib	0.1895	-0.2487	0.3504	0.2840	0.0329	-0.0160	-0.1518
ecpibc	0.4026	-0.1457	0.0266	0.1489	0.0372	-0.1330	-0.2629
ectpib	-0.1725	0.2809	-0.1838	0.5181	-0.2593	-0.0194	-0.0651
eccpib	-0.1224	0.2889	-0.1323	0.5518	-0.3021	-0.0021	-0.0913
ecahbr	0.2265	0.4197	0.0675	-0.0375	0.2730	-0.0429	-0.0797
ecinve	0.1385	-0.1691	0.2630	0.3786	0.1476	-0.3353	0.7234
ecbcbs	0.2624	0.3561	0.2312	-0.1726	-0.2315	-0.1211	-0.0221
eccom	0.3923	0.0238	-0.3585	0.0304	0.0216	0.1311	0.1347
ecebys	0.4196	0.1114	-0.2645	-0.0162	-0.0391	0.0875	0.1157
ecfbc	-0.0588	0.2473	-0.0356	0.2175	0.7708	-0.1187	-0.2829
ecggf	0.2952	-0.1589	0.2417	0.1462	-0.1235	-0.2187	-0.3282
ecrese	0.0948	0.0551	0.4167	0.1832	0.0704	0.8482	0.0632
ecgnb	-0.2625	-0.3561	-0.2312	0.1726	0.2315	0.1211	0.0221
ecibys	0.3314	-0.0791	-0.4402	0.0819	0.0900	0.1717	0.1465
ecrm	-0.0983	0.4331	0.1380	-0.0993	0.1057	-0.0489	0.3462

Variable	Comp8	Comp9	Comp10	Comp11	Comp12	Unexplain	sd
ecppib	-0.0902	0.7835	-0.1826	-0.1281	0.0509		0.0000
ecpibc	-0.3580	-0.0926	0.5536	0.5123	-0.0076		0.0000
ectpib	-0.0255	-0.0156	0.0604	-0.0206	0.7158		0.0000
eccpib	-0.0180	0.0134	-0.0269	0.0080	-0.6919		0.0000
ecahbr	-0.1613	0.0031	0.4220	-0.6917	-0.0363		0.0000
ecinve	-0.1073	-0.2511	-0.0563	-0.0668	-0.0031		0.0000
ecbcbs	-0.1407	-0.0560	-0.2861	0.1085	0.0396		0.0000
eccom	0.0972	0.0769	-0.1044	0.0047	0.0089		0.0000
ecebys	0.0520	0.0551	-0.1664	0.0316	0.0182		0.0000
ecfbc	0.0354	-0.1049	-0.3675	0.2263	0.0090		0.0000
ecggf	0.7370	-0.2735	0.0432	-0.1293	0.0221		0.0000
ecrese	0.0229	-0.2146	0.0212	0.0684	0.0262		0.0000
ecgnb	0.1407	0.0560	0.2861	-0.1085	-0.0396		0.0000
ecibys	0.1421	0.0963	-0.0251	-0.0269	-0.0026		0.0000
ecrm	0.4565	0.3971	0.3665	0.3739	-0.0132		0.0000

Source: Authors Elaboration.

Table 5 Principal Components Variables Analysis

This table reflects the information data that contains each of the economic competitiveness index variables.

For the first component, the most important variable is the exports of goods and services as a percentage of GDP (ecebys), which provides the 42% of information data. GDP per capita in constant prices (ecpibc), is the second variable in importance to the component 1. Provides the 40% of information data. This results help us to pose a preliminary conclusion: to improve economic competitiveness, is necessary increase the exports of goods and services and the GDP per capita, in that order.

Rankings

We present multidimensional indices results. We adjusted the outcomes to analyze data rankings in a comparative way. With that purpose we standardized according to the formula:

AVCP = (VCP - Min VCP / Max VCP - Min VCP) 100 (1)

Where:

AVCP = Principal Component Adjusted Value

VCP = Principal Component Value

Min VCP = Principal Component Minimum Value

Max VCP = Principal Component Maximum Value

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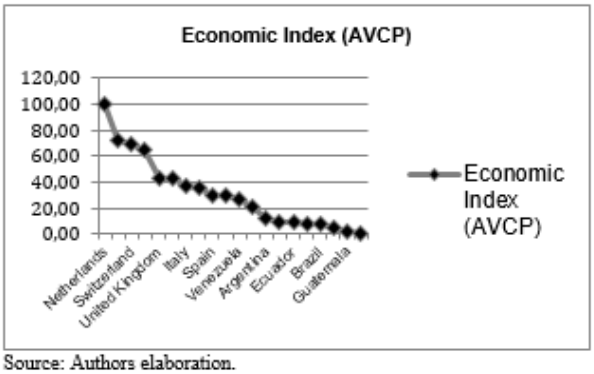
Rank	Country	Economic Index (AVCP)
1	Netherlands	100.00
2	Sweden	71.72
3	Switzerland	70.06
4	Germany	64.56
5	United Kingdom	43.79
6	France	43.26
7	Italy	36.95
8	Russia	36.32
9	Spain	29.56
10	Chile	29.43
11	Venezuela	26.63
12	Mexico	20.88
13	Argentina	12.40
14	Turkey	10.14
15	Ecuador	10.09
16	Dominican Rep.	8.35
17	Brazil	7.77
18	Peru	5.68
19	Guatemala	1.76
20	Colombia	0.00

Source: Authors elaboration. Adjusted from original results, using the methodology of Ruiz-Porras and Hosten to analyze data rankings in a comparative way (Ruiz-Porras and Hosten, 2012).

Table 6 Economic Competitiveness Index Ranking

The economic competitiveness index ranking shows many European countries at top levels. All developed economies defend their top position using their good economic performance. Many of top countries are big economies with industrialization and large infrastructure development. The second part of the ranking demonstrate how developing countries can improve their economic competitiveness increasing their exports and GDP per capita.



Source: Authors elaboration.

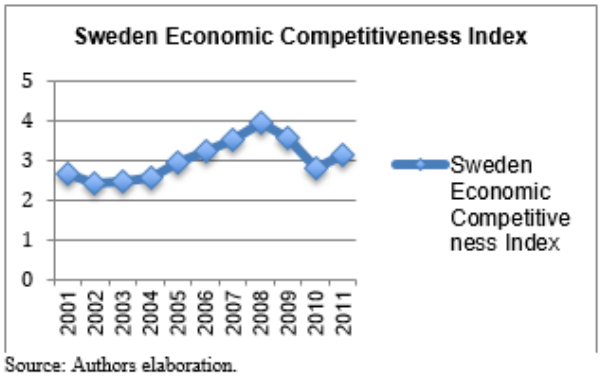
Graphic 1 Economic Competitiveness Index Graphic Comparison

The graphic expression of the economic competitiveness index ranking, allows a comparative analysis in the same geometric plane. It shows the rank difference between countries and provides the opportunity to determine how close or far is a particular country of its economic development, in comparison with others. Onwards, we show the three top countries economic competitiveness index performance. Added to the graphic modeling, we present a description of each economic competitiveness performance using time contextualization to outline preliminary conclusions.

Source: Authors elaboration.

Graphic 2 Netherlands Economic Competitiveness Index Performance

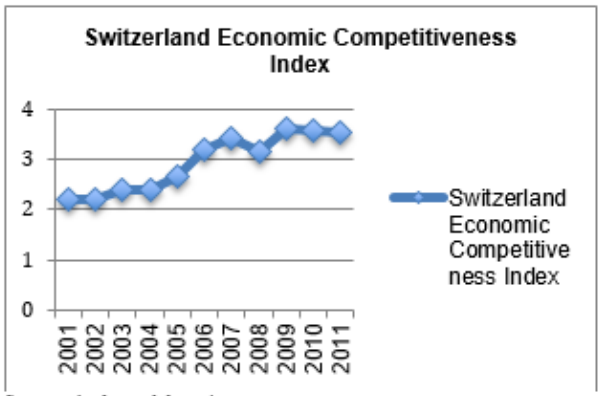
Netherlands economic competitiveness performance has increased since 2001. In 2008 and 2009 arrested its development, and even decrease, obviously as a reflection of financial crisis. It improve its performance in 2010, and for the last year, achieve its maximum level.



Source: Authors elaboration.

Graphic 3 Sweden Economic Competitiveness Index Performance

Sweden economic competitiveness performance has increase since 2001. Sweden economic constant development decrease on the period 2009-2010, as a result of world financial crisis. For the last year, the Swedish economy has a recovery. Sweden is experimenting an improvement of its economic competitiveness, but has not get its top level, that was achieved in 2008.



Source: Authors elaboration.

Graphic 4 Switzerland Economic Competitiveness Index Performance

Switzerland economic competitiveness performance has increase since 2001. Its constant development lowered its rate in 2008 period. Its increasing to high levels even after 2008 crisis and its largest improve corresponds to the 2009. Last couple of years, Switzerland economic competitiveness have been decreasing.

Principal Components Analysis

According with our primary selection of variables, we use a sample of 220 observations for 20 countries (ten biggest economies from Latin-America, and ten biggest economies from Europe).

We focus on the group of variables importance levels to competitiveness indices elaboration. Our results show the component 1 equation and variables relative weights on competitiveness determination for each dimension. In this case and because of the large number of variables, we use just the three most important variables. This analysis also allows outlining the conclusions section. Next table focuses on the group of variables importance levels to economic competitiveness index elaboration.

Variables	Equation
ecebys (0.4196)	Comp1= (0.4196) ecebys + (0.4026) ecpibc + (0.3923) eccom…
ecpibc (0.4026)	
eccom (0.3923)	

Source: Authors elaboration.

Table 7 Principal Components Variables Weights Analysis and Equation

Conclusions

The results of our study shows that the most important variable to economic competitiveness determination is exports of goods and services as a percentage of GDP.

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According to our competitiveness index results, if a country wants to improve its competitiveness at the economic dimension, it should increase its exports of goods and services, its GDP per capita, and develop its commercial sector. In this order of importance.

These aspects strengthen the idea which indicates that international trade and commerce produces growth and national development. Many of those ideas have been established by traditional economists like Adam Smith (Smith, 1776), or in more recent studies, in the context of the Heckscher-Ohlin model (Blaug, 1997).

In relation to future research, we consider that is necessary to develop new methods to estimate competitiveness. Whether the new methods enhance accuracy or diminish data bias, the better measurement of the phenomena would provide better basis to delineate public policy in order to achieve economic competitiveness of countries.

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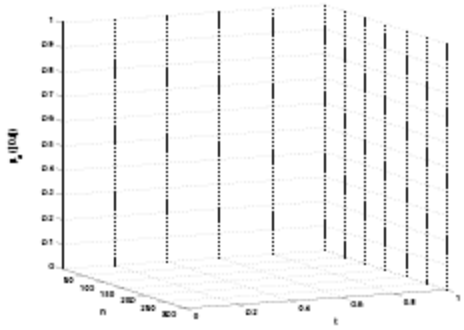

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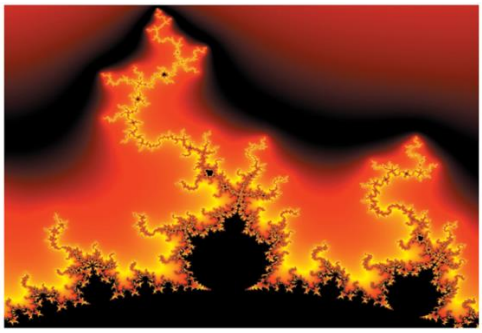

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