Handbook T-I

Finance and Business: Economic Challenges and Expectations

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ECORFAN Finance and Business: Economic Challenges and Expectations

Volumen I

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Handbooks TI

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Content

Income and wages embedded in the growth of industrial sector output in Latin America

Ingresos y salarios contenidos en el crecimiento del producto del sector industrial en América Latina

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The main contributions of this research are that it analyzes the internal market from the aspect of income and salaries in certain Latin American economies with current techniques in the focus of the Input-Output model (growth and not impact) that allow exploring the structural dynamics of the economies. The key aspects are in the field of social sciences and in particular of economics, since development is discussed and it is argued that this requires the intervention of the State through the strengthening of the internal market, although this situation is not a characteristic of the Mexican economy, but of several Latin American economies. The work makes an evaluation of income and wages in different countries and with the techniques used it is possible to conclude which countries have a better internal market according to the performance of product growth, wages and income. In this paper, the analysis of the domestic market has been with the effects of consumption, income and wages, assuming that in the total accounts these activities are performed by residents of a country. The results suggest that by these elements the economies analyzed during 1995 and 2011 have significantly affected the domestic market. That the intention to integrate the economies to the external market is by reducing labor costs that are reflected in low levels of income and wage growth and activity in general. The economies of Brazil, Chile, Colombia, Costa Rica, Mexico and Peru in general have shown a drop in the share of consumption product, and in their income and wage content. The vertical distribution of income and wages has not shown favorable results for the activation of the domestic market, the underdevelopment of the economies is due to the trend of increasing contributions of imported intermediate inputs, this dependence has made the effect of income and wages weak on the domestic market. The comparison of the vertical distribution of income and wages contained in the consumption product is due to the growth path that the economies have used, if we consider in two groups those that grow above 4%, for example, Chile, Costa Rica and Peru, only the latter has influenced the domestic market, because its path is intensive in domestic inputs and wage compensation; on the other hand, the group of less than 4%, only Brazil has been the country that has pushed the domestic market with intensive paths in domestic inputs and wage compensation. The growth of this period shows that the economies present a weak domestic market in 1995 and 2011, as well as a weak impulse of income, wages and consumption in the growth paths during 1995 - 2011.

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Resumen

Latin America is an underdeveloped region with high poverty levels and a significant concentration of income. The export promotion model has not yet overcome these characteristics; conversely, they have worsened. This paper aims to measure the vertical distribution of income and wages in Brazil, Chile, Colombia, Costa Rica, Mexico, and Peru using Input-Output tables for 1995–2011 and the income and wages contained in economic growth. The document hypothesizes that due to the export promotion model, which has led to a significant concentration of income and low wages, the internal market has been weakened, leading to low growth. This paper proposes that to increase per capita income among economies, it is necessary to modify the contributions of state activity and, thereby, the distribution among the other factors and inputs in economic growth.

Income and wages embedded in the growth of industrial sector output in Latin America

Objectives	Methodology	Contribution
This paper aims to measure the vertical distribution of income and wages in Brazil, Chile, Colombia, Costa Rica, Mexico, and Peru using Input-Output tables for 1995–2011 and the income and wages contained in economic growth. 	Input – Output Model and Analysis of Economic Growth using Input – Output Tables 	Measure the effect of wage growth and income growth for a one-percentage-point increase in GDP growth. 

Input – Output Model, Income-Wage, Growth

Resumen

América Latina es una región subdesarrollada con altos niveles de pobreza y una alta concentración del ingreso, estas características no han sido superadas con el modelo de la promoción de exportaciones, por el contrario, parece que sean agudizado. El objetivo de este trabajo es medir la distribución vertical del ingreso y de los salarios en Brasil, Chile, Colombia, Costa Rica, México y Perú con las tablas de Insumo – Producto para 1995 – 2011 y el ingreso y salarios contenidos en el crecimiento económico. La hipótesis del documento es que derivado del modelo económico el mercado interno ha estado más debilitado pues se ha incrementado la concentración del ingreso y los bajos salarios, lo cual se ha traducido en un bajo crecimiento. Este trabajo propone que para incrementar el ingreso per cápita entre las economías es necesario modificar las aportaciones de la actividad del Estado y con ella la distribución entre el resto de los factores e insumos en el crecimiento económico.

Ingresos y salarios contenidos en el crecimiento del producto del sector industrial en América Latina

Objetivos	Metodología	Contribución
Es medir la distribución vertical del ingreso y de los salarios en Brasil, Chile, Colombia, Costa Rica, México y Perú con las tablas de Insumo – Producto para 1995 – 2011 y el ingreso y salarios contenidos en el crecimiento económico. 	Modelo de Insumo – Producto y Análisis del crecimiento con las tablas de Insumo – Producto 	Medir el efecto del crecimiento de los salarios y del ingreso por un punto porcentual del crecimiento del producto. 

Modelo de Insumo – Producto, Ingresos, Salarios y Crecimiento

Introduction

Growth and welfare of the population are variables in economic development; however, inequality in the distribution of wealth and income is detrimental to economic growth. The conflict of redistribution between capital and labour and low economic growth stems from bad economic policy strategies (Alesina and Rodrik, 1994). The strategy of openness, deregulation and privatisation developed over more than 20 years of structural reforms in Latin America does not give the signs of convergence as promoted by free trade theory (Barro and Sala-i-Martin, 1990; Lucas,1988, Sala-i-Martin, 1996, Romer, 1986), it is necessary to correct undesired effects such as poverty and inequality to achieve better levels of development (Deneulin and Sanchez, 2017; Levy, 2013; Lopez, 2010; Merino, et al. 2020; Morley, 2000; Santos and Villatoro, 2018).

As an effect of the pandemic between 2019 and 2020, in Latin America, extreme poverty and poverty increased from 11.4% to 13.1% and from 30.4% to 32.8%, respectively, while the median Gini coefficient for the region varied from 0.456 to 0.464 in these same years (ECLAC, 2022). Although historically the region has been characterised by high income concentration, countries show different patterns; for example, some countries such as Bolivia, Costa Rica, Dominican Republic, Mexico and Paraguay have experienced significant reductions in inequality, while in others, such as Brazil and Chile, relative stability or a slight increase was detected, however, countries such as Argentina, Colombia and Peru present significant challenges due to recurrent economic crises and thus increasing poverty. Social policies are crucial, but a more comprehensive approach is needed to address the underlying causes of inequality and ensure that economic growth benefits all sectors of the population (Amarante et. al. 2023).

The current growth model has undermined the importance of policies towards the domestic market and the idea of industrialisation as an engine of growth. Under the analysis of trade liberalisation, it was expected that industrialisation would develop through the inflow of foreign investment and once countries used comparative advantages, wages and employment would grow, which would mean an improvement in income distribution (IMF, 2001). The paper argues that the basis of development is the performance of the domestic market, where industry becomes the engine of growth, pushing productivity growth, employment and along with it income distribution, so it is necessary that the state takes the relevant role in this process through an industrial policy that allows improving the development of local demand and regions.

The objective of this paper is to measure the vertical distribution of income and wages in Brazil, Chile, Colombia, Costa Rica, Mexico and Peru with the Input-Output tables for 1995 - 2011 and the income and wages contained in economic growth. The hypothesis of the paper is that due to the economic model, the weakness of the domestic market with income concentration and low wages, the economies have not achieved sustained growth.

The structure of the paper is organised as follows: in the next section, the theoretical framework that argues that development starts from the strength of the domestic market by boosting and integrating the industrial sector into the productive structure is presented, in section 3 the methodology to measure the vertical distribution of income and wages contained in output and growth is presented, Section 4 presents the results of the economies, Section 5 discusses the feasibility of promoting the domestic market in the context of the global economy of Latin American economies, and finally Section 6 presents the conclusions and proposals for influencing the levels of income and wages contained in output and growth.

Theoretical framework

Rostow (1959), in his analysis of the stages of economic growth, considers the development of the internal market, where he says that, in the take-off phase, it is necessary for the country to increase its investments in industry and infrastructure, which in turn would increase productivity and wages. Thus, as wages rise, so will consumption. This increase in domestic consumption reinforces the demand for domestically produced goods and services, which stimulated domestic production. In this approach, the domestic market played a key role in the growth cycle, because increased consumption capacity encouraged the expansion of local industries and created an environment conducive to private sector investment. Indeed, Kaldor (1975) shows that, in a closed economy, the industrial sector's impetus to growth is conditioned by demand, which in turn is conditioned by agents' wages and incomes.

In the theories of growth, the development of the internal market has been present, understood as a geographical space; for example, in the neoclassical closed model, moving from one equilibrium to another is due to technological change, which assumes that the economy develops, therefore development depends on the fact that in the internal market the prices of capital and labour are equal to their productivity, so that in savings and investment decisions, the capital-labour ratio is equal to depreciation (Ross, 2022).

The development of the internal market was most notorious in structural approaches, which explain that the causes of underdevelopment are due to a weak internal market where investments do not flourish, therefore, the industrial sector does not drive development (Rosenstein-Rodan, 1943; Lewis, 1955). The task of developing the domestic market has been executed by economic policy, for example, infant industry protection was a key to developing the US and German markets (Hamilton, 1934; List, 1942); however, in many currently developed countries it has been directed by economic policy towards the domestic market, which promotes growth impulses from supply and demand to domestic industry (Chang, 2011). In fact, this economic dualism approach allowed development theories such as dependency and Latin American structuralism to gain momentum, suggesting that the engine of growth is the industrialisation of the productive structure (Lechuga and Vera, 2024; Prebish, 1949; Sunkel, 1978).

The structural approach is based on the notion that the economy is a system constituted by agents that play a dual role in economic activities, the dual intervention of agents is due to the flow of wealth in the system (Barros and Lessa, 1969). Each economic phase is constituted by a distribution, in production between factors and inputs, and in consumption between agents. In this sense, the system is integrated by a productive structure in which the productive elements are distributed among the agents and that, in the generation of each good, the producers are interrelated among themselves because they buy inputs produced by others. In the consumption phase, the goods of production are distributed among the agents, each consumption unit of each agent depends on the interrelationship with other agents, because once the agents receive income from the productive structure, they share goods with other agents who do not receive income, this social structure interrelates the actions of the agents and is reflected in their income and expenditure.

The economic system depends on the interrelations of the productive structure and the social structure and on the interrelations within them (Lowe, 1955; Pasinetti, 1981, Schumpeter, 1944).

Leontief analysed the production structure, and his model helped to identify sectors that are strategic in the process of industrialisation. Under this scheme, not all sectors have the same role in economic growth; derived from productive interdependence, some activities have a greater connection by offering and demanding inputs for their production and the production of others, so that stimulating them allows the economy to grow at a higher level than if other types of sectors were stimulated (Hirschman, 1958).

Leontief's (1936) model aims to characterise sectors according to their hierarchy, circularity and interdependence. It starts from an understanding of the economy as a system from an open view of the system, i.e. it considers the social structure of income and expenditure relations of the agents in the production process as independent; however, his method suggests that variations in the income and expenditure of agents influence the size of the level of output. Unlike the neoclassical view, his analysis starts from prices and quantities of products determined in a period where the value of output is the same by supply or demand.

Derived from the circular flow, the value of production is a summation of the costs of both factors and inputs, representing a linear system in recording the accounts, likewise, the value of production is determined by the sum of its sales (intermediate and final). The Leontief model is based on the construction of a table that has three components, a double-entry table, which indicates the costs and input sales of the sectors, and two single-entry tables, one for factor payments by sector, and one for purchases of final goods demand. In the determination of the branches the Input-Output (IP) model assumes that each industry produces a homogeneous good, that each sector uses the same technology and the returns to scale structure is constant; it is a linear model (Astori, 1978; Leontief, 1937; Miller and Blair; 2009).

Leontief's (1937) model is static and considers that from a theoretical point of view, output growth in the long run is determined by investment and that the development of the production structure means that it becomes more complex in the sense that sectors have more direct and indirect connections, he points out that in underdeveloped economies the domestic market is usually dominated by a small number of sectors, mainly agriculture and natural resource extraction. This means that there is less diversification of products and services, there is little competition, in addition to the limited supply of goods for consumers, there are restrictions on the purchasing power of the population, which is low, which in turn affects the ability of companies to grow and expand. The domestic market of underdeveloped economies is characterised by import dependence and low levels of productivity (Leontief, 1967).

The study of the internal market from the IP model is related to the analysis of the components of demand and the internal economic structure, where income and wages play a determining role for investment and, together with it, the level of development.

Income and wages in the Input-Output model

The Leontief model holds that the gross value of output is defined as follows:

$$x = (I - A)^{-1} f \tag{1}$$

Where A is the matrix of technical coefficients and f is the vector of final demand, which can be constituted by the vectors of consumption (c), investment (inv), government expenditure (g), exports (e) and imports (m). It is a model that measures the variation of output by variation of final demand, whose production in each sector has constant returns to scale defined by the multipliers or the Leontief matrix ((I-A)^(-1)). With the model, one can define what is the size of the output generated by some final demand activity; for example, the output generated by consumption can be defined as follows:

$$x_c = (I - A)^{-1} c \tag{2}$$

However, the income contained in the output generated by consumption is defined as the income generated by the consumption of the product:

$$\varsigma_c = \hat{l}(I - A)^{-1} c \tag{3}$$

Where $\hat{l}$ is the diagonal matrix of the coefficients of the employment compensation coefficients (wn/x), which are the workers' earnings. The vector $i'\hat{l}(I - A)^{-1}$ sWith income multipliers measuring the amount of direct and indirect income requirements to satisfy a unit of final demand (Katz, 1980; Miyazawa, 1976), in the case of equation (3) of consumption-generated output, we can define it as the vertical distribution of income which, similar to the vertical specialisation of trade, can be analysed as the vertical distribution of income as:

$$DVy = \left(\hat{l}(I - A)^{-1} c\right) * \left(\widehat{i'c}\right)^{1} \tag{4}$$

In this way, the vertical income distribution is obtained as the average weight of the income multipliers used in the production of final consumption according to their share.

Employment compensation (wn) is the sum of the total payments to workers, which are different from each other, because the income received by workers depends on the productive activity and the skills of the workers. Indirectly we can calculate the average wage vector of the activity as:

$$w = i'[\widehat{wn}(\hat{n})^{-1}] \tag{5}$$

where a n is the vector of employment and from a proportion of the total cost of employment compensation over the total employment of the sector, the average wage of the branch is defined, so with this indicator one can extend the notion of the vertical distribution of income by that of the average wage as follows:

$$DVw = \widehat{\omega}\ (I - A)^{-1} c * \left(\widehat{i'c}\right)^{1} \tag{6}$$

Where $\hat{\omega}$ shows the diagonal matrix of average wage coefficients (w^(x^)^(-1)), equation 6 defines the direct and indirect requirements of branch average wages in the output created by consumption as the share of consumption. Expressions 4 and 6 show the sectoral income and average wage contained in the consumption output in terms of their shares in the total consumption of the economy.

The above equations show the conventional analysis of the IP model, and from them, the characteristics of the production structure in terms of its interdependence, hierarchy, complementarity and circularity. When analysing growth some authors have suggested using the method of growth analysis with IP tables (AGEIOT) from which it is possible to decompose the growth contributions of the IP table accounts, without modifying the assumptions in them (Aoun, et. al. 2024; Cyrek, 2024, Kawiana, et. al. 2024, Varnavskii, 2024).

The method consists of two IP tables of different years (t and t+1), using the average growth rate of the period between them, the growth of the final year is simulated using the assumption of constant returns to scale, so the level of production of the final year, even when it maintains the same proportion, the size of its coefficients, is greater or smaller depending on whether or not the production of each sector grew, thus subtracting this hypothetical growth from the initial situation, the contribution to growth of the factors and inputs used is obtained. Formally it is obtained as follows:

$$x^t = A^t + v^t = i, \quad x^{t+1} = A^{t+1} + v^{t+1} = i$$
$$x^t + \Delta = (A^t + v^t) + \hat{\Delta}(A^t + v^t) = (i'A^{tt} + v^{tt}) = x^{tt}$$
$$\Delta = x^{tt} - x^{t-1} = (i'A^{tt} + v^{tt}) - (i'A^{t-1} + v^{t-1}) = (i'A^{\Delta} + v^{\Delta}) \quad (7)$$

Equation 7 shows that the growth of the economy can be input or factor intensive, or it can be in constant proportions, which are of the same or very similar intensity. Thus, the model describing the growth rate of output is defined in equation 8, which is a simile of the static price model, which measures variations in the contributions of value added to growth according to the multipliers of the technical input coefficients.

$$\Delta' = \left(i'^{A^{\Delta}} + v^{\Delta}\right) \rightarrow \Delta' - i'^{A^{\Delta}} = v^{\Delta} \rightarrow \Delta'\left(I - \hat{\Delta}'^{-1}A^{\Delta}\right) = v^{\Delta} \rightarrow \Delta = v^{\Delta}\left(I - \hat{\Delta}'^{-1}A^{\Delta}\right)^{-1} = v^{\Delta}\left(I - \mathrm{B}^{\Delta}\right)^{-1} = v^{\Delta}L^{\Delta} \quad (8)$$

As can be seen B^{Δ} is the matrix of technical input coefficients describing the ratio of input contributions per percentage point of output change. In the static model, the size $(I - A)^{-1}$ depends on A, the smaller the multiplier, and given the characteristics of the theoretical model of the IP table, they range between 1 and 2 referring to a unit or monetary value.

Dynamic multipliers depend on the ratio of input contributions to growth and output growth, therefore dynamic multipliers can have broader results. Dynamic multipliers $(I - \mathrm{B}^{\Delta})^{-1}$, depend on the matrix of technical contribution coefficients B^Δ whose entries β_ij^Δ$\gtreqless$0 are explained by $A^{\Delta} \gtreqless 0$, $\Delta \gtreqless 0$ and a combination of them. The multipliers that arise with AGEIOT depend on the size of B^Δ, for example, if Δ<0 and A^Δ>0, it means that β_ij<0 therefore I-(〚-B〛^Δ)>1 and the inverse are less than 1; however, if Δ>0 and A^Δ<0 mathematically shows the same results, but theoretically two distinctive aspects are enclosed. When the result of (I-B^Δ)^(-1) is less than 1 it is because (Δ^(-1))A^Δ>1, if Δ and A^Δ are of different signs, the aggregate value defines the sign of the multiplier.

Taking into account the results and the constitution of equation 8, we can calculate the multipliers of the contribution coefficients of wage compensation to employment or income and that of wages in the following way:

$$\rho' = (\lambda'^{*})(I - B^{\Delta})^{-1} \quad (9)$$
$$\varpi' = (w^{*})\hat{\Delta}(I - B^{\Delta})^{-1} \quad (10)$$

λ'^{*} is the column vector of the income contribution coefficients, i.e. , $\lambda'^{*} = l'^{\Delta}\left(\hat{\Delta}\right)^{-1}$so equation 9 shows the income contribution multiplier for output growth growth, while $w*\Delta\Delta$ are the coefficients of wage growth on output growth, so equation 10 calculates the effect of wage growth per percentage point of output growth.

Results

1. We have used the IP tables published by the OECD ISIC rev 3 for the years 1995 and 2011, which disaggregates activities into 34 industrial branches for two reasons; one is that it is a base that covers a larger number of Latin American countries, and the other is that it has the disaggregated components of value added, since the current versions, the value added account is compressed to a vector line. Within the tables, the accounts for taxes and subsidies on intermediate and factor products have been aggregated into a single account (government account).

2. Although the information for this analysis is limited, a couple of adjustments have been made. Firstly, with regard to wages, there is no homogeneous information that is consistent with the disaggregation of the tables, according to OECD data, which refer to wages measured in constant 2017 dollars; thus, the average sectoral wage and the average per worker are considered as an assumption for the development of this paper, which implies that the average growth of wages is general across branches and workers.

3. To perform the AGEIOT we have used the output data at constant 2010 prices published by the World Bank, from this, the value of the total output of the economies was redistributed among the branches according to the nominal share contained in the IP tables, thereby obtaining an average real growth rate of each sector for the period 1995 - 2011. The average growth rate for the period has been used according to World Bank data which are in constant 2010 US dollars. With such amounts the total output for each branch of the economy was disaggregated according to the information in the IP tables and in this way the value of output in constant dollars was calculated and the real growth rate of each branch was obtained.

4. Table 1A presents the results of the differential between 2011 - 1995 of the shares of output generated by consumption over the total, its income content, and the vertical distribution of income and wages for the industrial sector of the economies of Brazil, Chile and Colombia, while Table 1B is for the economies of Costa Rica, Mexico and Peru. Table 1A shows that Brazil and Colombia show a fall in the share of output generated by consumption, while the income content in Brazil and the vertical distribution of wages in Chile have reduced the domestic market. The vertical distribution of income in Brazil and Colombia has increased in both economies (2.7 and 0.10%), in the case of Costa Rica, Mexico and Peru, Table 2B indicates that the economies have not suffered negative changes in the distribution of consumption-generated output, the increase in the share of consumption output reveals an improvement in the domestic market; a situation that is confirmed by the income and wages contained in consumption, only the Mexican economy in that period shows no changes.

5. The industrial sectors that increased the share of consumption product did not remain constant, Table 1A and 1B show that the Motor vehicles, trailers and semi-trailers sector is one of the relevant sectors in the countries, but with different importance; for example, in Brazil it was the country where the production to consumption decreased the most, in Colombia and Costa Rica it grew the most, while in Chile and Peru its growth is similar (115 and 133% respectively) but the vehicles sector is not the most outstanding, in Mexico this sector increased by 5%. The results suggest that in those sectors where the share of consumption output increased, it may be due to the existence of an internal market; where the sector contributes with positive differences in income and wage distributions; since the existence of sectors that increase their output, but do not contribute to income and wage distributions slows down growth.

6. The results in Tables 1A and 1B show that industry in Brazil has improved vertical income and wage distributions, while in Chile these have worsened, vertical income distributions in Colombia and Mexico have fallen in most industries and have seen a small improvement in vertical wage distributions, the opposite situation to that experienced in Peru.

7. Table 2A and 2B present the growth path, in total output, the tables reveal that the economies presented intensive growth paths, in Brazil, Colombia and Peru it is intensive in domestic intermediate inputs; in Chile and Costa Rica they were intensive in imported intermediate inputs, only Mexico in the aggregate presented an intensive path in value added, sustained in the gross operating surplus account.

8. Although Brazil, Colombia and Peru have different paths than Mexico, they have the same characteristic in the influence of the state on value added, as the contributions of taxes minus subsidies, the negative sign is that subsidies on goods and on factors contribute to growth. In the value added accounts, Brazil and Peru have a greater participation in wage compensation, while Mexico and Colombia are those of gross operating surplus; in the case of Chile and Costa Rica the contribution of value added, Chile is intensive in gross operating surplus and Costa Rica in wage compensation; however, taxes are greater than subsidies, showing that in Chile this contribution is lower than in Costa Rica.

9. On the other hand, the industrial sector in all economies has witnessed the intensive growth path in imported intermediate inputs, while, in value added contributions, on the one hand, Brazil, Chile and Costa Rica have presented a higher contribution from wage compensation, while, on the other hand, Colombia, Mexico and Peru have highlighted the contribution to gross operating surpluses. These results suggest that the industrial sector has driven the domestic market more in Brazil, Chile and Costa Rica, although in the national economies, Brazil has maintained greater effects on the domestic market, both in production and wage compensation, and in the latter, Peru, but as in Chile, Colombia and Costa Rica, it does not drive the domestic market in intermediate inputs (as they are imported) but in value added Chile, Colombia, Costa Rica and Mexico the contributions of gross operating surplus stand out in the contribution of value added.

10. Tables 3A and 3B present the results of the multipliers of the domestic and imported technical contribution coefficients, and the multipliers of the income contribution coefficients and the multipliers of the wage growth multipliers per unit of output growth. As can be seen, the results of the national technical input coefficient multipliers have effects in the same direction as their inputs, i.e. they are either positive or negative; however, in terms of their size they are different because one is referred to the absolute size of growth and the other is for a percentage point of growth.

11. In the case of the contribution coefficients multipliers indicate, for example, that for the vehicle sector in Brazil, the use of imported inputs boosts the sector's growth by 20% of each percentage point, while for domestic origin it is 2.7%. As for the income multipliers, 82% of each percentage point of output growth is generated by the contributions to income growth on the contribution coefficients; while in the case of the multipliers of the wage growth coefficients on output growth, they indicate that for the vehicle sector to grow by one percentage point, wages must grow by 5.2% in addition to the growth rate they have experienced according to the national technical contribution coefficients, while with the imported ones they must grow by 2.7%.

12. In some countries, the effects of technical input coefficients in high-tech industrial sectors require imported inputs, such as vehicles in Brazil and computers in Colombia and Mexico. In general, the effects of the contributions to growth according to the technical contribution coefficients of imported inputs indicate that they have a greater weight in Brazil, Chile, Costa Rica, Mexico and Peru. From an overall point of view, the growth of required wages per percentage point of output in the coefficients of the technical contribution of imported inputs is higher. These results suggest that the effect of the external sector on the production structure does not benefit the domestic market, nor in the level of income and wages contained in the growth of the domestic market.

Box 1

Table 1 A

Share of output created by consumption and its income content, vertical income and wage distribution Differences between 2011 - 1995 (Percentages)

Rama	Brazil				Chile				Colombia			
	x_c	ς_c	DVy	DVw	x_c	ς_c	DVy	DVw	x_c	ς_c	DVy	DVw
3 Food, beverages and tobacco	-58	-0,5	3,0	0,00	-6	-2,4	-0,9	-0,0106	1	-0,7	0,0	0,0164
4 Textiles, leather and footwear	-40	-1,5	2,1	-0,0003	119	-1,7	-0,6	-0,0080	19	1,1	0,4	0,0074
5 Wood, wood products and cork	-23	-0,2	0,2	-0,0001	-9	-0,4	-0,1	-0,0020	7	0,1	0,0	0,0003
6 Pulp, paper, paper products, printing and publishing	-38	-0,3	1,2	-0,0003	6	-1,0	-0,4	-0,0047	-5	-0,2	0,0	0,0048
7 Coke, refined petroleum products, nuclear fuel	-61	0,3	0,7	0,0001	45	2,3	0,8	0,0142	-9	-1,3	-0,4	0,0021
8 Chemicals and chemical products	-63	-0,3	2,2	-0,0003	15	-2,0	-0,8	-0,0101	11	-0,2	0,1	0,0088
9 Rubber and plastic products	-48	0,3	1,1	0,0001	-6	-1,1	-0,4	-0,0057	-2	0,3	0,1	0,0034
10 Other non-metallic mineral products	-22	0,0	0,3	0,0000	0	-0,2	-0,1	-0,0007	-5	-0,1	0,0	0,0011
11 Basic metals	-42	0,5	1,0	0,0002	-8	-0,1	0,0	0,0004	-25	-0,1	0,0	0,0019
12 Fabricated metal products	-42	-0,2	0,9	-0,0001	-4	-0,3	-0,1	-0,0011	2	-0,3	-0,1	0,0011
13 Machinery and equipment, ncp	-45	0,4	1,4	0,0000	-6	0,2	0,1	0,0020	-51	-0,1	0,0	0,0037
14 Computers, electronic and optical equipment	-29	0,1	0,8	0,0004	2	0,9	0,3	0,0060	33	-0,1	0,0	0,0007
15 Electrical machinery and apparatus	-42	0,1	0,8	0,0000	3	0,0	0,0	-0,0001	-8	-0,3	-0,1	0,0012
16 Motor vehicles, trailers and semi-trailers	-64	2,2	4,0	0,0011	115	-0,1	0,0	-0,0003	47	-0,4	-0,1	0,0006
17 Other transport equipment	-38	0,2	0,6	0,0001	200	0,0	0,0	0,0000	-74	-0,3	-0,1	0,0004
18 Manufacture ncp; recycling	-40	-0,5	0,5	-0,0003	107	0,3	0,1	0,0019	-41	0,0	0,0	0,0022
Structural average	-42.2	-0.30	2.7	0.0022	19.6	0.1	0.0	-0.0033	-4.5	0.00	0.10	0.0145

Source: Own elaboration based on the Input-Output tables published by the OECD.

x_c: share of output created by consumption, ς_c: income contained in consumption output, DVy: vertical distribution of income contained in consumption output, and DVw: vertical distribution of wages contained in the consumption product.

Box 2

Table 1 B

Share of output created by consumption and its income content, vertical income and wage distribution Differences between 2011 - 1995 (Percentages)

Rama	Costa Rica				Mexico				Peru			
	x_c	ς_c	DVy	DVw	x_c	ς_c	DVy	DVw	x_c	ς_c	DVy	DVw
3 Food, beverages and tobacco	10	-2,64	-0,5	-0,032	6	-0,2	0,0	0,0018	-33	0,9	0,5	-0,0019
4 Textiles, leather and footwear	86	-2,29	-0,7	-0,038	21	-1,1	-0,2	0,0005	23	-2,4	-0,6	-0,0058
5 Wood, wood products and cork	44	-0,16	0,0	0,000	6	-0,2	0,0	0,0001	14	-0,1	0,0	-0,0008
6 Pulp, paper, paper products, printing and publishing	-30	-1,52	-0,4	-0,023	9	-0,9	-0,2	0,0005	-33	0,4	0,2	-0,0008
7 Coke, refined petroleum products, nuclear fuel	125	-1,07	-0,4	-0,021	45	0,6	0,1	0,0004	-45	0,3	0,1	-0,0003
8 Chemicals and chemical products	15	-1,45	-0,3	-0,021	31	-0,1	0,0	0,0008	-42	0,5	0,2	-0,0024
9 Rubber and plastic products	17	-0,45	0,0	-0,003	12	-0,1	0,0	0,0003	-29	-0,2	0,0	-0,0017
10 Other non-metallic mineral products	-2	-0,14	0,0	-0,002	1	-0,1	0,0	0,0002	-23	-0,3	-0,1	-0,0006
11 Basic metals	-102	-0,16	0,0	0,000	-4	0,0	0,0	0,0001	-5	-0,2	-0,1	-0,0017
12 Fabricated metal products	18	-0,18	0,0	-0,001	4	0,0	0,0	0,0003	-11	-0,2	0,0	-0,0011
13 Machinery and equipment, ncp	41	-0,03	0,1	0,004	12	0,3	0,1	0,0002	27	-0,4	-0,1	-0,0016
14 Computers, electronic and optical equipment	8	-0,04	0,1	0,005	5	0,0	0,0	0,0003	621	0,4	0,2	-0,0005
15 Electrical machinery and apparatus	16	-0,12	0,0	-0,001	-2	-0,1	0,0	0,0002	36	-0,1	0,0	-0,0014
16 Motor vehicles, trailers and semi-trailers	892	-0,21	0,1	0,002	5	0,4	0,1	0,0006	133	0,3	0,1	-0,0006
17 Other transport equipment	-40	-0,39	-0,1	-0,008	-3	0,0	0,0	0,0000	-63	0,4	0,1	0,0002
18 Manufacture ncp; recycling	94	-0,19	0,0	-0,001	11	-0,2	0,0	0,0004	41	-0,8	-0,2	-0,0047
Structural average	-42.2	-0.30	2.7	0.002	20	0.09	0.03	-0.0033	-4.5	0.00	0.10	0.0145

Source: Own elaboration based on the Input-Output tables published by the OECD.

x_c: share of output created by consumption, ς_c: income contained in consumption output, DVy: vertical distribution of income contained in consumption output, and DVw: vertical distribution of wages contained in the consumption product.

Box 3

Table 2 A

Contribution of factors and inputs to growth between 1995 and 2010 (2010 prices)

Ramas	Brazil							Chile							Colombia						
	D	A^m	A^n	VA	Tn	L	K	D	D	A^m	VA	Tn	L	K	D	A^n	A^m	VA	Tn	L	K
3 Food, beverages and tobacco	2.3	7.1	-0.3	-4.5	-2.1	2.6	-5	2.4	0.7	1.2	0.5	0.5	-0.5	0.5	2.6	5.5	1.6	-4.5	-4.3	0.4	-0.6
4 Textiles, leather and footwear	-0.7	1.2	1.4	-3.3	-2.7	4.1	-4.7	-4.6	-6.9	12.6	-10.3	1	0.4	-11.7	2.5	-0.8	1.6	1.7	-4.5	6.5	-0.3
5 Wood, wood products and cork	0.9	11.8	1.9	-12.8	-0.6	2.3	-14.5	0.7	16	0.6	-16.1	0.8	-0.9	-16	8.6	-12.9	1.3	20.2	-2.7	11.9	11
6 Pulp, paper, paper products, printing and publishing	2	1.1	0.5	0.4	-2.7	0.7	2.4	2.3	3.7	1.6	-3	0.5	-4.7	1.2	0.7	1.4	-1.4	0.7	-3.7	4.2	0.2
7 Coke, refined petroleum products, nuclear fuel	4.3	8.2	2.5	-6.4	-1.2	2.3	-7.5	6.4	-17.2	21.5	2.1	5.3	8.6	-11.8	8.6	-18.8	-3.3	30.7	-4.5	-13.4	48.6
8 Chemicals and chemical products	3.4	9.5	2.9	-9.2	-2.3	0.5	-7.4	1.6	10.9	9.9	-19.2	0.3	-7.5	-12	1.3	0.2	3.3	-2.2	-5.4	2.1	1.1
9 Rubber and plastic products	2.3	0.5	4.4	-2.6	-1.8	8.4	-9.2	0.2	-3.2	7	-3.6	0.7	-5.6	1.3	1.6	-1.4	5.4	-2.4	-3.8	7	-5.6
10 Other non-metallic mineral products	2.5	7.9	1.6	-7	-2.2	7.5	-12.3	2.6	-1.4	9.9	-5.9	0.5	-0.4	-6	2.8	-4.7	-0.3	7.8	-4.8	3.3	9.3
11 Basic metals	6.9	4.6	2.5	-0.2	-2.5	5.3	-3	7.5	-19.3	7.5	19.3	2	3.9	13.4	7.6	7	-3.7	4.3	-8	0.1	12.2
12 Fabricated metal products	3.9	5.1	2.3	-3.5	-3.3	-1.7	1.5	2.5	-5.8	-1.1	9.4	0.4	-0.2	9.2	1.1	-7.8	4.7	4.2	0.1	-2.2	6.3
13 Machinery and equipment, ncp	5.4	2.1	3	0.3	-1.5	7.4	-5.6	5.2	-14.2	-4.5	23.9	0.3	6.2	17.4	5.4	-6.3	5.5	6.2	-4.7	6.1	4.8
14 Computers, electronic and optical equipment	-0.9	-9	5.7	2.4	-1.1	8	-4.7	9.1	-6.9	-2.1	18.1	1.2	16.9	0	0.8	1.2	5.9	-6.3	-10.1	2.2	1.6
15 Electrical machinery and apparatus	2.8	10.8	2.5	-10.5	-3.6	1.6	-8.5	5.7	-18.1	7.2	16.6	-0.3	3.3	13.6	1.3	0.4	7.9	-7	-0.1	-2	-4.9
16 Motor vehicles, trailers and semi-trailers	5	5.4	4.1	-4.5	-1.4	14.1	-17.2	-0.1	3.4	-5.8	2.3	3.5	1.4	-2.6	2.1	-7.2	7.2	2.1	-1	-2.5	5.6
17 Other transport equipment	5.1	8.9	3.4	-7.2	-2.1	2.4	-7.5	4.3	-1.4	1.5	4.2	0.6	3.6	0	4.7	1	18.6	-14.9	-0.3	-6.4	-8.2
18 Manufacture ncp; recycling	1.3	4.2	1.1	-4	-4.6	-3.6	4.2	-0.4	-4	6.1	-2.5	0.5	4.4	-7.4	19.2	6.6	6.5	6.1	-4.4	-0.5	11
Total	3.2	2.9	1.4	-1.1	-4	3	-0.1	4.5	-0.6	3.3	1.8	0.2	-0.2	1.8	3.3	1.3	0.7	1.3	-3.1	1.1	3.3

Source: Own elaboration based on the Input-Output tables published by the OECD. D: growth rate, An: domestic inputs, Am: imported inputs, VA: value added, Tn: net taxes less product and factor subsidies, L: wages and K: gross operating surplus

Box 4

Table 2 B

Contribution of factors and inputs to growth between 1995 and 2010 (2010 prices)

Ramas	Costa Rica							México							Perú						
	D	A^n	A^m	VA	Tn	L	K	D	A^n	A^m	VA	Tn	L	K	D	A^n	A^m	VA	Tn	L	K
3 Food, beverages and tobacco	2	-3.3	1.2	4.1	0.2	2.9	1	2.2	-6.2	4.2	4.2	-0.1	-2.2	6.5	5.4	4.5	-1.2	2.1	-0.2	2.5	-0.2
4 Textiles, leather and footwear	-2.7	-6.9	2.2	2	-0.6	6.1	-3.5	-1.6	-6	3.7	0.7	-0.8	-3.9	5.4	0.7	-4.7	5.1	0.3	-0.5	5.3	-4.5
5 Wood, wood products and cork	1.6	-3.5	1.2	3.9	-0.4	2.9	1.4	-0.5	-3.3	5.4	-2.6	-1.1	-0.1	-1.4	-1	-2	0.4	0.6	-0.8	-7.2	8.6
6 Pulp, paper, paper products, printing and publishing	1.9	6.6	-3.4	-1.3	-0.1	7.4	-8.6	-0.8	-0.8	3.6	-3.6	-1.4	-4.8	2.6	6.5	2.4	1.8	2.3	-0.6	1.1	1.8
7 Coke, refined petroleum products, nuclear fuel	291.2	130.6	142.9	17.7	3.1	-4.2	18.8	5.5	-4.4	19.1	-9.2	2	-6.7	-4.5	13.2	-4.6	16.1	1.6	-3.1	-0.3	5
8 Chemicals and chemical products	0.7	2.3	-3.2	1.6	0.2	5.4	-4	0.6	-5.9	7.9	-1.4	-1.3	-4.4	4.3	6	-4.7	8.5	2.2	-0.4	-0.4	3
9 Rubber and plastic products	3.3	2.8	-2.5	3	-0.1	2.1	1	1.3	-5.3	10.3	-3.7	-1.1	-5	2.4	5.2	4.1	-0.3	1.5	-0.4	-0.5	2.4
10 Other non-metallic mineral products	4.1	-1.6	0.4	5.3	-0.1	0.9	4.5	1.1	-2.4	4.5	-1	-1.9	-4.1	5	6.3	0.1	3.2	3	-0.6	2.4	1.2
11 Basic metals	7.6	12.1	-5.3	0.8	0.1	2.4	-1.7	4	1.5	0.3	2.2	0.5	-4.5	6.2	6.1	-4.1	8.6	1.6	-0.8	-5.5	7.9
12 Fabricated metal products	4.4	9.6	-2.9	-2.3	-0.5	-0.7	-1.1	2.8	-4.3	6.5	0.6	-1.1	-3.1	4.8	5.1	-15.5	19.7	0.9	-0.7	-2.6	4.2
13 Machinery and equipment, ncp	3.5	-8	9.1	2.4	-0.5	8.4	-5.5	3.7	-5.9	8.7	0.9	-1.5	-12	14.4	2	-13.3	14.1	1.2	0	-0.5	1.7
14 Computers, electronic and optical equipment	9	-3.2	15.5	-3.3	-0.8	-5.4	2.9	2.7	0.7	6.4	-4.4	-0.5	-2	-1.9	1.6	-30.5	34.3	-2.1	0	-1.9	-0.2
15 Electrical machinery and apparatus	3.2	-11.5	7.5	7.2	-0.3	4.5	3	2.7	2.4	3.3	-3	-0.9	-4.9	2.8	2.5	5.4	3	-5.9	-0.2	-4.1	-1.6
16 Motor vehicles, trailers and semi-trailers	1.7	2.6	-2.6	1.7	0.5	7.3	-6.1	4.3	-12.1	13.3	3.1	0.1	-2.9	5.9	2.2	4.3	2.2	-4.3	-0.1	-3.4	-0.8
17 Other transport equipment	7	8.1	-1.8	0.7	-0.8	-21.4	22.9	4.4	10.5	8.6	-14.7	0	-9.3	-5.4	12.9	-1.8	4.4	10.2	0.3	5.4	4.5
18 Manufacture ncp; recycling	-1.9	-1.5	-0.9	0.5	0	8	-7.5	1.1	-7.9	7.5	1.5	-0.8	-1.5	3.8	0.2	-5	3.1	2.1	-0.5	-3.6	6.2
Total	4.3	1.2	1.9	1.2	0.4	3.7	-2.9	2.8	-1.9	2.5	2.2	-2.3	-0.2	4.7	4.7	3.1	1.5	0.1	-0.4	2.8	-2.3

Source: Own elaboration based on the Input-Output tables published by the OECD. D: growth rate, An: domestic inputs, Am: imported inputs, VA: value added, Tn: net taxes less product and factor subsidies, L: wages and K: gross operating surplus.

Box 5

Table 3 A

Multipliers of technical contribution coefficients and income and wage growth between 1995 and 2010 (2010 prices)

Ramas	Brasil						Chile						Colombia					
	Inter.	Imp.	$\rho'n$	$\rho'm$	$\varpi n'$	$\varpi m'$	Inter.	Imp.	$\rho'n$	$\rho'm$	$\varpi n'$	$\varpi m'$	Inter.	Imp.	$\rho'n$	$\rho'm$	$\varpi n'$	$\varpi m'$
3 Food, beverages and tobacco	-1	1	-1	3.3	0.2	1.8	1.4	1.6	2.6	-5.1	0.3	-1.4	1.1	30.4	66.6	-3.8	-2.2	-0.2
4 Textiles, leather and footwear	0.4	0.5	-3.4	6.8	0.7	-4.4	0.4	-0.4	-0.2	5.6	0.4	-0.7	1.3	-23.2	50.4	-13.3	1.3	1.4
5 Wood, wood products and cork	4.6	1.1	-4.2	10.5	-1.8	9.0	61.7	0.5	-21.7	-4.3	0.4	-39.8	2.5	-60.9	140.9	10.9	-0.8	2.6
6 Pulp, paper, paper products, printing and publishing	1.5	0.4	0.6	1.2	-0.1	2.3	0.6	5.7	1.7	-11.1	0.0	0.3	-1	36.1	84.7	51.7	0.4	10.1
7 Coke, refined petroleum products and nuclear fuels	1.4	2	-0.9	8.7	-0.7	0.9	1.1	-2.6	-0.4	4.4	-0.1	0.2	-3.2	-41.3	-91.5	-0.7	2.6	1.2
8 Chemicals and chemical products	2.2	0.5	-0.3	0.7	-0.2	2.3	6.5	6	-3.5	-29.4	-0.2	0.8	0.8	42.1	92.9	20.8	-2.3	4.0
9 Rubber and plastic products	3.4	1.9	-3.6	11.3	-0.6	3.5	1.5	-16.4	9.1	-965.8	0.8	-8.6	1.8	-76.8	171	-7.2	4.4	0.9
10 Other non-metallic mineral products	1.8	0.3	-3.1	-0.7	-0.3	2.3	2	-7.1	-1.7	-6.6	0.6	3.1	-2.7	-98.1	215.1	8.5	-6.0	2.2
11 Basic metals	1.5	0.3	-0.6	1.7	-0.2	0.9	2.7	-5.2	0.2	2.9	0.8	1.8	-0.1	1.9	13.9	7.5	0.7	1.7
12 Fabricated metal products	1.8	0.5	0.4	-4.9	-0.2	1.7	-1.3	-21.2	1	-22.9	0.1	1.8	7.9	-71.4	-153	8.2	-4.9	3.6
13 Machinery and equipment, ncp	1.9	2	-1.5	10.4	0.4	1.6	-0.1	-1.1	1.7	3.3	-0.3	0.5	2.2	-21.3	37.3	1	2.1	2.0
14 Computers, electronic and optical equipment	0.6	-0.7	-1.5	4.9	0.1	-1.8	1.6	-1.8	2.5	2.6	-0.1	0.2	0.5	367.8	763.7	4.4	27.1	6.0
15 Electrical machinery and apparatus	2	1.7	-0.1	7.7	-0.8	2.2	-0.6	-17	1.1	13.5	-0.8	0.1	0.7	7.4	15.5	-6.8	-0.6	-3.4
16 Motor vehicles, trailers and semi-trailers	2.7	20.3	-4.4	82.2	5.2	2.4	-2.1	2.2	-0.8	178.7	0.2	0.0	4.4	-110.3	-238.7	0.4	7.2	4.2
17 Other transport equipment	2	14.9	-0.7	60.3	-5.9	1.6	8.7	-22.3	0	6	-0.6	-1.0	0.8	3.2	-6.3	-1.1	-0.5	-0.2
18 Manufacture ncp; recycling	2.3	6.2	4.2	-49.7	-2.9	4.7	12.3	-112.3	-0.7	105	5.2	6.6	0.7	5.9	-11.8	0	-0.8	0.0

Source: Own elaboration based on the Input-Output tables published by the OECD. Inter: domestic technical input coefficient multipliers, Imp: imported technical input coefficient multipliers, ρ'n: domestic income input multipliers, ρ'm: imported income input multipliers, ϖn: domestic requirements of wage growth per percentage point of output, ϖm'.

Box 6

Table 3 A

Multipliers of technical contribution coefficients and income and wage growth between 1995 and 2010 (2010 prices)

Ramas	Costa Rica						Mexico						Peru					
	Inter.	Imp.	$\rho'n$	$\rho'm$	$\varpi n'$	$\varpi m'$	Inter.	Imp.	$\rho'n$	$\rho'm$	$\varpi n'$	$\varpi m'$	Inter.	Imp.	$\rho'n$	$\rho'm$	$\varpi n'$	$\varpi m'$
3 Food, beverages and tobacco	-9.3	1.6	5.1	1.6	1.0	0.9	-1.8	1.1	-2.3	1.2	-0.4	-0.2	1.6	-6.5	6.5	-27.1	0.0	-0.1
4 Textiles, leather and footwear	-1	0.6	0.8	-1.1	0.0	-0.3	-1.7	1.2	-2.1	2.2	0.2	0.2	-0.5	32	32	-16	0.0	0.7
5 Wood, wood products and cork	-3.4	1	1.4	1.5	0.5	0.7	-1.6	1.1	-1	-0.2	0.6	0.7	-5.5	8.2	-8.2	73.4	0.1	0.2
6 Pulp, paper, paper products, printing and publishing	1.5	-0.3	3.2	-0.9	0.0	0.2	-1.6	1.2	-6.7	6.2	0.5	0.5	5.2	-12.7	12.7	53.3	-0.1	-0.3
7 Coke, refined petroleum products, nuclear fuel	1	1.8	-0.2	0.1	-0.1	0.0	-1.9	1.3	-1.5	-1.5	-0.1	-0.1	-4.6	0	-0.1	49	0.1	0.0
8 Chemicals and chemical products	3.7	-0.1	3.7	-1	-0.3	0.3	-1.8	1.2	-9	8.6	-0.8	-0.7	-12.6	19.3	-19.3	163	0.3	-0.4
9 Rubber and plastic products	0.7	-0.4	2.5	1.1	0.0	0.1	-1.7	1.3	-5.6	5.2	-0.5	-0.4	8	-143.8	-143.8	120.8	-0.2	-2.9
10 Other non-metallic mineral products	-0.9	0.7	0.4	1.2	0.0	0.0	-1.5	1.1	-4.2	3.9	-0.4	-0.4	5.6	4.8	4.8	52.7	0.1	0.1
11 Basic metals	0.6	-0.6	0.7	-0.1	0.1	0.1	1.8	1.1	-1.6	1.3	-0.2	-0.1	-0.9	0.2	-0.2	22.7	0.0	0.0
12 Fabricated metal products	1.4	-0.4	-0.7	-0.7	-0.2	0.1	-1.6	1.3	-1.7	1.6	-0.2	-0.2	-7.4	3.9	-3.9	91.6	0.2	0.1
13 Machinery and equipment, ncp	-0.2	5.8	2	-8.2	0.2	-0.8	-1.6	1.4	-3.7	4.1	-0.2	-0.1	-40.3	2.9	-2.9	522.8	-0.8	-0.1
14 Computers, electronic and optical equipment	-0.4	1.9	-0.4	1.9	0.0	-0.3	1.5	1.9	-1	-1.8	-0.2	-0.3	-58.1	2.7	-2.7	-102	-1.2	-0.1
15 Electrical machinery and apparatus	-0.3	7.1	1	8.1	0.2	-1.0	1.5	1.6	-2.3	2.8	-0.2	-0.2	0.1	7	-7	-8.6	0.0	-0.1
16 Motor vehicles, trailers and semi-trailers	1.8	-0.8	0.4	-3.6	0.2	0.3	-1.4	1.6	-1	1.6	-0.1	-0.2	0.8	7.5	-7.5	-11.5	0.0	-0.2
17 Other transport equipment	0.9	-0.9	-2.6	-3.3	-0.1	0.1	1.6	1.4	-2.7	-2.8	-0.2	-0.1	-13.4	0.1	0.1	187.3	-0.3	0.0
18 Manufacture ncp; recycling	-3.1	-2.4	1.6	-2.5	-0.6	-0.2	-1.6	1.3	-1.9	1.9	-0.4	-0.4	-1.3	406	-406	0.9	0.0	82.8

Source: Own elaboration based on the Input-Output tables published by the OECD. Inter: domestic technical input coefficient multipliers, Imp: imported technical input coefficient multipliers, ρ'n: domestic income input multipliers, ρ'm: imported income input multipliers, ϖn: domestic requirements of wage growth per percentage point of output, ϖm'

Conclusions

The theory of Latin American structuralism seeks to explain why certain regions lag behind in terms of per capita income and why this lag is accompanied by marked distributional inequality, both within the lagging region and between countries. Their main argument was the terms of trade and productivity (Lechuga and Vera, 2024; Pinto, 1970; Prebish, 1949; Sunkel, 1978). Thus, these visions shared the view that in Latin American economies, highly productive industries coexist with others of high productive backwardness derived from low levels of productivity and stagnation with traditional production. The argument they put forward for achieving development is the increase in productivity and with it the internal market.

In this paper, the analysis of the domestic market has been done with the effects of consumption, income and wages, assuming that in the total accounts these activities are carried out by residents of a country. The results suggest that by these elements the economies analysed during 1995 and 2011 have significantly affected the domestic market. The intention to integrate the economies into the external market is to reduce labour costs, which is reflected in low levels of income and wage growth and activity in general, so that productive specialisation has not borne the fruits that were expected with the openness model (Álvarez; 2024).

The economies of Brazil, Chile, Colombia, Costa Rica, Mexico and Peru have generally shown a fall in the share of consumption output, and in their income and wage content. The vertical distribution of income and wages has not shown favourable results for the activation of the domestic market, the underdevelopment of the economies is due to the tendency of increasing contributions of imported intermediate inputs, this dependence has made the effect of income and wages weak on the domestic market. The results suggest that, across economies, there are different levels of the domestic market; up to 2011, the economies show that the effect of income and wages is low on the level of output, suggesting that demand is not growth-activating, as it is a phenomenon derived from income concentration (Bárcena and Prado, 2016).

The comparison of the vertical distribution of income and wages contained in the consumption product is due to the growth path that economies have used, if we consider in two groups those that grow above 4%, for example, Chile, Costa Rica and Peru, only the latter has influenced the domestic market, as its path is intensive in domestic inputs and wage compensation; on the other hand, the group of less than 4%, only Brazil has been the country that has pushed the domestic market with intensive paths in domestic inputs and wage compensation. The growth of this period shows that the economies present a weak domestic market in 1995 and 2011, as well as weak income, wage and consumption boosting growth paths during 1995 - 2011.

Indeed, to increase incomes and wages depends on productivity, however, it can also be through the participation of the State through the promotion of an internal market policy, in which subsidies to products such as factors affect the growth of incomes and wages; however, as in the period of industrialisation, it is necessary to generate certain internal conditions of the productive structure as well as external to it, in which the external sector influences. However, in the face of the deindustrialisation of the economies, the economies have driven growth not only in services but also in the increase of informal employment (Sánchez, 2024).

The economies analysed require a new model to achieve development; an industrial policy helps to achieve the development of the internal market; however, industrial policy by itself does not create qualitative change in the economic system; a social policy that includes a greater number of agents is also required, in such a way that investment activities are indirectly guaranteed in the national economy. Currently, in Mexico, a social policy has been employed through universal access to welfare, which explains why Mexico has improved its poverty and extreme poverty indices, so it is possible that the internal market has improved; in Costa Rica, although economic policy has not changed either, social policy has had greater relevance since it has addressed the social inclusion of indigenous and vulnerable groups or the ‘bono proteger’ programme, derived from the pandemic. These social policies have coincided with certain conditions within these economies and the foreign trade they maintain with other trading partners, in this sense, the socio-economic structure within the countries, as well as their trade agreements, influence the development of the internal market.

Declarations

We declare that the work is original and authored by us.

Conflict of interest

The authors declare that they have no conflicts of interest. They have no financial interests or personal relationships that could have influenced this book.

Authors' contribution

The work was carried out as a whole and each section was the result of team work, however, the organization of the elaboration was as follows:

Marquez-Mendoza, Marco Antonio: Carried out the hypothesis and measurement techniques, in addition to sections 2, 3 and 5.

Llanez-Anaya, Helmer Fernando: Worked on the bases and the drafting of the document, and proposed sections 1 and 4.

Availability of data and materials

We have used the IP tables published by the OECD ISIC rev 3 for the years 1995 and 2011 that disaggregates the activities in 34 industrial branches, which can be obtained from *https://data-explorer.oecd.org/vis?df[ds]=DisseminateFinalDMZ&df[id]=DSD_STAN%40DF_STAN&df[ag]=OECD.STI.PIE&dq=A.DEU..B1G.V.XDC&pd=2015%2C&to[TIME_PERIOD]=false*

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Abbreviations

AGEIOT: Analyses of Growth Economic Input Output Tables
IMF: International Monetary Fund
IP: Input - Output
ISIC rev.: International Standard Industrial Classification Revision
OECD: Organisation for Economic Co-operation and Development0073

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Rural companies as engines of development: Ruralia 4.0 community educational center

Empresas rurales como motores de desarrollo: Ruralia 4.0 centro educativo comunitario

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Key Handbooks

Ruralia 4.0's research highlights how the solidarity economy drives technological innovation, agroecology and community autonomy in rural development. First, technological innovation focuses on digital tools that modernize education and foster collaboration, equipping communities with skills to meet current technological challenges. The solidarity economy, a central pillar, proposes a model of cooperation and shared ownership that prioritizes collective well-being over profit. Through agroecology, sustainable practices that preserve the environment and strengthen food security are implemented. Finally, the focus on local autonomy and self-sufficiency promotes recampesinization and traditional knowledge, supporting self-sufficiency and reducing external dependence, which strengthens the local economy in a context of solidarity. To generate universal knowledge, it is key to integrate solidarity economy, agroecology, technological innovation, dialogue of knowledge and community autonomy. Solidarity economy promotes an inclusive economy, based on cooperation and collective wellbeing, promoting alternative economic models that prioritize social and environmental wellbeing. Agroecology, as an integral discipline, fuses science, practice and social activism to promote sustainable food production in harmony with nature. Technological innovation facilitates access to knowledge and enhances continuous learning, as long as it is adapted to local needs. The dialogue of knowledge, by recognizing the richness of traditional knowledge alongside scientific knowledge, builds an inclusive and ethical vision. Finally, community autonomy allows populations to manage their resources, developing resilience and self-sufficiency. Together, these elements enable knowledge that responds to global challenges in an inclusive and sustainable way. The research concludes that a community development model based on solidarity economy, agroecology and technological innovation can strengthen the resilience and autonomy of rural communities. Solidarity economy fosters an inclusive approach where cooperation and collective well-being are priorities, while agroecology offers sustainable agricultural practices that improve food security and protect the environment. Technological innovation is essential to modernize learning and facilitate access to resources adapted to local needs. In addition, the study highlights the importance of dialogue of knowledge, which integrates traditional and scientific knowledge, enriching the development of sustainable strategies. Self-management and community autonomy are key to the long-term sustainability of these practices, allowing communities to reduce their external dependence and build solutions adapted to their context. This approach contributes to equitable, sustainable development in tune with contemporary challenges.

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Handbook shelf URL: https://www.ecorfan.org/handbooks.php

Abstract

Ruralia 4.0 is a community educational center dedicated to offering comprehensive training based on the principles of Solidarity Economy. One of the pillars of Ruralia 4.0 is Agroecological Production, where sustainable methods that respect the environment and optimize the use of local resources are taught. Through practical workshops, participants learn to cultivate quality food, thus promoting food security. Another key component is Education on Solidarity Economy, which emphasizes cooperation and collective well-being. Additionally, Ruralia 4.0 stands out for its focus on technological innovation, implementing tools that facilitate continuous training, information exchange, and collaboration, empowering the community and promoting sustainable and resilient development.

Rural Companies as Engines of Development: Ruralia 4.0 community educational center.		
Objectives	Methodology	contribution
To establish a community educational center that promotes integral development through the solidarity economy, agroecology, technological innovation, and collective health. The objective is to improve the quality of life and strengthen community autonomy in Amaxac de Guerrero, Tlaxcala, Mexico, through training in sustainable practices that optimize local resources, promote food security, and create resilient solutions for collective benefit and community cooperation.	The methodology used in the Ruralia 4.0 educational center is based on educational workshops that focus on the solidarity economy, agroecology, and technological innovation. First, a participatory diagnosis is carried out to identify local needs and potentials. Based on this information, a program of practical workshops is designed and adapted in which participants learn about agroecological methods, community management, and accessible technology for sustainable solutions. During the workshops, participants collaborate in activities of cultivation, collection and analysis of local resources, as well as in the development of collective projects that promote the economic and social autonomy of the community. These workshops not only transfer knowledge, but also strengthen local organization and community empowerment, promoting self-management and resilience through practices that respect and value the natural environment.	The Ruralia 4.0 initiative contributes to community development in Amaxac de Guerrero by implementing an educational model based on the solidarity economy, agroecology and innovative technology. This approach provides the community with tools to achieve food self-sufficiency and improves social cohesion by integrating values of cooperation and sustainability. In addition, it promotes environmental preservation and the improvement of collective health, promoting practices that strengthen resilience and adaptability in the face of social and ecological challenges.

Solidarity economy, Agroecology, Technological innovation

Resumen

Ruralia 4.0 es un centro educativo comunitario que se dedica a ofrecer una formación integral basada en los principios de la Economía Solidaria. Uno de los pilares de Ruralia 4.0 es la Producción Agroecológica, donde se enseñan métodos sostenibles que respetan el medio ambiente y optimizan el uso de recursos locales. A través de talleres prácticos, los participantes aprenden a cultivar alimentos de calidad, promoviendo así la seguridad alimentaria. Otro componente clave es la Educación sobre Economía Solidaria, que enfatiza la cooperación y el bienestar colectivo. Además, Ruralia 4.0 se destaca por su enfoque en la innovación tecnológica implementando herramientas facilitan la capacitación continua el intercambio de la información y la colaboración, empoderando a la comunidad y promoviendo un desarrollo sostenible y resiliente.

Empresas Rurales como Motores de Desarrollo: Ruralia 4.0 centro educativo comunitario.		
Objetivos	Metodología	Contribución
Establecer un centro educativo comunitario que promueva el desarrollo integral a través de la economía solidaria, agroecología, innovación tecnológica y salud colectiva. El objetivo es mejorar la calidad de vida y fortalecer la autonomía comunitaria en Amaxac de Guerrero, Tlaxcala, México, mediante la capacitación en prácticas sostenibles que optimicen recursos locales, fomenten la seguridad alimentaria y creen soluciones resilientes para el beneficio colectivo y la cooperación comunitaria.	La metodología empleada en el centro educativo Ruralia 4.0 se basa en talleres educativos que se enfocan en la economía solidaria, la agroecología y la innovación tecnológica. Primero, se realiza un diagnóstico participativo para identificar las necesidades y potenciales locales. A partir de esta información, se diseña y adapta un programa de talleres prácticos en los que los participantes aprenden sobre métodos agroecológicos, gestión comunitaria, y tecnología accesible para soluciones sostenibles. Durante los talleres, los asistentes colaboran en actividades de cultivo, recolección y análisis de recursos locales, así como en el desarrollo de proyectos colectivos que promuevan la autonomía económica y social de la comunidad. Estos talleres no solo transfieren conocimientos, sino que también refuerzan la organización local y el empoderamiento comunitario, fomentando la autogestión y la resiliencia mediante prácticas que respetan y valoran el entorno natural.	La iniciativa Ruralia 4.0 contribuye al desarrollo comunitario en Amaxac de Guerrero al implementar un modelo educativo basado en la economía solidaria, agroecología y tecnología innovadora. Este enfoque proporciona a la comunidad herramientas para lograr la autosuficiencia alimentaria y mejora la cohesión social al integrar valores de cooperación y sostenibilidad. Además, fomenta la preservación ambiental y la mejora de la salud colectiva, promoviendo prácticas que fortalecen la resiliencia y adaptabilidad frente a retos sociales y ecológico.

Economía solidaria, Agroecología, Innovación tecnológica

Introduction

Ruralia 4.0 is a community education centre for innovation and sustainability in education. Its main mission is to offer a comprehensive education based on the principles of the Solidarity Economy, promoting essential values such as cooperation, equity and respect for the environment. In an increasingly interconnected world, Ruralia 4.0 responds to new social and economic demands by integrating technological innovation and contemporary practices that enrich the teaching-learning process. This community education centre, located in Amaxac de Guerrero, Tlaxcala, Mexico, has the mission to build local capacities to face the challenges of the 21st century through training based on principles of Solidarity Economy, agro-ecological production, collective health and technological innovation. Therefore, its programmes are designed to include the entire population, from childhood to adulthood, ensuring inclusive and accessible training.

The importance of this approach lies in the fact that it addresses fundamental problems such as food security and sovereignty, economic and social marginalisation, and lack of access to educational technologies, ensuring that education is not only inclusive, but transformative. The combination of technological innovation and agro-ecological principles represents an added value compared to other techniques, as it integrates contemporary digital tools with traditional sustainable practices, building a bridge between ancestral knowledge and modern demands.

The central problem that Ruralia 4.0 seeks to solve is the vulnerability of rural communities in the face of food insecurity, economic precariousness and lack of technological training. The main hypothesis guiding this initiative is that the implementation of comprehensive and contextualised education can transform rural communities into models of resilience, self-sufficiency and sustainable development, addressing both immediate needs and future generations.

The Ruralia 4.0 proposal aims to create a community education centre that promotes the integral development of the community through education, environmental care, collective health, technological innovation and solidarity economy, in order to improve the quality of life and strengthen community autonomy. This approach seeks to transform the reality of rural communities by providing them with practical tools and knowledge that will enable them to face the challenges of the present and build a more sustainable, equitable and resilient future.

This paper is organised in 6 main sections that explain in detail the educational model of Ruralia 4.0, its theoretical foundations and the results obtained in its implementation:

1. Concept of Solidarity Economy
2. Concept of Agroecology
3. Concept of Technological Innovation
4. Methodology
5. Results
6. Conclusions

Concept of Solidarity Economy

The solidarity economy is a socio-economic model that promotes cooperation, collective ownership and democratic decision-making among its members. According to the National Institute of Social Economy, the social and solidarity economy (SSE), Figure 1, encompasses a series of initiatives that seek to transform traditional forms of economy by promoting relationships based on trust, solidarity and community participation.

These initiatives focus on collaborative work and the shared management of resources and goods, generating an economy oriented not only towards economic profit, but also towards meeting the needs of its members and the communities in which they operate.

Box 1

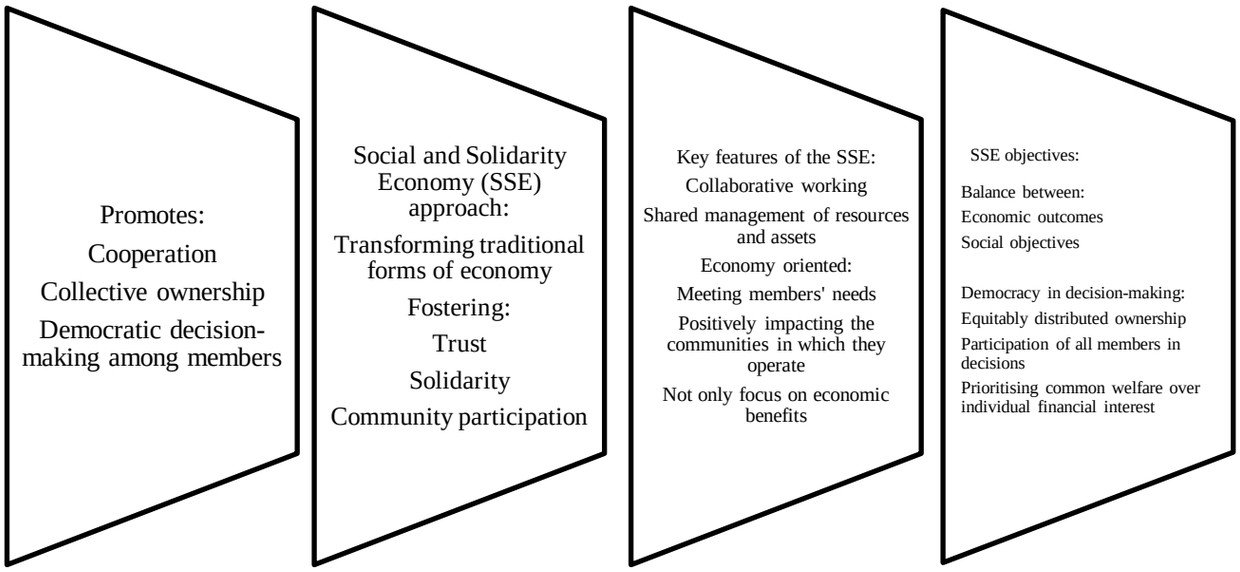

Figure 1

Outline of the Solidarity Economy

Source: based on information from the National Institute of Social Economy 2021

The social and solidarity economy (SSE) implies a paradigm shift by seeking a balance between economic outcomes and social objectives in a system where all members are owners and participate democratically in decision-making. This means that ownership is not concentrated in a single person or in the capital contributions of the members, but is distributed equally among all participants. Decisions are therefore taken collectively, prioritising the common good over individual financial interests.

Among the fundamental characteristics of the SSE are: democratic decision-making, shared ownership, equitable distribution of benefits among members, and a strong social commitment focused on the well-being of the community. In addition, the management of organisations adopting this model is autonomous and transparent, so that capital does not determine the influence on decisions or control of the organisation.

Although economic profitability remains relevant in this model, social and environmental sustainability becomes an essential pillar. Organisations operating under SSE principles have the responsibility to be economically viable, but they must also ensure that the profits generated have a positive and direct impact on the territories where they are present. This implies that they must not only be competitive and self-sufficient, but also contribute to local development and to the improvement of the quality of life of the community (National Institute of Social Economy, 2021).

The social sector of the economy is fundamental to the social and solidarity economy (SSE), Figure 2, in Mexico and is supported by the Political Constitution of the United Mexican States, in particular Article 25. This article establishes the collaboration between the public, private and social sectors in the economic development of the country.

In this context, the Law of the Social and Solidarity Economy (LESS) recognises the social sector as one of the fundamental pillars of the national economy, integrating diverse forms of social organisation, such as ejidos, communities, cooperatives and other entities that manage the production, distribution and consumption of goods and services in a solidarity-based and responsible manner. (Bonfil, C. C., 2020).

Box 2

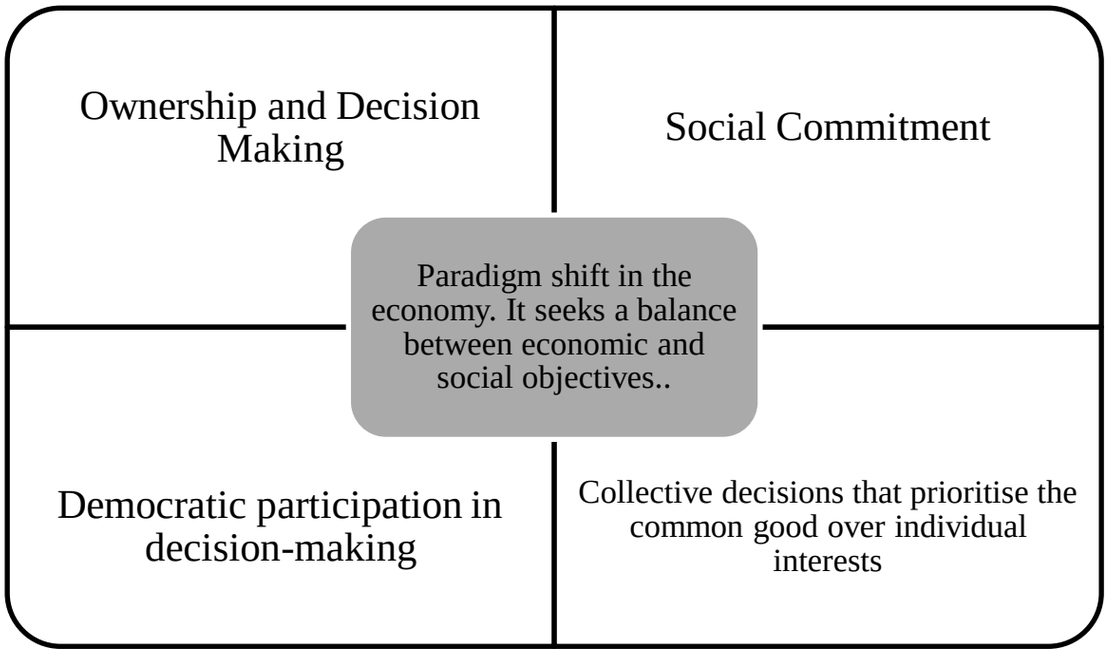

Figure 2

Fundamental characteristics of the SSE

Source based on information from the National Institute of Social Economy

Organisations of the Social Sector of the Economy (OSSE), mentioned in the Law on the Social and Solidarity Economy (LESS), encompass various forms of organisation that aim to meet the needs of society through cooperation and solidarity. These bodies include ejidos, communities, cooperatives, workers' organisations and enterprises where ownership is majority employee-owned. All these actors share the goal of fostering a more equitable and just economy, focused on social welfare, the development of the territories in which they operate and the improvement of the living conditions of their members (Chávez & Barro, 2020).

The social and solidarity economy (SSE) is presented as an alternative to conventional economic models, proposing a more humane, inclusive and solidarity-based approach to the management of economic resources. This form of organisation is based on democratic control by the members, equity in the distribution of benefits and continuous training of its members. This enables people to empower themselves collectively, manage their resources responsibly and contribute to social welfare, while at the same time strengthening their productive and organisational capacities (Ortega, 2022).

The solidarity economy is presented as an alternative to the capitalist model, based on principles that differ significantly from those of the dominant system: capitalist development is characterised as being driven by big capital and influenced by values that promote free markets, competition, individualism and a state with minimal intervention. In contrast, the SSE is carried out through communities formed by small associated enterprises or worker cooperatives, which are organized in federations and operate in an environment where, despite competing in the same markets, values of cooperation and mutual support among people or enterprises prevail.

It is important to emphasise that the solidarity economy does not seek to challenge or dismiss development, which, despite being framed within a capitalist context, contributes to the progress of humanity. It aims to promote more equitable development, distributing both profits and losses more fairly. Solidarity economy does not operate in a separate sphere from capitalism and the formal market; on the contrary, it seeks to find within the existing economic reality development alternatives that are based on more humane and ethical values. This approach not only offers a more inclusive and fairer approach to the economic sphere, but also seeks to strengthen the social fabric by fostering solidarity and cooperation between individuals and communities. Through the solidarity economy, it aims to build a development model that prioritises collective well-being over individual profit, thus promoting greater equity and social justice in today's economic environment.

In doing so, it opens the door to new forms of economic organisation and operation that not only generate wealth, but also improve the quality of life of the people involved, promoting a more responsible and sustainable economy. Solidarity economy is thus a viable and transformative option in a world where the search for the common good.

Concept of Agroecology

Agroecology emerges not only as an agricultural practice, but as an integral solution capable of addressing these challenges from multiple dimensions. Toledo (2012) defines agroecology as a three-dimensional discipline that integrates science, practice and social movement, offering a holistic and sustainable approach to food production.

In Latin America, as a region of immense biological and cultural diversity, it has become a ready scenario for the evolution and application of agroecology. The region's rich agricultural tradition, combined with its particular socio-economic and environmental challenges, provides a unique context for the implementation of agroecological practices. Toledo & Barrera-Bassols (2008) highlight how agroecology has responded to ecological and social demands arising from critical and alternative thinking, promoting production systems that are adaptive, just and in harmony with the natural environment.

Agroecology in Latin America has undergone what Toledo & Boege (2010) describe as a 'triple transformation', marking a significant shift in the cognitive, technological and socio-political aspects of agriculture. This change has been largely driven by peasant and indigenous movements that, through the adoption of scientific advances in agroecology, have promoted practices that enhance the autonomy and resilience of rural communities (Funes et al., 2002; Wezel et al., 2009).

In Latin America, agroecology began with the profound agricultural wisdom of its original peoples. These communities developed resilient and adaptive farming systems according to the diversity of climates and ecosystems of the region, based on principles of diversification, rotation and sustainable management of natural resources. These practices, which today we recognise as agroecological, were fundamental to the survival and food sovereignty of numerous communities over the centuries (Altieri & Toledo, 2011).

Recognition of agroecology rapidly expanded due to its ability to simultaneously address issues of food production, social equity and environmental sustainability. International organisations such as the FAO (Food and Agriculture Organization of the United Nations) began to promote agroecology as a key to achieving food security and adapting to climate change in vulnerable contexts. In Latin America, this resonated deeply, as the region is highly susceptible to the effects of climate change and faces persistent challenges of inequity (FAO, n.d.).

For their part, social movements have played a crucial role in the dissemination and implementation of agroecology in Latin America. Numerous movements have emerged to revalue ancestral knowledge and indigenous agricultural practices, integrating them with modern agroecological principles. These movements, often led by indigenous and peasant communities, have promoted crop diversification, soil and water conservation, and sustainable food production, contributing significantly to food security and climate resilience in their regions (Altieri & Toledo, 2011).

The impact of social movements on agroecology has also been seen in the political sphere. In countries such as Bolivia and Ecuador, social mobilisation has led to the inclusion of rights of nature and food sovereignty in national constitutions, establishing a legal framework for the protection of agroecological systems and rural livelihoods (Claeys, 2015). These legislative victories are testimony to the power of social movements to influence public policy in favour of agroecology.

However, despite these advances and according to Fernandes (2009) and van der Ploeg (2008, 2010a), current territorial disputes reflect the struggle for autonomy and the reconfiguration of spaces in favour of divergent interests. These involve rural social movements and agribusiness, which seek to reterritorialise rural spaces according to their visions and objectives. According to Fernandes (2009), there is a constant struggle for access, control and use of land, generating territories of domination and resistance (Fernandes, 2009).

As van der Ploeg (2008, 2010a) suggests, peasant autonomy implies a constant struggle to build and maintain a self-managed resource base that strengthens co-production with nature, reducing dependence on external markets. This vision emphasises the importance of strengthening the relationship between producers and nature through agroecological practices in order to achieve greater control over the territory (van der Ploeg, 2010b).

Both agribusiness and rural social movements are attempting to reterritorialise rural spaces and reconfigure them in favour of their interests. While one seeks maximum profit extraction on the one hand, the other seeks to defend and (re)build communities, it is in this context that recampesinisation emerges as their tool to realise their objectives.

The practice of re-campesinisation has a direct impact on the autonomy of rural communities. By reducing dependence on external inputs, such as chemical fertilisers and patented seeds, and by promoting diversified production systems, communities can achieve greater food self-sufficiency. This process also contributes to the conservation of native seeds and agricultural biodiversity, crucial elements for food sovereignty and ecological resilience (Altieri & Toledo, 2011).

However, despite its benefits, recampesinisation faces several challenges. Pressure from agro-industrial expansion, unfavourable agricultural policies and climate change threaten the viability of peasant farming practices. But this does not diminish the growing awareness of environmental problems and food insecurity that has led to a renewed appreciation of agroecology and re-campesinisation as key strategies for a sustainable future.

In the specific case of communities such as Amaxac de Guerrero, re-campesinisation represents not only a return to traditional agricultural practices but also a reaffirmation of peasant identity and culture in the context of globalisation.

The implementation of agroecology in the municipality of Amaxac de Guerrero presents an invaluable opportunity to simultaneously address the challenges of environmental sustainability, socio-economic development and food security. In this last aspect, nutritional food security in the municipality of Amaxac de Guerrero is affected by various factors related to agriculture and rural development. The current agricultural situation in Amaxac is characterised by small farms, environmental degradation and limited access to sustainable technologies. To address these challenges and promote food security in the region, it is essential to adopt an agroecological approach that integrates sustainable and environmentally friendly practices.

Agroecology is presented as a tool to improve food production in a sustainable way and promote food security in Amaxac de Guerrero. By combining traditional peasant knowledge with agroecological practices, the resilience of local farming systems can be strengthened and access to nutritious, quality food can be guaranteed.

Community participation plays a key role in developing effective strategies to improve food security in Amaxac. Collaboration between farmers who offer their products in places such as the ‘mercadito Alternativo’ is highlighted to strengthen farmers' capacities, promote crop diversification and foster food self-sufficiency. This type of organisation helps to promote agricultural and nutritional diversity is another aspect of ensuring a balanced and varied diet in Amaxac de Guerrero. The conservation of agricultural biodiversity and the promotion of local and nutritious foods are fundamental to improving the quality of the population's diet and preventing malnutrition.

Despite challenges such as poverty, food insecurity and lack of access to nutritious food, there are also opportunities in Amaxac de Guerrero to improve food security through innovative and sustainable agroecology-based approaches. Such as the optimal use of space and local resources, as most agricultural land in Amaxac de Guerrero is limited in space and requires maximising the use of environmental resources and available land, through polycultures, agroforestry, home gardens, altitudinal zoning, fragmentation of the land and rotations. It is important to highlight the importance of promoting agroecological practices, solidarity economy and self-management in rural communities as key strategies to improve food and nutrition security in municipalities. These approaches not only strengthen local production and access to healthy food, but also promote environmental sustainability and the long-term well-being of local populations.

According to Barkin (2012), the concentration of capital has had significant negative effects on society, which highlights the urgent need to reconsider market rationality as its fundamental principle. It is crucial to move towards new forms of social and economic organisation that overcome current models, which have intensified individualism, the commodification of nature and the primacy of private property. This underlines the importance of incorporating indigenous and local epistemologies in the development of alternative strategies for sustainable regional resource management (Barkin, 2010). As Barkin (2009) points out, social and technological innovation is key to generating viable socio-economic alternatives.
Considering the perspectives of authors such as Toledo and Barrera-Bassols (2008), who emphasise the need to recognise and value traditional knowledge in environmental management, it is essential to combine local knowledge with science in order to build a society based on a new sustainable rationality. In this sense, the dialogue of knowledge is presented as an essential tool to challenge the hegemony of unitary visions and promote cultural and biological diversity (Barkin, 2012).

It is essential to consider the experiences of peasant and indigenous communities that have opted for self-management and empowerment in the administration of their natural resources. From a scientific perspective, these practices provide valuable lessons for developing sustainable development models that are based on social justice and intergenerational equity. This highlights the need to strengthen empowerment processes and build alliances between communities to address global socio-environmental challenges. It is also crucial to rethink current social paradigms and foster diversity of perspectives, knowledge and rationalities in the search for sustainable and just development. Through the multidisciplinary approach suggested by authors such as Barkin, it is possible to envision the construction of a new social paradigm that integrates ethical, community and ecological values, which would contribute to forge resilient societies in harmony with the natural environment.

Concept of Technological Innovation

Technological innovation can be defined as the introduction of significant improvements in products, processes or services through the use of advances in science and technology (Croitoru, 2012). According to the Organisation for Economic Co-operation and Development (OECD), technological innovation refers to the implementation of a new or significantly improved product or process (OECD, 2018). This may include changes in materials, components, software, systems or processes that enable greater efficiency, quality or sustainability.

Technological innovation is not only the creation of something completely new, but also the substantial improvement of something existing. For example, the introduction of more sustainable technologies in agricultural production or the creation of software that optimises industrial processes are examples of how technological innovation can take both incremental and disruptive forms.
According to recent studies, technological innovation can be classified into two main categories: incremental innovation and disruptive innovation (Christensen, 2015).

Incremental innovation: This refers to incremental improvements in existing products or processes. This form of innovation is common in industries that seek to optimise and refine their current technologies to remain competitive. A clear example of this is the evolution of smartphones, where each new generation introduces improvements in speed, camera, or functionality without changing the essence of the product.

Disruptive innovation: In contrast, disruptive innovation introduces technologies that drastically change the market or industry. These innovations often have a profound impact, eliminating or replacing previous models. An emblematic example is the emergence of streaming platforms such as Netflix, which completely transformed the entertainment industry and displaced traditional formats such as movie rentals.

Technological innovation has been identified as a key factor in long-term economic growth. According to Solow (1957), technological progress is responsible for a large part of productivity growth in developed economies. Firms that invest in research and development (R&D) tend to be more competitive globally and can offer higher quality products at lower prices. The relationship between technological innovation and economic development is particularly strong in sectors such as advanced manufacturing, biotechnology, and information technology.

However, despite its importance, technological innovation presents challenges that include limited access to financial resources for research, cultural resistance to change, and lack of adequate government policies to promote technological development. According to Rogers (2014), the diffusion of new technologies also faces challenges due to the lack of adequate infrastructure or the low level of education in some regions.

This is why technological innovation is fundamental to the advancement of modern society. From incremental improvements to disruptive innovations, the development of new technologies and their integration into production processes and services has enabled sustained economic growth and transformed the way people live and work. However, to reap the full benefits of innovation, it is essential to overcome existing barriers by fostering effective public policies, investing in research and development, and creating a culture open to technological change.

Methodology

The Methodology is based on educational workshops focused on promoting social and solidarity economy, agroecology and technological innovation, following a series of key steps that allowed not only the transfer of knowledge, but also the creation of sustainable local solutions through the active participation of the community where the Community Education Centre is located. In conclusion, this methodology based on educational workshops was structured in a way that ensures knowledge transfer, promotes the creation of sustainable solutions and fosters community empowerment.

Results

The ‘Roots and Wings’ workshop, (Figure 3 and 4), achieved an active participation of community members, who were involved in various activities to identify and value local flora and fauna. Participants demonstrated an increase in their knowledge of the region's biodiversity and its importance for the ecological balance.

In addition, group dynamics were carried out to encourage discussion on sustainable practices and the implementation of concrete actions to preserve the natural environment. As a result, a collective commitment towards the conservation of biodiversity was generated, with the creation of a community action plan that includes the implementation of clean-up and reforestation days. The feedback received by the participants highlights a renewed sense of belonging and a greater responsibility towards the care of the environment.

Box 3

Figure 3

Roots and Wings Workshop

Source [Photograph obtained from the course "Roots and Wings" Workshop 2024].

Box 4

Figure 4

Roots and Wings Workshop

Source: Photograph obtained from the course "Roots and Wings" Workshop 2024

The workshop "Training in Robotics and Sustainability through Mechanical Engineering" was carried out with the active participation of teachers from various basic level institutions. Throughout the sessions, key topics related to the principles of speed and power transmission of gears, as well as essential concepts in robotics were addressed (figure 5).

Participants showed a remarkable interest and willingness to learn about the application of these principles in education. During the workshop, practical demonstrations were carried out to facilitate the understanding of the theoretical concepts.

Box 5

Figure 5

Workshop "Training in Robotics and Sustainability through Mechanical Engineering".

Source:Photograph obtained from the course "Training in Robotics and Sustainability through Mechanical Engineering".

Photograph 3: Hernández, Hernández, A. (2024). Workshop "Training in Robotics and Sustainability through Mechanical Engineering".

The impact of the workshop was reflected not only in the acquisition of technical knowledge, but also in the creation of a collaborative community among teachers. This space allowed the exchange of ideas and experiences, enriching the pedagogical practices of each participant. In addition, teachers received guides and teaching resources that facilitate the implementation of robotics projects in their schools, adapted to local needs and contexts.

Through interactive activities, teachers learned to build simple robotic models that emulate real situations, integrating sustainability concepts. These activities not only strengthen their students' learning in areas such as mathematics, science and technology, but also foster critical 21st century skills such as problem solving, teamwork and creative thinking.

Importantly, the workshop served as a starting point for teachers to improve their use of educational technology. With the support of the training received, they are better equipped to create more dynamic, inclusive and sustainable learning environments, aligned with the global challenges of our time. The success of the workshop reinforces the importance of continuing to develop initiatives that integrate technology and sustainability in basic education, as these areas not only improve educational quality, but also inspire future generations to seek responsible and sustainable solutions to the challenges facing our societies.

Conclusion

The Ruralia 4.0 project has begun to generate a positive impact in the community of Amaxac de Guerrero, promoting economic autonomy and sustainability through training programmes. In the long term, it is envisaged that this initiative will not only boost community resilience, but also strengthen support networks with external actors and expand access to workshops, thus consolidating a solidarity-based development model.

The Social and Solidarity Economy (SSE) is presented as a viable alternative for building social relations based on solidarity and mutual trust. This approach seeks to cultivate a strong community spirit, encouraging the active participation of all members of society, regardless of age, gender or socio-economic status. SSE advocates an economic model that prioritizes collective well-being over individual profit, promoting a sense of belonging and collaboration among community members.

The implementation of SSE aims to create support networks that facilitate collaboration and joint work between individuals and organisations. This approach not only contributes to the empowerment of communities, but also enables citizens to become active agents of change, rather than mere recipients of external policies. Furthermore, the promotion of the SSE can result in the creation of sustainable jobs and the strengthening of the local economy, which positively impacts on the quality of life of the inhabitants.

SSE is not limited to the generation of economic resources; it also addresses social, cultural and environmental aspects, promoting integral development that benefits the whole community. This translates into a more supportive, participatory and resilient environment, where all stakeholders can contribute and benefit equitably. By adopting an SSE approach, the foundations are laid for a more just and equitable society, where prosperity is not only understood as an economic goal, but also as a commitment to social and environmental well-being, making use of technological innovation while promoting sustainable practices.

Declarations

Conflict of interest

The authors declare that they have no conflicts of interest. They have no financial interests or personal relationships that could have influenced this book.

Authors' contribution

Perez-Garcia, Andrea: I contributed to the idea and implementation of the development of collective projects that promote the economic and social autonomy of the community.

Hernández-Hernández, Angel: I contributed to the development of the material for the workshop on Robotics and Sustainability Training through Mechanical Engineering.

Availability of data and materials

No database

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Abbreviations

ESS	Social and Solidarity Economy
LESS	Law on the Social and Solidarity Economy
OSSE	Organisations of the Social Sector of the Economy
FAO	Food and Agriculture Organization of the United Nations, in Spanish Food and Agriculture Organization of the United Nations
OCDE	Organisation for Economic Co-operation and Development

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Use the APA system. It should not be numbered or bulleted; however, if numbering is necessary, it will be because it is referred to or mentioned somewhere in the book.

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Impact of AMIB professional certification on financial engineering students at UPTx

Impacto de la certificación profesional AMIB en los estudiantes de ingeniería financiera de la UPTx

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Area: Social Sciences
Field: Business and Management
Discipline: Business and accounting
Subdiscipline: Finance, banking and insurance

Key Handbooks

Infer on the relevance of the AMIB Figure III certification in Financial Engineering students, from a personal, academic and professional development perspective, which leads new students to develop within the framework of the aforementioned certification, thus helping them to face the labor market in the Mexican Financial System, providing a broader view of the positive impact of the certification. The key aspects are undoubtedly the knowledge of the benefits that a student of Financial Engineering can obtain by being certified in the figure III of the AMIB, which will undoubtedly serve as a reference for making decisions on whether or not to opt for the path of taking the certification. It can be concluded that the professional certification of financial engineers before the AMIB offers graduates of the Polytechnic University of Tlaxcala a clear differentiator in the labor market. It raises their competitiveness, expands their job opportunities and guarantees their ability to perform in a highly regulated and dynamic sector. For the UPTx, promoting this certification process reinforces its commitment to excellence and the training of professionals prepared for the challenges of the financial, economic, social, sustainable and technological innovation future. On the other hand, the perception of the certified students regarding their personal, academic and professional development that the AMIB Figure 3 certification has given them, has been very positive according to the results obtained.

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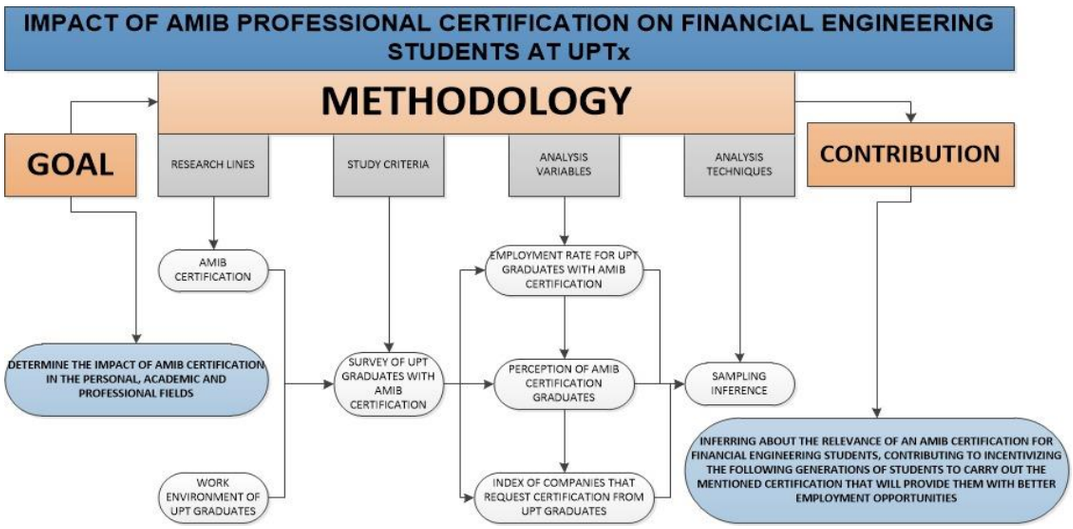
Abstract

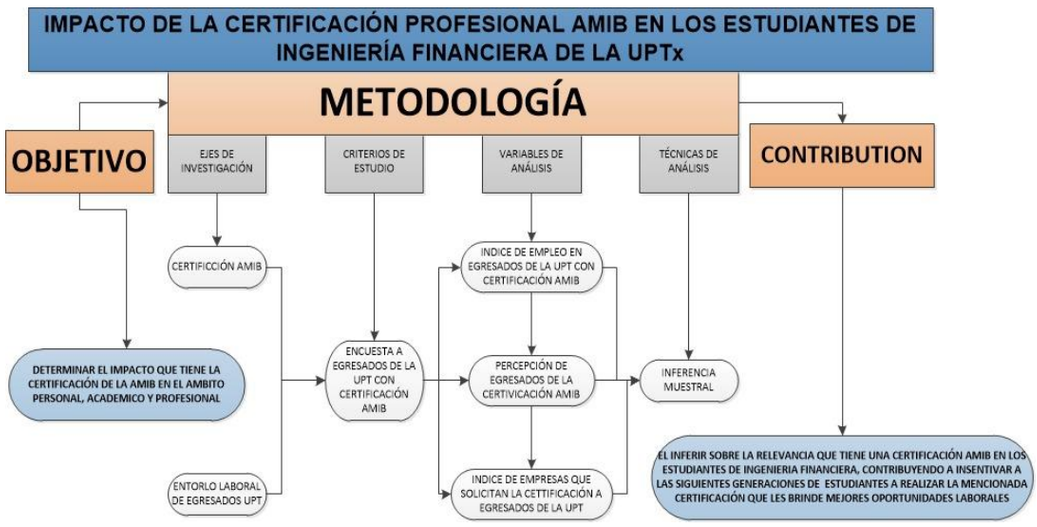
The purpose of this work is to investigate the impact that the Investment Strategy Advisor Certification Figure III of the Mexican Association of Stock Market Institutions, A. C. (AMIB), has on the professional field of Financial Engineering students at the Polytechnic University of Tlaxcala (UPTx). This study is conducted through the application of a research instrument, which consists of a survey of students who have obtained the certification as part of the university's management to provide students with a tool that contributes to their integration into the labor market. The analysis of the instrument is conducted using an inferential method for interpreting the results obtained from the applied instrument.



Certification, Financial Engineers UPTx, Figure III AMIB

Resumen

El presente trabajo, tiene como objetivo indagar sobre el impacto que tiene la certificación en la figura III de la Asociación Mexicana de Instituciones Bursátiles, A. C. (AMIB) en el ámbito profesional de los estudiantes de Ingeniería Financiera de la Universidad Politécnica de Tlaxcala (UPTx). Dicho estudio se realiza mediante la aplicación de un instrumento de investigación consistente en una encuesta a los estudiantes que han logrado la certificación mencionada como parte de la gestión que hace la UPTx para brindar a los estudiantes una herramienta que coadyuve a su integración en el mercado laboral. El análisis del instrumento se realiza mediante un método inferencial para la interpretación de los resultados arrojados del instrumento aplicado.



Certificación, Ingenieros Financieros UPTx, Figura III AMIB

Introduction

The model currently prevailing at the UPTx is based on competences, in which the institution ensures that the student acquires the necessary competences to perform in the labour market, but one of the great challenges of the educational model is the application of suitable instruments to ensure that the student has acquired these competences; in this sense, Ruiz (2006) refers to the importance of certifying the competences acquired during the learning process.

One of the profiles on which Financial Engineering students at the UPTx are oriented, among others, is to develop within the Stock Market field, thus demanding that they have knowledge and competences aimed at developing professionally in the aforementioned field. However, what would be the tool that could evaluate the competence of students in this field?

AMIB's Figure III certification is a valuable alternative to certify the aforementioned knowledge, as it is an authoritative regulatory body in charge of certifying the technical capacity of securities promoters, operators and advisors throughout the financial sector and provides a seal of guarantee on their technical and professional capacity. This recognition generates confidence in stock exchange, banking and insurance institutions. Firms are more likely to hire certified professionals to ensure regulatory compliance, which reduces the risk of sanctions. Certified financial engineers are trained to comply with current regulations, such as the Securities Market Law, and have up-to-date knowledge and specific skills to operate in complex financial markets.

For this reason, the UPTx has taken this certification as a turning point between the knowledge acquired in the classroom and the competences required in the labour field, being the instrument that can evaluate the competences of the UPTx Financial Engineering students in terms of financial and stock market knowledge. The certification process has been implemented at the UPTx as of January 2023, with 60 students already certified as a result of the aforementioned process, who are the object of study of the present work.

The objective of this project is to determine how the AMIB Figure III Certification has impacted the professional development of the certified students, through the analysis of information obtained by applying an instrument consisting of a survey, making inferences on the information collected and concluding on the impact indicated.

Development

Professional certification plays a growing strategic role in Mexican education policy as it is seen as a means to achieve objectives, including raising the quality of the higher education system (Flores, 2014).

In the report prepared for the National Council for Standardisation and Certification of Labour Competences, Norther, comments on the certificate of competences, that its issuing implies a prior competence assessment process, and that the standardised system does not accredit studies carried out, but rather that it is a validation of a demonstrated competence based on a standardised standard. He adds that the certificate is a guarantee of quality in relation to what the worker is able to do and the competences he or she possesses.

He concludes in his studies that people certified by CONOCER earn twice as much as non-certified workers. He also mentions that certification is linked to formal employability since 93% of certified people work in the formal sector.

It explains that certified workers receive a higher income than their peers, considering the same job, hours, gender and level of schooling. (Norther, 2022).

In the paper called benefits of a professional certification, Renato Santos Figueiredo explains that ‘a certification is a formal statement from an institution (public or private, national or international) that endorses that the candidate was successfully passed an examination or a series of procedures established by the institution’ (Norther, 2022).

Figueiredo also explains that obtaining professional certification allows for official recognition that a person possesses certain specific skills, which is why a certification is very important as it seeks qualified placement. In addition, he points out that professional certification not only contributes to the professional aspect, but also to the personal aspect as it allows them to be sure that their skills are recognised. So professional certifications allow for differentiation and competitiveness (Figueiredo).

In her comparative study between Spain and Mexico, María Edith Gómez Gamero, mentions that the role of education currently possesses greater commitment than ever, since the training of young people who face changing work environments requires the development of competences and their certification, considering that both factors are associated with employability, understood as the knowledge, skills and attitudes of adequacy of workers to the job. (Gamero, 2011).

The General Directorate of Professions, an institution belonging to the Ministry of Public Education, states that 'professional certification represents a suitable means to demonstrate to society who are the professionals who have achieved the updating of their knowledge and greater experience in the performance of their profession or speciality, with the purpose of improving their professional development, obtaining greater competitiveness and offering highly professional services' (Ministry of Public Education, 2005).

Method

For the development of this article, the following questions have been established around which the research revolves:

1. How has the AMIB Figure 3 certification impacted on the personal development of the certified students?
2. How has the AMIB Figure 3 certification impacted on the knowledge of the certified students?
3. How has the AMIB figure 3 certification impacted on the professional development of the certified students?

In order to carry out the relevant study that aims to investigate and conclude on the above questions, an instrument consisting of the application of a survey has been applied, in which the object of study are the students of the Financial Engineering degree of the UPTx, who have been certified in the AMIB figure 3 as part of the management that is carried out within the University. The survey is presented in ANNEX 1.

On the other hand, within the methodology, the different research axes, study criteria, variables and analysis techniques are established, which are shown in Figure 1.

Box 1

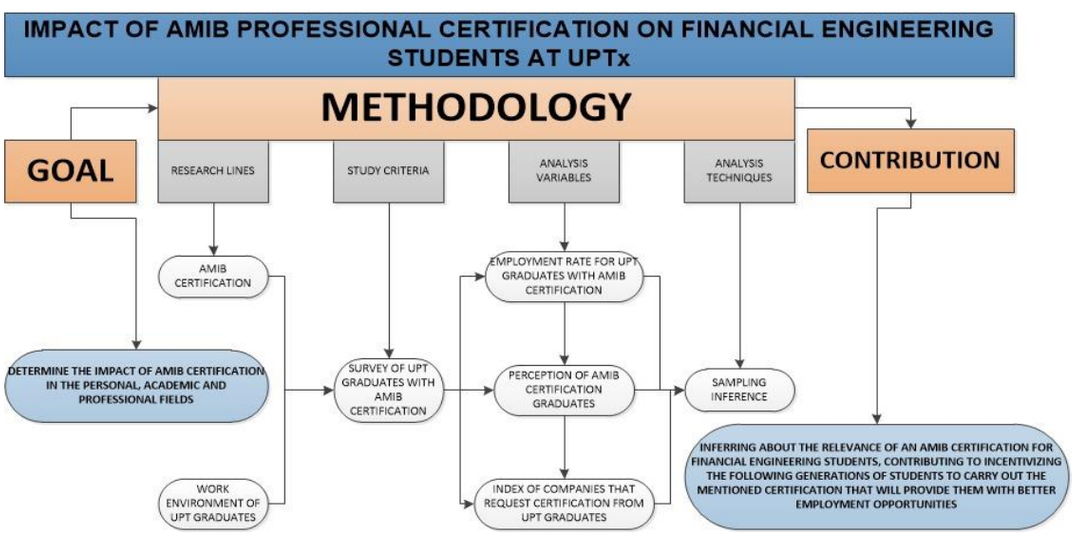


Figure 1

Diagram of the research method

Source: Own elaboration (2024)

To establish the sample size, the sample size calculation formula for finite populations has been applied and is shown below:

$$n = \frac{\sigma^2 Npq}{e^2(N-1)+\sigma^2 pq} \quad (1)$$

Where:

n = number of elements (sample size)
σ = confidence level
N = universe or population
p = probability in favour
q = probability against
e = estimation error (precision in the results)

Results

For the calculation of the sample for the application of the research instrument, the following parameters are taken as values.

σ = 1.96
N = 60
p = 0.8
q = 0.2
e = 0.05

Substituting parameters into Equation 1, we obtain:

$$n = \frac{1.96^2 * 60 * 0.8 * 0.2}{0.05^2(60-1)+(1.96^2 * 0.8 * 0.2)} \quad (2)$$

This gives a sample size of 49 surveys.

Subsequently, when the surveys were applied, the results shown in Table 1 were obtained, which shows the concentration of the application of the instrument used for this study.

Box 2

Table 1

Concentrated survey results

1. How do you perceive that AMIB Certification has impacted your personal development?		**2. How do you perceive that the AMIB Certification has impacted your knowledge of Finance?**	
Excellent	19	Excellent	29
Very good	19	Very good	15
Good	11	Good	5
Bad	0	Bad	0
Very bad	0	Very bad	0
3. Are you currently working or are you currently in the process of your stay?		**4. How do you perceive that AMIB Certification has impacted your professional development?**	
		Excelente	**Excellent**
Si	36	Very good	19
		Good	10
No	8	Bad	0
		Very bad	***0***

.

Source: Own elaboration (2024)

Figure 2 shows the results on how students perceived that the AMIB certification influenced their personal development.

Box 2

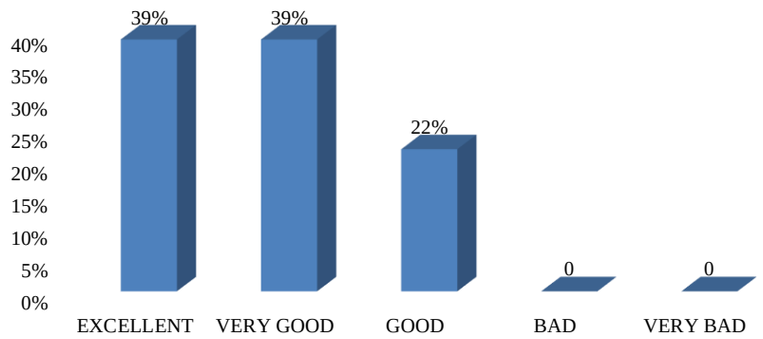


Figure 2

Students' perception of the AMIB certification on their personal development

Figure 3 shows the percentages of the results regarding how students perceive that AMIB certification has influenced their knowledge of finance issues.

Box 3

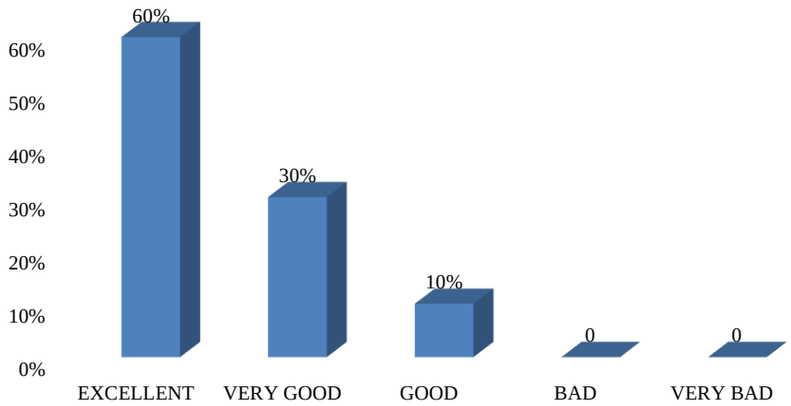


Figure 3

Students' perceptions of AMIB certification on their knowledge of finance

Figure 4 shows the results concerning the current prevailing employment rate of students who have obtained AMIB certification.

Box 4

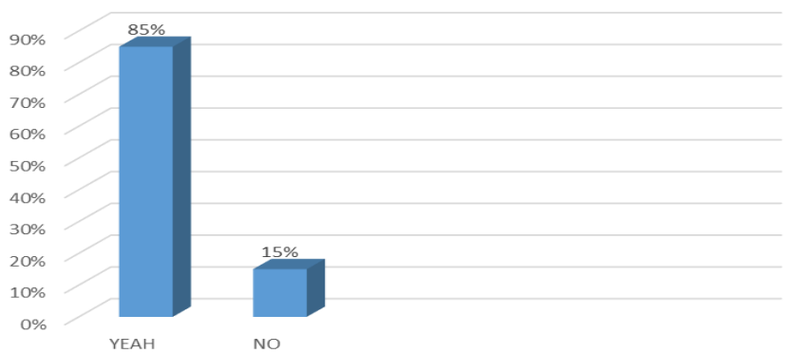


Figure 4

Occupancy rate of AMIB-certified students

Figure 5 shows the results in terms of percentages in terms of how students perceive the impact of AMIB certification on their professional development.

Box 5

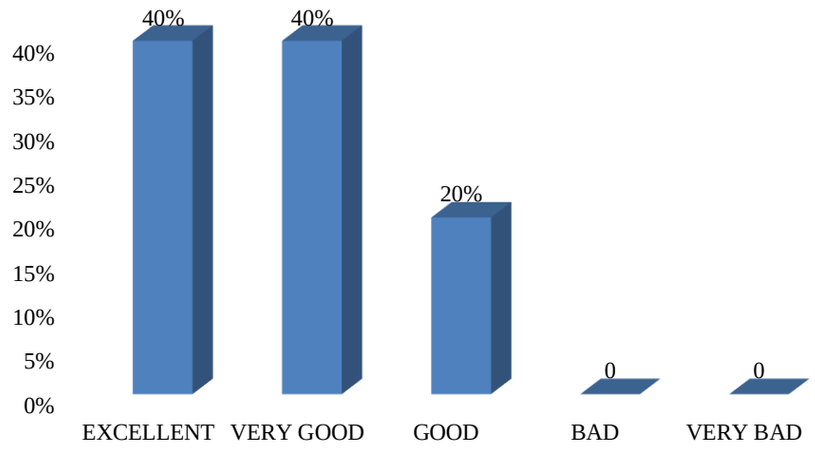


Figure 5

Students' perception of AMIB certification on their professional development

Discussion

In accordance with the questions posed in the method and according to the results obtained through the applied instrument, the following approaches have been discerned:
How has the AMIB Figure 3 certification impacted on the personal development of the certified students?

According to the results shown in Figure 2, the certification has had a very positive impact on the personal development of the students, as 78% have a highly positive perception in this respect.
How has the AMIB Figure 3 certification impacted on the knowledge of certified students?
Based on the results of the survey, students have had a significant impact on the development of their financial literacy, with 90% reporting a very positive impact in this area.

How has the AMIB Figure 3 certification impacted the professional development of the certified students?

In this regard, the results are highly encouraging, since on the one hand the employment rate of the certified students, whether they are doing their internships or already in formal employment, is 85%, which is a reflection of the positive impact of the AMIB certification. It is worth noting that the students who are currently working are working in the stock market sector, which is one of the main objectives of the students who opt for the certification programme. On the other hand, the perception of the certified students is very encouraging since 80% of them have evaluated this impact in a very satisfactory way.

Conclusions

In summary, the professional certification of financial engineers before the AMIB offers graduates of the Polytechnic University of Tlaxcala a clear differentiator in the labour market. It increases their competitiveness, broadens their job opportunities and guarantees their ability to perform in a highly regulated and dynamic sector. For the UPTx, promoting this certification process reinforces its commitment to excellence and the training of professionals prepared for the challenges of the financial, economic, social, sustainable and technologically innovative future.

On the other hand, the perception of the certified students regarding their personal, academic and professional development that the AMIB Figure 3 certification has given them, has been very positive according to the results obtained, to cite some experiences described by some certified students we have the following:

Olga Malinalli Ramos Morales, 22 years old, gives the following account: 'This year I finished my university degree as a financial engineer at the UPTx. A few months ago I joined the professional world as a Junior Executive in the corporate department of Banco Santander. From day one, I had the opportunity to immerse myself in a dynamic and challenging environment that has allowed me to develop key skills in the financial sector. My main role is to support the team in various tasks related to customer service, product promotion and management of banking operations. In my experience, having the AMIB Figure III certification has provided me with a solid financial knowledge of products and services, which allows me to provide an informed follow-up to clients. This certification increases credibility with clients and opens up opportunities for professional development. It also ensures compliance with current regulations and standards, operating in an ethical manner. It improves communication skills, allowing for better interaction with customers and provides a competitive advantage in a demanding labour market'.

The above reveals the relevance that certification has had in the professional, personal and knowledge lives of the students, and the following final recommendations are suggested as a conclusion to this research:

1. It is particularly and emphatically recommended to continue with the AMIB Figure 3 certification management process by the UPTx and, as far as possible, to establish mechanisms so that more students have access to this process.

2. As a final recommendation, the possibility of investigating the concrete impact of the certification in terms of employment is left for further research in a later work.

Annexes

Annex 1. Survey applied to students certified in AMIB fig. 3 through the UPT.

1. How do you perceive that AMIB Certification has impacted your personal development?

☐ Excellent
☐ Very good
☐ Good
☐ Bad
☐ Very bad

2. How do you perceive that the AMIB Certification has impacted your knowledge in Finance?

☐ Excellent
☐ Very good
☐ Good
☐ Bad
☐ Very bad

3. Are you currently working or are you currently in the process of your stay?

☐ Yes
☐ No

4. How do you perceive that AMIB Certification has impacted your professional development?

☐ Excellent
☐ Very good
☐ Good
☐ Bad
☐ Very bad

Declarations

Conflict of interest

We, the authors, declare that we have no conflicts of interest. We have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

Authors' Contribution

Sánchez-García, Gustavo: Idea Generation, Introduction, Method, Results, Discussion and Conclusion.

Rivera-Torres, Hilda: Generation of the Idea, Development, Bibliography.

Ordoñez-Carrera, Joel Trinidad: Introduction, Conclusions.

Maldonado-Hernández, Ivonne: Conclusions, Editing.

Availability of data and materials

We declare that we have available the data on which the research was based, to consult them and make them available at any time they are required.

Funding

The research did not receive any type of funding.

Abbreviations

AMIB (Mexican Association of Stock Market Institutions).

UPTx (Polytechnic University of Tlaxcala)

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Internal and external forces for effective informal entrepreneurship in Tlaxcala

Fuerzas internas y externas para el emprendimiento informal efectivo en Tlaxcala

Ordoñez-Gallegos, Jesús Fabián *[a] & Rodríguez-Cuecuecha, Josefa [b]

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Area: Social Sciences
Field: Administration and business
Discipline: Administration and management
Subdiscipline: Business Administration

Key Handbooks

According to the document 2 main contributions are established, the first one is the analysis of the internal forces that impact informal entrepreneurship to understand the challenges faced by entrepreneurs in Tlaxcala, it has a replicable methodology so the simplicity and approach allows applying the study in other regions, thus providing a basis for future research and economic development policies in similar contexts. Understand the forces, so it is important to identify and analyze personal capabilities and resources, as well as economic, political and competitive conditions, and understand the motivations, as it is key to generate a theory that explains why people undertake in informal situations. Resilience is highlighted as a guide on how to remain competitive and sustainable in diverse contexts. The qualitative-exploratory methodology allows for comparative studies to enrich the general knowledge of informal entrepreneurship in other contexts and regions. The impact of internal forces is confirmed. Most entrepreneurs are motivated by the search for financial independence and lack of opportunities. It is observed that informal entrepreneurship is accessible to different generations and that success is not linked to a high level of education. The resilience of entrepreneurs stands out as a way of facing the market and overcoming obstacles. The research, while representative, suggests that expanding the sample and using more resources could improve the accuracy of the findings. Because of its focus on internal forces, further exploration of some of the external factors is recommended.

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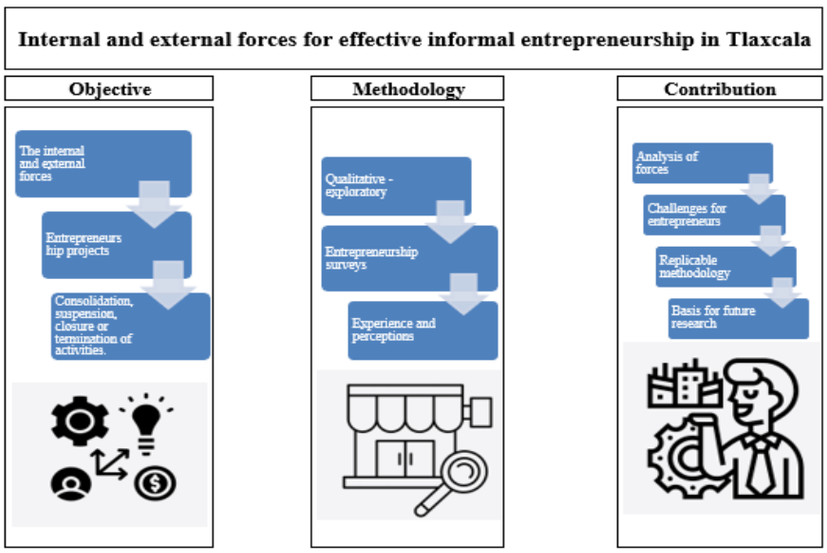
Handbook shelf URL: https://www.ecorfan.org/handbooks.php

Resumen

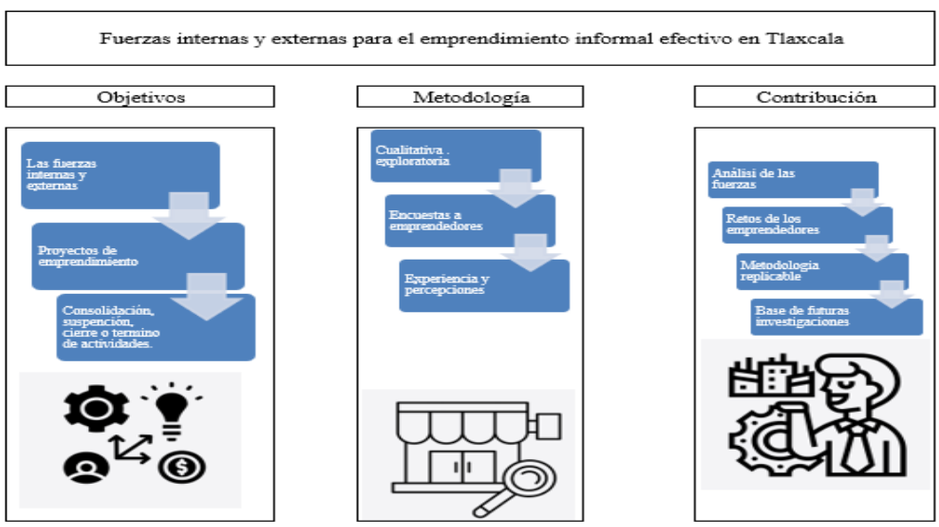
The article is based on the thesis Internal and External Forces for Effective Informal Entrepreneurship in Tlaxcala. It aims to identify the internal and external factors that most influence entrepreneurial projects in the state, analyzing their effects on growth and sustainability. The study uses a qualitative-exploratory methodology, including surveys of entrepreneurs in Tlaxcala to gather detailed insights into these forces. This approach helps explore the experiences and perceptions of entrepreneurs, offering qualitative data to better understand the challenges they face. By focusing on internal forces affecting informal entrepreneurship, the research contributes to identifying strategies for improving entrepreneurial outcomes. The methodology's simplicity and adaptability make it replicable in other regions, providing a foundation for further studies and informing economic development policies in similar contexts. This work seeks to enhance the stability and growth of informal businesses or explain the factors leading to their closure.



Entrepreneurship, informality Internal, External, Forces, Effective and Tlaxcala

Resumen

El artículo se basa en la tesis Fuerzas Internas y Externas para el Emprendimiento Informal Efectivo en Tlaxcala. Su objetivo es identificar los factores internos y externos que más influyen en los proyectos emprendedores, analizando sus efectos en el crecimiento y la sostenibilidad. El estudio utiliza una metodología cualitativa-exploratoria, incluyendo encuestas a emprendedores para obtener información detallada sobre estas fuerzas. Este enfoque permite explorar las experiencias y percepciones de los emprendedores, ofreciendo datos cualitativos para comprender mejor los desafíos que enfrentan. Al centrarse en las fuerzas internas que afectan al emprendimiento informal, la investigación contribuye a identificar estrategias para mejorar los resultados. La simplicidad y adaptabilidad de la metodología la hacen replicable en otras regiones, proporcionando una base para estudios y políticas de desarrollo económico en contextos similares. Este trabajo busca mejorar la estabilidad y el crecimiento de los negocios informales o explicar los factores que llevan a su cierre.



Emprendimiento, Informalidad, Fuerzas Internas, Externas, Efectivas, Tlaxcala.

Introduction

Entrepreneurship is an activity that involves the creation and management of a business or enterprise in order to generate profits and create jobs. In the state of Tlaxcala, in recent years there have been problems with entrepreneurship that have affected its effectiveness. Some approaches are described in this paper. Mohanty (as cited in Teran-Yepez and Guerrero-Mora, 2020, p. 6) establishes the theory postulated by the Harvard School of Management that mentions the forces that influence the effectiveness of the project, which is the one selected for this research work, in the same way it justifies why it is important to work on the subject.

The paradigms that surround the activity of starting a project or business are presented, which are proposed at the University of Piura in Peru, what innovation consists of and everything concerning the methodology for the development of the research, the most important parts being sampling, the research instrument, the population, the sample, characteristics for discrimination and the questionnaire that is to be applied to obtain the data. Finally, a brief discussion, analysis and conclusion of the work is given.

Objective

To identify the internal and external forces, whose components affect to a greater extent and how they affect entrepreneurship projects in the state of Tlaxcala, so that they can improve their situation and grow, thus consolidating their permanence, or if not, they can be suspended, closed, and end their activities.

Theoretical Framework

Entrepreneurship

It is a process in which a person or group of people detect opportunities based on their capacities and experiences, with which they create opportunities that serve to generate an economic benefit. Ruiz Cedeño, S. D. M. & Palacios Dueñas, A. E. (2020).

The etymological root of the term and its history is that a recent research by Ruiz Cedeño and Palacios Dueñas (2020) indicates that, from the etymological point of view, the verb emprender comes from the French entreprendre, and likewise the word entreprendre comes from the Vulgar Latin root (in, en, prendĕre) which has the equivalent of coger, atrapar, tomar. They also mention that the first record dates from between 1030 and 1095 in Aragonese, while in Spanish the word emprender was used until 1981.

Informality

Textually Loayza, N., & Sugawara, N. (2017) in their research describe informality as the set of enterprises, workers and activities that operate outside legal and regulatory frameworks.
It involves the inappropriate distribution of resources and brings with it the loss of the advantages of legality, such as police and judicial protection, access to formal credit institutions and participation in international markets.

Theory

The theory of the internal and external forces of entrepreneurship arises in the 80‘S Harvard Business School by Howard Stevenson and David E. Gumpert, after a while it is taken up again in the 90’S and developed by a group of researchers led by the academic Jeffrey A. Timmons considered as the founder of entrepreneurship education in the United States for the University of Boston.

Internal forces

The internal or endogenous forces of entrepreneurship as part of an entrepreneurial model where the opportunity, resources and team are considered, however it will be analysed from the influence for the ability to create and maintain an effective business.

- Entrepreneurial skills: ability to identify opportunities, decision-making and leadership.
- Innovation: developing products, processes and technologies
- Adaptation to change: ability to adapt to market, technology and environmental changes to maintain competitiveness and sustainability.

External forces

On the other hand, in terms of external forces, the theory highlights the following factors:

- Economic environment: macroeconomic and government policies affect demand, financing.
- Competition: affects the demand for products or services, as well as their ability to obtain financing or attract talent.
- Regulation: Government laws and regulations affect the operation, as well as their ability to compete in the market.

Motivation

On the other hand, entrepreneurship has different reasons and objectives that lead a person to start a business or start a project, so talking about entrepreneurship also makes us think about how the air or this need arises.

It is born from different perceptions, the first being the need to obtain an income and the second to obtain experience, this according to a research published by pérez paredes (2019) where he explains that there are 2 perceptions: convenience and feasibility where convenience establishes the approach through the family structure, education, peers, and feasibility which is considered the set of knowledge, resources and previous experiences.

In this way the research conducted by Gutama Chuñir & Jiménez Benavides, (2017) explains that entrepreneurship is taken due to the need for opportunities to achieve life goals.

In this way then should we undertake or not, the debate is about taking action so the unknown is in the predisposition to start the business or have the initiative in the near future, oppositely the philosopher Peter F. Drucker 1986 (as cited in Gutama Chuñir & Jiménez Benavides, 2017), describes that a small business even being new is not an entrepreneurship because he considers that to be considered as such it must be more than the common and generate a great result.

Inherently to carry out this exercise is not bad, but there are risks as in any other activity so it makes entrepreneurship is not suitable for everyone, some of the most common risks is to carry out the formalization and start-up financial risks and the need to have specialized skills and knowledge as in administration trade finance and law.

Paradigms

Paradigms are beliefs and values, theories and assumptions that form references for the interpretation and understanding of an entrepreneurial phenomenon (Alumini, 2020).

According to Alumini (2020), entrepreneurship has four paradigms management where the entrepreneur is omnipresent, organisation-centred, innovation, and the last of the paradigms is experience gained over time.
News

In the state of Tlaxcala has played an important role in the economic development of the country in recent years entrepreneurship has been growing and consolidating with an impacting economic activity in the region as announced by the governor Lorena Cuellar Cisneros in 2022:

Tlaxcala is in the top 3 places nationally of states with higher growth and economic recovery despite the impact of the pandemic COVID- 19 (Muñoz, 2022, para. 1).

Methodology

The research is approached from a qualitative-exploratory methodology, using a survey of entrepreneurs in Tlaxcala to obtain in-depth information on the internal and external forces that impact on entrepreneurship projects. This survey will allow us to explore the experiences and perceptions of entrepreneurs and obtain qualitative data.

Inclusion criteria

We will focus on the entrepreneurial population of the state of Tlaxcala with an active economic activity in the last few years, where we will concentrate on Tlaxcala, Chiautempan and Apizaco, being these central points of entrepreneurship, where projects between 2 and 5 years old will be considered, allowing us to focus on entrepreneurships with a trajectory and which are informal.

Research instrument

It is a survey that aims to obtain concrete information and guarantee privacy and confidentiality to the participants. Around 80 surveys will be applied as there are different limitations, one of them being access to the entrepreneurs and their willingness to participate in the research, the reluctance or lack of time on the part of the entrepreneurs and economic resources. In this way, the quality and integrity of the data will be maintained, prioritising the reliability of the information.

Results

Box 1

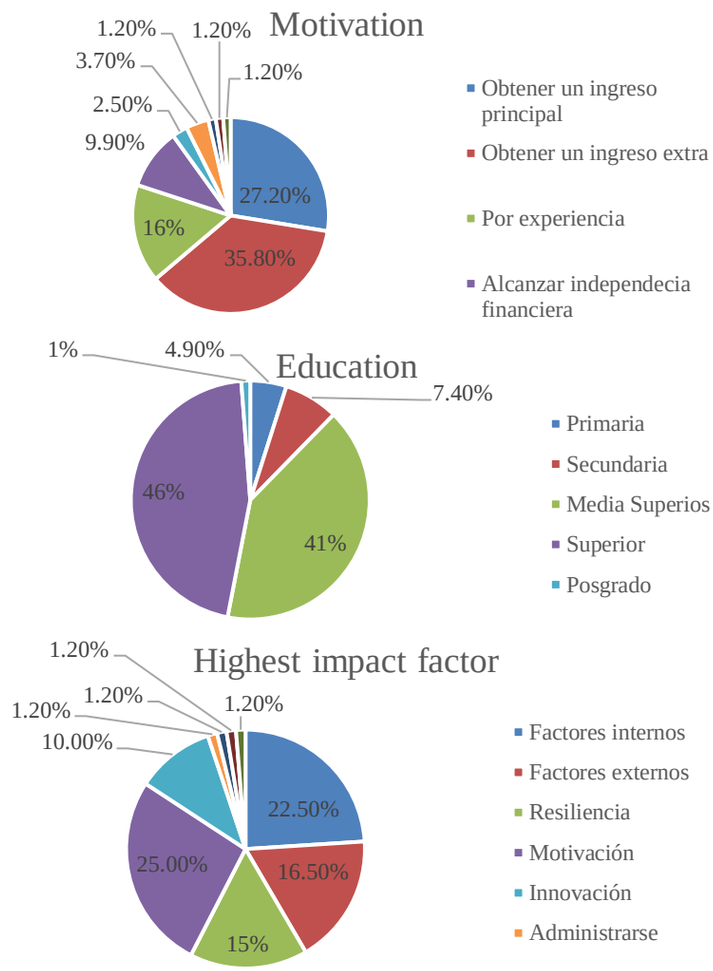


Figure 1

Research results

Source: Author

Discussion

It can be seen that the results are similar to those expressed in the theory and to a greater extent the entrepreneurs express that motivation and external factors have a greater impact on their projects. Thus, the present document explores the impact in Tlaxcala and opens the opportunity to go deeper into some of the factors. In this way, the concordance of the results with the expected ones can be confirmed. It is also expected to improve the results by refining the methodology and obtaining results with a larger sample.

This is due to limitations ranging from the availability of the entrepreneurs to the budget. However, the simplicity of the study makes it easy to replicate the study in any other state.

Analysis and conclusion

The results provide a comprehensive overview of the informal entrepreneurial ecosystem in Tlaxcala where it is possible to analyse the great diversity of ages among entrepreneurs, with entrepreneurship being accessible to different generations, to show the adaptability of entrepreneurs, that they are mainly motivated by the search for financial independence, lack of opportunities and that success is not linked to educational level.

Internal forces generate both positive and negative impacts highlighting key areas that may need support to be effective, addressing the concerns of those experiencing negative impacts such as crime.

Declarations

Conflict of interest

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

Authors' contributions

Ordoñez, Jesús Fabián: Contributed to the project design, writing, survey implementation and analysis of results.

Rodríguez, Josefa: I contributed with the revision of the extension, contribution of ideas, corrections and suggestions.

Availability of data and materials

The data necessary to generate the graphs will be available in Google Forms, by requesting access by e-mail, sent to the author's e-mail address.

Funding

This research did not rely on any third party funding, only the author's own capital was used for travel expenses and the application of the survey, as well as the necessary available resources such as a laptop.

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Abbreviations

p. Page
para. paragraph

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Antecedents

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Geopolitics of the U.S. election and its impact on the financial sector

Geopolítica de las elecciones de Estados Unidos y su impacto en el sector financiero

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Area: Social Sciences
Field: Sociology
Discipline: Social Change and Development
Subdiscipline:

Key Handbooks

Importance of geopolitics in the movements of financial markets and the influence of the electoral process in the United States as a conditioning factor that promotes changes. The historical geographic pivot, the geopolitical aspect in the decision making of the electoral process and the development of the systemic cycles of capital in its phases of order and chaos. The policy of containment against China is a tactic shared by both Democrats and Republicans. From the beginning of the sanctions against Huawei by Donald Trump's administration, to the maintenance of the same, as well as the exercise of tariff impositions, the only difference between them lies in the relocation of their investments, since while the Democratic candidate thinks of an expansive economic policy, the Republican candidate proposes a more protectionist plan and the return of investments to U.S. territory (which, by extension of the T-MEC, includes Mexico). A good part of Trump's aggressive political speeches are for electoral purposes, since, as has been mentioned, the return of the productive sector with a view to attempting a new phase of accumulation and expansion of the financial sector, as a result of the exhaustion of the US financial sector, within its own territory does not represent a feasible path for a new phase of accumulation and material expansion impulse that would precede a new cycle of financial expansion. It is further proven that the geographical component is imperative in historical events, as well as in the determination and implementation of financial investment plans. This is an essential component for the world economy, since it is through it that it is possible to diagnose how each region of the planet influences global supply chains and the importance of controlling these disputed spaces.

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Abstract

This research aims to analyze the possible scenarios of the outcome of the electoral process for the renewal of the presidency of the United States, which will be held on November 5, 2024, in the context of very relevant events that may define the economic and financial future in the short, medium and long term worldwide. Such situation is linked to the events in three disputed fronts in which the U.S. intervention maintains influence and therefore its effects impact on the productive sector and the financial sphere. Such analysis is useful to consider a general panorama that allows companies to plan their future investments in full exercise of their finances.

Geopolitics of the US elections and their impact on the financial sector.

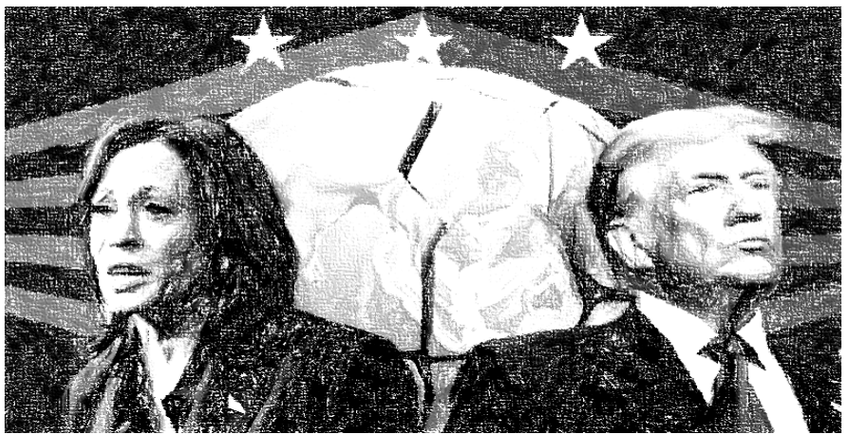
Targets	Methodology	Contributions
• Analyze the possible scenarios of the outcome of the electoral process for the renewal of the presidency of the United States, whose vote will take place on November 5, 2024. • To examine events on three fronts in geopolitical disputes in which U.S. intervention maintains influence and whose effects therefore have an impact on the productive sector and the financial sphere. • Explore different scenarios that allow companies to plan their future investments in the short, medium and long term in full exercise of their finances.  Created by The Pyramid School from Noun Project  Created by kai b from Noun Project  Created by LUTFI GANI AL ACHMAD from Noun Project	The methodology used in this research is mainly qualitative of a dialectical type supported by a quantitative model. The research is divided into the following sections. The first part corresponds to the theoretical framework for approaching the problem. The second section focuses on the approach to the hypothesis using qualitative methodological tools. Subsequently, the outcome scenarios are presented as results and their contribution to the analysis of the problem. Finally, to summarize the most important data that the present research has been able to reach by specifying the implications that financial movements from an event such as the 2024 election in the United States can generate in the world.  Created by corpus delicti from Noun Project  Created by Icogenic from Noun Project	• Demonstration that the geographic component is imperative in historical events, as well as in the determination and implementation of financial investment plans. • Politically, the contention for containment against China is a tactic shared by both Democrats and Republicans. • To argue that the fronts in dispute are the result of a phase of chaos in the U.S. financial sector in collision with the phase of order of the productive apparatus and consequent financial expansion of China. • The financial sector can be influenced by a wide combination of factors, so that the outcome of a choice does not necessarily determine the development of the phases of capital accumulation.  Created by Siti Maryatun from Noun Project  Created by bird studio from Noun Project

Geopolitics, United States, Financial markets, Presidential renewal, Investment maintenance, Electoral aims, Disputed front

Resumen

La presente investigación pretende analizar los posibles escenarios del resultado del proceso electoral para la renovación de la presidencia de los Estados Unidos, cuya votación se efectuará el 05 de noviembre de 2024, teniendo como contexto acontecimientos muy relevantes que pueden definir el devenir económico y financiero en corto, mediano y largo plazo a nivel mundial. Tal situación está ligada a los eventos en tres frentes en disputa en los que la intervención estadounidense mantiene influencia y que por lo tanto sus efectos impactan sobre el sector productivo y la esfera financiera. Dicho análisis resulta útil para tener un panorama que permita a las empresas planificar sus inversiones futuras en pleno ejercicio de sus finanzas.

Geopolitics of the US elections and their impact on the financial sector.



Targets	Methodology	Contributions
• Analizar los posibles escenarios del resultado del proceso electoral para la renovación de la presidencia de los Estados Unidos, cuya votación se efectuará el 05 de noviembre de 2024. • Examinar los eventos en tres frentes en disputa geopolítica en los que la intervención estadounidense mantiene influencia. • Explorar los diferentes panoramas que permitan a las empresas planificar sus inversiones futuras en el corto, mediano y largo plazo en pleno ejercicio de sus finanzas.	La metodología empleada en esta investigación es mayoritariamente cualitativa de tipo dialéctico con apoyo de un modelo cuantitativo. La investigación se divide en las siguientes secciones. La primera parte corresponde al planteamiento del marco teórico de abordaje del problema. La segunda sección se centra en el abordaje de la hipótesis a partir de herramientas metodológicas cualitativa. Posteriormente, en tercera secuencia, se presentan los escenarios de desenlace como resultados y su aporte en el análisis del problema para finalmente resumir los datos más importantes a los que la investigación presente ha logrado llegar, enfatizando las implicaciones de los movimientos financieros a partir de un evento como la elección de 2024 en Estados Unidos es capaz de generar en el mundo.	• Demostración de que el componente geográfico es imperativo en los eventos históricos, así como en la determinación e implementación de planes financieros de inversión. • Desde el aspecto político, la disputa por de contención contra China es una táctica compartida tanto por demócratas como por republicanos. • Exponer que los frentes en disputa son el resultado de una fase de caos del sector financiero estadounidense en colisión con la fase de orden del aparato productivo y consecuente expansión financiera de China. • El sector financiero puede ser influido por una amplia combinación de factores, por lo que el resultado de una elección no necesariamente determina el desenvolvimiento de las fases de acumulación del capital

Geopolítica, Estados Unidos, Mercados financieros, Renovación presidencial, Mantenimiento de inversiones, Objetivos electorales, Frente en disputa

Introduction

This research aims to analyse the possible scenarios that the 2024 presidential election in the United States may trigger in financial markets, the effects of which have the potential to be defining in the correlation of forces in the world. According to some authors, including Alfredo Jalife-Rahme, US hegemony in the global economy and finance has been in decline for at least two decades [1].

The rise of China on the world financial stage has been a key factor that has triggered a dispute with the United States, the first confrontations of which took place in 2018 with the announcement of economic sanctions against the Chinese telecommunications company Huawei.

Given that the political discourse seeks to introduce the narrative that the Republican candidate is either good or bad and vice versa with respect to his Democratic opponent, it is worth noting that the restrictive US economic policy towards Chinese influence on the global economy has been maintained regardless of the party that has governed in the last two terms.

On the other hand, the conflicts in Ukraine and Palestine are two fronts in which US policy efforts to maintain its interests in these regions today, together with the confrontation with China, could trigger a potential war scenario.

In order to analyse this phenomenon, the research is divided into the following sections. The first part corresponds to the theoretical framework for approaching the problem. The second section focuses on the approach to the hypothesis using qualitative methodological tools. Subsequently, the outcome scenarios are presented as results and their contribution to the analysis of the problem in order to finally summarise the most important data that the present research has managed to arrive at, specifying the implications that financial movements based on an event such as the 2024 election in the United States are capable of generating in the world.

Given this general context, the aim is to discern the scenarios in which the three aforementioned fronts may unfold in accordance with the interests that the candidates for the US presidency represent, since both options differ subtly in the outcome of these disputes.

The theoretical framework proposed in the paper is Giovanni Arrighi's movement of systemic cycles of accumulation, in addition to the contributions that geopolitical analysis offers, given the nature of the world regions in which the dispute over resources also generates the movement of capital. Finally, a brief mathematical forecast of stock market indices is made according to their own historical behaviour by means of an autoregressive model, simply to provide a reference for the possible future behaviour of financial markets in the short term.

The hypothesis to which we will refer in this paper is that the results of the 2024 elections in the United States will alter the outcome of the three disputed fronts in which the US presence maintains a presence in the conflicts, given that they represent key points for the control of the strategic productive resources that drive the financial sector in its future investments.

[1] The aforementioned author has quoted from his work *El lado oscuro de la globalización. Globalisation and post-globalisation* in 2000, he put forward the hypothesis of a multipolar world based on the strategic alliance between Russia and China.

Jalife-Rahme, Alfredo (2000). *El lado oscuro de la globalización. Globalisation and post-globalisation*. Cadmo and Europe.

Box 1

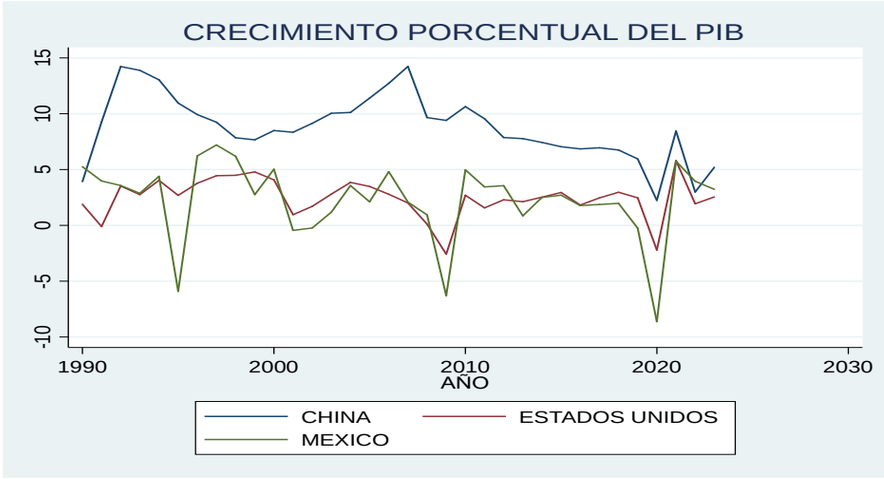


Figure 1

Percentage GDP growth in China, the United States and Mexico

Source: own elaboration based on World Bank data

Box 2

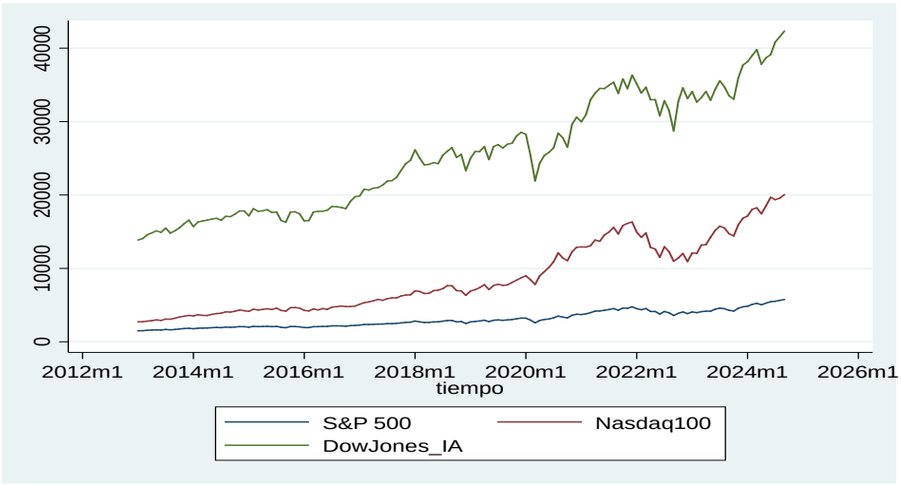


Figure 2

Performance of the S&P500, Dow Jones IA and Nasdaq100 indices

Source: own elaboration based on data obtained from the website https://mx.investing.com/

Box 3

Figure 3

Silk Roads

Source: World Economic Forum. Retrieved from the website: https://es.weforum.org/agenda/2018/02/la-nueva-ruta-de-la-seda-ya-es-una-realidad

Box 4

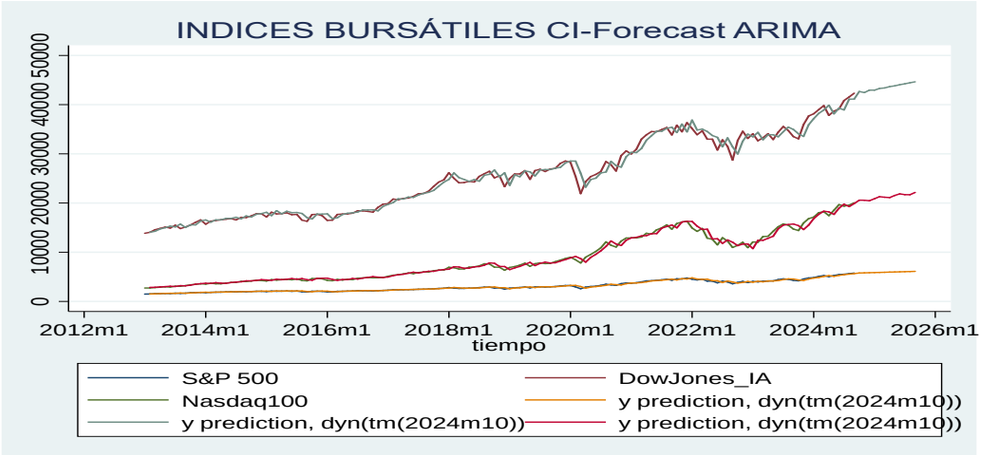


Figure 4

Forecast of the S&P500, Dow Jones IA and Nasdaq100 indices in the months following the November 2024 election

Source: own elaboration based on monthly averages of the quotation indexes obtained through the website. https://mx.investing.com

Methodology

Methodological introduction

At the beginning of the 20th century, Halford John Mackinder published one of the works that would have the greatest impact on the political arena in Great Britain and which is still considered today as a reference in world geopolitics, *The Geographical Pivot of History*, in which the relevance of a particular geographical area, the region of Russia and China, is highlighted. The importance of this work lies in the fact that it is not only a geographical and historical analysis of what is usually referred to as the Old World, but also a political stance aimed at controlling the resources available in this area of the planet. Both then and now, a century later, this area still represents a point of conflict for the same reasons, its immense resources.

However, as Giovani Arrighi argues in his book, *The Long Twentieth Century*, the systemic cycle of accumulation corresponding to Great Britain culminated to give way to the US cycle, which, in the face of the rise of the Chinese economy, seems to be showing signs of entering a new phase of change. As the aforementioned author points out: 'we explicitly conceive of financial expansions as long periods of fundamental transformation of the agencies and structure of the processes of capital accumulation on a global scale' (p.108). Developing this approach further, 'we identify the onset of financial expansions with the moment when the leading business agencies of the preceding commercial expansion shift their energies and resources from commercial activity to monetary activity' (Ibid.). (Ibid.)

The concept of the hegemonic state is also raised in the two meanings that Arrighi also points out, which are as follows:

A state can therefore become a world hegemonic power because it can plausibly claim to be the driving force behind an expansion of the collective power of those who hold power vis-à-vis those subject to it. Or, conversely, a state can become a world hegemonic power because it can plausibly claim that the expansion of its power vis-à-vis some or even all other states is in the general interest of those subject to the authority of all other states' (p. 45).

In dealing with the financial sector, the terms *order* and *chaos* are also used, the former being understood as the predominance of an expansion of production and trade, and the latter as a successive phase of that in which the rise of the financial sector is predominant. He also adds the concept of *systemic chaos*, which he defines as follows: 'It is a situation that arises because conflict increases beyond the threshold at which powerful corrective tendencies are triggered, or because a new set of behavioural patterns and norms is imposed on an older set of patterns and norms without totally displacing it or grows within it, or by a combination of these two circumstances' (p. 46).

As an additional part of the methodology, the main characteristics of the proposals put forward by the candidates for the US presidency are analysed, both in terms of the agenda they promote, as well as those factors that in a veiled or expressed way support one or other of the candidates, highlighting this as the context of the interests that each one represents and this being fundamental in the narrative and political action.

It is noted that an autocorrelative econometric analysis as a forecasting option for the behaviour of the stock markets through three indices, namely S&P500, Dow Jones IA and Nasda100, is only useful if it adheres to the criteria of the characteristics of ARIMA models, highlighting the one that states the following: 'it is assumed that the random disturbances ($_{at}$) present in the series are independent of each other, there is no correlation between them. Therefore, there is no modellable pattern'.

In this regard, previous works that take into account political changes as a structural factor of a correlation model in stock market indices were consulted, mentioning the work of Ana Karen Romero Orozco, Alma Berenice Méndez Sáenz and Martha del Pilar Rodríguez García, who in 2020 published as *Análisis de correlación a índices bursátiles durante el efecto Trump*, concluding, after the implementation of their operative hypothesis, H1: Donald Trump's statements regarding Mexico have an effect on the Mexican economy, that said phenomenon, once DolnaldTrump assumed the office of the presidency, quote, 'After the first year of his presidency it can be observed that there is no effect as commented in the results.' (p. 1160)

It is precisely a cause-effect trend that was intended to be shown as proof of the influence of the outcome of the US election. This precedent is also consistent with an analysis published by the financial institution JP Morgan, whose authors conclude in the same vein as the previously referenced research, 'However, once the results are announced and this dissipates, stocks tend to rise on the feeling of greater clarity about the future' (Faller and Snyder, p. 1160). (Faller and Snyder, 2024).

Nevertheless, a 12-month forecasting exercise from October 2024 based on ARIMA models was carried out for the aforementioned stock market indices and the graph resulting from this methodological process is offered as a mere reference of the possible future behaviour of these indices.

Methodology. Analysis from three complementary perspectives: geographical, economic-financial and political

The approach of the theory of systemic cycles is recognisable in the current scenario, in which China's economy has gone from a phase of trade expansion, a period in which it earned the epithet of *the world's factory* and whose indicator that confirms this is the rate of growth of its GDP since 1990 and for at least a quarter of a century, presenting peaks in which this growth rate exceeded 10% but which, according to World Bank data, since 2010 this rate has been attenuated.

On the other hand, the US GDP, in the same period, has had an erratic dynamic, with special emphasis on the decade of the 2000s in which its Gross Domestic Product contracted and which also coincides with China's entry into the World Trade Organisation (WTO), with 2008 being the turning point in which the most acute economic crisis of its contemporary history occurred. Graph 1 below shows the behaviour of Chinese and US GDP over the last three decades[1].

The reason for including this reference is precisely to indicate the dynamics of trade expansion and how this in gross terms has tended to decline or stagnate rather than expand over the last decade. In any case, there have been events that show the growth of both Chinese and US finance.

In the case of China, the founding of the Asian Investment and Infrastructure Bank in December 2015 (Braulio Moro, 2015), the implementation of the Made in China 2025 plan that same year, as well as the de-dollarisation of its trade with the BRICS countries more recently in 2024, within the framework of the annual summit of the members of the economic bloc. Such a financial transaction project presupposes the implementation of an alternative currency independent of the US dollar (Jalife-Rahme, 2024).

On the US side, as we have seen, the dynamics of its GDP in the last ten years have been declining (Graph 1), while its stock market sector, as an indicator of financial activity, has shown a growing trend, as shown in Graph 2 below.

In accordance with Arrighi's proposals, US hegemony is in confrontation with the rise of Chinese leadership, understood as the direction of a system of states in the direction of the latter, plausible in the creation of organisations through which the United States exercised its development policy in accordance with its interests, such as the World Bank, the International Monetary Fund, etc.

On the other hand, China's rise contains the obverse characteristics of the hegemonic state conceptualised by the aforementioned author in which, to paraphrase his planning, a state also exercises hegemony if it is able to attract others to its own vision of development. This can be corroborated given that China's global policies have led it to promote the formalisation of the BRICS (Brazil, Russia, India, China and South Africa) in which it is pushing its financial agenda through this economic bloc, as well as through the implementation of the RCEP at the beginning of 2020 as a key trade bloc in its Silk Roads plan.

In such a context, the two counterparts coexist in an antagonistic manner: while the period of chaos has been present in the reality of the United States, plausibly due to the 2008 crisis in which its financial sector experienced its sharpest fall in recent times, at the same time the Chinese productive apparatus continued to expand as part of a process of order, i.e. expansion of its productive base.

On the geographical side, the New Silk Road plan, within the framework of China's OBOR plan (Agueda Parra, 2018), which represents one of the most ambitious infrastructure projects in history, comparable to the scope of the Marshall Plan in the mid-20th century, is not to be underestimated. As highlighted in an article published in the World Economic Forum, the purpose of this plan is to provide an alternative to two hotspots of great geostrategic importance, the Strait of Malacca in Malaysia and the Bab al Mandeb strait between Yemen and the area known as the Horn of Africa[2], as shown in image no. 1.

Based on the map shown above, Ukraine does not appear to be directly related to the silk routes, yet it has highly influential features in world trade. According to a publication by the International Monetary Fund, both Russia and Ukraine, protagonists of the disputed scenario mention: ‘The two countries account for a quarter of world wheat exports and a fifth of barley and maize exports, and more than half of sunflower oil exports, and supply about an eighth of all calories traded in the world.’ (Stanley, A. 2022)

Moreover, the Ukrainian scenario has an additional geographic component, its potential as one of the world's leading suppliers of critical raw materials essential to industries such as defence, high-tech, aerospace and green energy [3] Seen in this light, this region of the world is key in geo-economic as well as geopolitical terms. However, the political component that gives context to the elections requires a comparative analysis of the interests that both the Democratic candidate, Kamala Harris, and the Republican candidate, Donald Trump, represent and that, therefore, their political proposals not only involve US society, but are the starting point for the effects on the productive and financial spheres at a global level. Essentially, the two candidates differ significantly in their treatment of the three conflicting fronts mentioned above. Candidate Kamala Harris has declared her support for NATO in Ukraine and has broad donor support. However, if she were to maintain all fronts, the conflicts would end up unravelling through critical events.

On the other hand, on Donald Trump's side, according to author Alfredo Jalife-Rahme (2024), with this candidate the Ukraine front could have a negotiation outcome, so that for the time being there would be a scenario of relative peace. This does not exempt him from a more restrictive policy against China in an attempt to contain its advance towards other regions of the world, especially Latin America. To conclude the methodological analysis, it is worth returning to two of the concepts proposed by Giovanni Arrighi: *chaos* and *order* as processes that can coexist simultaneously, but not indefinitely over time. In this sense, the process of *chaos* corresponding to an expansive phase of the financial sphere is recognisable on the US side due to its long lethargy in production, and on the other hand, the *order* corresponding to a phase of material growth in production is the one in which China still finds itself, but at the same time, it is beginning to show signs of exhaustion.

In either case, there is a phase of confrontation for territorial domination in which the relocation of the financial surpluses generated from the material base becomes inevitable as the phase of productive accumulation finds its limits in the territories in which it settled. It is in this way that we can understand why China seeks new trade and supply routes by investing through infrastructure in the territories where it makes inroads, and why the United States has gradually found itself invaded by the new competition not only in previously dominated territories, but also in its own territory.

Results

Geography, politics and the historicity of systemic cycles

As already mentioned**,** in the interwoven global economic and financial scenario of which extensive analysis has already been made, it is worth mentioning that the territories in dispute, already envisioned for more than a century as strategic points for the control and domination of markets through the flow of resources, seem to be the same.

It is pertinent to note that the territory that Halford John Mackinder called the 'pivot region' still maintains its position as such. It can be determined why the three hot conflict fronts already mentioned are so important in the way they unfold: Russian military intervention in Ukraine, the escalation of Israeli aggression in Palestine, and the continuing threats on the island of Taiwan. These three points strategically surround the pivotal region par excellence and exert pressure on these territories, which, faced with such a threat, are determined to contain it as far as possible from their borders so that their interests and domains are not undermined.

On the political side, according to a publication by JP Morgan (Faller & Snyder, 2024), the electoral process for the renewal of the US presidency does not affect the financial sector for three reasons:

1. If the premise is that corporate stocks do not perform well in election years, the study cited above shows that returns during election and non-election years are marginal, and sentence, volatility is a characteristic of stocks in the stock market, not an investment mistake, so once the uncertainty of the election outcome dissipates, stocks tend to rise in performance again.

2. Markets do not collapse if one candidate or the other wins. In a comparison with two past elections, 2008 and 2020, the collapse in financial markets was due to the mortgage sector crisis and the presence of the Covid-19 pandemic respectively. In contrast, financial markets tend to perform well in the period after the election result.

3. The Federal Reserve (Fed) adjusts its interest rate policy even in election years. This is irrespective of who wins on election day. So the Fed seeks to maintain its policy of controlling inflation and promoting economic growth.

While the publication states that it does not represent the Fed's position, it is acknowledged that there is a benchmark that the outcome of elections is not a determining factor in the behaviour of financial markets over time. Although there may be negative or positive variations in the days before or after, this is still a random reaction whose effects are diluted.

In fact, based on a forecast estimate, taking into account only the historical behaviour of the three stock market indices shown in Graph 2, in the short term the US financial sector is expected to maintain its growth trend in the months following the election, as shown in Graph 3 below, which models the likely 12-month behaviour of these indicators**[4]**.

This can be explained if, in line with Arrighi's theory, we take into account that the United States still exercises its role as a hegemonic state, i.e. its processes of accumulation and material and financial expansion depend on the capacity of its companies to overcome the dispute over territories in the face of the appearance of a new state that competes against it on the same terms of hegemonic tendency.

It should also be noted that both China and Russia exercise a strategic alliance in what both states have determined to be a threat to the manoeuvres of dominance that the United States seeks to impose on their economies and territories. In fact, the BRICS bloc is looking for a way to implement a common currency in their trade, finance and central bank reserves as a way to shake off US control of the dollar, as Jan Krikke writes in an article on 9 August 2024. Such a move, if announced in the next few years, would have strong repercussions for the US financial sector and could be a decisive incentive in the intensification and outcome of the current conflict fronts. Its eventuality does not depend on who wins the US presidency, but on how these situations are dealt with.

Discussions. Dispelling the siren call

As has been shown, the behaviour of financial markets does not in itself depend on voting in the United States, given that the US still maintains its role as a hegemonic economy, although it is no longer unipolar. Thus, there is no place in the study for trying to induce a favourable image of one or the other of the contenders to their mutual detriment.

Although it is worth mentioning that, although on the surface the Democratic candidate may have certain links with China that could mean an attenuation of geostrategic frictions, the reality is that both the Republicans, as was the case during Donald Trump's term, and the Democrats in Joe Biden's administration, both parties maintain a protectionist policy towards the Asian country, as can be seen in the announcements of 17 April, 14 May and 12 June 2024, in which different types of restrictions and economic sanctions against China were announced by the Democratic Party's ruler.

Moreover, the fact that the Democratic candidate comes from an ideological line in which the submission of Russian territory is a key objective, and that there is a risk of war escalating to global levels, is worrying. However, this scenario tends more towards a situation of deterrence than a concrete reality, since, in the very extreme and undesirable scenario in which the culmination of any of the three geostrategic fronts were to take place in such a way, the prognosis would be mutual annihilation, both sides would lose and so would the whole world.

On the Republican side, while efforts to contain China would intensify, the resolution of at least one of the three fronts is likely to dissipate the risk of a global-scale conflict. However, it requires a more radical repositioning of investment. In pursuit of this goal, there is the possibility that the US economy could implode, or that new fronts of dispute could be generated to provide an escape route for its financial sphere.

As for China, its rise as a hegemonic state depends on a key factor that will give solidity to such a permutation: the de-dollarisation of its economy and finances. This is because the dollar is also used as a hegemonic weapon[5] that epitomises the fact that the United States is in a phase of systemic chaos, since its main advantage over its competitor is not the development and accumulation of its production but the expansion of its financial apparatus, which has been exhausting its possibilities for growth both on Chinese territory (*offshore*) and on its own territory (*nearshore*).

Conclusions

Based on the results obtained during the course of the research, it is possible to discern the following:

- The policy of containment against China is a tactic shared by both Democrats and Republicans. From the beginning of the sanctions against Huawei by Donald Trump's administration, to their maintenance, as well as the imposition of tariffs, the only difference between the two lies in the relocation of their investments, since while the Democratic candidate thinks of an expansive economic policy, the Republican candidate proposes a more protectionist plan and the return of investments to North American territory (which, by extension of the T-MEC, includes Mexico).

- Much of Trump's aggressive political discourse is for electoral purposes, since, as has been mentioned, the return of the productive sector with a view to attempting a new phase of accumulation and expansion of the financial sector, as a result of the exhaustion of the US financial sector, within its own territory does not represent a feasible path for a new phase of accumulation and material expansion that would precede a new cycle of financial expansion.

- There are, however, some contested territories that may provide an escape valve in the short, medium and long term. These territories include the so-called lithium triangle in South America, the negotiated access to the world's first oil and gas reserves located in Venezuelan maritime waters, and Mexico's competitive and comparative advantage as a *nearshoring* destination for US companies, which would allow it to reaffirm its role as a hegemonic power on this side of the globe.

- It is also shown that the geographical component is imperative in historical events, as well as in the determination and implementation of financial investment plans. This is a primordial component for the world economy, as it is through it that it is possible to diagnose how each region of the planet influences global supply chains and the importance of controlling these disputed spaces.

Finally, in the specific case of Mexico, given its high degree of economic dependence on the United States, it is possible that the political effects will be more significant. Nevertheless, there are certain palliatives that allow a margin of manoeuvrability in the face of possible future scenarios: the *nearshoring* that provides new investments, with the announcement of plants in the chip sector being the fundamental capitalist industry par excellence at present, and on the monetary side, Banxico's adjustment of the interbank interest rate by only 0.25 percent to 10.75 percent, reflects the attempts to maintain a stable economy in terms of inflation and the exchange rate. Banxico's conclusions in this regard are that: 'Going forward, it expects the inflationary environment to allow for discussion of adjustments in the reference rate. It will take into account the prospect that global shocks will continue to fade and the effects of weak economic activity. [The central bank reaffirms its commitment to its priority mandate and the need to persevere in its efforts to consolidate a low and stable inflation environment'. (p. 2)

Annexes.

Appendix

The procedure by which the forecast presented in Graph 3 was modelled is shown. Forecast of the S&P500, Dow Jones IA and Nasdaq100 indices in the months following the November 2024 election. It should be recalled that an ARIMA model that has the presence of stationarity maintains as fundamental properties constant mean, variance and autocorrelation over time, while, in its residual error terms, there is the presence of white noise as a test of randomness of the correlogram whose characteristics are zero mean, constant variance, covariance equal to zero, and zero covariance.

For the white noise tests of each model, the Portmanteu test was used, the hypothesis test of which states the following:

H0 Prob chi2 < 0.05 no evidence of white noise.
H1 Prob chi2 > 0.05 there is evidence of white noise.
Stata15 software was used to test the models.
ARIMA(2,1,1) model of the S&P500 index, the p-value of its independent terms is significant at 0.05 %.

[1] In the graph shown, the Mexican GDP is also taken into account as a reference to contrast its dynamics with those of the countries that are the object of study of this research and to be of interest due to the close relationship that the economic-financial activities of this country have with its partner and neighbour to the north.

[2] The specific analysis can be found in the article entitled 'Why Yemen and the Little Red Sea Strait is so important for global shipping'.

Metcalfe, Tom (28 December 2023). Why Yemen and the Little Strait of the Red Sea is so important to global shipping. National Geographic. https://www.nationalgeographic.es/historia/2023/12/yemen-mar-rojo-bab-el-mandeb-estrecho-important-world-sea-transport-world-world-transport

[3] Ukraine is a key potential supplier of rare earth metals such as titanium, lithium, beryllium, manganese, gallium, uranium, zirconium, graphite, apatite, fluorspar and nickel. Despite the war, Ukraine has the largest titanium reserves in Europe (7% of world reserves). It is one of the few countries mining titanium ores, crucial for the aerospace, medical, automotive and shipbuilding industries. Katser-Buchkovska, Nataliya (19 July 2024). *Future of critical raw materials: Ukraine's strategic role in global supply chains*. World Economic Forum. Available at: https://es.weforum.org/agenda/2024/07/el-futuro-de-las-materias-primas-criticas-el-papel-estrategico-de-ucrania-en-las-cadenas-globales-de-suministro/

[4] The estimation of optimal models for a meaningful forecast is provided as part of the annexes to this paper.

[5] This circumstance becomes evident in the face of the numerous and constant economic sanctions that the United States unilaterally uses to undermine the economies of those states that represent a threat or opposition to its interests, such as the embargo on Russian reserves in Europe, the economic sanctions on Iran or Venezuela, and which propagandistically sell smoke signals that these countries lack democracy and that this is the factor that impedes their economic growth. The underlying reality is the use of the dollar as an instrument by which US hegemony seeks to impose its interests by subjugating territories. See:

ARIMA regression

Sample: 2013m2 - 2024m9 — Number of obs = 140
Wald chi2(3) = 12.28
Log likelihood = -889.92 — Prob > chi2 = 0.0065

D.sp500	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
sp500						
_cons	30.34849	10.96141	2.77	0.006	8.864519	51.83247
ARMA						
ar						
L1.	-.8052373	.2930871	-2.75	0.006	-1.379677	-.2307972
L2.	-.181033	.0665531	-2.72	0.007	-.3114747	-.0505912
ma						
L1.	.657757	.2955264	2.23	0.026	.0785359	1.236978
/sigma	139.4155	7.55802	18.45	0.000	124.602	154.2289

Note: The test of the variance against zero is one sided, and the two-sided

The result of their white noise test for the S&P500 index is as follows:

```
. predict e211_sp500, residuals
(1 missing value generated)

. wntestq e211_sp500

Portmanteau test for white noise
---------------------------------------
 Portmanteau (Q) statistic =    55.0759
 Prob > chi2(40)           =     0.0567
```

ARIMA (4,1,3) model of the Nasdaq100 index

ARIMA regression

Sample: 2013m2 - 2024m9 — Number of obs = 140
Wald chi2(7) = 902.57
Log likelihood = -1072.65 — Prob > chi2 = 0.0000

D.nasdaq100	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval]
nasdaq100						
_cons	126.2876	62.955	2.01	0.045	2.898075	249.6771
ARMA						
ar						
L1.	.4829074	.2262669	2.13	0.033	.0394324	.9263825
L2.	-.7597625	.09899	-7.68	0.000	-.9537794	-.5657456
L3.	.6075228	.2267262	2.68	0.007	.1631476	1.051898
L4.	.1495055	.0714644	2.09	0.036	.009438	.2895731
ma						
L1.	-.5562511	.2307864	-2.41	0.016	-1.008584	-.1039179
L2.	.8450297	.1012227	8.35	0.000	.6466369	1.043422
L3.	-.6014335	.235845	-2.55	0.011	-1.063681	-.1391858
/sigma	511.9581	24.34632	21.03	0.000	464.2402	559.676

Note: The test of the variance against zero is one sided, and the two-sided confidence interval is truncated at zero.

The result of the white noise test for the Nasdaq100 index is as follows:

```
. predict e413_nasdaq, residuals
(1 missing value generated)

. wntestq e413_nasdaq

Portmanteau test for white noise
---------------------------------------
 Portmanteau (Q) statistic =    37.4177
 Prob > chi2(40)           =     0.5871

. wntestb e413_nasdaq
```

ARIMA (1,1,2) model of the Dow Jones index IA

ARIMA regression

Sample: 2013m2 - 2024m9 — Number of obs = 14
Wald chi2(3) = 45.0
Log likelihood = -1178.308 — Prob > chi2 = 0.000

D. dowjones_ia	Coef.	OPG Std. Err.	z	P>|z|	[95% Conf.	Interval
dowjones_ia						
_cons	202.1483	76.94259	2.63	0.009	51.34355	352.95
ARMA						
ar						
L1.	-.686135	.1492958	-4.60	0.000	-.9787494	-.393520
ma						
L1.	.5490527	.1474154	3.72	0.000	.2601238	.837981
L2.	-.2733083	.0696843	-3.92	0.000	-.4098871	-.136729
/sigma	1093.132	53.99038	20.25	0.000	987.313	1198.95

Note: The test of the variance against zero is one sided, and the two-sided confidence interval is truncated at zero.

The result of the white noise test for the Dow Jones IA index is as follows:

```
. predict e112_dj, residuals
(1 missing value generated)

. wntestq e112_dj

Portmanteau test for white noise
---------------------------------------
 Portmanteau (Q) statistic =    35.6883
 Prob > chi2(40)           =     0.6647
```

Declarations

Conflict of interest

The author declares that he has no conflict of interest. I have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

Authors' contribution

Esteban-Rodríguez, José Luis. Contributed to the project idea, research method and technique.

Availability of data and materials.

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Abbreviations

BRICS Brazil, Russia, India, China, South Africa.
Fed Federal Reserve System
WTO World Trade Organisation
NATO North Atlantic Treaty Organisation

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Monitoring the United States Business Cycle in real time, via an MFD-FM

Monitoreando en tiempo real los Ciclo de Negocio de Estados Unidos, vía un MFD-FM (Modelo de Factor Dinámico de Frecuencia Mixta)

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Key Handbooks

It is proposed to use the common factor of a Mixed Frequency Dynamic Factor Model (MFD-FM) to monitor in real time the business cycles in the USA. It was defined as a two-factor NowCasting 2 type model: a common factor, which captures the co-movement between variables and another that estimates the idiosyncratic movements of each variable. Five key macroeconomic indicators 3 were used and the Kalman filter was employed for the estimations. The proposed model was able to identify the impact of the Subprime crisis, COVID-19 and the Ukraine-Russia conflict. It is proposed to use this model for other countries and business sectors.

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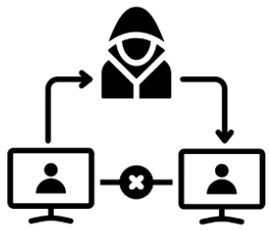
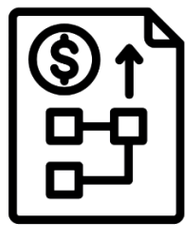
Handbook shelf URL: https://www.ecorfan.org/handbooks.php

Abstract

It is proposed to use the common factor of a Mixed Frequency Dynamic Factor Model (MFD-FM) to monitor business cycles in the US in real time; The MFD-FM was defined as a NowCasting type model with two factors: a common factor, which captures the co-movement between the variables and another that estimates the idiosyncratic movements of each of them. Five key macroeconomic indicators were used and the Kalman filter was used for the estimates. The proposed model was able to identify the impact of the Subprime crises, COVID-19 and the conflict between Ukraine and Russia. It is proposed to use this model for other countries and business sectors.

Monitoring the United States Business Cycle in real time, via an MFD-FM

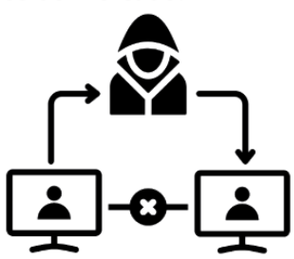
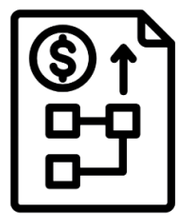
Objective	Methodology	Contribution
Build an automaton that monitors the business cycles of the American market in real time. 	Define the communication models and language that will establish real-time decision making in market cycles. 	Investment decision making through information collected by an automaton. 

NowCasting, Economic cycle, Kalman filter

Resumen

Se propone emplear el factor común de un Modelo de Factor Dinámico de Frecuencias Mixtas (MFD-FM) para monitorear en tiempo real los ciclos de negocio en EUA; el MFD-FM se definió como un modelo de tipo NowCasting de dos factores: un factor común, que captura el co-movimiento entre las variables y otro que estima los movimientos idiosincráticos de cada una de ellas. Se utilizaron cinco indicadores macroeconómicos claves y se empleó el filtro de Kalman para las estimaciones. El modelo propuesto fue capaz de identificar el impacto de las crisis Subprime, COVID-19 y el conflicto entre Ucrania y Rusia. Se propone utilizar este modelo para otros países y sectores empresariales.

Monitoreando en tiempo real los Ciclo de Negocio de Estados Unidos, vía un MFD-FM

Objetivo	Metodología	Contribución
Construir un autómata que monitoree en tiempo real los ciclos de negocio del mercado Estadounidense. 	Definir los modelos y el lenguaje de comunicación que establecerán las tomas de decisiones en tiempo real de los ciclos de mercado. 	Toma de decisiones en inversión a través de la información recopilada por un autómata. 

NowCasting, Ciclo económico, Filtro de Kalman

Introduction

In this century, the world's economies have been subject to a number of events that have generated great volatility and rapid changes in the global economic environment. The integration of multiple data sources and the ability to update estimates in real time have become crucial to obtain an accurate and up-to-date picture of the state of the economy. State-space models such as Mixed Frequency Dynamic Factor Models (MDF-FMs) have become fundamental tools in this area due to their ability to handle data of different frequencies and their flexibility to incorporate new data as they become available.

State-space models allow the representation of dynamic systems where observable variables are influenced by unobservable factors (states) that evolve over time. These models are highly adaptable and are applied in a variety of contexts, from estimating business cycles and growth trends to modelling volatility in financial markets (Harvey, 1989; Stock & Watson, 1991). A prominent feature of these models is the use of the Kalman filter, which facilitates the estimation and prediction of unobservable states efficiently and in real time (Kalman, 1960; Durbin & Koopman, 2012).
An important development in this field is the integration of state-space models with dynamic factor models, which has enabled the estimation of common unobservable factors affecting multiple time series.

These common factors capture the co-movement between different economic indicators, significantly improving forecast accuracy and providing a deeper understanding of the underlying dynamics of the economy (Forni *et al*., 2000; Doz *et al*., 2011).

The MFD-FM model is particularly relevant in this context, as it can combine data with different sampling, e.g. quarterly and monthly, to provide estimates or forecasts of the variables involved. Each time a new data is received, either monthly or quarterly, the model is updated, allowing for a continuous and real-time revision of the estimates. This continuous updating capability is crucial for informed and timely decision-making in economic policy and financial management (Giannone *et al*., 2008).

The importance of the common factor in these models cannot be underestimated. By capturing the shared variations among various economic indicators, the common factor allows for a more coherent and robust integration of the available information. This not only improves the accuracy of forecasts, but also provides a basis for the interpretation and analysis of economic outcomes (Stock & Watson, 2002).

Thus, the use of data of different frequencies and the continuous updating capability of MFD-FM models highlight their relevance in economic forecasting (Giannone *et al*., 2008; Aruoba *et al*., 2011). The identification and estimation of common factors play an essential role in improving the accuracy and usefulness of these forecasts, contributing significantly to a better understanding and management of economic dynamics.

In particular, key macroeconomic indicators that reflect the state and evolution of the economy are generally: Gross Domestic Product (GDP), inflation rate (CPI), employment generation, real estate sector evolution. The behaviour of these variables is fundamental to assess the economic health of a country and relevant for investment decisions.

A Mixed Frequency Dynamic Factor Model (MDF-FM) is proposed for the United States consisting of the variables: Gross Domestic Product, GDP USA; interest rate, INTEREST RATE USA; inflation rate, Consumer Price Index; employment, Labor Force Participation Rate; and housing index, House Price Index; the description of each of them is in the data section.

The state-space model is constructed as a two-factor NowCasting model, a first common factor characterising the general movements of the set of variables in the model and an idiosyncratic factor showing the particular behaviour of each one. In particular, it is proposed to use the common factor as the indicator of the state of the US economy. Two test periods were used, the first from January 2004 to December 2013, which covers the Subprime Mortgage crisis (December 2007 to June 2009); and a second period from January 2013 to March 2024, the period during which the COVID19 virus appeared (February 2020 to April 2020) and the conflict between Ukraine and Russia started, 24 February 2022.

The proposed model was able to identify the impact of the Subprime crisis, the COVID-19 pandemic and the Ukraine-Russia conflict; it also showed how the performance of a single variable is not determinant in signalling business cycles in the United States. Finally, it is argued that based on the common factor of the proposed model, the US business cycle is still in a contractionary phase, with inflation under control, but at levels above the desired 3.25 versus 2; the interest rate has not started to decline; and labour force levels are below those reached before the pandemic. Future work is proposed to apply this same model to other countries and even business sectors.

General explanation of the issue and why it is important.

What is its added value compared to other techniques?

Focus clearly on each of its characteristics

Explain clearly the problem to be solved and the central hypothesis.

Explanation of the sections of the book.

Development of the headings and sub-headings of the book with subsequent numbers.

Literature review on forecasting

State-space models are flexible and adaptable tools for analysis and forecasting in economics and finance. These models allow the representation of dynamic systems in which observable variables are influenced by unobservable factors that evolve over time. The use of the Kalman filter in the estimation and forecasting of these models has been widely recognised and used due to its effectiveness and relevance in the field of economic and financial analysis. Key applications and developments of state-space models in economics and finance are explored.

State-space models and the Kalman filter were first introduced in the context of systems engineering and control (Kalman, 1960). Their application to economics and finance began to gain acceptance in the 1970s, and these methods began to be increasingly adopted and used by researchers and practitioners in these areas. Harvey (1989) is one of the seminal texts, '*Forecasting, structural time series models and the Kalman filter*' shows how these methods are adapted for economic analysis, presenting a wide range of applications, from time series to more complex structural models.

One of the most common applications of state-space models in macroeconomics is the estimation of business cycles and growth trends. Kuttner (1994) used a state-space model to separate trend and cycle in US GDP data, providing an estimate of the output gap[1] that is crucial for monetary policy. Similarly, Stock and Watson (1991, 1999) applied these models to construct coincident and forward-looking indices of economic activity.

State-space models have also been widely used to model and forecast inflation. An important example is the work of Kim and Nelson (1999), who used a state-space regime-switching model to capture variations in inflation dynamics. Their approach allowed them to identify periods of high and low inflation, as well as the underlying factors driving these changes.

In finance, state-space models have been used to model volatility and risk. Engle and Watson (1981) used these models to analyse financial market volatility, while Hamilton (1989) applied regime-switching models to asset price series to capture changes in volatility and expected returns. State-space GARCH models, introduced by Harvey, Ruiz and Shephard (1994), have been instrumental in understanding the dynamics of volatility in financial markets.

An important development has been the integration of state-space models with dynamic factor models. This approach has allowed the estimation of unobservable factors affecting multiple time series. Forni *et al*. (2000) and Doz, Giannone and Reichlin (2011) have developed methods for estimating these models, which have been widely applied for economic analysis and forecasting macroeconomic variables.

The ability of state-space models to incorporate real-time data and provide up-to-date forecasts has been particularly valuable and is named Nowcasting. Giannone, Reichlin and Small (2008) demonstrated how these models can be used to improve GDP forecasts using data available in real time. This approach has been adopted by central banks and other institutions to improve real-time decision making. For Mexico, in the work of Delajara, Hernández Álvarez and Rodríguez Tirado (2016), who introduced a real-time database for the Mexican economy and proposed a mixed-frequency dynamic factor model (MDF-FM) for backcasts, nowcasts and forecasts of short-term GDP growth. They compared their factor-based estimates with those of professional forecasters over the period from 2008Q2 to 2014Q2, finding that their factor-based forecasts outperformed those of the consensus of professional forecasters in real time, despite some structural instability during the 2008-09 crisis and its aftermath in 2010.

State-space models have evolved to become essential tools in economic and financial analysis. Their ability to handle incomplete and noisy data, together with the flexibility to model complex dynamics, makes them useful for many applications. As estimation and computational methods continue to advance, these models are likely to continue to play a crucial role in economic research and policy-making.

Methodology

Macroeconomic variables are fundamental to analysing and understanding a country's economy. In the following section, we list some of the most common macroeconomic variables, their importance and their relationship.

Relationship between the data used

In this study, five important macroeconomic variables were used:

US Interest Rate (Interest Rate USA), US Labor Force Participation Rate (Labor Force Participation Rate), the Consumer Price Index or CPI (Consumer Price Index); the House Price Index or HPI (House Price Index), and Gross Domestic Product (GDP), these indicators interact with each other and reflect different aspects of a country's economic health.

The relationship between them is explained below:

1. **Interest Rate USA and Consumer Price Index (CPI),** Interest rates have a direct relationship with inflation, which is measured through the CPI. When the Federal Reserve (FED) raises interest rates, it is generally with the aim of ‘cooling’ the economy and controlling inflation. On the other hand, lower interest rates can stimulate consumer spending and business investment, increasing demand for goods and services, which can potentially lead to higher prices, i.e. higher inflation.
2. **Interest Rate USA and House Price Index (HPI)**. Interest rates have a direct impact on the HPI. Lower interest rates make mortgage loans more affordable, which can increase the demand for housing and thus raise house prices. Conversely, higher interest rates can reduce the demand for housing, as financing costs increase, which can lead to a decrease in house prices.
3. **US Labour Force Participation Rate and Consumer Price Index (CPI)**, The labour participation rate can influence the CPI through its effect on labour supply and demand. A high labour participation rate increases labour supply, which can control wage pressures and thus production costs, which can help to keep inflation low. On the other hand, low participation can lead to labour shortages, raising wages and possibly consumer prices.
4. The relationship between the labour participation rate and the**House Price Index (HPI)** can be described as follows: high labour participation rates generally indicate a healthy economy, which can increase the demand for housing and, consequently, house prices. In addition, a strong labour market can provide consumers with the confidence and financial means to purchase homes.
5. **United States Core PCE Price Index Annual Change**, The personal consumption expenditures (PCE) price index, excluding food and energy prices due to their volatility, is a preferred measure of inflation for the Federal Reserve. Core PCE provides a clearer picture of underlying inflation trends and is central to monetary policy decision-making. High core inflation can signal the need to raise interest rates.

These indicators not only reflect the current economic situation, but also influence policy decisions. For example, if inflation is high, the Fed may choose to raise interest rates to 'calm' the economy. On the other hand, if the economy is slowing down, the FED may lower interest rates to stimulate growth, thus affecting both the CPI and the HPI. The labour participation rate is also crucial to assess the strength of the labour market and its ability to support economic growth without generating inflationary pressures.

The following table (table 1) presents the frequency of publication and periodicity of the economic indicators used.

[1] The output gap is the difference between an economy's current level of output (actual GDP) and its potential level (potential GDP). A positive output gap indicates output above the sustainable level, generating inflationary pressures. A negative output gap suggests output below potential, associated with unemployment and idle capacity.

Box 1

Table 1

Frequency of Publication of Economic Indicators in the U.S.A.

Indicator	Frequency of Publication	Periodicity
US Interest Rate (Interest Rate USA)	Decided by the Federal Reserve FOMC	Eight times a year, approximately every six weeks.
Labour Force Participation Rate (Labour Force Participation Rate)	Published by the Bureau of Labor Statistics (BLS)	Monthly
Consumer Price Index (CPI)	Published by the Bureau of Labor Statistics (BLS)	Monthly
House Price Index (HPI)	Published by the Federal Housing Finance Agency (FHFA).)	Quarterly (with monthly reports)
United States Core PCE Price Index Annual Change	Published by the Bureau of Economic Analysis (BEA)	Monthly

Econometric Model

A mixed-frequency dynamic factor dynamic factor econometric model (MF-DFM) is proposed that allows for the inclusion of missing data and mixed frequency indicators: The proposed specification is very similar to that presented in Aruoba and Diebold (2010); Camacho and Pérez-Quirós (2010); Cristiano, Hernández, and Pulido (2012); and Rodríguez (2014), and DelaJara (2016). This model extracts the common variances between quarterly GDP ($y_{1,t}$) and monthly indicators ($y_{h,t}$ para $h = 2,\dots N$) separating out the comovement captured by the unobservable factor(f_t) of idiosyncratic movements $u_{n,t}$, for $h = 2,\dots N$. The basic equations of the model are:

$$[y_{1,t}\, y_{2,t}\, y_{3,t} \vdots y_{N,t}] = \left[\gamma_1 \left(\tfrac{1}{3}f_t + \tfrac{2}{3}f_{t-1} + f_{t-2} + \tfrac{2}{3}f_{t-3} + \tfrac{1}{3}f_{t-4}\right) \gamma_2 \textstyle\sum_{j=0}^{11} f_{t-j}\, \gamma_3 \sum_{j=0}^{11} f_{t-j} \vdots \gamma_N \sum_{j=0}^{11} f_{t-j}\right] + + \left[\tfrac{1}{3}v_{1,t} + \tfrac{2}{3}v_{1,t-1} + v_{1,t-2} + \tfrac{2}{3}v_{1,t-3} + \tfrac{1}{3}v_{1,t-4}\, v_{2,t}\, v_{3,t} \vdots v_{N,t}\right] \quad (1)$$

where (γ_n) are the factor loadings (or weights). The dynamics of the factors are modelled as autoregressive processes:

$$f_t = \phi_1 f_{t-1} + \phi_2 f_{t-2} + \cdots + \phi_P f_{t-P} + e_t,\ \ e_t \sim i.i.d.N(0,1) \quad (2)$$

$$u_{n,t} = \phi_{1n} u_{n,t-1} + \phi_{2n} u_{n,t-2} + \cdots + \phi_{Qn} u_{n,t-Qn} + \epsilon_{n,t},\ \ \epsilon_t \sim i.i.d.N(0, \sigma^2_{\epsilon_n})\ para\ n = 1,2,\dots m, N \quad (3)$$

The model assumes mutual independence between f_t y $u_{n,t}$.

To estimate the factors f_t y $u_{n,t}$, the system is rewritten in the form of a state-space model and the Kalman filter is used to solve it. The state-space equations are:

$$[y_t = HF_t + \xi_t, \quad \xi_t \sim N(0,R)] \tag{4}$$

$$F_t = TF_{t-1} + \zeta_t, \quad \zeta_t \sim N(0,Q) \tag{5}$$

The measurement equation relates the observed indicators to the factors, and the transition equation specifies the dynamics of the factors. To handle missing data, each missing data is replaced with a random value, keeping the matrices compliant. The modified measurement equation is:

$$y_t = H_t^* F_t + \xi_t, \quad \xi_t \sim N(0,R_t^*) \tag{6}$$

The Kalman filter is applied to obtain optimal estimates of the parameters and the F_t matrix, updating the predictions and error equations as new data are received. This allows a continuous and real-time revision of the estimates and in particular of the system state (common factor), improving the accuracy and usefulness of the economic forecasts. In particular, in this paper it is this factor that is associated with the state of the business cycle in the United States.

Results

We analyse the behaviour of the common factor over the present century, divided into two periods: the first from January 2003 to December 2013, which covers the subprime mortgage crisis (December 2007 to June 2009); and a second period from January 2014 to March 2024, the period during which the COVID19 virus appeared (February 2022) and the conflict between Ukraine and Russia began (February 2022). For the NBER (National Bureau of Economic Research), the periods of expansion and contraction of the US economy during this century are summarised in Table 2 below:

Box 2

Table 2

Periods of economic expansion and contraction in the United States according to the NBER.

Peak month (peak quarter)	Valley month (valley quarter)	Contraction	Expansion	Cycle
December 2007(2007Q1)	June 2009 (2009Q2)	18	73	91 (81)
February 2020 (2019Q4)	April 2020 (2020Q2)	2	128	130 (146)

These periods of expansion and contraction in the US business cycle are benchmarked for their relationship to the common factor, then each variable is checked against the common factor.

Period 2004 – 2013

During the first period of analysis, from January 2003 to 2013, the biggest crisis of this century took place, associated with an overvaluation of mortgage credit. Figure 1.a, which plots the dating of the NBER versus the common factor, shows how the common factor from the end of 2004 entered a period of contraction, increasing its fall just on the date that the NBER indicates the beginning of the Subprime crisis. The expansion phase of the common factor, associated with this crisis, begins eight months before the date of the recovery indicated by the NBER. The behaviour of EU GDP vs. the common factor, Figure 1.b shows a synchronous movement between these series during the beginning and recovery of the Subprime crisis, GDP starts a phase of deceleration of its value that accompanies the common factor in its contraction from July 2005 to November 2008; and starts its recovery and expansion at the same time as the common factor from December 2008 to July 2011.

With respect to the CPI, Figure 1.c, it is observed how the CPI before the onset of the Subprime crisis, showed an upward trend since late 2004, which coincides with the contraction phase of the common factor, the CPI moves inversely with respect to the common factor; both variables signalled a deterioration in the US economy since late 2024; Also, both the peak of the CPI and the trough of the common factor marked the peak of the effect of the crisis and the moment of its recovery; the higher the inflation, the greater the deterioration of the economy, and the lower the inflation, the recovery and expansion of the economy.

On the other hand, the interest rate, Figure 1.d, began to rise steadily from June 2004 until June 2006, and remained constant until June 2007, six months before the onset of the crisis. This increase in interest rates was reflected as a sustained deterioration of the common factor. In July 2007, a period of interest rate reduction began, five months before the onset of the crisis. This interest rate reduction did not contain the fall in the common factor, which lasted until November 2008; in December 2008, the common factor began to recover with an interest rate close to zero per cent. The effect of both the rise and fall in the interest rate had a lagged effect on the movement of the common factor (contraction - expansion).

In relation to the labour force, Figure 1.e, the labour force remained constant until before August 2008, while the common factor was in a period of contraction; in September of the same year a contraction of the labour force began, which continued until the end of this period, December 2013; the contraction of employment did not coincide with the expansion in the common factor, or recovery of the US economy. The labour force was affected by the subprime crisis, and its effects lasted until the end of 2013.

Finally, the US House Price Index, Figure 1.f, was from the beginning of this period until March 2007 in a strong upswing, while the common factor contracted, and this contraction of the common factor continued until November 2008. The housing index started to contract from April 2007, eight months before the onset of the crisis. Finally, the housing index started to expand in March 2011, accompanying the expansionary phase of the common factor.

In conclusion, during this period the common factor showed signs of contraction of the US economy, since the beginning of 2004, based on a decline in GDP; high inflation levels; rising interest rates; and a sustained increase in housing values. The recovery of the common factor, on the other hand, was eight months ahead of the NBER's defined start date for recovery from the crisis, based on GDP recovery, controlled inflation and an interest rate close to zero. On the other hand, the peak of the housing bubble, April 2007, brought forward the NBER-defined start date of the crisis, and the effects of the crisis on the labour sector were maintained during this first period of analysis.

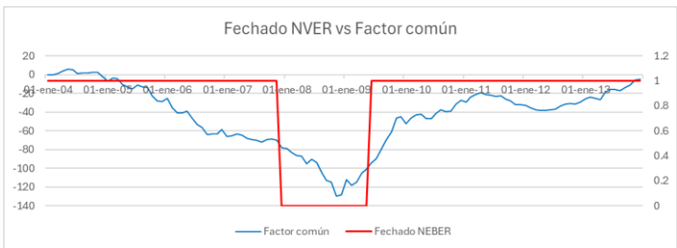


Figura 1.a. Relación entre el fechado del NBER y el factor común durante la crisis Subprime.

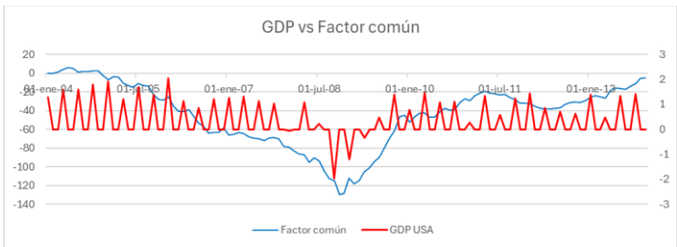


Figura 1.b. Comportamiento del GDP de los Estados Unidos versus el factor común durante la crisis Subprime.

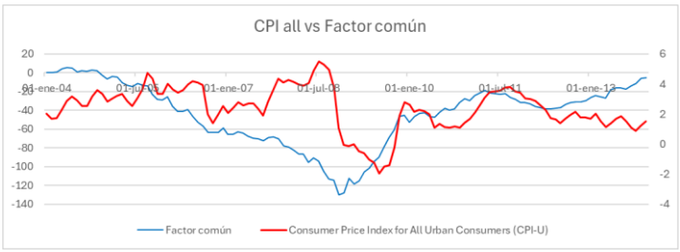


Figura 1.c. Índice de Precios al Consumidor (CPI) versus el factor común durante la crisis Subprime.

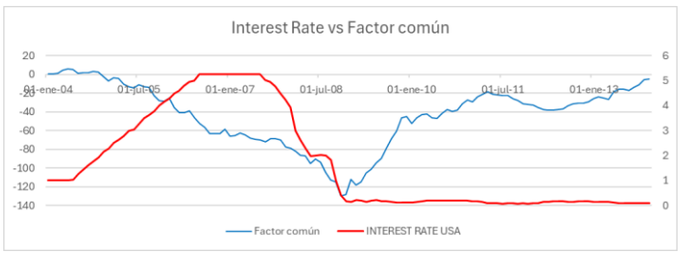


Figura 1.d. Tasa de interés versus el factor común durante la crisis Subprime.

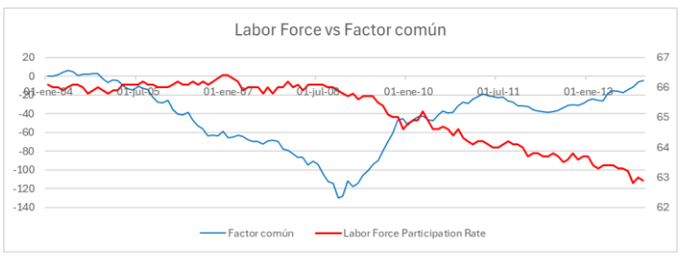


Figura 1.e. Fuerza laboral versus el factor común durante la crisis Subprime.

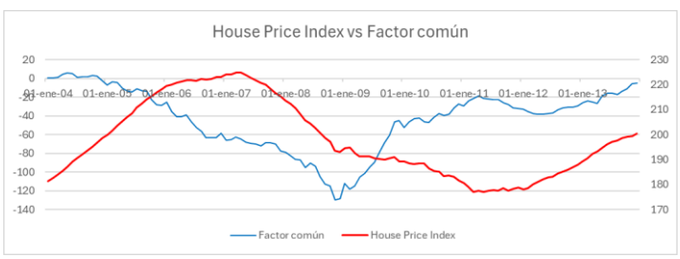


Figura 1.f. Índice de Precios de la Vivienda (House Price Index) versus el factor común durante la crisis Subprime.

Period 2014 – 2024

In the second period of analysis, from January 2017 to May 2024, the NBER only identified a period of contraction and expansion, associated with the COVID crisis19 (see Figure 2.a), which was of very short duration, two months, and with a period of expansion that continues until mid-2024. Also, during this period, the conflict between Russia and Ukraine began, which has not yet ended.

For the COVID19 crisis, the common factor brought forward the start of the contraction and coincided with the expansion of this business cycle, see Figure 2a. One thing that stands out in the behaviour of the common factor is the signalling of a contraction in mid-2022, which coincides with the start of the conflict between Ukraine and Russia, February 2022.

During this period, GDP had an abrupt downward and upward shift during the months of February to July 2020, which coincides with the beginning and end of the BIBVOC pandemic crisis19 , see Figure 2.b; also, at the beginning of the conflict between Ukraine and Russia, quarter 2022Q1, it showed a fall in its value, which has been maintained to date; the common factor accompanied GDP in this behaviour in a coincident manner.

The CPI or inflation rate, in this period was stable from January 2017 February to April 2020, the same behaviour as the common factor, see Figure 2.c. At the beginning of 2019 both the CPI and the common factor began a contraction that ended in May 2020; the factor contracted and inflation decreased during the period of the COVID19 crisis, from January to May 2020. The recovery from this crisis was characterised by a sustained increase in inflation until June 2022, the same behaviour of the factor, which expanded during this period; on the other hand, in July, four months after the start of the conflict between Russia and Ukraine, a decrease in the inflation rate began, coinciding with the decrease in the common factor.

Figure 2.d shows how the interest rate at the beginning of this period began an upward phase, which was accompanied by a stable common factor. Six months before the appearance of COVID19, in July 2019, the interest rate starts a downward period until it reaches levels close to zero, the downward movement of both the interest rate and the common factor anticipated the onset of the COVID19 crisis. In April 2020 the interest rate reached a level close to zero, which was maintained for eleven months, March 2022, during which time the common factor experienced an expansion; subsequently, in April 2022, the interest rate began a significant upward period, the common factor slowed and contracted.

The labour force, Figure 1.e, before the onset of the COVID19 pandemic showed constant levels; until February 2020, when the pandemic crisis began, it fell sharply; also, two months later, in April, it recovered significantly and began an upward movement, without reaching pre-pandemic levels. The behaviour of this index versus the common factor was coincident, except for the last nine months, where the factor is in a contraction phase, while the labour force remains constant.

Finally, Figure 1.f shows how the value of housing has increased steadily since the beginning of this period, with small slowdowns during the COVID19 pandemic crisis and at the beginning of the Ukraine-Russia conflict.

At the end of the period, the common factor is sending early signals about the onset of the COVID19 pandemic crisis, as well as exposing that the conflict between Russia and Ukraine is affecting the US business cycle. In particular, the common factor anticipated the crisis, from the beginning of 2019 it started a downward phase, which coincided with the slowdown and fall of the interest rate; it also coincided with the recovery from the crisis, with an interest rate close to zero and inflation and the labour force in an upward phase. Finally, the common factor is contracting, since October 2021, four months before the start of the Russia-Ukraine conflict, inflation, CPI and the interest rate are also showing the effect of this conflict.

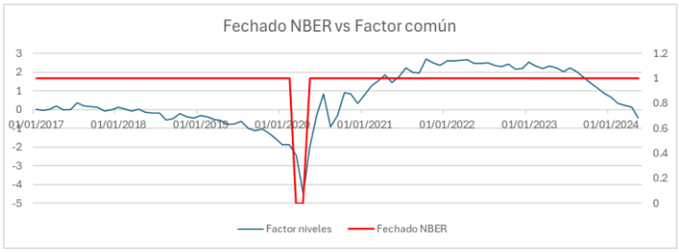


Figura 2.a. Relación entre el fechado del NBER y el factor común durante la crisis del COVID-19.

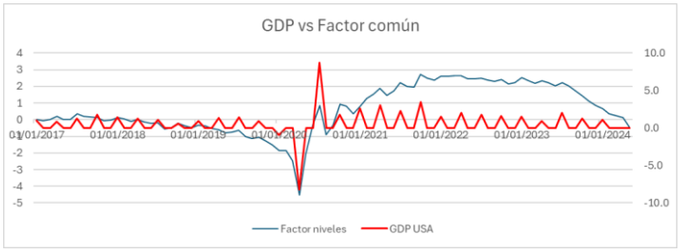


Figura 2.b. Comportamiento del GDP de los Estados Unidos versus el factor común durante la crisis del COVID-19.

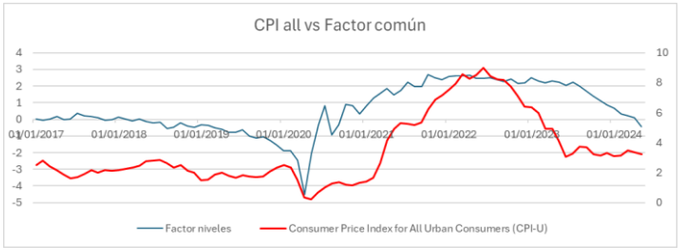


Figura 2.c. Índice de Precios al Consumidor (CPI) versus el factor común durante la crisis del COVID-19.

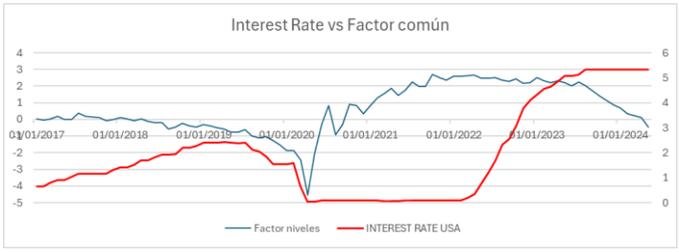


Figura 2.d. Tasa de interés versus el factor común durante la crisis del COVID-19.

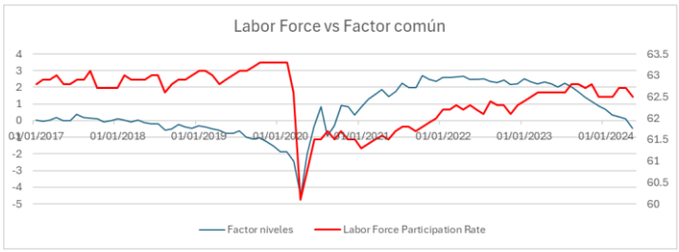


Figura 2.e. Fuerza laboral versus el factor común durante la crisis del COVID-19.

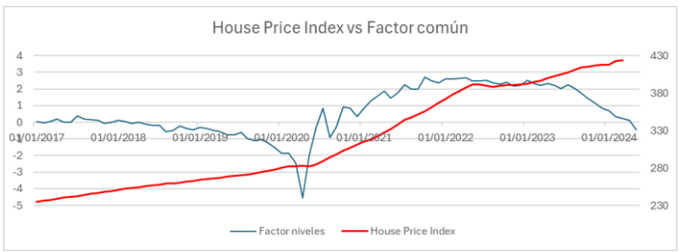


Figura 2.f. Índice de Precios de la Vivienda (House Price Index) versus el factor común durante la crisis del COVID-19.

Conclusions

In conclusion, during the first period of analysis the common factor showed signs of contraction of the US economy, from the beginning of 2004, based on a decline in GDP; elevated inflation levels; rising interest rates; and a sustained increase in housing values, ahead of the onset of the Subprime crisis. On the other hand, the recovery of the common factor came eight months ahead of the NBER-defined start of the crisis recovery, based on GDP recovery and an interest rate close to zero. On the other hand, the peak of the housing index bubble, April 2007, was eight months ahead of the NBER-defined start date of the crisis, and the effects of the crisis on the labour sector were maintained during this first period of analysis.

In the second period, the behaviour of all variables was affected by the effect of the COVID19 pandemic. In particular, both the interest rate and inflation were the variables that were not only affected by the pandemic, but also had important effects due to the conflict between Ukraine and Russia, accompanying the contraction of the common factor. In this second test period, the common factor anticipates the onset of the COVID19 crisis, and coincides with the beginning of the recovery.

In summary, it can be concluded that the performance of a single variable is not determinant in signalling the business cycles in the United States, and it was also observed that the behaviour of each variable with respect to the cycles was not homogeneous over time, for example: interest rates, at some moments were synchronous with both the business cycle and the common factor, and at other moments asynchronous; likewise, other variables show lower levels than in the period prior to the pandemic. It can be said that, at the time of this research, the US business cycle is in a contractionary phase, with inflation under control, but at levels above the desired 3.25 versus 2; the interest rate has not started to decline; and labour force levels are below pre-pandemic levels.

The model was able to identify the impact of the Subprime crisis and COVID-19 pandemic; as well as the impact of the Ukraine-Russia conflict, demonstrating the usefulness of the MFD-FM in adapting to significant economic and political disruptions.

This paper provides a detailed and technical analysis that demonstrates the power of advanced statistical models in contemporary economic analysis, highlighting how they can significantly improve our understanding and response to economic cycles.

Future Applications

The model's success in accurately predicting economic trends suggests broad potential for application in other national and international contexts, providing investors, governments and the public with a robust tool for near real-time economic monitoring.

Annexes

Appropriate tables and sources.

The international standard is 7 pages minimum and 14 pages maximum.

Declarations

Conflict of interest

The authors declare that they have no conflicts of interest. They have no financial interests or personal relationships that could have influenced this book.

Authors' contribution

Benoit-Pauleter, Gerard: Contributed to the project idea, research method and technique.

Availability of data and materials

Indicate the availability of the data obtained in this research.

Funding

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Abbreviations

MFD-FM	Mixed Frequency Dynamic Factor Model
COVID-19	Pandemic Virus COVID 19

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Importance of motivation in job performance: case study engineering services company

Importancia de la motivación en el desempeño laboral: caso de estudio empresa de servicios de ingeniería

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Area: Engineering
Field: Engineering
Discipline: Industrial engineer
Subdiscipline: Control and measurement of productive processes

Key Handbooks

To be able to determine the impact that motivation has within the aspects of productivity in engineering services companies, establishing the existing relationship between these two variables in order to generate a solid proposal that facilitates the management of organizations. Soft skills knowledge, the application of competencies, the measurement of processes, the new business dynamics of management and development. Staff motivation plays a key role today in establishing and defining methods to enhance the capabilities of workers while increasing productivity. Undoubtedly, motivation is still an issue in question due to the profile of each employee, however, understanding and meeting their needs is key to decision making and thus continue to raise competitiveness. In this sense, motivation does not act in isolation, but also includes elements such as effective communication, trust, empathy, teamwork and commitment, which make up a potential mix of activity and attitude of the worker in their environment. The current challenge for companies, especially SMEs, is to be able to manage this element in order to grow as a whole, since unfortunately current efforts have focused mainly on the management of processes and monetary resources, leaving aside the human capital, which is one of the most important assets of organizations. The main contribution of this research lies in providing in a theoretical and methodological way the relevance of motivation nowadays, as a key factor that allows companies to be more productive and competitive, generating synergy in work teams and promoting the integration of the indispensable factors of personality and leadership in daily management.

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Handbook shelf URL: https://www.ecorfan.org/handbooks.php

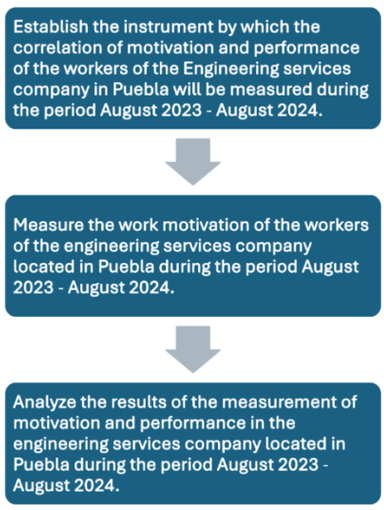
Abstract

This research aims to expose the importance and impact of work motivation on the performance of workers and its role in an engineering services company, as well as to identify the most efficient incentives to achieve such motivation. On the other hand, it seeks to explain how other factors such as organizational climate and leadership intervene in the development of personnel, as well as to recognize the most viable incentives that SMEs could provide, since they are mostly family businesses that have few resources and the profit they obtain often represents an obstacle to granting economic incentives. A quantitative approach is used through the application of a questionnaire and a performance evaluation instrument, which aims to achieve the objective of establishing the relationship between the variables and identifying the key factors to be able to increase the competitiveness of organizations. It was possible to identify the impact of motivation on work performance through the analysis of the results obtained.

Importance of Motivation in Job Performance: Case Study Engineering Services Company

Objective

To determine the relationship between the variables motivation and performance in an engineering services company during the period August 2023 - August 2024.



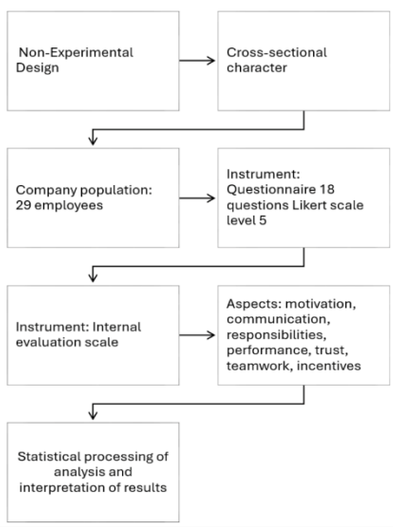
Methodology

This research corresponds to a non-experimental design since none of the variables were manipulated during the study. It also corresponds to a transversal character, since the measurements of the variables were carried out at a single moment.

To carry out the research, an engineering services company located in the municipality of Puebla is considered as the object of study. It has a staff of 29 workers, of which 20 are operators and 9 are administrative.

To carry out the motivational evaluation in the workers, an 18-question questionnaire was used that includes topics addressed in the theoretical framework: communication, assignment of activities, job performance, teamwork, recognition, trust, incentives.

The questionnaire is on the Likert scale level 5, which is a measurement method used mainly for the purpose of quantifying the opinion of the sample or population. The questions that make up the questionnaire cover topics such as the incentives sought to the perception of the work environment in the company and its activities, with the aim of knowing the factors that, given the context of the company, represented a greater impact on staff motivation. On the other hand, to evaluate the performance of the workers, a tabulated evaluation of the manager towards the workers was used.



Contribution

Based on the results obtained through the development of research and the application of instruments, it can be concluded that staff motivation plays a key role today in being able to establish and define methods that allow the capabilities of workers to be enhanced while increasing productivity.

Without a doubt, motivation continues to be an issue in question due to the profile of each collaborator, however, understanding and addressing their needs is key to decision-making and thus continuing to increase competitiveness.

In this sense, motivation does not act in isolation, but also includes elements such as effective communication, trust, empathy, teamwork and commitment, which make up a potential mix of activity and attitude of the worker in his environment.

The current challenge for companies, and especially SMEs, is to be able to manage this element in order to grow together, since unfortunately current efforts have focused mostly on the management of processes and monetary resources, leaving aside human capital, which is one of the most important assets of organizations.

The main contribution of this research lies in providing theoretical an methodological information on the relevance of motivation today, as a key factor that allows companies to be more productive and competitive by generating synergy in work teams and promoting the integration of the essential factors of personality and leadership in daily management.

Motivation, Job Performance, Human Capital

Resumen

La presente investigación expone la importancia e impacto de la motivación laboral en el desempeño de los trabajadores y su papel en una empresa de servicios de ingeniería, al igual que identificar los incentivos más eficientes para alcanzar dicha motivación. Por otra parte, se busca explicar la intervención de los factores clima organizacional y liderazgo en el desarrollo del personal, al igual que reconocer los incentivos más viables que podrían proporcionar las PyMEs, ya que se trata en su mayoría de empresas familiares con pocos recursos, y la utilidad que obtienen muchas veces representa un obstáculo para otorgar incentivos. Se utiliza un enfoque cuantitativo mediante la aplicación de un cuestionario y una evaluación del desempeño, lo cual pretende alcanzar el objetivo de establecer la relación existente entre las variables e identificar los factores clave para elevar la competitividad de las organizaciones. Se logró identificar el impacto de la motivación en el desempeño laboral mediante el análisis de los resultados obtenidos.

Importancia de la Motivación en el Desempeño Laboral: Caso de Estudio Empresa de Servicios de Ingeniería

Objetivo	Metodología	Contribución
Determinar la relación entre las variables motivación y desempeño en una empresa de servicios de ingeniería durante el periodo agosto 2023 – agosto 2024. Establecer el instrumento mediante el cual se medirá la correlación de la motivación y el desempeño de los trabajadores de la empresa de servicios de Ingeniería en Puebla durante el periodo agosto 2023 - agosto 2024. ↓ Medir la motivación laboral con la que cuentan los trabajadores de la empresa de servicios de ingeniería ubicada en Puebla durante el periodo agosto 2023 – agosto 2024. ↓ Analizar los resultados de la medición de la motivación y desempeño en la empresa de servicios de ingeniería ubicada en Puebla durante el periodo agosto 2023 - agosto 2024.	La presente investigación corresponde a un diseño no experimental ya que ninguna de las variables fue manipulada durante el estudio. Asimismo, corresponde a un carácter transversal, ya que las mediciones de las variables se realizaron en un solo momento. Para realizar la investigación se considera como objeto de estudio una empresa de servicios de ingeniería ubicada en el municipio de Puebla, la cual cuenta con una plantilla de 29 trabajadores, de los cuales 20 son operarios y 9 administrativos. Para realizar la evaluación motivacional en los trabajadores se utilizó un cuestionario de 18 preguntas que incluye temas abordados en el marco teórico: comunicación, asignación de actividades, desempeño laboral, trabajo en equipo, reconocimiento, confianza, incentivos. El cuestionario es en escala Likert nivel 5, el cual es un método de medición utilizado principalmente con el propósito de cuantificar la opinión de la muestra o población. Las preguntas que conforman el cuestionario abarcan temas como los incentivos buscados hasta la percepción del clima laboral en la empresa y sus actividades, con el objetivo de conocer los factores que dado el contexto de la empresa representaron un mayor impacto en la motivación del personal. Por otro lado, para evaluar el desempeño de los trabajadores, se utilizó una evaluación tabulada del gerente hacia los trabajadores. Diseño No Experimental → Carácter Transversal ↓ Población de la empresa: 29 colaboradores → Instrumento: Cuestionario 18 preguntas escala Likert nivel 5 ↓ Instrumento: Escala de evaluación interna → Aspectos: motivación, comunicación, responsabilidades, desempeño, confianza, trabajo en equipo, incentivos ↓ Procesamiento estadístico de análisis e interpretación de resultados	Con base en los resultados obtenidos mediante el desarrollo de investigaciones y la aplicación de instrumentos, se puede concluir que la motivación del personal juega un papel clave hoy en día para poder establecer y definir métodos que permitan potenciar las capacidades de los trabajadores al tiempo que se incrementa la productividad. Sin duda, la motivación sigue siendo un tema en cuestión debido al perfil de cada colaborador, sin embargo, comprender y atender sus necesidades es clave para la toma de decisiones y así seguir incrementando la competitividad. En este sentido, la motivación no actúa de forma aislada, sino que también incluye elementos como la comunicación efectiva, la confianza, la empatía, el trabajo en equipo y el compromiso, que conforman una mezcla potencial de la actividad y actitud del trabajador en su entorno. El reto actual de las empresas, y en especial de las PYMES, es poder gestionar este elemento para crecer en conjunto, ya que lamentablemente los esfuerzos actuales se han centrado mayormente en la gestión de procesos y recursos monetarios, dejando de lado el capital humano, que es uno de los activos más importantes de las organizaciones. El principal aporte de esta investigación radica en aportar información teórica y metodológica sobre la relevancia de la motivación en la actualidad, como factor clave que permite a las empresas ser más productivas y competitivas generando sinergias en los equipos de trabajo y promoviendo la integración de los factores esenciales de la personalidad y el liderazgo en la gestión diaria. Éxito organizacional Gestión de la cultura organizacional Liderazgo Comunicación Trabajo en equipo Motivación

Motivación, Desempeño laboral, Capital Humano

Introduction

Motivation plays an important role in everyone's life, and in the labour aspect, it also represents a topic of high impact, because the interest that the staff shows for the company, its productivity and its optimal development must be considered. On the other hand, companies have the main objective of obtaining the highest possible productivity, which from a social aspect shows a contradiction with the main interests of the workers, who look for an adequate organisational climate in the company in which they carry out their work.

Companies must have a good work motivation for their workers to develop more efficiently, however, they must identify the incentives that have a better impact on staff to achieve their needs as individuals, and thus be able to progress together the company and its workers.

Angulo (2018), highlights in his research that staff have suggested that top management should give more importance to employees rather than capital. A good alternative would also be to have participative leadership so that staff are more motivated and do not feel insecure or distrustful when participating in meetings. Communication is basic for the development of all companies, and if employees have greater participation, as a consequence they will be more motivated to perform their tasks, as they see their opinions reflected in the area in which they work.

According to Romero (2019), the aspects that most affect workers' performance are working conditions, welfare conditions and remuneration, leadership and professional development. It has been found that people seek to have their personal needs met in order to stimulate their work performance and achieve greater efficiency within the company. Based on the findings of Salazar (2020), it is found that employee behaviour is influenced by a lack of encouragement at work, such as feelings of control and pressure from management, leading to poor motivation enrichment to perform their jobs.

Much of this motivation is influenced by salary rewards, bonuses and improved working conditions in general. In order for employees to perform at their best, they must feel a sense of ownership of the work they do and receive some reward from the company in order to generate interest and excitement for their work. It is of utmost importance that the company-employee relationship takes place in an environment of trust, security and empathy.

On the other hand, Fuentes (2020) concluded in his research that a large part of work engagement is directly related to personnel, as achievement needs are intrinsic to people and can be reflected in all aspects of their lives. Actions such as employee training are insignificant, as they do not meet the personal needs of each employee, neither is promotion to more senior positions, and financial remuneration even seems to have a negative influence on job performance.

It is essential to remember that personal needs will always override work needs, so employees must be motivated not only by financial incentives, but also morally.

Sumba (2022), shows that the lack of interest on the part of employees is largely due to the fact that the organisational climate is often inadequate, a consequence of poor strategic planning on the part of the top management of SMEs, who lack sufficient knowledge as they are largely family businesses. Finally, the main characteristic of SMEs is that most of them are companies that do not have a suitable organisation, and this means that employees are often affected by this, as the lack of planning is a cause of disinterest among workers and this has a negative impact on productivity.

Development

Company

An industrial company, according to Chávez (s.f.), are those of great magnitude with respect to size, personnel and machinery, which are in charge of acquiring raw materials to later transform and commercialise them. As mentioned, industrial companies tend to have a significantly larger number of employees compared to other types of companies, so there are more factors to consider in order to have an optimal organisational climate and thus be able to build a productive and motivated company at the same time.

Similarly, most industrial companies focus on perfecting their processes until they have as few errors or downtimes as possible, which is why workers often find themselves working extra days or tasks that do not correspond to their areas. Taking into account the previous points, it can be seen that industrial companies are those dedicated to the transformation of raw materials for trade, and have quality measures in their processes to obtain the highest possible productivity.

Labour performance

Taking the idea of García (2001), performance is defined as the actions or behaviours analysed in the personnel that are of importance or value for the fulfilment of the organisation's objectives. Similarly, performance can be measured in individual or group terms, as required. On the other hand, it must be complemented by a continuous orientation towards effective performance, which is achieved when workers perform their activities in alignment with the organisation's goals so that both parties can meet their objectives.

Taking up the idea put forward by Pérez (2001), the evaluation of work performance is defined as the process by which the results obtained from the work performed are analysed, as well as the degree of absenteeism, with the aim of discovering how productive the worker is, after which it can be analysed whether future performance can be improved by means of certain measures that the company can opt for, such as incentive systems to improve performance.

Organisational culture

Organisational culture, according to Riaza (2021), is defined as the norms and/or values by which a company is managed, and it is important to have a good internal and external organisational culture, as this ensures adequate development.

Negocios y empresa (s.f.) indicates that there are main elements that influence organisational culture, which are:

- Customs: Equipo editorial Etecé (2020), points out that customs are habits that are obtained through repetition and constancy.
- Routines: Gardey and Pérez (2021) say that routines are acquired by repeating the same task or activity numerous times, subsequently developing them semi-automatically without the need to use reasoning.
- Emotions: According to Equipo Editorial Sanarai (2023), emotions are psychophysiological reactions or alterations that occur in response to external stimuli.
- Attitudes: According to Monsalve (2023), attitudes are the posture presented by a person or persons with respect to external situations, and can be applied in different circumstances.
- Convictions: Real Academia Española (n.d.) shows that beliefs are conformities or assent regarding something.
- Forms of interaction: Esneca (2022), states that social interaction is the action of emitting a message with the aim of generating stimulus in another person or persons. If no stimulus is produced, it is not an interaction.
- Behaviours: Mimenza (2023), presents that behaviours are the actions that a subject executes, and it is the mode of expression with respect to an environment, situation or context.

Human capital

According to the Royal Spanish Academy (2022), a worker is a person who has a paid job, such distribution includes, but is not limited to, the economic, as it can also be compensated morally or being provided with certain facilities. Specifically, workers in the industrial area have the characteristic of having specific knowledge about the tasks they have to carry out, most of the time it is physical or manual work.

The quality or efficiency of these tasks can be affected by the performance of the workers, and it has been found that this performance is influenced by the motivation of the workers at the time of executing their actions.

On the other hand, Facturama (2023), points out that a worker is an individual hired to perform a certain action or actions in exchange for a salary, and his or her rules and relationship with the employer is governed by the Federal Labour Law (LFT).

Ángel Hermosilla (2003), points out that among the new skills required of the industrial worker are the capacity for rotation, polyvalence, flexibility, responsibility and initiative, giving way to aspects such as teamwork or creativity. In addition, creativity is considered a key factor in the new industry, with the power of ideas being the most relevant for the competitiveness of companies in the contemporary market.

From the context of the human factor in companies, the conditions under which they operate represent one of the most important areas for the implementation of technologies and the generation of Industry 4.0, because key elements such as organisational culture, resistance to change and lack of integration of processes can lead to an organisation not effectively developing the implementation of technological elements that allow them to gradually improve their administrative and operational operations.

Methodology

The present research corresponds to a non-experimental design since none of the variables were manipulated during the study, and it also corresponds to a transversal character, since the measurements of the variables were carried out at a single point in time. In order to carry out the research, the object of the study is an engineering services company located in the municipality of Puebla, which has a staff of 29 workers, of which 20 are operators and 9 are administrative.

The total population of workers (29 members) will be taken to obtain the sample to apply the instrument. To calculate the sample of the population, the following formula was used:

$$n = \frac{N * Z^2 * p * q}{e^2 * (N-1) + Z^2 * p * q} \quad (1)$$

Where n is the sample size, N is the population size, Z is the confidence level dependent parameter, e is the error level, while p and q are the probabilities of the event occurring or not occurring. Substituting the data, we obtain:

$$n = \frac{29 * 1.96^2 * 0.5 * 0.5}{0.05^2 * (29-1) + 1.96^2 * 0.5 * 0.5} = 25.644 \quad (2)$$

Given the result obtained, a sample of 26 workers will be considered.

Techniques and instruments for collecting information or data

In order to carry out the motivational evaluation of the workers, a questionnaire of 18 questions was used, comprising topics addressed in the theoretical framework: communication, assignment of activities, work performance, teamwork, recognition, trust, incentives.

The questionnaire is on the Likert scale level 5, which is a measurement method used mostly for the purpose of quantifying the opinion of the sample or population. The questions that make up the questionnaire cover topics such as desired incentives to the perception of the working environment in the company and its activities, in order to know the factors that, given the context of the company, represented a greater impact on staff motivation.

On the other hand, for the evaluation of the employees' performance, an evaluation of the manager towards the employees was used:

Box 1

Table 1

Performance evaluation

Operational and/or Administrative Area			
Position	Name	Score	Range
1			
2			
3			
4			

Result	
Score	***Range***

Value	Range	Description	Action
5	1-10	Poor performance	Trial period 15-30 days. Re-evaluation
4	11-20	Sufficient performance	Trial period 30-60 days. Training
3	21-30	Performance close to expected	Candidate for training, wait for next evaluation.
2	31-40	Satisfactory performance	Compensation
1	41-50	Exceptional performance	Compensation

Source: Engineering Services Company (2023.

Results and Discussion

According to the results of the performance evaluation in January 2024, it was obtained that the majority of the staff was with a grade 2, however, there are 3 workers who obtained grade 3 in the evaluation applied, so it is considered that the overall performance is in a positive state for the company, however, as mentioned above, it could improve slightly to find a regularisation of all workers and the activities they exercise.

For the month of March there has been an improvement in terms of job performance, as certain workers who did not reach rank 2 finally achieved it in the last evaluation, on the other hand, the overall result obtained a score of 33.5, which is considered as an overall performance of grade 2 (Satisfactory) and which meets the objectives set.

Returning to the idea put forward in the theoretical framework by Calderón (2023), labour conformity is the level of acceptance that workers have in relation to the tasks they carry out, so in the present case it is highlighted that workers are satisfied and satisfied with respect to the activities they currently perform, since the average obtained was 4. 192, being this value considered as high and positive for the company, on the other hand, the variance obtained a value of 0.481, which indicates that the general labour conformity is adequate, this allows workers to express themselves on various aspects of the company and this helps positively to the growth of the same, as well as facilitates them to adequately perform the tasks that are given to them.

The enthusiasm with which the workers carry out their work is also an aspect to consider in relation to the appropriate performance in the development of the companies, taking up this idea, question 2 obtains as results a value for the mean of 4.192, since the majority of the answers obtained were with a value of 4 and 5, with 50% and 34.6% of the total answers, respectively. As a result, it can be deduced that the work motivation of the workers with regard to their activities is adequate, as no disagreement was expressed in this respect.

Monotony in the activities can bring negative results in the company, because according to the theoretical framework, it can lead to work fatigue and risks for the physical and mental health of the staff, which has a negative impact on their performance. Therefore, question 3 asks about the conformity with the variety of tasks performed by the workers, and from the answers obtained it can be concluded that there is diversity in them, since the mean value was 4.154 and the variance was only 0.455, which is a low value that reflects positivity on the part of the workers, since most of the answers are between the values of 4 and 5.

For question 4, which asks about the conformity with having accepted the current work being carried out, the values obtained were 4.307 for the mean and 0.301 for the variance, which reflects a great majority of the workers' conformity with the work they accepted. It is worth noting that only one response had a value of 3 and the rest were between the values of 4 and 5, which shows that the staff has received the work as they expected when they accepted the job, so it is not considered that there is nonconformity in the company as a whole regarding this topic.

According to the ORT Uruguay University (n.d.), internal communication is one of the pillars for good organisational performance, so it is important to ensure and promote it among and with workers. Taking into account the above, from the responses obtained it can be concluded that the internal communication that currently exists can be considered adequate, as the average of the responses obtained was 4, while the variance has a value of 0.56, which shows that communication is acceptable and adequate, however, there is some area of opportunity, as there is also a considerable percentage that has been shown to be neutral.

As discussed in the theoretical framework, teamwork is of great importance for workers to be in an appropriate state and for the company to perform efficiently, therefore, Cardona and Wilkinson (2006), consider that teamwork requires coordination by workers to meet the proposed objective.

Taking into account the previous idea, question 6 shows that 50% of the workers completely agree with collaborating with their colleagues, while 42.3% agree, in addition, the mean of responses obtained a value of 4.423, while the variance was 0.413, these being considered healthy values for the development of the company.

Considering the idea addressed in the theoretical framework by Forward (2023), moral incentives are those that are not monetary, but through the valuation in the job that is performed, so it is an aspect that should be considered so that workers can develop in a better way and be in an appropriate work environment.

Based on the above, it can be concluded that there is an acceptable work motivation in the company, since the mean of the answers in question 7 had a value of 4 with 53.8%, while the rest of the answers are proportionally distributed between the values of 5 and 3, so the resulting variance has a value of 0.48%, which is considered low.

According to Maslow's pyramid, the need for recognition in public is important for the development of an individual, so question 8 asks about the conformity with receiving recognition in front of co-workers, and the results obtained were 3.885 for the mean and 0.746 for the variance, which shows that there is a disparity in the answers, since the values are distributed in a similar way, and this may be due to the fact that some individuals prefer public treatment more than others.

It is important that workers' opinions are taken into account, as this encourages their collaboration as well as their commitment to their work. Taking the above idea, question 9 asks the worker's perception of how their opinion is taken into account in the company, and the results obtained were 3.807 for the mean and 0.721 for the variance, so it can be concluded that there is a diversity of opinion among the workers, and this may be directly due to their performance.

For question 10, the comfort of workers when expressing their disagreements with senior management is questioned, and the values obtained for the mean and variance were 3.653 and 0.875, respectively, so it is considered a possible area of opportunity in the company, since 42.3% expressed neutrality and this may demonstrate a lack of worker-employee trust in the topic of complaints or suggestions.

According to Díaz (2015), labour trust allows the mission and vision of the company to be developed efficiently and collaboratively, so it is important that it is carried out in a comprehensive manner, therefore, question 11 considers the labour trust that exists in the company, and the results obtained show that, In contrast to the results of question 10, there is good direct trust between the individual and his or her superiors, which may be due to the fact that when it comes to complaints, they are not listened to or taken into account by senior management, but the interpersonal worker-boss relationship is better.

Returning to Maslow's pyramid, question 12 asks about conformity with the type of recognition given to workers, obtaining 38.5% of responses as neutral, a mean of 3.308 and a variance of 1.261, the latter being the highest value obtained for variance of all the questions. Taking into account the above, the results of question 12 reflect that there are different opinions regarding the perceived recognition, and this may be due to the performance of each worker or, on the other hand, a lack of confidence in expressing their opinion to the company's senior management, since according to the results obtained from question 11, 26.9% do not feel confident in talking to their superiors.

Taking the results obtained from question 13, it can be deduced that the feedback provided by superiors to their workers is regular, as 46.2% of workers agree with the feedback that already exists in the company, but on the other hand, the mean of the responses obtained was 3.923 and the variance was 0.553, this is because a significant percentage of the company has shown indifference in this regard and this shows a possible need on the part of superiors to provide feedback on the activities carried out by workers so that they can further improve their performance.

According to Giraudier (2004), the work climate is a key point in the development of companies and their potential growth, and is the product of good organisational practices that involve the agreement of the workers, and in this case, they have shown to be mostly satisfied with the climate that exists in the company, since 57.7% have declared to be in agreement. The mean obtained was 3.923, while the variance had a value of 0.553, which is considered good as there was no considerable diversity in the responses.

Considering what was addressed in the formulation of the problem, it is relevant to develop a sense of belonging in the staff so that they can feel an integral part of the work team and thus increase their commitment to the company and its objectives.

Taking into account the previous idea, question 15 asks whether the worker considers himself to be an integral part of the company, and the answers obtained conclude that the sense of belonging is positive in the company, as the mean number of answers was 4.077%, and the value for the variance was 0.474, these data show that the workers do not show any disagreement with regard to feeling excluded in the need to carry out team work, which can have a positive impact on the organisational climate and other factors.

Taking the results obtained from question 16, it is concluded that the economic incentives granted by the company are an aspect that could be improved, since the mean obtained had a value of 3.5, which is considered regular, and the variance was 1.14, a considerably high value, this is due to the fact that there is a lot of diversity in the answers, this may be a consequence of the fact that the incentives granted are based on the performance of the worker, so that each individual's perception may vary. Likewise, it should be considered that, as mentioned in the theoretical framework, the viability of this type of incentive depends entirely on the economic disposition of the company, and in this case, it is not considered viable to implement more incentives of this nature.

Taking up the idea of SAP Concur Team (2023), career development incentives foster growth opportunities for employees, as better personal results enable them to perform better in their skills. Taking into account the above, it can be deduced that self-fulfilment needs are in a regular state for the company, as the average response obtained was 3.846 which is considered average, and the variance obtained was 0.695, as the majority of staff agree (42.3%) and neither agree nor disagree (30.8%). Data should be presented as concisely as possible, in the form of figures or tables, although very large tables should be avoided. In addition, the wording should be a logical sequence of what was obtained through the application of a methodology or statistical test.

Conclusions

With what was obtained through the development of the research and the application of the instruments, it can be concluded that staff motivation plays a key role today in establishing and defining methods to enhance the capabilities of workers while increasing productivity.

Undoubtedly, motivation is still a subject in question due to the profile of each employee, however, understanding and attending to their needs is key to decision making and thus continuing to increase competitiveness. In this sense, motivation does not act in isolation, but also comprises elements such as effective communication, trust, empathy, teamwork and commitment, which form a potential mix of activity and attitude of the employee in his or her environment.

The current challenge for companies, especially SMEs, is to be able to manage this element in order to grow as a whole, as unfortunately current efforts have focused mainly on the management of processes and monetary resources, leaving aside the human capital, which is one of the most important assets of organisations.

The main contribution of this research lies in contributing in a theoretical and methodological way to the relevance of motivation nowadays, as a key factor that allows companies to be more productive and competitive, generating synergy in work teams and promoting the integration of the indispensable factors of personality and leadership in daily management.

Declarations

Conflict of Interest

The authors declare that they have no conflicts of interest. They have no competing financial interests or known personal relationships that could have influenced the conduct of the research presented in this paper.

Authors' contributions

López-Nieto, Sergio Raúl: Is the sole author of the research and contributed to the project idea, research method and technique, development of diagrams, analysis of the information and writing of the article.

Availability of data and materials

Since this is a case study, the databases are the property of the company in question and served as the basis for the development of the project. This information is only available to the company's collaborators and to those developing improvement projects.

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Abbreviations

ORT Obshchestvo Remeslennogo zemledelcheskogo Truda
SME Small and Medium Enterprise
SAP Systems Applications and Products

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Background

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Optimization of moving averages applied to the stock market

Optimización de promedios móviles aplicados al mercado de valores

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Key Handbooks

It contrasts the crossing of moving averages against optimized moving averages in order to identify trend changes, to improve decision making in short and long positions of a financial asset in the stock market. There are many strategies for buying and selling financial assets, however, there is no one that is totally efficient, therefore the proposal of new strategies as support tools that together with others can offer better indicators for decision making, in this sense one of the most used tools for its simplicity and easy calculation are the moving averages, for this reason we propose the use of the crossing of moving averages in its weighted and exponential mode that when mixed with the same average but optimized, offer in some cases better results. The use of moving averages through the crossover strategy to determine short or long positions in financial assets of the stock market, are improved by combining the weighted moving averages and their optimization, likewise the returns obtained in high volatility time series are also improved by using the exponential moving averages and their optimization.

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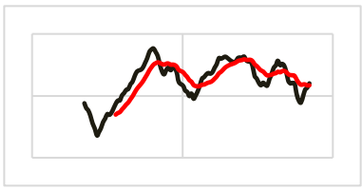
Abstract

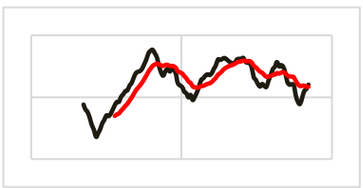
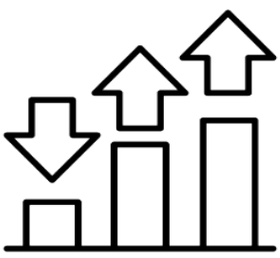
In the investment process, three stages are generally recognized: asset selection, construction of the investment portfolio and its management. There are innumerable techniques that aim to offer tools for decision making in each of the stages of the investment process. However, the portfolio management phase is where enthusiastic investors continue to look for new tools to have short or long positions (sell or buy), one of the simplest tools used is the crossing of moving averages, among others. , which use these same time series, so the proposed proposal is the combination of weighted and exponential moving averages, along with their optimized counterpart, with the intention of comparing how the use of optimized moving averages improves the results in returns to the Strictly apply the moving average crossover strategy.

Optimization of moving averages applied to the stock market		
Objective	Methodology	Contribution
Describe the use of optimized moving averages in the strategy known as “moving average crossover”, in order to establish buy or sell positions in financial assets in the stock market. 	The moving average crossing strategy is applied to a series of data with a high dispersion, to show that in these cases the common moving average crossing does not offer a positive return and these results are compared using the same strategy that allows obtaining returns. positives when using optimized moving averages. 	Improve results by applying moving average crossover, using a mix of common and optimized moving averages. 

Moving average, Crossing of moving averages and squared sum of errors

Resumen

En el proceso de inversión generalmente se reconocen tres etapas, la selección de activos, construcción del portafolio de inversión y la administración de este, existen innumerables técnicas que pretenden ofrecer herramientas para la toma de decisiones en cada una de las etapas del proceso de inversión, sin embargo, la fase de la administración del portafolio es donde los inversionistas entusiastas siguen buscando nuevas herramientas para tener posiciones en corto o largo (venta o compra), una de las herramientas más sencillas que se utilizan es el cruce de promedios móviles, entre otras, que utilizan estas mismas series de tiempo, por lo que la propuesta planteada es la combinación de los promedios móviles ponderados y exponenciales, junto con sus contraparte optimizada, con la intención de comparar como el uso de promedios móviles optimizados mejoran los resultados en rendimientos al aplicar estrictamente la estrategia del cruce de promedios móviles.

Optimización de promedios móviles aplicados al mercado de valores		
Objetivo	Metodología	Contribución
Describir el uso de promedios móviles optimizados en la estrategia conocida como “cruce de promedios móviles”, con el fin de establecer posturas de compra o venta en activos financieros del mercado de valores. 	Se aplica la estrategia de cruce de promedios móviles a una serie de datos con una alta dispersión, para mostrar que en estos casos el cruce de promedios móviles comunes, no ofrecen un rendimiento positivo y se compara estos resultados utilizando la misma estrategia que permite obtener rendimientos positivos al utilizar promedios móviles optimizados. 	Mejorar los resultados al aplicar el cruce de promedios móviles, al utilizar una mezcla de promedios móviles comunes y optimizados. 

Promedios móviles, Cruce de promedios móviles y suma cuadrada de los errores

Introduction

The use of moving averages is a widely used tool for forecasting (Frees, 2010), however, due to the easy application of these in various areas of knowledge have been built strategies that work properly for data that have low volatility, in the context of investments, mainly in the purchase and sale of financial assets there are many applicable techniques that together with other tools allow decision making (Mata A. D.), one of the methodologies used in technical analysis is the crossing of moving averages in different variations. In the application of moving averages there are different parameters that can be adjusted or optimised such as: periods, weights (weighted moving average), alpha (exponential moving average), among others that depend on the proposed formulation.

In this case we intend to show the application of the crossing of moving averages for the decision to buy or sell financial assets once a portfolio has been established based on the fluctuation of asset prices, for this purpose we mix weighted and exponential moving averages, as well as these optimised moving averages, which in some cases offer better results than the common use of the aforementioned averages, in situations of volatility.

Development

Moving averages

The moving averages (MA) are a simple tool to calculate, in addition that is used in different strategies of buying and selling as the crossing of moving averages. In this case we will refer to three types of moving averages, moving averages, weighted moving averages and exponential moving averages.

The moving average is calculated from a time series of which n values are known to have already happened or their value is known, then, the estimate for the next time period is simply calculated through its average (MA), i.e,

$$PM_{n+1} = \frac{\sum_{i=1}^{n} V_i}{n} \quad (1)$$

An example is shown in Table 1

Box 1

Table 1

Example of moving average

Date	BIMBO
01-ene	$ 34.55
08-ene	$ 35.07
15-ene	$ 35.31
22-ene	$ 33.38
29-ene	$ 33.79
05-feb	$ 34.42

Source: Own elaboration, 2024

In this case we take the prices of BIMBO shares from five previous periods and with these prices or values of the time series we can approximate the price of February fifth which is not yet known, the moving average approximation suggests that the value could be $34.42.
Characteristics of moving averages (Anderson, 2016).

1. It is an easy way to approximate the next value in the time series.
2. There are different methodologies that involve the use of moving averages to buy or sell financial assets.
3. Due to its simplicity, it is easy to implement in spreadsheets and/or program in any language.
4. When a large period is taken, generally the moving average graph is smoothed.
5. When a small period is taken, the moving average chart is more sparse and tries to track more closely the changes that occur in the actual values of the time series.

Moving average crossover

The series of moving averages of periods and another of , under the same time series is performed where (Mata, 2012).

If the small average () crosses over the large (), then, it is recommended to buy if you do not have this asset in your portfolio or hold if you already have it.

In the case that the small period moving averages cross below the large one, it is recommended to sell the asset.

Moving averages can also be used as leading indicators of the economic cycles that a market undergoes, these changes are explained in (Sosa, 2011) and their relationship with the technical analysis of the stock market.

Box 2

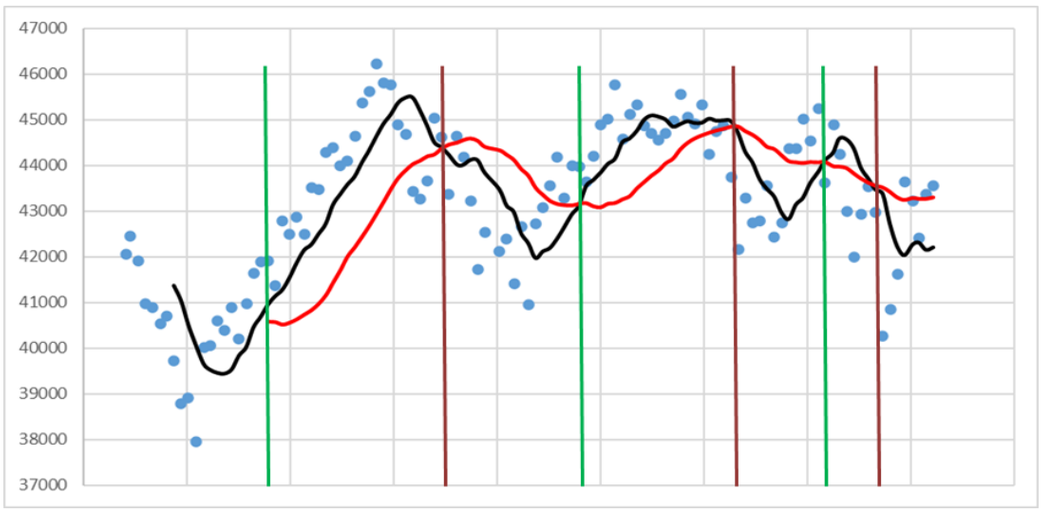


Figure 1

Moving average crossover

Source: Own elaboration, 2024

Figure 1 shows 112 historical prices of the Mexican Stock Exchange (BMV) Price and Quotations Index (IPCMXX) shown as blue dots, also attached is the moving average of p=7 time periods (black line) and q=20 respectively (red line).

According to the strategy described above where the green vertical line is to buy and the brown line is to sell, the results of the operations carried out during the whole period of time are reflected in Table 2, where strictly applying the strategy of crossing moving averages leads to a negative return.

Box 3

Table 2

Calculation of returns when using the crossover of moving averages

Period	Performance
1	3.47%
2	-3.38%
3	-1.47%
TOTAL	-1.38%

Source: Own elaboration, 2024

To avoid negative returns, it is necessary to apply other techniques and models that allow better decisions to be made in order to increase the yield of the available resource.

Weighted moving average

If there is a time series {V_1,V_2,...,V_n } of which n values are known that already happened or their value is known, then, the estimation for the next time period is calculated through the weighted moving average (WMA), where weights {w_1,w_2,...,w_n } must be defined, which represent how important a particular value is for the calculation of the average, thus, the weighted moving average is defined as$PMP_{n+1} = \sum_{i=1}^{n} \quad w_i V_i$. According to the characteristics of the PMP average, it must be fulfilled that $w_1 + w_2 + \cdots + w_n = 1$ and to be applied to company values, it should be considered that the prices closest to the value to be approximated are the following PMP_{n+1}, should have higher weights, this is achieved by defining the calculation of the weights in the following way

$$w_i = \frac{i}{(1+2+\cdots+n)} \tag{2}$$

and it is also guaranteed that the sum of the w's is one. (Mata, 2012).

Estimating the correct parameters for a time series when applying moving averages can be such a non-trivial case that even the application of heuristic methodologies is necessary as shown by (Myladis R Cogollo, 2013) and (Eddy Mesa, 2012).

Box 4

Table 3

Example of weighted moving average

Date	BIMBO	w's
01-ene	$ 34.55	0.06666667
08-ene	$ 35.07	0.13333333
15-ene	$ 35.31	0.2
22-ene	$ 33.38	0.26666667
29-ene	$ 33.79	0.33333333
05-feb	$ 34.21	

Source: Own elaboration, 2024

An example is shown in Table 3, it can be noticed that the values of the weights are increasing as they are closer to the value of the period being approximated (05-Feb), in this example the value approximated by PMP is $34.21, which is different from the one obtained by PM which is $34.42 presenting a small difference.

Crossover of weighted moving averages (WMA).

The previously discussed strategy of crossing moving averages does not change when using PMP, it is bought when the lower period PMP crosses above the higher period PMP.

Figure 2 shows the PMP line in black when p=5 and the red line when q=20, the original series is shown in blue dots, while the green vertical lines mark the time to buy and the brown vertical lines mark the time to sell.

Box 5

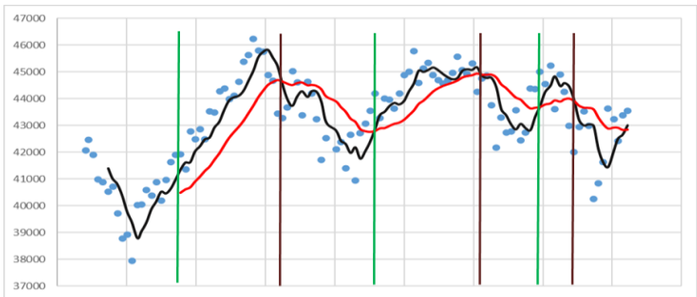


Figure 2

Weighted moving average crossover

Source: Own elaboration, 2024

This example also shows three marked periods from which the following table of returns can be obtained:

Box 6

Table 4

Weighted moving average crossover returns

Period	Performance
1	3.23%
2	1.27%
3	-4.61%
TOTAL	-0.10%

Source: Own elaboration, 2024

Unfortunately, if the strategy is applied as is, the return is again negative, although in this case the return obtained by PM was reduced from -1.38% to -0.10% using PMP.

Exponential moving average

If a time series is available $\{V_1, V_2, \dots, V_n\}$ for which n values are known to have already occurred or their value is known, then the estimate for the next time period is calculated through the exponential moving average (EMA), where PME_{n+1} es some value between the parametric line joining the approximate value in the preceding period and the approximate value in the preceding period and the approximate value in the preceding period PME_n and the real value V_n also from the previous period

$$PME_{n+1} = \alpha V_n + (1 - \alpha) PME_n \quad (3)$$

where α is the parameter of the line, so it must be between zero and one (0<α<1), in the case of company values (Mata A. D., 2012) recommends that $\alpha = \frac{2}{n}$.

By induction it can be shown that the WEPs, although they only consider the actual and approximate values of the previous period, actually provide a weighted sum of all the previous time periods which is easier to calculate. $PME_1 = V_1$ and in the following the formal definition of WEP is used. Other exponential moving average approaches applied to yields have also been proposed by some authors (Eduardo Piza Volio, 2006). Table 5 shows an example of the WEP

Box 7

Table 5

Example of exponential moving average

	Alfa	**0.4**
Date	**BIMBO**	**PME**
01-ene	$ 34.55	$ 34.55
08-ene	$ 35.07	$ 34.55
15-ene	$ 35.31	$ 34.76
22-ene	$ 33.38	$ 34.98
29-ene	$ 33.79	$ 34.34
05-feb		$ 34.12

Source: Own elaboration, 2024

it is observed that unlike the moving and weighted average they only offer an approximation after the periods occurred, which for the previous examples, however, PME offers different approximations to the first value from the third period. In the case of PME the approximation offered as of February 05 is $34.12.

Exponential moving average crossover (EMA).

The strategy is the same, it is bought when the lower period PMP crosses above the higher period PMP. Figure 3 shows the EMA line in black when and the red line when , the original series is shown in blue dots, while the green vertical lines mark the time to buy and the brown ones the time to sell

Box 8

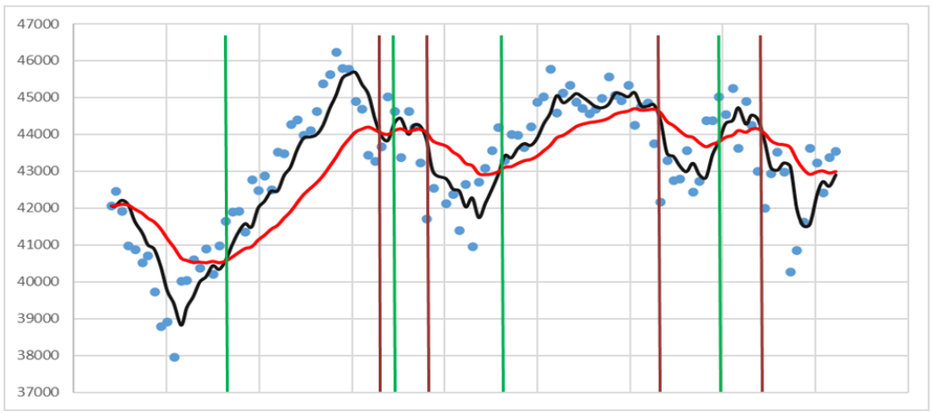


Figure 3

Exponential moving average crossover

Source: Own elaboration, 2024

Unfortunately when applying the strategy to the WEPs for this particular case the performance is significantly reduced, as shown in the table below.

Box 9

Table 6

Exponential Moving Average Crossover Returns

Period	Performance
1	4.86%
2	-6.50%
3	-2.58%
4	-6.69%
TOTAL	-10.91%

Source: Own elaboration, 2024

In this example the exponential moving averages represent the worst approximation with respect to the selected periods and the CPIXX values. However, this does not mean that the technique does not work because it is due to the data and the application of the rule without considering the fact that it is difficult to make a decision to sell even if you know that you will make a loss, so the use of other tools can improve the results when making a decision.

Optimisation of moving averages.

As an alternative tool, the application of the optimisation of moving averages is shown. For this purpose, it should be noted that moving averages can only be optimised by considering the parameters involved in their calculation as a variable, which is why only weighted and exponential moving averages are susceptible to optimisation. In this case, the point error is defined as the difference between the real value and the approximate value.

$$E_i = V_i - PM_i \tag{4}$$

As an example consider that for February 05 the price of Bimbo is $33.36, then, the error of the weighted moving average is

$$E = \$33.36 - \$34.21 = -\$0.84$$

i.e. when using PMP, there was an error of -$0.84.

In the case of the exponential moving average, the error in the estimation would be

$$E = \$33.36 - \$34.12 = -\$0.76$$

The result indicates that PME for this approach is better than PMP. It is important to consider that the errors of each point that has passed in the time series have different values, therefore, when considering the sum of all the errors of the past values, this does not represent the error of the whole period, to avoid this, each point error must be squared and the error of the whole period is considered as the square sum of these errors, generally this sum is known as the Sum Squared Error (SCE).

$$SCE = \sum_{j=1}^{m} \quad E_j^2 \tag{5}$$

Where m represents the number of values $\{V_1, V_2, \dots, V_m\}$ que are being considered as the period of analysis, from which either MIP or WEP can be calculated.

Optimisation of the weighted moving average.

As an example we have the following time series:

Box 10

Table 7

BIMBO share prices

Date	BIMBO
01-ene	$ 34.55
08-ene	$ 35.07
15-ene	$ 35.31
22-ene	$ 33.38
29-ene	$ 33.79
05-feb	$ 33.36
12-feb	$ 31.96
19-feb	$ 30.95
26-feb	$ 30.71
05-mar	$ 27.71
12-mar	$ 31.01
19-mar	$ 31.53
26-mar	$ 33.99
02-abr	$ 32.25

Source: Own elaboration, 2024

If we want to estimate the five-period weighted moving average n=5, considering a nine-period analysis period m=9, the results are shown in Table 8.

Box 11

Table 8

Calculation of the sum squared of the errors for PMP

	Date	BIMBO	PMP	E^2
	01-ene	$ 34.55	1	
	08-ene	$ 35.07	2	
	15-ene	$ 35.31	3	
	22-ene	$ 33.38	4	
j	29-ene	$ 33.79	5	
1	05-feb	$ 33.36	$ 34.21	0.71021295
2	12-feb	$ 31.96	$ 33.86	3.61134533
3	19-feb	$ 30.95	$ 33.11	4.67799452
4	26-feb	$ 30.71	$ 32.24	2.33811032
5	05-mar	$ 27.71	$ 31.58	15.0280606
6	12-mar	$ 31.01	$ 30.10	0.82468593
7	19-mar	$ 31.53	$ 30.12	1.97927269
8	26-mar	$ 33.99	$ 30.48	12.2943113
9	02-abr	$ 32.25	$ 31.68	0.32532467
			SCE	41.7893183

The results in the table show that SCE=41.78, which is the error made when approximating the time series by PMP for nine periods. In order to optimise the weighted moving averages the following optimisation problem is posed$Min\ SCE$

$$SA \quad \sum \quad w_i = 1\,0 \leq w_i \leq 1 \tag{6}$$

Which minimises the SCE, subject to the constraints of the PMP parameters.

The result of the optimisation is presented in Table 9.

Box 12

Table 9

PMP optimisation results

	Date	BIMBO	PMPO	E^2
	01-ene	$ 34.55	1	
	08-ene	$ 35.07	2	
	15-ene	$ 35.31	3	
	22-ene	$ 33.38	4	
j	29-ene	$ 33.79	5	
1	05-feb	$ 33.36	$ 33.68	0.09802668
2	12-feb	$ 31.96	$ 33.49	2.34316691
3	19-feb	$ 30.95	$ 32.35	1.97108178
4	26-feb	$ 30.71	$ 31.23	0.2712953
5	05-mar	$ 27.71	$ 30.78	9.4443159
6	12-mar	$ 31.01	$ 28.56	6.01155272
7	19-mar	$ 31.53	$ 30.08	2.12032973
8	26-mar	$ 33.99	$ 31.38	6.77051429
9	02-abr	$ 32.25	$ 33.29	1.08311862
			RSS	30.1134019

Source: Own elaboration, 2024

After optimisation there is a decrease in the error of the whole analysis period from SCE=41.78 to SCE=30.11, which, in practical terms according to the error, the optimised weighted moving averages (WMA) offer a better approximation.

When comparing the values of the weights (w) the results are

Box 13

Table 10

w values after optimisation

w	
PMP	PMPO
0.06666667	0
0.13333333	0
0.2	0
0.26666667	0.28278176
0.33333333	0.71721824

Source: Own elaboration, 2024

It can be interpreted that compared to the weightings used for PMP which considers the previous five periods to approximate the next one, after optimisation, it is optimal that it is only necessary to consider 71.72% of importance of the last value and 28.27% of the penultimate one.

Box 14

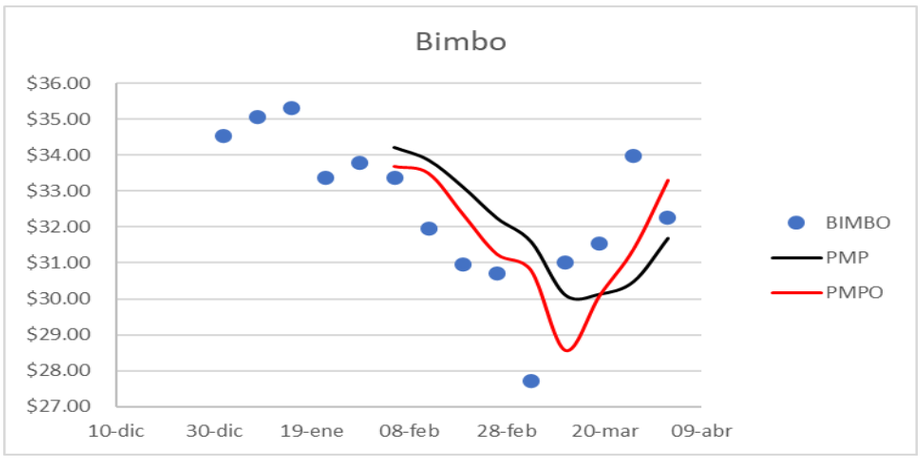


Figure 4

Comparison of PMP and PMPO.

Source: Own elaboration, 2024

Figure 4 shows how the time series of Bimbo's price (blue), is better approximated by the PMPOs as they track BIMBO's changes more closely than the PMP, although both trend the values, the PMPO reflects the drastic changes in the values.

Crossing weighted and optimised moving averages

The crossover of 8-period weighted moving averages (WMA8) and optimised 17-period weighted moving averages (WMA17) is considered as an investment strategy.

PMP8 has a sum squared error of SCE8=224.56 and PMPO17 reduces the SCE to SCE17=112.23, the corresponding plot of these PMPs and the original series is shown in Figure 5.

Box 15

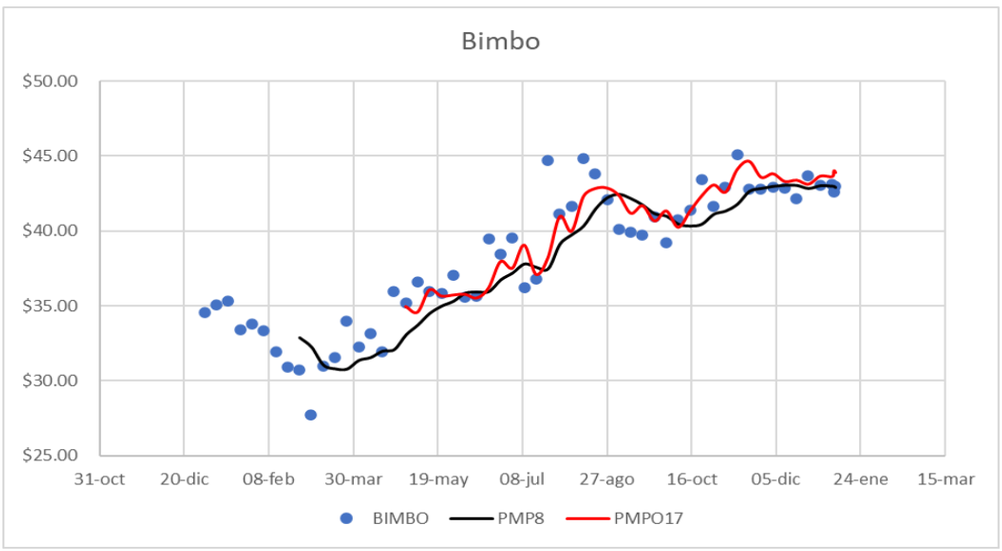


Figure 5

Crossover of weighted and optimised weighted moving averages

Source: Own elaboration, 2024

The results of this study show that the use of optimised weighted averages improves investment decision making.

Optimisation of the exponential moving average.

In the case of the exponential moving average the only parameter to be considered is α, so that the optimisation problem is

$$SA \quad Min\, SCE \;\; 0 \leq \alpha \leq 1 \tag{7}$$

The result of the optimisation is shown in Table 11, under the same basic characteristics of the procedure done for the MTPs, the time series is shown in Table 11, with five periods n=5 and considering a period of analysis of nine periods m=9.

Box 16

Table 11

WEP optimisation results

		Alfa	0.8003933	
	Date	**BIMBO**	**PMEO**	E^2
	01-ene	$ 34.55	$ 34.55	0
	08-ene	$ 35.07	$ 34.55	0.27
	15-ene	$ 35.31	$ 34.97	0.11616655
	22-ene	$ 33.38	$ 35.24	3.43734056
j	29-ene	$ 33.79	$ 33.75	0.00151927
1	05-feb	$ 33.36	$ 33.79	0.17722732
2	12-feb	$ 31.96	$ 33.45	2.23061745
3	19-feb	$ 30.95	$ 32.25	1.69908781
4	26-feb	$ 30.71	$ 31.21	0.24675505
5	05-mar	$ 27.71	$ 30.81	9.64363039
6	12-mar	$ 31.01	$ 28.33	7.19366831
7	19-mar	$ 31.53	$ 30.47	1.11886767
8	26-mar	$ 33.99	$ 31.32	7.10453339
9	02-abr	$ 32.25	$ 33.45	1.44653953
			SCE	30.8609269

Source: Own elaboration, 2024

According to the definition of PME α=0.4, which after optimisation the optimal value is α=0.8004, in this case the sum squared of the errors is reduced from SCE=37.97 to SCE=30.86.

Figure 6 shows the original time series, the exponential moving averages and the optimised exponential moving averages.

Box 17

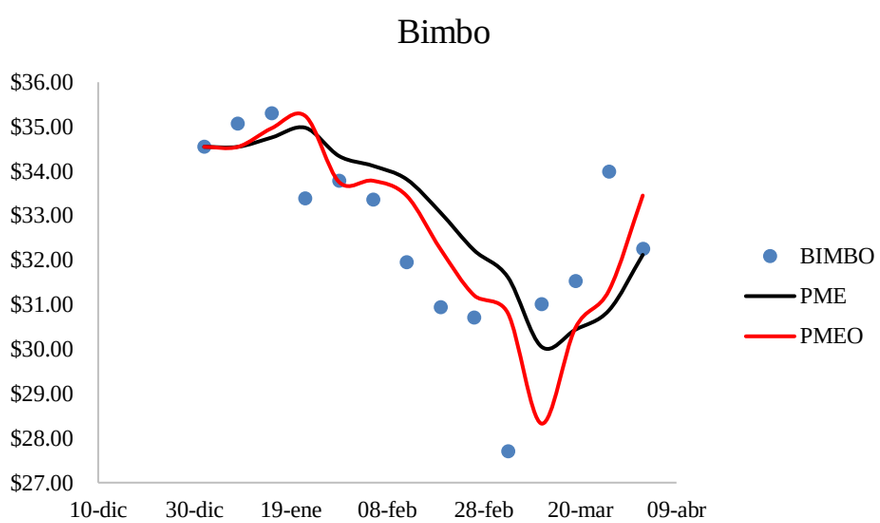


Figure 6

Comparison of PME and PMEO

Source: Own elaboration, 2024

Exponential and optimised moving average crossover

In this case, the exponential moving average crossover strategy is applied, but now the results of the optimised eight-period exponential moving average PMEO8 and the seventeen-period exponential moving average PME17 are used. In particular the 17-period SCE SCE17=394.62 is reduced to SCE8=186.4 after the optimisation of the PMEO8.

Box 18

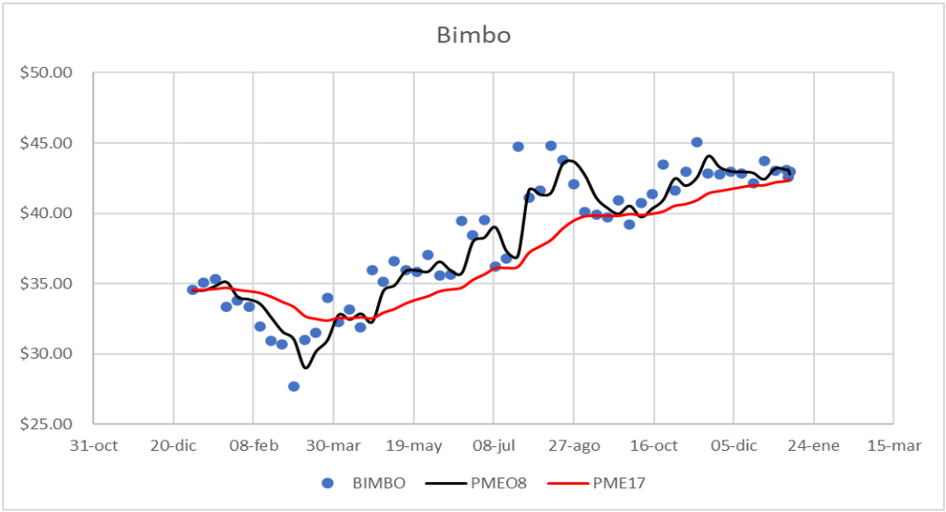


Figure 7

Exponential and optimised exponential moving average crossover

Source: Own elaboration, 2024

From the crossover of moving averages for this case, a return of 27.06% is obtained, improving the results obtained when using only the common moving averages.

Results

The use of moving averages, whether common, weighted or exponential for short and long positions, does not always offer positive returns, especially in stocks that have a high volatility in the time period of study, where it is difficult to establish trends through the smoothing of the time series when using moving averages, for example when using weighted moving averages the return was negative or had losses of 0.10%, while with the exponential moving average the losses increased to 10.91%. However, when combining the weighted moving average with the optimised weighted moving average the performance was positive, with gains of 32.15% and 27.06% with the exponential.

Conclusions

Regarding the moving averages in the three models considered, moving average, weighted moving average and exponential moving average, when applying the technique of crossing moving averages in none of the cases satisfactory results were obtained, since the performance in all cases shown is negative, this does not mean that if applied to another series of data from another company, things are similar, also if other periods different from those of the examples are considered it is possible that they also improve the performance and offer better results for decision making.

The parameters considered for weighted moving averages and exponential moving averages, in common applications are well determined by the values proposed in their definition, however, when considering the model error and applying the optimisation process these parameters are significantly improved offering better approximations to the next estimated value, which can be used to make better decisions regarding the purchase and sale of company shares.

Declarations

Conflict of Interest

The authors declare that they have no conflicts of interest. They are not aware of any financial interest or personal relationships that could affect the interests of third parties with respect to the publication of the book chapter.

Authors' contributions

Muñoz-González, Sergio: Development of the idea and review of the methodology.

Saldaña-Carro, César: Review of the model and conclusions.

Barragán-Orta, José: Editing and data collection.

Torres-Romero, Román: Review of results.

Availability of data and materials

All data shown are public, as stock exchange issuers are required to make public all their financial information.

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Abbreviations

BMV Mexican Stock Exchange
IPCMXX Índice de Precios y Cotizaciones (Price and Quotation Index)
PM Moving Average
PME Exponential Moving Average
PMEO Exponential Moving Average Optimized
PMP Weighted Moving Average
PMPO Weighted Moving Average Optimized Moving Average
SCE Sum Squared of Errors

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Antecedents

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Basics

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Industry 4.0 in SMEs in the commercial sector in the central region of the state of Tlaxcala for greater regional competitiveness

La Industria 4.0 en las PYMES del sector comercial en la región centro del estado de Tlaxcala para una mayor competitividad regional.

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Emphasis on how the incorporation of advanced technologies such as Industry 4.0 tools could increase competitiveness and efficiency. In adopting Industry 4.0, SMEs must take a proactive approach to digitization and improve their ability to integrate disruptive technologies to adapt to today's dynamic markets. SMEs in the commercial sector in the central region of Tlaxcala are at a critical point for their competitive development, especially in the context of adopting technologies associated with Industry 4.0. Despite the fact that there is a clear awareness among entrepreneurs about the importance of these tools to improve productivity and efficiency, several obstacles prevent their full implementation. Among the main barriers identified are the lack of financial resources, the limited technical training of personnel and the lack of local specialists who can adequately guide and advise on the digitization process. These structural challenges coincide with previous studies that indicate that Mexican SMEs, particularly in less industrialized regions, face greater difficulties in integrating emerging technologies. Therefore, the incorporation of Industry 4.0 in Tlaxcala's SMEs has the potential to transform their regional competitiveness, but its success will largely depend on the ability of these companies to overcome the internal and external obstacles that limit their development. Investment in human capital, the modernization of technological equipment and the creation of strategic alliances will be key for SMEs to take full advantage of the benefits of digital transformation. In this sense, competitiveness should not only be measured in terms of technological innovation, but also in the adaptability and resilience of companies in the face of an increasingly dynamic global economic environment. Only through a sustained commitment to innovation and the appropriate institutional support will SMEs in the commercial sector in Tlaxcala be able to consolidate themselves as relevant players in the region's economic development.

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Abstract

Small and medium-sized businesses (SMEs) have become an important analysis factor to boost the country's economy, due to the large concentration of companies that exist and the job offer they generate. The objective of this research work is to analyze the current technological situation of SMEs in the commercial sector in the central region of the state of Tlaxcala, for the incorporation of the principles of Industry 4.0 and thus be able to increase their regional competitiveness. The research is exploratory and descriptive; It was decided to analyze the commercial sector, due to the high concentration in the study region. This is through a survey applied to 187 small and medium-sized companies. The use of Information and Communication Technologies (ICT) is notable, with a large percentage of SMEs using digital platforms to make sales, manage electronic payments and promote their products on social networks. The incorporation of Industry 4.0 in Tlaxcala's SMEs has the potential to transform their regional competitiveness, but its success will largely depend on the ability of these companies to overcome internal and external obstacles that limit their development.

Objective	Methodology	Contribution
The objective of this work is to analyze the current technological situation of SMEs in the central region of the state of Tlaxcala, for the incorporation of the principles of Industry 4.0 and to increase their regional competitiveness. 	• **Method.** Exploratory and descriptive research. • **Technique.** Survey (questionnaire). • **Location.** Central region of the state of Tlaxcala. • **Application of the instrument.** From January 4 to April 26, 2024. • **Analysis unit.** Small and medium-sized businesses. • **Population.** 294 companies. • **Sample.** Probabilistic with a sample of 187 companies. • **Data analysis methods.** Descriptive quantitative analysis. 	• Promotes regional competitiveness. • Technological innovation and modernization in the business sector. • Strengthening local economies. 

SMEs, Local development, Industry 4.0

Resumen

Las pequeñas y medianas empresas (PYMES) se han convertido en un factor importante de análisis para impulsar la economía del país, debido a la gran concentración de empresas que existen y por la ofrta de empleos que generan. El objetivo de éste trabajo de investigación es analizar la situación tecnológica actual de las PYMES del sector comercial en la región centro del estado de Tlaxcala, para la incorporación de los principios de la Industria 4.0 y así poder incrementar su competitividad regional. La investigación es de tipo exploratoria y descriptiva; se optó por analizar al sector comercial, debido a la gran concentración existente en la región de estudio. Esto a través de una encuesta aplicada a 187 pequeñas y medianas empresas. El uso de Tecnologías de la Información y la Comunicación (TIC) es notable, con un gran porcentaje de PYMES utilizando plataformas digitales para realizar ventas, gestionar pagos electrónicos y promover sus productos en redes sociales. La incorporación de la Industria 4.0 en las PYMES de Tlaxcala tiene el potencial de transformar su competitividad regional, pero su éxito dependerá en gran medida de la capacidad de estas empresas para superar los obstáculos internos y externos que limitan su desarrollo.

Objetivo	Metodología	Contribución
El objetivo de éste trabajo es analizar la situación tecnológica actual de las PYMES de la región centro del estado de Tlaxcala, para la incorporación de los principios de la Industria 4.0 y poder incrementar su competitividad regional. 	• **Método.** Investigación exploratoria y descriptiva. • **Técnica.** Encuesta (cuestionario). • **Localización.** Región centro del estado de Tlaxcala. • **Aplicación del instrumento.** Del 04 de enero al 26 de abril de 2024. • **Unidad de análisis.** Pequeñas y medianas empresas. • **Población.** 294 empresas. • **Muestra.** Probabilística con una muestra de 187 empresas. • **Métodos de análisis de los datos.** Análisis cuantitativo descriptivo. 	• Impulsa la competitividad regional. • Innovación tecnológica y modernización en el sector empresarial. • Fortalecimiento a las economías locales. 

PYMES, Desarrollo local, Industria 4.0

Introduction

Micro, small and medium-sized enterprises (MSMEs) are the most dynamic and representative economic segment worldwide, accounting for more than 90% of economic units and responsible for a significant share of global employment (INEGI, 2020). Their role as drivers of economic growth is undeniable, especially in local contexts where their contribution is crucial for social and economic development. In regions such as the central zone of the state of Tlaxcala, these enterprises are mainly concentrated in commercial sectors, generating employment and promoting the regional economy. However, they face significant structural challenges that limit their competitive capacity, including low technological adoption, low innovation capacity and lack of access to strategic resources. These factors underline the urgent need to identify effective solutions, with Industry 4.0 being one of the most promising strategies to strengthen their competitiveness.

Industry 4.0 represents not only a technological evolution, but a paradigm shift in business management, integrating cyber-physical systems, big data, advanced automation and the Internet of Things (IoT). This technological revolution offers significant added value compared to other traditional strategies, as it enables process optimisation, facilitates real-time decision-making and improves operational efficiency. These features can transform the way SMEs operate, opening up new market opportunities and strengthening their responsiveness to today's demands. However, their implementation presents challenges, especially in the context of Tlaxcala, where enterprises face barriers such as lack of financial resources, lack of trained personnel and limited technological infrastructure.

The competitiveness of SMEs depends not only on internal factors, but also on an environment that fosters fair competition and innovation. Competition among firms promotes the supply of better quality products and services, encouraging small and medium-sized enterprises to improve their productivity and develop strategies that respond to market needs (Núñez, 2021). In Tlaxcala, this competitiveness is reflected in municipalities such as Chiautempan, Tlaxcala and Apizaco, where the concentration of SMEs responds to factors such as access to markets, availability of labour and proximity to strategic resources (Saldaña *et al.*, 2012). These firms play a central role in the local economy, acting as development agents that can drive productive modernisation through the adoption of advanced technologies. However, the incorporation of Industry 4.0 tools in the region's SMEs is not without its challenges. García (2010) highlights that the complexity of these technologies, together with their high costs and the need for specialised personnel, represent significant barriers to their implementation. Furthermore, Seseña and López (2017) identify common mistakes in the adoption of these technologies, such as the lack of a clear strategic direction, the inadequate application of technological tools and the absence of continuous monitoring. These factors are exacerbated in Tlaxcala due to the lack of strategic alliances and limited external support for technological innovation.

Most of the small and medium-sized enterprises in the state belong to the central region (see Figure 1), thus contributing to socio-economic development and employment generation. The location of this type of enterprises is characterised by the fact that they are located where there are agglomerations or the necessary resources to generate profitability, i.e. in the centre of a region. Because of this, companies are forced to compete with each other, promoting innovation to become attractive to the population.

Box 1

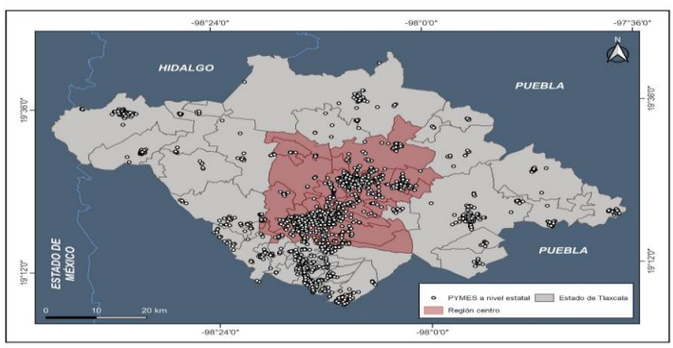

Figure 1

Concentration of small and medium-sized enterprises in the central region of the state of Tlaxcala.

Source: Own elaboration based on INEGI (National Statistical Directory of Economic Units [DENUE])(2023).

Regarding the number of small and medium-sized enterprises that will be analysed in this research work and that exist in the state of Tlaxcala, there is a total of 1,897 economic units, representing 3.42% of the total number of enterprises, the largest percentage being micro-enterprises with 96.3% and the rest being large enterprises (0.28%) (INEGI, 2023). The central region stands out with a total of 794 SMEs, representing 41.85% of the total (see Table 1). Regarding the concentration of SMEs by economic sector in the central region of the state of Tlaxcala, 37% correspond to the commercial sector, 34% to the industrial sector and 29% to the services sector. It should be noted that this regionalisation is taken into account based on the 2018 State Programme for Land Use and Urban Development of the state of Tlaxcala.

Box 2

Table 1

Number of SMEs in the State of Tlaxcala

Region	Small enterprises	Medium-sized companies	Total PYMES
North (Tlaxco)	82	16	98
West (Calpulalpan)	164	16	180
East (Huamantla)	263	41	304
Centre (Tlaxcala)	672	122	794
South (Zacatelco)	456	65	521
State total	1,637	260	1,897

Own elaboration based on INEGI (National Statistical Directory of Economic Units [DENUE]) (2023

.

Thus, the objective is to analyse the current technological situation of SMEs in the commercial sector in the central region of Tlaxcala, identifying the specific barriers that limit the incorporation of the principles of Industry 4.0. Through an exploratory and descriptive approach, we seek to highlight the competitive advantages that these technologies can offer and propose strategies for their effective implementation. The relevance of this analysis lies in the need to strengthen local development through the technological modernisation of SMEs.

Theoretical framework

What is Industry 4.0.

Industry 4.0 is considered as that technological revolution that will modify not only industry, but also various parts of society as well as the economy. It has the ability to provide information to improve production systems in an intelligent way. This is with the help of emerging technologies that enable real-time enterprise information for better business decision making, risk prevention and operational management. The current industrial revolution not only emphasises the improvement of productivity and long-term competitiveness, but is also trying to address issues such as sustainable urbanisation, the use of renewable energies, the care of natural resources and population growth (Castillo, 2024).

The fourth industrial revolution precedes three previous revolutions that were transcendental for the development of Industry at a global level, from the emergence of the steam engine, the automobile, the means of communication, the arrival of computing together with Information and Communication Technologies, to what is now known as cyber physical systems, with a great variety of technologies to automate processes, store information and the interconnection between various devices to perform a specific task (see Table 2).

Box 3

Table 2

The four industrial revolutions.

Name	Period	Features
First industrial revolution	19th century	Steam engines for the mechanisation of production.
Second industrial revolution	Early 20th century	Electric motors, mass production, combustion engines, the rise of the aeroplane and the automobile, as well as the telephone and radio.
Third industrial revolution	70s of the 20th century	Automation and the emergence of information technology.
Fourth industrial revolution	21st century	Cyber-physical systems, information processing, intelligent decision-making.

Source: own elaboration based on Joyanes (2017).

According to Peralta *et al.* (2020), the main technological tools that comprise Industry 4.0 are the following:

The cloud. It stores a large amount of information and stores it, so that it can be used at any time with only Internet access.

Autonomous robots. They are configured to perform certain operations within the production system, so that there is greater efficiency.

Simulation. It is used to evaluate projects, by generating various scenarios and thus can determine the success or failure of the same. It helps to save time and resources used in such a project.

The integration of horizontal and vertical systems. It is sought through collaborative work between the various areas of the company, ranging from production to sales, to increase levels of automation and a better flow of information.

The industrial internet of things. This is considered the essential aspect for the development of all the elements that make up Industry 4.0.

Cyber security. It helps to safeguard the information contained in the cloud by means of security systems, in order to avoid data loss or hacking.

Additive manufacturing or 3D printing. It is used to design objects based on virtual models and, once the model is ready, it is sent to be printed as a three-dimensional object.

Augmented reality. Allows the identification of specific environments with physical and virtual situations, to analyse them and thus improve certain aspects in the fields of medicine, aeronautics, military, industry, among others.

Álvarez (2021) mentions that companies need tools that he called ‘digital enablers’, which are those that allow them to drive the digital transformation process. This is because the physical dimension is combined with the virtual dimension to generate an intelligent industrial revolution (see Figure 2).

Box 4

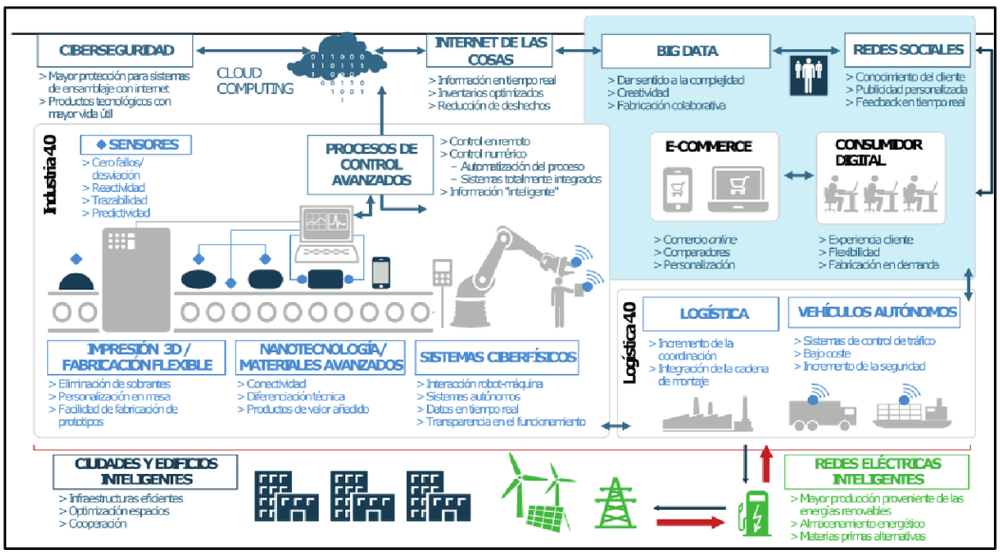

Figure 2
Industry 4.0 Ecosystem

Source: Álvarez (2021)

Small and medium-sized enterprises

In the case of small and medium-sized enterprises, they are considered to be a determining factor in the economic development of a country, as they generate jobs, promote investments and activate production. When referring to a company, one thinks of a system with resources determined for the production and exchange of goods and services, with the aim of satisfying existing demand and obtaining an economic benefit, mainly (Bada *et al.*, 2013). In defining small and medium-sized enterprises, it is necessary to consider certain qualitative and quantitative criteria in order to identify these types of companies within the total number of companies in a given country.

According to Herrera (2011), the quantitative criteria most commonly used to define small and medium-sized enterprises are: total number of workers, net capital, total assets, gross income, export earnings, investment in machinery and equipment, and wages and salaries paid. The criterion of the number of workers was used to identify small and medium-sized enterprises in the commercial sector in the central region of the state of Tlaxcala in order to carry out the survey in this type of enterprises.

The rhombus of national advantage or Porter's diamond

Competitiveness in a nation has become necessary to contribute to the improvement of the quality of life of its population. To explain this, Porter (1991) conducted research he called 'the competitive advantage of nations', in which he mentions that a nation's competitiveness is determined by the ability of firms to innovate. Firms tend to gain advantage because of the challenges they face from competition. In order to generate competitive advantage, nations have to succeed in particular sectors. Regarding the definition of the term competitiveness, the author commented that the concept associated with competitiveness at the national level is that of productivity. Productivity relates to the measurement between the output of a given country, with resources and an estimated time frame for it; this becomes fundamental for a better long-term standard of living of that country.

Therefore, it becomes complex to try to explain competitiveness at the national level. Instead, it is necessary to understand those factors that determine its growth and level of performance. To provide an answer, one must focus not only on the economy as a whole, but also on individual economic sectors and sub-sectors, seeking specialisation and boosting their consolidation.

Porter established four broad attributes within a nation that form the national advantage diamond, which are:

1. **Factor conditions.** This relates to a country's situation in terms of productive factors, such as labour, capital, infrastructure and essential resources in order to be able to compete.
2. **Demand conditions.** This refers to the existing demand for a specific product or service in terms of the economic sector and the market in which it is found.
3. **Related and ancillary sectors.** The presence in a country of suppliers and sectors that have a high level of international competitiveness.
4. **Company strategy, structure and rivalry.** These are the conditions that exist in a country for companies to form, organise, manage and consolidate themselves, in order to be able to compete internally (Porter, 1991).

These elements promote firms to seek the use of novel technologies as a form of competitive advantage to face competition. For this reason, the aim is not to incorporate all the tools of Industry 4.0, but rather those that help a specific sector in relation to its daily activities. SMEs must be in a favourable environment, hence the use of the 4 determinants of national advantage proposed by the author. It is important to consolidate small and medium-sized enterprises, as they are somehow involved in this process of national competitiveness. The role of small and medium-sized enterprises is important for the generation of national competitive advantage, which is why a series of things are determined that they must do to achieve this competitiveness and to have a leader within them to guide them in this.

Only companies that are specific to a country can achieve a competitive advantage. Such is the case of small and medium-sized enterprises, which are mostly created by people originating from the country where they are located. It is important to stress the role of innovation in competitiveness and that this is created by challenges within companies. Leadership is also necessary, as competitive advantage comes from good leadership that uses and optimises the forces of the rhombus to promote improvements in certain aspects. Companies must be in a constant state of change and improvement, adopting the necessary technology to carry out their activities in a more effective way that helps them to position themselves in the market, as they can do with the tools of Industry 4.0. Porter points out that this must become a goal not only for companies, but also for nations, as they must not only survive, but also achieve international competitiveness. But it should not be a one-off, but a constant one (Porter, 1991).

In short, it can be said that a country's competitiveness is created, it does not emerge by itself. The idea is that the interest rate, the exchange rate, labour costs are the main determinants of competitiveness, but this is wrong. To boost national competitiveness, the focus must be on certain sectors, as well as on making companies continuously innovative. By incorporating Industry 4.0 tools within companies, it somehow contributes to increased productivity and competitiveness, a situation that also boosts national competitiveness.

Methodology

An exploratory and descriptive research was carried out by applying a survey to small and medium-sized enterprises in the commercial sector in the central region of the state of Tlaxcala. A probability sample was determined with a population of 294 SMEs in the commercial sector, using a confidence level of 95% and a margin of error of 5%. The minimum acceptable sample was 167 questionnaires to be applied, so a total of 187 questionnaires were completed between 4 January and 26 April this year, and a quantitative descriptive analysis of the data collected was chosen (see Table 3). It was decided to analyse the commercial sector, due to the high concentration of this sector in the central region, with 80%.

Box 5

Table 3

Research method

Method	Exploratory and descriptive research
Technique	Survey (questionnaire)
Location	Central region of the state of Tlaxcala
Application of the instrument	From 04 January 2024 to 26 April 2024
Unit of analysis	Small and medium-sized enterprises in the commercial sector
Population	294 enterprises
Sample	Probabilistic with a sample of 187 enterprises
Methods of data analysis	Descriptive quantitative analysis

Results

Figure 3 shows the distribution of the questionnaires applied in the central region of the state of Tlaxcala, where most of the questionnaires were applied in Apizaco (52 questionnaires), Tlaxcala (43 questionnaires) and Chiautempan (33 questionnaires), due to the fact that most small and medium-sized enterprises are located there

Box 6

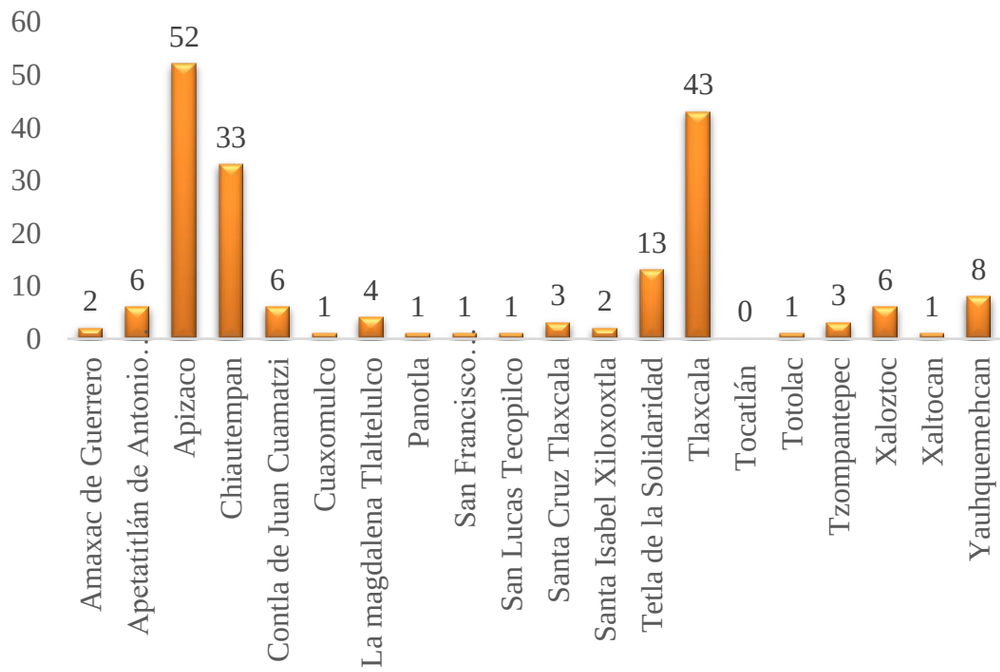

Figure 3

Number of questionnaires applied per municipality in the central region of the state of Tlaxcala.

Source: own elaboration (2024).

The average age of the respondents was 40 years old. In relation to gender, 57% of the entrepreneurs who responded were men and the rest were women (43%). Regarding the level of education of the entrepreneurs who answered the survey, it was identified that 44% have completed university, 33% have completed high school, 15% have completed secondary school and 4% have a master's degree.

On the other hand, the average year in which the small and medium-sized enterprises started operations was 2014, with an average age of 10 years. It could be said that these companies are already consolidated to a certain extent, to some extent facing the Covid-19 pandemic that was experienced a few years ago. Regarding the constitution of the companies, 75% of the SMEs are registered with the tax authorities (individual, legal entity, etc.) and the rest are not registered with the tax authorities (25%).

Figure 4 shows that the main innovation factors that enterprises are always doing are: 48% are looking for new ways to reach customers; 43% offer new products or services depending on customer suggestions and 35% added materials, labour or tools to reduce the costs of the enterprise. On the other hand, those aspects that have mostly not been applied in the enterprises are: 49% have not received support from any external institution to increase the level of technological innovation and 43% have not formed strategic alliances with other enterprises in the same sector to undertake technological innovation projects.

Box 7

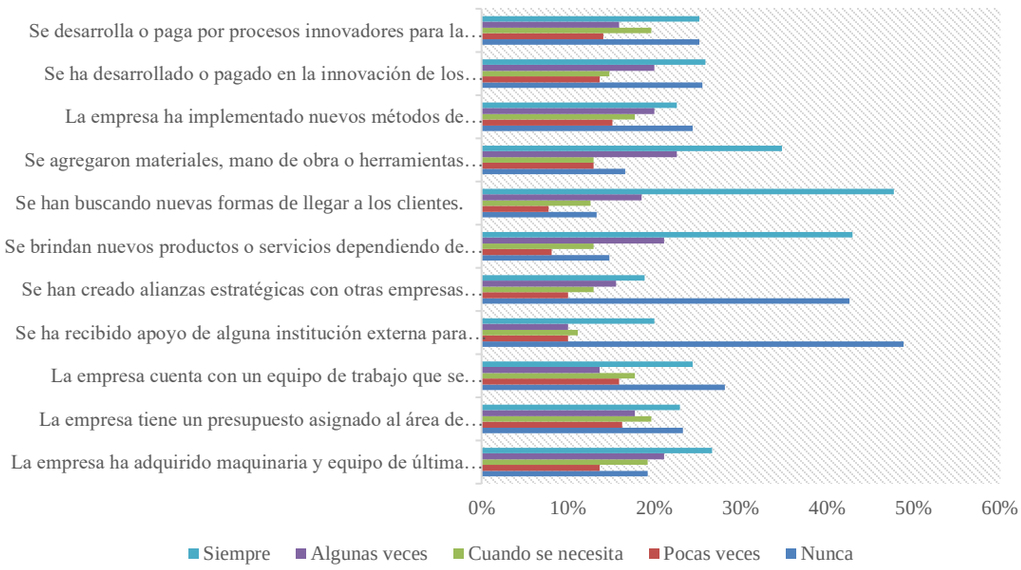

Figure 4

Factors of innovation in SMEs in the commercial sector.

Source: own elaboration (2024).

Regarding the use of Information and Communication Technologies (ICT) in small and medium-sized enterprises in the commercial sector, Figure 5 shows that the vast majority know what they are and use them in the enterprises. These include the use of e-commerce (50%); electronic devices to make card payments (54%); online payments for some sales (50%); websites or social networks (63%); specialised software for the business line (54%); they have a computer, tablet or other electronic device to manage the business (76%) and Internet connection in the business (86%).

Box 8

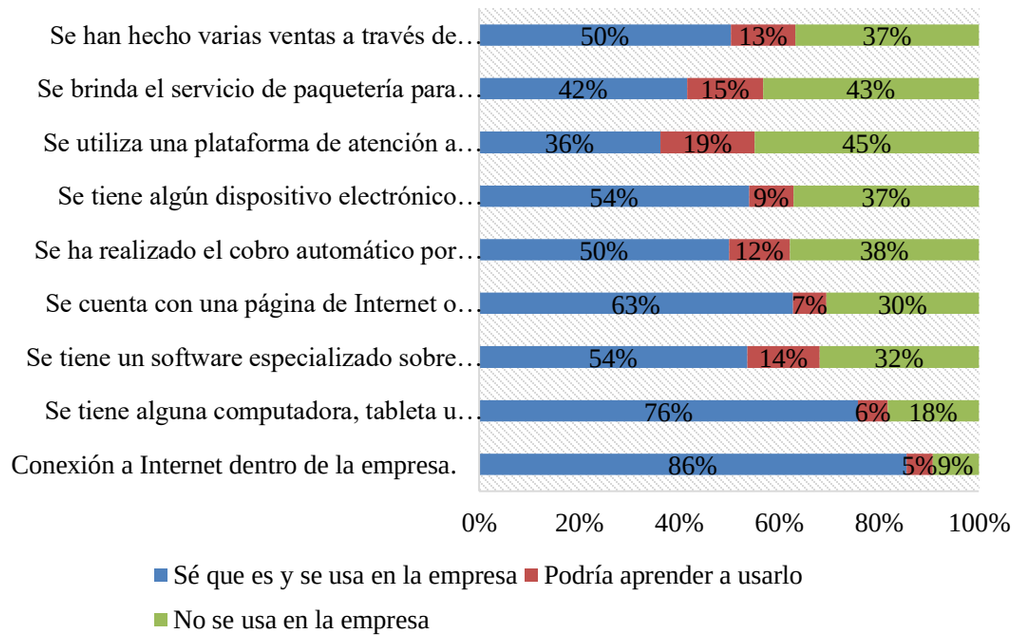

Figure 5

Information and Communication Technologies used by SMEs in the commercial sector.

Figure 6 shows the challenges that SMEs in the commercial sector would face when adopting this industry, which are: 26% say capital investment in training and technological equipment; 23% training of existing staff; 15% acquiring new customers to generate revenue to enable the implementation of these technologies; 11% acquiring new knowledge; 10% no challenge; 8% resistance to change and the rest (8%) using the best IT tools to improve the productivity of the work group.

Box 9

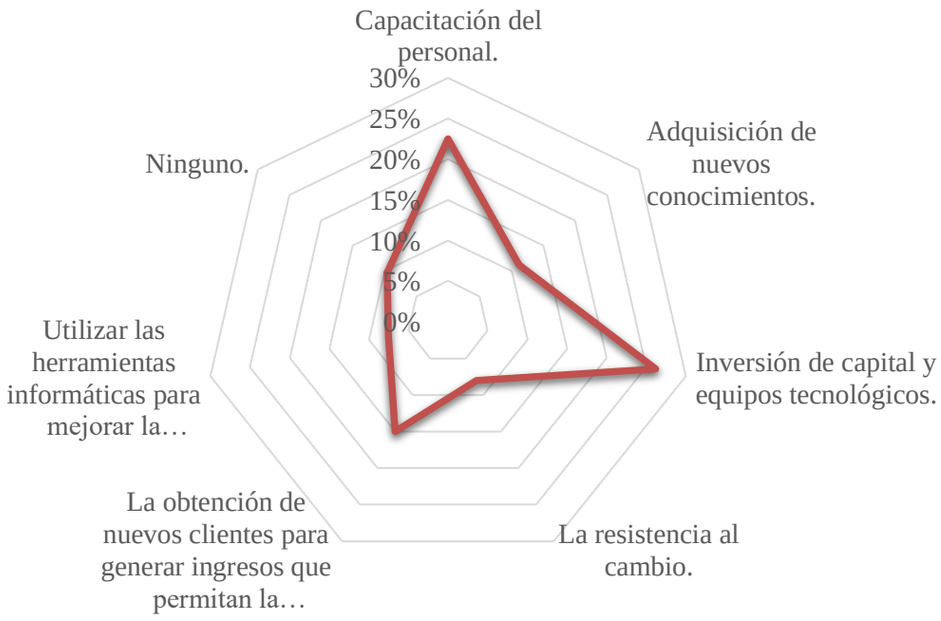

Figure 6

What challenge would SMEs in the commercial sector face in adopting this Industry?
Source: own elaboration (2024).

Of the 187 companies surveyed, 81% said they would implement some Industry 4.0 tools and 19% said they would not. The main reasons for and against the implementation of Industry 4.0 are as follows (see Table 4):

Box 10

Table 4

Reasons to implement Industry 4.0

Reasons in favour	Reasons against
● Because you can have greater accessibility to the company's information. ● To have a more complete team and provide a better service to customers. ● To provide better strategic solutions to customers and thus increase competitiveness. ● It is important for the company to have access to new technological scopes to facilitate the management of the company, because in the long run it can be beneficial for the owners of the companies to trust their workers without having to be close to them, teaching them how to do things or correcting them.	● Because there are no specialists in the state of Tlaxcala. ● Because there are not enough resources for its implementation. ● Because there is not enough knowledge. ● Because of the high cost of the technology.

Discussion

The implementation of Industry 4.0 principles in small and medium-sized enterprises in the commercial sector in the central region of Tlaxcala faces significant challenges. Despite the fact that the vast majority of entrepreneurs recognise the importance of technology to improve competitiveness, the results show that 19% do not consider it feasible to incorporate these tools due to a lack of financial resources, specialised knowledge and the absence of specialists in the region.

This scenario reflects common obstacles that companies face when implementing advanced technologies, such as poor strategic direction, lack of monitoring of the tools used and the absence of operational projections. In the case of SMEs in Tlaxcala, these problems are compounded by the lack of strategic alliances and limited external support for technological innovation, which is evident in the 49% of respondents who have not received any support. In addition, lack of capital and resistance to change on the part of entrepreneurs are critical barriers that need to be overcome. Investment in training and equipment acquisition is a central challenge preventing SMEs from efficiently adopting Industry 4.0 tools.

Despite these challenges, there are positive points. A significant 81% of companies expressed interest in implementing at least some Industry 4.0 technology tools. Reasons in favour include the possibility of improving accessibility to information and strategic decision-making, as the competitiveness of companies is directly related to their ability to innovate and adapt to new challenges. In terms of technology use, ICT is one of the areas with the highest adoption, especially in the use of electronic devices to make payments and in the implementation of social networks to interact with customers. However, the lack of deeper integration of simulation or cybersecurity tools suggests that many companies have not yet fully understood the scope of Industry 4.0.

Conclusions

SMEs in the commercial sector in the central region of Tlaxcala are at a critical point for their competitive development, especially in the context of adopting technologies associated with Industry 4.0. Although there is a clear awareness among entrepreneurs about the importance of these tools to improve productivity and efficiency, several obstacles prevent their full implementation. Among the main barriers identified are the lack of financial resources, the limited technical training of personnel and the lack of local specialists who can adequately guide and advise on the digitisation process. These structural challenges are in line with previous studies indicating that Mexican SMEs, particularly in less industrialised regions, face greater difficulties in integrating emerging technologies.

Still, a positive aspect emerging from the research is the willingness of most companies to explore at least some Industry 4.0 tools. The use of Information and Communication Technologies (ICT) is notable, with a large percentage of SMEs using digital platforms to make sales, manage electronic payments and promote their products on social media. However, the adoption of more advanced technologies such as simulation, autonomous robots or cybersecurity remains limited, reflecting a lack of deep understanding of the full potential of Industry 4.0 to transform production processes.

Furthermore, the research reveals that SMEs in Tlaxcala operate in an environment where institutional support is scarce. Nearly half of the companies surveyed mentioned not having received any support from external institutions to increase their level of technological innovation. This finding underlines the importance of government, universities and other business support organisations playing a more active role in providing resources, training and advice. Without a coordinated effort to boost technical training and provide access to adequate financing, local SMEs are likely to continue to face difficulties in remaining competitive in an increasingly digitised and demanding market. Therefore, the incorporation of Industry 4.0 in Tlaxcala's SMEs has the potential to transform their regional competitiveness, but its success will largely depend on the ability of these firms to overcome the internal and external obstacles that limit their development. Investing in human capital, upgrading technological equipment and creating strategic alliances will be key for SMEs to fully reap the benefits of digital transformation. In this sense, competitiveness should not only be measured in terms of technological innovation, but also in the adaptability and resilience of companies in the face of an increasingly dynamic global economic environment. Only through a sustained commitment to innovation and adequate institutional support, SMEs in the business sector in Tlaxcala will be able to consolidate themselves as relevant actors in the economic development of the region.

Declarations

Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contribution

The three authors actively collaborated in each section of this paper.

Availability of data and materials

Data were easily accessible, as information from primary and secondary data was used, through official websites and reliable documents.

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Abbreviations

DENUE National Statistical Directory of Economic Units

INEGI National Institute of Statistics and Geography

MIPYMES Micro, small and medium-sized enterprises

POTDUT Programa Estatal de Ordenamiento Territorial y Desarrollo Urbano del estado de Tlaxcala (State Program for Land Use Planning and Urban Development of the State of Tlaxcala)

SMEs Small and medium-sized enterprises

ICT Information and Communication Technologies

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Challenges of sustainable urban development in the face of climate change: analysis and proposals

Retos del desarrollo urbano sostenible frente al cambio climático: análisis y propuestas

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Discipline: City, territory and sustainability
Sub-discipline: Others

Key Handbooks

In theoretical-conceptual terms, novel aspects are addressed such as the integration of the Process Analysis approach (Carrillo, 2002), circular economy concepts and complementary aspects such as Urban Development, Sustainability and Climate Change. Likewise, in methodological terms, an analysis of contemporary problems is addressed in terms of the determining factors that impact the structure of urban development and climate change. In the first case, the aspects that make up the main urban areas of the polynuclear type and the changes foreseen for the period 2000-2035 are analyzed, as well as the territorial areas that, at the international level, will have an impact on cultivated areas, desert areas, regions with potential for reforestation and areas at risk due to the rise in sea level. Indeed, of the twenty largest megacities, it is expected that, by 2035, close to 80% will be located in developing countries. This poses enormous challenges for governments and socio-economic systems. The interdisciplinary approach addressed in this paper exposes structural causes such as the interrelationship in phenomena such as the world economic order, water, fuels, the population explosion and, naturally, climate change; emphasis is placed on the main industrial zones in the world, according to the scale of the geographical areas. With regard to the effects of climate change, the impacts on health and well-being are analyzed, as well as the effects on cities, settlements and infrastructure. It is proposed that, within the framework of the circular economy, various renewable energies should be present to enable a positive effect of climate variations, such as wind and solar energy, wastewater treatment plants, electric and hybrid cars, biofuels, blue energy and geothermal energy. In short, this is a fresh and updated vision of these two areas of research; both sustainable urban development and climate change, in which public policies are an important and irreplaceable factor in the solution, as well as strategies for social participation.

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Abstract

By 2020, the human population exceeded eight billion inhabitants, of which 60% are located in urban areas and their regions. Accelerated urbanization is the product of an economic system that encourages competitiveness and technological innovation but also generates multiple contrasts, one of which was pointed out by ECLAC, since the greatest market failure is climate change. The central objective is to analyze the structural causes that impact urban development, as well as its relationship with climate change and, based on this, generate alternative solutions. New forms of territorial configuration, such as metropolises and megalopolises, tend to be a determining factor in the worsening of the effects of climate change and lead to greater social risk and vulnerability. Public policies must be oriented towards a model in which social participation is a determining element.

Challenges of sustainable urban development in the face of climate change: analysis and proposals		
Objective	**Methodology**	**Contribution**
The central objective is to analyze the structural causes that impact urban development, as well as its relationship with climate change and. based on this generate alternative solution. 	This Is a mixed-type research, under the deductive approach that explores two research axes: i) effects of accelerated urban expansion at an international level and; i) effects of climate change, derived from economic-demographic concentration And accelerated urbanization. At the same time, the structural causes of these two phenomena are analyzed, which are summarized in the following indicators: changes in the economic structure, demographic growth by continental region, analysis ofthe high urban concentration in the twenty largest megalopolises in the world; viable alternatives from the circular economy approach and; outline of guidelines for addressing solutions to this problem. 	In theoretical and conceptual terms, novel aspects are addressed, such as the integration of the Process Analysis approach (Carrillo 2002), concepts of the circular economy and complementary aspects such as Urban Development, Sustainability and Climate Change. In methodological terms, an analysis of contemporary problems is addressed, considering determining factors that impact the structure of urban development and climate change. The aspects that make up the main polynuclear urban areas and the changes expected for the period 2000-2035 are analyzed, as well as the territorial areas that at an international level Will impact on crop areas, desert areas, regions with reforestation potential and areas at risk due to rising sea levels, Of the twenty largest megalopolises, it is expected that, by 2035, nearly 80% will be located in developing countries. This poses enormous challenges for governments and economic-social systems The interdisciplinary approach addressed by this work exposes structural causes such as the interrelationship in phenomena such as the world economic order, water,-fuels, population explosion and, naturally, climate change; the emphasis is placed on the main industrial zones in the world, according to the scale of geographic areas. Regarding the effects of climate change, the impacts on health and well-being are analyzed. as well as the effects on cities, settlements and infrastructure In short, it is a fresh and updated vision of these two axes of research; both sustainable urban development and climate change in which public policies are an important and irreplaceable factor in the solution as well as strategies for social participation. 

Urban development, Climate change, Circular economy, Public policies. Risks and vulnerability

Resumen

La población humana, para el año 2020 rebasó los ocho mil millones de habitantes, de los que el 60% se localiza en áreas urbanas y sus regiones. La urbanización acelerada es producto de un sistema económico que alienta la competitividad y la innovación tecnológica pero que también generan múltiples contrastes, uno de ellos señalado por la CEPAL, pues la mayor falla del mercado es el cambio climático. El objetivo central es analizar las causas estructurales que impactan el desarrollo urbano, así como su relación con el cambio climático y a partir de ello, generar propuestas alternativas de solución. Las nuevas formas de configuración territorial, como las metrópolis y megalópolis tienden a ser un factor determinante en el agravamiento de los efectos del cambio climático y propician mayor riesgo y vulnerabilidad social. Las políticas públicas deben ser orientadas hacia un modelo en el que la participación social sea un elemento determinante.

Retos del desarrollo urbano sostenible frente al cambio climático: análisis y propuestas		
Objetivo	**Metodología**	**Contribución**
El objetivo central es analizar las causas estructurales que impactan el desarrollo urbano, así como su relación con el cambio climático y a partir de ello. generar propuestas alternativas de solución. 	Esta es una investigación de carácter mixto, bajo el enfoque deductivo que explora en dos ejes de investigación: i) efectos de la expansión urbana acelerada a nivel internacional y; i) efectos del cambio climático, derivado de la concentración económico demográfica y de la acelerada urbanización. Al mismo tiempo, Se analizan las causas estructurales de esos dos fenómenos, que están resumidas en los siguientes indicadores: cambios en la estructura económica, crecimiento demográfico por región continental, análisis de la alta concentración urbana en las veinte megalópolis más grandes del mundo; alternativas viables a partir del enfoque de la economía circular y; esbozo de lineamientos para la atención de soluciones a esa problemática. 	En términos teórico-conceptuales se abordan aspectos novedosos como la integración del enfoque del Análisis de procesos (Carrillo, 2002). conceptos de la economía circular Y aspectos complementarios como Desarrollo urbano, Sostenibilidad y Cambio climático, En términos metodológicos, se aborda un análisis de la problemática contemporánea, - considerando factores determinantes que impactan en la estructura del desarrollo urbano y del cambio climático. Se analizan los aspectos que conforman las principales áreas urbanas de tipo polinuclear y los cambios previstos para el periodo 2000 -2035, así como las áreas territoriales que a nivel internacional, impactarán en zonas de cultivo, áreas desérticas, regiones con potencial de reforestación y zonas de riesgo por la elevación del nivel del mar. De las veinte megalópolis de mayor tamaño, se prevé que, para el año 2035, cerca del 80% se localizarán en países en desarrollo, Esto plantea enormes retos y desafíos para los gobiernos y los sistemas económico-sociales El enfoque interdisciplinario que aborda este trabajo expone causas estructurales como la interrelación en fenómenos como el orden económico mundial, el agua, los combustibles, la explosión demográfica y naturalmente, el cambio climático; se coloca el énfasis en las principales zonas industriales, en el mundo, según escala de las áreas geográficas Por lo que se refiere a los efectos del cambio climático se analizan los impactos en la salud y el bienestar, así como los efectos en las ciudades, asentamientos e infraestructura. En resumen se trata de una visión fresca y actualizada de esos dos ejes de investigación; tanto del desarrollo urbano sostenible como del cambio climático, en el que las políticas públicas son un importante e insustituible factor de solución tanto como las estrategias de participación social. 

Desarrollo urbano, Cambio climático, Economía circular, Políticas públicas. Riesgos y vulnerabilidad

Introduction

Today's world is undergoing various phenomena that affect the development of humanity. By the year 2020, according to data from the United Nations, the human population of the planet will exceed eight billion inhabitants. The most worrying phenomena are related to accelerated urbanisation, with around 60% of humanity located in these areas; the drastic effects caused by global warming that have affected extensive areas of cities, suburban and coastal areas due to extreme weather phenomena. The central objective of this work is to analyse the structural causes that impact on urban development, as well as their relationship with climate change and, consequently, to generate alternative proposals for solutions.

The paper is organised into this section and four sections. The first section deals with a review of the process analysis approach, as well as the theory of complex systems, which together are referred to as an alternative approach that helps to understand the problem. The second section is entitled Human development and climate change: a look at recent problems. This section analyses a set of elements that allow us to identify global urbanisation in the period 1980-2020, and also identifies the geographical areas that in the medium term will represent risks for agricultural development, flooding and the use of solar energy. It also identifies the geographical regions with the highest population growth rates and analyses the variations of megacities in the world during the period 2000-2035.

The third section is entitled the current challenges of sustainable urban development and climate change. Emphasis is placed on the need to combine land-use and ecological planning policies, and the adverse impacts of climate change on the health and well-being of the population are identified. Emphasis is also placed on the circular economy approach and renewable energies as alternatives for both cleaning up the environment in urban areas and reducing the negative effects of climate change.

The last section is entitled conclusions and recommendations and points out the usefulness of having adopted the process analysis approach that allows us to disentangle sustainable urban development and climate change from the complex socio-economic and environmental problems from which the research axes presented here derive. Indeed, contemporary urbanisation is a multidimensional process and only through the theory of complex systems was it possible to identify the impact of the economic structure on the territory, as well as to assess the growing trend of high economic-demographic concentration in large cities and urban mega-regions. In terms of recommendations, the emphasis is placed on the fact that the only way to foresee and reduce extreme weather events is by quantifying the damage to economic infrastructure that they cause and the high social and environmental financial costs. Therefore, the triple helix model becomes an alternative to generate multi-sectoral commitments, both from private sector companies, research centres and universities and, of course, the commitment and role of governmental entities.The bibliography consulted for this purpose is presented at the end.

I. An alternative approach: complex systems and process analysis

According to recent reports, the scientific community agrees that the profound changes in the international economic structure have generated variations both in growth rates and in the effects of these variations due to cyclical crises that impact on the distribution of income and wealth, the wage levels of the labour sectors, the insufficiency of markets to attend to an adequate allocation of material resources, and multiple social problems that derive from these imbalances (ECLAC, 2000). This complex socio-economic problem is followed by the direct impacts of the economic system on the territory and the serious urban-regional inequalities that result in a growing tendency towards hyper-urbanisation. This panorama is exacerbated by the global environmental crisis that is expressed, among other factors, in climate change, the depredation of natural resources, environmental deterioration and serious climatic effects, such as hurricanes, abundant rainfall and, on the other hand, desert areas and serious deforestation and unstoppable changes in land use (Flores, 2022).

Some of the most distressing questions derived from this panorama are the following: What are the effects of the international economic system on urban-regional development; what elements are involved in the processes of accelerated urbanisation and the formation of megacities; what is the relationship between accelerated urbanisation and global warming; what is the degree of effectiveness of sectoral and regional public policies to face the challenges of urban development and climate change?

In the rigorous analysis of these issues, the scientific method undoubtedly plays a key role. Indeed, the rigour with which the tools and auxiliary methods are approached will be of great use in answering these questions.

From the wide range of tools available in the field of epistemology, it is likely that both the process analysis approach and the theory of complex systems will help to clarify both the causes of these problems and contribute to explaining possible alternative solutions.

The Process Analysis Approach

The process analysis approach is an approach that 'starts from the premise that a desired outcome is most efficiently achieved when the activities to be performed and the resources required are managed as a process' (Torres, 2023).

Complex Systems Theory

One of the antecedents that is related to this conceptual tool is the Systems Theory that considers the conformation of a totality in whose interrelationships various components are present (Bertalanffy, 2017).

Complex systems refer to a large set of individual components that interact with each other and can modify their internal states as a product of such interactions. In a broader context, the interactions referred to can generate collective and global behaviours that emerge as a collective process and cannot be reduced or explained by considering the constituent elements in isolation (Miramontes, 1999; 83).

Other researchers have considered complex systems as part of a comprehensive framework of analysis for complex problems that require an interdisciplinary approach; this includes general principles about the composition, dynamics and evolution of a system, methodological guidelines and a constructivist epistemic foundation (Becerra, 2019; 5). Complex systems cannot be solved by a single discipline; they require different areas for their analysis and study. Problems such as global warming and climate change need to be studied by different disciplines in order to find a solution (Corona, 2021).

Relevant concepts

Sustainable development

'It is the process of classification and adaptation, through the planning of the urban environment, in its social, financial and physical aspects, it also involves the demographic and physical expansion, the increase of productive actions, the height of the socioeconomic situations of the population, the maintenance of cities in good working conditions, the preservation and improvement of the environment' (Secretaría de Desarrollo Urbano y Vivienda-CdMx, 2024).

Sustainability

'Meeting the needs of the present without compromising the ability of future generations to meet their own needs' (Global Compact, 2023). Strive for a balance between economic growth, social stability, care and attention to natural resources and the environment; a democratic political system, an open and forward-looking culture and technological innovation.

Climate change

According to the UN Intergovernmental Panel on Climate Change (IPCC), climate change is a phenomenon that occurs when the average weather conditions in a place begin to change. This can be caused by natural factors or by human activities' (IPCC, 2021).

As can be seen, these theoretical-conceptual tools are very useful and allow us to answer the questions that were formulated at the beginning of this section, as well as to clarify some of the doubts that arise from them.

Undoubtedly, these concepts have been useful and will help us in the description and analysis of two major areas of research in this work: sustainable urban development and the effects of climate change on territorial and environmental problems.

II. Urban development and climate change: a look at recent issues

After the Second World War, the world considered various alternatives for integrated development. In the decades that followed, various international meetings have been held to generate alternatives, particularly for developing countries.

World urbanisation in 1980 was distributed as follows: rural areas occupied 60.7% of the world's territory; other urban areas, with less than 300,000 inhabitants, occupied 20.4%; smaller cities, with between 300,000 and 500,000 people, represented 2.4% of the territory; and small cities, with between 500,000 and one million people, 3.5%; while medium-sized cities, with between 500,000 and one million people, represented 3.5%. 5%; while medium-sized cities of one to five million inhabitants constituted 6.6%; large cities of five to ten million inhabitants accounted for 2.9%; and megacities, with more than ten million people, represented 1.5% of the world's territory (see Figure 1).

Box 1

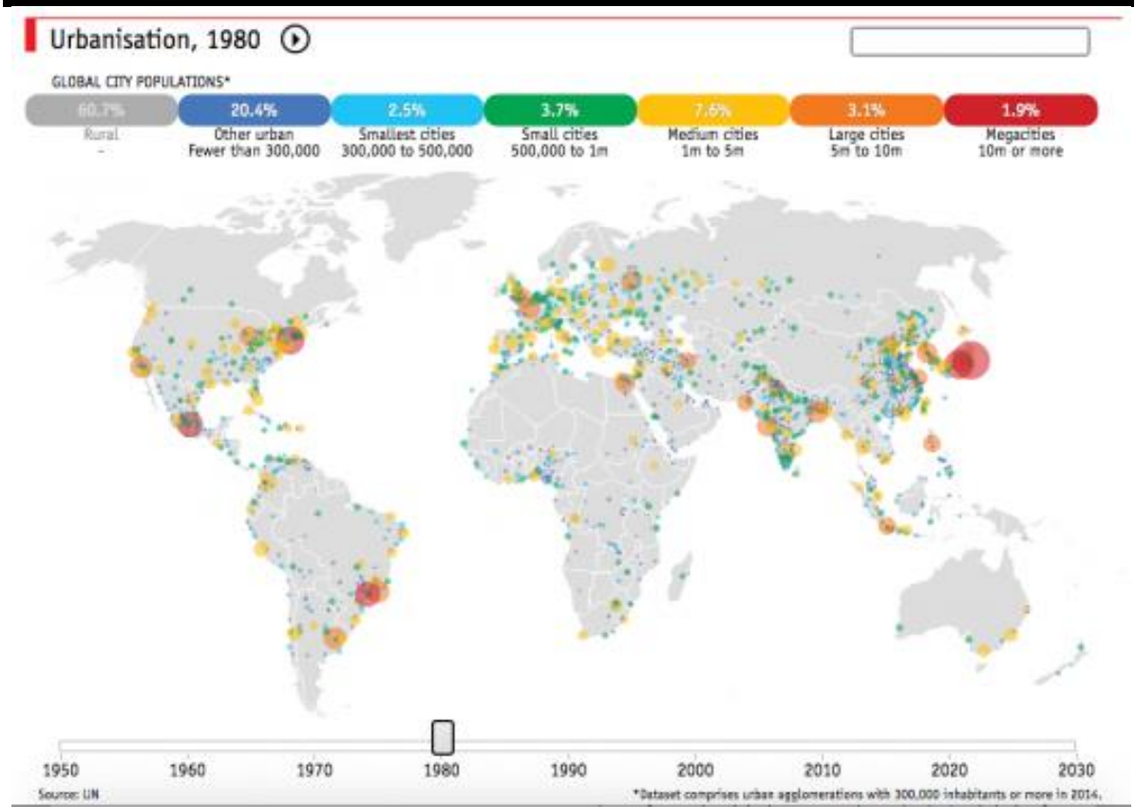

Figure 1
World urbanisation in 1980

Source: The Economist, (2015). Available at: https://www.economist.com/node/21642053?fsrc=scn/tw/te/dc/ed/brightlightsbigcities

By 2020, global urbanisation had increased compared to 1980, rural areas had decreased to 43.8% (16.9% difference with 1980 figures), other urban areas, with less than 300,000 inhabitants, increased to 23.2%; smaller cities, where 300,000 to 500,000 people live, represented, by the year referred to at the beginning, 3.7% of the territory, and small cities with 500,000 to one million people also increased to 5.3%, while medium-sized cities with one to five million inhabitants constituted 12.1%, large cities with five to ten million inhabitants increased to 4.3% and megacities to 7.6% of the world territory (see Figure 2).

Box 2

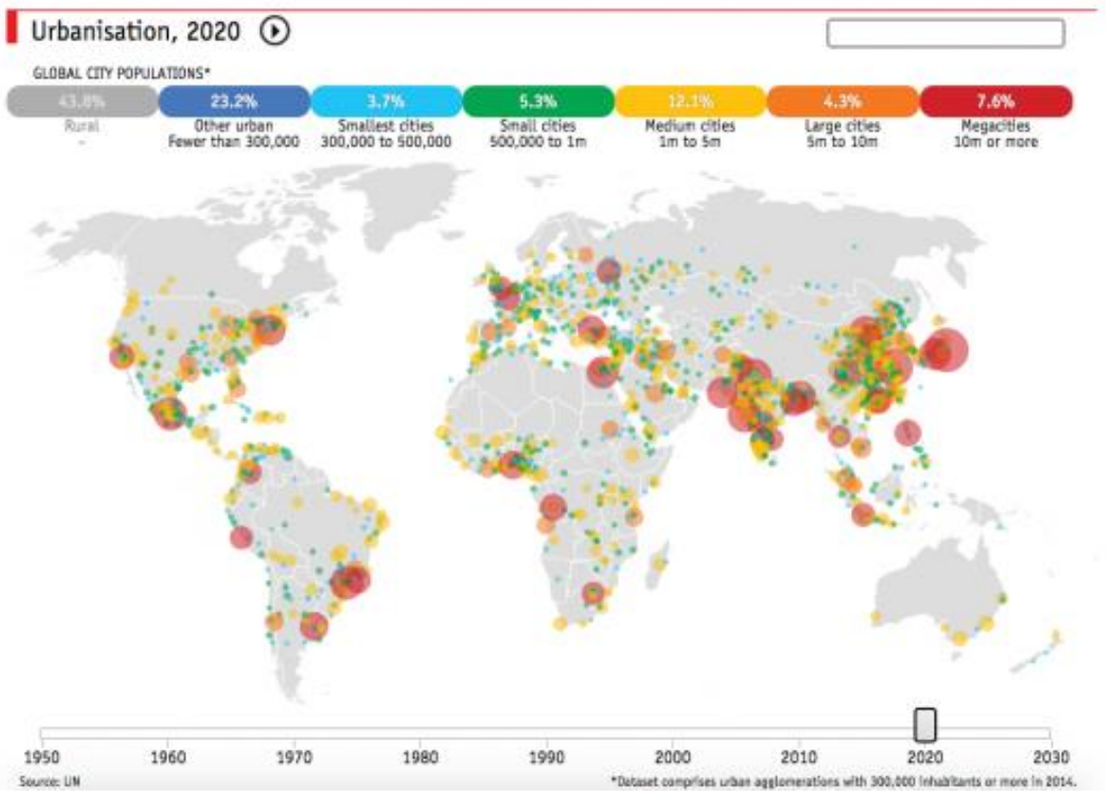

Figure 2

Global urbanisation in 2020.

Source: The Economist, (2015). Available at: https://www.economist.com/node/21642053?fsrc=scn/tw/te/dc/ed/brightlightsbigcities

During the Paris Agreement, it was established that the maximum temperature increase for the planet must be up to 2°C. If it is not exceeded, the Earth and its living beings will suffer the consequences (Mohorte, 2021). If this is not exceeded, the Earth and the living beings that inhabit it will suffer the consequences (Mohorte, 2021).

In the event that the temperature is exceeded and reaches 4°C, the consequences for the different regions of the planet would be: in the case of the Arctic Passage, being one of the most valuable shipping routes open all year round, it would affect the habitable areas of Canada and Russia, as it would become one of the few food growing areas or would simply be uninhabitable due to the high altitudes at which it is located; in the United States of America and Mexico desertification would occur, causing forced migration northwards, and natural resources would be scarce as the Colorado River would be used for agriculture and geothermal energy; the glaciers of Patagonia would also melt and become new arable areas, although the soils would need to be prepared for their use; Scandinavia, the United Kingdom, Northern Russia and Greenland would be the cities that would provide refuge for much of the world's population; in Southern Europe, the deserts would become uninhabitable due to the high altitudes at which they are located; in Southern Europe deserts have invaded the continent, rivers have dried up and the Alps are without snow; most of the Himalayan glaciers in Asia have melted, affecting many of the region's rivers; in India, Pakistan and Afghanistan isolated communities remain in small groups; Australia would be occupied by people and food crops, the rest of the continent is devoted to solar energy production and solar energy extraction and uranium mining for nuclear energy; New Zealand would be unrecognisable, densely populated, and some cities would be in intensive agricultural use; and Polynesia, as well as other coastal regions, would disappear under the sea (see Figure 3).

Box 3

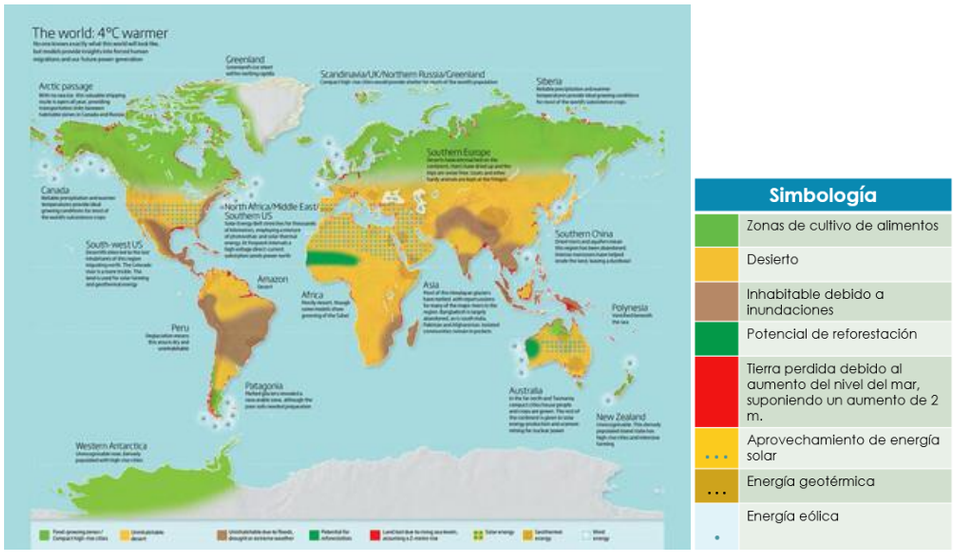

Figure 3

Simulation of the world with temperatures of 4°C, by region (scenarios **from 2021).**

Source: Mohorte, (2021). Available at: https://www.xataka.com/magnet/asi-quedara-mundo-cuando-temperaturas-hayan-ascendido-4o-c-encima-media

Globally, the last three decades, in terms of population growth and its impact on the regions, have shown two relevant phenomena: i) on the one hand, the population has not stopped growing; and on the other, ii) the regions with the highest population growth rates are those that, comparatively speaking, have the lowest levels of development. It is likely that these population differences will continue to impact the territory, the environment and deepen urban-rural inequalities in the coming decades (Flores, 2022; 19).

The latter is the case of Africa, which increased from 638.1 to 1,460.4 million inhabitants, with an average annual growth rate, for the period 1990-2023, of 2.28%, making it the region with the greatest population dynamism. In addition, regions such as Asia stand out, which, although comparatively speaking, have a lower growth rate, in the same period, their population volumes are high; they went from 3,211 to 4,753 million inhabitants and a population growth rate of 1.48%. Other regions with high volumes of population concentration are Europe, which increased from 721 to 742 million people, with an average population growth rate of 1.02% in the same period. Latin America and the Caribbean increased its population from 442 million to 664 million, with an average growth rate of 1.50 per cent. The world average shows a high increase, from 5,316 to 8,045 million inhabitants, with an average growth rate of 1.51%, slightly higher than the average population growth in the LAC region (see Table 1)

Box 4

Table 1

Population growth by region, 1990-2023. (Absolute values)

Regions/Year	1990	2015	2023	Growth rate (1990-2023) (%)*
Africa	638 157 237	1 201 107 939	1 460 481 773	2.288
Asia	3 211 352 077	4 459 437 459	4 753 079 727	1.480
Europe	721 497 282	742 107 449	742 272 653	1.028
Latin America and the Caribbean	442 565 114	623 076 488	664 997 121	1.502
North America	275 860 329	360 464 919	378 904 407	1.373
Oceania	26 743 825	40 403 284	45 575 768	1.704
World total	5 316 175 864	7 426 597 538	8 045 311 449	1.513

(*) Rate calculated with the formula P=N^f÷ N^i·100, where:
P=Population growth rate in the respective period.
N^f=Represents the population at the end of the interval.
N^i=Represents the population at the beginning of the interval.

Source: Own elaboration based on United Nations (2022). World Population Prospects 2022. Disponible en: https://population.un.org/wpp/

The world's largest metropolises in 2000 were Tokyo, Japan (with 26.4 million inhabitants); Mexico City, Mexico (18.1); Sao Paulo, Brazil (18.0); New York, USA (16.7); Mumbai, India (16.1), among others. Regarding the changes for the year 2021, Tokyo remains in the number one position, but with an increase in its population to 37.3 million inhabitants; although it has increased its population, Sao Paulo and Mexico City fall in position four with 22.2 and five with 21.9 million inhabitants, respectively; and in position two and three are Delhi, India (31.1) and Shanghai, China (27.7). With regard to projections for the year 2035, Japan's birth rate is expected to continue to affect Japan and cause a decrease in population, placing it at number two with 36.0 million inhabitants; Delhi, India drastically increases its numbers and is placed at number one with 43.3 million population, a difference of 12.2 from 2021; Shanghai, China remains at number three with 34.3 million; Dhaka, Bangladesh rises to number four with 31.2 million (in 2021 it was at number six with 21.7 million), as well as Cairo, Egypt which was at number seven in 2021 (see Table 2).

Box 5

Table 2

Largest metropolises in the world, years: 2000-2021-2035 (absolute values)).

#	2000	Population (millions)	2021	Population (millions)	2035	Population (millions)
1	Tokio, Japan	26.4	Tokio, Japan	37.3	Delhi, India	43.3
2	Mexico City, Mexico	18.1	Delhi, India	31.1	Tokio, Japan	36.0
3	Sao Paulo, Brazil	18.0	Shanghai, China	27.7	Shanghái, China	34.3
4	New York, United States	16.7	Sao Paulo, Brazil	22.2	Dhaka, Bangladesh	31.2
5	Mumbai, India	16.1	Mexico City, Mexico	21.9	Cairo, Egypt	28.5
6	Calcutta, India	13.1	Dhaka, Bangladesh	21.7	Mumbai, India	27.3
7	Los Angeles, United States	13.1	Cairo, Egypt	21.3	Kinshasa, Democratic Republic of Congo	26.6
8	Shanghai, China	12.9	Beijing, China	20.8	Mexico City, Mexico	25.4
9	Dhaka, Bangladesh	12.5	Mumbai, India	20.6	Beijing, China	25.3
10	New Delhi, India	12.4	Osaka, Japan	19.1	Sao Paulo, Brazil	24.4
11	Karachi, Pakistan	12.1	Karachi, Pakistan	16.4	Lagos, Nigeria	24.4
12	Buenos Aires, Argentina	12.0	Chongqing, China	16.3	Karachi, Pakistan	23.1
13	Jakarta, Indonesia	11.0	Stambul, Turkey	15.4	New York, USA	20.8
14	Osaka, Japan	11.0	Buenos Aires, Argentina	15.2	Chongqing, China	20.5
15	Beijing, China	10.8	Kolkata, India	14.9	Calcutta, India	19.5
16	Rio de Janeiro, Brazil	10.7	Kinshasa, Democratic Republic of Congo	14.9	Lahore, Pakistan	19.1
17	Metro Manila, Philippines	10.0	Lagos, Nigeria	14.8	Manila, Philippines	18.6
18	Seoul, South Korea	9.9	Manila, Philippines	14.1	Osaka, Japan	18.3
19	Paris, France	9.6	Tianjin, China	13.7	Bangalore, India	18.0
20	Cairo, Egypt	9.4	Guangzhou, China	13.6	Istanbul, Turkey	17.9

For the year 2021, see: Harrouk, (2024). Available: https://www.archdaily.mx/mx/906667/las-20-ciudades-mas-grandes-del-mundo-en-2018

Y las proyecciones para el año 2035, consúltese: Thorton, (2019). Disponible en: https://es.weforum.org/agenda/2019/02/se-predice-que-10-ciudades-obtendran-el-estatus-de-megaciudades-para-2030/#:~:text=Tokio%2C%20por%20supuesto%2C%20estar%C3%A1%20en,conocimientos%20generales%20de%20geograf%C3%ADa%20actualizados.

The United Nations Development Programme (UNDP-UN) defines human development as a process that measures the quality of life, either by country or federal entity; it shows the contrasts between the different units of territorial analysis and, in some way, helps governments to design public policies with a greater degree of effectiveness (Carrillo, 2002; 22-23).

Of the twenty metropolises shown in Table 2, for the year 2000, only six entities were classified as developed metropolises and fourteen as developing; with respect to the projection for 2035, only four will be in development and sixteen in the process of development (see Table 3).

Box 6

Table 3

Population growth by region, 1990-2023. (Absolute values)

Level of development	Year 2000	Year 2035
Metropolis in developed countries	6	4
Metropolis in developing countries	14	16
Total	20	20

Source: Prepared with data from Table 2.

Remarks:

- The world's urban population will continue to grow in a concentrated manner in large urban regions (megacities).
- Megacities will continue to serve as huge markets for goods, products, services and factors of production (land, labour, capital and technology).
- Comparatively speaking, these mega-urban regions in developing countries will, by the next decade, account for about 80% of the world's mega-regions.

Different environmental problems interact and relate to each other in various ways. The global economic order has connections to other factors, suggesting that global economic structures influence and affect other aspects such as resource consumption, inequality and climate change. Another vital element for the functioning of living things on the planet is water, which is linked to hunger, desertification, deforestation and resource depletion, meaning that access to water is critical and that water scarcity can aggravate other problems, be it population explosion, climate change that is influenced by issues such as fuel consumption and deforestation.

Finally, it is necessary to emphasise the importance of addressing these challenges from the perspective of ethics and solidarity, i.e. from a more humane and cooperative approach (see Figure 4).

Box 7

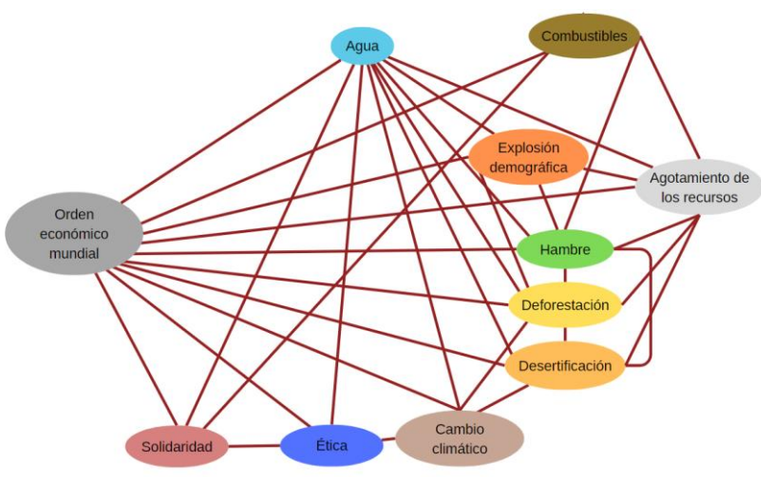

Figure 4

Interactions between environmental problems

Source: Flor, J. I. (2006), P. 130.

Industrial activity around the world is concentrated in specific regions of the world, the large industrial areas are located in North America, specifically in the Great Lakes between the St. Lawrence and the northeastern US; as well as Asia, specifically Japan and; Western Europe including countries such as Germany, France and the UK, which are industrial powerhouses in the automotive, chemical and manufacturing sectors. Other important industrial areas of industrial production, although on a smaller scale compared to the larger areas are Beijing, Shanghai and South Korea, key regions leading in technology and electronics; Moscow and the Urals of Russia are also key players. Finally, there are smaller industrial areas such as Taiwan, Singapore, South Australia, South Africa and Mexico (see Figure 5).

Box 8

Figure 5

Major industrial zones in the world

Source: Perez, (2016). Available at: https://prezi.com/nrk60ifv8vnx/zonas-industriales-por-continentes-y-regiones/

I. The current challenges of sustainable urban development and climate change

Ecological Land Use Planning is an "environmental policy instrument that seeks to plan land use and productive activities in order to protect the environment and take advantage of natural resources" (Secretaría de Medio Ambiente y Recursos Naturales, 2021). This instrument is composed of five stages, which are: a) formulation, b) issuance, c) execution, d) evaluation and, e) modification (see Figure 6).

Box 9

Figure 6

Ecological Spatial Planning

Source: Ordenamiento Ecológico Territorial, paper by Dr. Omar Arellano of UNAM. National Technological Institute of Mexico (2019). Available at: https://desarrollosustentablekfoj.blogspot.com/2019/04/que-es-el-ordenamiento-ecologico.html

Globally, the degree of adverse health and well-being impacts attributed to climate change is high or very high in infectious diseases, malnutrition, mental health and displacement, and has impacted heavily on cities, settlements and infrastructure, causing flooding, storms in coastal areas and damage to key economic sectors. In the case of Central and South America, the impact has been assessed as medium, but in the case of North America, the damage is high or very high (see Figure 7).

Box 10

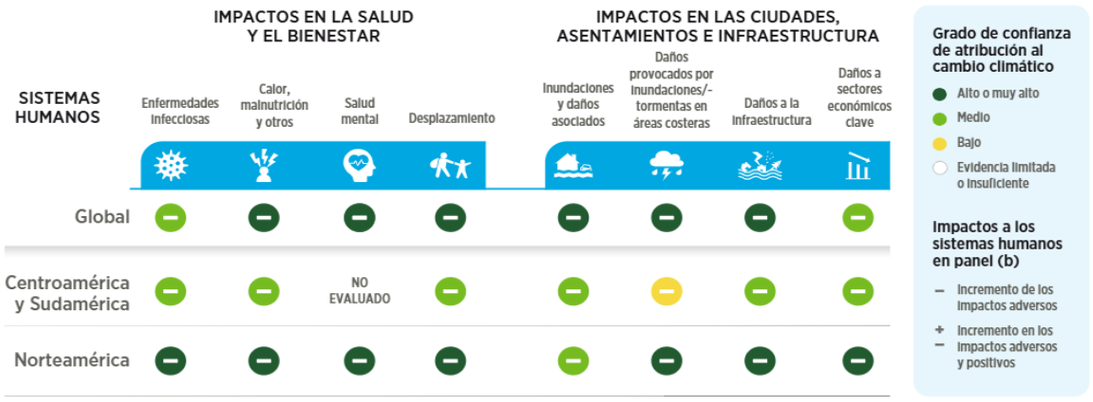

Figure 7

Adverse health and welfare impacts attributed to climate change

Source: Astorga, I., Sorio, R. and Bauhoff, S.-Inter-American Development Bank (2023). P. 9. Available at: https://publications.iadb.org/publications/spanish/viewer/Salud-y-cambio-climaticocomo-proteger-la-salud-de-las-personas-frente-a-la-crisis-climatica.pdf

The circular economy is "a model of production and consumption that involves sharing, renting, reusing, repairing, renewing and recycling existing materials and products as often as possible to create added value. In this way, the life cycle of products is extended" (European Parliament, 2023). Some renewable energies that would contribute to this model are blue, wind, solar, geothermal energies; wastewater treatment plants and municipal solid waste treatment plants; as well as electric cars and biofuels (see Figure 8).

Box 11

Figure 8

Circular Economy and Renewable Energy

Source: Own elaboration based on Cen, (2023); Fundación Aquae (2021); Grupo Hidráulica, (2023); Parque Científico Tecnológico-Universidad Autónoma de Sinaloa, (2023); Portal Ambiental, (2022); Real Estate Market & Lifestyle, (2024); Rincón Educativo; (2024), Roca, (2022) and; Viet, (2022).

Conclusions and recommendations

It has been useful to consider the Process Analysis Approach (Carrillo, 2002), according to which reality in the universe is complex and everything is related to everything. In this presentation there are two axes of research that were developed, and only for the purpose of analysis they were separated: sustainable urban development and climate change.

Sustainable urban development is a multidimensional process that is the result, among others, of factors such as: population growth, natural and social; the impact of the economic structure on the territory, the growing tendency to consider cities and mega-urban regions as large markets for land, labour, capital and technology.

The governments of the different countries must foresee, plan for and deal with the negative effects of climate emergencies. Specifically those related to damage to the health of the population and severe weather variations, such as floods, heat waves, overflowing rivers, hurricanes and rising sea levels that affect economic infrastructure and generate high financial, social and environmental costs.

The Triple Helix Model should be taken up again to generate this type of academic meetings; linking and collaboration between private sector companies, universities and research centres and civil society.

There are enormous potentialities and opportunities for the current stage we are living through to generate proposals in the field of renewable energies under a sustainable development approach that, in the short term, will have an impact on improving the quality of life and levels of social welfare.

Declarations

Conflict of interest

No, there is no conflict of interest.

Authors' contribution

Not applicable, as single author. The idea, the structure of the scientific article, the information, the statistical data, the conceptualisation, the methodology and the development of the work was carried out in this way. Sincere thanks to the Communication Intern María Itzel Serrano Meza, for the collection of information and the support to format this work as a scientific article.

Availability of data and materials

The advantage offered by the National System of Researchers is that all the production of its members is reported in the databases of the Rizoma platform of the National Council of Humanities, Science and Technology (CONAHCyT) of Mexico. It is therefore feasible to consult this material and these data on the aforementioned platform.

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Abbreviations

CEPAL-ONU	Comisión Económica para América Latina y el Caribe- Organización de las Naciones Unidas
CONAHCyT	National Council for the Humanities, Science and Technology
IPCC-ONU	Intergovernment Panel Climate Change-Organización de las Naciones Unidas
PNUD-ONU	Programa de Naciones Unidas para el Desarrollo- Organización de las Naciones Unidas
PRODEP-SEP	Programa de Mejoramiento del Profesorado-Secretaría de Educación Pública
SNII-CONAHCyT	Sistema Nacional de Investigadoras e Investigadores- Consejo Nacional de Humanidades, Ciencia y Tecnología

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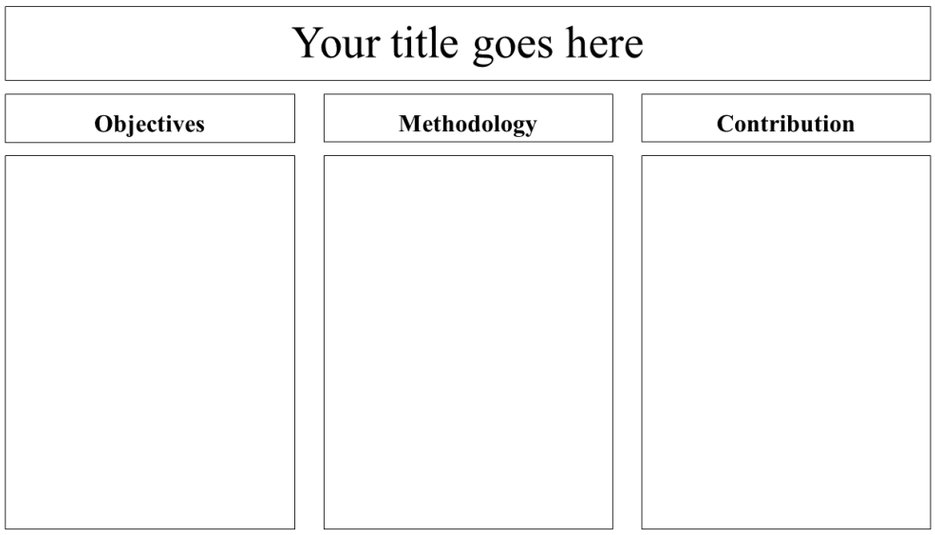

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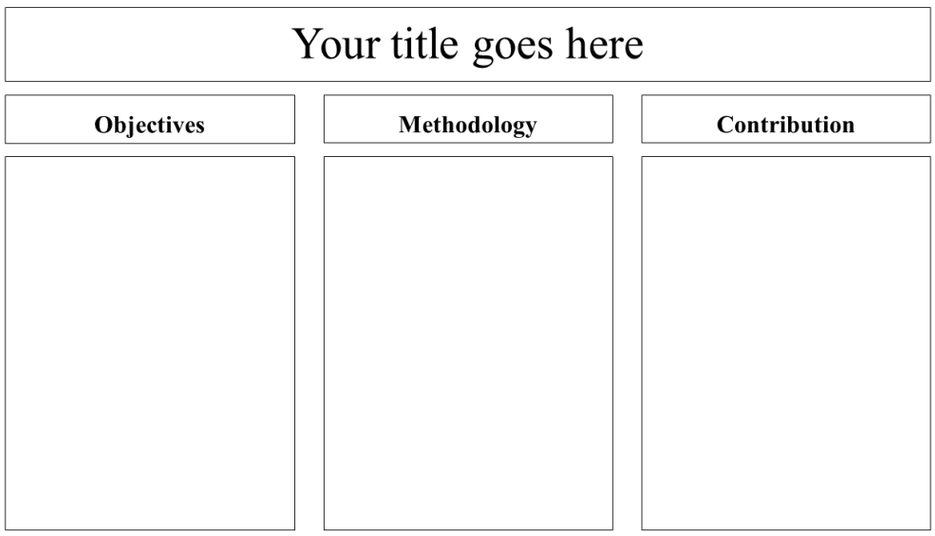

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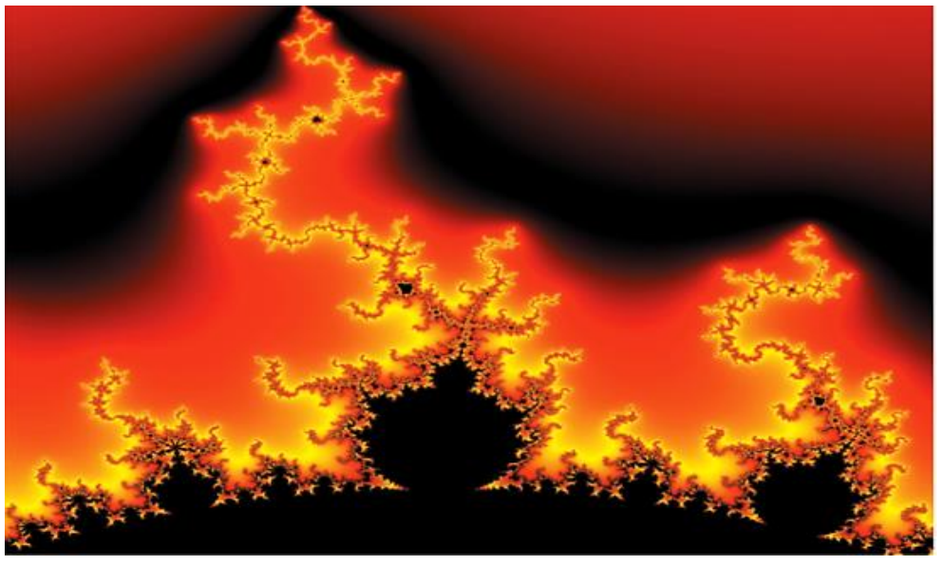

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