



# Financial performance and administrative practices in Mexican microenterprises: An analysis with artificial neural networks

*Desempeño financiero y prácticas administrativas en las microempresas mexicanas: un análisis con redes neuronales artificiales*

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## Abstract

The aim of this study is to analyze the impact that the adoption of management practices in Mexican microenterprises (1 to 10 employees) have on their financial performance, proxied by gross income levels. For this purpose, two analyses are performed: one econometric, and another employing Artificial Neural Networks using micro data from Business Practices in Small Firms in Developing Countries from the World Bank survey. Both analyses show that control practices, financial planning, as well as capital stock and owner age and education, have a significant influence on financial performance; however, marketing practices, purchasing and inventory control, as well as control of purchases and maintenance seemingly have no major impact on financial performance of these firms.

*JEL Codes:* D22, C45, L25

*Keywords:* Financial performance; Organizational practices; Microfirms; Artificial neural network (RNA)

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## Resumen

El presente estudio tiene como objetivo analizar el impacto que la adopción de prácticas administrativas en microempresas mexicanas (1 a 10 empleados), tiene sobre su desempeño financiero, representado por niveles de ingresos brutos. Con tal propósito se realiza dos análisis: uno econométrico, y otro mediante Redes Neuronales Artificiales, utilizando microdatos de la encuesta Business Practices in Small Firms in Developing Countries del Banco Mundial, 2008-2014. Ambos análisis muestran que las prácticas de control, planeación financiera, así como, el stock de capital y la edad y educación del dueño, ejercen una influencia significativa sobre el desempeño financiero, no así las prácticas de mercadotecnia, control de compras e inventarios y de registro de costos y mantenimiento.

*Códigos JEL:* D22, C45, L25

*Palabras clave:* Desempeño financiero; Prácticas administrativas; Microempresas; Redes neuronales artificiales (RNA)

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## Introduction

In recent years, important research projects (Álvarez, Carrasco and Córdova, 2016; Barrera, Acosta, Armenteros, Morales and Rio Ramírez, 2016; Ramos, 2015; and García Osorio, Quintero Quintero and Arias-Pérez, 2014) have analyzed the role of adopting administrative practices in business performance. However, the vast majority of them have concentrated on the study of large companies, characterized by their shareholding, accounting, management, and organizational structures with a certain level of development. Few studies analyze the impact of the adoption of certain types of administrative practices in microenterprises, and even less so in emerging economies such as Mexico.

The aim of this paper is to analyze whether some practices and variables (financial planning, capital stock, marketing, purchase and inventory control, registration of cost and maintenance, and the age and education of the owner) play a decisive role in the performance of microenterprises (1 to 10 employees). The information used consists of microdata obtained from the “Business Practices in Small Firms in Developing Countries” survey, developed by the World Bank between 2008-2014. The empirical application includes both econometric and artificial neural network techniques.

The hypothesis to be tested indicates that the adoption of certain types of administrative practices plays an important role in understanding the financial performance of this segment of companies. The study is particularly relevant since the topic has been scarcely studied for this segment of companies and, mainly in developing economies.

The study is structured in 5 sections, in addition to the present introduction. The second section reviews the literature; the third section describes some of the main characteristics of both the information from the survey and from organizations with fewer than 10 employees in Mexico; the fourth section describes the econometric and artificial neural network methodologies used; the fifth section analyses the results obtained; and finally, the sixth section offers the conclusions derived from the study.

The empirical evidence reveals a differentiated importance in the adoption of accounting and financial practices by the analyzed companies. The only practice that shows having a significant impact on the financial performance (approximate by the income, measured in sales) of the organizations, is financial planning; while the practices of marketing, registration of

cost and maintenance, and purchases and inventory control are not statistically significant to explain the variations in sales, or their impact on them is limited. The capital stock and the age and education of the owner are variables that also contribute to the explanation of the financial performance of this segment of organizations.

Given the importance of MSMEs (Micro, small, and medium-sized enterprises) in Mexico, both in terms of the number of companies and the generation of employment, it is important to know their nature and the main determinants of their financial performance. In this sense, this work aims to provide relevant information for the formulation of strategies, programs, and public policies that promote practices within companies and, thus, improve the performance of this segment of organizations.

## Related studies

The contribution of micro, small, and medium-sized enterprises to the GDP and employment<sup>1</sup> around the world is extremely important, which is why the attention of governments, academia, and professionals on the subject has increased significantly (Jacques Filion, Cisneros and Mejía Morelos, 2011; Bizarrón, Palacios, Bobadilla and García, 2014; Huerta, Ruiz and Baltazar, 2013; García and Villafuerte, 2015).

Among the lines of research that have been most developed are those related to the main problems and difficulties that these types of companies encounter in their development (García and Osorio, 2014; Jiménez, Rodas and Quiroz, 2017; Vera-Colina, Melgarejo-Molina and Mora-Riapira, 2014), their contribution to the economic activity (Huerta, Ruiz and Baltazar, 2013), and the various factors that affect their development (Rubio Bañón and Aragón Sánchez, 2002; Sánchez and Bañón, 2005; Barbosa and Ayala, 2014).

With respect to this last point—which is the line of research addressed in this work—among the factors that have been detected in the literature as crucial in business performance is the use of Information and Communication Technologies. In this regard, Guzmán, Guzmán and Fuentes (2016) analyze the impact of the use of ICTs on companies in Guayaquil; Méndez, Páez, and Lozano (2016) study the application of ICTs in SME management systems in the port sector; and Gómez, López, Vicario and Sánchez (2015) document the role of ICTs in the context of small companies and their implementation. Said researches indicate that the implementation of ICTs is important to improve business performance, but that there are still some limitations to it.

Another aspect that has been highlighted as relevant to the performance of MSMEs has been financing and access to it. García and Villafuerte (2015) study financing constraints in Ecuador and how these constraints impact investment decisions. García and Osorio (2014) address the problem of corporate financing in the segment and the national guarantee system in Colombia; and Jiménez, Rodas and Quiroz (2017) analyze the financing option in Guayas through the issuance of securities in the stock market.

Specifically, and regarding the performance of MSMEs and administrative practices, Gómez (2014) proposes that an important factor that generates change within these organizations is the implementation of communication tools within them. For their part, Ramírez, Beltrán and Nieto (2016) highlight the importance of process management as a trigger for competitiveness

<sup>1</sup> Kok et al. (2011) show that 85% of creation of employment is due to MSMEs. The WTO report (2016) indicates that the average contribution of MSMEs to GDP is 45% (55% in developed countries, and 35% in developing countries)

in the industrial sector in Queretaro. Gómez, Balderas and Rangel (2016), as well as Gómez op. cit., point out that adequate communication and a positive work climate are key factors in the performance of companies in the services sector.

Although research has been conducted on MSMEs as a type of enterprise, there are important differences between them, particularly between micro, small, and medium enterprises. Thus, this study analyses the microenterprise and the factors that affect its financial performance. There are, though few, some studies that specifically analyze microenterprises, among which are those by Alsaaty, Zenebe and Sengupta (2016), who study the impact of macroeconomic factors on micro-American enterprises. Their results suggest that domestic macroeconomic variables have a very important influence on the performance of such organizations. For his part, Yazdanfar (2013) examines the determinants of profitability in microenterprises in Switzerland. The study provides evidence that company size, profitability in previous periods, growth, and productivity have a positive impact on company profitability, while the age of companies and industrial affiliation affect it negatively.

Although literature on microenterprises in Mexico is scarce, Fajnzylber, Maloney and Montes-Rojas (2009) analyze the characteristics of enterprises related to their participation in credit markets, access to training, payment of taxes, and membership in business or industrial associations. Their results provide evidence that companies that participate in business associations, pay taxes, and borrow formally and informally have higher profitability and a higher probability of permanence; while companies that do not belong to business associations and receive credit have lower rates of return. The authors attribute this phenomenon to market and government failures that limit the ability of companies to reach optimal sizes.

This research contributes to the research efforts previously mentioned, analyzing the main determinants of financial performance in companies with 1 to 10 employees in Mexico. Empirical analysis incorporates two methodologies: econometric regression with cross-sectional data and artificial neural networks, allowing the evidence to be contrasted and confirmed.

## **Characteristics of the sample**

### *MSMEs in Mexico*

The “Business Practices in Small Firms in Developing Countries” survey of the World Bank was conducted in Mexico between 2008 and 2014. It has data for slightly more than 10,000 companies with less than 10 employees, distributed in three main sectors of economic activity: manufacturing, services, and commerce. It gathers information on age and years of education of the owner, age of the company, capital stock, gross profits, income, inventory value, adoption of marketing practices, purchase and inventory control, registration of cost and maintenance and financial planning, among others. Of the total information provided by the survey, only the 7690 consistent observations are used.<sup>2</sup>

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<sup>2</sup> To validate the consistency of the information, a cross reference between the profit margin and total revenue was done. Since total income is equal to total costs plus a profit margin, the following condition must be met:  $Y \geq \text{Margin}$ , i.e., total earnings cannot exceed income; for observations in which this condition is not met (just over 2,000) the data were not taken into account, leaving 7,690 valid observations to work with.

Table 1  
 Types of Practices

Marketing practices	Purchasing and inventory control	Registration of costs and maintenance	Financial planning
Visit competitors to review prices		Save written records	Review financial performance monthly
Visit competitors to compare products		Register each purchase and sale	Have sale objectives for the following year
Ask current clients to see what products should be offered	Negotiate for lower prices	Use records to know the cash flow	Compare sale objectives with the monthly budget
Ask former clients why they stopped making purchases	Compare with alternative suppliers	Use records to know if sales increase	Have a cost estimate for the following year
Use special offers to attract clients		Analyze thoroughly the costs of the main products	Prepare a profit and loss statement
To have had publicity in the last 6 months	Not running out of stock frequently	Know which products are more profitable	Prepare a cashflow statement
		Have a written monthly budget	Prepare a balance sheet
		Have records that can document ability to pay	Prepare an income and expenses statement

Source: Own elaboration based on Business Practices in Small Firms in Developing Countries 2008-2014, World Bank.

The survey collects adoption information on 4 business practices, primarily accounting and financial practices. Each practice is made up of a set of questions, aimed at knowing whether the organization performs specific tasks or not. Table 1 shows the set of tasks that make up each specific practice.

Given that each organizational practice is made up of a different number of tasks, the data were standardized by dividing the number of tasks performed by each company for each practice by the total number of tasks available in that practice, in order to make the information available for each practice comparable; as a result, values ranging from 0 to 1 in each practice are obtained.

Table 2 shows some of the main characteristics of the companies interviewed; on average, they are organizations that sell \$16,960 dollars a month, with owners who are 45 years old and who have completed only junior high school education; they are organizations that have an average of 3.4 years in the market and a capital stock equivalent to 1.2 months of sales. Their gross profit margin is just over a third of their sales.

Table 2  
 Average indicators of the sample

	Total	Commerce	Services	Manufacturing
Observations	7,690	4,956	2,359	375
Monthly sales (USD)	16,960	15,063	19,971	19,458
Age of the owner (years)	45.2	46.2	43.3	43.1
Education of the owner (years)	8.5	8.2	9.0	8.5
Age of the company (year)	3.4	3.3	3.5	3.6
Stock capital (USD)	19,847	19,543	20,341	17,474
Profit margin (%)	35.6	35.8	35.4	35.0

Source: Own elaboration based on Business Practices in Small Firms in Developing Countries 2008-2015, World Bank.

By comparison, companies in the services sector have the highest average sales, capital stock and education levels, while those in the commerce sector (65% of the total number of companies in the sample) have the highest profit margins, even though their sales are on average 25% lower than those in the manufacturing and services sectors. The manufacturing companies (4.9% of the sample) are the oldest.

## Methodology

The characteristics of the available information make it possible to use econometric methods that allow establishing a functional relationship based on pre-established theoretical models, but also, given the amount of information available, it is possible to develop non-parametric estimation models, as is the case with ANN models (Bechara *et al.*, 2009). Based on the above, both approaches are carried out, allowing comparison between results.

### Regression model with cross-section data

The regression model consists of specifying and estimating a relationship model between the variables related to a given theoretical matter (Novales, 1993); it has one (or more) dependent variables and a set of independent or explanatory variables and establishes a relationship between them, of the form:

$$Y = f(x_1, x_2, x_3, \dots, x_k; \beta) \quad (1)$$

When the type of relationship established between the variables is a linear relationship, the general model acquires the following form:

$$y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + u_i \quad i = 1, 2, \dots, n \quad (2)$$

Where:

$$y = (y_1, y_2, \dots, y_n)$$

$$\beta = (\beta_1, \beta_2, \dots, \beta_n)$$

$$x = \begin{pmatrix} x_{11} & \cdots & x_{1m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{pmatrix}$$

$$u_i = (u_1, u_2, \dots, u_3)$$

The  $\beta_i$  parameters transfer the effects or impacts of the set of independent variables  $x_i$  on the dependent variable  $y$ . The aim is for the set of explanatory variables to be closely related to the dependent variable; to the extent that this occurs, the error term  $u_i$  will tend to be smaller.

The procedure of Ordinary Least Squares (OLS) minimizes the quadratic error of function 14, through the process:

(3)

$$\min \beta_0, \beta_1, \beta_2 \text{ SRC}(\beta_0, \beta_1, \beta_2) = \sum_{i=1}^n (y_i - \beta_0 - \beta_1 x_{1i} - \beta_2 x_{2i})^2$$

Where SCR represents the sum of residues squared.

Minimizing function (3) provides an unbiased linear estimator of minimum variance, which “is efficient when the error term follows a normal distribution, i.e., has the least possible variance among all the unbiased estimators, whether linear or non-linear”, Novales (1993), pp. 67.

This result, on the one hand, allows analyzing the degree in which the independent variables are capable of explaining the behavior of the dependent variable; on the other hand, when the regression  $\beta_i$  coefficients are analyzed, it allows measuring the individual impact of each of the  $x_i$  independent variables on the dependent  $y_i$  variable.<sup>3</sup>

### *Artificial Neural Network*

An Artificial Neural Network (ANN) is a parallel distribution processor that works with a large quantity of data, which possesses a natural propensity to store experimental knowledge and turn it into information available for its use (Haykin, 1999). It resembles the brain in two aspects:

1. The knowledge of an Artificial Neural Network is acquired, as is the case of a Biological Neural Network, through a learning process.
2. The connecting forces between the neurons, called synaptic weights, are used to store the knowledge generated through the learning processes.

An ANN can be defined as a guided graph (Larrañaga, Inza and Moujahid, 2003) that complies with the following properties:

- i. Each node (neuron) is associated with an  $X_i$  state variable.
- ii. Each connection  $(i, j)$  among the nodes (neurons)  $i$  and  $j$  is associated with a weight  $w_{ij} \in \mathbb{R}$ .
- iii. Each node (neuron)  $i$  is associated with a threshold  $\theta_i \in \mathbb{R}$ .
- iv. A  $f_i(X_1, \dots, X_n, W_{i1}, \dots, W_{in}, \theta_i)$  function is defined for every node  $i$ , which depends on the weights of its connections, the threshold, and the states of the nodes  $j$  that are connected to node  $i$ . The value of this function provides the new state of the node.

In this way, ANNs can define both linear and nonlinear parameters mapped from an input to an output of the  $Y=Y(X; W, A)$  type, which is a continuous function of both the inputs and the  $W$  parameters and of the network architecture ( $A$ ).

A typical ANN architecture is divided into three segments (Bishop, 1995); the first is the input layer, which receives information from the outside; the second is the hidden layer, which establishes the relationship between the input variables (input layer) and the output variables (output layer), defined by:

Hidden layer:

$$a_j^1 = \sum_l W_{jl}^1 X_l + \theta_j^1; \quad h_j = f^1(a_j^1) \quad (4)$$

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<sup>3</sup> For more information on the assumptions that must be met in a linear regression model, see Novales (1993), Chapter 6.

And the third is the output layer, comprised of the sets of neurons that provide the response of the network, of the form:

$$a_j^2 = \sum_l W_{jl}^2 X_l + \theta_j^2; \quad h_j = h^2 (a_j^2) \quad (5)$$

An important difference between the types of ANN that exist is the number of layers that integrate the learning processes (hidden layers); a larger number of layers allows the approximation of more complex processes. Here, we use a hidden-layer ANN, known as multi-layer perceptron.

The process by which the hidden layers model store information and try to represent the functional forms of the data received in the input layer is known as neuron training. In this process, a subset of data  $D = \{X^{(n)}, t^{(n)}\}$  is used by adjusting the  $W$  of Function (5), minimizing the error of the function by means of the gradient descent method, expressed in the Function (6):

$$E_D(w) = \frac{1}{2} \sum n \sum i ((t_i^{(n)} - y_i(x^{(n)}; w))^2 \quad (6)$$

The minimization is based on continually evaluating the  $E_D$  gradient through the chain rule to find the derivatives, following the steps below:

Establish the synaptic weights and initial thresholds.

Execute one of the bases to obtain a response from the network against the  $i$ -th pattern.

Those errors are interpreted as error signals associated with this process; these errors are calculated using:

$$\left( \sum_{k=1}^S \left( \sum_{j=1}^0 W'_{kj} Y_j^r - \theta_k \right) W_{kj} \right) \frac{\partial f(\sum_{l=1}^n W_{jl} X_j^r - \theta_j)}{\partial (\sum_{l=1}^n W_{jl} X_j^r - \theta_j)} \quad (7)$$

1. The total current increase is calculated for each and every one of the patterns, thresholds, and weights  $\Delta W'_{kj}$  and  $\Delta W'_{ji}$ .
2. The weights and thresholds are updated.
3. The total error is calculated once more at  $t+1$ . If this error is not satisfactory, that is, if it is not the absolute minimum found through the decrease of the gradient, the error is once more interpreted as an error signal of the process; repeat step 3 until finding the absolute minimum.

Additionally, for each of the hidden and output layers, an activation function is estimated, which is determined by the estimation algorithm. The activation function relates the weighted sum of units in a layer to the values of units in the correct layer. This activation function is different for the hidden layers and the output layer.

## Analysis of the results

### Econometric application

Through the model developed in section 3.1, the following function is estimated:

$$Y/L_t = C + \beta_1 ED + \beta_2 EduD + \beta_3 Ant + \beta_4 Stock + \beta_5 PracMark + \beta_6 PracCont + \beta_7 PracReg + \beta_8 PracPlan$$

Where: *ED* is the age of the owner; *EduD* are the years of education of the owner; *Ant* is the age of the company on the market; *Stock* is the capital stock; *PracMark* are the marketing practices; *PracCont* are the accounting practices; *PracReg* are the registration of cost and maintenance practices; *PracPlan* represents the financial planning practices; and  $\beta_1, \dots, \beta_8$  are the coefficients estimated for each of the variables.

Table 3  
 Results of the econometric estimation

	Standardized coefficients (Beta)	t-statistic	Significance	Standard error
(Constant)		-18.536	.000	1284.788
Age of the owner	.044	5.086	.000	18.090
Education of the owner	.061	6.569	.000	60.151
Age of the company	-.034	-4.033	.000	149.633
Capital stock	.289	35.650	.000	.008
Marketing practices	-.012	-1.253	.210	173.676
Financial planning practices	.626	62.180	0.000	371.862
Registration of cost and maintenance practices	-.049	-4.638	.000	134.973
Purchase and inventory control practices	-.017	-1.676	.094	134.742

Source: Own elaboration with data from the econometric estimation

Note: Dependent variable, sales per employee as income proxy

The econometric analysis shows a differentiated importance of the adoption of administrative practices for the companies under study. Although, overall, they show to be important to explain the growth of sales, the practice that turns out to be more important is financial planning.

The variables of age and education of the owner are statistically significant at a level of 5% and show the expected signs. According to the coefficients, the age of the owner allows them to accumulate certain types of experience and knowledge that impact sales; however, the coefficients are low, indicating that the impact, although positive, is small.

On the other hand, the age of the company, although statistically significant, does not show the expected sign. Theoretically, a positive sign would indicate that the longer the organization is in the market, the more it tends to accumulate experience that allows it to know its customers and competitors and increase sales and, consequently, revenue. The fact that seniority shows a negative sign may be a result of the high mortality of micro organizations in Mexico; given that the average age of the companies in the sample is of only 3 years, as they accumulate years, sales tend to be lower, and by the third year they become so low that they are forced to close.

The capital stock is statistically solid for the explanation of variations in sales, and its impact is the second highest of the set of variables analyzed. It shows the expected sign and is congruent with the idea that the greater the physical capital available to workers, the higher their productivity, and this is reflected in sales.

The most important variable to explain sales behavior is the adoption of financial planning practices, which include timely reviews of budgets, expenses, and profits and losses of organizations, as well as future sales planning. The coefficient is statistically significant and positive, a fact that reinforces the idea that the adoption of certain types of organizational practices can influence the performance of companies.

The practices of purchase and maintenance registering, and purchase and inventory control do not show the expected sign; the latter is not statistically significant at the 5% level. The model as a whole is statistically significant ( $F=0.00$ ) and has a goodness of fit coefficient, measured by the determination coefficient  $R^2$  of 0.521.

#### ANN model

Once the econometric model has been estimated, an Artificial Neuronal Network model was done. Of the 7,464 observations considered valid, 61.1% were used for neuron training, 29.9% for correct training tests, and the remaining 8.9% were used to validate how close the values predicted by the Network are to the actual values.

The type of ANN used is a multi-layered perceptron; the input layer receives information on the following variables or factors: age of the owner, years of education of the owner, age of the business, capital stock, and degree of adoption of 4 administrative practices (marketing, purchase and inventory control, registration of cost and maintenance, and financial planning).

Table 4  
Case processing summary

		N	Percentage
Input layer variables: Age of the owner; education of the owner; Age of the company; Capital stock; Degree of adoption of marketing practices, purchase and inventory control, registration of cost and maintenance, and financial planning.	Training	4564	61.1%
	Tests	2233	29.9%
	Reserve	667	8.9%
Valid		7464	100.0%
Number of hidden layers			
Hidden layers		1	
Number of units in hidden layer 1			
		4	
Activation function			
		Hyperbolic tangent	
Dependent variables			
	1	MONTHLY SALES	
Number of units			
Output layers		1	
Scale change method for the dependent scales			
		Standardized	
Activation function			
		Identity	
Error function			
		Sum of squares	

Source: Own elaboration with modelling data

The results show a hidden layer comprised of 4 units—shown in Table 4—whose activation function is the hyperbolic tangent,<sup>4</sup> and the output layer, which has an activation function for the revenue per employee that relates the weighted sum of units of a layer with the values of units in the correct layer, returned unchanged (identity function) using the function  $\gamma(c)=c$ . The results are shown in Table 3.

The analysis of the reserve sample indicates that ANN results are robust for estimating monthly sales performance. Figure 1 shows the actual and estimated values for the reserve

<sup>4</sup> Given by the function  $\gamma(c) = \tanh(c) = \frac{e^c - e^{-c}}{e^c + e^{-c}}$

sample. For 90% of the observations (companies with monthly sales of less than \$40,500 dollars), the ANN estimates the behavior of sales by company to have errors of less than 3%; however, for those organizations with monthly sales of more than \$40,500 dollars (10% of the reserve sample), the value of sales is systematically overestimated by the neural network. This could be an indicator that the higher the sales, the more complex the factors influencing their determination.

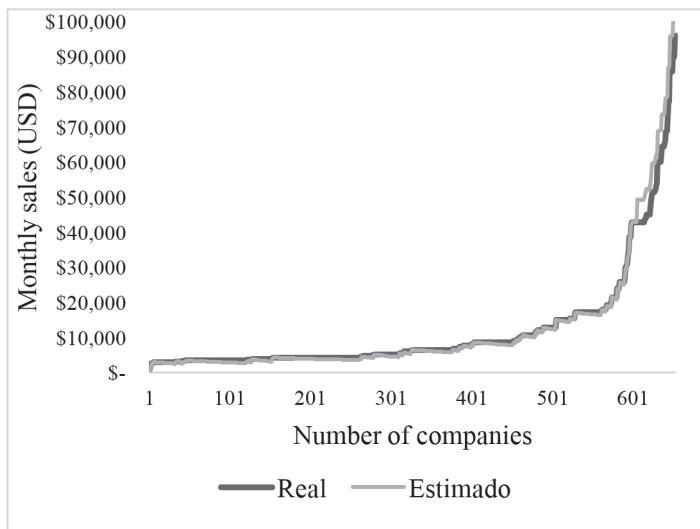


Figure 1. Graphical representation of the results of the estimation  
Source: Own elaboration of ANN, based on data from the World Bank.

Regarding the variables introduced in the input layer, Graph 2 shows the analysis of the importance of the variables; the results are relatively coincidental with those obtained using econometric methods. The most important organizational practice to explain sales performance is financial planning. This result indicates that as companies keep an accounting record of their sales and costs, analyze their budgets, and make estimates about future costs and sales, they are able to more efficiently manage their business, allowing them to increase sales.

The second variable in terms of importance is capital stock; this indicates that if organizations have more physical capital, they are able to respond more quickly to increases in demand. This result is consistent with the neoclassical growth theory, which states that a larger capital stock per worker increases work productivity.

At the same time, marketing practices, which could be defined as market intelligence strategies (which not only include advertising, but primarily competitive analysis and the launch of special deals to attract customers), play an important role in determining monthly revenue.

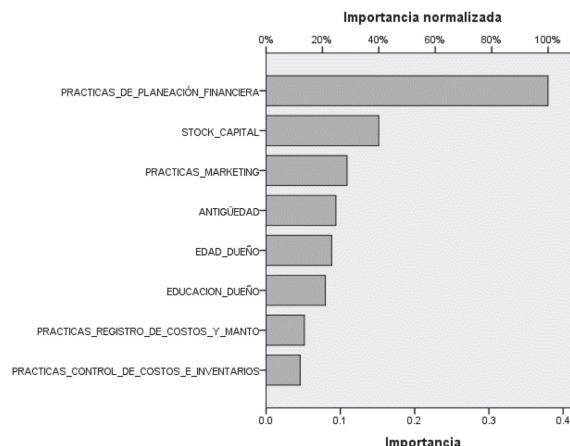


Figure 2. Standardized importance of each factor

On the other hand, the age of the organization on the market takes 4th place in terms of importance to explain sales. Given the characteristics of the analyzed segment (microenterprises), the average age of the sample is relatively low (just over 3 years), which suggests that companies are located in early stages of the learning curve, so that small differences in time on the market can represent important learning distances, as is also validated by the econometric analysis.

Variables such as the age and education of the owner are not relevant to explain the sales performance, mainly because education barely reaches basic (junior high school).

Finally, there are two accounting practices, which on average have the least influence on the level of sales. On the one hand, the registration of cost control and maintenance and, on the other, inventory control practices. Given the characteristics of the analyzed segment of companies (companies with an average of 3 employees, mainly from the commercial sector), the probability of a high proportion being family businesses tends to increase. The results indicate that, for this type of organization, the development of practices that allow differentiation of personal and organizational assets and a systematic record of costs are, at best, scarce.

The results obtained coincide, in a certain sense, with those obtained by Fajnzylber, Maloney and Montes-Rojas (2009), given that in order for the activities that these authors indicated (participation in the credit market, payment of taxes, access to training, and membership of business associations) to be carried out, it is necessary to have certain practices within the organizations. Fajnzylber *et al.* refer to the fact that the characteristics of organizations persist over time as they are correlated with unobserved entrepreneurial skills and capabilities. Some of the unobserved characteristics could be the lack of training in financial and accounting practices, derived from the educational deficiency of Mexican entrepreneurs.

## Conclusions

Extensive literature shows the importance of adopting management practices in the performance of small, medium, and large enterprises; however, research on microenterprises is very limited. Examining the case of microenterprises in Mexico, this study identifies a

differentiated importance in their adoption by these enterprises. To measure their impact, an econometric analysis was applied, as well as another one through the Artificial Neural Networks of nearly 8,000 companies from the “Business Practices in Small Firms in Developing Countries” survey of the World Bank, and the results are compared.

In terms of the preliminary analysis of the survey, the average indicators reflect an alarming situation of educational backwardness on the part of Mexican entrepreneurs, since the average level of education is junior high school, which implies that some of them know how to read, write, and perform basic mathematical operations, but do not have the skills and knowledge related to the practices suggested in this research, nor the basic tools to acquire them.

The empirical results show that financial planning practices—which include: monthly review of sales (actual and estimated), budgeting of costs and annual sales, and the preparation of accounting records of financial performance—are those that show an impact on the financial performance of the company, estimated from sales revenue. In contrast, the practices of purchase and inventory control, and purchase and maintenance registration, do not show a significant impact on the financial performance of companies, whereas the capital stock significantly impacts monthly income, validating the theory that a higher ratio of capital per worker impacts productivity and, subsequently, sales.

The ANN analysis is capable of explaining, with errors of less than 3%, the monthly sales of companies with sales of less than \$740,000 pesos per month. However, for organizations with revenues above this amount, the Network tends to systematically overestimate the value of sales, which indicates that, for larger companies, other factors influence their performance.

The results contribute to the literature by providing information on key aspects of the financial performance of Mexican micro-organizations, including financial planning practices and the variables of capital stock, and age and education of the owner of the company. The former implies that the support granted by the public and private sectors to this sector should not only be accompanied by resources and technical training, but ought to also include financial advice to promote the success of the organization. The variables of capital stock and education of the owner, the second and third factors, point to the need to implement a comprehensive investment strategy in education to increase the level of knowledge and skills of the Mexican population and develop technological innovations that allow small businesses to intensify their level of capital used.

The agenda of future research studies could include the study of financial performance in microenterprises in other countries, for comparative purposes. Likewise, the differences or similarities between the aspects that trigger the performance of these organizations according to the sector they belong to could be studied. In terms of methodology, some other models could be applied, such as apparently unrelated regressions.

## References

Alsaaty, F., Zenebe, A. and Sengupta, S. (2016) The Influence of Some Macroeconomic Factors on the Growth of Micro Firms in the United States Available at SSRN: <https://ssrn.com/abstract=2775339> or <http://dx.doi.org/10.2139/ssrn.2775339>. Access on 12/June/2017

Alvarez, A. T. V., Carrasco, L. V. M., y Córdova, Z. A. F. (2016). Estrategia organizacional y la rentabilidad en empresas del sector automotriz de la Zona Central del Ecuador. *Revista Eniac Pesquisa*, 5(2), 181-192. <http://dx.doi.org/10.22567/rep.v5i2.399>

Barbosa, D. M. E., y Ayala, A. H. (2014). Factores que influyen en el desarrollo exportador de las pymes en Colombia. *Estudios Gerenciales*, 30(131), 172-183. <https://doi.org/10.1016/j.estger.2014.04.006>

Barrera, D. H., Acosta, M. D. C. A., Armenteros, Y. V., Morales, J. A. M., y del Rio Ramírez, B. (2016). Competencias Directivas En El Sector Industrial: Medición Del Desempeño En Empresas De Coahuila, Mexico. *Revista Internacional Administración y Finanzas*, v. 9 (3) p. 1-28, 2016. Available at SSRN: <https://ssrn.com/abstract=2673171> Access on 05/July/2017

Bechara, J. E. A., Cruz, J. C. T., y Ceballos, H. V. (2009). Predicciones de modelos econométricos y redes neuronales: el caso de la acción de SURAMINV. *Semestre Económico* Universidad de Medellín, 12(25), 95-109. Available from <[http://www.scielo.org.co/scielo.php?script=sci\\_arttext&pid=S0120-63462009000300007&lng=en&nrm=iso](http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-63462009000300007&lng=en&nrm=iso)>. Access on 07 / Aug. / 2017

Bishop, C. M. (1995). Neural networks for pattern recognition. Oxford university press. Disponible en <http://www.cs.ukzn.ac.za/~sviriri/Books/Machine-Learning-Pattern-Recognition/book5.pdf> Consultado 23/May/2017

Bizarrón, M. E. B., Palacios, E. M. C., Bobadilla, L. I. Z., y García, N. L. A. (2014). El desarrollo de la Mipyme y la vinculación universitaria en Puerto Vallarta, Jalisco. *European Scientific Journal, ESJ*, 10(19). Available at <http://www.eujournal.org/index.php/esj/article/view/3788/3604>. Access on 18/Junio/2017

Fajnzylber, P., Maloney, W. F., y Montes-Rojas, G. V. (2009). Releasing constraints to growth or pushing on a string? Policies and performance of Mexican micro-firms. *The Journal of Development Studies*, 45(7), 1027-1047. <http://dx.doi.org/10.1080/00220380802264911>

García Osorio, O., Quintero Quintero, J., y Arias-Pérez, J. (2014). Capacidades de innovación, desempeño innovador y desempeño organizacional en empresas del sector servicios. *Cuadernos de Administración*, 27(49), 87-108. Available at <http://www.redalyc.org/html/205/20541034005> Access on 14/July/2017

García, G. H., y Villafuerte, M. F. (2015). Las restricciones al financiamiento de las PYMES del Ecuador y su incidencia en la política de inversiones. *Actualidad Contable FACES*, 18(30). Available at <https://www.saber.ula.ve/handle/123456789/40593>. Access on 28/July/2017

García, M. L. S., y Osorio, S. C. B. (2014). El problema de financiamiento de la PYME y el sistema nacional de garantías en Colombia. *Contaduría Universidad de Antioquia*, (62), 69-88. Available at <http://aprendeenlinea.udea.edu.co/revistas/index.php/cont/article/view/18912>. Access on 19/May/2017

Gómez, L. A., Balderas, H. C., y Rangel, D. O. (2016). Diagnóstico del clima laboral en una empresa PyMes del sector servicios. *Red Internacional de Investigadores en Competitividad*, 9(1), 1090-1102. Available at <http://www.riico.net/index.php/riico/article/view/61>. Access on 27/June/2017

Gómez, M. E. (2014). Implementación de herramientas de comunicación interna como generadoras de cambios en las PyMES. Razón y Palabra Available at:<<http://oai.redalyc.org/articulo.oa?id=199532731009>> ISSN 1605-4806 . Access on 14/Julio/2017

Gómez, M., López, C., Vicario, B. P., y Sánchez, A. (2015). Las TIC en el contexto de las pequeñas empresas-Percepciones, actitudes y creencias de los empresarios de Pymes en relación a su integración en la actividad laboral. *Investigação Qualitativa em Educação*. CIAIQ2014, 3. Available at <http://www.proceedings.ciaiq.org/index.php/CIAIQ/article/view/461>. Access on 15/Mayo/2017

Guzmán, M. G., Guzmán, M. M., y Fuentes, M. R. (2016). Análisis del uso de las TIC en las pymes de Guayaquil en el año 2015. *Revista OIKOS*, 20(41). ISSN 0718-4670 • pp. 109 – 119. Available at <https://dialnet.unirioja.es/descarga/articulo/5841091.pdf>. Access on 13/May/2017

Haykin, S. (1999). *Neural Networks. A Comprehensive Foundation*, Prentice-hall.

Huerta, L. M., Ruiz, C. L., y Baltazar, E. R. (2013). PYMES: contribuciones a la economía y competitividad en México. *Observatorio de la Economía Latinoamericana*, 1. Available at <http://www.eumed.net/cursecon/ecolat/mx/2013/economia.html>. Access on 22/June/2017

Jacques Filion, L., Cisneros, L. F., y Mejía Morelos, J. H. (2011). *Administración de pymes: Emprender, dirigir y desarrollar empresas*. Pearson.

Jiménez, L. R. G., Rodas, M. F. G., y Quiroz, M. Q. G. (2017). Opción de Financiamiento a Pymes ubicadas en la Provincia del Guayas enfocadas en la Búsqueda de Capitales mediante la Emisión de Títulos a través del Mercado de Valores Ecuatoriano. *Empresarial*, 10(40), 21-30. ISSN No. 1390-3748. Available at <https://dialnet.unirioja.es/descarga/articulo/5924579.pdf>. Access on 18/May/2017

Larrañaga, P., Inza, I., y Moujahid, A. (2003). *Modelos Probabilísticos para la Inteligencia Artificial y la Minería de Datos: Selección de Variables*. Curso de Doctorado. Available at <http://leo.ugr.es/doctopgm/cartel.pdf>. Access on 10/June/2017

Kok, J., Vroonhof, P., Verhoeven, W., Timmermans, N., Kwaak, T., Snijders, J., & Westhof, F. (2011). Do SMEs create more and better jobs. *Report prepared by EIM for the European Commission DG Enterprise and industry, Brussels, European Commission*. Available at [https://www.researchgate.net/profile/Ton\\_Kwaak/publication/216757815\\_Do\\_SMEs\\_create\\_more\\_and\\_better\\_jobs/links/0912f50ab3e7cd1d91000000.pdf](https://www.researchgate.net/profile/Ton_Kwaak/publication/216757815_Do_SMEs_create_more_and_better_jobs/links/0912f50ab3e7cd1d91000000.pdf). Access on 18/July/2017

Méndez, Páez, y Lozano (2016) La aplicación de las TIC en los sistemas de gestión de las PyME del sector portuario. *Redes de Ingeniería*, 7(1), 24-40. <https://doi.org/10.14483/udistrital.jour.redes.2016.1.a5>.

Novales, A. (1993). *Econometría* (2<sup>a</sup> edición). McGraw-Hil.

Ramírez, L. S. M., Beltrán, J. M., y Nieto, E. S. D. (2016). Gestión por procesos como factor de competitividad de PyMes del sector industrial en el estado de Querétaro. *Red Internacional de Investigadores en Competitividad*, 9(1), 816-832. Available at <http://riico.net/index.php/riico/article/view/45> Access on 25/May/2017

Ramos, A. L. (2015). Desempeño, miedo al error y capacidad de innovación en una muestra de directivos de empresas de servicios españolas. *Interciencia*, 40(4), 224-232. Available at: <<http://www.redalyc.org/articulo/oai?id=33935906009>> ISSN 0378-1844. Access on 28/June/2017

Rubio Bañón, A., y Aragón Sánchez, A. (2002). Factores explicativos del éxito competitivo. Un estudio empírico en la pyme. *Cuadernos de Gestión* 2(1): 49-63. Access on <http://hdl.handle.net/10810/7024>. Access on 14/July/2017

Sánchez, A. A., y Bañón, A. R. (2005). Factores explicativos del éxito competitivo: el caso de las pymes del estado de Veracruz. *Contaduría y administración*, (216). Available at <http://www.cya.unam.mx/index.php/cya/article/view/568>. Access on 07/June/2017

Vera-Colina, M. A., Melgarejo-Molina, Z. A., y Mora-Riapira, E. H. (2014). Acceso a la financiación en Pymes colombianas: una mirada desde sus indicadores financieros. *Innovar*, 24(53), 149. Available at <https://search.proquest.com/openview/7c09a2abdef467d8a1585ad1e03c70aa/1?pq-origsite=gscholar&ycbl=2035726> Access on 08/June/2017

WTO (2016) Informe de comercio mundial 2016. Available at [https://www.wto.org/spanish/res\\_s/booksp\\_s/world\\_trade\\_report16\\_s.pdf](https://www.wto.org/spanish/res_s/booksp_s/world_trade_report16_s.pdf). Access on 29/July/2017

Yazdanfar, D. (2013). Profitability determinants among micro firms: evidence from Swedish data. *International Journal of Managerial Finance*, 9(2), 151-160. <https://doi.org/10.1108/17439131311307565>.