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ORIGINAL
Research article

Exogenous variables as predictors of neighborhood store*

Variables exógenas como predictoras de las ventas en las tiendas de barrio

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Abstract
Neighborhood stores are an engine of the country's economy. However, they are exposed to situations such as the arrival of discount stores, the use of digital channels, changes in consumer habits, and poor physical structures. Therefore, studying exogenous variables to forecast their effect on sales is relevant. The objective of this study is to model econometrically to forecast the effect of exogenous variables on the sales of neighborhood stores. The research uses a quantitative, descriptive, correlational field method with two phases; the first is applying a measurement instrument to a cluster sample of 66 stores. From the data collected in the second phase, econometric models were tested to establish the effect of the exogenous variables on the sales of neighborhood stores. Based on the values found in the proposed model, it can be inferred that the most influential variable is the unemployment rate, followed by the employment rate and inflation. It is concluded that it is essential for neighborhood stores to reflect on the effects of environmental variables on their commercial activity to be financially sustainable and prepared in times of economic crisis. The study suggests that shopkeepers

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should be aware of exogenous variables to optimize their sales and avoid being immersed in an unstable financial situation.
Keywords: Retail Trade, Neighborhood Stores, Exogenous Variables, Sales

Resumen
Las tiendas de barrio es un motor de la economía del país, no obstante, están expuestas a situaciones como la llegada de tiendas de descuento, el uso de canales digitales, los cambios en los hábitos de consumo, las deficientes estructuras físicas, entre otros, por tanto, es relevante el estudio de las variables exógenas para pronosticar su efecto sobre las ventas. El objetivo de este estudio es modelar econométricamente para pronosticar el efecto de las variables exógenas en las ventas de las tiendas de barrio. La investigación utiliza un método cuantitativo, descriptiva, correlacional, de campo, con dos fases, en la primera la aplicación de un instrumento de medición a una muestra por conglomerados de 66 tiendas. A partir de los datos recaudados en una segunda fase se probaron los modelos econométricos para establecer el efecto de las variables exógenas en las ventas de las tiendas de barrio. En función de los valores encontrados en el modelo propuesto se puede inferir que la variable de mayor influencia es la tasa de desempleo, seguida por la tasa de empleo y la inflación. Se concluye que es importante que las tiendas de barrio reflexionen sobre los efectos que tienen sobre su actividad comercial las variables de entorno para estar preparadas en momentos de crisis económica y lograr ser sostenibles financieramente. El estudio sugiere el conocimiento que deben tener los tenderos de las variables exógenas a fin de optimizar sus ventas y no verse inmersos en situaciones financieras inestables.
Palabras Clave: Comercio Minorista, Tiendas de Barrio, Variables Exógenas, Ventas

SUMMARY

Introduction

The sales volume of an economic activity can be affected by various factors (Arreaga et al.,2023). some of these can be the price of the good, that of substitute products, consumer income, as well as changes in consumption habits; these variations, on many occasions, can cause reductions in sales (Castillo-Girón, Martínez & Ayala-Ramírez, 2019).

In this order of ideas, it is worth clarifying that the neighborhood store market becomes one of the drivers of retail trade. In an interview with Acosta (2017), there are approximately 720,000 retail stores in the country that cover all types of businesses and allow cost savings for those who do not have the means or time to travel to a supermarket to purchase their products and have complementary strategies (Ortiz & Peralta, 2014). In addition, many stores are considered symbols of tradition and experience (as they allow a direct relationship between the shopkeeper and the inhabitants of a neighborhood Paramo Morales (2012).

However, analyzing the current national scenario, retail store sellers are going through a sales crisis, as are many other sectors of society (Díaz-Ortega et al., 2020). about the possible causes that generate such a situation, Fernández and Carrillo (2017) studied this phenomenon in order to be able to propose strategies to reduce the impact of the factors that tend to affect sales volumes, as they are losing market share so that it is possible to avoid the extinction of such stores due to the strong competition they currently face (Villegas-López et al.,2023).

In this field, there are several studies by Contreras Cuentas, Rojano Alvarado & Macías (2021), and Buitrago (2019) identifying certain aspects, such as the arrival of discount stores. Fellizolla et al. (2020) made known that this new competition has employed a strategy of low prices and digital channels (Barón-López, 2023; Morales, 2021) social networks (Botero et al., 2020) and with this has massively invaded trade (Morales et al., 2019 and Molina et al. 2019), has developed studies of changes in consumer habits. In addition, a modern physical structure (Sánchez-Flack et al., 2016) and safety, hygiene, and offers for authors such as (Bohórquez-López et al., 2022).

On the other hand, the lack of knowledge of the variables is a determining factor within the business model and the analysis of a company's sales, given that the lack of knowledge of these variables can cause such a model to fail by presenting a negative reaction to market fluctuations, thus affecting its goals and policies of reaction to market trends.

This research work analyzed the outlook of the retail stores in the La Cumbre neighborhood, taking into account the realization of an econometric model that considers exogenous variables such as inflation, employment rate, and unemployment rate in order to forecast their influence on sales; this is of vital importance because there is a lack of a previous study that allows to recognize the current state of the retail market of La Cumbre neighborhood and the factors that are affecting its sales volumes.

Resolution scheme

1. Research problem

What is the predictive model that predicts the effect of exogenous variables on sales in neighborhood stores?

2. Methodology

The research was exploratory and descriptive. A quantitative study was carried out in two phases: collection of primary information and development of an econometric model. In the first phase, a survey was designed for buyers and sellers to measure the possible variables that affect the volume of sales; an instrument or survey was applied to the shopkeepers of La Cumbre neighborhood in the city of Bucaramanga. Through the research in La Cumbre, a census was conducted that established that there are about 320 retail stores, which gives us an idea of the size of the population. As for the probability of success, it was taken as 50.00% because there is no previous data about the number of businesses impacted by exogenous variables that reduce the volume of sales. To determine the sample size knowing the population size, we used the following equation:

$$n = \frac{NZ_{\alpha}^{2}pq}{d^{2}(N-1)+Z_{\alpha}^{2}pq} \qquad [1]$$

Where:
n is the sample size
N is the population size
Z_{α}^{2} is the square of the confidence interval
p is the probability of success
q is the probability of failure

d is an admissible error

Using a success rate of 50.00%, an error of 10.00%, and a confidence interval of 90.00%, we have:

$$n = \frac{320 * 1.645^2 * 0.5 * 0.5}{0.1^2(320 - 1) + 1.645^2 * 0.5 * 0.5}$$

n it is 66 surveys

The sampling method selected was cluster sampling (Lami, Díaz-Caro, & Mesias, 2023), dividing the population of neighborhood stores into subpopulations; in this case, because it is a geographic area, it can also be called area sampling, where each area is a block of the La Cumbre neighborhood. For each block, all the elements of the sample were included in a probabilistic way, applying the simple random system.

In this context, due to the informal nature of the administration of the stores and the fact that some are reluctant to reveal their income, it was not always possible to obtain the monthly income records of each store, in some cases because they do not keep a daily record of income and expenses that allows establishing their sales volume at the end of the month and in other cases where this does occur. However, the owner often does not want to reveal the amount of money he/she manages because he/she does not feel confident to provide such data. Therefore, the data analysis was done with the 16 stores that provided such information for the study period between January 2016 and March 2020.

In the second phase, the econometric model was made with the sales forecasts and related the income with several exogenous variables, such as the period of the year, inflation and employment and unemployment rates, data extracted from the information provided by the Banco de la República (Banco de la República, 2020).

3. Writing plan

3.1 Exogenous variables

Exogenous variables are those variables that affect the performance of an economic model but are themselves unaffected by any of the relationships described in the model (Hrishikesh, Pramod & Radhika, 2019). Also, “default variables” are referred to as those variables that help provide explanations for endogenous variables and values that are determined from outside the model, which are exogenous variables or default variables. These variables, also called boundary variables, influence the system but are not influenced by it and are not controlled at will, hence their name (Vasrsavsky, 1984).

Likewise, exogenous variables help to explain changes in endogenous variables. It is common to include past values of endogenous variables in the default set (Del Sol Software, 2020). Since the exogenous variables are predetermined, they are independent of the disturbance term in the model. That is, they satisfy the assumptions of explanatory variables in a regression model.

Similarly, the exogenous variables selected are the unemployment rate, employment rate, and inflation. Inflation is an upward price movement, irreversible and self-perpetuating, caused by an excess of demand over supply capacity (Blanchard, 2017) due to the fact that it is not

possible to control the supply or demand of the products sold in a neighborhood store by the shopkeeper because it is a macroeconomic phenomenon, it is considered an exogenous variable.

In addition, the National Administrative Department of Statistics (DANE) defines the employment rate as "the percentage ratio between the employed population (OC) and the number of people in the Working Age Population (PET)" (Mankiw, 2012). Likewise, it defines the unemployment rate as "the percentage ratio between the number of people who are looking for work (DS) and the number of people in the labor force (EAP)," that is, the percentage of the labor force that is unemployed (Mankiw, 2012). Therefore, this variable is clearly exogenous.

4. Research results

4.1 Actual sales in neighborhood stores

Sales data obtained from stores that provided such information are compiled in Table 1 below.

Table 1. ***Inflation, employment rate, unemployment and sales in local stores***

INFLATION	EMPLOYMENT RATE (%)	UNEMPLOYMENT RATE (%)		ANNUAL	MONTH	SALES
7.45	58.42	14.07	2016	1	Enero	2.95
7.59	61.36	10.33		2	Febrero	4.67
7.98	60.13	10.17		3	Marzo	5.67
7.93	61.11	9.10		4	Abril	4.92
8.20	60.14	9.02		5	Mayo	6.21
8.60	60.73	10.24		6	Junio	6.25
8.97	60.39	10.38		7	Julio	6.10
8.10	60.40	9.90		8	Agosto	5.71
7.27	61.50	9.25		9	Septiembre	4.47
6.48	61.84	9.04		10	Octubre	4.71
5.96	61.75	8.69		11	Noviembre	5.85
5.75	61.03	9.81		12	Diciembre	12.07
5.47	58.40	13.42	2017	1	Enero	4.04
5.18	59.37	11.02		2	Febrero	4.75
4.69	59.68	10.58		3	Marzo	4.42
4.66	59.93	10.73		4	Abril	5.67
4.37	59.91	10.18		5	Mayo	5.38
3.99	60.43	10.82		6	Junio	5.68
3.40	59.35	11.31		7	Julio	6.35
3.87	60.54	9.92		8	Agosto	5.53
3.97	60.26	10.53		9	Septiembre	4.48
4.05	60.29	9.49		10	Octubre	5.16
4.12	60.17	9.57		11	Noviembre	5.51
4.09	60.08	9.84		12	Diciembre	12.11
3.68	56.57	13.45	2018	1	Enero	6.43
3.37	57.96	11.87		2	Febrero	4.58
3.14	59.87	10.55		3	Marzo	5.25
3.13	59.23	10.68		4	Abril	5.31
3.16	60.33	10.13		5	Mayo	5.83
3.20	59.04	11.07		6	Junio	6.23
3.12	60.29	10.13		7	Julio	4.75
3.10	59.11	10.09		8	Agosto	4.95
3.23	60.29	10.48		9	Septiembre	4.97
3.33	59.62	10.23		10	Octubre	5.00
3.27	59.05	9.84		11	Noviembre	6.79
3.18	59.27	10.73		12	Diciembre	9.21
3.15	56.36	13.74	2019	1	Enero	5.89
3.01	57.63	12.43		2	Febrero	4.40
3.21	58.67	11.98		3	Marzo	5.24
3.25	57.91	11.14		4	Abril	4.97

3.31	58.83	11.24		5	Mayo	6.06
3.43	58.95	10.75		6	Junio	4.93
3.79	59.55	10.34		7	Julio	6.87
3.75	57.90	11.38		8	Agosto	6.69
3.82	59.45	10.05		9	Septiembre	5.82
3.86	59.11	10.37		10	Octubre	6.35
3.84	59.52	10.38		11	Noviembre	6.72
3.80	59.39	10.54		12	Diciembre	12.02
3.62	57.16	12.87	2020	1	Enero	6.32
3.72	58.30	11.54		2	Febrero	6.12
3.86	52.78	13.39		3	Marzo	5.76
3.51	41.19	23.47		4	Abril	6.07
2.85	45.02	24.49		5	Mayo	5.88
2.19	45.28	24.87		6	Junio	5.05
1.97	45.72	24.69		7	Julio	7.25
1.88	49.49	19.56		8	Agosto	6.80
1.97	51.98	18.26		9	Septiembre	6.77
1.75	53.91	16.78		10	Octubre	5.18
1.49	54.42	15.39		11	Noviembre	7.34
1.61	55.12	16.02		12	Diciembre	12.22

Source: own elaboration.

Table 2 shows the summary of the sales made by the selected stores in the period under study; it shows changing movements, with high points that fall after a short time; it is observed that there is an increase in sales in November, at the end of the year, it could be derived from the Christmas season or the positive image of the store (Treviño & Treviño, 2021). However, in general terms, there is no stability in sales as a result of the strong competition they have had to face during the last few years. Goh, Tang & Ng (2020) obtained similar results as the inflation rate affects the occupancy rate.

Table 2. ***Actual sales between January 2016 and March 2020***

ANNUAL	MONTH	REAL SALES IN MILLIONS OF PESOS ($)
2016	1 January	2.95
	2 February	4.67
	3 March	5.67
	4 April	4.92
	5 May	6.21
	6 June	6.25
	7 July	6.10
	8 August	5.71
	9 September	4.47
	10 October	4.71
	11 November	5.85
	12 December	12.07
2017	1 January	4.04
	2 February	4.75
	3 March	4.42
	4 April	5.67
	5 May	5.38
	6 June	5.68
	7 July	6.35
	8 August	5.53
	9 September	4.48
	10 October	5.16
	11 November	5.51
	12 December	12.11
2018	1 January	6.43
	2 February	4.58
	3 March	5.25
	4 April	5.31
	5 May	5.83
	6 June	6.23
	7 July	4.75
	8 August	4.95

	9	September	4.97
	10	October	5.00
	11	November	6.79
	12	December	9.21
2019	1	January	5.89
	2	February	4.40
	3	March	5.24
	4	April	4.97
	5	May	6.06
	6	June	4.93
	7	July	6.97
	8	August	6.69
	9	September	5.82
	10	October	6.35
	11	November	6.72
	12	December	12.02
2020	1	January	6.32
	2	February	6.12
	3	March	5.76

Source: own elaboration.

4.2 Predictive model

The analysis was performed, and a model was found to predict the data. The centered moving average analysis was used. Due to the seasonality of the data, it is not only necessary to calculate the centered moving average, but it is also necessary to establish the seasonal ratio, the seasonal index, and the adjusted seasonal index, which will be used to calculate the seasonally adjusted sales and sales forecasts once the data have been linearized, it is observed how the quality of service in the retail trade is relevant to maintain the average sales (Prada & Acosta-Prado, 2017).

Next, Tables 3,4, and 5 show the seasonal index adjusted for each of the records obtained with which the forecast was made. In the analysis of the values of the coefficient of determination, it is observed that as variables are added to the model, the proportion of data explained by the independent variables increases; therefore, it is justified to choose it as the best model (table 5).

Table 3. ***Period as independent variable***

	COEFFICIENTS
Intercept	5.39
Period	0.02
Adjusted R^2	0.113

Source: own elaboration.

The linearization of the seasonally adjusted data, with the period and inflation variables, is shown in Table 4.

Table 4. ***Period and inflation as independent variables***

	COEFFICIENTS
Intercept	4.019
Period	0.0383
Inflation	0.195
Adjusted R^2	0.165

Source: own elaboration.

The linearization of the seasonally adjusted data, with three variables: the period, inflation, and the employment rate, is shown in Table 5.

Table 5. ***Period, inflation, and employment rate as independent variables***

	COEFICIENTES
Intercept	17.87
Period	0.034
Inflation	0.161
Employment rate	-0.168
Unemployment rate	-0.336
Adjusted R^2	0.233

Source: own elaboration.

Therefore, the model is as follows:

$$Y_i = w_i(0.034x_{1i} + 0.161x_{2i} - 0.168x_{3i} - 0.336x_{4i} + 17.87)$$

Where:
Y_i is the average sales in each period
w_i is the seasonally adjusted index for each period
x_{1i} is the period in which sales are calculated
x_{2i} is inflation for the period in which sales are calculated
x_{3i} is the employment rate for the period in which sales are calculated
x_{4i} is the unemployment rate for the period in which sales are calculated

Based on the coefficients for the model variables, it can be stated that according to the model, there is an increase of 0.034 million pesos for each increase in the period for the period analyzed, there is an increase of 0.161 million for each point that inflation increases, a reduction of 0.168 million for each point that the employment rate increases and a reduction of 0.336 million for each point that the unemployment rate increases, additionally there is a value of 17.87 million that is independent of the variables analyzed. Based on the values found in the proposed model, it can be inferred that the most influential variable is the unemployment rate, followed by the employment rate and inflation. Research by authors such as Aceves & Absalón (2023) has shown a positive relationship between inflation and economic growth.

As can be seen in Table 6, the graph of actual sales versus sales predicted by the model found that although there is a difference between the values of both series, an analysis based on statistical indicators allows making statements about the goodness of fit of the model proposed. In addition, when observing the graph, it can be seen that the values predicted by this model are closer to the real values; the only difference is observed between March and December 2020, probably because the inflation variables and employment and unemployment rates have greater incidence than the period variable on sales and such sales are predicted based on the real results that only arrive until March 2020, similar results for informal trade obtained (Fajardo-Hoyos, Gómez-Sánchez & Sarmiento-Castillo, 2018, p. 137) “being a retailer reduces sales revenue incrementally in informal businesses.”

Table 6. ***Actual sales vs forecast***

	ANNUAL	MONTH	PERIOD, INFLATION AND EMPLOYMENT	PERIOD AND INFLATION	PERIOD	REAL
2016	1	January	4.12	4.96	4.87	2.95
	2	February	4.38	4.52	4.41	4.67
	3	March	4.84	4.78	4.58	5.67
	4	April	5.70	5.45	5.21	4.92
	5	May	6.04	5.61	5.31	6.21
	6	June	6.05	6.14	5.71	6.25
	7	July	5.75	5.84	5.35	6.10
	8	August	5.45	5.37	5.05	5.71
	9	September	4.86	4.74	4.57	4.47
	10	October	5.15	4.99	4.93	4.71
	11	November	6.34	5.99	6.00	5.85
	12	December	10.44	10.31	10.37	12.07
2017	1	January	5.22	5.96	6.04	4.04
	2	February	4.27	4.31	4.39	4.75
	3	March	5.00	4.94	5.11	4.42
	4	April	4.79	4.82	4.97	5.67
	5	May	5.67	5.51	5.72	5.38
	6	June	5.02	5.15	5.40	5.68
	7	July	5.13	5.23	5.58	6.35
	8	August	5.48	5.34	5.59	5.53
	9	September	4.97	4.99	5.18	4.48
	10	October	5.30	5.02	5.18	5.16
	11	November	7.26	6.89	7.07	5.51
	12	December	9.84	9.47	9.70	12.11
2018	1	January	5.57	5.98	5.18	6.43
	2	February	4.26	4.33	4.51	4.58
	3	March	5.11	5.08	5.32	5.25
	4	April	5.05	4.97	5.18	5.31
	5	May	5.83	5.74	5.96	5.83
	6	June	5.42	5.43	5.62	6.23
	7	July	5.71	5.62	5.81	4.75
	8	August	5.93	5.64	5.82	4.95
	9	September	5.23	5.27	5.40	4.97
	10	October	5.39	5.26	5.35	5.00
	11	November	6.81	6.42	6.52	6.79
	12	December	9.99	9.94	9.09	9.21
2019	1	January	5.83	6.35	6.44	5.89
	2	February	4.42	4.63	4.70	4.40
	3	March	5.24	5.51	5.54	5.24
	4	April	5.47	5.39	5.39	4.97
	5	May	6.13	6.23	6.20	6.06
	6	June	5.95	5.91	5.85	4.93
	7	July	6.25	6.19	6.04	6.87
	8	August	6.19	6.21	6.05	6.69
	9	September	5.93	5.78	5.61	5.82
	10	October	5.85	5.76	5.56	6.35
	11	November	7.06	7.03	6.77	6.72
	12	December	12.15	12.15	11.69	12.02
2020	1	January	6.62	7.05	6.81	6.32
	2	February	5.03	5.16	4.95	6.12
	3	March	6.16	6.03	5.75	5.76
	4	April	4.70	5.83	5.60	
	5	May	4.33	6.60	6.44	
	6	June	3.84	6.11	6.07	
	7	July	3.94	6.29	6.27	
	8	August	5.00	6.30	6.28	
	9	September	4.69	5.87	5.82	
	10	October	4.45	5.40	5.37	
	11	November	5.11	5.79	5.79	
	12	December		12.21	12.14	

Source: own elaboration.

Table 7 shows the results of the differences in squares between the models. It can be noted that the smallest difference between the actual and predicted results exists in the case of the model for which the period, inflation, and employment and unemployment rate variables are taken into account. This square of the difference indicates how far the model errors are from the data collected. This difference is directly proportional to the inaccuracy of the model. These results coincide with those of Sabando-García et al. (2022).

Table 7. ***Differences of squares for the models***

AÑO	ANUAL	MES	DIFFERENCES IN SQUARES	PERIOD DIFFERENCES IN SQUARES PER AND INFLATION	DIFFERENCES IN SQUARES PER, INFLATION AND EMPLOYMENT
2016	1	January	1.37	4.01	3.67
	2	February	0.08	0.02	0.07
	3	March	0.69	0.79	1.19
	4	April	0.60	0.28	0.08
	5	May	0.03	0.35	0.80
	6	June	0.04	0.01	0.29
	7	July	0.12	0.07	0.56
	8	August	0.07	0.12	0.44
	9	September	0.16	0.07	0.01
	10	October	0.19	0.08	0.05
	11	November	0.24	0.02	0.02
	12	December	2.64	3.09	2.88
2017	1	January	1.40	3.71	3.99
	2	February	0.23	0.20	0.13
	3	March	0.34	0.28	0.47
	4	April	0.77	0.72	0.49
	5	May	0.09	0.02	0.12
	6	June	0.44	0.29	0.08
	7	July	1.49	1.26	0.60
	8	August	0.00	0.03	0.00
	9	September	0.24	0.26	0.49
	10	October	0.02	0.02	0.00
	11	November	3.04	1.90	2.43
	12	December	5.15	6.94	5.81
2018	1	January	0.75	0.21	0.06
	2	February	0.10	0.06	0.00
	3	March	0.02	0.03	0.00
	4	April	0.07	0.12	0.02
	5	May	0.00	0.01	0.02
	6	June	0.67	0.64	0.38
	7	July	0.92	0.76	1.13
	8	August	0.96	0.48	0.75
	9	September	0.07	0.09	0.18
	10	October	0.15	0.07	0.12
	11	November	0.00	0.14	0.08
	12	December	0.61	0.53	0.78
2019	1	January	0.00	0.21	0.30
	2	February	0.00	0.05	0.09
	3	March	0.00	0.07	0.09
	4	April	0.26	0.18	0.18
	5	May	0.01	0.03	0.02
	6	June	1.03	0.95	0.83
	7	July	0.38	0.46	0.68
	8	August	0.24	0.23	0.41
	9	September	0.01	0.00	0.04
	10	October	0.26	0.36	0.63
	11	November	0.12	0.10	0.00
	12	December	0.02	0.02	0.11
2020	1	January	0.09	0.53	0.23

2	February	1.18	0.92	1.37
3	March	0.16	0.08	0.00

Source: own elaboration.

Conclusions

The variable that has the greatest influence on sales is the unemployment rate because as unemployment increases, the level of income decreases. Therefore, the volume of sales for neighborhood stores is reduced. The increase in the employment rate causes a reduction in sales; this may happen because, having more purchasing power, buyers prefer to buy in supermarkets or wholesale instead of making use of the "find" service of the stores; this would explain the contradictory behavior between the employment rate and its effect on sales.

A large percentage of sales is not influenced by the variables studied, which needs to be reflected in the independent value of the model and the low coefficient of determination found for the best model. The model found does not have a high coefficient of determination, so it is recommended in further studies to add more variables that are explanatory for the phenomenon, such as distance to competitors of supermarkets and price variation with competitors.

The model found should be adjusted to include more exogenous variables. However, it should be noted that it is not possible to find a model of exogenous variables that has a high coefficient of determination because much of the sales behavior is due to endogenous variables that can be the subject of a future study. Neighborhood stores need to reflect on the effects that environmental variables have on their commercial activity in order to be prepared in times of economic crisis and to be financially sustainable.

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