TPM Vol. 32, No. S2, 2025
ISSN: 1972-6325
https://www.tpmap.org/

IMPACT OF RESILIENCE AND TRANSFORMATION ON THE ECONOMIC PERFORMANCE OF MSMES POST-COVID-19: ANALYSIS WITH MULTIPLE REGRESSION, ANOVA AND BOX PLOTS

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Abstracts
This paper analyzes how organizational adaptive capacity and structural transformation processes influenced the economic performance of micro, small and medium-sized enterprises (MSMEs) in Ecuador during the post-pandemic period. A methodological strategy of quantitative approach and exploratory analysis was employed, which included the estimation of multiple linear regression models, tests of variance (ANOVA) and visualizations through box plots, using financial records for the year 2022 provided by the Superintendence of Companies. The findings indicate that variables such as the volume of assets, equity and income have a significant impact on net income, explaining about 41% of its variability. In addition, relevant differences were identified in performance according to company size, with medium-sized companies showing the greatest capacity for economic recovery. The graphical analysis revealed marked disparities in the distribution of resources and financial results, especially in microenterprises, suggesting structural limitations. From these results, it is inferred that intangible factors -such as operational flexibility, technological incorporation and collaborative alliances- play a key role in the resilience of MSMEs. The study provides useful inputs for the formulation of strategies and public policies aimed at business strengthening.

Key words: MSMEs, business resilience and transformation, economic performance, Multiple Regression, Anova.

INTRODUCTION

When the world woke up in 2020, the COVID-19 pandemic was affected, this phenomenon caused a disruption in developing economies such as Ecuador and Latin American countries, as well as the rest of the world Bartik et al. (2020). Countries suffered a drastic drop in their economies reflected in their macroeconomic and microeconomic indicators. In emerging economies such as Latin America, this impact was particularly severe: regional GDP contracted by 7.7% in 2020, while poverty increased by 22 million people, reversing decades of social gains. This directly affected MSMEs due to their structural vulnerability (Teece D. , 2007)ECLAC (2021). In Ecuador, these companies represent more than 93.7% of the business fabric and are essential for the generation of employment and territorial development. Although 2022 marked a recovery phase, not all companies managed to adapt or prosper, many closed (INEC, 2024)Chit et.al., (2022). According to the SRI 3494 economic companies between 2020 and 2021 due to the pandemic.(EKOS, 2021)
For a company to survive external factors such as the Covid-19 pandemic, the first thing is to have resilience, an important term, which means the ability of people to face extreme changes, prepare, adapt, prepare strategies

(Martelo et al., 2023). In the business context Ritter & Pedersen (2020)He describes it as the ability to respond productively to significant changes and cope with the unforeseen. But it is necessary that joint actions be carried out between households (society), private enterprise and the government. For example, economic reactivation programs are important to support SMEs. According to Dini & Heredia (2021), in Latin America, governments deployed measures around four objectives: maintaining liquidity in the short term, protecting the labor market, promoting the production of goods and services, and facilitating access to credit. Despite the not very encouraging outlook for Ecuador since the GDP in 2019 had fallen by 7.8% and for 2021 it registered an increase of 2.8% due to exports, added to this the Vaccination of the Population that in 2020 in the Government of Lenin Moreno was low, reactivation programs were implemented for companies, one of them called Reactívate Ecuador. (PRIMICIAS, 2020)

Another important factor is innovation. To innovate is to successfully exploit new ideas or new knowledge, assuming more risk than competitors, to achieve a superior competitive position, companies obtain competitive advantages if they constantly innovate. In this context, both the manager and the employees in times of crisis undergo the necessary changes to survive in the market, an effort of the entire group and that uses means such as technology for communication, promotion, organization, work, synergy. (Ferras, 2014)

Many businesses that began as ventures took off taking advantage of the pandemic, for example, e-commerce through social networks: from a barter of products, sale of cleaning products, health, education, as well as in gastronomy, here many restaurants that did not have home delivery innovated with the incorporation of App and were able to maintain their home sales La Hora (2021). According to Amoah et al. (2021), the use, adaptation, and increase of social networks turned out to be beneficial for small and medium-sized companies, because it helped to effectively market their products and services, taking advantage of the interaction they allow, to attract customers; in turn, achieving closer contact, which allowed them to know the specific needs of their customers. The key was e-commerce in times of distress Bravo et al., 2022; Dvorak, et al., 2021; Effendi et al., 2020; Fragoso, 2022; Hossain et al., 2022; Valdez-Juárez et al., 2022). Added to this is the entrepreneur's predisposition, the attitude to change. According to Weber (1984), the action of the entrepreneur is not peaceful or calm, on the contrary, mistrust, competition, individualism, are manifestations that occur in the innovative entrepreneur. In this sense, Schumpeter (1950) states that this dynamic is characterized by a "creative destruction", driven by the initiative of the entrepreneur to introduce changes in both the economy and the social structure.

This paper examines how Ecuadorian MSMEs faced post-pandemic challenges, what factors intervened such as resilience, how their transformation allowed them to operate to survive in the market and what effects it generated on economic performance in that year. In particular, business resilience is analyzed, understood as the ability to adapt, transform and maintain operational continuity in the face of adverse conditions. Recent literature identifies digital transformation and income diversification as critical survival factors. (Sullivan & Branicki, 2011)Bartik et al. (2020) showed that MSMEs with e-commerce were 2.5 times more likely to survive, while Hernández & et al. (2021) verified that reinvestment in technological assets mitigated losses by up to 40% 48. However, methodological gaps persist in Latin American studies: most focus on qualitative analyses or sectoral cases, omitting econometric assessments that quantify correlations between operational variables and post-pandemic financial performance. General equilibrium models (such as G-Cubed) have projected global macroeconomic impacts, but their application to MSMEs is limited, especially in dollarized economies such as Ecuador, where exchange rate rigidity amplified the costs of importing inputs.(Osorio-Herrera, 2020)

Our theoretical framework integrates theTheory of Dynamic Capabilities (Teece D. , 2007), which conceptualizes resilience as strategic adaptation through reconfiguration of resources, involves permanent processes of change and renewal that generate greater value and competitiveness to the organization and theComplexity Economics, which explains interconnections between corporate financial health and macroeconomic stability. Finally, the role of the "entrepreneurial spirit" described by Schumpeter (1912) is reflected in those companies that, despite structural limitations, incorporated commercial or digital innovation to sustain operations, in line with research that highlights the role of entrepreneurship as an engine of economic reactivation in post-crisis contexts (Arthur, 2013)(Cavallo et al., 2020; Audretsch et al., 2022).

This article addresses such gaps through a robust quantitative approach, we will analyze a sample of 1835 MSMEs with cross-sectional 2022, using the Multiple Regression method to model net profit (Var.Dep.) as a function of size, employment, income, taxes, assets and equity with the ANOVA technique with post-hoc Sidak to compare cross-sectoral differences, the Box Diagrams to evaluate regional distribution of resilience.

METHODOLOGY

The research adopts a qualitative approach at the beginning, as it focuses on a systematic literature review of articles with similar research, which allow identifying and contextualizing the key concepts of resilience and business transformation within the field of MSMEs, especially in post-pandemic scenarios.

As for the quantitative approach, the database of the Superintendence of Companies transversal type of the year 2022 was used with a total of 37,949 companies. When refining the base, we worked with an analytical

sample of 1835 MSMEs considering the criteria: that they belong to the Province of Guayas, of the corporate sector, that their activities represented in ISIC belong to C = Commerce, F = Construction, G = Sales. H = Transportation and Maintenance, I = Services, J = Information and Communication, K = Financial Activities, M = Professional Activities, R = Art and Entertainment and that has Income Tax greater than zero. For the processing of the data, inferential techniques such as Multiple Regression were used to predict the dependent variable Net Profit, Box Plot to visualize the distribution of the variables, as well as the outliers and Anova will allow comparing means between groups, for which the dependent variable is Net Profit and the independent variables are Equity, Assets, Numbers of Employees, Income from Sale, Income Tax Caused.

RESULTS

The first exploratory analysis is shown in Table No.1, a statistical summary of the variables. It can be said that, of the 1835 companies analyzed, MSMEs have an average of 21 employees, assets valued at an average of $2,160,163.46 as well as $856,902.11 in assets and their average income from sales generated in that year for $1,456,678.60 and from this the respective $89,520.75 was generated.

Table No. 1 Exploratory-Descriptive Statistical Analysis

Variable	N	Minimum	Maximum	Mean	Std. Deviation
No. of Employees	1835	0	706	20,55	44,140
ASSETS	1835	253,6500000	44261317,16	2160163,462	2988759,796
EQUITY	1835	-2186732,05	27609246,59	856902,1111	1953189,207
REVENUE (SALES)	1835	1,500000000	4984815,880	1456678,597	1294645,153
Net Profit 2022	1835	-1211740,44	4521158,380	89520,75416	271852,6051
Valid N (listwise)	1835				

Note: The summary of descriptive statistics of the independent and dependent variables, prepared with IBM SPSS, is presented

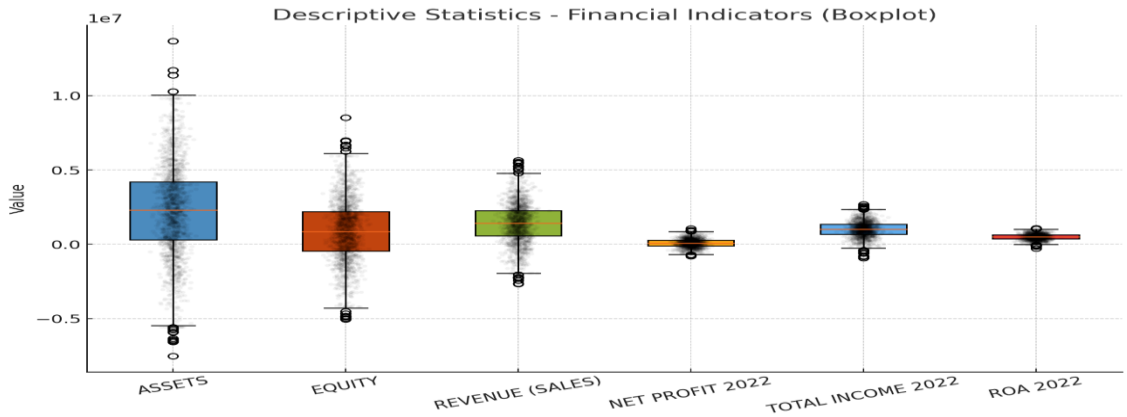
To complement the above, Graph No. 1 shows the variables Assets and Equity with greater dispersion and asymmetry, there is evidence of a significant concentration of values below 5 million, but with multiple extreme values that far exceed 20 million, it may be due to the size of the companies and their operational capacity.

Sales revenue and total revenue reflect a more compact distribution, with less dispersion. This would indicate that, although companies may differ significantly in equity and asset size, their revenues tend to be grouped into more homogeneous ranges.

Net income for the year also has a near-zero concentration of data, which could be indicative of low operating margins, high costs, or inefficient resource management. The existence of several positive extreme values suggests that a small number of companies achieved relevant profits, but they are not representative of the general behavior.

Finally, the Income Tax caused shows the smallest scale and dispersion among all the variables. This is consistent with the behavior of net income, while income tax is generated from taxable profits.

GRAPH NO. 1 BOX DIAGRAM



Note: The box plot of the independent and dependent variables for the outliers, prepared with Stata MP 16, is observed

The results of the Regression Model are shown in Table No. 2, it is revealed that the independent variables of assets, equity, sales income, number of employees and Income Tax explain 41% (R2) of the variability in Net Income for 2022. The model is statistically significant and the relationship between the chosen variables and the dependent one is positive and moderately strong 64%(R) and has no autocorrelation problems since the

statistician Durbin Watson at 2.115. This is in line with the central idea of the article that the financial and operational structure directly influences the economic performance of MSMEs during a post-pandemic recovery.

TABLE NO.2 REGRESSION MODEL

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			Sig. F Change	Durbin - Watson
						F Change	df 1	df2		
1	.640[a]	.409	.408	209247.0041	.409	253.324	5	1829	.000	2.115

a. Predictors: (Constant), EQUITY, No. of Employees, Accrued Tax 2022, REVENUE (SALES), ASSETS
b. Dependent Variable: Net Profit 2022
Note: The Regression Model with its R2, developed with IBM SPSS, is presented
Table No. 3 presents the analysis of correlations between the model's predictor variables, in which a strong negative correlation between assets and equity (r = -0.804) stands out, which could reflect an inversely related financial structure between equity capital and total assets, possibly due to the intensive use of external financing in certain MSMEs. as well as the correlation of sales income and income tax caused (r = -0.413), which suggests that higher revenues do not necessarily translate into a higher tax burden, possibly due to tax benefits or accumulated losses. In contrast, the correlations for the other variables are mostly weak ($r < \pm 0.10$), which indicates low multicollinearity between predictors, especially between the number of employees and the other variables. These results support the validity of the multiple regression model, since no correlations are identified that compromise its statistical stability.

TABLE NO. 3 CORRELATIONS AND MULTICOLLINEARITY
COEFFICIENT CORRELATIONS[a]

Model		EQUITY	No. of Employees	Accrued Tax 2022	REVENUE (SALES)	ASSETS
1	**Correlations**					
	EQUITY	1.000	-0.003	-0.004	0.103	-0.804
	No. of Employees	-0.003	1.000	0.022	-0.297	0.020
	Accrued Tax 2022	-0.004	0.022	1.000	-0.413	-0.043
	REVENUE (SALES)	0.103	-0.297	-0.413	1.000	-0.202
	ASSETS	-0.804	0.020	-0.043	-0.202	1.000
	Covariances					
	EQUITY	1.815E-5	-0.001	-2.070E-6	1.991E-6	-9.755E-6
	No. of Employees	-0.001	13674.668	0.300	-0.158	0.007
	Accrued Tax 2022	-2.070E-6	0.300	0.014	-0.001	-1.457E-5
	REVENUE (SALES)	1.991E-6	-0.158	-0.001	2.077E-5	-2.625E-6
	ASSETS	-9.755E-6	0.007	-1.457E-5	-2.625E-6	8.114E-6

a. Dependent Variable: Net Profit 2022
Note: The correlations of the variables with respect to Net Income, prepared with IBM SPSS, were applied
The Anova made in Table No. 4. Compare the 2022 Net Income in the three sectors such as micro, small and large companies. Highly significant differences are observed: F=26.13 P<0.001, therefore the size of the company influences profitability (Net Income). Here, medium-sized companies occupy the first place with an average profit of $129,652.09 compared to microenterprises that only reflect an average of $6,070.58. Bartlett's test ($\chi^2 = 727.78$; $p < 0.001$) confirms heteroskedasticity (uneven variances between groups), which validates the use of robust post-hoc tests (Bonferroni/Scheffé/Sidak) for specific comparisons.

TABLE NO. 4 ANOVA

```
. oneway Utilidadneta2022 Tamaño, bonferroni scheffe sidak tabulate

                Summary of Utilidad neta 2022
     Tamaño |      Mean   Std. Dev.       Freq.
------------+------------------------------------
    MEDIANA |  129652.09   343255.86         978
MICROEMPR.. |  6070.5758   82651.948         207
    PEQUEÑA |  55714.207    153331.1         650
------------+------------------------------------
      Total |  89520.754   271852.61       1,835

                           Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      3.7595e+12      2   1.8797e+12     26.13     0.0000
 Within groups      1.3178e+14   1832   7.1932e+10
------------------------------------------------------------------------
    Total           1.3554e+14   1834   7.3904e+10

Bartlett's test for equal variances:  chi2(2) = 727.7776  Prob>chi2 = 0.000
```

Note: ANOVA technique was applied to see difference between groups, elaborated with Stata MP 16
Finally, Table No. 5 shows the three Bonferroni, Scheffe and Sideak tests, which agree that there are significant differences in the three sectors, i.e., between medium vs. micro and medium vs. small enterprises ($p < 0.001$), but not between micro and small enterprises ($p > 0.05$), because they have similar utility groups.

TABLE NO.5 ROBUST POST-HOC TESTS

Comparison of Net Income 2022 by Size (Bonferroni)	Row Mean-Col Mean | MEDIANA MICROE.. MICROE.. | -123582 0.000 PEQUEÑA | -73937.9 49643.6 0.000 0.061
Comparison of Net Income 2022 by Size (Scheffe)	Row Mean-Col Mean | MEDIANA MICROE.. MICROE.. | -123582 0.000 PEQUEÑA | -73937.9 49643.6 0.000 0.068
Comparison of Net Income 2022 by Size (Sidak)	Row Mean-Col Mean | MEDIANA MICROE.. MICROE.. | -123582 0.000 PEQUEÑA | -73937.9 49643.6 0.000 0.060

Note: It was corroborated with Bonferroni, Scheffe and Sidak multiple comparison methods, to compare means between groups
made with Stata MP 16

DISCUSSION

The results obtained allow us to identify relevant structural patterns in Ecuadorian MSMEs during the recovery process after the global health crisis. In particular, there is a notable asymmetry in the distribution of assets and wealth, with most cases being concentrated below five million dollars, but with extreme values exceeding twenty million. This equity heterogeneity, also reported by regional studies such as that of Juárez et al. (2021) in Mexico, is related to significant gaps in access to financing and investment capacity, generating disparities in economic performance within the same business sector. This dispersion may be one of the factors that explains the high volatility in net income, whose behavior was partially explained by structural variables, with a coefficient of determination (R^2) of 41%, which supports the relevance of financial soundness to face crisis situations (Bartik et al., 2020).
From a theoretical perspective, some findings are counterintuitive. For example, the negative correlation between assets and equity ($r = -0.804$) indicates an intensive use of debt as a financing strategy, reflecting a

high dependence on external resources. This strategy, also documented in Colombian microenterprises during the pandemic, suggests a prioritization of immediate liquidity over long-term sustainability, raising the risk of insolvency in contexts of uncertainty (Osorio-Herrera, 2020)(Craig et al., 2020). Similarly, the inverse relationship between income and income tax (r = -0.413) can be attributed to the impact of compensatory fiscal policies implemented in countries such as Ecuador, where tax exemptions or benefits were granted to companies with low margins (CEPAL, 2021)

Regarding the hierarchy by firm size, the data confirm that medium-sized companies obtained significantly higher levels of net profit (M = $129,652), compared to micro and small companies (statistically significant differences with $p < 0.001$). This empirical evidence supports the Theory of Dynamic Capabilities, by showing that firm size facilitates reinvestment in innovation, digitalization and diversification processes, which are key to achieving organizational resilience in turbulent environments (Teece D. , 2007)(López Fernández et al., 2016). On the other hand, the absence of significant differences between micro and small enterprises ($p > 0.05$) suggests the existence of shared structural barriers, such as informality, low technification and limited access to financing, recurrent phenomena in developing economies. (World Bank, 2022)

The multiple regression model, with a correlation $R = 0.64$ and $R^2 = 0.41$, shows that assets, income and equity partially explain net income. However, 59% of the variance remains unexplained by accounting variables, suggesting the influence of intangible factors, such as adaptability, collaborative networks or strategic innovation. This coincides with what Sullivan & Branicki (2011) have argued, who identify the existence of invisible organizational capabilities as key elements for business survival in crisis contexts.

For the public sector, these findings will serve to implement public policies focused on the microenterprise segment, whose equity structures and income levels are markedly lower (mean assets = $6,070.58), which limits their ability to recover. With programs that include financial instruments accessible to companies such as credit guarantees, smart subsidies or access to soft lines of financing, they could have a significant effect on their sustainability. Secondly, digitalisation appears to be an essential strategy. The low dispersion in revenues between firms (as measured by the box plots) suggests homogeneity in traditional business models. Promoting tools such as e-commerce and digital platforms, as has happened successfully in the Peruvian entrepreneurial ecosystem, could diversify sources of income and reduce structural vulnerability.(IDB, 2020)(Vasquez & Loayza, 2021)

CONCLUSIONS

The results obtained in this study allow us to affirm that business resilience, understood as the capacity for structural and financial adaptation, played a determining role in the economic performance of Ecuadorian MSMEs during 2022. Multiple regression showed that variables such as the volume of assets, equity and sales income have a significant effect on net income, explaining 41% of its variability. This finding reinforces the importance of a solid financial structure as a foundation to face adverse economic contexts. In addition, the analysis of variance (ANOVA) revealed significant differences in profitability levels according to firm size, highlighting medium-sized companies as the segment with the greatest post-pandemic resilience, in line with theories of dynamic capabilities and strategic change management.

In addition, the graphical analysis using box plots made it possible to visualize the marked dispersion in assets and net income, as well as the existence of internal asymmetries between business groups. These structural differences, especially visible between microenterprises and their larger peers, show a critical gap in access to financing, digitalization and innovation. While accounting factors partially explain economic performance, the model suggests that non-financial dimensions such as operational agility, collaborative networks, and organizational learning could be equally determinants in post-crisis sustainability. Therefore, it is recommended that public policies aimed at economic reactivation focus on strengthening the resilience of micro and small enterprises, not only through financial instruments, but also through the development of strategic and technological capacities that allow them to face future scenarios of high uncertainty.

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