

## Measuring the Financial Pulse: A Statistical Analysis of Working Capital and Insolvency Risk in 21st Century Manufacturing SMEs

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### Abstract

*This paper aims to investigate the analysis and relationship between working capital and the risk of corporate insolvency. It adopts a quantitative approach and is based on the review of the statements of financial position presented in the SUPERCIAS database, covering a set of 112 SMEs that have maintained their constancy during the period 2017 to 2020. Data collection was carried out from secondary sources, using an observation sheet as a means of recording. Various statistical techniques were applied in the analysis, including a descriptive analysis and Spearman's Rho correlation, in addition, Ecotrim software was used to predict into the future over a period of 12 quarterly observations (3 years) and also time series through the ARIMA model, which facilitated the construction and development of four ARIMA projection models of the two variables as a function of size to obtain a better time series model such as SARIMA in order to identify the most appropriate size and year to make future predictions with greater accuracy. The results reflected how companies by size (small and medium) experienced changes throughout the study period. In addition, in the years 2019 and 2020, the working capital and insolvency risk variables were impacted due to the pandemic in this sector, resulting in a deterioration of their values. Both working capital and insolvency risk showed a moderately negative correlation. It was also concluded that medium-sized companies are the most suitable for forecasting.*

**Keywords:** Capital, Labor, Insolvency risk, Manufacturing, SMEs.

### Introduction

The global economy faced its greatest challenge in more than a century with the COVID-19 crisis, marked by a drastic contraction in activity in 90% of countries, shrinking the world economy by about 3% and triggering significant rates of poverty globally (World Bank, 2022). This situation provides a crucial scenario for investigating the causes affecting companies in the manufacturing sector comprising the entire zone 3, a pillar for economic growth.

The manufacturing sector, essential to society, has demonstrated resilience by providing

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indispensable products and contributing to recovery. Globally, it accounts for 14.3% of GDP in Latin America, with a striking average contribution of 12.69% to GDP over the last decade (European Central Bank, 2019; Economic Commission for Latin America and the Caribbean, 2017). However, the financial crisis of 2008 affected access to financing for SMEs (Ocampo, 2009). In the midst of this storm, a challenging question emerges: how are working capital and insolvency risk related in manufacturing SMEs in zone three in the years 2017 to 2020?

Ecuador, facing economic changes, has in manufacturing SMEs pillars for economic growth, but faces obstacles such as access to financing and business informality, especially outside urban areas (Delgado-Olaya et al., 2022; Ferraro, 2019). With ups and downs in the sector during the pandemic, it is crucial to explore the causes of insolvency and its relationship with working capital.

This study delves into the intersection of working capital and insolvency risk in manufacturing SMEs in Ecuador. Encompassing as a general objective analyze working capital in relation to insolvency risk in manufacturing SMEs in zone three in the years 2017 to 2020.

Using a rigorous approach, we analyze its impact on financial management, with the purpose of providing tools and knowledge to strengthen the local economy and the country in general. This article explores the deep connection between working capital and insolvency risk in zone three manufacturing SMEs, offering insights for their current and future reality, while contributing to local and national economic soundness.

#### Justification

This paper is justified by the relevance of manufacturing industries, categorized in ISIC (International Standard Industrial Classification of All Economic Activities) 4.0, in Ecuador's zone 3, and their influence on the country's economic growth. As the manufacturing sector experiences moderate growth, it becomes necessary to investigate its key components, such as working capital and insolvency risk, to understand their impact on the financial health of small and medium-sized enterprises (SMEs). This analysis is particularly significant given that SMEs constitute a fundamental part of the country's economic and labor fabric. Moreover, it aligns with previous studies that have highlighted the importance of these variables in the evaluation and forecasting of business performance.

In their study, Van Horne & Wachowicz (2010) indicate that working capital is proposed by theories that deal with financial management, as they stated the management of the company's current assets and the financing needed to support the current assets. The creditors of short-term liabilities represent the current liabilities of an SME that are subtracted from current assets for the purpose of assessing the adequacy of income to working capital to meet the needs of the company in the short term.

On the other hand, Kaya (2022) state that they were the first to define a series of financial ratios that addressed the identification of weaknesses in the health of a company and exposed the risk of default. On the basis of their views, financial ratios measuring profitability, debt and equity are often used in static and dynamic environments to predict business failure. In other words, the analysis of insolvency risk through the application of estimates and calculation of indicators makes it possible to determine the health of SMEs and prevent business failure.

### Theoretical reference

#### Finance

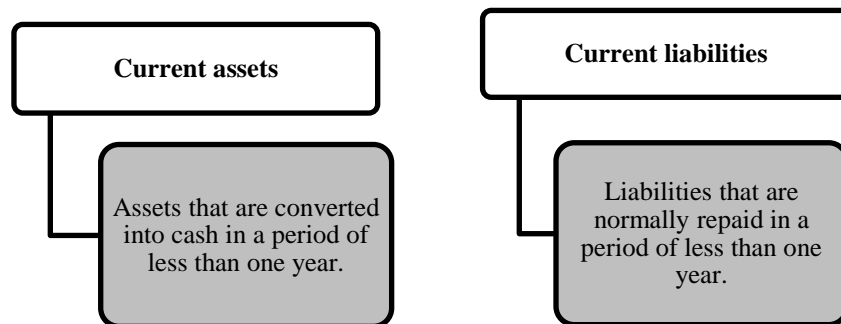
Finance is essential for strategic decision making. Gitman & Zutter (2012) highlight that

investment project evaluation, risk and return analysis, and obtaining adequate financing are some of the key areas in which financial concepts are applied in business. According to Madura (2015) personal financial planning involves the management of an individual's income, expenses, savings and investments, with the objective of maximizing financial well-being.

### Working capital

According to the research of Ponce et al. (2019) working capital is defined as the amount of money necessary for a company to carry out its operations on a regular basis during a production cycle while recovering the sales made. In addition, it is emphasized that this indicator serves as a measure of solvency, as it reflects the company's ability to meet its short-term debts. In other words, working capital represents the funds necessary for the company to maintain its normal activity without setbacks.

Figure 1. Accounts for the calculation of working capital



Source: Own elaboration, based on Van Horne & Wachowicz (2010).

### Insolvency risk

Insolvency risk is a crucial aspect that organizations must take into account in their financial management. It refers to the inability of a company to meet its financial obligations and can have serious consequences for its survival (Gitman & Zutter, 2012). Also they reaffirm that insolvency is defined as the inability of a company to meet its payment obligations, both short and long term. For Corona et al. (2014) insolvency occurs when a company's liabilities exceed the value of its assets, generating a significant risk to its ability to continue operating in a sustainable manner.

According to de Mendonça & Barcelos (2021) insolvency risk is a fundamental concern for companies, as it can affect their financial stability and ability to meet their obligations.

### Altman Z-Score Z-Model

The Altman Z model was developed by Edward Altman in 1968 using discriminant analysis. Altman applied this model to a sample of 66 companies in the manufacturing sector between 1946 and 1965, half of these companies had suffered bankruptcy, while the other half continued to operate until 1966, taking into account 22 financial ratios. Subsequently, he reduced these ratios to 5, which were sufficient to determine the level of insolvency of 27 of the companies analyzed (Altman et al., 2004).

## Methodology

This research adopted a quantitative approach with the purpose of numerically measuring and analyzing the behavior of the variables under study: working capital and insolvency risk. Secondary sources were used, specifically data from the Superintendence of Companies, Securities and Insurance. The research was based on a scientific approach and the use of the hypothetico-deductive method. We sought to verify hypotheses and

predictions through rigorous data analysis.

In addition, reference is made to the population under study, composed of 112 companies belonging to region 3 of the Ecuadorian manufacturing industry, which remained in constant operating status during the period from 2017 to 2020.

According to Arias (2018) techniques refer to the various ways in which information can be obtained. These techniques are skills and abilities employed in the different stages of the research, thus guiding the construction of knowledge. An observation record was made by those companies that have maintained their stability over time, according to the records of the SUPERCIAS (Superintendence of Companies, 2022). This made it possible to calculate working capital and insolvency risk using the information contained in their corresponding accounting accounts.

For the calculation of the indicators, data were taken from the statement of financial position for each year, based on the following formulas:

$$\text{Working capital} = \text{Current assets} - \text{Current liabilities}$$

$$Z - \text{Altman} = 1,2x_1 + 1,4x_2 + 3,3x_3 + 0,6x_4 + 1,0x_5$$

Once this Z-Altman indicator has been calculated for the companies analyzed, it will be interpreted using the following scale:

Table 1. Interpretation of the company zones according to Altman Z-Score

Z-Score	Zone	Details
> 2.99	Secure	No concern or good financial health
Between 1.81 and 2.99	Gray or ignorance	The financial condition of the company cannot be established.
< 1.81	Bankruptcy	Bankruptcy

Source: Own elaboration, based on Lizaraburu (2015).

In the present investigation, a quantitative approach was applied to measure the behavior of the variables. Descriptive statistics (measures of central tendency, measures of dispersion and the coefficient of variation) were used to understand the behavior of the variables.

In the subsequent stage of the research, Spearman's Rho coefficient was used to analyze the degree of fit and the relationship between the two variables, through its implementation, it is feasible to evaluate the relationship of dependence or independence existing between working capital and insolvency risk, considering the period of analysis.

Table 2. Interpretation of Spearman's Rho coefficient

Coefficient	Relation
-09.1 a -1.00	Perfect negative correlation
-0.76 a -0.90	Very strong negative correlation
-0.51 a -0.75	Significant negative correlation

-0.11 a -0.50	Average negative correlation
-0.01 a -0.10	Very weak negative correlation
0.00	There is no correlation between the variables
+0.01 a +0.10	Weak positive correlation
+0.11 a +0.50	Average positive correlation
+0.51 a +0.75	Significant positive correlation
+0.76 a +0.90	Very strong positive correlation
+0.91 a +1.00	Perfect positive correlation

Source: Own elaboration, based on Hernández Sampieri et al. (2014).

During the execution of the proposed analysis, the results obtained from the sample adequacy assessment using the KMO (Kaiser-Meyer-Olkin) test and Bartlett's test of sphericity are considered. These tests condense the verification of the fundamental assumptions and allow us to decide the feasibility of proceeding with the analysis process.

Finally, as an explanatory study, an econometric projection approach was implemented, using an ARIMA time series model based on the Box-Jenkins methodology to predict future values of the variables with evaluation metrics such as mean square error and mean absolute error to validate the predictions of the ARIMA model. The purpose of this model is to disentangle the future dynamics of each variable based on its historical behavior, taking into consideration its magnitude. On this occasion, we chose to focus on medium-sized companies, since they represent the highest concentration in zone three, which in turn provides us with greater precision and conclusive results of our model. The formulation of this equation in the econometric model is as follows:

$$Y_t = B_1 + B_2 Y_{t-1} + \dots + B_3 Y_{t-2} + \dots + u_t$$

The best model for both working capital and insolvency risk for medium-sized companies was used to determine the best model:

- An optimal ARIMA model for the specific variables and a SARIMA (P,D,Q) was obtained, this representation is presented as follows:

$$\phi_P(B^S) \nabla_{s^D} (Z_{t-u}) = \theta_Q(B^S) a_t$$

The constant  $\mu$  is the level of the original process  $Z_t$

$$\phi_P(B^S) = 1 - \phi_S B^S - \phi_{2S} B^{2S} - \dots - \phi_{PS} B^{PS}$$

Seasonal autoregressive polynomial of order P

$$\phi_P(B^S) = 1 - \theta_S B^S - \theta_{2S} B^{2S} - \dots - \theta_{QS} B^{QS}$$

Seasonal moving average polynomial of order Q

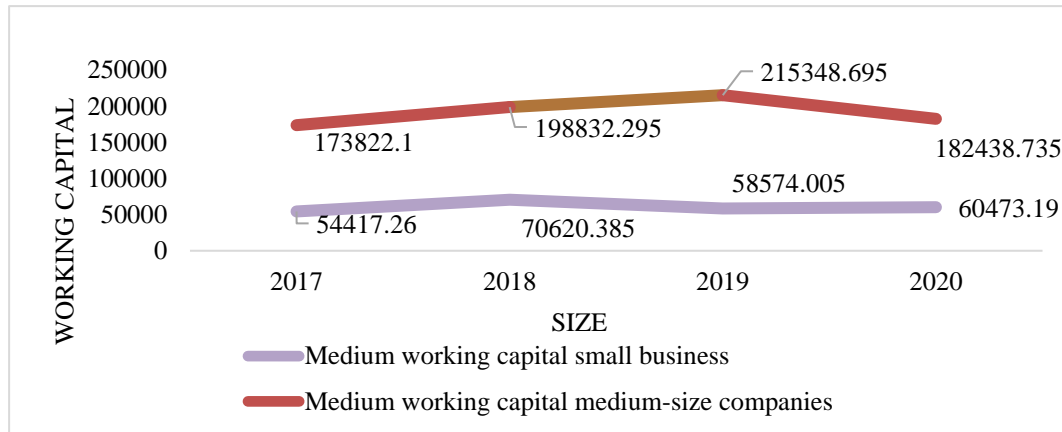
$a_t$  white noise process

The manipulation of the information was carried out using SPSS version 26, Ecotrim and R-Studio software tools, which made possible an exhaustive exploration and study of the factors involved, in line with the established objectives.

## Results

Initially, smaller companies accounted for 53.6% of a total of 112 companies in Ecuador's Zone 3 manufacturing sector. On the other hand, medium-sized companies made up 46.4%, totaling 52 companies, which have maintained a constant presence in the period from 2017 to 2020. This pattern of distribution in the business structure reflects a trend similar to that observed in various sectors in the country, where the share of companies' participation in the economy increases as their size decreases.

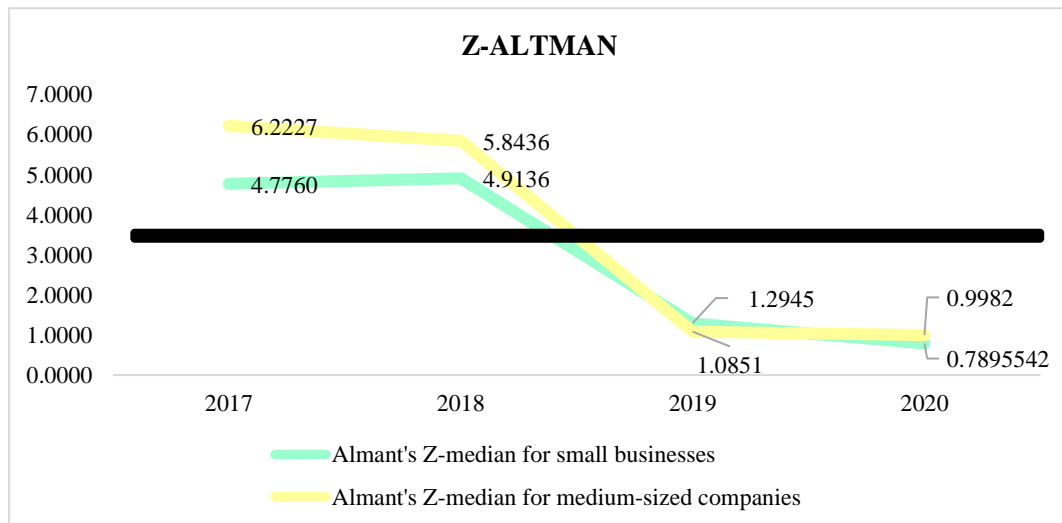
Figure 2. Behavior of median working capital by SME size.



Source: Own elaboration (2023).

Figure 2 shows that, in the case of small companies, growth is evident from 2017 to 2018. From that year onwards, a decrease in the median working capital is recorded in 2019, followed by a stabilization during the 2020 period. On the other hand, for medium-sized companies, growth is observed from 2017 to 2018, followed by a significant drop between 2019 and 2020.

Figure 3. Behavior of the median Z-Altman according to SME size



Source: Own elaboration (2023).

In Figure 3 from 2017 to 2018, problems were observed in relation to liquidity risk in these companies, which continued until mid-2018. Thereafter, liquidity problems and insolvency risk in these companies increased significantly. Between mid-2018 and the end of 2019, the insolvency risk experienced a remarkable growth in these companies. This deterioration in the financial situation deepened further in the period from 2019 to 2020, as shown in the chart for 2019.

To achieve the second objective, when the results are generated by the obtained values of Spearman's Rho coefficient, we will be able to define how and to what extent working capital affects insolvency risk in manufacturing SMEs.

Table 3. Correlation of working capital and insolvency risk by Spearman's Rho

Year	Relation		Spearman's Rho	Analysis
2017	Working capital and Z-Altman	Correlation coefficient	,153	Average positive correlation
		Sig. (bilateral)	,107	
		N	112	
2018	Working capital and Z-Altman	Correlation coefficient	,012	Weak positive correlation
		Sig. (bilateral)	0,897	
		N	112	
2019	Working capital and Z-Altman	Correlation coefficient	-0,244**	Average negative correlation
		Sig. (bilateral)	,010	
		N	112	
2020	Working capital and Z-Altman	Correlation coefficient	-0,233*	Average negative correlation
		Sig. (bilateral)	0,014	
		N	112	

Source: Own elaboration (2023).

In Table 3 it was observed that in the years 2017 and 2018 present a positive correlation and in the years 2019 and 2020 a negative correlation therefore the null hypothesis is rejected and the alternative hypothesis is accepted, supporting the perspective raised that there is a correlation between the level of working capital and the insolvency risk.

Then, the economic software Ecotrim and the quarterly methodology were used, applying an indicator of Boot, J.C.G. Feibes, W. and Lisman, based on the median and by company size for the four years of study. The auto.arima (facilitates the automatic generation of the most appropriate ARIMA model for the variables), i.e., it guarantees compliance with the estimation assumptions and contains relevant components. In this way, a SARIMA (P,D,Q) model is immediately obtained.

For this purpose, the results are generated from R-Studio:

For the modeling, the model was applied to working capital and insolvency risk in medium sized companies.

Table 4. Coefficients of the working capital model of medium-sized companies

ARIMA (2,0,0)			
Coefficients:			
	ar1	ar2	mean
	16.436	-0.8097	191273.65
s.e.	0.1246	0.1279	5140.76

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$\sigma^2 = 12076902$ : log likelihood = -153.43

AIC=314.87 AICc=318.5 BIC=317.96

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Source: Own elaboration (2023).

Table 5. Coefficient of the insolvency risk model of medium-sized enterprises

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ARIMA (2,0,0) (1,0,0)

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Coefficients:

	ar1	sar1
	0.8779	-0.5583
s.e.	0.1116	0.2464

$\sigma^2 = 0.07392$ : log likelihood = -1.87

AIC=9.74 AICc=11.93 BIC=11.87

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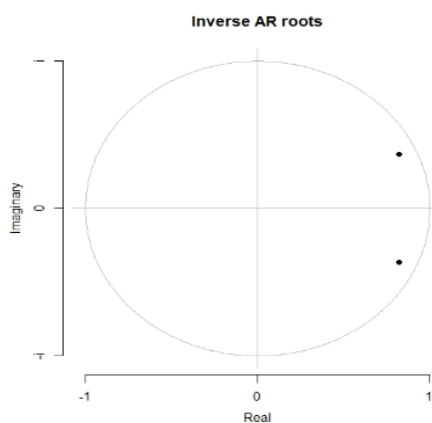
Source: Own elaboration (2023).

Table 4 shows that the coefficients of the ARIMA model showed that the optimal estimated model, suggested by the AUTOARIMA function, uses the parameters P=2, I=0 and MA=0 in the ARIMA components. The choice of these parameters was based on the minimization of the Akaike and Bayesian criteria, indicating that this configuration is the most accurate for predicting the future behavior of working capital in these companies.

Table 5 presents the coefficients of the ARIMA model, highlighting that the optimal estimated model, proposed by the AUTOARIMA function, corresponds to a SARIMA model. This indicates that the AUTOARIMA function suggests that the most effective strategy to anticipate insolvency risk in smaller firms is through an ARIMA model that incorporates an additional component of structural change. Specifically, this component has parameters P=1, I=1 and MA=0 in the ARIMA components, and P=1, I=0 and MA=0 in the structural component.

Unit Root Test

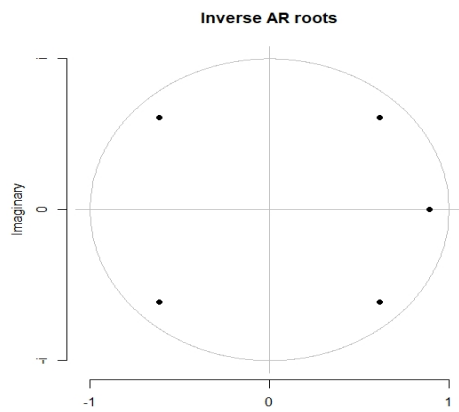
Figure 4. Unit root test of working capital years 2017 to 2020



Source: Own elaboration (2023).



Figure 5. Unit root test of insolvency risk years 2017 to 2020

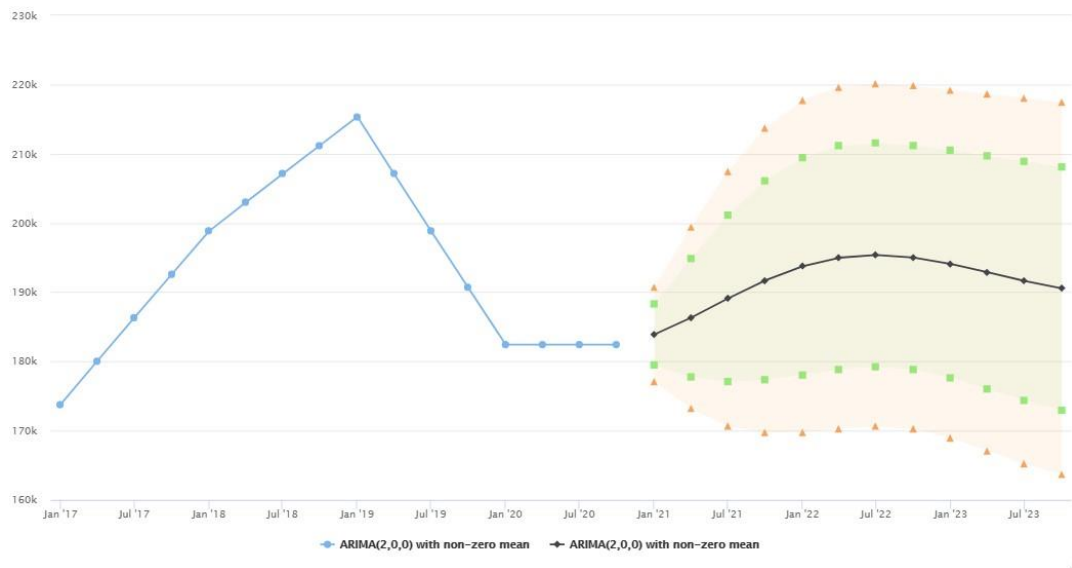


Source: Own elaboration (2023).

Figure 4 and 5 showed that the estimation assumption of the ARIMA model was met, since the residuals generated by this model remained within the unit circle. This consistency with white noise suggests that the ARIMA model used fits the observed data adequately.

#### Projection of the Arima model

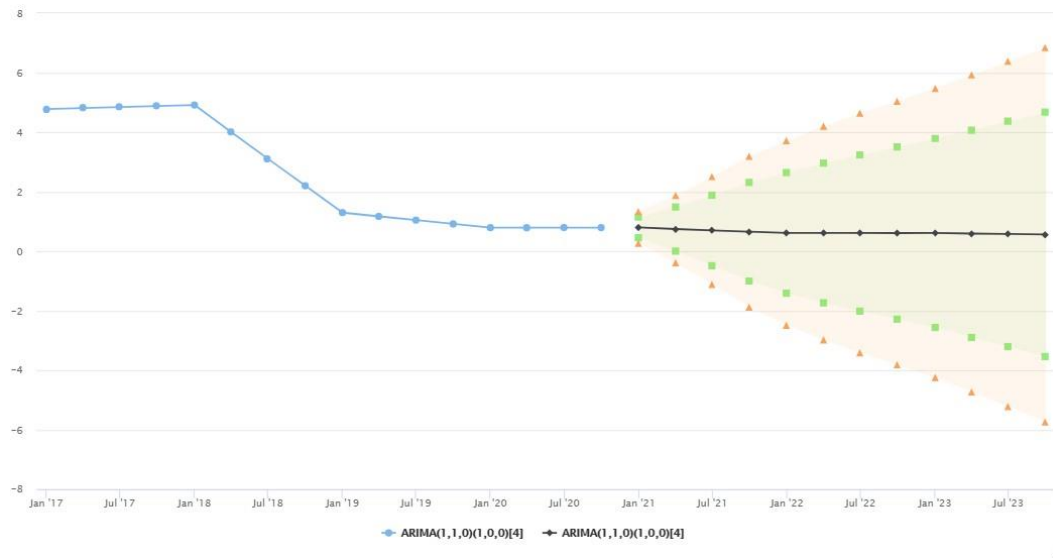
Figure 6. Arima model projection of working capital



Source: Own elaboration (2023).

In Figure 6, working capital, an expected growth in this indicator was observed from June 2021 to July 2022. However, from that point until June 2023, a steady growth is expected. Finally, a moderate decrease is projected until the end of the study period. These results reflect the expected fluctuation in the working capital indicator, without showing a systematic trend of sustained growth or decline.

Figure 7. Arima model projection of insolvency risk



Source: Own elaboration (2023).

Figure 7 shows that from June 2021 to July 2023 there is an increase in the insolvency risk in these companies. A constant growth in this indicator is expected. Subsequently, a not so significant constant is projected until the end of the study period.

The results obtained support the hypothesis of an inverse relationship between working capital and insolvency risk. Furthermore, they are in line with previous research that has demonstrated the importance of maintaining an adequate level of working capital to mitigate financial risk in firms. The interpretation of these results suggests that firms should carefully consider their working capital management strategies to maintain a sound financial position and avoid insolvency situations.

The findings support the importance of efficiently managing working capital to avoid significant financial risks. These results also provide a basis for future research and financial management strategies in the context of medium-sized companies in Ecuador.

## Conclusions

A comprehensive analysis of the Ecuadorian manufacturing sector highlights the concentration of companies in Tungurahua and the preeminence of the institutional form of the corporation. The present study reveals that smaller, small and medium-sized companies play a key role in this scenario. The economic recession experienced between 2017 and 2020, triggered by the change of government, the decrease in public investment and the fall in household consumption had a forceful impact on working capital and insolvency risk indicators. The Covid-19 pandemic further exacerbated this situation in 2020, raising the insolvency risk represented through the Z-Altman indicator.

This analysis highlights the greater vulnerability of small firms compared to medium-sized ones. The trends showed two distinct phases in the relationships between working capital and insolvency risk, with the linear association being more pronounced in more recent years due to the worsening of the economic crisis. Despite future projections, which indicate stable behavior, but not substantial improvements, political uncertainty and economic insecurity pose significant challenges for the manufacturing sector. The implications of this situation are crucial, as long-term economic growth and the well-being of the population are intrinsically linked to the success of this sector.

The limitations of the study, such as the absence of non-economic considerations and the

length of the analysis period, open up opportunities for future research. It is recommended to further explore the implications of technological specialization and the level of investment in the sector, as well as to consider non-quantitative contextual factors that could influence the results. As the sector faces continuing challenges, the question arises as to how government policies and corporate mitigation measures can support these companies and thereby foster sustainable growth in a fluctuating economic environment.

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