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Analysis of the liquidity, solvency and profitability of the mining companies listed on the S&P/BVL Mining Index during the 2004–2020 period.

Análisis de la liquidez, solvencia y rentabilidad de las empresas mineras del S&P/BVL Mining Index en el período 2004-2020

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Resumen

La minería es uno de los sectores que más contribuye con el crecimiento de la economía de varios países, con comportamientos cíclicos como el denominado *boom* del precio de los metales, que se generó en el periodo 2004-2012, lo que genera el interés de los inversionistas de identificar el desempeño financiero de las empresas de este sector. En este sentido, este artículo tiene como objetivos analizar el nivel de liquidez, la solvencia y la rentabilidad de las empresas mineras peruanas del S&P/BVL Mining Index en el período 2004-2020, considerando que la minería es una de las actividades que más contribuye con el crecimiento del PBI y con la generación de puestos de trabajo en el Perú. Para tal efecto, la investigación tiene un enfoque cuantitativo, mediante la recolección de datos de los estados financieros de las empresas a través de Bloomberg. El diseño es no experimental, con un nivel descriptivo, comparativo y longitudinal. Asimismo, para el análisis estadístico se han realizado pruebas de estadística descriptiva y prueba de hipótesis de t de Student. Del análisis de los resultados, se destaca que la liquidez, solvencia y rentabilidad de este grupo de empresas ha presentado un mejor desempeño en el período denominado *boom* del precio de los metales, con una clara disminución en el período posterior a este ciclo.

Palabras clave: liquidez, solvencia, rentabilidad, S&P/BVL Mining Index, empresas mineras.

Abstract

In several countries, mining contributes more than most sectors to economic growth. But the activity is marked by cyclical behaviour, including booms in the price of metals—such as that which occurred in the period 2004-2012. Therefore, it is important for investors to identify the financial performance of companies in the sector. This study aims to analyse the levels of liquidity, solvency, and profitability of Peruvian mining companies listed on the S&P/BVL Mining Index for the period 2004–2020, given the contribution of mining to GDP growth and employment in Peru. We utilise a quantitative approach, collecting data from the companies' financial statements through Bloomberg. The research design is non-experimental, based on a descriptive, comparative, and longitudinal approach. For the statistical analysis, descriptive statistics tests and Student's t-test were carried out. Analysis of the results reveal that the liquidity, solvency, and profitability of this group of companies exhibited a better performance during the metal-price boom period, with a marked decrease in the following period.

Keywords: Liquidity, solvency, profitability, S&P/BVL Mining Index, mining companies.

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Introduction

Before making decisions about participating in company ownership, both in times of prosperity and of crisis, investors pay special attention to certain financial indicators obtained from financial reports in order to identify any relationships between levels of profitability, liquidity, and debt that may reflect the investment and financing decisions made by management.

Numerous authors have researched these indicators and their interrelations in specific sectors. These authors have selected listed companies due to the ease of access to data and the importance of these companies' results to the overall economic activity in their countries (Al-Homaidi et al., 2020; Ayoush et al., 2021; Barbuta-Misu et al., 2019; Caro et al., 2018; Nguyen & Nguyen, 2020; Tai & Li, 2020).

It is important to determine the financial behaviour of companies in certain contexts; this is true of mining companies worldwide, which witness significant rises and falls in their results, as reflected in their financial indicators, as a result of increases and subsequent decreases in the price of minerals.

Background

National economies are underpinned by their foremost sectors; and in the case of many emerging countries, one of the main economic activities is mining. Peru is one such economy. From the Inca Empire to the present day, the country's mining sector has contributed greatly to development and growth.

In relation to the aforementioned boom in the price of metals, Flores et al. (2017, p. 5) note that "from 2003 to 2012, mining assumed a leading role economically, which was reflected not only in the growth in GDP and the sector's exports but also in the greater weight of its tax contribution."

The importance of the mining sector for the Peruvian economy is supported by various indicators, such as gross domestic product (GDP), in which its share was 8.3% in 2015, 9.7% in 2016, and 9.8%. in 2017. Another key indicator in this regard is exports; between 2008 to 2017, mining accounted for 60% of the country's foreign exchange. As regards taxation, the income and other (sales and consumption) taxes generated by mining totaled 132,876 million soles from 2007 to 2016 (Consorcio de Investigación Económica y Social, 2018).

These indicators are supported by Peru's prominence in terms of global mining reserves and production, with the country ranking among the top positions for certain minerals. For example, in 2015, Peru's copper and zinc reserves were the third largest in the world; in the case of silver, the second largest; for lead, the fourth; and for gold, the sixth (Organismo Supervisor de la Inversión en Energía y Minería, 2017).

After the metal price boom came to an end, mining companies began to experience a downturn in revenues, which affected not only their profitability but also the financial indicators of liquidity and indebtedness.

In the Peruvian case, these events were reflected in the financial situation of mining companies listed on the Lima Stock Exchange (BVL); as such, they are likely to have had an impact on the price index, especially over the 2004 to 2020 period, which spans the boom and subsequent decrease in international metal prices. The weakening of Chinese demand, as well as international political instability, prompt investors to move away from mining, which affects the bottom line of mining companies (Vásquez and Zurita, 2016) and, in turn, their financial indicators. For the purposes of this research, the sample corresponds to mining companies listed on the S&P/BVL Mining Index, which is a "free-float adjusted capitalisation-weighted index that serves as a benchmark for the performance of mining stock prices" (S&P Dow Jones Índices, 2022).

Objectives

This research focuses on the financial information pertaining to mining companies listed on the S&P/BVL Mining Index during the 2004-2020 period, for which we have set three objectives. The first is to analyse the level of liquidity of the group of companies in the sample over the stipulated period; the second is to analyse their solvency; and the third is to analyse their level of profitability.

Justification and scope

Mining is one of the sectors that contributes the most to GDP growth and job creation in Peru, among other equally important variables. In recent times, this economic activity has had a significant percentage share in the structure of the country's GDP (having been surpassed only by the manufacturing and service sectors). This attests to the relevance of the analysis of the financial and economic position of the companies that regulate the sector (Molina et al., 2018).

Since the start of the 21st century, the rise in international mineral prices has had a major influence on the economic position of the countries in which mining is a major contributor to foreign exchange, and this has been reflected in the profit margins of the companies operating therein. In this regard, the calculation and analysis of the main financial indicators for companies in the sector will prove very useful in assessing the impact of the fluctuation in the price of minerals on the financial structure of these companies over the period.

This study is justified by the importance of the designated financial indicators for the financial management and business decision-making processes of organisations. Along similar lines, Nguyen and Nguyen (2020) refer to various authors' proposals regarding the factors behind company profit levels, which include "financial leverage, financial solvency, financial adequacy, financial independence, liquidity, company size, growth, capital structure, firm ages, and other management decisions" (p. 49).

In turn, the practical justification for this research lies in its contribution to the theory of financial analysis, based on ratios complemented by statistical tests, for a group of companies in a sector that plays a major part in the Peruvian economy.

To this end, the study draws on prior applications of the ratio technique in the literature as well as the financial information of the selected companies, such that no limitations on proceeding with the research have been identified.

Literature review

Financial analysis of companies is carried out through the application of various techniques, for which the accounting reports of the organisations concerned are an essential element. Such analysis is useful in evaluating resource management by means of the examination of the investment and financing decisions made in order to obtain these resources. The most common technique applied to this end is that of financial ratios, as will be explored later in the section.

The ratios approach has been developed in various studies on the analysis of companies' financial statements. A review of the literature reveals how authors have applied this technique in their research; for instance, in "Método de Ratios Financiero Aplicado en Empresas Peruanas Listadas," the authors financially analysed a group of listed Peruvian companies from different sectors in order to identify the relationship between the ratios calculated and the situation of the company and the Peruvian economy (Burneo et al., 2017).

Likewise, in the article "Análisis Empírico de Correlación Entre el Indicador de Estructura de Capital y el Indicador de Margen de Utilidad Neta en Pequeñas y Medianas Empresas," the authors employed a quantitative methodology and the Pearson correlation coefficient to analyse whether there is a relationship between the selected financial ratios (Barrera et al., 2020).

Relatedly, focusing on a selection of companies from various sectors in the Czech Republic, Lenka (2017) utilised a regression analysis to identify the relationship between certain financial ratios; the results showed a negative relationship between the ROE and the leverage of the companies in the sample. It is important to note that in the case of companies in the mining and quarrying sector, the relationship between these ratios—unlike the findings for other sectors—was positive.

Theoretical foundations of the financial analysis

Business activity plays an important role for a companies' growth and economic development, while also paving the way for job creation. In this

context, a companies' financial and economic position must be evaluated on an ongoing basis in order to meet objectives and sustain sound financial health.

It is important to identify the factors that are involved in and influence company performance: above all, those linked to variables in the internal and external environment, the financial and economic structure, investment and financing decisions adopted in a given context, legal regulations, and others. Numerous authors have delved into the study and theory of financial analysis, and most agree on the importance of these factors in the business decision-making process as part of achieving the goals and objectives established by company management (Barbei & Neira, 2015; Camisón-Haba et al., 2022; Doupnik & Perera, 2007; Gitman & Zutter, 2012; Marbelis, 2009; Ross et al., 2018).

It is also important to consider that profitability is one of the main objectives that organisations set, and to boost profitability, efficient resource management is necessary. This means having the liquidity indicators to allow adequate access to the required resources, as well as making financing decisions that guarantee a balance between internal and external sources for proper company operation (Ayoush et al., 2021; Nejadmalayeri & Usman, 2022; Zheng, 2022).

Liquidity indicators

Indicators are among the most frequently used measures in financial analysis to assess the capacity of organisations to meet the payment of their obligations in the short term. Creditors, suppliers, and owners, among other stakeholders, pay special attention to the financial ratios employed to evaluate business liquidity because they provide information on the timely fulfilment of payment obligations.

The most common financial ratios for assessing the liquidity of non-financial entities are the current ratio, or general liquidity ratio, and the acid test (Caro et al., 2018; Gitman & Zutter, 2012; Hammi, 2014; Pessoa, 2016; Ross et al., 2018). The financial analysis methodology also features other ratios, which are not taken into consideration for the purposes of this research. The following paragraphs describe the selected ratios.

Current ratio

The current ratio (also known as the general liquidity ratio) is the most commonly used financial indicator to assess an organisation's liquidity level, and is obtained using data from financial statements. To calculate the ratio, current assets are divided by current liabilities on a certain date in order to obtain an indicator with which to determine whether the level of resources invested in the short term (current assets) will allow the company to meet its short-term payment obligations (current liabilities) as they reach their maturity date (Gitman & Zutter, 2012).

Numerous authors agree that liquidity management is one of the most important considerations for a business, especially in times of financial crisis—and even a global health crisis such as the COVID-19 pandemic—so strategies must be designed to allow for the necessary working capital to cover investment decisions and meet contracted payment obligations (Ayoush et al., 2021; Hammi, 2014; Remuiñán, 2012; Ruiz, 2010).

It is important to stress that this financial indicator, same as the others, cannot be analysed in isolation. First, each element in its calculation must be analysed in turn; and second, additional information must be factored in, since a low ratio is not necessarily a sign of problems meeting payment obligations while a high ratio does not always imply a solid payment capacity. Indeed, in the analysis of efficiency in resource management, it should be recalled that "a high current ratio index and a longer cash cycle lead companies towards better performance" (Al-Homaidi et al., 2020).

Acid test

A second important financial ratio for analysing the liquidity level of non-financial organisations is the acid test, which, unlike the current ratio, excludes less liquid or slower-moving resources such as inventories, prepaid expenses and biological assets. Barbuta-Misu et al. (2019) and Sierpińska-Sawicz (2021), among other authors,

highlight the importance of liquidity indicators in financial evaluation, and so it is important to take into account the degree to which resources can be converted into cash. It is here that the acid test indicator becomes relevant; in its calculation, discounting assets with the least possibility of becoming cash provides us with a more accurate measure.

Solvency ratios

Another group of financial ratios related to the payment of obligations are those of solvency, which also provide information on the capacity of an organisation to meet its payment obligations; but unlike indicators of liquidity, these ratios take into account the long term as well as the short term. Of the wide variety of solvency indicators, some of the most frequently used are the total debt ratio, the capital debt ratio and interest coverage (Caro et al., 2018; Gitman & Zutter, 2012; Hammi, 2014; Pessoa, 2016; Ross et al., 2018), which will be described in the following paragraphs.

Total debt ratio

This is one of the most widely used financial ratios to assess the level of solvency of a non-financial organisation, based on the information contained in the statement of financial position on a given date. For its calculation, the total liabilities assumed by the company, both current and non-current, are divided by the total assets. Its results reveal the degree to which an organisation's resources or assets have been financed by creditors (Gitman & Zutter, 2012; Ross et al., 2018).

The evaluation of an organisation's level of leverage promotes understanding of the way in which debt can improve its value. In the opinion of Tai and Li (2020), this is because "debt financing can bring more benefits to companies through the role of financial leverage, and its tax shield effect can help companies save tax expenses;" (p. 615).

Total debt ratio

This is another important financial indicator that allows analysis of the level of indebtedness or financial leverage of a company, in which total debt and total capital are linked (Gitman & Zutter, 2012; Ross et al., 2018). It is very useful to identify the level of debt usage the company requires to finance its resources in order to carry out its operations, in comparison with owner financing. As with the other financial indicators, a broader analysis is required that incorporates other elements so as to facilitate interpretation in a complete context.

Interest coverage

This financial ratio makes it possible to evaluate long-term solvency and provides a measure of the number of times that operating profit—known as profit before interest and taxes (EBIT)—covers the interest generated by the obligations contracted with creditors. It is calculated by dividing the EBIT by the interest charges that have been generated during the corresponding period (Gitman & Zutter, 2012; Ross et al., 2018).

Profitability indicators

This group of financial ratios, linked to business management, is intended to evaluate efficiency in the use of resources to which an organisation has access. Authors focusing on financial management have proposed a variety of ratios to this end; some of the best known of these studies will be explored below (Gitman & Zutter, 2012; Pessoa, 2016; Ross et al., 2018).

Operating margin

This ratio is calculated based on information contained in the income statement, such that it shows the yield obtained before interest and taxes; thus, for its calculation, earnings before interest and taxes are divided by the total revenue from sales and/or services obtained in a given period.

EBITDA margin

Another important indicator in the analysis of profitability is the ratio known as Earnings Before Interest, Taxes, Depreciation and Amortisation (EBITDA). In the view of Ross et al. (2018), this indicator is used for a direct examination of

the operating cash flows, without including the effect of the capital structure or that of taxes.

Net profit margin

The most widely used financial ratio in the analysis of profitability is that obtained by dividing the net result obtained in a financial year by the net income obtained during that same financial year. It is an indicator that includes the effect of operating expenses, the cost of financing, and the effect of tax rates (Gitman & Zutter, 2012). The result obtained from this indicator reflects the performance of each monetary unit of income generated by the company in a financial year.

Return on assets (ROA)

This indicator, known by some authors as the company's economic profitability, links data from the income statement and the statement of financial position. Its aims to show the level of efficiency with which the organisation uses its resources. To determine the ratio, the net result for a period is divided by the total resources invested by the company on the same date. This assures information on the degree of efficiency with which a company uses its assets, connecting the generation of sales income and net profit (Ross et al., 2018).

Return on equity (ROE)

Return on equity is one of the main indicators used to measure the profitability of a company. This indicator is determined by dividing the net result for the period by the company's total equity on the same date; in this way, its capacity to create value for shareholders can be identified. The greater the result, the greater the level of profitability Ross et al., 2018).

Mining commodities and their importance to the economy

The term "commodities" is related to various raw materials, mostly natural resources, that are traded in national and international markets and are required for the manufacture of other products. The participation of commodities in international trade goes hand in hand with constant price fluctuation. This volatility is influenced by various factors, such as economic crisis, war, climatic phenomena, and political situations.

In the specific case of mining, numerous authors have centred on the behaviour of mining commodities and their impact on the world economy, as well as that of the main countries that produce these raw materials. Prior research has found evidence of how the volatility in the price of these commodities has significantly influenced the economic growth of some countries, such as Peru—especially during the first 15 years of the 20th century (Fonseca & Santillán, 2018; Gomero, 2017; Gutiérrez & Contreras, 2019; U.S. Geological Survey, 2020).

Methodology

The research approach is quantitative; according to Bernal (2014), this approach employs data collection to demonstrate a hypothesis by means of a numerical measurement process and the application of statistical analysis. Thus, this study collects data from the financial statements of the companies in the selected sample, through Bloomberg and by applying the documentary analysis technique, determines their financial indicators for the period 2004–2020. The research design is non-experimental, based on a descriptive, comparative, and longitudinal approach. For the statistical analysis, descriptive statistics tests and Student's t-test were carried out.

Student's t-test is a hypothesis test of the mean of a single population (Molina, 2022) that assesses whether the means of two groups are statistically different from each other. In the present case, the test compares two samples of size ≤ 30 (Sánchez, 2015). Student's t-test makes the following assumptions: 1) the observations in each group follow a normal distribution; 2) the standard deviation in both samples is the same; and 3) the independence of the observations (Gómez-Gómez et al., 2013).

The population is composed of the 30 Peruvian mining companies listed on the Lima Stock Exchange, and included in the S&P/BVL index. These companies are presented on Table 1.

Table 1. Population of mining companies in S&P

No.	Sector	Variable income
1	Alturas Minerals Corp.	ALT
2	Bear Creek Mining Corporation	BCM
3	Candente copper corp.	DNT
4	Castrovirreyna Compañía Minera S.A. - en liquidación	CASTROC1
5	Compañía de Minas Buenaventura S.A.A.	BUENAVC1
6	Compañía Minera Poderosa S.A.	PODERC1
7	Compañía Minera San Ignacio de Morococha S.A.A.	MOROCOC1
8	Compañía Minera Santa Luisa S.A.	LUISAI1
9	Fosfatos del Pacífico S.A. - Fospac S.A.	FOSPACC1
10	Minera Andina de Exploraciones S.A.A.	ANDEXAC1
11	Minera IRL Limited	MIRL
12	Minsur S.A.	MINSURI1
13	Nexa Resources Atacocha S.A.A.	ATACOAC1
14	Nexa Resources Peru S.A.A.	NEXAPEC1
15	Panoro Minerals Ltd.	PML
16	Perubar S.A.	PERUBAI1
17	PPX Mining Corp.	PPX
18	Pucara Gold Limited	TORO
19	Regulus Resources inc.	REG
20	RIO2 Limited	RIO
21	Shougang Hierro Peru S.A.A.	SHPC1
22	Sierra Metals INC.	SMT
23	Sociedad Minera Cerro Verde S.A.A.	CVERDEC1
24	Sociedad Minera Corona S.A.	MINCORC1
25	Sociedad Minera El Brocal S.A.A.	BROCALC1
26	Southern Copper Corporation	SCCO
27	Southern Peru Copper Corporation - Sucursal del Perú	SPCCPI1
28	Tinka Resources Limited	TK
29	Trevali Mining Corporation	TV
30	Volcan Compañía Minera S.A.A.	VOLCAAC1

Source: Bolsa de Valores de Lima (2022).

Table 2. Sample of mining companies on the S&P/BVL Mining Index

No.	Sector	Variable income
1	Compañía de Minas Buenaventura S.A.A.	BUENAVC1
2	Minsur S.A.	MINSURI1
3	Nexa Resources Peru S.A.A.	NEXAPEC1
4	Sociedad Minera Cerro Verde S.A.A.	CVERDEC1
5	Sociedad Minera el Brocal S.A.A.	BROCALC1
6	Southern Copper Corporation	SCCO
7	Trevali Mining Corporation	TV
8	Volcan Compañia Minera S.A.A.	VOLCAAC1

Source: Bolsa de Valores de Lima (2022).

As noted earlier, the sample corresponds to mining companies listed on the S&P/BVL Mining Index. Probabilistic sampling, which improves the prospects of a representative sample of the population, yields the companies outlined on Table 2. Panoro Minerals LTD. was ruled out because this company did not generate income in the period of analysis and so the research indicators cannot be calculated in this case.

Analysis and interpretation of results

This section describes the results of the descriptive statistical tests and the Student's t hypothesis test performed on the sample of eight (8) Peruvian mining companies from the S&P/BVL Mining Index.

The results obtained from the measurement of the companies' liquidity ratios show that they have undergone major changes in terms of this group of indicators; the best results were obtained during the metal price boom period, followed by a downward trend in the later years of the observation window.

Minsur and Cerro Verde posted the best results of the companies in the sample, as can

Table 3. Results of descriptive statistics: liquidity ratios

Current ratio				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	0.72	3.82	2.20	1.04
Minsur	1.02	11.15	3.68	3.07
Nexa	0.64	3.91	2.28	1.08
Cerro Verde	1.23	9.85	3.70	2.17
Brocal	0.53	10.43	2.60	2.75
Southern	1.70	5.02	2.90	0.82
Trevali	0.23	4.60	1.70	1.19
Volcan	0.55	3.16	1.39	0.73
Acid test				
Firm	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	0.57	3.61	1.89	1.03
Minsur	0.67	9.96	3.20	2.86
Nexa	0.48	3.73	2.03	1.11
Cerro Verde	0.79	8.83	2.96	2.05
Brocal	0.53	10.43	2.59	2.76
Southern	1.21	4.21	2.15	0.81
Trevali	0.22	4.58	1.46	1.20
Volcan	0.31	2.43	1.14	0.62

Source: Compiled by authors.

Table 4. Results of descriptive statistics: debt ratios

Total debt				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	0.13	0.37	0.24	0.07
Minsur	0.22	13.17	4.49	4.05
Nexa	0.26	0.64	0.49	0.10
Cerro Verde	0.08	0.43	0.26	0.09
Brocal	0.15	0.53	0.37	0.13
Southern	0.92	2.80	1.67	0.69
Trevali	1.65	10.45	4.49	3.16
Volcan	1.25	3.95	2.23	0.82
Debt capital				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	0.15	0.59	0.32	0.12
Minsur	0.08	1.25	0.55	0.36
Nexa	0.35	1.75	1.02	0.36
Cerro Verde	0.09	0.75	0.38	0.17
Brocal	0.18	1.12	0.64	0.31
Southern	-168.29	200.29	-0.81	72.82
Trevali	0.11	1.53	0.53	0.38
Volcan	0.34	3.97	1.34	1.03
Interest coverage				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	-14.45	386.97	57.43	99.55
Minsur	-0.09	1 369.98	288.27	492.24
Nexa	0.21	81.40	18.10	21.00
Cerro Verde	1.07	15 072.34	2 323.83	3 758.92
Brocal	-256.12	4 493.80	534.81	1 472.13
Southern	4.32	35.17	15.27	9.12
Trevali	-85 888.00	7.98	-5 374.58	21 470.25
Volcan	-16.66	272.90	52.37	94.12

Source: Compiled by authors.

be seen on Table 3. That is, within the observation window, these companies present the best average capacity to meet their obligations in the short term. On the other hand, the companies with the lowest average resources available to meet their obligations immediately are Trevali and Volcan.

Regarding the level of solvency of the group of companies, the analysis shows that their level of indebtedness and the debt-to-capital ratio decreased in the first years of the boom, and then when it ended, around 2012, these indicators increased markedly. In general, interest coverage was high among the companies during the period, decreasing significantly after the end of the boom to the point where, for some companies, coverage for interest expenses was not achieved due to the operating losses generated.

As part of the analysis of the solvency level, Table 4 presents the descriptive statistics for the indebtedness, or solvency, ratios. It shows that the best result for total financial debt is that obtained by Buenaventura and Cerro Verde, both of which sustained a low level of indebtedness to

Table 5. Results of descriptive statistics: profitability ratios

Roa				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	-7.34	28.69	9.35	12.62
Minsur	-16.22	33.11	11.27	12.90
Nexa	-8.67	36.44	9.38	9.40
Cerro Verde	0.49	50.23	21.78	17.46
Brocal	-10.13	89.39	13.87	24.71
Southern	5.39	34.21	17.93	9.70
Trevali	-36.36	2.36	-7.96	11.03
Volcan	-19.65	42.58	7.74	16.57
EBITDA				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	-6.67	57.40	32.55	18.22
Minsur	36.04	73.28	50.79	26.16
Nexa	-1.26	63.95	39.26	15.13
Cerro Verde	37.22	70.62	56.10	10.28
Brocal	-11.65	68.33	32.48	20.57
Southern	38.15	62.86	51.48	6.40
Trevali	8.91	42.81	26.97	17.08
Volcan	-54.32	61.13	30.11	27.00
Operating margin				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	-16.68	50.79	17.10	21.84
Minsur	-93.64	71.16	31.25	36.17
Nexa	-14.27	57.76	24.68	16.12
Cerro Verde	15.31	64.84	45.95	16.75
Brocal	-38.36	66.53	19.96	28.93
Southern	28.03	57.47	43.68	8.44
Trevali	-14.53	28.26	10.37	12.61
Volcan	-73.83	56.86	15.83	31.08
Net profit margin				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	-34.13	86.41	24.35	39.59
Minsur	-68.19	49.66	20.36	28.10
Nexa	-21.02	34.39	13.95	12.36
Cerro Verde	2.98	66.59	31.13	19.49
Brocal	-44.48	47.24	10.79	24.70
Southern	10.95	37.32	25.76	8.02
Trevali	-112.42	8.95	-25.03	34.11
Volcan	-57.13	38.82	6.06	28.80
Roe				
Company	**Min**	**Max**	**Average**	**Standard deviation**
Buenaventura	-8.68	47.85	14.16	18.22

(*Continúa*)

Minsur	-23.30	42.57	13.10	16.26
		Roe		
Nexa	-14.00	48.23	13.13	13.23
Cerro Verde	0.68	70.38	26.36	23.91
Brocal	-11.52	142.96	17.47	36.17
Southern	6.91	43.66	23.78	12.61
Trevali	-52.68	4.93	-11.42	16.93
Volcan	-26.46	57.47	11.58	22.30

Source: Compiled by authors.

assure their generation of resources. Meanwhile, for the debt-to-capital indicator, the best average result is again presented by Buenaventura and Cerro Verde, while Southern is the company that recorded the worst result. In the measurement of interest coverage, Cerro Verde exhibited the best average result, well above the sample average. In turn, Trevali obtained the worst average result in the period analysed.

Although the research design is not explanatory, it is important to note the possible causes of certain atypical results in the total debt ratio and in the interest coverage. For the total debt ratio, Minsur and Trevali present a greater increase in total assets in comparison to the increase in total liabilities, especially in the last years of the period, giving rise to the results obtained. In the case of interest coverage, Cerro Verde has a high ratio compared to the overall sample, because at most points it does not incur interest expenses, and at those at which it does, they are minimal. In the case of Trevali, the explanation lies in the negative results it obtained at various points of the observation window.

In relation to the third objective—profitability analysis of the companies in the sample—the indicators of operating margin, net profit margin, EBITDA, ROA, and ROE underwent significant increases in the early years of the metal price boom and began to decline once the boom period had come to an end.

Table 5 shows the descriptive statistics results for the profitability ratios of the companies in the sample. The measurement of return on assets shows that the companies with the best economic performances in the sector are Cerro Verde and Southern, while Trevali is found to have performed the worst. In the case of EBITDA, Cerro Verde again comes out on top, with an operating performance that exceeds the other companies studied.

The next profitability ratios applied are operating margin (UO) and net profit margin (UN). In the case of these ratios, the best results are again those of Cerro Verde and Southern, from which it can be inferred that these companies have the capacity to generate profits from the activities associated with their corporate purpose and by way of the resources invested. The final indicator is ROE, which measures the rate of return on the investment made by the company partners and/or shareholders. The ROE results illustrate that the companies with the best financial performances are Cerro Verde and Southern. Meanwhile, Trevali obtained the worst result under this indicator.

Finally, to determine whether the companies presented stable behaviour during the observation window (2004-2020), a hypothesis test is established through the following verification rule:

H_0= The company did not present a better financial indicator than the sample as a whole.
H_1= The company presented a better financial indicator than the sample as a whole.

Given the reference that the observation window is seventeen (17) years (2004 –2020), a Student's t test is proposed for n<30. In this case, the rejection value is defined as $t_e < 1.7549$ for an alpha of 5% with n-1 degrees of freedom (DF).

Student's equation 1 for n<30

$$t_e = \frac{\overline{X_e} - \mu}{\left(\frac{\sigma_e}{\sqrt{n-1}}\right)}$$

Where:

t_e = statistic t for company e

X_e = Average indicator score for company e

μ= Mean of the population studied

σ_e = Standard deviation of indicator for company e

n = number of years analysed

Student's t test for n<30 yields the following results:

In this regard, Table 6 shows that based on the hypothesis test carried out, Volcan performed best, with just two of the ten hypothesis tests rejected. The companies whose results are less than satisfactory are Buenaventura and Trevali, for which, four of the ten hypothesis tests are rejected. The design of Table 6 is based on that employed by various authors; its contents are explained in the formulation of the hypothesis test and verification rule. Likewise, the results for the cases in which the hypothesis is rejected are described above.

As noted, the observation window covers up to 2020, which corresponds to the beginning of the COVID-19 pandemic; as such, it was considered necessary to remove the results of the ratios obtained in 2020 in order to compare them with the results obtained in normal periods. Table 7 presents a comparison of the average for the companies in the sample across each indicator, where a significant decrease can be observed in all indicators calculated. Again, some atypical values are observed, which are explained by the results obtained by Southern and Trevali.

Given that Peru is one of the world's biggest copper producers, a comparison is performed to determine whether there is any relationship between the variation in the price of this metal and the variation in the ratios analysed. To this end, a ratio has been selected from each group: liquidity, total debt, and ROE.

The empirical analysis of the interdependencies established between the price of copper and the indicators of liquidity, total debt and ROE is verified through diagnostic testing, such as descriptive statistics and correlation tests.

After calculating the descriptive statistics of the interdependence between the copper price and the liquidity, total debt, and ROE indicators, an estimation is conducted to determine whether the variables present a normal distribution. For this purpose, the Shapiro-Wilk Test is applied.

To test for a correlation between the price of copper and the ratios of liquidity, debt, and return on equity, the Pearson correlation is proposed as a first measure. However, as shown on Table 9, two of the variables studied do not present a normal distribution. Therefore, the application of non-parametric correlation techniques, such as Spearman's correlation or Kendall's correlation, is proposed.

For its part, Spearman's correlation is based on the ordering of the data and measures the monotonic relationship between two variables. That is, it measures whether the variables increase or decrease together, but not necessarily at the same rate. Kendall's correlation is also based on the ordering of the data, but it measures the association between the rankings of two variables. Within this framework, the results of Spearman's and Kendall's non-parametric correlation techniques are presented on Table 10.

As regards the non-parametric correlation techniques, a negative result is evident, which means that there is an inverse or negative relationship between the variables. That is, as the value of one variable increases, the value of the other variable decreases. It is important to note that a negative correlation does not necessarily mean that one variable causes the other, as there may be other variables that affect the relationship between them. Therefore, a careful analysis must be performed to determine whether the relationship between the variables is causal or simply correlational.

Conclusions

The liquidity analysis of the Peruvian mining companies listed on the Lima Stock Exchange, included in the S&P/BVL Mining Index, reveals that the best results for these indicators were

Table 6. Results of Student's t-test

Company	Current ratio	Acid test	Total debt	Debt capital	Interest coverage	ROE	ROA	Operating margin	Net profit margin	EBITDA
Volcan	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected
Minsur	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected
Nexa	H1 is rejected	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected
Cerro Verde	H1 is not rejected	H1 is rejected	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected
Brocal	H1 is rejected	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected
Southern	H1 is not rejected	H1 is rejected	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected
Buenaventura	H1 is rejected	H1 is rejected	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected
Trevali	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is rejected	H1 is rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected	H1 is not rejected

Source: Compiled by authors.

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Table 7. Comparison of ratios without effects of COVID-19

Ratio	Average		Variation	
	2020	2004-2019	Absolute	%
Current ratio	2.03	2.50	-0.47	-18.80%
Acid test	1.63	2.17	-0.54	-24.88%
Total debt	0.93	1.69	-0.76	-44.97%
Debt capital	-19.79	1.74	-21.53	-1 237.36%
Interest coverage	-0.09	-277.93	-277.84	-99.97%
ROA	-5.18	11.87	-17.05	-143.64%
EBITDA	10.12	41.61	-31.49	-75.68%
Operating margin	-4.37	28.47	-32.84	-115.35%
Net profit margin	-22.70	18.12	-40.82	-225.28%
ROE	-9.92	16.07	-25.99	-161.73%

Source: Compiled by authors.

Table 8. Descriptive statistics of the relationship between the price of copper and the indicators of liquidity, total debt, and ROE

Variables	Copper	Liquidity	Total debt	ROE
Mean	294.86	2.51	1.70	15.37
Standard Error	18.17	0.14	0.18	4.51
Median	295.64	2.38	1.28	8.54
Standard Deviation	72.70	0.57	0.73	18.05
Sample Variance	5 285.26	0.33	0.54	325.97
Kurtosis	1.00	-1.53	0.19	-1.01
Skewness	-0.35	0.29	0.94	0.54
Range	310.15	1.58	2.52	55.64
Maximum	441.78	3.33	3.45	45.72
Minimum	131.63	1.75	0.93	-9.92
Sum	4 717.83	40.16	27.27	245.96
Count	16.00	16.00	16.00	16.00
AAD	54.25	0.50	0.64	15.50
MAD	42.94	0.36	0.29	11.15
IQR	72.46	1.01	1.12	26.96

Source: Compiled by authors.

Table 9. Results of Shapiro-Wilk test

	Copper	Liquidity	Total debt	ROE
Shapiro-Wilk Test	148.756	1.820	0.727	27.789
W-stat	0.968	0.886	0.854	0.905
p-value	0.804	0.049	0.016	0.097
Alpha	0.050	0.050	0.050	0.050
Normal distribution	Yes	No	No	Yes

Source: Compiled by authors.

obtained during the metal price boom years, and were followed by a marked decrease in the last years of the observation window in the late 2010s.

As with the liquidity indicators, the solvency indicators for the companies in the sample presented the lowest level of indebtedness during the boom period—a trend that began to reverse after this period ended, when companies began to see significant increases in their levels of indebtedness and their debt-to-capital ratios. This situation was also reflected in the fact that after the boom, some of the companies failed to cover their interest expenses.

As far as the profitability analysis is concerned, the trend is similar; the indicators of operating margin, net profit margin, EBITDA, ROA, and ROE denoted positive returns during the boom years, but these indicators were subject to a significant decrease after this period. This illustrates a clear relationship with the cycle that unfolded during the observation window.

Finally, as a result of the application of the Student's t test, it is concluded that the Volcan company is the one that reflects a better performance, in relation to the sample under study, because, of ten of the hypothesis tests carried out, only two were rejected. In the same analysis, Buenaventura and Trevali were the companies that obtained the least satisfactory results with the hypothesis tests, rejecting four.

The results of this study could be complemented by further research in which the observation window incorporates a new period of metal price rises between 2021 and 2022, as well as a benchmarking analysis. This would allow for a detailed comparison of the ratios of the companies in the sample and those of the sector as a whole, in which possible differences could be explained by internal and external factors that intervene directly in or influence the calculation of the ratios.

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