

Quantifying the Impact of the COVID-19 Pandemic on Copper Price Trends Using Time Series Analysis

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Abstract. This paper explores the complex correlation between the COVID-19 epidemic and the price fluctuations of copper, an essential metal in multiple industries. The research seeks to analyze patterns and changes in copper pricing over a ten-year period using advanced time series analysis techniques. Historical data forms the basis for predicting the prices of copper. It allows for a comparison between pre-pandemic projections made using the ARIMA Model and the actual data observed after the pandemic. Such an evaluation allows for a nuanced understanding of the impact of this global health crisis on the copper market. By scrutinizing the discrepancies between projected and actual data, the study sheds light on the resilience and adaptability of the copper industry in the face of significant external disruptions. This deeper understanding not only contributes to the knowledge base surrounding the economics of copper but also provides insights into the broader capacity of industries to withstand and respond to unforeseen challenges. Acquiring a more profound comprehension of this subject not only enhances the existing information about the economics of copper, but also offers valuable insights into the overall ability of industries to endure and react to unexpected obstacles.

Keywords: Copper price; COVID-19; ARIMA model.

1. Introduction

Copper is considered an essential metal in various sectors across the globe. Its adaptability allows it to be used in a wide range of sectors, such as plumbing systems and electrical wiring, which makes it an essential resource [1]. It is critical to comprehend the significant effects the COVID-19 has on the copper sector due to the far-reaching effects it has on a global scale. This study aims to meticulously analyse and quantify the pandemic's influence on the dynamics of copper pricing. By employing robust time series analysis methods, the primary objective is to unravel the intricate patterns underlying the fluctuations in copper price over the past decade.

This investigation prompts the fundamental research question: What are the discernible effects of the COVID-19 pandemic on the pricing dynamics of copper over the course of the last decade? There are several reasons why understanding the effect of the pandemic on the pricing of copper is vital. Primarily, it allows us to comprehend the resilience and adaptability of the copper industry when facing unforeseen global shocks. Secondly, this research offers valuable data for gauging economic stability and assisting in preparing potential mitigations for disruptions in the industry.

This paper will begin by examining existing literature on the copper industry, time series analysis, and the pandemic's significant effects on relevant industries. Subsequently, a thorough exposition of the data sources utilised, and an elaborate depiction of the methodology implemented in the time series analysis will ensue. Then, the paper will delve into an in-depth analysis of copper pricing trends spanning the last decade, aiming to quantify the specific impact brought about by the COVID-19 pandemic. This is followed by an explanation of the investigation's limitations in the evaluation. Finally, a summary of the results as well as conclusions from our analysis and subsequent industry implications will be detailed.

The Globe and mail argues that the surge in prices has been driven by a resurgent global demand, tightening supply chains and speculation surrounding copper's role in a green future. Although concerns over the outbreak initially pushed copper prices to multi-year lows, they have soared more than 80% on the back of a series of fiscal stimulus measures around the world in 2022 [2]. Experts

such as Dennis Gartman pointed out that, driven by expansionary monetary policy, commodity prices have experienced an unprecedented rise. Some believe the rally, including in copper prices, is an overextension led by speculators [3].

The COVID-19 epidemic had a major effect on copper prices, which had a dramatic effect on the industry. RIM Research team uses Granger's Causality test to analyse the data and determine the correlation between copper prices and the spread of COVID-19 cases worldwide. This was supported by data from copper mine production and import-export activities, showing how the pandemic disrupted the dynamics of the copper market.

Chile is the largest copper-producing nation and was facing a reduction in output due to operational workforce cutbacks during the pandemic. Thus, global copper production was highly disrupted due to shutdowns of copper mines in various countries. Meanwhile, other factors such as demand of copper in the electric vehicle sector as well as China's manufacturing and infrastructure activities have also played crucial roles in driving copper prices to record highs [4].

2. Methods

2.1. Data Source

The primary data, encompassing copper, is sourced from the Bloomberg Terminal, a robust market tracking software, ensuring the reliability of this research. The copper price used is with Bloomberg ticker LMCADS03:COM 3Mo Copper since it is most commonly traded.

The monthly closing values of the data will be utilised to assess and forecast the price of steel because of its non-consecutive character and high non-integer frequency. This yields a more manageable total of 120 observations and makes it possible to create a more reliable dataset with a constant frequency of 12.

2.2. Method Introduction

Given that the WHO announced the COVID-19 pandemic on March 11, 2020, this date has been designated as the official commencement of the pandemic in this research paper. For this reason, values dated before to March 11, 2020, are referred to as pre-pandemic to streamline the segmentation of our data. For semantic clarity, values dated after March 11, 2020, are referred to as post-pandemic. Despite the fact that COVID-19 outbreaks spread differently in different parts of the world, this definition shows our data analysis is consistent and comparable.

Autoregressive Integrated Moving Average (ARIMA) model is being used in the analysis and it is a versatile family of models that mainly apply to stationary time series with relatively stable statistical features [5]. Given that some seasonality is observable in our data, below is an explanation of the Seasonal ARIMA (p,d,q)(P,D,Q)[m] model parameters [6]: p: Order of the autoregressive model (no. of lagged terms). q: Order of the moving average model (no. of lagged terms). d: Number of differences required to make the time series stationary. P: Order of the seasonal autoregressive model. Q: Order of the seasonal moving average model. D: Number of seasonal differences applied to the time series. m: seasonality or frequency of the model.

3. Results and Discussion

3.1. Model Results

The required differencing to make the pre-pandemic monthly closing steel price training time series data stationary is shown in figure 1.

A non-stationary time series is suggested by the decreasing autocorrelations seen in the ACF plot as the lags get longer. This pattern depicts a scenario where prior observations have a long-term impact on current values by indicating a protracted influence of past values on present ones. The gradual decline in autocorrelations, lacking a rapid drop-off, signifies the presence of an underlying

trend or seasonality within the series. This observation suggests the necessity to address and account for these inherent patterns in the data.

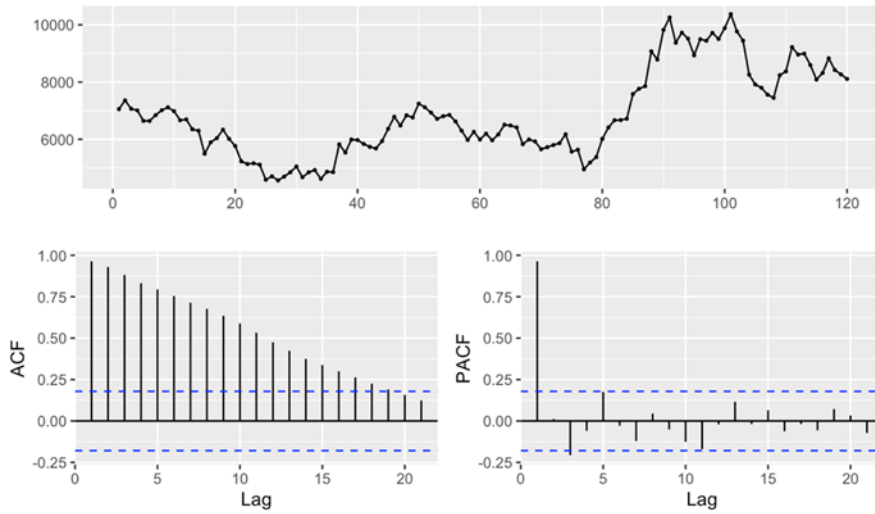


Fig. 1 Grammar of Graphics plot

In the PACF plot, there is a large spike at lag = 1, which indicates that there might be a first-order differencing needed [7]. Differencing, which involves subtracting successive data, tries to attenuate underlying patterns or seasonalities that contribute to autocorrelation at lag = 1, promoting stronger series stationarity. The ensuing significant fall in the PACF for higher delays within the critical values implies that the direct influence of previous observations fades soon after differencing. The choice of using ARIMA (0,1,3)(0,0,1)[12] are, therefore, being made for monthly copper price (Figure 2, 3).

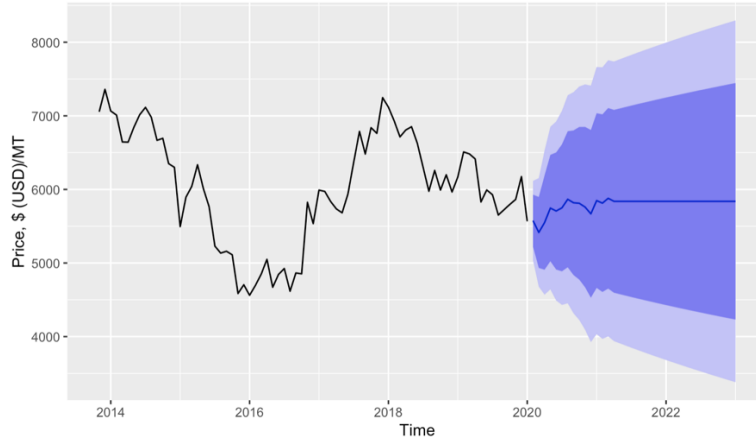


Fig. 2 ARIMA Model with pre-pandemic copper price

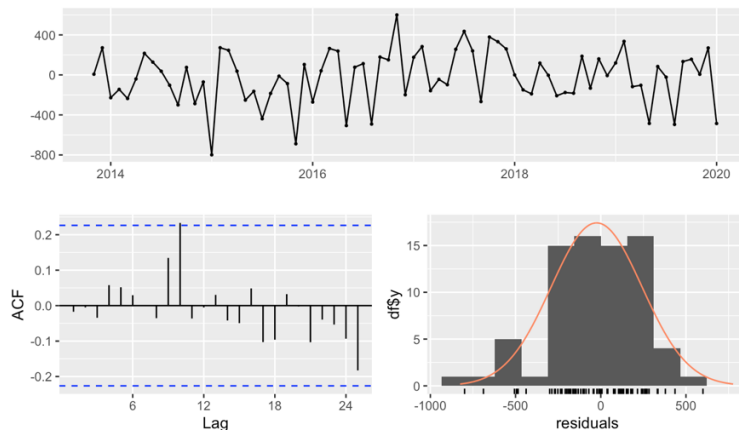


Fig. 3 Residuals from ARIMA (0,1,3)(0,0,1)[12]

The p-value derived from the Ljung-Box test at 0.7285 is much greater than the 5% significance level, meaning that we should not reject the null hypothesis. According to figure 4, the observations at the extreme ends of the distribution exhibit slight deviations from the straight line; however, overall, this sample data appears to adhere closely to a normal distribution. Overall, this is determined to be an effective forecasting model as its residuals also predominantly fall within the critical values and hence are consistent with white noise while performing normal distribution with large p-value according to figure 3.

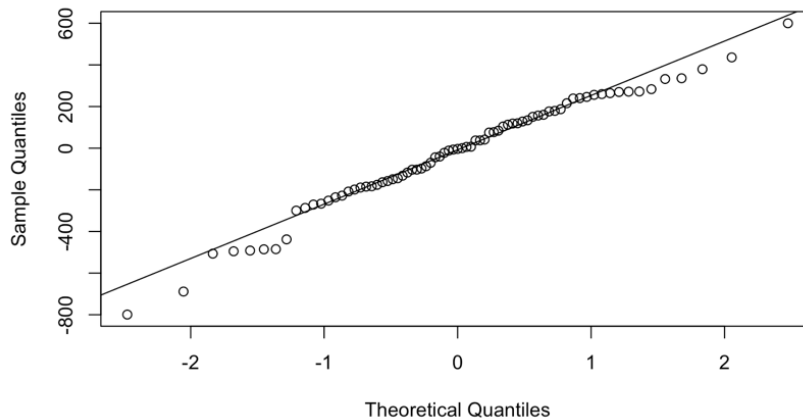


Fig. 4 Normal Q-Q Plot

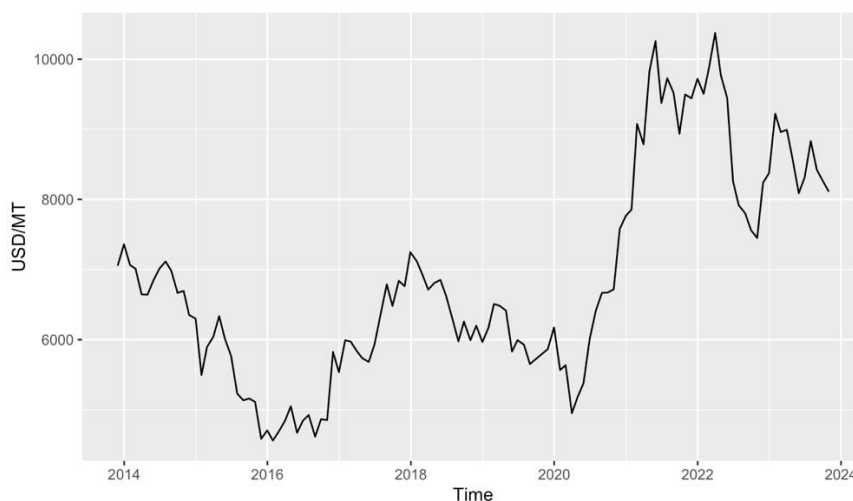


Fig. 5 Copper Price with monthly closing values

Upon comparing the actual post-pandemic data in figure 5 against the ARIMA model's predictions, an unforeseen surge has been notably observed since the pandemic's onset. This surge surpassed the projected range outlined by the ARIMA model, diverging notably from the anticipated forecast. Nonetheless, recent trends indicate a gradual regression back towards the projected range, aligning more closely with the ARIMA model's forecasted trajectory.

3.2. Evaluation

After extensively exploring the impact of the COVID-19 pandemic on copper prices trends, it is necessary to carefully evaluate our findings and highlight key factors. This evaluation aims to critically analyse the results and gain a deeper understanding of the impact of the pandemic. By establishing a nuanced perspective on key issues such as the accuracy of pandemic onset assumptions, potential oversight of other influencing factors and complex global demand and supply dynamics, we aim to uncover the complex layers beyond the pandemic affecting copper industry trends, providing a comprehensive perspective on the findings.

Generalized Assumption of the Pandemic's Start Date: Although this paper assumes a global start date for the pandemic of March 11, 2020, this may not accurately apply to all countries. For example, in November/December 2019, China reported early cases of COVID-19, highlighting the need for careful consideration of regional differences [8].

Potential Oversight of Other Factors: Given that our primary focus is on changes in copper prices dynamics during the COVID-19 pandemic. While mentioning producer side factors, other influencing factors, including market regulation, geopolitical changes, advances in extraction technology, infrastructure development, and regional socio-economic policies, may affect copper prices and production dynamics and contribute to the observed trends [9]. These potential influencing factors warrant further investigation as they could significantly influence fluctuations in copper prices and production trends, providing a fuller picture beyond the direct impact of the pandemic.

Demand-side Factors: Price fluctuations for copper can be closely linked to shifting patterns of demand around the world that are influenced by a variety of geopolitical and economic factors. Although the primary focus of our analysis is on direct impacts, it is important to investigate these intricate linkages to comprehend industry trends and modifications. Beyond the immediate effects of the pandemic, an understanding of these intricate relationships can offer important insights into the copper industry's complex responses [10].

4. Conclusion

Overall, this investigation's findings offer strong proof that the COVID-19 epidemic had a quantifiable impact on production and pricing trends of steel throughout the past decades. Fluctuations in copper price dynamics also reveal an interesting phenomenon. When delving deeper into its patterns, a rather high volatility surfaced. Copper's inherent volatility may stem from its status as a publicly traded commodity, susceptible to rapid market reactions and sentiment. Therefore, this heightened volatility hints at the growing challenge of accurately forecasting copper prices, given the inherent unpredictability and instability of its market behavior.

The findings of the research highlight the broader ramifications for the global copper sector. Following COVID-19, adaptive initiatives such as increased supply chain resilience and market-responsive techniques will be critical. For timely changes to counter comparable economic shocks, continuous trend analysis is recommended. Strategic production planning that is aligned with seasonal trends helps optimise resource allocation and efficiently fulfil market demands. Due to heightened copper price volatility, enhanced risk management practises such as scenario preparation and real-time market monitoring are required. Furthermore, building a more sophisticated forecasting process that takes into account subtle market dynamics might help with well-informed decision-making, needing additional study for accuracy and responsiveness.

In light of the quantitative findings within this study, these revelations offer a potential roadmap for navigating the post-pandemic landscape within the copper industry. This insight could potentially pave the way for strategic advancements aimed at mitigating risks and capitalizing on emerging prospects specifically pertaining to time series forecasting.

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