**UNIVERSITI TEKNOLOGI MARA**

# THE CHINA'S MACROECONOMIC IMPACT TOWARDS THE GLOBAL METAL PRICES

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Final Year Project submitted in fulfilment of the requirements for degree of Bachelor of Business Administration (Hons) Investment Management

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# AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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# ABSTRACT

This research paper explores if the relationship of China macroeconomic would significantly impact the commodity prices. The SVAR model has been used in this research paper in other to evaluate the relationship between China macroeconomics and commodity prices. In the literature review of this paper, it was provided with previous literature that tells the previous research paper analysis either there is significant impact or not between the China macroeconomics and commodity prices.

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# CHAPTER ONE
# INTRODUCTION

## 1.1 Introduction

Recently, China is known as the world largest importer group of commodities and highly dependence on imported commodities. China also known as the second largest economy and largest holder of foreign reserves. In addition, China is also has become a big player in commodity markets (Klotz, Lin, and Hsu, 2014). Due to this matter, commodity market is exposed to China's macroeconomic development (Hamilton, 2009). Today, Asia was acknowledged as the largest user globally of every industrial metal (Fernandez, 2018). In Asia, China was noted as the biggest consumer followed by Japan, South Korea, and India (Fernandez, 2018).

Other than that, London Metals Exchange (LME) traded metal in 2011 recorded that China control about 39.96% Aluminum, 50.18% lead, 33.66% zinc, 42.47% tin and 13.88 gold (BGS, 2013). However, in 2012, China recognized as major producer of 22 out of 41 elements and elements group that are economic value (BGS, 2012). According to Pitfield, 2010, stated that the country is just not the biggest producer but also the main consumer for many metals and minerals.

According to Liao, Qian, and Xu in 2018, China has become the main importer and buyer of major commodities. In addition, it is about 40% and 12.58% of oil consumption and copper worldwide in 2015 according to International Copper Study Group (ICGS) and Energy Information Administration (EIA). Due to higher demand, China plays a big role in global commodities (Liao, Qian, and Xu, 2018).

## 1.2 Background of the study

China is a major consumer of commodities globally. Changes in China's macroeconomics position and policies really affect the country's domestic financial market and global commodities demand (Liao, Qian, and Xu, 2018). News about Chinese domestic consumption doesn't affect market much and globally, world market concern on China's economic announcement instead of domestic indicator (Baum, Kurov, and Wolfe, 2015). According to Liao, Qian, and Xu, in 2018, even for some days without any macroeconomic announcement were released, the China financial market would still be intact. For example, a spike in China's stock market and the CNY sentiment can reflect the prospect of economic growth or better economic policies in near future. This indicates that there is a possibility increase in demand of commodity by China and it will affect the commodity prices to increase.

In addition, nonferrous metal plays an important role in various industries, such as technology. Furthermore, their futures markets are important to metal producers, customers, retailers, and other countries (Ma and Xiong, 2021). In financial economics, price bubble is a challenging topic, but it is a common topic that been discussed for past decades. According to Blanchard and Watson in 1982 and Kindleberger and Aliber in 2005 stated that the definition of price bubble is significant price fluctuation compared to the intrinsic value of the assets.

However, the metal price fluctuation might be due to the macroeconomic fundamental's mechanism and speculative factors (Ozgur, Yilanci, & Ozbugday, 2021). Relatively, boost in industrialization and commodity-intensive growth in emerging countries will affect the commodity demand and led to increase in global metal prices (Vansteenkistee, 2009). For some emerging countries, usually they reacted to international commodity price and had a low level of economic development. Due to this, researchers use those countries as research topic for impact commodity price's volatility towards the macroeconomy (Zhang, Du, and Li, 2020).

## 1.3 Problem statement

Recently, major challenge that has been facing in many countries is the damage from climate change that affect the economy worldwide (Jones, Elliott and Nguyen-Tien, 2020). According to Paris Accord, they aim to reduce emission of Carbon Dioxide (C02) and other Greenhouse Gases (GHGs). They are trying to keep the average temperature at the 1.5°C level. Changes in commodity prices provide many connections in financial term (Ozgur, Yilanci, & Ozbugday, 2021). The slow movement of economic growth in commodity might be lead from the increasing in the nonferrous metal prices (Chen et al, 2019). Moreover, based on the financial perspective, the changes in metal prices can be associated to market inefficiency and give signal to those speculators and arbitrageurs to gain profit in a short term (Narayan and Liu, 2011).

In addition, those who engage directly or indirectly in the commodities trade has an upper hand during the positive momentum of commodity prices, but this will not cut down the risk of losses from the burst of bubble price (Brooks et al., 2015). Other than that, other than investor politician and policy makers pay higher concern on the commodity bubble. This is due to fluctuation when commodity price bubble affects the economic activity, the price stability, exchange rates, balance of payment deficit and other macroeconomic indicators (Ozgur, Yilanci, & Ozbugday, 2021).

Increase in industrialization and economic growth in emerging countries that led by China hint to increase their demand for commodities in return that it will pressure the commodity price to be more fluctuate (Chen et al., 2019).

## 1.4 Research questions

i) What is the impact of China's Consumer Price Index on the Iron Ore and Aluminum prices?

ii) What is the impact of China's Producer Price Index on the Iron Ore and Aluminum prices?

iii) What is the impact of China's Import Price Index on the Iron Ore and Aluminum prices?

iv) What is the impact of China's Money Supply Growth on the Iron Ore and Aluminum prices?

## 1.5 Research objectives

i) To investigate the relationship of China's Consumer Price Index on the Iron Ore and Aluminum prices.

ii) To investigate the relationship of China's Producer Price Index on the Iron Ore and Aluminum prices.

iii) To investigate the relationship of China's Import Price Index on the Iron Ore and Aluminum prices.

iv) To investigate the relationship of China's Money Supply Growth on the Iron Ore and Aluminum prices.

## 1.6 Significance of the study

This research paper is to expand the understanding on the impact of Iron Ore and Aluminum prices towards China's Consumer Price Index, Producer Price Index, Import Price Index and Money Supply Growth. This paper is also based on the previous research paper that have significant topic. It tells that these papers are not based on logical thinking but already consider the past research. According to Klotz in 2014, there are few works of research paper related to the topic of relationship between China's macroeconomics factors and international commodity prices.

The price of irrelevant commodities sometimes boost or drop in unison, and it is called as the comovement by the researchers (T.Zhang, et al. 2020). According to Pindyck and Rotermberg in 1990 found that the commodity price reflected to move together while the common macroeconomics shocks. Due to this matter, many researcher widen the research are and use variety of economics and use statistical models for empirical research (T.Zhang, et al. 2020).

## 1.7 Scope of the study

For this research paper, it is more focusing on Iron Ore and Aluminum price impact towards the China's macroeconomic. The China's macroeconomics that been used for this paper is CPI, PPI, IMPI and M2 Growth. There reason behind the topic of this research paper is because recently China has become the world biggest user of Iron Ore and biggest producer of Aluminum. This is important to see if the China's macroeconomic would affect the Iron Ore and Aluminum prices.

In addition, the data collection was focused on range of year 2016 until 2020. The data will be gathered from various sources such as Eikon Reuters, State Statistical Bureau of China, World Bank Data, Ministry of Commerce China and Westmetal. The period chosen due the data availability. Some of the data only provide from year 2016 until latest. Due to this matter, it would provide good result if the data collection were consistent and aligned with other variables.

## 1.8 Limitations of the study

### 1.8.1 Time Constraint

This research paper needs to be conducted during the internship program which make it a bit difficult since the researcher had to focus on the internship program and to meet the due date of this research paper. In other to have proper writing and understanding of this research paper, the researcher needs more time to read the related article and understand the article.

### 1.8.2 Data Availability

There is no problem in term of the sources of the data, but there is an issue on the process of getting the data. For example, since the topic is about China macroeconomics, some of the websites are hard to access. The researcher needs several try to get through the website such as Ministry of Commerce China. Due to this, it takes time on the process of gathering the data.

### 1.8.3 Time Horizon

For the time horizon, it was decided to use 10 years period and on monthly basis from year 2010 until 2020 but due the limitation of the data where some of the variable didn't provide date from year 2010 on a monthly basis. The researcher had a few changes in term of the data period where it was decided to choose from year 2016 until 2020 on monthly basis. By doing these changes, the data will be more relevant to the research topic.

### 1.8.4 Language Barrier

Other limitation that researcher face is the language barrier. This happen when the researcher gets through to the China government website, it comes out in mandarin. Due to this, the researcher needs to translate the website by using translator extension provided by Google Chrome.

# CHAPTER TWO
# LITERATURE REVIEW

## 2.1 Overview

From the past study, the relationship between metal prices and China macroeconomic is an interesting topic to going further. This is because it keeps on expanding and those commodities were using globally.

## 2.2 Iron Ore

The Iron Ore price fluctuated were not driven by China's inflation or supply but more on the demand side (Cheng and Yang, 2021). The price shows a drastically fluctuated in early year 2000 and its belief that the shift in the price have correlation with inflation (Ahn et al., 2017). China also is known as the biggest importer of Iron Ore since 2003 and consuming about 30% or more of the total production globally (Ma et al., 2013).

Iron Ore also known as important subject to national strategic reserves and essential industrial raw material (Cheng and Yang, 2021). In addition, Iron Ore is proven that it has been an important subject in both real economy and market resources. Due to this, Iron Ore prices is significant economic parameter that can heavily affect a country (Su, Wang, Chang and Peculea, 2017). Iron Ore also is the main input in producing crude steel and manufacture steel product (Etienne, 2016). Moreover, the Iron Ore price fluctuation is just not affecting a country but also a business. According to Astier in 2015, when the price of Iron Ore is declining, mines will face a difficult situation and it might need to close their operation.

## 2.3 Aluminum

Copper and Aluminum are very important nonferrous metal in term of value, both are highly contributed to almost every industrial sector (Figuero-la- Ferretti et al., 2015). According to Creti et al, the stock market has the highly corelated with oil, non-ferrous metal such as Copper and Aluminum and have weaker to negatively correlated with agricultural product and precious metal.

## 2.4 China Consumer Price Index

Consumer Price Index (CPI) is basically used for the purpose to measure the level of price for commodities and services from the consumers perspective (Chen and Yang, 2021). According to Wen et al. in 2019 and Chen et al. in 2020, a lot of researchers argued that the commodity price can significantly affect the PPI but not for CPI.

Most of the previous study focused on the impact of commodity prices on CPI and PPI. The researcher also pointed out that the impact on PPI is significantly higher compared to the CPI (Chen and Yang, 2021). Chen and Yang in 2021 also quoted that China's CPI is mainly contributed with daily necessities but it is not steel-intensive product, and the Iron Ore is related raw material for steel production.

## 2.5 China Producer Price Index

Producer Price Index (PPI) is known as a composed predominantly of commodities in the production field. The global Iron Ore price can influence the PPI across the industry chain, but it took at least one year (Chen and Yang, 2021). China's PPI has weak impact towards supply shock and not much persistent but the impact towards the special demand and global demand are greater.

According to Chen and Yang in 2021, global demand shock affects the China's PPI in positively and significantly but a declining in Iron Ore prices were drive by weaker global demand and as a result the China's inflation in 2010 until 2013 is slightly downward.

## 2.6 China Import Price Index

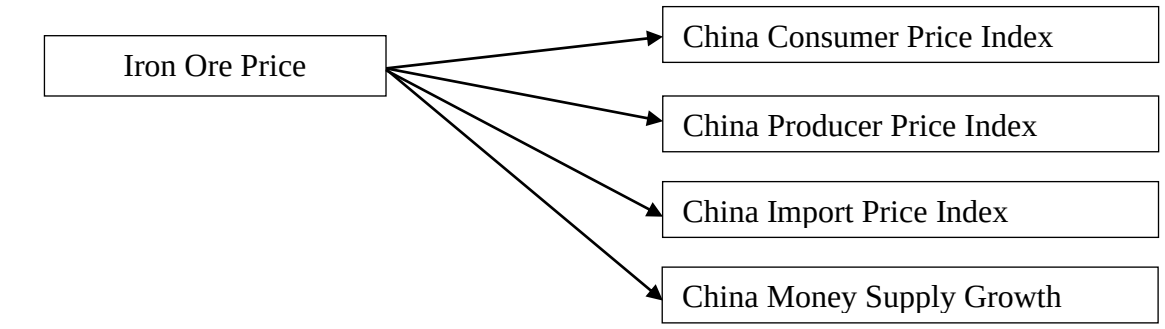
Iron Ore enters China via global trade channels and after that enters the industrial production as raw materials. Due to this Iron Ore price is most likely to have a significant impact on the import price level (Chen and Yang, 2021). The China's IMPI can be negatively influenced by special global demand and supply. In comparison, the special and global demand are significantly better on China's IMPI compared to supply shock (Chen and Yang, 2021).

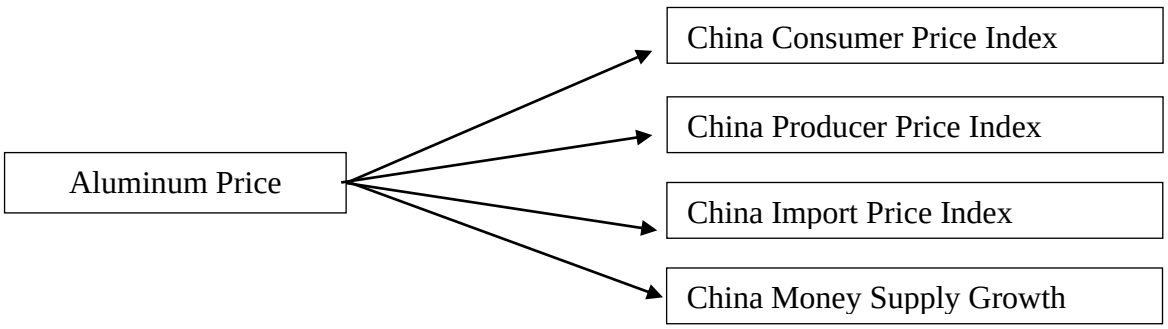
## 2.7 China Money Supply Growth

Money supply play an important role that can affect the commodity prices. The monetarist believe that monetary phenomenon will trigger the inflation. On the other hand, U-shaped nonlinear effect has been found in Money Supply on commodity price and it is a positive effect. It indicates that on a later phase money supply raise the commodity price. In addition, increase in money supply will lead to inflation and can push the commodity price higher (Lin and Xu, 2019).

Moreover, to avoid the impact of risen in commodity price, the government responsible to develop targeted measure by implement moderate monetary policy (Lin and Xu, 2019). According to Klotz et al in 2014, stated that a drop in interest rate lead by the monetary supply expansion and it will push the real commodity price higher above long-term equilibrium price. Song et al in 2019 assume that central bank use money supply growth when implementing monetary policy.

## 2.8 Theoretical/ Research Framework



# CHAPTER THREE
# RESEARCH METHODOLOGY

## 3.1 Introduction

This research paper proposed a study of the impact of Iron Ore and Aluminum prices Consumer Price Index (CPI), Producer Price Index (PPI), Import Price Index (IMPI) and Money Supply growth (M2 Growth). In this chapter it will explain on the method used for this paper, data collection, timely basis, sampling, and the hypothesis development.

## 3.2 Sampling

The sample of population used in this research paper are coming from Country and Commodities. For country it was specified to China country while for commodities it was specified for metal such as Iron Ore and Aluminum. The data was taken on monthly basis from year 2016 until 2020.

## 3.3 Data Collection

| | |
|---|---|
| Data Collection | Eikon Reuters, State Statistical Bureau of China, World Bank Data, Ministry of Commerce China and Westmetal. |
| Dependent Variables | Iron Ore Price, Aluminum Price |
| Independents Variables | China CPI, China PPI, China IMPI and China M2 Growth |
| Sample Description | Country and Commodity |
| Period | 5 years (2016 – 2020) |
| Basis | Monthly |

Table 1: Data Collection, Variables, Sample, Period and Basis

### 3.4 Dependent Variables

This research paper used two dependent variable which is Iron Ore prices and Aluminum price. The reason of using these two dependent variables is because that both of it was mentioned in previous research study. In addition, metal is kind of material that is widely used globally. Due to that, it is important which kind of factor that can contribute to shift the price of those metals.

| **Dependent Variables** |
|---|
| Iron Ore Price |
| Aluminum Price |

Table 2: Dependent Variables

### 3.5 Independent Variables

| Variable | Expected Findings |
|---|---|
| China CPI | China Consumer Price Index has significant impact on Iron ore and Aluminum prices. |
| China PPI | China Producer Price Index has significant impact on Iron ore and Aluminum prices. |
| China IMPI | China Import Price Index has significant impact on Iron ore and Aluminum prices. |
| China M2 Growth | China Money Supply Growth has significant impact on Iron ore and Aluminum prices. |

Table 3: Independent Variables and Expected Finding

## 3.6 Hypothesis Statement

| Variable | Hypothesis |
|---|---|
| China CPI | $H_0$: China CPI is insignificant towards Iron ore and Aluminum Price<br>$H_1$: China CPI is significant towards Iron ore and Aluminum price |
| China PPI | $H_0$: China PPI is insignificant towards Iron ore and Aluminum Price<br>$H_1$: China PPI is significant towards Iron ore and Aluminum price |
| China IMPI | $H_0$: China IMPI is insignificant towards Iron ore and Aluminum Price<br>$H_1$: China IMPI is significant towards Iron ore and Aluminum price |
| China M2 Growth | $H_0$: China M2 Growth is insignificant towards Iron ore and Aluminum Price<br>$H_1$: China M2 Growth is significant towards Iron ore and Aluminum price |

Table 4: Hypothesis Statement

## 3.7 Research Methodology

This research paper was conducted using SVAR model. SVAR model is called as Structural Vector Autoregression model, and it was proposed by Sims in 1986. This model can evaluate lag relations and simultaneous relations (Chen and Yang, 2021). In addition, few research study has used this model for example Stock and Watson in 1996 and Cogley and Sargent in 2001. Other than that, Kang et al. in 2016 also spotted that the SVAR model explain that the global liquidity has a significant impact towards commodity price since the global financial crisis.

According to Kilian in 2009, Herwart and Plodt in 2016 and Ioannidis and Ka in 2018 quoted that the SVAR model is one of the methods that has been widely used. This method also focusses on dynamic relationship between time series data and more inclined (Song et al., 2019). Moreover, SVAR model is well backed by the economic theory and sets the limitation relationship between variables recently (Cunado and Gracia, 2015; Rehman, 2018). This method is an effective method to analyse the impact of structural external shocks (Kilian, 2019; Hu et al., 2017).

# CHAPTER FOUR
# ANALYSIS AND RESULT

## 4.1 Descriptive Analysis

Descriptive analysis used to summarize and point out pattern in dataset which involve dependent and independent variables. The analysis was described by using Mean, Median, Maximum, Minimum, Standard Deviation, Skewness level, Kurtosis and Probability.

Sample: 1 60

| | ALU_PRICE | IO_PRICE | CHINA_CPI | CHINA_IMPI | CHINA_PPI | M2_GROWTH |
|---|---|---|---|---|---|---|
| Mean | 1848.671 | 137.1235 | 102.2183 | 101.7527 | 101.2833 | 0.097350 |
| Median | 1818.085 | 127.8800 | 102.1000 | 101.5500 | 100.2500 | 0.091500 |
| Maximum | 2287.930 | 261.3600 | 105.4000 | 113.8800 | 107.8000 | 0.140000 |
| Minimum | 1480.100 | 72.06000 | 99.50000 | 86.90000 | 94.70000 | 0.080000 |
| Std. Dev. | 211.4531 | 37.14061 | 1.057739 | 6.797494 | 3.590721 | 0.015916 |
| Skewness | 0.185757 | 0.940121 | 0.790130 | -0.008811 | 0.154962 | 0.770253 |
| Kurtosis | 2.200122 | 3.898823 | 4.874864 | 2.245123 | 1.842686 | 2.649087 |
| Jarque-Bera | 1.944568 | 10.85798 | 15.03084 | 1.425376 | 3.588570 | 6.240742 |
| Probability | 0.378218 | 0.004388 | 0.000545 | 0.490324 | 0.166246 | 0.044141 |
| Sum | 110920.2 | 8227.410 | 6133.100 | 6105.160 | 6077.000 | 5.841000 |
| Sum Sq. Dev. | 2638033. | 81386.05 | 66.00983 | 2726.149 | 760.7033 | 0.014946 |
| Observations | 60 | 60 | 60 | 60 | 60 | 60 |

Figure 1: Aluminum Price, Iron Ore Price, CPI, IMPI, PPI and M2 Growth

For Aluminum price the mean is 1848.671, it indicates that the average Aluminum price from 2016 until 2020 is 1848.671. The maximum price for Aluminum is 2287.930 while the minimum is 1480.100. The median for Aluminum price is 1818.085 it measures the central of skewed distribution. The skewness is 0.185757 which is positively skewed to the right, and it indicates that the size of the left-handed tail is larger than the right-handed tail. For the kurtosis is 2.200122. As for the Jarque-bera, the p-value recorded 0.378218 which is more than the rule of thumb at 5% significance level. It indicates that the data is normally distributed.

For Iron Ore Price the mean is 137.1235, it indicates that the average Iron Ore price from 2016 until 2020 is 137.1235. The maximum price for Iron Ore is 261.36 while the minimum is 72.06. The median for Iron ore price is 127.88 it measures the central of skewed distribution. The skewness is 0.940121 which is positively skewed to the right, and it indicates that the size of the left-handed tail is larger than the right-handed tail. For the kurtosis is 3.898823. As for the Jarque-bera, the p-value recorded 0.004388 which is less than the rule of thumb at 5% significance level. It indicates that the data is not normally distributed.

For China Consumer Price Index (CPI) the mean is 102.2183, it indicates that the average CPI from 2016 until 2020 is 102.2183. The maximum CPI is 105.40 while the minimum is 99.50. The median for CPI is 102.10 it measures the central of skewed distribution. The skewness is 0.790130 which is positively skewed to the right, and it indicates that the size of the left-handed tail is larger than the right-handed tail. For the kurtosis is 4.874864. As for the Jarque-bera, the p-value recorded 0.000545 which is less than the rule of thumb at 5% significance level. It indicates that the data is not normally distributed.

For China Import Price Index (IMPI) the mean is 101.7527, it indicates that the average IMPI from 2016 until 2020 is 101.7527. The maximum IMPI is 113.88 while the minimum is 86.90. The median for IMPI is 101.55 it measures the central of skewed distribution. The skewness is -0.008811 which is negatively skewed to the left, and it indicates that the size of the right-handed tail is larger than the left-handed tail. For the kurtosis is 2.245123. As for the Jarque-bera, the p-value recorded 0.490324 which is more than the rule of thumb at 5% significance level. It indicates that the data is normally distributed.

For China Producer Price Index (PPI) the mean is 101.2833, it indicates that the average PPI from 2016 until 2020 is 101.2833. The maximum PPI is 107.80 while the minimum is 94.70. The median for PPI is 100.25 it measures the central of skewed distribution. The skewness is 0.154962 which is positively skewed to the right, and it indicates that the size of the left-handed tail is larger than the right-handed tail. For the kurtosis is 1.842686. As for the Jarque-bera, the p-value recorded 0.166246 which is more than the rule of thumb at 5% significance level. It indicates that the data is normally distributed.

For China Money Supply Growth (M2) the mean is 0.097350, it indicates that the average M2 growth from 2016 until 2020 is 0.097350/9.735%. The maximum growth for M2 is 0.14/14% while the minimum is 0.08/8%. The median for M2 growth is 0.0915/9.15% it measures the central of skewed distribution. The skewness is 0.770253 which is positively skewed to the right, and it indicates that the size of the left-handed tail is larger than the right-handed tail. For the kurtosis is 2.649087. As for the Jarque-bera, the p-value recorded 0.044141 which is less than the rule of thumb at 5% significance level. It indicates that the data is not normally distributed.

## 4.2 Correlation Analysis

### 4.2.1 Aluminum

Covariance Analysis: Ordinary
Date: 01/10/22 Time: 23:22
Sample: 1 60
Included observations: 60

| Correlation<br>Probability | ALU_PRICE | CHINA_CPI | CHINA_IMPI | CHINA_PPI | M2_GRWT |
|---|---|---|---|---|---|
| ALU_PRICE | 1.000000<br>----- | | | | |
| CHINA_CPI | -0.284171<br>0.0278 | 1.000000<br>----- | | | |
| CHINA_IMPI | 0.571594<br>0.0000 | -0.235651<br>0.0699 | 1.000000<br>----- | | |
| CHINA_PPI | 0.735812<br>0.0000 | -0.275171<br>0.0333 | 0.857318<br>0.0000 | 1.000000<br>----- | |
| M2_GRWT | -0.694774<br>0.0000 | -0.230741<br>0.0761 | -0.470272<br>0.0001 | -0.417385<br>0.0009 | 1.000000<br>----- |

Figure 2: Correlation Result for Aluminum

Above result shows the correlation of Aluminum price with China Macroeconomics. The China CPI shows that it has negative and weak correlation of -0.284171 on the Aluminum price. The significant is measure by p-value where there rule of thumb of less than 5% result that the variable had significant impact to dependent variable or reject the null. As a result, for China CPI shows that it has a significant with Aluminum price where the p-value is 0.0278 which less than 5%.

Other than that, is China IMPI where the result shows it has positive and moderate correlation of 0.571594 on the Aluminum price. The significant is for China IMPI shows that the p-value is 0.0000 which less than 5%. This indicates that the China IMPI is significant where the rule of thumb of 5% applied to reject the null.

Moreover, China PPI result shown that it has positive and strong correlation of 0.735812 on the Aluminum price. The significant for China PPI is measured by the result of p-value where it is 0.0000 which less than 5%. On the result wise, it tells that the China PPI is significant to Aluminum Price

On the other hand, China M2 Growth shows that it has negative and moderate correlation of -0.694774 on the Aluminum price. The significant is for China M2 growth shows that its p-value is 0.0000 which less than 5%. The result of p-value that are less than 5% indicates that the variable has significance impact with dependent variable and the China M2 growth has significance impact with Aluminum Price.

### 4.2.2 Iron Ore

Covariance Analysis: Ordinary
Date: 01/10/22 Time: 23:23
Sample: 1 60
Included observations: 60

| Correlation<br>Probability | IO_PRICE | CHINA_PPI | CHINA_IMPI | CHINA_CPI | M2_GRWT |
|---|---|---|---|---|---|
| IO_PRICE | 1.000000<br>----- | | | | |
| CHINA_PPI | -0.208342<br>0.1102 | 1.000000<br>----- | | | |
| CHINA_IMPI | -0.146938<br>0.2626 | 0.857318<br>0.0000 | 1.000000<br>----- | | |
| CHINA_CPI | 0.007909<br>0.9522 | -0.275171<br>0.0333 | -0.235651<br>0.0699 | 1.000000<br>----- | |
| M2_GRWT | -0.195777<br>0.1338 | -0.417385<br>0.0009 | -0.470272<br>0.0001 | -0.230741<br>0.0761 | 1.000000<br>----- |

Figure 3: Correlation Result for Iron Ore

Above result shows the correlation of Iron Ore Price with China Macroeconomics. The China CPI shows that it has positive and weak correlation of 0.007909 on the Iron Ore price. The significant is measure by p-value where there rule of thumb of less than 5% result that the variable had significant impact to dependent variable or to reject the null. As a result, for China CPI shows that it is insignificant with Iron Ore price where the p-value is 0.9522 which more than 5%.

Other than that, for China IMPI the result shows it has negative and weak correlation of -0.146938 on the Iron Ore price. The significant is for China IMPI shows that the p-value is 0.2626 which more than 5%. This indicates that the China IMPI is insignificant where the rule of thumb of 5% applied when fail to reject the null.

Moreover, China PPI result shown that it has negative and weak correlation of -0.208342 on the Iron Ore price. The significant for China PPI is measured by the result of p-value where it is 0.1102 which slightly more than 5%. On the result wise, it tells that the China PPI is insignificant to Iron Ore Price.

On the other hand, China M2 Growth shows that it has negative and weak correlation of -0.19577 on the Iron Ore price. The significant is for China M2 growth shows that its p-value is 0.1338 which more than 5%. The result of p-value that are less than 5% indicates that the variable has significance impact with dependent variable and the China M2 growth is not significance with Iron Ore Price.

## 4.3 4.3 Regression Analysis

### 4.3.1 Aluminum

Dependent Variable: LNALU_PRICE
Method: Least Squares
Date: 01/08/22 Time: 01:00
Sample: 1 60
Included observations: 60

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 16.20370 | 2.989599 | 5.420024 | 0.0000 |
| LNCHINA_CPI | -3.855327 | 0.566317 | -6.807725 | 0.0000 |
| LNCHINA_IMPI | -0.815884 | 0.156891 | -5.200333 | 0.0000 |
| LNCHINA_PPI | 2.539945 | 0.289221 | 8.782019 | 0.0000 |
| LNM2_GRW | -0.509371 | 0.040673 | -12.52357 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.890068 | Mean dependent var | 7.515790 |
| Adjusted R-squared | 0.882073 | S.D. dependent var | 0.114453 |
| S.E. of regression | 0.039304 | Akaike info criterion | -3.555339 |
| Sum squared resid | 0.084963 | Schwarz criterion | -3.380810 |
| Log likelihood | 111.6602 | Hannan-Quinn criter. | -3.487071 |
| F-statistic | 111.3270 | Durbin-Watson stat | 1.164853 |
| Prob(F-statistic) | 0.000000 | | |

Figure 4: Regression Result for Aluminum

| Estimated Equation |
|---|
| **LNALU_PRICE = 16.2037 - 3.8553*LNCHINA_CPI - 0.8159*LNCHINA_IMPI + 2.5399*LNCHINA_PPI - 0.5094*LNM2_GROWTH** |

Equation 1: Estimated Equation for Aluminum Regression

Based on the result above, it shows that all the independent variable is significant where the P-value is 0.0000 less than 5% level of significance. This indicates that the China CPI, IMPI, PPI and M2 growth had significant impact towards the Aluminum Price.

| Variable | Decision Rule |
|---|---|
| China Consumer Price Index (CPI) | When P-value < 0.05, reject the null hypothesis China CPI is statistically significant |
| China Producer Price Index (PPI) | When P-value < 0.05, reject the null hypothesis China PPI is statistically significant |
| China Import Price Index (IMPI) | When P-value < 0.05, reject the null hypothesis China IMPI is statistically significant |
| China Money Supply Growth (M2) | When P-value < 0.05, reject the null hypothesis China M2 growth is statistically significant |

Table 5: Significant Result for Aluminum

#### *4.3.1.1 T-Test*

T-test are used to measure the hypothesis individually in regression. The reason to use t-test is because the individual result of regression tells that if the China's CPI, PPI, IMPI and M2 growth had a significant impact towards Aluminum Price. The Degree of Freedom (DOF) for the regression is calculated by number of observation (N) – Number of independent variables (K) – 1. The DOF is 55 (60-4-1) for this regression. The critical value for the two-sided test at 5% significance level with DOF of 55 is 2.0000, by comparing the t-value and the critical value, it can be decided if the variable is significant or not. If the t-value is larger than the critical value, it means that to reject the null hypothesis and vice versa.

| Independent Variables | T-value | Critical T-value | Decision rule | Decision |
|---|---|---|---|---|
| China CPI | 6.807725 | 2.000 | 6.807725 > 2.000 | Reject the null, Significant |
| China PPI | 5.200333 | 2.000 | 5.200333 > 2.000 | Reject the null, Significant |
| China IMPI | 8.782019 | 2.000 | 8.782019 > 2.000 | Reject the null, Significant |
| M2 Growth | 12.52357 | 2.000 | 12.52357 > 2.000 | Reject the null, Significant |

Table 6: T-test Result for Aluminum

#### *4.3.1.2 F-Test*

F – test used to measure the multiple hypothesis such a compound of null hypothesis. As shown on the result, the F-value from the regression is 111.3270 while the critical f-value is 2.53 for the 5% significant level.

| F-Value | Critical F—Value | Decision Rule | Decision |
|---|---|---|---|
| 111.3270 | 2.53 | Reject the null hypothesis since the F-Value > Critical Value / 111.2370 > 2.53 | The result shows that the equation is overall fit and significant |

Table 7: F-test Result for Aluminum

#### *4.3.1.3 Coefficient of Determination ($R^2$)*

The $R^2$ used to measure the overall fit of data on the dependent variable. The larger the number of $R^2$, the stronger overall fitness of independent on dependent variables. Generally, the $R^2$ result is between $0 < R^2 < 1$, the closer the $R^2$ to 1 indicates that it has an excellent overall fit. From the regression result, the $R^2$ is 0.890068 or 89% overall fit. it means that 89% of the dependent variables can be explained by the regression model, while the remaining of 11% couldn't be explained.

#### *4.3.1.4 Adjusted Coefficient of Determination (Adjusted $R^2$)*

Adjusted $R^2$ used to measure the equation's fits with the same dependent variable and different numbers of independent variables. However, adjusted $R^2$ is not good enough to used when comparing the fits of two equation with different dependent and independent variables. From the result, the Adjusted $R^2$ is 0.882073 or 88.21%. this indicates that when the DOF is adjusted, about 88.21% of independent variable could be explained.

### 4.3.2 Iron Ore

Dependent Variable: LNIO_PRICE
Method: Least Squares
Date: 01/09/22 Time: 17:15
Sample: 1 60
Included observations: 60

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 28.71395 | 18.94975 | 1.515268 | 0.1354 |
| LNM2_GRWT | -0.688021 | 0.257808 | -2.668733 | 0.0100 |
| LNCHINA_PPI | -2.533457 | 1.833245 | -1.381952 | 0.1726 |
| LNCHINA_IMPI | 0.055803 | 0.994462 | 0.056114 | 0.9555 |
| LNCHINA_CPI | -3.025283 | 3.589631 | -0.842784 | 0.4030 |

| | | | |
|---|---|---|---|
| R-squared | 0.141084 | Mean dependent var | 4.887125 |
| Adjusted R-squared | 0.078617 | S.D. dependent var | 0.259540 |
| S.E. of regression | 0.249129 | Akaike info criterion | 0.137964 |
| Sum squared resid | 3.413591 | Schwarz criterion | 0.312493 |
| Log likelihood | 0.861082 | Hannan-Quinn criter. | 0.206232 |
| F-statistic | 2.258541 | Durbin-Watson stat | 0.194035 |
| Prob(F-statistic) | 0.074482 | | |

Figure 5: Regression Result for Iron Ore

| Estimated Equation |
|---|
| **LNIO_PRICE = 28.7139 - 3.0253*LNCHINA_CPI + 0.05580*LNCHINA_IMPI - 2.5335*LNCHINA_PPI - 0.6880*LNM2_GROWTH** |

Equation 2: Estimated Regression for Iron Ore

Based on the result above, it shows that only M2 growth is significant where the P-value is 0.0100 less than 5% level of significance. This indicates that the China M2 Growth is significant with Iron Ore prices. Other variables such as IMPI, PPI and CPI is insignificant towards the Iron Ore Price where the P-value for IMPI is 0.9555, CPI is 0.4030 and PPI is 0.1726.

| Variable | Decision Rule |
|---|---|
| China Consumer Price Index (CPI) | When P-value < 0.05, reject the null hypothesis<br>China CPI is statistically insignificant Iron Ore Price |
| China Producer Price Index (PPI) | When P-value < 0.05, reject the null hypothesis<br>China PPI is statistically insignificant Iron Ore Price |
| China Import Price Index (IMPI) | When P-value < 0.05, reject the null hypothesis<br>China IMPI is statistically insignificant Iron Ore Price |
| China Money Supply Growth (M2) | When P-value < 0.05, reject the null hypothesis<br>China M2 growth is statistically significant with Iron Ore Price |

Table 8: Significant Result for Iron Ore

#### *4.3.2.1 T-Test*

The reason to use t-test is because the individual result of regression tells that if the China's CPI, PPI, IMPI and M2 growth had a significant impact towards Iron Ore Price. The Degree of Freedom (DOF) for the regression is calculated by number of observation (N) – Number of independent variables (K) – 1. The DOF is 55 (60-4-1) for this regression. The critical value for the two-sided test at 5% significance level with DOF of 55 is 2.0000, by comparing the t-value and the critical value, it can be decided if the variable is significant or not. If the t-value is larger than the critical value, it means that to reject the null hypothesis and vice versa.

| Independent Variables | T-value | Critical T-value | Decision rule | Decision |
|---|---|---|---|---|
| China CPI | 0.842784 | 2.000 | 0.842784 < 2.000 | Fail to Reject the null, Insignificant |
| China PPI | 1.381952 | 2.000 | 1.381952 < 2.000 | Fail to Reject the null, Insignificant |
| China IMPI | 0.056114 | 2.000 | 0.056114 < 2.000 | Fail to Reject the null, Insignificant |
| M2 Growth | 2.668733 | 2.000 | 2.668733 > 2.000 | Reject the null, Significant |

Table 9: T-test Result for Iron Ore

#### *4.3.2.2 F-Test*

F – test used to measure the multiple hypothesis such a compound of null hypothesis. As shown on the result, the F-value from the regression is 2.258541 while the critical f-value is 2.53 for the 5% significant level.

| F-Value | Critical F—Value | Decision Rule | Decision |
|---|---|---|---|
| 2.258541 | 2.53 | Fail to reject the null hypothesis since the F-Value < Critical Value / 2.258541 < 2.53 | The result shows that the equation is not overall fit |

Table 10: F-test Result for Iron Ore

#### *4.3.2.3 Coefficient of Determination ($R^2$)*

The $R^2$ used to measure the overall fit of data on the dependent variable. The larger the number of $R^2$, the stronger overall fitness of independent on dependent variables. Generally, the $R^2$ result is between $0 < R^2 < 1$, the closer the $R^2$ to 1 indicates that it has an excellent overall fit. From the regression result, the $R^2$ is 0.141084 or 14.11% overall fit. it means that 14.11% of the dependent variables can be explained by the regression model, while the remaining of 85.89% couldn't be explained.

#### *4.3.2.4 Adjusted Coefficient of Determination (Adjusted $R^2$)*

Adjusted $R^2$ used to measure the equation's fits with the same dependent variable and different numbers of independent variables. However, adjusted $R^2$ is not good enough to used when comparing the fits of two equation with different dependent and independent variables. From the result, the Adjusted $R^2$ is 0.078617 or 7.86%. this indicates that when the DOF is adjusted, about 7.86% of independent variable could be explained.

## 4.4 Heteroskedasticity Analysis

### 4.4.1 Aluminum

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 0.593480 | Prob. F(4,55) | 0.6688 |
| Obs*R-squared | 2.482576 | Prob. Chi-Square(4) | 0.6478 |
| Scaled explained SS | 1.632614 | Prob. Chi-Square(4) | 0.8029 |

Figure 6: Heteroskedasticity Result for Aluminium

The result above shows a heteroskedasticity result were Aluminum price as dependent variable. The rule of thumb is to reject the null hypothesis when the result of Observation*R-Square (NR) is greater than the chi-square critical value. According to the result above, the NR is smaller than chi-square critical value at 31.4 (from the chi-square critical value table in appendices). This indicates that it fails to reject the null and it tells that there is no evidence heteroskedasticity. In addition, the data was run in double-log form because it is one of the remedies to deal with heteroskedasticity.

### 4.4.2 Iron Ore

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 10.52030 | Prob. F(4,55) | 0.0000 |
| Obs*R-squared | 26.00784 | Prob. Chi-Square(4) | 0.0000 |
| Scaled explained SS | 17.00282 | Prob. Chi-Square(4) | 0.0019 |

Figure 7: Heteroskedasticity Result for Iron Ore

The result above shows a heteroskedasticity result were Iron Ore price as dependent variable. The rule of thumb is to reject the null hypothesis when the result of Observation*R-Square (NR) is greater than the chi-square critical value. According to the result above, the NR is smaller than chi-square critical value at 31.4 (from the chi-square critical value table in appendices). This indicates that we reject the null hypothesis, and it tells that there is heteroskedasticity problem. The data for Iron Ore

price and China macroeconomics was run in double-log form because it is one of the remedies to deal with heteroskedasticity.

# CHAPTER FIVE
# CONCLUSION AND RECOMMENDATION

## 5.1 Introduction

This chapter will elaborate on the overall findings of independent and dependent variables. This chapter will include the main finding, expected finding, limitation during study and recommendation that can be used in the future research paper.

## 5.2 Conclusion and Main Finding

The topic of commodity prices could reflect due to macroeconomics changes is a good research study to conduct. This is because commodity is huge not just involve non-ferrous metal, it also includes oil, agriculture commodity and others. In addition, it is traded worldwide, every country had their main commodity that they rely on the most such as in China they rely more on producing Aluminum and importing the Iron Ore. That is what makes the research topic become more interesting because they are one of the countries that monopoly the non-ferrous metal. In this research study, four independent that will monitor closely is China CPI, IMPI, PPI and M2 Growth.

First and foremost, for the Aluminum price the result prove that all the independent variable is significant. For China CPI it shows that it has a weak negative correlation and significant with Aluminum price, China IMPI shows that it has a moderate positive correlation with Aluminum price and significant, China PPI result prove that it has a strong positive correlation with Aluminum Price and significant, and M2 growth shows that it has moderate negative correlation and significant with Aluminum Price. The result for Aluminum price relationship with China macroeconomics is aligned with researcher early hypothesis where the researcher believes that China macroeconomics of CPI, IMPI, PPI and M2 growth is significant towards Aluminum Price.

Secondly, for the Iron Ore price relationship shows that only M2 growth had a significant impact with IO price while CPI, IMPI and PPI is proved to be insignificant with IO price. In term of the correlation with Iron Ore price, China CPI shows that it has a weak positive correlation with Iron Ore price and insignificant. For the China IMPI it shows that it has weak negative correlation and insignificant with Iron Ore price. The China PPI prove that it has a weak negative correlation with Iron Ore price and still insignificant. Lastly is M2 growth is the only variable is significant with Iron Ore price but has a negative weak correlation.

On the overall result it explained that as a biggest producer of Aluminum, China macroeconomics is the key point to take into consideration to evaluate the progression of Aluminum price while as the biggest importer of Iron Ore, China's macroeconomics doesn't affect much of Iron Ore price compared to Aluminum price.

## 5.3 Limitation of Study

### 5.3.1 Lack of Time

The researcher has less time in the proses on conducting this research paper. Which means that, the researcher must spend more time to understand the journal or references. It takes a lot of time to spend to get better understanding on the research topic. Without a proper understanding researcher couldn't provide a solid result of research or it may be minor error on the research study such as relationship of variables with other variables.

### 5.3.2 Language Barrier

The researcher unable to read certain references due to different languages use. For example, during data gathering some website use mandarin instead of English. The researcher needs to translate the language by using translate extension in chrome but a direct translate from Mandarin to English is not always correct. This could affect the researcher understanding and the research paper.

### 5.3.3 Problem on Gathering the Data

During the first phase of data collection there is few changes happen where China Gross Domestic Product should be used but due to lack of information it needs

to change to other variable. Other than that, the second problem occur when the data for certain variable can't be run through the E-Views, then the researcher decide to drop the variable and only use four variables instead of five. With proper and good relationship of variable could led to better result in regression.

## 5.4 Recommendation

In conclusion, the researcher is experiencing a lot of things in conducting research paper such know the background idea of the research topic, make sure it is an interesting topic for researcher and proper time management. The result of previous research is quite same with researcher expected finding. On the other hand, there is many gaps that could be filled to provide a better research paper about the topic.

In addition, for future reference, researcher could at least have a study on the commodity areas before choosing the topic so that researcher will not wating their time just to get better understanding of the topic. It could help the researcher to identify a good topic that they will enjoyed and understand more while doing it.

# CHAPTER SIX
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# APPENDICES

Unit root test

Aluminum Price

Null Hypothesis: LNALU_PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -0.534609 | 0.8764 |
| Test critical values: | 1% level | -3.546099 | |
| | 5% level | -2.911730 | |
| | 10% level | -2.593551 | |

Iron Ore Price

Null Hypothesis: LNIO_PRICE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.317219 | 0.0736 |
| Test critical values: | 1% level | -4.124265 | |
| | 5% level | -3.489228 | |
| | 10% level | -3.173114 | |

China CPI

Null Hypothesis: LNCHINA_CPI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.977358 | 0.1472 |
| Test critical values: | 1% level | -4.121303 | |
| | 5% level | -3.487845 | |
| | 10% level | -3.172314 | |

China IMPI

Null Hypothesis: LNCHINA_IMPI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -0.462125 | 0.9827 |
| Test critical values: | 1% level | -4.121303 | |
| | 5% level | -3.487845 | |
| | 10% level | -3.172314 | |

China PPI

Null Hypothesis: LNCHINA_PPI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | 0.211060 | 0.9976 |
| Test critical values: | 1% level | -4.127338 | |
| | 5% level | -3.490662 | |
| | 10% level | -3.173943 | |

China M2 Growth

Null Hypothesis: LNM2_GROWTH has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -0.767573 | 0.9625 |
| Test critical values: | 1% level | -4.124265 | |
| | 5% level | -3.489228 | |
| | 10% level | -3.173114 | |

Cointegrated Test

Aluminum Price

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| | | | Asymptotic: n=1000 | |
| F-statistic | 4.322078 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |
| Actual Sample Size | 56 | | Finite Sample: n=60 | |
| | | 10% | 2.323 | 3.273 |
| | | 5% | 2.743 | 3.792 |
| | | 1% | 3.71 | 4.965 |

Iron Ore Price

| F-Bounds Test | | Null Hypothesis: No levels relationship | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| | | | Asymptotic: n=1000 | |
| F-statistic | 1.200586 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |
| Actual Sample Size | 57 | | Finite Sample: n=60 | |
| | | 10% | 2.323 | 3.273 |
| | | 5% | 2.743 | 3.792 |
| | | 1% | 3.71 | 4.965 |

Chi-Square Table

| Degrees of Freedom | Level of Significance (Probability of a Value at Least as Large as the Table Entry) | | | |
|---|---|---|---|---|
| | 10% | 5% | 2.5% | 1% |
| 1 | 2.71 | 3.84 | 5.02 | 6.63 |
| 2 | 4.61 | 5.99 | 7.38 | 9.21 |
| 3 | 6.25 | 7.81 | 9.35 | 11.34 |
| 4 | 7.78 | 9.49 | 11.14 | 13.28 |
| 5 | 9.24 | 11.07 | 12.83 | 15.09 |
| 6 | 10.64 | 12.59 | 14.45 | 16.81 |
| 7 | 12.02 | 14.07 | 16.01 | 18.48 |
| 8 | 13.36 | 15.51 | 17.53 | 20.1 |
| 9 | 14.68 | 16.92 | 19.02 | 21.7 |
| 10 | 15.99 | 18.31 | 20.5 | 23.2 |
| 11 | 17.28 | 19.68 | 21.9 | 24.7 |
| 12 | 18.55 | 21.0 | 23.3 | 26.2 |
| 13 | 19.81 | 22.4 | 24.7 | 27.7 |
| 14 | 21.1 | 23.7 | 26.1 | 29.1 |
| 15 | 22.3 | 25.0 | 27.5 | 30.6 |
| 16 | 23.5 | 26.3 | 28.8 | 32.0 |
| 17 | 24.8 | 27.6 | 30.2 | 33.4 |
| 18 | 26.0 | 28.9 | 31.5 | 34.8 |
| 19 | 27.2 | 30.1 | 32.9 | 36.2 |
| 20 | 28.4 | 31.4 | 34.2 | 37.6 |

Source: Based on *Biometrika Tables for Statisticians*, Vol. 1, 3rd ed., 1966, with the permission of the *Biometrika* trustees.

Note: The table plots the cumulative probability $Z > z$.

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