



## **The trend of copper price in 2019**

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## **Abstarct**

Copper has always been one of the most important metals for the use of urbanization and industrialization. Globally, the market for copper is one of the largest of all metals behind iron and aluminum. Looking back into the history, copper price has been through fluctuations, booms and crashes. Entering 2019, lights shed on commodity market again. How copper price is going to behave in the short term? What are the variables that are affecting the copper price behave in the long term? This essay is trying to find the variables that are affecting copper price trend in the long term forecast the copper price trend in the short term. For the long term analysis, analyzing firstly through demand and supply methodology of analyzing new demand and remaining supply is the basic methodology. The demand side would be focused on for analyzing different influencing factors more than the supply side. For the short term forecast, the technical analysis would be employed. After this reading this thesis, an idea of the copper price trend in the short term and defining the variables that are affecting the copper price in the long term would be possible.

## **Introduction**

This thesis is divided into 8 chapters. In the beginning of the essay, the state of art would be discussed and other researchers' methodology and achievements would be discussed and summarized. In the third chapter, the thesis' methodology would be explained. In the fourth chapter, a more detailed introduction of the background knowledge of copper would be discussed here including the historical copper price, the usage of copper, the consumption, the geographical consumption of copper and the supply of the copper. In the fifth chapter, regression analysis would be used to find out which variables are affecting the copper price market, and would be used for long term forecast for copper price. And a

final formula of copper price would be included. In the sixth chapter, technological analysis would be applied for the short term copper price movement, and a forecast of copper price movement would be given. In the seventh chapter, a discussion around the trade war would be carried out. The relationship of trade war between china and United states's time frame and the copper price would be compared in order to see if this political situation is affecting the copper price. And the last chapter would be a conclusion of this thesis.

### **State of the art**

For the forecast of copper price trend, former scholars have used different forecast method. For example, the relationship between copper consumption and GDP [6]. The future demand of copper driven by population increase and per capital incomes enlargement. The supply and demand method are widely used due to that copper is one of the raw materials and it suits the rule of supply and demand. Hence the price would be driven high with higher demand and lower supply, on the hand, would be dragged low by lower demand and higher supply. However, the calculation of demand and supply varies. There are two main approaches: Historical analysis and scenario analysis. The essence of the historical analysis is that the researcher tries to speculate the demand price trend through the study of the historical behavior of the copper price trend. From the previous studies, the methodologies included time series analysis method, elastic coefficient method, multi-objective linear programming method, input-output method. However, due to that the historical analysis method is based on the mathematical statistics of historical data, and there are political or policy influences that are not quite well explained in this approach. Also, due to the natural defects of historical analysis of speculating the future based on the past, this approach needs to be improved by integrating with other approaches. That is to say, the qualitative analysis is integrating into the quantitative analysis. Scenario Analysis method, due to the combination of quantitative analysis and qualitative analysis of the characteristics, but also subjective factors such as non-quantifiable factors and the future of the various possible situations and the results of the maximum consideration. Scenario Analysis method has better predictive effect than other prediction methods such as

historical analysis method, Chen et al. has used the VAR vector autoregressive model to predict the demand for Chinese steel [7].

## **Methodology**

This essay would use bottom-up approach to identify the factors that affect copper price to draw a conclusion taking into consideration all the factors.

The supply and demand method is applied in this essay as well. But this essay would focus on more the calculation demand than for the supply. The methodology of calculating the demand and supply of copper is demonstrated below.

The multilinear regression analysis is used for forecasting copper demand. First, from the previous state of art and also from researching, the factors that influence the copper price would be listed and then selected.

After defining the factors that could influence the copper price demand. The datas are obtained from Thomson Reuters and other different data resources.

Then, define the copper demand as the dependent variables, other factors as independent variables. Apply the regression analysis, exclude factors that don't apply to the model and get the final model.

For the supply of copper, not much discussion would be here, and the data is taken directly from the mining ministry of Chile and other resources.

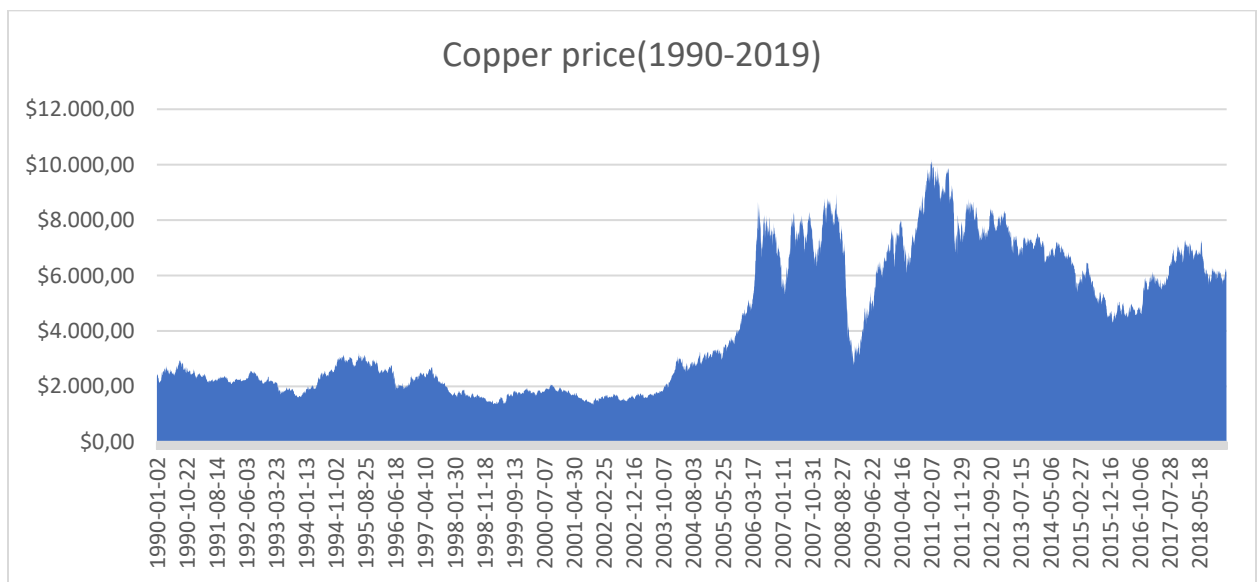
After obtaining the variable most corelated to the copper price trend, and the supply fluctuation. Another regression analysis would be carried out including the variable, the supply fluctuation rate and copper price trend in order to find if there is a correlation between the three. Hence, we draw a formula of calculating future copper price.

Next approach is technical analysis. It would not be the main approach to forecast the copper price trend, but an approach to help decide the upturn or downturn tendency. In this approach, a focus on patterns of price movements, trading signals and various other analytical charting tools would be discussed to evaluate the copper price's strength or weakness. Regarding copper price trend, and the forecast of 2019, it is not such a long term forecast that technical analysis is still effective. And copper, as a kind of commodity, would be suitable for the technical analysis.

## Copper market price

Since 1990 until 2019, Copper price has gone through three stages. In the first stage from 1990 till 2002, copper price has stayed around 2000\$ per tonne. In the second stage, from 2002 till 2008, copper has taken off and risen fast to reach about 8000\$ per tonne. In 2008. Due to the financial crisis, copper price has dropped down sharply to around 3000\$ per tonne. And from 2008 onwards, in the third stage, copper price has gone through sharp rise from 2008 till 2011, steady downturn from 2011 till 2016, and from 2016 till the end of 2018, copper price has slightly risen,. The average copper price in 2018 is 6522\$ per tonne.

The evolution of copper price could be seen in the graph below.



(Data resource: London Metal Exchange)

## Usage of copper

Copper and its alloys are so widely used that it is so strongly related to a country's economy development.

According to the copper development association, copper usage could be categorized in to four sectors: Electrical, Construction, Transport, Other.

## **Electrical**

Copper is one of the most effective conductor of electricity due to its characteristics of corrosion resistance, ductility, malleability. As electricity needs have become widely demanded for infrastructure construction requirement in the process of economy development, as long as a country is stepping into a more civilized and better economy developed country, the demand of usage of copper would be increased along the way.

Electrical applications, the prosperity of computer technology, televisions, mobile phones and other portable electronic devices have played an crucial role in recent years for the consuming of copper.

For the usage of: electronic connectors, heat sinks, circuitry wiring and contacts, printed circuit boards, welding electrodes, micro-chips, semi-conductors, magnetrons in microwaves, vacuum tubes , electromagnets, etc.

Apart from the usage for electricity and electronic applications, there is another industry which needs large quantities of copper----telecommunications. No matter it is local area network internet that require the use of finely twisted copper wires, or the use of unshielded twisted wires, the third industrial revolution of information technology and the fast development of internet has dramatically increased the consumption of copper. Despite the fact that internet are becoming wireless, however, the interface devices such as modems and routers remain dependent on the copper.

What's more, the progress of renewable energy sector, such as wind and solar energy, not only has not decreased the use of copper, but also has increased it. Due to the fact that copper is integral to the motors and distribution systems associated with alternative energy technology.

## **Construction**

In the construction sector, for many hundreds of years, copper has always ben used as an architectural metal due to its characteristic of being lightweight, durable, corrosion-resistant, and easy to join. Many buildings and houses use copper as doors, handles, doorknobs, locks, tables, faucets, hinges, lighting and bathroom fixtures for construction. The usage of copper for construction could date back to thousand of years ago, for example,

many medieval churches and cathedrals have been adorned by pure copper, and this tradition is still kept till nowadays that it is used on government buildings.

Also, copper is widely used in hospital buildings and medical facilities, for being bacteriostatic properties, for faucets, door handles, etc.

And due to this characteristic, copper tubing is widely used for portable water and heating systems in most of the developed countries.

### **Transport**

Electrical vehicles, trains, boats, planes all have crucial parts to be dependent on the electrical and thermal characteristic of copper. Apart from the traditional usage, the growing use of electronic components, such as onboard navigation system, anti-lock braking systems, and heated seats, has continued to increase demand for the copper. Moreover, the growing demand for hybrid and electric cars will continue to increase copper consumption due to that they require twice or third the size of copper than manufacturing a traditional car. Due to that the batter structure change require more usage of copper

High speed trains also consume large quantity of copper, and high speed trains are developing in a dramatic speed.

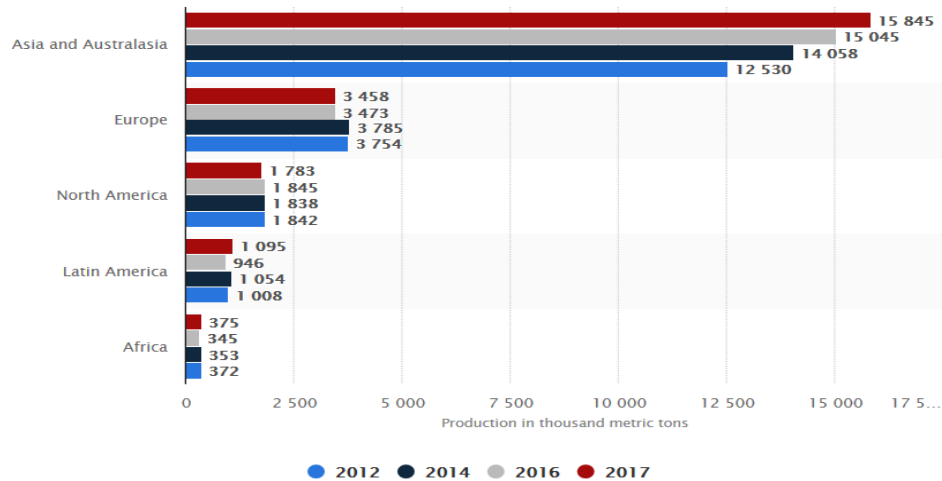
### **Others**

Domestic appliance: domestic appliance especially used for cooking and heating, such as pots and pans, stoves, ovens, water heating units.

Industrial machinery: Machines that are used for manufacturing in a factory, such as motors.

### **The consumption of copper**





(Data resource: The statistics portal)

From this graph, it could be seen that, Asia is the top one for consuming copper from 2012 onwards, and Europe ranks the second. North America ranks the third. It also can be seen that, North America and Europe region has decreased the copper consumption from 2012 to 2017, where Europe has a more sharp decrease. On the contrary, Asian region has increased the copper consumption by 12%, 7%, 5.3% in 2014, 2016, 2017. It could be seen that Asian region has been the main drive force for the copper demand.

Further on this essay would be looking into macro economy situations, both in emerging market and developed market, especially, a more detailed analysis of China and India would be presented given that these two markets have increased a lot of the portion of copper demand and are influencing the copper price with their own fluctuations of economy.

Furthermore, a focus on the influence of economy of China on the copper price would be emphasized, in order to identify, if there is, correlation of China's GDP with the copper price, and how strong it is. Regarding the remaining supply, an analysis of the copper mines situation in Chile would be carried out, a discussion about the remaining quantity and new opportunities of finding copper mines would also be included.

### **The supply of copper**

### Factors that affect the supply of copper

There are many factors that could affect the supply of copper. The first one, would be the price of the copper itself, If the copper price increase, the supply of the copper would normally increase as well according to the supply and demand rule. On the other hand, if the copper price decreases, the supply of the copper would accordingly decrease. Also, the expectation of the copper price for the future, the speculation of the copper price, would also influence the production. The second one, is the price of the substitutes. If others metal that ha the similar function as copper decreases the price, the copper demand would decrease, so as the copper price. And according to the first rule, the copper price itself affect the supply. The third one, is the cost of production. The labour price, wages, would certainly affect the supply, As the cost of production is higher, the lower the supply of the copper. Sometimes there are strikes that stop the production of copper, it would first improve the cost of production, and lower the production by lower efficiency. Hence, to push the copper price higher. The fourth one, is the development of technology. As the more developed the technology, more efficient the production would be. And sometimes some technologies would lower the cost of production as well. The fifth one, is the government policy. Take Chile government for example, to approve more new mines or not, would also affect the supply of copper. And taxation policy, a higher tax for mining would improve the cost of production.

### Global copper production forecast

Chile is the world's biggest copper producer while Peru followed in second place and China followed in third place. The copper supply in 2019 is estimated to a 1.6% increase compared to 2018. As it is a price forecast trend for 2019, future copper deficit problem would not be discussed here.

País	2018 p			2019 f			2020 f		
	ktmf	Diff	var. %	ktmf	Diff	var. %	ktmf	Diff	var. %
Chile	5.845	341	6,2	5.941	96	1,6	6.024	83	1,4
Perú	2.420	-24	-1,0	2.505	85	3,5	2.442	-63	-2,5
China	1.433	-224	-13,5	1.483	50	3,5	1.535	52	3,5
RD Congo	1.180	85	7,8	1.357	177	15,0	1.425	68	4,5
EE.UU	1.182	-75	-6,0	1.259	77	6,5	1.284	25	2,0
Zambia	1.007	66	7,0	1.103	96	9,5	1.202	99	9,0
Australia	946	86	10,0	1.003	57	6,0	1.008	5	0,5
Indonesia	800	133	20,0	480	-320	-40,0	624	144	30,0
Kazajistán	779	34	4,5	775	-4	-0,5	759	-15	-2,0
Rusia	744	4	0,5	733	-11	-1,5	744	11	1,5
México	727	-15	-2,0	764	36	5,0	794	31	4,0
Canadá	535	-59	-10,0	568	32	6,0	551	-17	-3,0
Otros	3.038	36	1,2	2.977	-61	-2,0	3.052	74	2,5
<b>Mundo</b>	<b>20.636</b>	<b>387</b>	<b>1,9</b>	<b>20.967</b>	<b>331</b>	<b>1,6</b>	<b>21.464</b>	<b>497</b>	<b>2,4</b>

	2018 p		2019 f		2020 f	
	ktmf	Var. %	ktmf	Var. %	ktmf	Var. %
<b>Producción cobre mina</b>	20.636	1,9	20.967	1,6	21.464	2,4
<b>Oferta de Refinado</b>	23.312	-0,4	23.849	2,3	24.310	1,9
Primario	19.590	0,7	20.058	2,4	20.429	1,8
Secundarios	3.722	-5,7	3.791	1,9	3.882	2,4
<b>Demanda de refinado</b>	23.501	0,9	24.076	2,4	24.495	1,7
China	12.262	4,0	12.569	2,5	12.757	1,5
Resto del mundo	11.239	-2,2	11.507	2,4	11.738	2,0
<b>Balance de Mercado</b>	<b>-189</b>		<b>-227</b>		<b>-185</b>	

<b>Precio del cobre US\$ x libra</b>	<b>2,97</b>	<b>3,05</b>	<b>3,08</b>
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(Data resource: Cochico)

## Commodity trading market and ways to invest in copper

There are commodity trading market all around the world to make sure that the trading of futures contracts could be facilitated smoothly and the benefits of trades are protected. In China, there are Shanghai futures exchange etc 4 commodity exchanges, In US, the most well known one is The Chicago Board Of Trade, In UK, there is London metal exchange etc commodity trading market, and all other futures exchanges around the world.

To invest I copper and influence the copper price. There are several ways of investing. First, to directly invest in the raw material, which is not quite convenient way for normal

investors. Second, to invest in companies that has things to do with the copper, for example, companies that produce copper. Third, to invest in ETFs that track the copper price trend. Forth, to trade futures and options in the commodity exchange market. From the four methods above, the two methods that influence more to the copper price should be the first one and the last one, in which there is more direct trading of copper itself.

## **Explain the regression model**

Correlation: Correlation means strength and direction of a statistic relationship combined by the dependence and association. There are different kinds of correlations relate to the level of the relationship, which are weak correlation, strong correlation, perfect positive correlation, and perfect negative correlation. Variance is the spread out of one variable. Covariance is the joint spread at two variables. Correlation compare covariance across different data sets. To build a regression model, we check the correlation to make sure the correlation is not 0.

### **2 Sample correlation**

Sometimes we don't have full access to population correlation because the lack of access to all the data, so instead of using the population correlation, we use the sample correlation instead. The sample correlation has the database not based on all the data available, but on a percentage of data. The formula for the sample correlation is the same as the calculation for the population correlation, however, the data set are from the sample data. So the sample correlation is a random variable. It is needed to do a hypothesis test to see if the sample correlation is not equal to 0 with a 95% confidence. So with the null hypothesis  $H_0: \rho=0$  and  $H_1: \rho \neq 0$  to make sure that correlation equals to 0 is not included in the confident interval, other wise we could reject the correlation and there is no need to continue with the regression model building. Or with testing, it is also possible to test if a regression coefficient is significant.

### **3 What types of model are used**

The simplest regression model is the linear model. Where the equation looks like something:

$$Y = a + bX + \text{Error}$$

Where Y is the dependent variable, X is the independent variable. From simultaneous equations, it could be obtained the estimate of parameters to fit in the model.

Goodness of fit : More spread-out data has a less fitness than less spread-out data. Goodness of fit measures how much is the data explained by the model and how well a statistical model fits a set of observations. Residuals sum for estimated variables, which is the unexplained part of the model.

Check the model /Validation I want to check if there are true errors around the model, investigate the nature of the relationships.

There are four key assumptions that needed to be tested for the regression model, which are independence, normality, homoscedasticity and linearity.

Regarding linearity, opposite to non linearity, is the basic for the linear regression model.

About independence, the residual of the fitted model are independent from each other. To make sure there is no pattern in the residuals, the covariance and correlations between the different disturbances are all zero, also called serial independence. An error occurring at period would not be carried over to next period t+1. If there is autocorrelation, the estimated variances of the regression coefficients will be biased and inconsistent, and therefore hypothesis testing is no longer valid.

Homoscedasticity, which is also called the constant variance, requires that the variance of the errors are simultaneous with the predicting variables.

Normality means that the errors are generated from a normal distribution model.

Transformation : Pattern in the residual analysis for example a growth model,

Multiple linear regression model: In the multiple linear regression model there is more than one independent variable, which is extended by a simple linear regression model. The equation of the multiple linear model could be explained by something like this:

$$Y = a + b_1 X_1 + b_2 X_2 + \dots + b_k X_k$$

Prediction with regression: We use X to predict Y since the X issued to predict, it is the predictor variable. The scores being predicted on the Y variable are called the outcome variables.

Prediction is not perfect unless the correlation coefficient is equal to +1 or -1. The stronger correlation, the smaller r the error would be, the weaker the correlation, the bigger the error would be.

The method of least squares is used to create the line of best fit. The line of best fit is the line with the least error in the sum of squares. The line of best fit represents the improvement of the predicted model over simply predicting with the mean.

There is whole variability of the data, the total variance is explained by a part that could be explained by the general linear model. However, some of the variance would be due to residual error, or, residual variance. The part that could be explained by the general linear model should be much larger than the variance that couldn't be explained due to the residual error.

Once the regression model is established, the  $r$  value is squared to create an effect size. The  $R^2$  is the percent of variability in the  $Y$  variable explained by the variability in the  $X$  variable. The closer  $R^2$  is to 1, the better is the model and its prediction.

### **Variables that affect the demand side**

The demand side from copper construction, are mainly constructed by four things: electrical, transportation, construction, manufacturing. From which, the following variables are observed to see the relationships between them.

### **Emerging Markets**

Geographically speaking, the emerging market demand has been playing a very important part for the copper demand for the last 10 years. So emerging markets should not be ignored when analysing the demand for copper. It is due to the development of economy requires more electricity, more construction for the transformation from countryside zone to the urban zone. And demand for development of transportations, for example, more railways and more vehicles demand. And also, the manufacturing side, more domestic appliances are needed for example, due to the improve of life quality of people. Among the emerging market, the demand from china should not be overlooked. As it shows in the consumption table, China consumes almost half of the copper as a percentage. Meanwhile, comparing to us, the copper consumed Per Capita is much lower in China. So China still has potential huge demand to push up the copper price.

Secondly, the consumption ability, which is decided mainly by the income of the consumers would finally decide if they buy more domestic appliance, more electronic vehicles. Electricity is something inelastic, that wouldn't be affected much by the price once the facilities have been set up. Domestic appliance and vehicles are more elastic. As the income of consumers improve, the more domestic appliance and vehicles they buy. And the income of customers, would be related to the GDP of the economy. Besides, the level of inflation (in this essay, the change of CPI index is analysed), would affect the consumers' consumption ability as well. The higher the inflation index, the lower purchasing power, on the contrary, the lower inflation rate, theoretically, the higher purchasing power.

## GDP

Gross domestic product is an index for measuring the total market value of the goods and service produced in a country within a certain time period of time, which only includes purchases of newly produced goods and service, excluding the sale and resale of goods produced in previous period of time. The main components for GDP are consumption, investment, government spending and net exports. It is assumed the higher economic growth, the more commodities are needed for purchasing.

To find the exact correlation, calculation of the correlations are applied to each of them, and it is seen that there is a very weak positive correlation between the world GDP and copper price, which is 0.078. And there is a negative correlation between China GDP and copper, which is -0.276, and a slighter stronger correlation between the United States GDP and copper price, which is -0.4096. However, according to the demand-supply theory, the higher demand of copper, the higher price of copper. So as the GDP develops, it increases the demand the copper logically, and so the copper price would tend to rise given the assumption that the supply keep steady. So there should a positive correlation between the GDP and copper price. The correlation of negative results should be a coincidence, and the resulted should be aborted.

After applying regression analysis, it could be seen that there is no correlation between world GDP with copper price, and neither correlation between the china GDP and copper price, neither correlation between the United States GDP and copper price.

So, another assumption is, there is correlation between the world GDP growth rate and china GDP growth rate, united states GDP growth rate and copper price.

To prove this Assumption. I take the data of the world GDP growth rate, china GDP growth rate and united states GDP growth rate from 2008-2017. Again in order to find the exact correlation, calculation of the correlations are applied to each of them, and it is seen that there is a positive correlation between the world GDP growth rate and copper price, which is 0.469. And there is also a positive correlation between China GDP growth rate and copper, which is 0.466, and a slighter weaker but still positive correlation between the United States GDP growth rate and copper price, which is 0.32.

From the regression analysis, it could be proved that there is correlation between the GDP growth rate and copper price. So from the calculations above, we find a positive correlation between world GDP growth rate and copper change rate.

This consumption is based on that the higher GDP, the more consumption of copper, and so the copper price would be driven up.

However, from the analysis of detailed copper consumption, it could be seen that Asian region is the main driven force for the copper consumption. So, a regression analysis of Asian region GDP growth rate and copper change rate would be carried out.

Since the GDP growth in Asia are mainly driven by the East Asia the pacific region, the region includes China, Hong Kong, Macau, Taiwan, Japan, Mongolia, North Korea, and South Korea, Australia. However, India has a increased development of GDP, and so an increased demand of copper, hence, an increased consumption of copper. So the GDP of India is taken into consideration in another column. So there is a GDP growth rate in East Asia that includes India and GDP growth rate in East Asia that doesn't includes India.

However, this correlation is between the GDP growth rate and copper price. Another assumption is that there could be or could not be a stronger correlation between the GDP growth rate and copper yearly change rate.



In order to prove there is correlation, copper change rate is calculated using the formula: From the correlation calculation, the correlation between East Asia region without India is a positive correlation of 0.7583, and the correlation between East Asia region with India is also a positive correlation of being 0.7457. However, the former has a slightly higher positive correlation. Up till now, this is the highest correlation with the copper price change rate. So the GDP growth rate of East Asian + pacific region is most correlated to the copper yearly change rate.

### Industrial production Index

Industrial production index is an economic indicator that measures the economic output, or, by other words, level of production for the sector of manufacturing, construction, etc. The industrial production index is published at the end of every month. Unlike other indexes, the industrial production Index is not an absolute number, it is an index level comparing to the base year. In the data withdrawing from world bank, it is based on year 2015 so far.

### Stocks indexes

#### FTSE China A50

In china, there are mainly currently two stock exchange market in mainland. One is located in Shanghai, founded in December, 1990, and the other one is located in Shenzhen, founded in July, 1991. In shanghai stock exchange market, there are 1426 companies (2018) listing in this stock exchange and has a total market capitalization of \$5.5 trillion, SDEM ranks the fourth largest stock exchange market in all over the world. In Shenzhen stock exchange market, there 2164 companies listing. The total market capitalization of Shenzhen stock exchange market is \$2.285 trillion (2015), ranks the 8<sup>th</sup> largest in the world.

A shares are securities of companies that are incorporated in mainland China and traded by renminbi only. Investors of A shares are either Chinese or institutional investors that specifically qualify.

FTSE china A50 index combined the largest 50 A shares companies listing in these two stock exchange market, by their full market capitalization.

So it is an index representative for the mainland companies.

#### S&P 500

The new York stock exchange is the world's largest stock exchange market, has a total market capitalization of US\$30.1 trillion(2018), and over 3000 companies listing there. The Nasdaq stock exchange market is the second largest stock exchange market, also located in new York. There are 2700 companies listing on the Nasdaq stock exchange market, including small-cap and large-cap companies and many tech giants. The S&P 500 index based on the 500 largest capitalization companies in US listed mainly on the NYSE( New York Stock Exchange Market) and NASDAQ Stock Exchange Market.

Below is the S&P monthly averaging closing price for the past 10 yrs.

#### Dow Jones Index

While Dow Jones Industrial Average(DJIA) include only 30 publicly owned companies with the largest capitalization. These companies that are included Dow Jones Industrial Average are also included in S&P 500 index.

#### FTSE 100 Index

The main stock exchange market in UK, is the London Stock Exchange market. It has a market capitalization of US\$4.59 trillion(2018). The financial times stock exchange index(FTSE 100), represents the 100 companies with the largest capitalization listed in the London Stock Exchange Market.

#### Euro stoxx 50

Euro stoxx 50 index is a weighted stock index for the European market, which is formed by the measurements of the largest blue chip 50 companies regarding market capitalization in the Europe. The 50 companies are selected from Euro stoxx index which include both mid-large market capitalization companies and small capitalization companies. Unlike other stock market index, the Euro Stoxx 50 represents quite a big portion of the original Euro Stoxx Index, which is 60%. So this index represents the European market.

#### DAX 30

The DAX is a German stock market index that consists 30 major publicly owned companies trading in the Frankfurt Stock Exchange market.

## WTI

West Texas Intermediate crude oil is an oil benchmark. There are in total three crude oil benchmarks, the West Texas Intermediate crude oil, North sea Brent crude, and Dubai crude oil. Among them, the West Texas Intermediate and Brent Crude are the more popular used ones, while WTI is produced, refined, and consumed in North America. And also, WTI crude oil is a higher quality oil than Brent crude.

The fluctuation of oil price has influence on the copper demand as well. As the crude oil price increases, the transportation industry, manufacturing industry would be affected. So the shipping cost for copper would be higher, hence the production cost for copper is higher. And in the manufacturing industry, the higher crude oil price would increase the cost for manufacturing generally, hence to increase the total price of the products, and reduce the demand of the products, finally, to reduce the demand of copper. However, the higher the **crude oil price** would create more jobs for the companies exploring oil, drilling oil, refining oil, and distributing oil. And these jobs creation would increase the demand of copper due to the higher income of these consumers. However, the influence of this, I assume would be lower than the previous one. The detailed analysis would be given in the following.

## Inflation index

The inflation index is an economic index used to measure the level of inflation in one economy. The most popular used index is the Consumer Price Index, which measure the fluctuations of price of daily products that regular consumers pay to maintain their daily life.

When inflation happens, the copper price would logically increase as well, since it helps to drive up all the prices of the different commodities. When prices start moving up due to inflation, some investors would choose to apply the momentum investing policy, speculating the copper price would go higher in the future and invest in futures contracts

with a higher price. With both the drive for the inflation and the speculation of upturn of the copper price, the price could go even higher. So some products of the commodities market could be used to hedge against the inflation. If the inflation level drops, the commodity price would drop as well. However, some commodities like gold, the value would rise during the economic crisis as a protection tool to keep the value of the assets. And the commodity market respond to general shock very swiftly, such in rise in demand. And also, the commodity market respond very quickly to the worldwide economic crisis. However, commodities index is also an leading indicator for the inflation.

We find a statistically and quantitatively robust relationship running from inflation to real commodity prices; a one percent permanent increase in the core price level leads to between a three and four percent increase in real commodity prices along the transition path. A shock to trend inflation also shows up in higher real commodity prices.

#### Fed fund rate

Federal fund rate is the interest rate depository institutions lend fund to other depository institutions overnight, which is the rate the borrowing bank pays to borrow the fund to the lending bank. It is determined by a Committee 8 right times or more through

The federal rate. Or interest rate, that could affect the copper price, is partially because the interest rate affect the cost of inventory.

First, the higher the interest rate, the higher cost of inventory, including the storage cost, higher risk. The higher interest the sooner the extractor would like to get rid of the copper inventory, from which non-interest is earned to liquidate the copper inventory in the market to earn interest from the proceeds. And also, as the interest rate is higher, the cost of capital would also be higher to raise capital into the whole chain for extracting copper, copper refining, copper distribution.

Second, the higher the interest rate, the higher carrying cost of inventory. During the supply chain of the copper, from the extracting point end to the consuming end, or the processing companies in between, the higher storage cost of inventory, the lower amount of copper they will purchase for the time being, so, would lower the demand of the copper essentially.

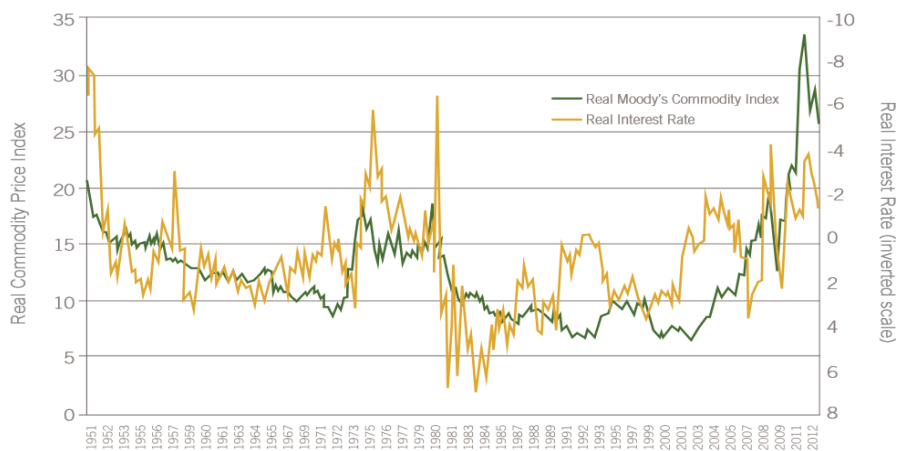
Third, the copper is part of the commodities and could be part of the portfolio of a portfolio manager to do hedge. If the interest is low, with low interest speculation, the investors

would go for equity market or bond instead rather than choosing the commodity market for investing.

Fourth, a rising interest rate, means a tightening monetary policy. In a tightening monetary policy, the dollar tend to increase value due to that investors would like to hold more, which would cause dollar value to strengthen. In the end it would cause the commodity price to go down. On the contrary in a easy monetary policy, the interest would go down, investors would

Commodity prices generally climb when interest rates fall, and fall when interest rates rise. But there are two different kinds of interest rate, the real interest rate and the nominal interest rate. If the nominal interest is high, but the inflation is higher, the real interest would be, on the contrary, lower. So, the interest talked in this article is the real interest rate.

#### REAL INTEREST RATES AND COMMODITY PRICES, 1950-2012



Source: Jeffrey Frankel

#### PBC base interest rate

The People's Bank Of China, the central bank of China, sets the central bank base interest rate. The Chinese interest rate refers to the central bank base interest rate. The Chinese central bank has complete liberty regarding the use of monetary policy. And the central bank sets the interest rate directly for the commercial banks. Same as the Fred rate, the PBC base interest rate has the same function to adjust inflation.

The price of substitutes and complements

The price of substitutes and complements would affect the copper demand as well. The cheaper the substitute material, the lower demand for copper. The cheaper the complement material, the higher demand of copper.

### **Regression Analysis**

I took the monthly data from May 2009 till December 2018 for the regression analysis.

From the left to the right:

The copper price is in metric ton by weight units and US dollar by currency.

The GDP growth rate is in percentage. The federal rate is in percentage. US Consumer Price Index. China industrial production index year-on-year change rate. FTSE CHINA A50 index in US dollars. WTI index. DXY US dollar index.

The first regression analysis puts copper as the dependent variables and other variables as independent variables. From the regression analysis, the following result is obtained.

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0,90872725
R Square	0,82578522
Adjusted R Square	0,81263693
Standard Error	545,047306
Observations	115

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	8	149264439	18658054,9	62,8055427	9,4624E-37
Residual	106	31490115,9	297076,565		
Total	114	180754555			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
Intercept	5872,51844	7178,43861	0,81807741	0,41514819	-8359,4343	20104,4712	-8359,4343	20104,4712
GDP	393,625104	113,343438	3,47285303	0,00074669	168,910713	618,339494	168,910713	618,339494
Fed rate	403,51618	217,391133	1,85617589	0,06620597	27,4828842	834,515244	27,4828842	834,515244
CPI US	22,3234376	31,0688474	0,71851515	0,47402053	-39,273574	83,9204493	-39,273574	83,9204493
CHN IPI	23,8152654	65,4703792	0,36375634	0,71676448	-153,61666	105,986129	-153,61666	105,986129
S and P	0,89473862	0,49333276	1,81366145	0,07255913	-1,8728188	0,08334157	-1,8728188	0,08334157

FTSE CHINA								
A50	1,19999069	0,27189987	4,41335521	2,4563E-05	0,66092276	1,73905862	0,66092276	1,73905862
WTI	25,7727336	6,58168987	3,91582317	0,00015968	12,7238933	38,8215739	12,7238933	38,8215739
	-	-	-	-	-	-	-	-
US DOLLAR	84,9727858	21,1163039	4,02403688	0,00010756	126,837912	43,1076595	126,837912	43,1076595

#### SUMMARY OUTPUT

##### Regression Statistics

Multiple R	0,890939
R Square	0,793773
Adjusted R Square	0,780281
Standard Error	590,2359
Observations	115

##### ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	7	1,43E+08	20496867	58,83507	8,06E-34
Residual	107	37276485	348378,4		
Total	114	1,81E+08			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
Intercept	16054,24	7361,193	2,180929	0,031378	1461,53	30646,94	1461,53	30646,94
GDP	348,2358	122,2341	2,848924	0,005262	105,9208	590,5507	105,9208	590,5507
Fed rate	542,2353	232,9408	2,327781	0,021805	80,45731	1004,013	80,45731	1004,013
CPI US	-15,8708	32,31309	-0,49116	0,624321	-79,9277	48,18611	-79,9277	48,18611
CHN IPI	-9,58855	70,81238	-0,13541	0,892544	-149,966	130,7887	-149,966	130,7887
S & P	0,039482	0,482555	0,081818	0,934944	-0,91713	0,99609	-0,91713	0,99609
WTI	18,58197	6,905518	2,690888	0,008271	4,892588	32,27136	4,892588	32,27136
US DOLLAR	-93,209	22,77753	-4,09214	8,31E-05	-138,363	-48,0552	-138,363	-48,0552



SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0,89092
R Square	0,793738
Adjusted R Square	0,782279
Standard Error	587,5473
Observations	115

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	6	1,43E+08	23911947	69,26747	9,33E-35
Residual	108	37282873	345211,8		
Total	114	1,81E+08			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
Intercept	15253,36	4362,377	3,49657	0,000685	6606,368	23900,34	6606,368	23900,34
GDP	333,1007	49,24863	6,763653	7,18E-10	235,4813	430,72	235,4813	430,72
Fed rate	518,9848	156,693	3,312113	0,00126	208,3922	829,5774	208,3922	829,5774
CPI US	-12,8167	23,03382	-0,55643	0,579067	-58,4738	32,84028	-58,4738	32,84028
S & P	0,046578	0,477516	0,097542	0,922477	-0,89994	0,993097	-0,89994	0,993097
WTI	18,36562	6,687537	2,746246	0,007064	5,109766	31,62148	5,109766	31,62148
US DOLLAR	-92,6395	22,28401	-4,15722	6,48E-05	-136,81	-48,4688	-136,81	-48,4688

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0,890932
R Square	0,79376
Adjusted R Square	R
Square	0,782302
Standard Error	587,5153
Observations	115

## ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	6	1,43E+08	23912623	69,27696	9,27E-35
Residual	108	37278817	345174,2		
Total	114	1,81E+08			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
Intercept	15787,88	6571,774	2,402377	0,017995	2761,485	28814,28	2761,485	28814,28
GDP	349,2429	121,0522	2,885059	0,004726	109,2963	589,1894	109,2963	589,1894
Fed rate	547,9558	221,1764	2,47746	0,014782	109,5458	986,3658	109,5458	986,3658
CPI US	-14,4622	27,21839	-0,53134	0,596275	-68,4137	39,48939	-68,4137	39,48939
CHN IPI	-10,2177	70,0691	-0,14582	0,884332	-149,107	128,6714	-149,107	128,6714
WTI	18,52283	6,835923	2,709631	0,007836	4,972843	32,07281	4,972843	32,07281
US DOLLAR	-93,045	22,58465	-4,11983	7,45E-05	-137,812	-48,2783	-137,812	-48,2783

The p value of CPI from US is too high, the p value from CHN IPI is too high as well. It would be first tried out excluding the china industrial production to see the results.

## SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0,890909
R Square	0,793719
Adjusted R Square	0,784257
Standard Error	584,8716
Observations	115

## ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	5	1,43E+08	28693680	83,88129	9,69E-36
Residual	109	37286157	342074,8		
Total	114	1,81E+08			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
Intercept	15787,88	6571,774	2,402377	0,017995	2761,485	28814,28	2761,485	28814,28
GDP	349,2429	121,0522	2,885059	0,004726	109,2963	589,1894	109,2963	589,1894
Fed rate	547,9558	221,1764	2,47746	0,014782	109,5458	986,3658	109,5458	986,3658
CPI US	-14,4622	27,21839	-0,53134	0,596275	-68,4137	39,48939	-68,4137	39,48939
CHN IPI	-10,2177	70,0691	-0,14582	0,884332	-149,107	128,6714	-149,107	128,6714
WTI	18,52283	6,835923	2,709631	0,007836	4,972843	32,07281	4,972843	32,07281
US DOLLAR	-93,045	22,58465	-4,11983	7,45E-05	-137,812	-48,2783	-137,812	-48,2783

Intercept	14872,64	1939,463	7,668432	7,78E-12	11028,69	18716,59	11028,69	18716,59
GDP	333,1173	49,02406	6,794976	5,99E-10	235,9532	430,2814	235,9532	430,2814
Fed rate	523,9925	147,3696	3,555635	0,000559	231,9107	816,0743	231,9107	816,0743
CPI US	-10,8958	11,89289	-0,91616	0,361603	-34,4672	12,67547	-34,4672	12,67547
WTI	18,27807	6,596844	2,77073	0,006577	5,20334	31,3528	5,20334	31,3528
US DOLLAR	-92,3992	22,04655	-4,1911	5,66E-05	-136,095	-48,7037	-136,095	-48,7037

After excluding the US CPI index, the regression analysis is carried out again.

#### SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0,890017
R Square	0,792131
Adjusted R Square	0,784572
Standard Error	584,4444
Observations	115

#### ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	4	1,43E+08	35795319	104,7948	1,34E-36
Residual	110	37573281	341575,3		
Total	114	1,81E+08			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95,0%</i>	<i>Upper 95,0%</i>
Intercept	13882,74	1609,437	8,625838	5,38E-14	10693,21	17072,27	10693,21	17072,27
GDP	336,4762	48,85107	6,887797	3,69E-10	239,6649	433,2876	239,6649	433,2876
Fed rate	437,9721	113,5046	3,85863	0,000193	213,0327	662,9115	213,0327	662,9115
WTI	14,86721	5,441922	2,731978	0,007336	4,082601	25,65183	4,082601	25,65183
US DOLLAR	-107,129	15,07356	-7,10711	1,25E-10	-137,002	-77,2572	-137,002	-77,2572

From the above regression analysis, it could be seen that the p value of these variables are now within a reasonable range. Now, it should be started checking if there are autocorrelation of the residuals. And if the residuals fits in the homoscedastic conditions.

<i>Regression Statistics</i>	
Multiple R	0,97164672

R Square	0,94409735
Adjusted R Square	0,94148508
Standard Error	302,347345
Observations	113

ANÁLISIS DE VARIANZA

	df	SS	MS	F	Significance F
Regression	5	165188770	33037753,9	361,40836	2,7214E-65
Residual	107	9781289,15	91413,9173		
Total	112	174970059			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	4240,30627	881,840616	4,8084724	4,9997E-06	2492,16009	5988,45244	2492,16009	5988,45244
GDP	50,9583789	31,6998576	1,60752706	0,11088575	-11,8828916	113,799649	-11,8828916	113,799649
Fed_rate	120,897275	61,9121391	1,95272328	0,05346449	-1,83631992	243,63087	-1,83631992	243,63087
US_DOLLAR	-33,518934	7,54274457	-4,44386439	2,1637E-05	-48,4715454	-18,5663226	-48,4715454	-18,5663226
Copper_1	1,03935247	0,09343692	11,1235742	1,4579E-19	0,85412468	1,22458026	0,85412468	1,22458026
Copper_2	0,26196609	0,0859624	-3,04744964	0,00290755	-0,43237652	-0,09155565	-0,43237652	-0,09155565

There are autocorrelation in the regression analysis, so it is needed that the variables need to be adjusted, or more variables need to be added into the regression analysis. Copper time lag 1 is added, but still, there is still autocorrelation in the residuals. After adding the copper time lag two, and applying the regression analysis again, the regression analysis shows that there is no more auto correlation in the results.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,971646723
R Square	0,944097355
Adjusted R Square	0,941485081
Standard Error	302,3473454
Observations	113

ANOVA					
	df	SS	MS	F	Significance F
Regression	5	165188770	33037754	361,40836	2,721E-65
Residual	107	9781289,1	91413,917		
Total	112	174970059			

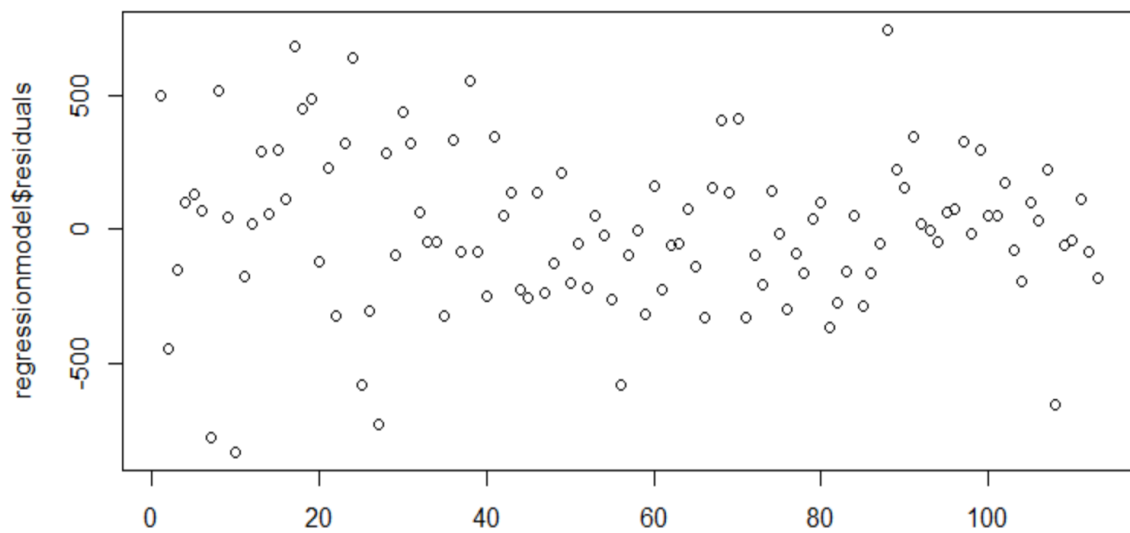
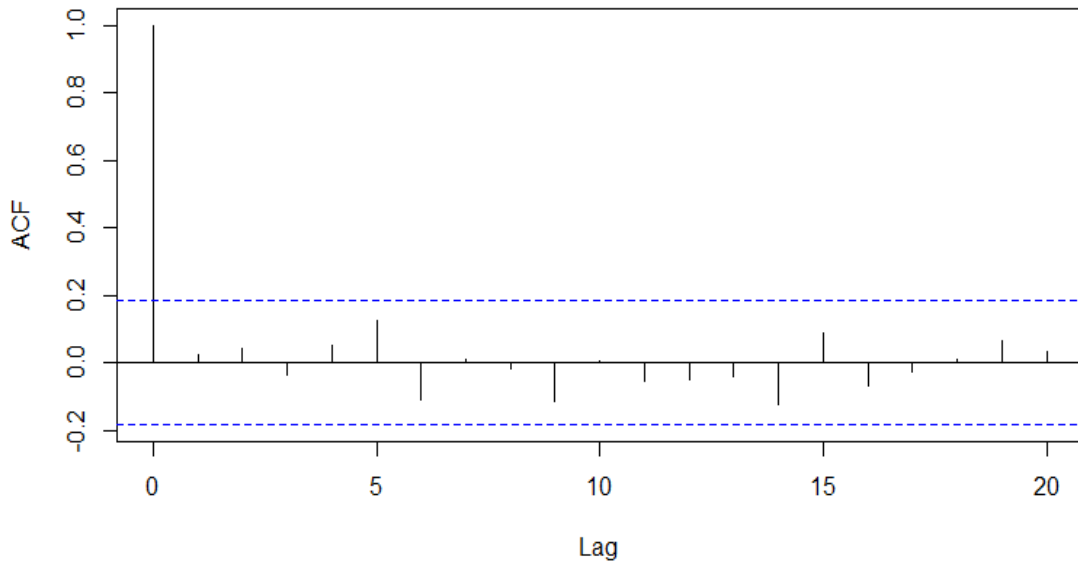
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	4240,306266	881,84062	4,8084724	5E-06	2492,1601	5988,4524	2492,16	5988,452
GDP	50,95837891	31,699858	1,6075271	0,1108858	-11,88289	113,79965	-11,8829	113,7996
Fed_rate	120,8972751	61,912139	1,9527233	0,0534645	-1,83632	243,63087	-1,83632	243,6309
US_DOLLAR	-33,51893396	7,5427446	-4,443864	2,164E-05	-48,47155	-18,56632	-48,4715	-18,5663
Copper_1	1,03935247	0,0934369	11,123574	1,458E-19	0,8541247	1,2245803	0,854125	1,22458
Copper_2	-0,261966088	0,0859624	-3,04745	0,0029075	-0,432377	-0,091556	-0,43238	-0,09156

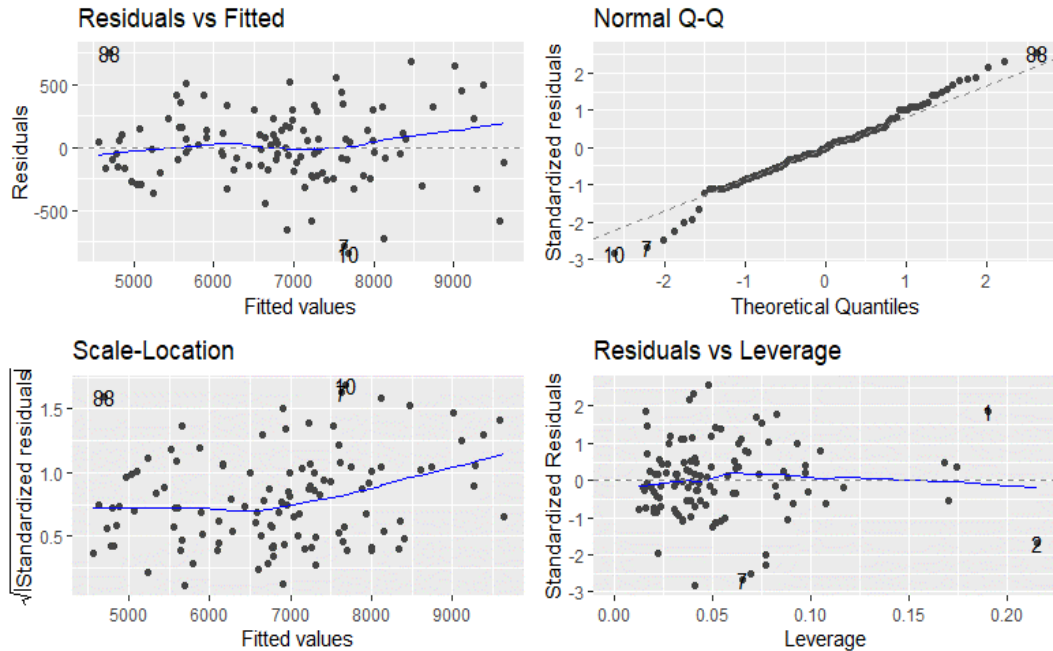
From the above regression analysis. It shows that there is no more autocorrelations, and the new formula would be carried out as below:

$$\text{Copper} = 4240 + 51 * \text{GDP} + 121 * \text{Fed\_rate} - 34 * \text{US\_DOLLAR} + 1,0393 * \text{Copper\_1} - 0,26197 * \text{Copper\_2}$$

This formula shows that there is a positive relationship between the copper and GDP growth rate, also a positive relationship between the federal interest rate and copper, and also a negative relationship between the copper price and the US dollar currency.

**Series regressionmodel\$residuals**





## Technical analysis

As copper is one kind of the commodity, different from equities, it is not suitable for fundamental analysis. On the other hand, technical analysis focuses on historical and current price development. One advantage of using current price and data of volume is that they are easily observable and obtainable. Much of the data used in fundamental analysis is based on assumptions or restatements, and these assumptions or restatements are not easy to obtain or to be made, sometimes absolutely not available for assets such as commodities or currencies. Commodities like copper, doesn't generate or have future cash flow, could choose technological analysis for alternative choice.

In general, technological analysis is to study and take advantage of emotions from the market, so called market sentiments, which is shown in the action of trading assets. Being different from fundamental analysis, technological analysis is only decided by one parameter, the equate, so called balance, between the supply and demand. The assumption suggests, traders who are more confident about the trading, in other words, that are probably better informed and know more information than normal investors, tend to trade in a volume much greater than other normal traders, hence, have a significant greater impact on the market price. It is not difficult to understand that price and volume, these two parameters, are the crucial points that needed to be studied. The most important

advantage of using actual price and volume data is that they are actual, not randomly presumed, not very difficult for analyst to calculate, observable and obtainable. However, in the case if the price and volume do not really reflect the current actual supply and demand, such as, for example, in the case of illiquid market and another case of existing market that influenced by outside manipulation.

As we all know, the market prices reflect both rational and irrational behaviors of different investors in the market, which implies that the efficient market hypothesis sometimes does not hold still. It is not difficult to understand technological analysis is based on the assumption that investors sentiments are reflected on the trends and patterns and most of the times could be repeated and made good use of for forecasting prices.

To make technological analysis work, it is also important to identify if it is a trend market or a market without a trend, so called non trend market. Trends means it defines a direction in prices, instead of a line, it is more than a direction rather than a line. Trend analysis is a technique widely used in technical analysis that attempts to forecast and predict the future stock price movements based on recently observed trend data, or mid-term data, or long-term data. There are three main types of trends: short-trend, intermediate- trend, and long-term trend. Other kinds of trend are not discussed in this essay. Trend analysis tries to forecast or predict a trend, such as a bull market trend, or a bear market trend, and follow that trend till there are certain signs suggesting the possibilities of a trend reversal, which means an opposite movement against the trend direction. Generally speaking, trend is the main or general direction of the market which is moving to or heading to during a certain time period. It is widely known that trends can be upward or downward, within bullish and bearish markets. The longer the trend, the easier it could be notified, the shorter the trend, the more difficult it could be caught. However, there is no minimum amount or maximum amount of time period for a trend.

Now I will give a brief introduction of Dow theory before giving technological analysis. The Dow theory is a theory which says the market is in an upward trend if one of its average advances above a previous important high and is accompanied or followed by a similar advance in the other average.

There are four main components to the Dow theory, which are summarized briefly here:

1. The market discounts everything.
2. There are three kinds of market trends.
3. Primary trends usually have three phases.
4. Trends persist until a clear reversal occurs.

### **Technical analysis indicators**

There are two types of market. The trending market and the range bound market, or, in other way, the side market. In the trending market, there is an obvious trend, the market is moving in one direction. In the rangebound or sideways market, the market is moving up and down in a specific range. Both types of market are suitable for the technical indicators. The first indicator is RSI, The relative strength indicator (RSI) aims to signal whether a market is considered to be overbought or oversold in relation to recent price levels. the RSI ranges from 0 to 100, when the RSI approaches over 70, it indicates that the asset is overbought, and it is likely that the price would drawback. When the RSI reaches 30, it indicates that the asset is oversold. It is likely that the price would rebound. If the RSI is between 50 and 70, the security has moved up over the past period; however, the uptrend has not been very pronounced. If the RSI is between 30 and 50, the security has moved down over the past period; however, the downtrend has not been very strong. So, when the RSI passes above 50 , it is usually considered as a bullish trend. When the RSI crossed down the 50 line, it is usually considered as a bearish trend. The RSI is often accurate when indicating a market reverse. However, large rallies and drops of the price would affect the RSI by creating false signals.

The second signal, is MACD.

It is not easy to avoid talking about moving average when we are talking about trends. The moving average is calculated from the average closing price, the average closing price has formed a series of data for a specified period. A moving average typically uses daily closing prices, but it can also be calculated for other types of data origins. Other price data such as the opening price or even the median price can also be used, maximum price or minimum price, on the other hand, are rare to see. At the very end of each new price period, that data is added to the calculation while the oldest price data in the series is eliminated and cut out.



For a simple moving average, the formula is the sum of the data points over a given period divided by the number of periods. In order to avoid the influence of some very strong fluctuations, moving average could be applied in this situation. However, in the normal calculation of moving averages, the data that are more recent, compared to the data that are more further away from the calculation point, are not calculated any differently. That's why weighted moving averages could be more representative than normal moving averages. Weighted moving averages assign a heavier weighting to more current data points since they are more relevant than data points in the distant past.

However, moving averages has its drawbacks such as its lagging character. All the moving averages are calculated from the previous historical data, there is a time lag before any signs reflecting a trend change. Sometimes, a stock price may head sharply in a trend direction that moving averages lags to report.

The moving average convergence/divergence is made of two exponential moving averages which help measure momentum. These moving averages and the changing distance between them, becomes MACD. Convergence means the moving averages are moving close together, and divergence means that they are moving away from each other. The position between the short term moving average and long term moving average would indicate the momentum of the price. The signal line is a moving average of the MACD values themselves. When the moving averages cross above the signal line, it indicates that the copper market is very likely going to experience an upturn. When the two moving averages crosses below the signal line, it indicates that the copper market is very likely going to experience a price downturn. Typical values for the MACD are 26 and 12 exponential moving averages, and 9 for the signal line. MACD is calculated by subtracting the 26-period EMA from the 12-period EMA. The MACD has a positive value whenever the 12-period EMA (blue) is above the 26-period EMA (red) and a negative value when the 12-period EMA is below the 26-period EMA. The further apart the moving averages, means the stronger the momentum, and the further away the MACD from the centre line. So it could indicate if the market is entering a momentum or exiting a momentum. MACD helps investors understand whether the bullish or bearish movement in the price is strengthening or weakening.

The third indicator is the Bollinger band. A Bollinger band is combined with moving average line and two standard deviations from the moving average line. The standard deviation measures the volatility of the market. The more volatile the market, the wider the band would be, the less volatile the market, the narrower the band would be. The tighter of a band, sometimes indicate volatility is coming soon following a too peaceful period. And when the price is reaching the edge of the band, it is more likely that it would reverse back to stay inside the band. The closer the prices move to the upper band, the more overbought the market is, and the copper price would be likely to go downturn, and the closer the prices move to the lower band, the more oversold the market, so the copper price would be very likely to go upturn.

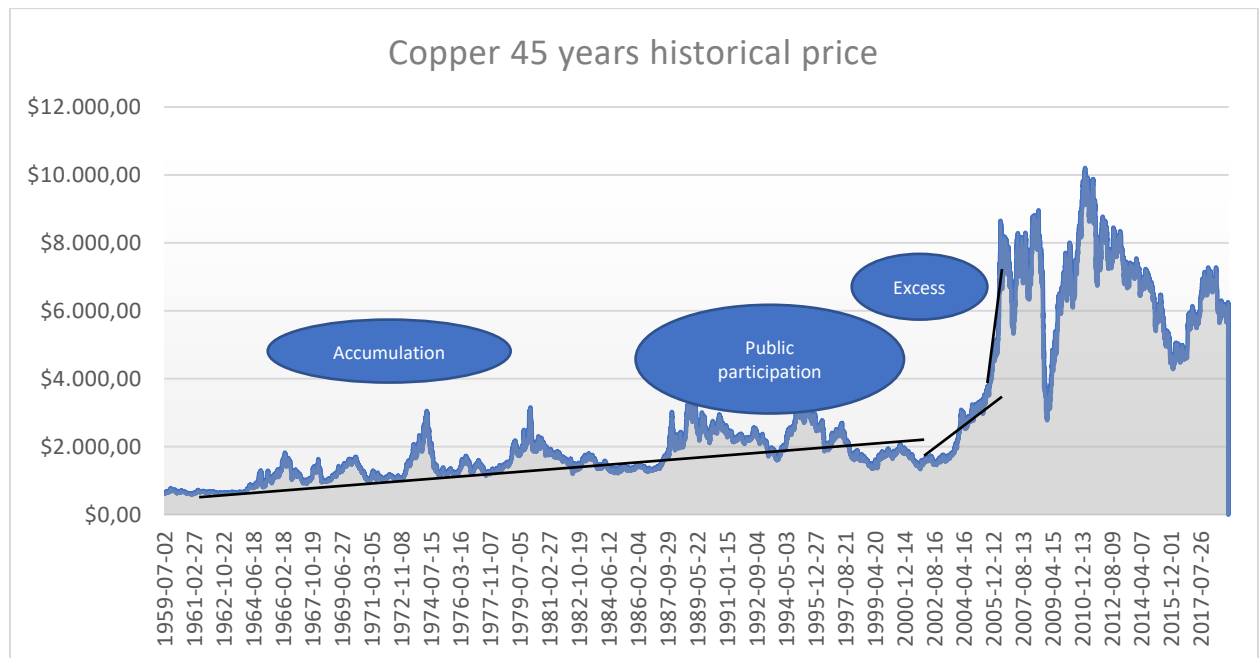
The fourth indicator is the super trend indicator. It is an indicator for the trend direction. The changing point between down trend and up trend, would indicate the direction of the market. And this indicator itself, already indicate the market trend. A Super trend indicator can be used on equities, futures or forex, and also on daily, weekly and hourly charts as well but normally, it is unsuccessful in a sideways-moving market. Also, super trend does not predict the direction, once the direction is recognized the super trend will direct you to initiate a position and recommend you to stay in the position till the trend maintains.

From the 45 years price charts as below, it could be seen that copper price has remained steady and gone through some small fluctuations before 2004, the copper price has remained below \$4000, and didn't break through the ceiling of \$4000. The copper price has broken though the ceiling of \$4000 at the end of 2015, from 2016 onwards, copper price has taken a jump in 2016 and reached \$8000. There are some fluctuations in 2017 and 2008, but generally the price has remain between \$6000 and \$8000. In 2009, due to the 2008 financial crisis, the copper has dropped sharply in 2009, to reach a point of around \$3000, and rebounded quickly afterwards in 2010, 2011, 2012. In 2010, the copper price has reached a historical new high, broken the new ceiling of \$10000. Afterwards, the copper price kept falling till the end of 2015 to reach the support level of \$4000 again. From 2016, the copper price has gone through a rise to reach the price of around \$7000 around the beginning of 2007 and the end of 2008. From that point onwards, the copper price has gone through a small decline to be back to the price level of around \$6000.

In the chart below, it is shown the copper price for the past 45 years. According to Dow theory, there are three stages of the development of the primary trend, the accumulation phase, the public participation phase and the excess phase. In a bull market, the excess stage is the final stage. In a bear market, after the accumulation phase, the public participation phase, there is a panic phase.

As for copper price, before 2004, it could be precepted as an accumulation phase. Between 2004 and 2005, there is a phase of public participation.

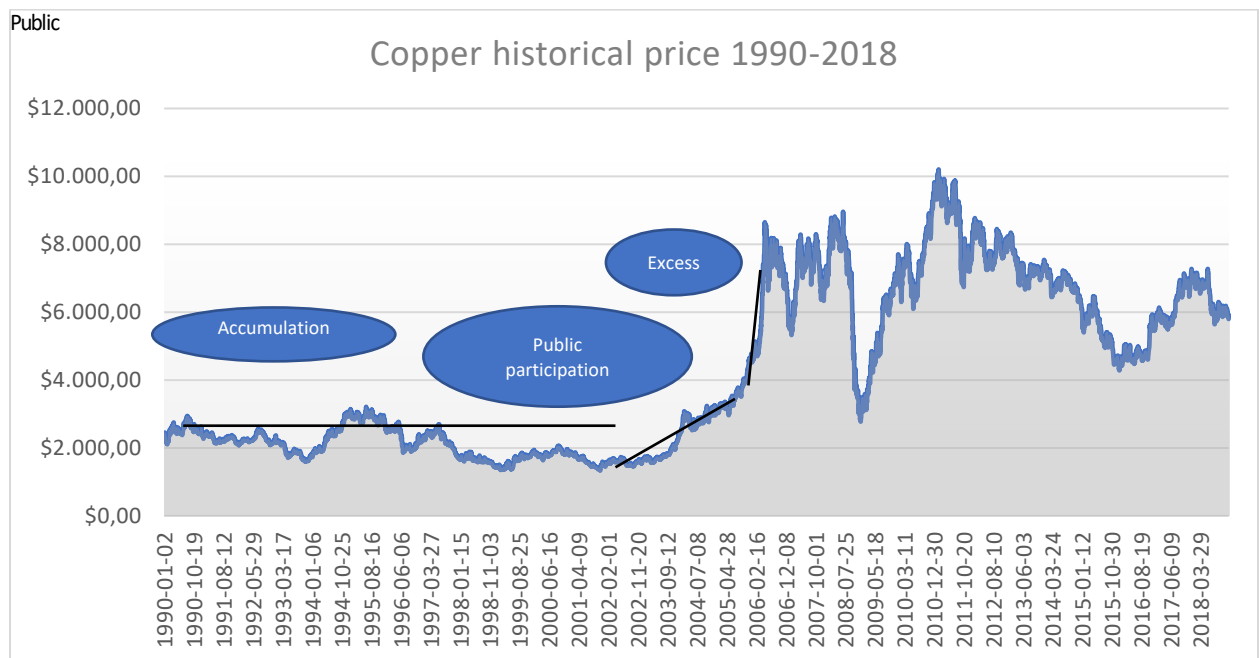
However, as for commodity like copper, the price is mainly decided by supply and demand. However, the price trend could be shown on the future expectation of investors who purchase futures for the commodity, in the case here, which is copper.



As it is a chart of copper price for the past 45 years, starting from 1959, which is quite a long period for copper price movement development, so a new time period from 1990-2018 is extracted from the data above and formed a new chart. The three phases in the period between 1990 and 2006, which are accumulations, public participation and excess period, could be clearly seen. From 1990 till the end of 2003, it could be analyzed as an accumulation phase, from the end of 2003 till 2005, it is a public participation phase, from 2005 the beginning of 2006, it is an excess phase. So from 1990 till 2006, as it is a very

long time period, it could be clearly seen that the primary trend of copper market is upward trend, and the copper price market during this time period, could also be easily seen as copper price bull market.

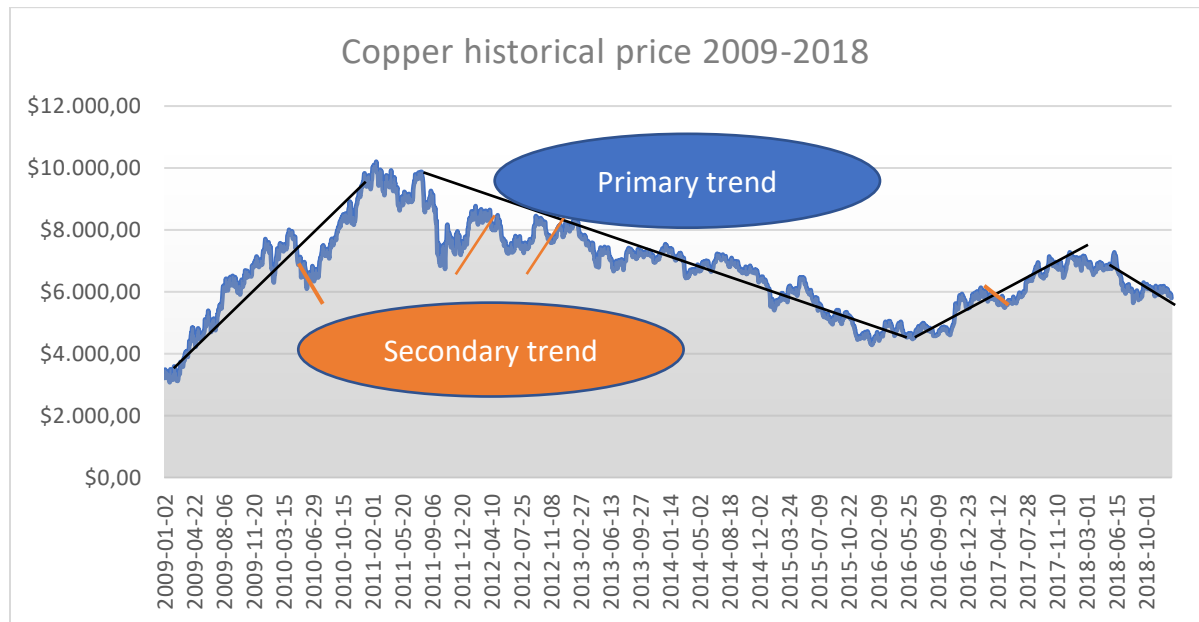
According to dow theory, after the excess phase, there is normally a collapse phase or panic phase that follows behind. After the new ceiling point in the beginning of 2006, the copper price has gone through a sharp drop during 2006 to reach the new floor of around \$5000. Afterwards, due to the newly strong demand of copper, the copper price has rebounded quickly in 2007.



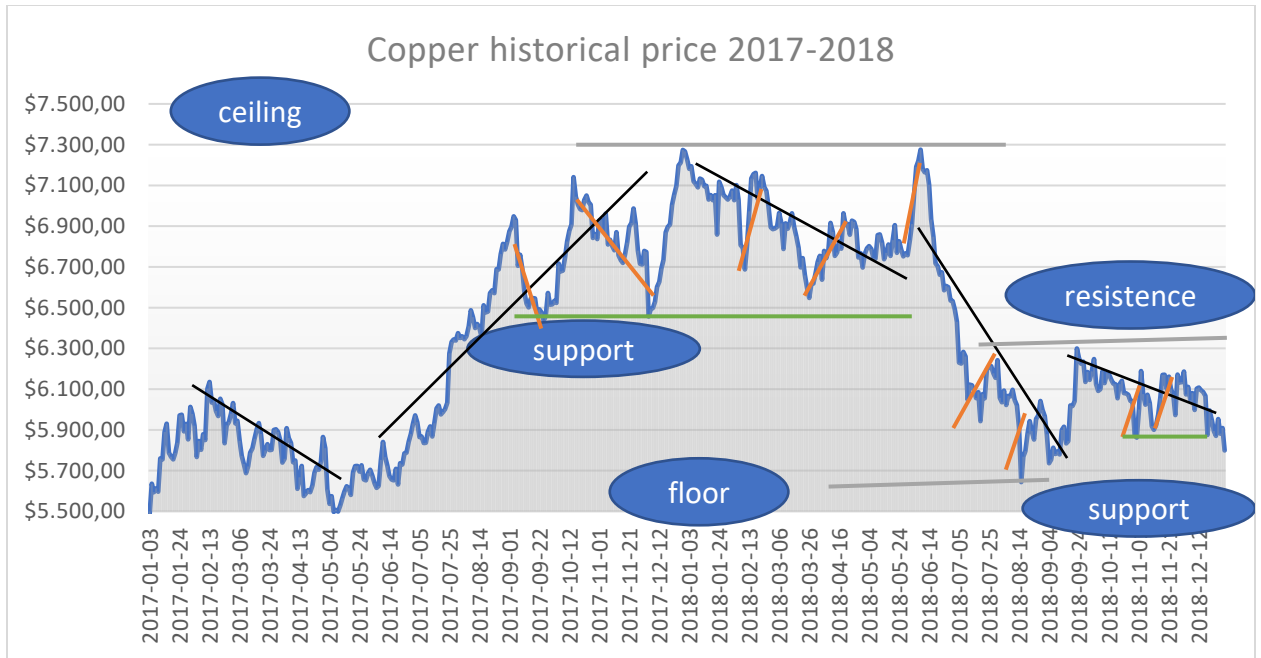
After 2008, the financial crisis has made the commodity market suffer as well, from 2009, the copper price keeps rebounding from around \$4000 till after 2 years, to reach the highest point \$10000 at the end of 2010.

This chart below shows the copper price revolution between 2009 and 2018. The primary trend, drawn as the black line below, has shown that between the beginning of 2009 and the end of 2010, it is an upward trend, from the end of 2010 till the beginning of 2016, it is a downward trend, from the middle of 2016 and the end of 2017, it is an upward trend, from the beginning of 2018 till the end of 2018, it is a downward trend.

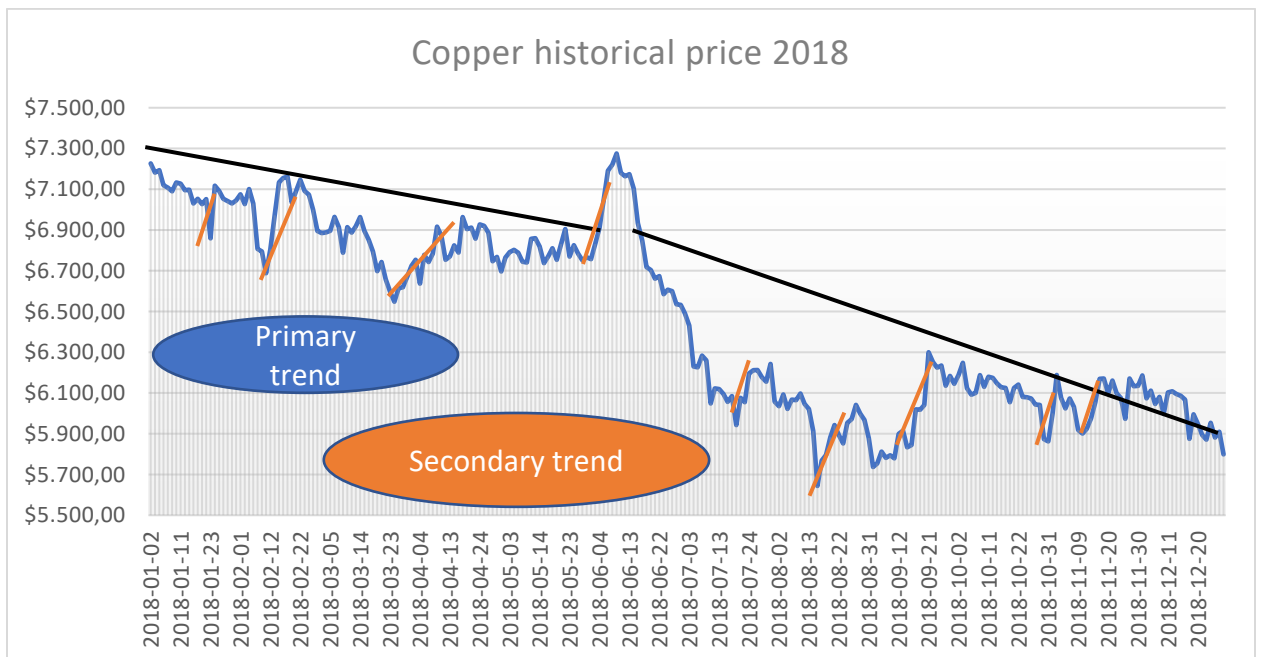
Apart from the primary trend, there is also secondary trend, as drawn by orange straight line below. It shows that there are several obvious reversal of trend. For example, the secondary trend in June 2010, which is a reversal downward trend. Another one in December 2011, which is an upward trend, another one in July 2012, which is a reversal trend of upward trend as well. And another one in April 2017, which is reversal downward trend.

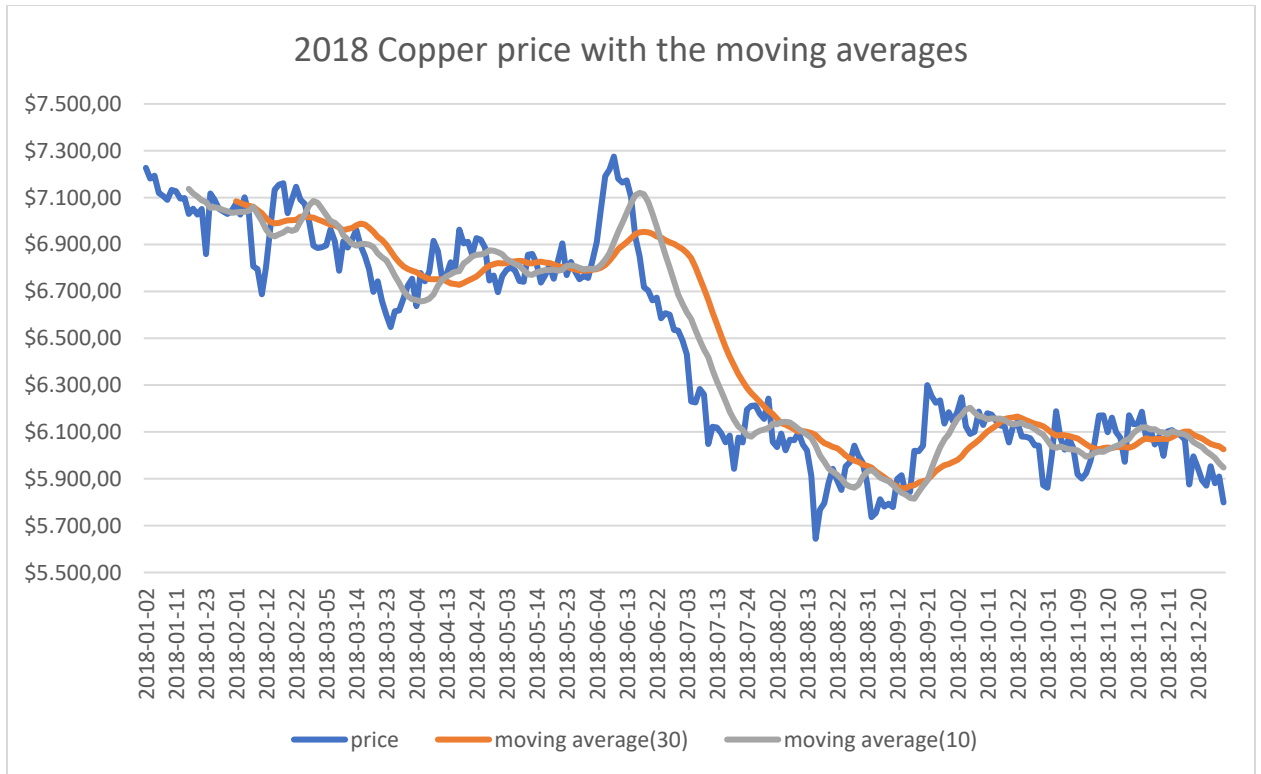


As technological analysis is more applied on short-term price movement development. The 2017-2018 period copper price is extracted from the 45 years price chart. It could be seen that in the beginning of 2007, there is a downward trend , from June 2017 till the end of 2017, it is an obvious upward trend. Starting from 2018, the copper price has an obvious downward trend. There are a lot of secondary trends as well, shown in orange straight lines as below. In June 2018, the secondary trend has become so strong that it reached the ceiling during this period. However, as it didn't break the ceiling, the copper price has gone down sharply afterwards till it breaks the support level of previous historical record of around \$6500, and went even down till around \$5700, then rebounded to around \$6300. From that point onwards, the copper price keeps declining till the end of 2018.



From the chart above, a closer look into 2018. There is a very obvious declining trend. There are several price reversals, some secondary trends, among them the most obvious one is around June 2018, though followed by a sharp downward decline.





From the beginning of 2019



Investing.com

Take the copper price since the beginning of 2019 for example. If the RSI approaches above the 70 at the end of February, the copper market is overbought, as the theory of technical analysis, the copper price would tend to go down. As it shows in the graph, RSI

approaches 70, the copper price dropped a bit down afterwards. However, when the copper price started dropping down a lot in May, the RSI indicator didn't show it was above 70, and didn't indicate the copper market was overbought. In the beginning of June, the RSI approached below 30, it showed that the copper market was over sold and the copper price would tend to rebound. As the price trend showed above, the copper approached the lower point around 2.599 and started rebounding in the beginning of the June.

In the beginning of 2019, The RSI was below 50, so the market is likely to experience a downtrend, and as it shows in the graph, the copper market was experiencing indeed a downtrend. From January to March, The RSI stayed above 50 until finally breaks the 70 limit. During this period, the copper price behaved as climbing mode, had an upturn momentum, until the RSI reaches 70. From the beginning of May till the end of June, the RSI crossed down stayed below 50, during this period the copper price kept declining.

Forecast: The RSI is rising, currently around 55, which is far away from 70, however, just crossed the 50 line. It is likely that the copper price would be entering an upturning momentum.

#### MACD

In the end of April, while the two moving averages lines crossed below the signal line, the copper market futures price started declining as well. In the end of January, while the two moving averages lines crossed over the signal line, it showed in the copper price market that the copper futures prices were going to experience an upturn. And it could be observed that the copper price in the end of January started climbing, Just as the MACD indicates. In the end of December 2018, while the two moving averages crossed below the signal line, it showed that in the copper price market the copper price would start declining as well. And as it could be observed from the graph, the copper price experienced a small decline.

Forecast: Firstly, as the two MACD lines are going crossing above the signal line, it is likely the copper price would experience an upturn in the short term. Secondly, The short term moving averages are above the long term moving average. It also shows that the copper price market is experiencing an upturn. Thirdly. As the distance between the short term moving average and the long term moving average is widening, it is likely that the copper market is going to experiencing a very strong upturn momentum.



## Bollinger band

At the end of January, it could be observed that the copper price is approaching the upper band of the Bollinger band. And the copper price market experienced an upturn. From the beginning of May till the mid of June. It could be observed that the copper price is approaching the lower band of the Bollinger band, and the copper price market is experiencing a downturn.

Forecast: It could be observed that in the beginning of July, the copper price crossed above the moving average line, and is approaching the upper band of the Bollinger band. It is likely that the copper price is entering an upturning trend, in other words. The copper market is likely to entering a bullish market.



## Super Trend

From the beginning of 2019 till February, the super trend line indicated that the market is maintaining on a downward trend. From February till the beginning of May, the super trend line turned into green, which shows that the copper price market maintained in a upward trend. From the beginning of May till the end of June, the super trend line indicated red, which indicates that the market is in an downward trend. From the super trend line, it is likely that the super trend line is going to cross the copper price line and change into a green upward trend line.

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## **The trade war**

As we have already passed 6 months, the trend of copper price could already been that it had an upward trend from the beginning of 2019 till March, and from March till May the copper price fluctuated around the level of \$6400, after that from May the copper price has dropped to the beginning level of 2019.

During the last year, two of the main copper consumption countries, China and US, have been going through trade wars, the tariffs both countries impose, have been affecting commodity prices. So first, it is because these two countries both consume a lot of copper, and the trade has affected the macroeconomic environment, resulting slowing down development of economy. As we have proved earlier, there is correlation between the macroeconomic situation and copper price, due to that copper is a crucial commodity for urbanization, which is the result from developing economy. Secondly, US and China have both imposed tariffs upon commodity products, affecting directly the commodity market. So has the copper price been influenced by the changing of agreements between US and China? And how deeply was it affected. I am going to look at the those announcements of trade war agreements and try to relate them with the copper price trend.

In order to do this, below there is a copper price graph during the past year, from June 2018 till June 2019 extracted from the website markets insider.



<https://markets.businessinsider.com/commodities/copper-price>

And below shows a graph of copper price for the past 3 years, where it could be seen that there is a sharp dropdown at the end of 2018.



<https://markets.businessinsider.com/commodities/copper-price>

On July 6, 2018, US implements first China-specific tariffs. The US Customs and Border Protection begins collecting a 25 percent tariff on 818 imported Chinese products valued at US\$34 billion.

On July 10, 2018, US releases second tariff list. The USTR releases a third list of tariffs of over 6,000 commodities originating in China (worth US\$200 billion), which will be subject to a 10 percent tariff.

On August 2, 2018, The USTR, at the direction of Trump, considers a 25 percent tariff rather than a 10 percent one on the list originally announced on July 10, 2018.

On August 3, 2018, China announces second round of tariffs on US products.

August 23, 2018 – US and China implement second round of tariffs, China files second WTO complaint

September 7, 2018 – Trump threatens new tariffs. After the public comment period for List 3 of US tariffs on Chinese products ended on September 6, 2018, Trump threatens to impose tariffs on US\$267 billion more. That would bring the total amount of tariffs threatened or imposed by the US on China to US\$517 billion, accounting for essentially all Chinese exports to the US. In 2017, the US imported US\$505 billion worth of products from China.

September 17, 2018 – US finalizes tariffs on US\$200 billion of Chinese goods

September 18, 2018 – China announces retaliation for US tariffs

September 22, 2018 – China cancels trade talks with US

November 9, 2018 – US and China resume trade talks

November 19, 2018 – US releases list of proposed export controls on emerging technologies.

December 2, 2018 – US and China agree to temporary truce

The US and China agree to a temporary truce to de-escalate trade tensions, following a working dinner at the G20 Summit in Buenos Aires on December 1, 2018. According to the agreement, both the US and China will refrain from increasing tariffs or imposing new tariffs for 90 days (until March 1, 2019), as the two sides work towards a larger trade deal.

December 14, 2018 – China to temporarily lower tariffs on US autos; resumes buying US soybean exports

Jan, 7-9, 2019, US and China engage in 3-day trade talks in Beijing. Both sides have agreed to continue to keep in close contact.

January 22, 2019 – US cancels preparatory talks with China

February 7, 2019 – Trump says he will not meet with Xi before trade deal deadline

February 11-15, 2019 – US and China hold trade talks in Beijing

February 21-24, 2019 – US and China hold trade talks in Washington; Trump extends tariff deadline

March 28-29, 2019 – US and China hold trade talks in Beijing after one month break

March 31, 2019 – China extends the suspension of additional tariffs on US autos and auto parts

April 30-May 1, 2019 – US and China hold trade talks in Beijing

US and Chinese negotiators continue trade talks in Beijing on Tuesday, April 30 and Wednesday, May 1. Mnuchin calls the talks “productive” and confirms that the two sides will continue negotiations in Washington the next week.

May 5, 2019 – Trump threatens to raise tariffs on China

May 10, 2019 – US increases tariff from 10 percent to 25 percent

May 13, 2019 – China announces tariff hikes on US products ,China announces that it will increase tariffs on US\$60 billion worth of US goods from June 1, 2019, in response to the tariff increases imposed by the US on May 10.

May 16, 2019 – US places Huawei on its ‘entity list’, banning it from purchasing from US companies

May 31, 2019 – China establishes its very own ‘unreliable entities’ list .

China announces that it will establish its very own unreliable entities list in retaliation to the US’ entity list.

June 1, 2019 – China increases tariffs on US\$60 billion worth of products.

From the information above, I organized the information into two categories, the good news and bad news, which are the good sign for the market and bad sign for the market.



The first period of the trade war, from the announcement of the starting of the trade till the trade war got steady, ranging from the beginning of June 2018 till December.

It could be observed from the graph that there is a big slash of copper price in the beginning of June, which is a coincidence with the announcement of the trade war in June. From August there is a rebound of copper price, followed by some fluctuations in September. From the end of 2018, December, the copper price starts going up, then it stopped in March, followed by fluctuations till May. Starting from May, the copper price starts declining again rapidly.

Relating with the trade war timeline.

The beginning of June, US has announced the trade war with China. From June to September, a series of more tariffs have been released and the tension of the trade between these two countries has intensified.

From the table below, it could be observed that good bad sign of the trade war occurs in July, August, September of 2018. And from the copper historical price chart, In July and August the copper price declined. In September the copper price fluctuated. In November and December of 2018, there is good sign of the trade war, and the copper price started climbing in the beginning of 2019. Starting from May, 2019, the bad signs of the trade war occurs again, and the copper price declined in May.

2018	BAD SIGN	GOOD SIGN
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JUN 2018	6, JUL; 10, JUL;	
JUL 2018		
AUG 2018	2, AUG; 3 AUG; 23 AUG;	
SEP 2018	7 SEP; 17 SEP; 18 SEP; 22 SEP;	
OCT 2018		
NOV 2018	19 NOV	9 NOV;
DEC 2018		2, DEC; 14 DEC;

2019	BAD SIGN	GOOD SIGN
JAN 2019	22, JAN	7-9, JAN;
FEB 2019	7, FEB	11-15 FEB; 21-24 FEB;
MAR 2019		28-29 MAR; 31 MAR;
APR 2019		30 APR-1 MAY;
MAY 2019	5, MAY; 10 MAY; 13 MAY; 16 MAY; 31 MAY;	
JUN 2019	1 JUN	

## **Conclusions**

From the regression analysis, it could be observed that the copper price is influenced by the federal interest rate, the US dollar currency value and the world GDP growth rate. The higher the world GDP growth rate, the higher the federal interest rate, the higher the copper price tend to be. And the higher the US dollar value, the lower the copper price tend to be. From the technical analysis, the copper price tend to rise in the future.



## Appendix

	2013	2014	2015	2016	2017	2018	2019	2020
<b>PRODUCTION</b>								
Global Refined Production	20680	21703	22051	22719	22852	23456	24086	24484
<b>CONSUMPTION</b>								
Total Mature Economies	5890	6164	6259	6280	6373	6479	6588	6712
...of which EU-28	3027	3137	3259	3267	3314	3359	3413	3473
...of which Japan	988	1064	1015	1005	1020	1031	1040	1054
...of which United States	1715	1800	1820	1840	1871	1918	1962	2010
...of which Canada	159	163	165	168	168	171	173	175
Total BRIC	10521	11018	11150	11528	11818	12118	12443	12777
...of which Brazil	422	388	322	291	290	301	313	322
...of which Russia	664	615	390	385	390	392	393	393
...of which India	455	440	458	472	488	525	562	607
...of which China	8980	9575	9980	10380	10650	10900	11175	11455
Total ASEAN Economies	831	886	944	1045	1074	1100	1132	1162
South Korea	714	745	726	730	741	748	760	767
Taiwan	437	461	472	494	507	520	530	539
Others	2255	2189	2261	2246	2292	2365	2424	2481
Global Consumption	20648	21463	21811	22324	22806	23330	23877	24438
Market Balance	32	241	240	395	46	126	210	46
<b>REPORTED STOCKS</b>								
Producer Stocks	734	942	938	758	..	..	..	..
Merchant Stocks	3	6	6	6	..	..	..	..
Consumer Stocks	82	96	95	88	..	..	..	..
Comex	15	24	63	88	..	..	..	..
Shanghai	126	106	183	147	..	..	..	..
LME	366	177	236	312	..	..	..	..
Total Stocks	1325	1350	1521	1399	1445	1571	1781	1827
Total as No. of weeks consumption	3.3	3.3	3.6	3.3	3.3	3.5	3.9	3.9
LME 3-Month Official (\$/tonne)	7345	6827	5493	4870	6200	6700	7000	7500

Date	Copper	GDP	Fed rate	CPI US	CHN Industrial production	S and P	FTSE CHINA A50	WTI	US DOLLAR
	US dollar/metric TON	%	%		YOY%				
may-09	4.568,63	-1,69	0,18	213,86	6,30	919,32		66,31	
jun-09	5.013,96	-1,69	0,21	215,69	7,00	987,48	1.628,70	69,89	80,16
jul-09	5.215,54	-1,69	0,16	215,35	7,50	1.020,62	1.916,46	69,45	78,35

ago-09	6.165,30	-1,69	0,16	215,83	8,10	1.057,08	1.408,15	69,96	78,17
sep-09	6.196,43	-1,69	0,15	215,97	8,70	1.036,19	1.499,96	70,61	76,65
oct-09	6.287,98	-1,69	0,12	216,18	9,40	1.095,63	1.633,32	77,00	76,30
nov-09	6.675,60	-1,69	0,12	216,33	10,30	1.115,10	1.708,32	77,28	74,79
dic-09	6.981,71	-1,69	0,12	215,95	11,00	1.073,87	1.761,60	79,36	77,86
ene-10	7.386,25	4,28	0,11	216,69	15,85	1.104,49	1.542,02	72,89	79,46
feb-10	6.848,18	4,28	0,13	216,74	20,70	1.169,43	1.565,23	79,66	80,36
mar-10	7.462,83	4,28	0,16	217,63	19,60	1.186,69	1.614,12	83,76	81,07
abr-10	7.745,08	4,28	0,20	218,01	19,10	1.089,41	1.461,87	86,15	81,87
may-10	6.837,68	4,28	0,20	218,18	18,50	1.030,71	1.309,69	73,97	86,59
jun-10	6.499,30	4,28	0,18	217,97	17,60	1.101,60	1.248,53	75,63	86,02
jul-10	6.735,25	4,28	0,18	218,01	17,00	1.049,33	1.366,01	78,95	81,54
ago-10	7.283,95	4,28	0,19	218,31	16,60	1.141,20	1.332,92	71,92	83,20
sep-10	7.709,30	4,28	0,19	218,44	16,30	1.183,26	1.317,51	79,97	78,72
oct-10	8.292,41	4,28	0,19	218,71	16,10	1.180,55	1.534,43	81,43	77,27
nov-10	8.469,89	4,28	0,19	218,80	15,80	1.257,64	1.395,12	84,11	81,20
dic-10	9.147,26	4,28	0,18	219,18	15,70	1.286,12	1.395,82	91,38	79,03
ene-11	9.555,70	3,13	0,17	220,22	14,90	1.327,22	1.390,42	92,19	77,74
feb-11	9.867,60	3,13	0,16	221,31	14,10	1.325,83	1.434,17	96,97	76,89
mar-11	9.503,36	3,13	0,14	223,47	14,40	1.363,61	1.461,21	106,72	75,86
abr-11	9.492,79	3,13	0,10	224,91	14,20	1.345,20	1.495,78	113,93	72,93
may-11	8.959,90	3,13	0,09	225,96	14,00	1.320,64	1.418,46	102,70	74,64
jun-11	9.066,85	3,13	0,09	225,72	14,30	1.292,28	1.421,40	95,42	74,30
jul-11	9.650,46	3,13	0,07	225,92	14,30	1.218,89	1.368,90	95,70	73,90
ago-11	9.000,76	3,13	0,10	226,55	14,20	1.131,42	1.329,46	88,81	74,12
sep-11	8.300,14	3,13	0,08	226,89	14,20	1.253,30	1.219,86	79,20	78,55
oct-11	7.394,19	3,13	0,07	226,42	14,10	1.246,96	1.301,28	93,19	76,17
nov-11	7.581,02	3,13	0,08	226,23	14,00	1.257,60	1.203,98	100,36	78,38
dic-11	7.565,48	3,13	0,07	225,67	13,90	1.312,41	1.187,69	98,83	80,18
ene-12	8.040,47	2,51	0,08	226,66	12,65	1.365,68	1.261,68	98,48	79,29
feb-12	8.441,49	2,51	0,10	227,66	11,40	1.408,47	1.321,98	107,07	78,74
mar-12	8.470,78	2,51	0,13	229,39	11,60	1.397,91	1.236,66	103,02	79,00
abr-12	8.289,48	2,51	0,14	230,09	11,00	1.310,33	1.315,46	104,87	78,78
may-12	7.955,64	2,51	0,16	229,82	10,70	1.362,16	1.279,69	86,53	83,04
jun-12	7.423,02	2,51	0,16	229,48	10,50	1.379,32	1.228,18	84,96	81,63
jul-12	7.584,26	2,51	0,16	229,10	10,30	1.406,58	1.176,12	88,06	82,64
ago-12	7.515,53	2,51	0,13	230,38	10,10	1.440,67	1.108,54	96,47	81,21
sep-12	8.087,74	2,51	0,14	231,41	10,00	1.412,16	1.140,36	92,19	79,94
oct-12	8.062,03	2,51	0,16	231,32	10,00	1.416,18	1.145,56	86,24	79,92
nov-12	7.711,23	2,51	0,16	230,22	10,00	1.426,19	1.117,21	88,91	80,15
dic-12	7.966,49	2,51	0,16	229,60	10,00	1.498,11	1.336,90	91,82	79,77

ene-13	8.047,36	2,65	0,14	230,28	10,00	1.514,68	1.441,08	97,49	79,21
feb-13	8.060,93	2,65	0,15	232,17	9,90	1.569,19	1.412,53	92,05	81,95
mar-13	7.645,58	2,65	0,14	232,77	9,50	1.597,57	1.288,19	97,23	83,22
abr-13	7.234,28	2,65	0,15	232,53	9,40	1.630,74	1.279,15	93,46	81,75
may-13	7.249,41	2,65	0,11	232,95	9,40	1.606,28	1.340,34	91,97	83,26
jun-13	7.000,24	2,65	0,09	233,50	9,30	1.685,73	1.129,77	96,56	83,14
jul-13	6.906,64	2,65	0,09	233,60	9,40	1.632,97	1.103,50	105,03	81,45
ago-13	7.192,92	2,65	0,08	233,88	9,50	1.681,55	1.163,43	107,65	82,09
sep-13	7.159,27	2,65	0,08	234,15	9,60	1.756,54	1.202,78	102,33	80,22
oct-13	7.203,02	2,65	0,09	233,55	9,70	1.805,81	1.206,36	96,38	80,20
nov-13	7.070,65	2,65	0,08	233,07	9,70	1.848,36	1.231,32	92,72	80,68
dic-13	7.214,90	2,65	0,09	233,05	9,70	1.782,59	1.173,09	98,42	80,04
ene-14	7.291,47	2,84	0,07	233,92	9,15	1.859,45	1.117,74	97,49	81,31
feb-14	7.149,21	2,84	0,07	234,78	8,60	1.872,34	1.072,40	102,59	79,69
mar-14	6.650,04	2,84	0,08	236,29	8,70	1.883,95	1.063,61	101,58	80,10
abr-14	6.673,56	2,84	0,09	237,07	8,70	1.923,57	1.076,00	99,74	79,47
may-14	6.891,13	2,84	0,09	237,90	8,70	1.960,23	1.077,22	102,71	80,37
jun-14	6.821,14	2,84	0,10	238,34	8,80	1.930,67	1.082,67	105,37	79,78
jul-14	7.113,38	2,84	0,09	238,25	8,80	2.003,37	1.192,51	98,17	81,46
ago-14	7.001,84	2,84	0,09	237,85	8,50	1.972,29	1.162,92	95,96	82,75
sep-14	6.872,22	2,84	0,09	238,03	8,50	2.018,05	1.180,44	91,16	85,94
oct-14	6.737,48	2,84	0,09	237,43	8,40	2.067,56	1.214,11	80,54	86,92
nov-14	6.712,85	2,84	0,09	236,15	8,30	2.058,90	1.380,46	66,15	88,36
dic-14	6.446,45	2,84	0,12	234,81	8,30	1.994,99	1.856,31	53,27	90,27
ene-15	5.830,54	2,86	0,11	233,71	7,55	2.104,50	1.699,78	48,24	94,80
feb-15	5.729,27	2,86	0,11	234,72	6,80	2.067,89	1.734,72	49,76	95,32
mar-15	5.939,67	2,86	0,11	236,12	6,40	2.085,51	1.932,58	47,60	98,36
abr-15	6.042,09	2,86	0,12	236,60	6,20	2.107,39	2.282,93	59,63	94,60
may-15	6.294,78	2,86	0,12	237,81	6,20	2.063,11	2.169,19	60,30	96,91
jun-15	5.833,01	2,86	0,13	238,64	6,30	2.103,84	2.053,71	59,47	95,49
jul-15	5.456,75	2,86	0,13	238,65	6,30	1.972,18	1.757,15	47,12	97,34
ago-15	5.127,30	2,86	0,14	238,32	6,30	1.920,03	1.539,90	49,20	95,82
sep-15	5.217,25	2,86	0,14	237,95	6,20	2.079,36	1.454,24	45,09	96,35
oct-15	5.216,09	2,86	0,12	237,84	6,10	2.080,41	1.590,41	46,59	96,95
nov-15	4.799,90	2,86	0,12	237,34	6,10	2.043,94	1.586,11	41,65	100,17
dic-15	4.638,83	2,86	0,24	236,53	6,10	1.940,24	1.649,95	37,04	98,63
ene-16	4.471,79	2,57	0,34	236,92	5,75	1.932,23	1.351,67	33,62	99,61
feb-16	4.598,62	2,57	0,38	237,11	5,40	2.059,74	1.336,42	33,75	98,21
mar-16	4.953,80	2,57	0,36	238,13	5,80	2.065,30	1.491,02	38,34	94,59
abr-16	4.872,74	2,57	0,37	239,26	5,80	2.096,95	1.478,20	45,92	93,08
may-16	4.694,54	2,57	0,37	240,24	5,90	2.098,86	1.469,79	49,10	95,89

jun-16	4.641,97	2,57	0,38	241,04	6,00	2.173,60	1.401,81	48,33	96,14
jul-16	4.864,90	2,57	0,39	240,65	6,00	2.170,95	1.424,87	41,60	95,53
ago-16	4.751,67	2,57	0,40	240,85	6,00	2.168,27	1.469,25	44,70	96,02
sep-16	4.722,20	2,57	0,40	241,43	6,00	2.126,15	1.436,53	48,24	95,46
oct-16	4.731,26	2,57	0,40	241,73	6,00	2.198,81	1.454,48	46,86	98,45
nov-16	5.450,93	2,57	0,41	241,35	6,00	2.238,83	1.530,77	49,44	101,50
dic-16	5.660,35	2,57	0,54	241,43	6,00	2.278,87	1.436,02	53,72	102,21
ene-17	5.754,56	3,16	0,65	242,84	6,15	2.363,64	1.502,30	52,81	99,51
feb-17	5.940,91	3,16	0,66	243,60	6,30	2.362,72	1.520,43	54,01	101,12
mar-17	5.824,63	3,16	0,79	243,80	6,80	2.384,20	1.511,96	50,60	100,35
abr-17	5.683,90	3,16	0,90	244,52	6,70	2.411,80	1.508,07	49,33	99,05
may-17	5.599,56	3,16	0,91	244,73	6,70	2.423,41	1.620,03	48,32	96,92
jun-17	5.719,76	3,16	1,04	244,96	6,90	2.470,30	1.690,48	46,04	95,63
jul-17	5.985,12	3,16	1,15	244,79	6,80	2.471,65	1.755,88	50,17	92,86
ago-17	6.485,63	3,16	1,16	245,52	6,70	2.519,36	1.833,61	47,23	92,67
sep-17	6.577,17	3,16	1,15	246,82	6,70	2.575,26	1.797,99	51,67	93,08
oct-17	6.807,60	3,16	1,15	246,66	6,70	2.584,84	1.928,13	54,38	94,55
nov-17	6.826,55	3,16	1,16	246,67	6,60	2.673,61	1.980,67	57,40	93,05
dic-17	6.833,89	3,16	1,30	246,52	6,60	2.823,81	2.028,15	60,42	92,12
ene-18	7.065,85	3,04	1,41	247,87	6,90	2.713,83	2.302,73	64,73	89,13
feb-18	7.006,52	3,04	1,42	248,99	7,20	2.640,87	2.108,57	61,64	90,61
mar-18	6.799,18	3,04	1,51	249,55	6,80	2.648,05	2.014,76	64,94	89,97
abr-18	6.851,51	3,04	1,69	250,55	6,90	2.705,27	1.925,35	68,57	91,84
may-18	6.825,27	3,04	1,70	251,59	6,90	2.718,37	1.925,77	67,04	93,99
jun-18	6.965,86	3,04	1,82	251,99	6,70	2.816,29	1.750,77	74,15	94,64
jul-18	6.250,75	3,04	1,91	252,01	6,60	2.901,52	1.726,50	68,76	94,49
ago-18	6.051,05	3,04	1,91	252,15	6,50	2.913,98	1.655,12	69,80	95,14
sep-18	6.050,76	3,04	1,95	252,44	6,40	2.711,74	1.728,78	73,25	95,13
oct-18	6.219,59	3,04	2,19	252,89	6,40	2.760,17	1.589,74	65,31	97,13
nov-18	6.195,92	3,04	2,20	252,04	6,30	2.506,85	1.581,56	50,93	97,27
dic-18	6.075,32	3,04	2,27	251,23	6,20	2.704,10	1.510,81	45,41	96,17
ene-19	5.939,10		2,40	251,71	5,75	2.784,49	1.706,54	53,79	95,58
feb-19	6.300,49		2,40	252,78	5,30	2.834,40	1.870,43	57,22	96,16
mar-19	6.439,46		2,41	254,20	6,50	2.945,83	1.951,20	60,14	97,28
abr-19	6.438,36		2,42	255,55	6,20	2.752,06	2.028,74	63,91	97,48
may-19	6.017,90		2,39	256,09	6,00	2.941,76	1.843,12	53,50	97,75

Below is a graph of industrial production index of the main countries in the world.

Source: world bank

And industrial production gross value added (YOY%) for China.

	US	JAPAN	GERMANY	INDIA	UNITED KINGDOM	FRANCE	ITALY	SPAIN
1990	61.66	105.51	71.94		98.7	91.03	110.52	99.85
1991	60.75	107.49	74		95.4	90.93	109.47	99.22
1992	62.53	101.31	72.99		95.83	90.28	108.32	96.13
1993	64.58	97.78	67.07		97.89	86.95	105.66	91.78
1994	67.98	99.01	69.18		103.07	90.15	112.1	99.02
1995	71.13	102.25	69.79	31.75	104.88	92.81	118.75	103.92
1996	74.37	104.65	69.39	34.61	106.31	93.62	116.76	102.41
1997	79.71	108.34	71.76	36.55	109.14	97.65	121.27	109.71
1998	84.36	101.25	75.01	38.21	110.32	101.67	122.78	115.68
1999	88.08	101.57	76.16	40.47	111.5	104.43	122.47	118.74
2000	91.49	107.09	80.39	42.92	113.54	108.78	127.66	123.97
2001	88.67	100.32	80.45	44.08	111.75	110	125.44	122.37
2002	89	99.19	79.46	46.24	110.19	108.71	123.56	122.33
2003	90.14	102.51	79.68	49.27	109.51	107.75	122.81	123.85
2004	92.56	107.37	83.14	54.61	110.26	110.34	122.56	125.75
2005	95.66	108.91	85.92	57.85	109.53	110.34	121.8	127.16
2006	97.83	113.63	90.86	64.18	110.22	111.14	126.23	132.04
2007	100.32	116.8	96.85	74.22	110.52	112.46	129.16	134.45
2008	96.85	113.06	97.73	79.91	107.84	109.63	123.83	124.15
2009	85.73	89.29	80.77	80.08	98.22	95.82	100.81	104.78
2010	90.43	102.66	90.44	87.88	101.38	100.28	107.85	105.6
2011	93.23	99.66	98.14	92.09	100.77	102.85	108.73	104.06
2012	96.06	100.31	97.05	91.87	98.04	100.34	102.48	97.22
2013	98.02	99.44	97.03	93.31	97.35	99.3	99.33	95.69
2014	101.02	101.32	98.95	97.53	98.81	98.25	98.7	96.88
2015	100	100	100	100	100	100	99.68	100
2016	98.07	99.7	101.51	105.21	100.96	100.43	101.75	101.86

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