Czech University of Life Sciences Prague

Faculty of Economics and Management

Master's Thesis

The impact of China’s inflation on global economy

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

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Economics and Management

Thesis title

The impact of China's inflation on global economy

Objectives of thesis

The purpose of this study is to find the positive and negative effects of inflation on global economic development in China under selected circumstances:

1. China's inflation on commodity prices (energy, commodities) in the international market.
2. Whether China's inflation will have an impact on global inflation.
3. Will China's inflation accelerate or slow down the global economy.

Methodology

The theoretical part will introduce China's role in global commodity markets and the possible impact on global commodity prices under the conditions of inflation in China. Summarizes previous research on China's inflation and world economic development.

Analysis part 1.According to a variety of econometric models, determine the variables as China's inflation rate, international energy price, international oil price, international commodity price and exchange rate, and explore the impact of China's inflation on commodity prices in the international market.

2.Use the VAR model to explore the relationship between Chinese inflation and global inflation.

The part of the evaluation will consider the impact of inflation through trade transmission and goods transmission.

The proposed extent of the thesis
50-60

Keywords

world trade; china; inflation; commodity price; economy

Recommended information sources

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Declaration

I declare that I have worked on my master's thesis titled " The impact of China’s inflation on World Economy" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 30.03.2024 _____

Bc. Chen Jiao

Acknowledgement

I would like to thank Ing. Ghaeth Fandi, Ph.D. and my advisor MSc. Mohammad Rehabi for their advice and support during my work on thesis.

I'm so lucky to have my family support and friends accompany. I love them. Also, I want to tell my flower here: YOU ARE THE BEST!

The impact of China’s inflation on global economy

Abstract:

This thesis focusses on the influence of China’s inflation to explore the relationship with international commodity price and global economy performance. To have a better understanding of the relationship between China’s inflation and commodity price, crude oil price will be selected to represent the commodity price. In this thesis, VAR model will be used to measure the data. Variables including China’s inflation, EU inflation, US inflation, World inflation, international crude oil price and world GDP growth rate. Two period will be found in this thesis- 2009.01 to 2021.12 and 2001 to 2021. The first period is used to explore the relationship between China’s inflation and international crude oil price. The second one is set to find the connection among China’s inflation, word inflation and global GDP growth rate. Based on VAR models results, it can be found that 1. China's inflation has a negative but not significant impact on international crude oil prices, and it is worth mentioning that the EU inflation rate has a more significant negative impact on international crude oil prices. 2. China's inflation has a negative but insignificant effect on global inflation. 3.China's inflation has a negative but insignificant effect on global GDP growth rate. However, the positive effect of EU inflation on global GDP growth rate is close to the level of significance.

Keywords: world trade; China; inflation; commodity price; economy

Dopad čínské inflace na světovou ekonomiku

Abstrakt:

Tato práce se zaměřuje na vliv čínské inflace a zkoumá její vztah k cenám komodit na mezinárodním trhu a výkonnosti globální ekonomiky. Pro lepší pochopení vztahu mezi čínskou inflací a cenou komodit bude jako reprezentant ceny komodity vybrána cena ropy. V této práci bude k měření údajů použit VAR model. Proměnné zahrnují inflaci v Číně, inflaci v EU, inflaci v USA, světovou inflaci, mezinárodní cenu ropy a míru růstu světového GDP. V této práci budou zjištěna dvě období - 2009.01 až 2021.12 a 2001 až 2021. První období slouží ke zkoumání vztahu mezi čínskou inflací a mezinárodní cenou ropy. Druhé je stanoveno ke zjištění souvislosti mezi čínskou inflací, slovní inflací a světovým tempem růstu GDP. Na základě výsledků VAR modelů lze zjistit, že 1. Čínská inflace má negativní, ale nevýznamný dopad na mezinárodní ceny ropy a za zmínku stojí, že míra inflace v EU má výraznější negativní dopad na mezinárodní ceny ropy. 2. Čínská inflace má negativní, ale nevýznamný vliv na světovou inflaci. 3. Čínská inflace má negativní, ale nevýznamný vliv na globální tempo růstu GDP. Pozitivní vliv inflace v EU na globální tempo růstu GDP se však blíží hladině významnosti.

Klíčová slova: světový obchod; Čína; inflace; cena komodit; ekonomika.

Table of content

Introduction

1.1 Background

With the deepening of economic globalisation, the world economic pattern has gradually stepped into a stage of increasingly close ties and interdependence. In this circumstance, the flows of capital and commodities in different countries and regions have become more and more rapid and frequent, and the economic ties between countries and regions have become increasingly close. Since 2001, China's economy has continued to grow at a rapid pace, playing an increasingly important role in the world of economy. In particular, after 2010, China became the world's second largest economy for the first time. As the world's second largest economy, the trend of China's economic development profoundly affects global economic stability and growth. Especially since its joining the World Trade Organization (WTO) in 2001, China has become increasingly prominent in the global economy, not only as one of the world's largest manufacturing centres, but also as one of the world's largest traders of goods and one of the world's largest traders of services, and one of the world's largest traders of goods and one of the world's largest traders of services.

In recent years, the global economy has faced multiple challenges, and the 2019 outbreak of the Epidemic has had a huge impact on the global economy, leading to disruptions in the supply chain and international trade, which in turned affected the level of global inflation. During this period, the resilience and recovery demonstrated by the Chinese economy was of significant importance in stabilising the global economy. However, as the pace of economic recovery accelerated, it was accompanied by higher raw material prices and increased production costs, which further pushed up the global inflation rate. In particular, as the world's largest consumer of raw materials and exporter of manufactured goods, inflation in China not only affects the domestic economy but also affects other countries and regions through global supply chains and trade networks, a phenomenon that is particularly pronounced today with the high degree of global economic integration.

In addition, Chinese inflation’s impact on the global economy is also reflected in its effect on international commodity prices. China is one of the largest importer of energy and raw materials, and changes in its demand for international commodities may have a direct

impact on global price levels. For example, China's large demand for resources including crude oil, coal and iron ore is one of the main factors driving fluctuations in the international prices of these commodities. Changes in China's inflation rate, therefore, affect the international commodity markets by influencing domestic demand and production costs, which in turn have a further impact on the global economic landscape.

To sum up, within the context of worldwide economic integration, conducting a detailed analysis of how China's inflation affects the global economy is crucial. This exploration is key to grasping the workings of the global economic system and tackling worldwide economic issues.

Objectives and Methodology

2.1 Objectives

The purpose of this paper is to discuss the complex impact of China's inflation on world economic development in a specific context, and to reveal the impact of China's inflation on commodity prices in the international market (the international price of crude oil), on global inflation trends, and on the global rate of economic growth. Specific research objectives include:

1. The impact of China's inflation on commodity prices in the international market: to analyze the impact mechanism of China's inflation on the price of international crude oil.
2. whether China's inflation has an impact on global inflation: to examine how China's inflation, as a global manufacturing centre and one of the largest commodity trading countries, affects global inflation.
3. whether China's inflation will accelerate or slow down the global economy: to examine the impact of China's inflation on the global economic growth rate.

The hypotheses of the study are:

Hypothesis 1: When China's inflation increases, commodity prices in the international market will also increase.

Hypothesis 2: An increase in China's inflation will lead to an increase in global inflation.

2.2 Methodology

This paper explores the impact of China's inflation on the global economy by constructing an econometric model (VAR model) and applying quantitative analysis. The research framework is based on three main goals: first, to analyse the impact of Chinese inflation on commodity prices in the international market; second, it explores the impact of Chinese inflation on the global inflation trend; and third, it assesses the role of Chinese inflation on the global economic growth rate.

The data needed for the study include the Chinese consumer price index (CPI) as a proxy variable for the inflation rate, international oil prices and global economic growth rate data. These data were obtained from the International Monetary Fund (IMF), the World Bank and the National Bureau of Statistics of China(NBSC). The data are divided into monthly and annual data, with monthly data including inflation rates for China, the United States, the European Union, and the WTI (international crude oil price). Annual data include inflation rates for China, the US, the EU and the world, as well as global GDP growth. The selected monthly time span is from 2009.01 to 2021.12 and the annual time span is from 2001 to 2021.

After modelling, this paper will further explore the causal relationship between Chinese inflation and global economic indicators by applying the Granger causality test. The purpose of Granger causality test is to identify whether there is a causal relationship between variables in the selected time series data. We will use it to test whether the past value of one variable can predict the future value of another variable.

In this paper, we will also use impulse response analysis to assess the short- and long-term impact of Chinese inflation on global economic indicators (international crude oil prices, global inflation rate and global economic growth rate). By simulating a shock to one standard deviation of China's inflation rate, it will be analysed how the impact of this shock on global economic indicators changes over time.

Literature Review

3.1 World Economy

The global economy is defined by the complex interconnections and mutual dependencies among nations' economies, which collectively form the entirety of the global economic landscape. When viewed through the lens of the international division of labor and the global market, it becomes evident that the global economy naturally interweaves the world's economies using various mechanisms, such as the exchange of labor, the mobility of capital, the circulation of goods, the transfer of technology, and the process of international economic integration, as highlighted by Charnock and Starosta (2016). Conversely, Ravenhill (2017) expands this definition to encompass the production, consumption, and trading of goods and services, along with the transboundary flows of capital, labor, and technology. Moreover, when considering the structure of national economies, it can be discerned that the contemporary global economy predominantly consists of three categories: socialist economies, with their emphasis on state control and planned resource distribution; developing economies, which are characterized by their ongoing industrialization efforts and associated challenges; and developed economies, known for their advanced industrialization, technological progress, and high living standards, as described by Smelser and Swedberg (2010).

UNCTAD (The United Nations Conference on Trade and Development) conceptualizes the global economy as consisting of two main elements: a unified global market and a singular production zone. It posits that the global economy's interconnectedness transcends mere trade and investment exchanges between nations; instead, countries and regions function as integral sub-components within the overarching structure of the global economy.

This era witnessed the emergence of multinational corporations and the integration of emerging markets into the global trade system (Krugman & Obstfeld, 2009).

3.1.1 Development of World Economy

The global economy emerged and evolved alongside human society's progression to the

capitalist stage, representing the earliest manifestation of international economic relations and the cross-border exchange of goods.

Between the 14th and 15th centuries, early signs of capitalism emerged in nations along the Mediterranean coast, leading to an increase in the international trade of goods. The age of geographical explorations around the 15th century laid the groundwork for creating a global market. Economic globalization originated from the foundational events of the Great Geographical Discoveries and the material advancements of the Industrial Revolution. The merging of these two elements marked the start of the historical journey towards today's economic globalization(Dong Yan, 2023).

From the 16th century to the middle of the 18th century, with the development of capitalism, geographic discoveries, the opening of colonies and the primitive accumulation of capital, the international exchange of commodities developed considerably, and the germ of the international division of labor appeared.

Between the mid-18th century and the 1870s, Europe and the United States saw the completion of the industrial revolution. This period marked the establishment of capitalist production methods and the rise of large-scale mechanized industries, leading to a situation where the production and market needs within individual countries could no longer be satisfied domestically. As countries and regions at varying stages of economic development joined the international division of labor and engaged in global trade, the economic systems of various nations began to integrate, laying the foundation for what would become the world economy.

In the latter half of the 19th century, a technological revolution, epitomized by the advent of electricity, significantly accelerated the development of productive forces. The creation and expansion of large-scale heavy industries, coupled with major advancements in the transportation sector, enhanced and tightened international economic connections. The exchange of goods and services reached unprecedented levels, and the production process took on a global dimension. This led to a high degree of interdependence and integration among national economies, creating a cohesive global economic entity.

Since the 1990s, the tide of economic globalization has permeated every facet of human existence, continually expanding and deepening in concert with the swift progress of the global economy.

Anthony Giddens (2013) noted that economic globalization can be summarized from two perspectives: Firstly, it represents a universal development process, enhancing and diversifying the connections between various countries and regions. Secondly, it has notably intensified the depth of interconnections, interactions, and mutual dependence among nations and regions.

The above discussion shows that the process of the world economy has reached the stage of globalization, and that the present-day world economic pattern is a development of globalization. Economic globalization promotes the degree of interconnectedness and influence among countries and regions. The influence of individual countries on the world economy is also increasing.

3.1.2 Main Contributors of Global GDP

The world economy refers to the global aggregation of various national economies, encompassing the distribution, production, and consumption of goods and services across all countries. Geographically, the world economy is made up of countries on all seven continents.

From the geographical discoveries of the sixteenth century to the present, globalization has become an unstoppable trend. The system of geographically concentrated production is an important part of this wave of globalization. In this framework, specific areas of the world act as the driving forces behind the global Gross Domestic Product (GDP). This concentration of production activities has led to a notable shift in economic geography, where a handful of countries now dominate global economic performance. (Llop, 2024).

Table 1 Top 20 GDP countries.

Rank	Country	GDP($Trillion)	% of global GDP
1	United States	23.32	23.91%
2	China	17.82	18.27%
3	Japan	5.01	5.13%
4	Germany	4.28	4.39%
5	India	3.20	3.28%
6	United Kingdom	3.14	3.22%
7	France	2.96	3.03%
8	Italy	2.16	2.21%
9	Canada	2.00	2.05%
10	Russian Federation	1.84	1.88%
11	Korea, Rep.	1.82	1.86%
12	Brazil	1.65	1.69%
13	Australia	1.56	1.60%
14	Spain	1.45	1.48%
15	Mexico	1.31	1.35%
16	Indonesia	1.19	1.22%
17	Netherlands	1.03	1.06%
18	Saudi Arabia	0.87	0.90%
19	Türkiye	0.82	0.84%
20	Switzerland	0.81	0.83%

Data source: World Bank

According to Figure 1, which details the top 20 nations by global GDP in 2021, it's evident that the global GDP composition spans seven key geographic areas: Asia, Europe, Latin America, North America, Africa, the Middle East, and Australia. From this table, China emerges as the leading GDP contributor in Asia, Germany dominates in Europe, and the United States stands out in North America. Collectively, these three nations contribute to 46.57% of the global GDP.

At the national level, a country's significant share of the global GDP can typically be associated with three main factors (Milanovic, 2022): 1. its major role in international

trade, 2. the market dominance of its products globally, and 3. its capacity to influence global prices.

Furthermore, in terms of the role of a country in international forums and multinational organizations, it depends to a large extent on its economic importance. (Jones and Klenow, 2016). According to Llop(2024), it was found that the United States (23.50%) contributed a whopping 23.5% of global GDP in 2014, followed closely by the European Union at 18.86% then finally China at 13.9% . The combined contribution of these three regions was about 56% of total production, confirming the clustering of world production in some small number of geographic regions.

The latest OECD data shows that in 2022, China's contribution to world GDP will be 22.3%, compared to 21.4% for the US and 18.9% for the EU. It shows that these three regions are the major economies of the world economy and contribute significantly to global GDP. It can also be noticed that China's contribution to global GDP has increased substantially.

3.2 China’s Globalization

3.2.1 China's entry into WTO

China's accession to the WTO in December 2001 has deepened its ties with the world economy, with total import and export trade amounting to US$509.65 billion in 2001 and US$6.31 trillion in 2022, making China the world's largest importer and exporter. Before joining the WTO, the tariff of intermediate goods was as high as 16.5%, but within six years after joining the WTO, the intermediate goods’ tariff rate dropped to 7.5% in 2007, a reduction of 9%. It can be said that the signing of WTO trade agreements has greatly reduced the uncertainty of trade policies and accelerated the process of China's integration into the world.

Looking at China's economy from the perspective of global interests, since China's accession to the WTO, rather than saying that the Chinese factor has pried up the world economy, it is more important to say that the Chinese economy and the economies of other countries have already formed a virtuous circle of complementary advantages, honour and

disgrace. While pursuing its own economic development, the Chinese economy has sought co-prosperity with the rest of the world.

Quesnay, the classical French economist, emphasized the economic cycle in his Table Economique, comparing it to the human blood system. By maintaining a virtuous cycle between production and consumption, and among all sectors of production, regions and countries, the economy can maintain stability and growth; on the contrary, any economic crisis is invariably the result of a break in the normal economic cycle. China's economic development has always insisted on integration and interaction with the world economy, which has now become a part of the world economy, and they influence each other.

The development of Chinese manufacturing industry not only fills the United States manufacturing industry "hollowing out" caused by the lack of supply, but also for the adjustment of the United States economic structure to create the conditions for the United States to indirectly promote the United States of America's high-tech, risky investment in the emerging industries in the absence of worry about the situation of the great strides forward. China's huge, efficient, and perfect manufacturing industry not only provides a "habitat" for global financial capital, but also enables foreign financial companies to enter the Chinese market to obtain huge profits. It shows that China's cumulative utilization of foreign capital from 2002-2012 exceeded US$1 trillion (NBSC).

The size and dynamics of the Chinese market shape the global layout of multinational corporations and promote the development of multinational corporations. The Chinese market has also become an important link in the global industrial chain. China is not only an irreplaceable link in the global production chain, but also in the global sourcing chain, and many multinational corporations have made the establishment of supply chains in China an indispensable part of their global strategies. No multinational company today can complete the design, procurement, production and sales chain without the Chinese market.

In addition, Chinese demand not only influences the price trend of international commodities, but also stabilizes them, and Chinese demand contributes to the growth of the world economy. Take the steel industry as an example, China's iron ore imports were 92.3 million tons in 2002, and then demand increased year by year, rising to 400 million

tons in 2008, and up to 600 million tons in 2011, making China the largest iron ore importer(NBSC).

Figure 1 China's GDP growth rate

Data Source: National Bureau of Statistics of China

The figure illustrates that following its reform and opening-up policy, China underwent several growth spurts, especially in the early and mid-2000s, indicating a phase of swift economic development and expansion. However, after the 2008 global financial crisis, China's economic growth has steadily decreased from its previous highs, with the growth rate significantly dropping to around 6-7% by the end of the observed period.

3.2.2 China's role in Global Economy

A) Manufacturing powerhouse

There are two reasons behind China's emergence as a manufacturing powerhouse: 1. the formation of global value chains. 2. China's accession to the World Trade Organization(IMF. 2021).

Sturgeon(2001) highlighted that the concept of Global Value Chains (GVCs) is characterized by three key dimensions: the scale of organization, the geographic extent, and the variety of production participants. Firstly, in terms of organizational scale, GVCs encompass all entities participating in the creation of a product or service. Secondly, from a geographical perspective, GVCs are inherently international in scope. Lastly, concerning the participants involved, GVCs comprise a range of entities including large

conglomerates, retailers, principal manufacturers, turnkey providers, and suppliers of components.

Since the 1990s, China's manufacturing industry, relying on the relative advantage of cheap labor, has been embedded in the global value chain from the processing and assembling link with low added value, and has rapidly gained an international competitive advantage at the low end of the value chain, gradually becoming a world manufacturing center. This integration and consolidation of the global value chain cannot be separated from the formation and role of the world's modular networking mechanism. (Huang et al., 2024).

Ernst and Kim (2016) noted that global production networks (GPNs) were networked collections of firms that co-produced a particular product in global space. GPNs are equivalent to global production networks established by leading TNCs from developed countries, linking value chain links and value-added activities across the globe through production linkages. As a leading manufacturing powerhouse, China has seen its contribution to the global manufacturing value added climb from 22.5% to almost 30%. Additionally, within China's large-scale industrial sector, the proportions of high-tech manufacturing and equipment manufacturing have grown from 9.4% and 28% in 2012 to 15.1% and 32.4% in 2021, according to the National Bureau of Statistics of China. This positions China's manufacturing sector at the heart of the global economy, indicating a significant shift towards China as the new epicenter of the global value network(Huang et al., 2024).

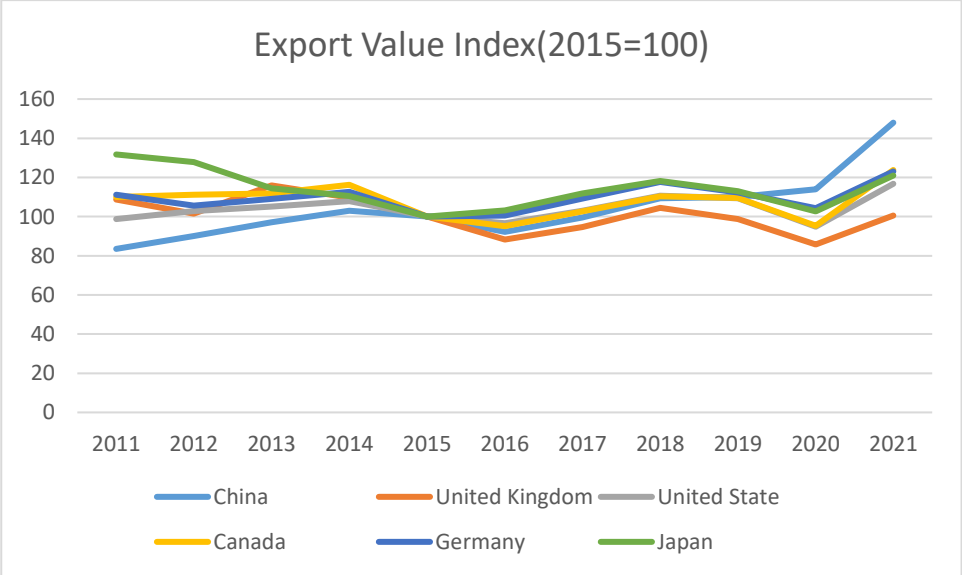
B) Stabilizers of the world economy

As of 2023, China boasts the most comprehensive and extensive industrial system globally, distinguished as the sole nation to encompass all 41 major industrial categories, 207 medium categories, and 666 minor categories as per the United Nations Industrial Classification (MIIT, 2023). It leads the world in the production of over 220 industrial products, positioning itself as a crucial hub in the global industrial and supply chains. Additionally, China serves as the largest trading partner for over 120 countries and regions, underscoring its pivotal role in international trade and economics.

Theoretically, the macroeconomy is a complex system under which various factors of production, economic activities and market players are interdependent and interact with each other. When a country's macroeconomy is stable, the price level tends to be more stable; when it encounters external shocks, economic overheating or stalling, drastic changes in the balance of payments, and large fluctuations in the exchange rate, prices are prone to major ups and downs. It can be said that the stability of global prices cannot be separated from the stability of the world economy, and the stability of the world economy cannot be separated from the economic stability of the major economies(Hakro and Ahmed, 2006).

As the largest economies in the world, the smooth operation of China's macroeconomy is in itself an important contribution to the development of the world economy and global price stability. As economic globalization continues to develop and developing countries in general, and China in particular, join the global generating network, the effective supply capacity worldwide continues to improve, and supply and demand for consumer durables such as televisions, refrigerators, cellular phones and computers, as well as for labour-intensive products such as textiles and clothing, are generally generous, which has to a considerable extent curbed the rise in consumer prices in various countries.

Figure 2 export value index



Data source: World Bank

From the above chart, we can find that China's export value index has improved tremendously over the past decade, from 80 in 2011 to over 140 in 2021.

3.3 Inflation

Considering the advancement of global economic integration and the increasing international trade, global inflation can have an impact on the prices of all countries through the channel of commodity exchange, and inflation is no longer an endogenous economic problem of countries, but a global problem. In this section, four basic theories of inflation will be introduced to provide theoretical support for the study of how inflation in a single country affects the prices of staples in the global economy and the rate of global inflation.

3.3.1 The definition of inflation

There is no uniform interpretation of inflation in economics, but it is generally recognized that inflation refers to the situation in which, under the credit-money system, the amount of money issued exceeds the actual amount of money needed for the circulation of commodities, resulting in a depreciation of paper money and a substantial, sustained, and comprehensive increase in commodity prices over a certain period. In other words, only a sustained, across-the-board, relatively large increase in the price level over a certain period can be defined as inflation. In essence, inflation is a phenomenon in which the quantity of money supplied exceeds the actual demand, resulting in too much money pursuing too few goods.

The following are the main indicators currently used to measure inflation:

- The Gross Domestic Product (GDP) Deflator is an index that measures price changes by comparing the ratio of GDP in current prices to GDP in prices of a base year. A deflator value over 100% indicates that the price level has risen compared to the base period. This measure comprehensively reflects the price changes of both production materials and consumer goods. However, due to its complexity, gathering data can be challenging, and it tends to lag in timeliness.
- The Consumer Price Index (CPI) tracks the price changes of a basket of consumer goods and services, using a weighted average based on fixed quantities from a previous period. It's simpler to calculate and provides a timely

reflection of price changes affecting household expenses. However, its scope is more limited, making it less effective at capturing broad macroeconomic trends.

- The Producer Price Index (PPI) focuses on the price changes at the production level, contrasting with the CPI, which looks at consumer prices. The Producer Price Index (PPI) tracks the average variation in selling prices that domestic manufacturers receive for their products over time, acting as a crucial gauge for price fluctuations within the industrial sector.

Usually, the consumer price index (CPI) is closely related to the lives of residents, and its changes are more likely to affect the nerves of consumers, and many countries have directly equated the consumer price index (CPI) with the inflation rate. In this paper, the consumer price index (CPI) is also directly considered as the inflation rate.

3.3.2 The international transmission of inflation theories

Theoretical studies of the international transmission of inflation in open economies fall into three main categories: the Keynesian theory of international inflation, the structural inflation theory of the neo-structuralist school, and the inflation theory of the monetary school. For example, the Keynesian macroeconomic model based on the short-run transmission of imported inflation in a standard open economy (Helliwell, 1969), the study of the structural characteristics of the international sectoral transmission of inflation based on the Scandinavian model (Aukrust, 1970), the monetarist open-economy model centered on long-run stock equilibrium (Dornbusch, 1973) , and so on, etc.

3.3.2.1 The quantity theory of money

Friedman (1996) examed a century's worth of data on the United States' money supply and inflation rates from 1867 to 1960, concluding that currency maintains neutrality over the long term. His findings indicated that variations in the money supply invariably manifest as changes in the inflation rate over extended periods. Friedman famously articulated, “Inflation is always and everywhere a monetary phenomenon,” attributing it directly to the rate at which the money supply grows compared to output. As a leading proponent of monetarism, Friedman advocated for aligning money supply growth with economic

expansion, cautioning that any excessive increase in money supply inevitably results in higher inflation levels.

Mccandless and Weber (1995) through their examination of data spanning several decades from 1960 to 1990 across 110 countries, identified a robust correlation between the money supply and inflation, with correlation coefficients ranging from 0.92 to 0.96. They concluded that, in the long run, inflation rate increases are a direct outcome of money supply growth.

Mundell (1965), a representative figure of international monetarist thought, believes that there is a positive relationship between a country's foreign exchange reserves and its own inflation level. That is, when a country in international trade is in a super position, foreign exchange reserves continue to increase, will lead to the price level of the country's rise, and will even trigger worldwide inflation. The conduction mechanism lies in the increase of foreign exchange reserves lead to the increase of foreign exchange account, foreign exchange account increased and then triggered the increase of base money investment, under the role of the money multiplier ultimately make the market money supply increase, which ultimately affect the level of inflation. The paper posits a fundamental principle within the monetary standard system: an increase in the money supply invariably results in a rise in the overall price level, highlighting a direct relationship between the quantity of money and inflation.

3.3.2.2 The demand-pull theory of inflation

John Maynard Keynes introduced the concept of demand-pull inflation, suggesting that when aggregate demand in an economy surpasses aggregate supply, it creates an "inflationary gap" that triggers a widespread and sustained increase in prices, essentially stemming from "too much money chasing too few goods" (Keynes, 1975). Essentially, this form of inflation arises when the total demand in an economy exceeds its full production capacity in the short term, leading to higher prices. This scenario is common during periods of brisk economic expansion, where heightened demand from consumers and businesses leads to price increases.

Krugman and Wells further explain that demand-pull inflation occurs with a rise in

aggregate demand, which can be triggered by increased government spending, heightened external demand, or a surge in the money supply (Krugman and Wells, 2005). These factors shift the demand curve to the right, and if the supply remains unchanged, it results in a rise in the price level.

This theory aligns with Milton Friedman's quantity theory of money, which posits that inflation is fundamentally a monetary phenomenon. According to Friedman, an expansion in the money supply is invariably reflected in an increase in the price level (Friedman, 1963), supporting the notion of demand-pull inflation.

However, the theory of supply shocks, proposed by Joseph E. Stiglitz, emphasizes that supply-side factors, such as rising production costs and diminishing resources, can also lead to an increase in the price level, in contrast to the idea of demand-pull inflation (Stiglitz, 1984).

3.3.2.3 The cost-push theory

Joseph E. Stiglitz pointed out that an increase in the cost of production (e.g., higher prices of raw materials, higher labor costs, etc.) leads to a shift to the left of the supply curve, which in turn pushes up the price level, even if aggregate demand remains constant(Stiglitz, 1984). This supply-side price pressure is referred to as Cost-push inflation.Stiglitz's study reveals that cost-push inflation is not only the result of changes in a single cost factor, but is also closely related to the market structure and price-setting mechanism.

Samuelson and Solow (1960) consider how increases in the cost of production (e.g., technological change or resource scarcity) can lead to inflation, emphasizing the importance of productivity gains in mitigating inflationary pressures.

Tobin (Tobin, 1993) discusses the role of inflationary expectations in including cost-push scenarios. He argues that inflationary expectations can themselves be a source of cost-push inflation if workers and firms expect prices to rise and adjust their wage and price settings accordingly.

Blanchard (Blanchard, 2003) explores the dynamics of macroeconomic policy, including inflation. He discusses how supply shocks such as higher oil prices or changes in the global economy can lead to cost-push inflation. Blanchard also emphasizes the interaction of supply shocks, monetary policy and inflation expectations in determining the inflationary trajectory of the economy.

3.4 China's inflation and global economy

Inflation is a major issue related to a country's people's lives, economic development and political stability, and it is also a key variable considered in the regulation of macroeconomic policies in various countries. In recent years, China's inflation is in a very unstable state due to multiple factors such as the COVID-19, global currency overshooting, carbon-neutral expectations and rising international crude oil prices. Statistics show that in 2019, China's consumer price index rose to 2.9% , an increase of 0.8% compared with 2018, and in November of the same year, the CPI index rose by as much as 4.5% year-on-year, with obvious inflation. 2020, the CPI rose by 2.5% year-on-year, basically realizing a reasonable price control for the whole year. However, in 2021, the consumer price level only rose 0.9% compared with 2020, far below the expected goal of national price control. 2022, China's CPI index rose 2% compared with the previous year, PPI rose 4.1%, increasing inflationary pressure (NBSC, 2022).

3.4.1 China’s Inflation

Looking at China's inflation from both the demand and supply perspectives, demand shocks had a major impact on inflation before the 2008 global financial crisis, and supply contributed more to inflation after the 2008 global financial crisis (Chen and Groenewold, 2019).

From the perspective of price rigidity, some scholars have suggested that the financial crisis of 2008 made China's categorized prices more volatile and persistent, leading to a greater and longer response to macroeconomic fluctuations. In addition, domestic components contributed more to post-crisis price volatility (Wu and Chong, 2019).

In recent years, inflation in China has been driven by a mix of demand and supply-side

elements. Before 2008, the primary cause of inflation was demand-pull, attributed to the swift expansion and transformation of China's economy following the reforms and opening initiated in 1978. This period saw accelerated urban development, a substantial rise in per capita income, and the rapid expansion of the consumer market. Together, these factors have contributed to the growth in demand for goods and services, especially in sectors such as real estate, automobiles, and home appliances. At the same time, China's large demand for energy and raw materials as the world's factory has also pushed up prices in the global market, and to some extent this cost-transfer effect has been reflected in domestic prices as well.(Zhiyong, 2009; Zhang, 2010; Zhao et al., 2016).

Since 2008, the significance of cost-push factors in driving inflation has grown. Cost-push inflation occurs when production expenses escalate. With China's economic expansion and its aging population, there has been a notable increase in labor costs. Additionally, China's role as a significant importer of various raw materials means that global market price fluctuations for these materials directly influence the production costs of Chinese companies.

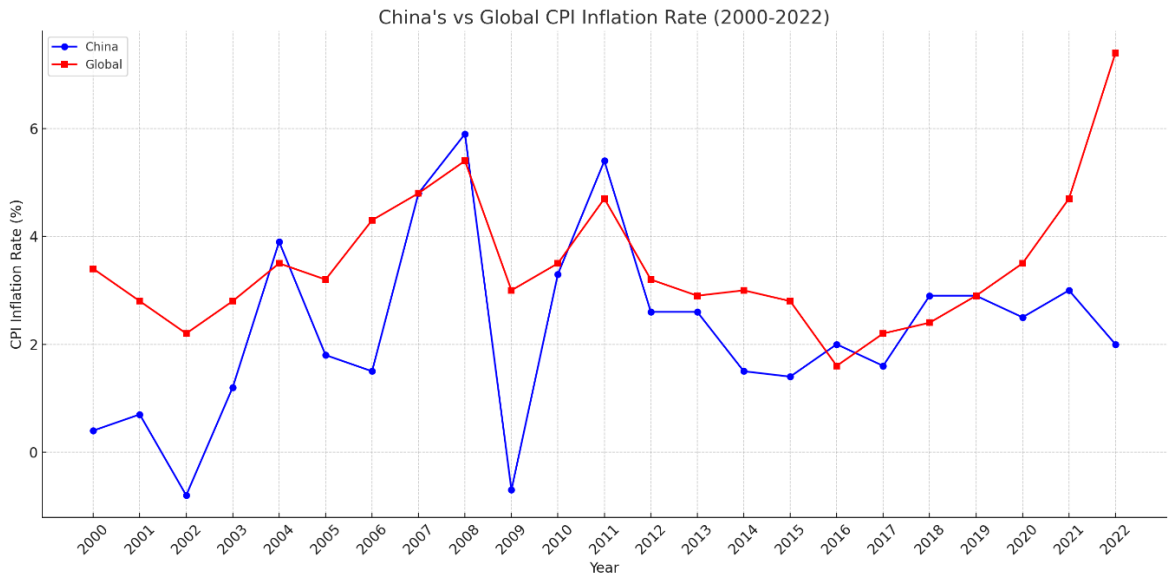


Figure 3 China and Global CPI inflation rate

Data Source: World Bank and IMF

The chart shows how China's CPI inflation compares to global CPI inflation between 2000 and 2022, revealing a large negative correlation between China's inflation and international inflation after 2019.

3.4.2 Current global economy

The stagnation of economic growth in the world's three largest economies—China, the United States, and the European Union—has significant implications for the global economic outlook, with inflation being a pressing concern as highlighted by the IMF in 2022. The global inflation rate, particularly in the US and major European economies, is surpassing expectations and leading to a stringent financing climate. The Chinese economy, in particular, is facing a more pronounced slowdown than anticipated, exacerbated by the impacts of pandemics and related countermeasures, while the conflict in Ukraine introduces further adverse effects. Consequently, global inflation has been on a rising trend throughout 2019. Given the considerable influence of the economic fluctuations of China, the US, and the EU on the global stage, their macroeconomic instability plays a critical role in shaping the global economic direction.

In developed economies, inflation often moves in tandem due to shared trends in commodity prices, as well as a synchronization of business cycles and monetary policies. Research by Ciccarelli and Mojon (2010) revealed that global factors were responsible for almost 70% of inflation variance among 22 OECD countries. The increased sensitivity of inflation to global economic shifts, a byproduct of globalization, extends beyond the conventional pathway of import prices. This sensitivity arises because heightened trade integration can enhance market competitiveness and diminish the pricing power of labor and firms.

Additionally, it seems that core inflation in the euro area is being influenced by both domestic and international output gaps (Busetti, Caivano and Delle Monache, 2021).

3.4.3 Global inflation synchronisation

The concept of globally synchronised inflation was first introduced at the beginning of the twenty-first century. Neely (2011)used a dynamic factor model to identify one global factor and seven regional factors from inflation data for 64 countries over the period 1951 to 2009. Using variance decomposition, he finds that the global factor explains, on average, about 35% of the variation in inflation, while the regional factors have an explanatory strength of 16%, with the two together explaining about 50% of inflation

fluctuations. And, he also analyses the extent to which inflation in each country responds to global, regional and national factors and finds that factors such as openness, the quality of financial institutions, and the independence of central banks play a key role.

Mumtaz and Surico (2012)analysed inflation data from industrialised countries through a dynamic factor model and similarly identified global and national factors. Their study highlights the importance of the global factor in describing the trend decline in inflation across countries, while pointing out the role of the national factor in explaining the volatility of inflation across countries. Their analysis of variance also shows that the global factor has increased its strength in explaining inflation across countries since the 1980s.

Monacelli (2005) disaggregated and analysed the Consumer Price Index (CPI) by product sector for four industrialised countries, the United States, Germany, France and the United Kingdom, and found that the global common factor explains about 15% to 30% of price fluctuations. They argue that this proportion reflects the lower bound role of global factors in common price volatility and, through further analysis, find that the synchronisation of price volatility across sectors is significantly and positively correlated with the intensity of trade in the sector, especially when product prices are denominated in US dollars, reflecting the synchronisation of exchange rate movements of currencies against the US dollar in each country.

Förster and Tillmann(2014)used a stratified factor model to analyse inflation data for both developed and developing countries. Their results show that more than two-thirds of inflation fluctuations can be explained by the country's own factors, while global factors explain less than 20% of the fluctuations in core CPI after excluding energy and food prices.

The overall synchronization of global inflation is reflected not only in the direct impact of global factors on national inflation fluctuations, but also in the interaction of regional and national factors. These studies highlight that in the context of globalisation, national or regional inflation can affect global inflation through complex economic and financial channels.

The discussion of imported inflation has its roots in the oil crisis of the 1970s, which led to a sharp rise in energy prices and "stagflation" in developed countries, which was neither demand- nor cost-push, but rather caused by supply-side inputs (Ivantsou, 2014). In the 21st century, with the development of economic globalization and trade liberalization, the characteristics of imported inflation have become more obvious (Bagliano and Morana, 2010). After China's accession to the WTO, its economy has been deeply integrated into the global economy, and it has been increasingly affected by international economic fluctuations, which has led to an increase in imported inflationary pressures during the upward cycle of international commodities. The theory of synergy between economic cycles and inflation under conditions of economic globalization has been identified as the theoretical basis for imported inflation, with studies suggesting that under the influence of international trade, international capital flows, macroeconomic policy coordination, exchange rate regimes and other factors, the main macroeconomic variables among major countries show strong positive correlations, with obvious synergistic features of economic fluctuations, and that the inflation of a number of countries also exhibits synergistic changes. characteristics, China is also affected by global inflationary factors and faces imported inflationary pressures in specific periods(Kim and Hammoudeh, 2013).

The study of the transmission mechanism of imported inflation has focused on the monetary perspective, revealing that increases in international commodity prices have a substantial impact on each country's inflation levels, with this effect being more pronounced in emerging economies (McCarthy, 2007). China has experienced significant impacts as well. From a monetary standpoint, developing countries operating under fixed exchange rate systems are generally less impacted by imported inflation. However, in recent years, as China's engagement with the global economy has deepened, the influence of international commodity prices on China's inflation through trade has become increasingly significant. Despite reforms in the exchange rate regime, these changes have not markedly diminished the strength of this transmission effect(Cecchetti and Moessner, 2008) .

In recent years, some scholars have also emphasized the transmission and macroeconomic impact of imported inflation as one of the sources of macroeconomic volatility. Yin Libo and Han Liyan(2014) analyze the two-way spillover effects of inflation between China and developed economies, as well as their characteristics and transmission mechanisms, and

conclude that there are significant spillover effects of other economies on China's inflation, and that there are significant spillover effects of other economies on China's inflation. There are obvious spillover effects on inflation in other economies, and the transmission through the trade channel is more prominent. It is found that the impact of international commodity price shocks on China's macroeconomic fluctuations cannot be ignored, and the impact of the financialization of the commodity market on China's macroeconomic fluctuations was significantly different before and after the financial crisis of 2008, with the U.S. quantitative easing policy being the main influencing factor(Zhang, Liu and Li, 2017). In a general equilibrium framework, imported inflation shocks can affect domestic output, consumption, net exports, and the price level, resulting in lower welfare losses when the level of trade openness is low, and the policy response in terms of monetary policy is usually ineffective, and fiscal spending should be increased moderately to hedge against the adverse effects of imported inflation(Fatai and Akinbobola, 2015). Zhang Tianding and Shi Zhan (2021) categorize international commodity prices and argue that "soft commodities" have a greater impact on China’s output, while "hard commodities" have a greater impact on China’s inflation.

3.4.4 Theoretical Model of the International Transmission of Inflation

It is assumed that under a fixed exchange rate system, the world economy as a whole and the generation and composition of inflation rates are contributed by individual countries and that each country is affected by the world economy. Then the theoretical model of inflation transmission will be analysed and explained mainly from the point of entry of the monetary theory previously described.

1) Monetarist Theoretical Model.

The central idea of monetarism is that inflation is essentially a monetary phenomenon, i.e. the rate of inflation is determined by the growth rate of the money supply (Milton Friedman).

Monetary analytics has three basic assumptions:

1. When an economy reaches equilibrium at full employment, the actual demand for money is consistently determined by factors like income and interest rates.
2. Over time, the demand for money remains steady, and variations in the money supply

have no impact on the real output.

3. The prices of goods traded internationally are set by global market forces, and over the long term, a nation's price and interest rate levels align closely with those of the international market.

Suppose the world consists of two countries, A and B. Then:

$P_a = eP_b$

$P_a$is the price level in country A, $P_b$is the price level in country B, P_w is the world price level.

If e=1, then: $P_a = P_b = P_w$

According to the assumptions of monetary theory we can get:

$$M = m(D + R) \qquad 3.4\text{-}1$$

where D is the base of the money supply provided domestically, i.e. domestic credit or domestic assets backing the money supply by the central bank.R is the base of the money supply from abroad, which is obtained through the balance of payments surplus and is represented by the international reserves. m is the money multiplier, which refers to the coefficient by which the banking system creates money by transferring mills deposits and loans, multiplying the base of the money supply. The monetary base is also known as strong money. If m is ignored, we get:

$$M_a = D_a + R_a \qquad 3.4\text{-}2$$

$$M_b = D_b + R_b \qquad 3.4\text{-}3$$

According to the money demand function we can get:

$$M_a = k_a P_a Y_a \qquad 3.4\text{-}4$$

$$M_b = k_b P_b Y_b \qquad 3.4\text{-}5$$

M_a is the amount of money in country A, M_b is the amount of money in country B. $k_a$and $k_b$are the ratio of cash holdings to nominal income for A and B. Y_a and Y_b are the real incomes of A and B. PY represents nominal income.

Carrying 3.4-1 over to 3.4-3 and *3.4-4* then summing them up gives the following:

$$M_w = M_a + M_b \tag{3.4-6}$$

$$M_w = (k_a Y_a + k_b Y_b) P_w \tag{3.4-7}$$

The equations 3.4-3, *3.4-4*, 3.4-5 and *3.4-6* determine the equilibrium of the quantity of money and prices in the two-country model (representing the world economy as a whole), and the equation can be transformed to obtain the equation of the world price level:

$$P_w = \frac{M_w}{k_a Y_a + k_b Y_b} \tag{3.4-8}$$

Taking the logarithm of 3.4-8 and taking the derivative and then adjusting it gives the formula for the world inflation rate (rate of price change):

$$\widehat{P_w} = \frac{M_w'}{M_w} - \frac{k'_a Y_a + k_a Y'_a + k'_b Y_b + k_b Y'_b}{k_a Y_a + k_b Y_b} \tag{3.4-9}$$

It can be obtained by bringing 3.4-7 and 3.4-8 to 3.4-9 :

$$\widehat{P_w} = \widehat{M_w} - \alpha \widehat{Y_a} - (1 - \alpha) \widehat{Y_b} \tag{3.4-10}$$

Where : $\alpha = \frac{M_a}{M_w}$

According to 3.4-10 the determinant of the inflation rate can be seen:

1. Inflation levels are affected by the discrepancy between the worldwide money supply and the global demand for actual currency. Global inflation speeds up when the growth in the money supply outstrips the needs of real economic expansion, particularly when the rate of money supply growth surpasses the growth rate of real GDP.
2. The worldwide price level is inherently linked to the global money supply, making it a variable that originates from within the system. Shifts in the global money supply are directly responsible for variations in the worldwide price level, which, in effect, manifest as inflation.
3. The supply of money in any given country is connected not just to its domestic

economic activities and real income but also to its specific demand for money.

4. The effect of a spike in global money supply on global prices is independent of the country initiating the increase in money supply. Essentially, changes in the money supply of any single country affect the overall global money volume. When a country's rate of money supply expansion exceeds the global real income growth rate, it triggers a general increase in prices worldwide.

The equation 3.4-10 can also be expressed as the following ordinary equation:

$$P = M - Y \qquad 3.4\text{-}11$$

Bringing the formula 3.4-11 to **Error! Reference source not found.** gives us

$$P = D + R - Y \qquad 3.4\text{-}12$$

It can also be seen from equation 3.4-12 that the impact of one country on the world inflation rate, or on another country, is related to that country's share of the world economy. That is, the contribution of money volume growth and real income growth to global inflation varies from country to country. The impact of a country's monetary policy on global inflation varies according to its position in the global economy. Dominant economies have a more pronounced impact on global inflation and may become exporters of inflation. Countries in a subordinate position, on the other hand, have a relatively smaller impact on the global inflation rate and are more likely to be importers of inflation.

Owing to the high degree of integration of the global economy, changes in the volume of money in any one country can affect the global economy through trade and financial channels, thereby influencing the world inflation rate.

3.5 Commodities

Commodities include energy commodities, basic raw materials and agricultural products that are used for production and consumption and can be circulated in large quantities across geographic regions but are not retailed. International commodity prices have always

been characterized by rapid and large changes, and between 2002 and 2007, they rose sharply, driven by the prices of energy commodities such as crude oil. In 2008, the global financial crisis led to a drastic reduction in demand for international commodities, resulting in a rapid decline in their prices, and in 2009, with the joint bailout by various countries, international commodity prices started a new round of increases. In 2014, the crude oil supply surplus, crude oil prices again led international commodity prices all the way down. It was not until 2016 that there was a trend of bottoming out and rebounding. International commodity prices are unpredictable, and their actual trends are often inconsistent with people's predictions. It is this kind of unanticipated price change that directly affects countries' import and export trade and balance of payments, and through a variety of transmission mechanisms, ultimately has an impact on countries' macroeconomies as a whole. Economic development cannot be separated from the material base, and international commodities have become an important factor affecting global economic development.

So, what factors influence the price volatility of commodities?

Research of Ayres, Hevia and Nicolini (2020) explored the connection between essential commodities and the real exchange rate, discovering a significant association between the prices of commodities like oil, aluminum, copper, corn, and the real exchange rate in developed economies, including Germany, Japan, and the United Kingdom.
Liu Lu, Zhang Xiang and Wang Haiquan (2018) empirically examined the impact mechanism of international commodity prices between 2005 and 2015 from the perspective of information friction. The results show that in the short term, the market environment is highly volatile, investor sentiment is unstable, and financial speculation has a greater impact on commodity prices; in the long term, the degree of information friction is low, and the influence of real demand on commodity prices plays a dominant role.

Tan Xiaofen, Liu Yang and Zhang Ming (2014) analyzed the quarterly data of international commodity prices from 1997 to 2012 by using vector autoregressive error correction models at both the demand and monetary levels, and investigated the driving factors of international commodity price fluctuations, including the China factor. The results show that aggregate demand is the main factor influencing international commodity prices, and

that China's influence on international commodity prices is weaker than that of developed countries.

In addition, many scholars have studied the price volatility of international oil prices, mainly in terms of OPEC and other factors. Bacon (1991)) attributed the increase in oil prices in the 1990s to the combination of geopolitical and demand factors. Kaufmann and Ullman (2009)) showed that OPEC oil production was a unidirectional Granger cause of the increase in oil prices through cointegration tests.

Kilian(2009) through an analysis of oil price fluctuations since the 1970s, identifies the reasons behind international oil price volatility as stemming from factors such as corporate alliances (like OPEC), significant political incidents in the Middle East, wars, oil embargoes, and the overarching global economic climate. Hamilton(2009) stated that a key factor behind the oil crisis was a supply shortfall, whereas the surge in international oil prices between 2007 and 2008 was driven by increased demand. Baumeister and Kilian (2012) explain the rise in international oil prices from mid-2003 to mid-2008 with a structural model of the oil market, concluding that the price increase during this period resulted from a repeat positive demand shock for industrial commodities, which in turn spurred the hike in oil prices.

3.4.5 Crude Oil

Crude oil, as a fundamental component of the global economy and a crucial energy source, plays a vital role in the worldwide economic infrastructure. It underpins both industrial production and transportation across all nations, marking its significance in the global energy landscape. Price volatility in crude oil directly impacts the costs associated with international trade, making the prices of both imports and exports susceptible to changes. Given its status as a primary input for numerous production processes, variations in crude oil prices can influence production costs, thereby affecting the pricing of final products. As per the cost-push inflation theory, escalations in crude oil prices lead to increased transportation and manufacturing costs, which are ultimately borne by consumers, contributing to inflation. The extensive and intricate supply chain of crude oil further

facilitates the transmission of its price changes to a wide array of commodities, such as agricultural and industrial products, and consumer goods, through shifts in supply and demand and the interplay of commodity substitution.

3.4.6 Inflation and international crude oil prices in China

As a major trading nation and a major importer of crude oil, when crude oil prices fluctuate, they can easily have an impact on domestic staple and consumer goods as well. Many existing studies have demonstrated the transmission of international crude oil prices on inflation in China.

Sun, Wang and Jia (2022) analyzed the impact of crude oil price shocks on China's price levels using a model that traces how such shocks affect different price indices within the country: 1. The Consumer Price Index (CPI) and the Means of Agricultural Productivity Price Index (MAPPI) are not directly impacted by crude oil price fluctuations, although they can experience indirect effects. 2. The extent and duration of crude oil price influences on various price indices differ, with the Export Price Index (EPI) experiencing the most significant impact. Additionally, Jiranyakul (2021)investigated the relationship between changes in crude oil prices and inflation within Asia-Pacific economies, highlighting a one-way causality from crude oil price alterations to short-term inflation.

Zhao *et al.*(2016) investigated the effects of oil price shocks on China's output and inflation, uncovering the dynamic repercussions of these shocks on the Chinese economy. Chen and Sun (2021) examined the asymmetric relationship between the prices of Chinese refined oil products and international crude oil, highlighting how Chinese wholesale price movements influence international oil prices, resulting in uneven price fluctuations.

Meanwhile, Song and Li (2015) explored the interplay between Chinese and international crude oil prices through the VEC-TARCH method, indicating that the volatility in both markets is primarily influenced by the transmission of earlier volatility forecasts.

Moreover, the dynamics between international crude oil futures prices and China's crude oil spot prices are characterized by a bidirectional lead-lag relationship, with the influence of futures prices on spot prices being particularly pronounced(Wu and Ge, 2018).

Practical Part

4.1 VAR model introduction

The vector autoregressive model (VAR model), an unstructured system of equations introduced by Sims in 1980 (Sims, 1993), consists of numerous interconnected equations without being grounded in any specific economic theory. Within this model, each equation regresses the endogenous variables against the lagged values of all the endogenous independent variables present in the system, thereby assessing the dynamics of all the endogenous variables. This model is widely employed for forecasting interrelated time-series data and for examining how systems of variables respond dynamically to random disturbances.

1) Why choose VAR model

The vector autoregressive (VAR) model stands as a prevalent tool in econometrics for analyzing and forecasting series of time-dependent variables that exhibit strong intercorrelations. Key features of vector autoregressive models include:

a. It can perform multivariate dynamic relationship analysis. The VAR model is capable of handling multiple time series variables simultaneously and analysing the dynamic relationships among them. Therefore, it is suitable for exploring the relationship between multiple economic indicators (Chinese inflation, international bulk product prices, global GDP growth rate).
b. Treatment of endogeneity issues. When selecting variables, many variables interact with each other, for example, Chinese inflation and global inflation. the VAR model can deal with this interdependence by treating all the variables as endogenous, and therefore it is suitable for the study of this paper.
c. Study of lagged effects. Because economic effects are often not instantaneous and have a certain lag. the VAR model belongs to the econometric models that measure time series of variables and can observe the dynamics of time series data by measuring the lagged terms of the variables.
d. The measurement estimation method is simple. Each equation in the vector autoregressive model is estimated using the most common OLS method and the data is relatively simple and straightforward.

e. Impulse response and method decomposition can be combined to obtain a more comprehensive and multifaceted interpretation.

Because of the above characteristics of the VAR model, this paper therefore chooses to use the VAR model to explore the relationship between China's inflation and international crude oil prices, global inflation, and global GDP growth.

2) Vector Autoregressive Model

The simple equation of vector autoregressive model can be expressed as:

$$Y_t = A_0 + A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + \cdots + \beta_{X_t} + \varepsilon_t \quad 4.1\text{-}1$$

where:

$Y_t$column vector represents m−dimensional endogenous variables.

$X_t$column vector represents m-dimensional exogenous variables

T is the number of samples, t=1,2….T

P is the lag order

ε_t represents the m-dimensional perturbation terms

A_1, $A_2 \ldots A_p$coefficients and matrix β each represent m*m and m*n dimensional coefficient matrices reflecting the dynamics between the variables.

After building the VAR model, a valid vector autoregressive model can be obtained using both the OLS method.

3) Granger causality test

In different economic environments, some variables have significant statistical relationships. Since the model cannot truly reflect the equilibrium relationship between the respondent variables and the explanatory variables, so if there is no causal relationship between the variables, then it will have a certain impact on the accuracy of the prediction results, therefore, to figure out the causal relationship between the selected variables, we will use Granger causality test. Granger causality test is used to determine whether a series of time series can predict the future values of another series of time series. If the past value of variable X significantly improves the accuracy of predicting the future value of variable Y, then X can be said to be Granger causally related to Y, i.e., X is a Granger cause of Y. For the sake of description, it is assumed that there exists a VAR model with binary quadratic variables:

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + A_3 X_{t-1} + A_4 X_{t-2} + \varepsilon_{1t} \quad 4.1\text{-}2$$

$$X_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 X_{t-1} + \beta_4 X_{t-2} + \varepsilon_{2t} \quad 4.1\text{-}3$$

For the Granger causality hypothesis of X_t and Y_t:

H0：If A_3=A_4=0， then $X_t$is not the granger reason of Y_t.

4) Impulse Response Function

In analyzing VAR models, the impulse response function serves as a tool to examine the dynamic responses to shocks within the model. This function allows for the estimation of how a one-standard-deviation shock from a random disturbance impacts the present and future values of the model's endogenous variables. This analysis presumes the existence of a two-variable VAR model:

$$Y_t = A_{1,y} Y_{t-1} + A_{2,y} Y_{t-2} + \beta_{1,y} X_{t-1} + \beta_{2,y} X_{t-2} + \varepsilon_{1t} \quad 4.1\text{-}4$$

$$X_t = A_{1,x} Y_{t-1} + A_{2,x} Y_{t-2} + \beta_{1,x} X_{t-1} + \beta_{2,x} X_{t-2} + \varepsilon_{2t} \quad 4.1\text{-}5$$

where：

$A_y, A_x, \beta_y, \beta_x$ are coefficient， ε_{1t} is error term.

We assume that the perturbation term is a white noise vector and that they are randomly independent. t takes values starting from 0, i.e., the perturbation is given in period 0.

Assume $Y_{-1} = Y_{-2} = X_{-1} = X_{-2} = 0$， $\varepsilon_{10} = 1, \varepsilon_{20} = 0$， This means that at period number 0, Y receives a positive perturbation (pulse), but X is not perturbed.

When t = 1, 2, it is assumed that $\varepsilon_{1t} = \varepsilon_{2t} = 0$， indicates that no new perturbations will affect these two variables after period 0.

Next we will discuss the response of Y_t and X_t:

When t=0， $Y_0 = 1$， $X_0 = 0$， bringing it into equation *4.1-4* and *4.1-5*, then：

When t=1， $Y_1 = A_{1,y}$， $X_0 = A_{1,x}$， brings the result into equation *4.1-4* and *4.1-5* again and then gives：

When t=2， $Y_2 = A_{1,y}^2 + A_{2,y} + \beta_{1,y} A_{1,x}$， $X_2 = A_{1,x} A_{1,y} + A_{2,x} + \beta_{1,x} A_{1,x}$,and so on we can get:

Y_0, Y_1, Y_2, Y_3……

This is called the response function of X due to the impulse of Y.

By the above method, we can also get the response function due to the pulse of X.

Subsequent subsections will incorporate impulse response functions to determine the impact that Chinese inflation may have on commodity prices (international crude oil), global inflation and global GDP growth rate.

4.2 Empirical Tests of Inflation in China

4.2.1 Data selection

This paper focuses on the relationship between Chinese inflation and international commodity prices (especially international crude oil prices). It also explores the relationship between Chinese inflation and global inflation and global GDP growth.

Next, we will build two vector autoregressive models:

1) Vector autoregressive model of Chinese inflation and international crude oil price.

2) Vector autoregressive model of Chinese inflation with world inflation and global GDP growth.

For the first vector autoregressive model of international crude oil prices, monthly data from 2009-2022 will be used to ensure sufficient sample data.

For the second vector autoregressive model for world inflation and global GDP growth, due to data constraints, the sample period chosen is annual data from 2001-2021. Below is a description of each variable that will appear in each:

Variables	Symbol	Index	Unite of measure	Time frequency	Time period
China's Inflation Rate	$I^{c,m}$	Consumer Price Index (CPI)	Annual rate of change	Monthly	2009.01-2021.12
European Union's Inflation Rate	$I^{E,m}$	Consumer Price Index (CPI)	Annual rate of change	Monthly	2009.01-2021.12
United States's Inflation Rate	$I^{U,m}$	Consumer Price Index (CPI)	Annual rate of change	Monthly	2009.01-2021.12
International Crude Oil Price	$P^{o,m}$	West Texas Intermediate (WTI)	Spot Price	Monthly	2009.01-2021.12
China's Inflation Rate	$I^{c,y}$	Consumer Price Index (CPI)	Annual rate of change	Annually	2001-2021
European Union's Inflation Rate	$I^{E,y}$	Consumer Price Index (CPI)	Annual rate of change	Annually	2001-2021
United States's Inflation Rate	$I^{U,y}$	Consumer Price Index (CPI)	Annual rate of change	Annually	2001-2021
Global Inflation Rate	$I^{w,y}$	Consumer Price Index (CPI)	Annual rate of change	Annually	2001-2021
Global GDP growth Rate	$G^{w,y}$	GDP growth rate	constant 2015 prices, expressed in U.S. dollars	Annually	2001-2021

Table 2 variable introduction

1. Inflation(CPI)

Inflation is defined as an increase in overall prices. There are various indicators to measure

inflation, and in this paper, the representative Consumer Price Index (CPI) is chosen as the indicator to measure inflation. There are two reasons for choosing the Consumer Price Index (CPI):

1. CPI is universal and representative. Based on changes in the price level of consumer goods and services, the CPI reflects the price changes faced by final consumers when purchasing goods and services, and therefore more directly reflects changes in the cost of living of residents. As the CPI is closer to the consumption reality of the general population, its movements are considered more representative of the level of inflation in a country, which in turn has an impact on global inflation.

2. Internationally common: The CPI is an internationally common measure of inflation, and most countries release CPI data on a regular basis. Using the CPI as a measure of China's inflation facilitates comparisons with data from other countries and further analyses the impact of China's inflation on the global economy (including inflation, crude oil prices and GDP growth). Based on these two points we chose the CPI as an indicator of inflation.

In this paper, two types of CPI data are chosen, one is monthly CPI data and the other is annual CPI data. Because the international crude oil price fluctuation is quite huge, choosing monthly data is good for more accurate calculation, so in the first VAR model, we will use monthly CPI data.

The source of data for the EU is Eurostat, and all other inflation data come from the IMF and WB.

2. International Crude Oil Price

The three major oil futures trading platforms in the global market today are the New York Mercantile Exchange (NYMEX) in the United States, the Intercontinental Exchange (ICE) in the United Kingdom, and the Dubai Exchange (DX) in the United Arab Emirates. They primarily deal with futures contracts for West Texas Intermediate (WTI), North Sea Brent, and Omani oil. Among these, NYMEX stands out as the leading exchange for energy financial derivatives, accounting for 60 percent of the trading volume. WTI oil futures represent the most significant and widely traded oil futures product worldwide, serving as a benchmark for global oil pricing. North Sea Brent oil, which is second in terms of

influence and pricing, sees its prices significantly impacted by those of WTI. Oman Oil futures, traded in Dubai and serving as a regional standard, have a more limited impact, with their price trends typically following those of WTI and Brent. Consequently, the WTI spot price is commonly used as the reference for the international oil spot price, based on historical data provided by the U.S. Energy Information Administration (EIA).

3. Global GDP growth Rate

Gross national product (GNP) is usually used to describe the size of the economy at a certain time. In this paper, GDP growth rate is chosen as a research variable to explore the relationship between inflation in China and the world economy. Because GDP growth rate is a dynamic indicator that can sensitively reflect the trend of the economy. It can effectively reveal the trend of economic growth or contraction, and can more accurately capture the immediate effect of inflation on the acceleration or slowdown of economic activity. Data on global GDP growth rates are obtained from the World Bank (WB).

4.2.2 Establish VAR mode

a. International crude Oil price VAR model

According to the VAR base expression *4.1-1*, VAR expressions can be obtained about China's inflation rate, international crude oil price, EU inflation rate, and US inflation rate:

$$P_t^{O,m} = A_0^{O,m} + \sum_{i=1}^{p} A_i^{O,m} I_{t-i}^{c,m} + \sum_{i=1}^{p} \beta_i^{O,m} P_{t-i}^{o,m} + \sum_{i=1}^{p} \gamma_i^{O,m} I_{t-i}^{E,m} + \sum_{i=1}^{p} \delta_i^{O,m} I_{t-i}^{U,m} + \varepsilon_t^{O} \quad 4.2\text{-}1$$

where：

$P_t^{O,m}$ is the monthly value of the international crude oil price at time t

$I_t^{c,m}$ is monthly data on China's inflation rate (CPI) at time t

$I_t^{E,m}$ is monthly data on EU's inflation rate (CPI) at time t

$I_t^{U,m}$ is monthly data on US's inflation rate (CPI) at time t

$A_i^{O,C,E,U}, \beta_i^{O,C,E,U}, \gamma_i^{O,C,E,U}, \delta_i^{O,C,E,U}$ are the coefficients of the model, indicating the strength of the relationship between the variables.

P is the lag order chosen for the model

$\varepsilon_t^{O,C,E,U}$ is error term.

b. Global inflation and global GDP growth

According to the VAR base expression *4.1-1*, the VAR model about China inflation rate, global inflation rate, US inflation rate and EU inflation rate can be obtained as follows:

$$I_t^{w,y} = A_{0,I}^{w,y} + \sum_{i=1}^{p} A_{i,I}^{w,y} I_{t-i,}^{w,y} + \sum_{i=1}^{p} \beta_{i,I}^{w,y} I_{t-i}^{C,y} + \sum_{i=1}^{p} \gamma_{i,I}^{w,y} I_{t-i}^{E,y} + \sum_{i=1}^{p} \delta_{i,I}^{w,y} I_{t-i}^{U,y} + \sum_{i=1}^{p} \alpha_{i,I}^{w,y} G_{t-i}^{w,y} + \varepsilon_t^{w,y} \quad 4.2\text{-}2$$

$$G_t^{w,y} = A_{0,G}^{w,y} + \sum_{i=1}^{p} A_{i,G}^{w,y} I_{t-i}^{w,y} + \sum_{i=1}^{p} \beta_{i,G}^{w,y} I_{t-i}^{w,y} + \sum_{i=1}^{p} \gamma_{i,G}^{w,y} I_{t-i}^{w,y} + \sum_{i=1}^{p} \delta_{i,G}^{w,y} I_{t-i}^{w,y} + \sum_{i=1}^{p} \alpha_{i,G}^{w,y} G_{t-i}^{w,y} + \mu_t^{w,y} \quad 4.2\text{-}3$$

where:

$I_t^{w,y}$ is the annual value of the international crude oil price at time t

$I_t^{c,y}$ is annual data on China's inflation rate (CPI) at time t

$I_t^{E,y}$ is annual data on EU's inflation rate (CPI) at time t

$I_t^{U,y}$ is annual data on US's inflation rate (CPI) at time t

Pis the lag order chosen for the model

$A_i^{W,C,E,U}, \beta_i^{W,C,E,U}$, $\gamma_i^{W,C,E,U}$, $\delta_i^{W,C,E,U}$ are the coefficients of the model, indicating the strength of the relationship between the variables.

$\varepsilon_t^{W,C,E,U}$ is error term.

4.2.3 Pre-processing of data

1) ADF unit root test

The ADF (Augmented Dickey-fuller Tested) unit root test looks at whether a set of time series is smooth or not. The smoothness of the time series is one of the prerequisites for using a VAR model. When performing the ADF unit root test, if a unit root exists, the series is not smooth. If there is no unit root, the series is smooth.

Therefore the hypothesis of ADF is:

H0: Presence of a unit root

H1: Absence of a unit root

If the test statistic for significance is below the threshold for any of the three confidence levels (10%, 5%, 1%), then there is a respective (90%, 95%, 99%) level of confidence in rejecting the null hypothesis.

Table 3 Monthly data ADF test

Variable	Test Statistic	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	p-value	Stationary?	Significance Level
CCPIM	-3.527	-4.015	-3.440	-3.140	0.03660	Ture	Significant 5%
EUCPIM	-1.175	-4.015	-3.440	-3.140	0.9155	False	Not significant
COP	-2.310	-4.015	-3.440	-3.140	0.4285	False	Not significant
USCPIM	-1.561	-4.015	-3.440	-3.140	0.8073	False	Not significant
D_USCPIM lag(3)	-5.336	-4.015	-3.440	-3.140	0.0000	True	1%
D_COP lag(3)	-6.906	-4.015	-3.440	-3.140	0.0000	True	1%
D_EUCPIM lag(3)	-3.503	-4.015	-3.440	-3.140	0.0391	True	Significant 5%

According to the table, it can be found that only the time series of CCPIM is smooth in the ADF test for the monthly initial data because the p-value (CCPIM)=0.03<0.05, which rejects the original hypothesis H0. The other time series cannot reject the original hypothesis, i.e., the other three variables (EUCPIM, USCPIM, COP) are not smooth. In order to make the data smooth, the three variables (EUCPIM, USCPIM, COP) were differentiated once. After the differentiation, ADF test was performed once again.

It was found that the statistical values of the differenced variables were all below the critical value at the 1% significance level and the p-values were all less than 0.05, indicating that the original hypothesis of the existence of a unit root was rejected, i.e., these differenced series were smooth. After satisfying that the data are smooth, the relationship between the variables will be observed later using the VAR model.

Table 4 Annual data ADF test

Variable	Test Statistic	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	p-value	Stationary?	Significance Level
$I^{c,y}$	-3.528	-3.750	-3.000	-2.630	0.0073	True	**5%**
$I^{E,y}$	-3.951	-3.750	-3.000	-2.630	0.0017	True	**1%**
$I^{U,y}$	-2.946	-3.750	-3.000	-2.630	0.0402	True	**10%**
$I^{w,y}$	-2.886	-3.750	-3.000	-2.630	0.0471	True	**10%**
$G^{w,y}$	-4.966	-3.750	-3.000	-2.630	0.0000	True	**1%**

According to Table 4, China's inflation rate (annual) has a 95 per cent probability of rejecting the H0-existence of a unit root. US inflation rate (annual) and world inflation rate have 90% probability to reject the original hypothesis.EU inflation rate (annual) data and world GDP growth rate (annual) data have 99% probability to reject the original hypothesis. After ADF test, these five time series are smooth.

2) Determine the optimal lag order P

The smoothed time series mentioned will be utilized to determine the optimal lag duration using Stata, starting with monthly data followed by annual data. During the data processing phase, the model's fit at various lag orders will be assessed according to different information criteria. These criteria include the Akaike Information Criterion (AIC), the Hannan-Quinn Information Criterion (HQIC), the Schwartz Bayesian Information Criterion (SBIC), and the Final Prediction Error (FPE).

Figure 4 optimal lag (month data)

Lag-order selection criteria

Sample: **2009m6** thru **2023m12** Number of obs = **175**

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-993.844				1.05383	11.4039	11.4333	11.4763
1	-741.446	504.8	16	0.000	.070707	8.70224	8.84895*	9.06393*
2	-727.534	27.824	16	0.033	.072437	8.7261	8.99018	9.37714
3	-708.761	37.546	16	0.002	.070229	8.69441	9.07586	9.6348
4	-685.792	45.938*	16	0.000	.06494*	8.61476*	9.11358	9.84451

* optimal lag

Figure 4 shows the result of selecting the optimal lag term for monthly data. From the above table we can see that the optimal lag order can be chosen as 2 or 4. It shows that based on the LR, FPE and AIC, the optimal lag could be considered as 4 for the lowest value. Combined judgement we will choose 4 as the optimal lag order.

Figure 5 optimal lag (annual data)

Lag-order selection criteria

Sample: **2005** thru **2021** Number of obs = **17**

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-123.556				2.54857	15.1242	15.1486	15.3693
1	-93.735	59.642	25	0.000	1.69259	14.5571	14.7032	16.0274
2	-44.1947	99.081*	25	0.000	.275882	11.67	11.9379	14.3657
3	.	.	25		.-7.0e-62*	.	.	.
4	2655.86	.	25	.	.	-302.454*	-302.04*	-298.288*

* optimal lag

Table 5 shows the selection of the optimal lag term for the annual data, for these five variables, the optimal lag order is 4 because at lag order 4, AIC, HQIC and SBIC reach their minimum values (-302.454, -302.040 and -298.288, respectively) . Therefore the optimal lag order for the VAR model of international inflation and global GDP growth rate will be chosen as 4.

4.2.4 The tests of model

1) stationary test

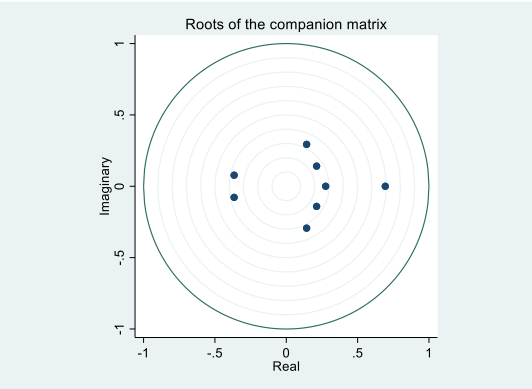


Figure 6 roots of the companion matrix (month data)

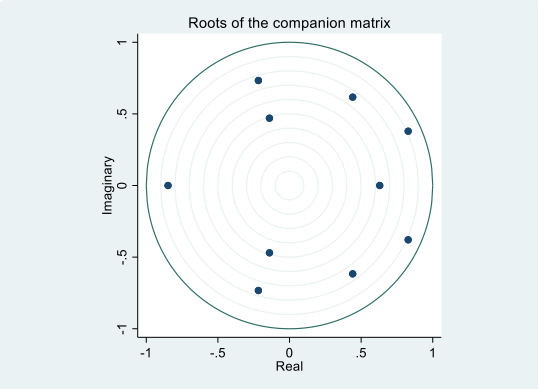


Figure 7 roots of the companion matrix (annual data)

After building the model, it needs to be tested for robustness. If the test results show that the modes of all eigenroots are less than 1, i.e., all eigenroots lie in the unit circle on the complex plane. Then the predictions of the model will not diverge. Therefore, the established VAR model meets the system stability conditions and can be further analysed. As shown in the figure above, both VAR models satisfy the condition of system stability.

2）Granger test

According to the ADF test mentioned above, the first-order differences of the three variables EUCPIM, USCPM, and COP are stable time series. Therefore we will use the first-order differences of these three variables to build a VAR model and keep the rest of the variables constant. Then Granger causality test is used to investigate the causal relationship between the main research objects: Chinese inflation (monthly data) and international oil price, Chinese inflation (annual data) and international inflation, Chinese inflation (annual data) and global GDP growth.

The following are the results of the tests:

1）D_COP 和 CCPIM

Figure 8 Granger test(D_COP AND CCPIM)

```
Granger causality test                          Sample: 2009m6 to 2010m9
                                                       obs = 16

H0: CCPIY does not Granger-cause d_COP

              F( 4, 7) =    0.57
              Prob > F =   0.6953

               chi2(4) =    5.18      (asymptotic)
         Prob > chi2 =  0.2691      (asymptotic)
```

Table 6 shows the results of the Granger test for d_COP and CCPIM with the hypothesis H0: CCPIY is not the Granger cause of d_COP. The above chart uses two methods for Granger test, one is F-statistic method and one is chi-square method. Based on the F-statistic it can be found that the p-value is 0.6953. this p-value is much greater than the general significant statistical value of 0.1, accepting the original hypothesis H0. From the chi-square method, the p-value = 0.2691, which is greater than the general significant statistical value of 0.1, accepting the original hypothesis H0. Therefore combining these two results, CCPIY is not a Granger cause of d_COP.WIY and CCPIY.

Figure 9 Granger test(WIY and CCPIY)

```
. gcause WIY CCPIY, lags(4)
Granger causality test                          Sample: 2005 to 2021
                                                       obs = 17

H0: CCPIY does not Granger-cause WIY

              F( 4, 8) =    1.55
              Prob > F =   0.2773

               chi2(4) =   13.15      (asymptotic)
         Prob > chi2 =  0.0105      (asymptotic)

.
```

Based on the above graph we can find that the F-statistic value is 1.55, with 4 indicating the number of lags and 8 the degrees of freedom. The corresponding p-value for the F-statistic is 0.2773, indicating it exceeds the conventional significance threshold of 0.05. Thus, the F-statistic analysis suggests insufficient evidence to reject the null hypothesis,

meaning there's no substantial proof that CCPIY Granger-causes WIY.

Conversely, using the chi-square method yields a chi-square statistic of 13.15 with 4 degrees of freedom. The chi-square statistic's p-value stands at 0.0105, which is below the standard significance level of 0.05. Hence, the chi-square test results provide adequate evidence to refute the null hypothesis, suggesting that CCPIY does indeed Granger-cause WIY.

In summary, the results of the F-statistic and the chi-square statistic diverge.The F-statistic approach is commonly used to compare the variance contribution of models, and it is applicable to continuous variables and when specific distributional assumptions are met. The chi-square method, on the other hand, is more commonly used for categorical data and scenarios that do not require normal distribution assumptions. Considering that the data in this paper does not assume a normal distribution scenario, we chose to use the chi-square statistic approach as the final result. Therefore, based on the chi-square statistic, we can say that at least to a certain extent, China's inflation rate has the ability to predict changes in the world's inflation rate.

2) CCPIY and WGDPGR

Table 5 Granger test(CCPIY and WGDPGR)

```
Granger causality test                                Sample: 2005 to 2021
                                                             obs = 17

H0: CCPIY does not Granger-cause WGGDPR

              F( 4,  8) =    0.75
              Prob > F =    0.5876

               chi2(4) =    6.33       (asymptotic)
             Prob > chi2 =  0.1756       (asymptotic)
```

The graph indicates that the F-statistic value is 1.55 with a p-value of 0.5876, which is above the typical significance threshold of 0.1. Therefore, according to the F-statistic, there isn't sufficient evidence to discard the null hypothesis, implying we lack substantial proof to assert that CCPIY Granger-causes WGDPGR.

Regarding the chi-square test, it presents a statistic value of 6.33 with a p-value of 0.1756. Given that this p-value is very close to the significance level of 0.1, the chi-square test

results suggest that, to some degree, CCPIY could be considered a Granger cause of WGDPGR.

In this paper, considering the chi-square statistic, we believe that there is a Granger causality between China's inflation and global GDP growth rate to a certain extent.

3) Estimation of VAR Model

A. International Oil Price VAR Model Estimated Coefficients

Table 6 VAR Model Estimated Coefficients (month data)

d_COP	Coefficient	Std. err.	z	P>|z|	[95% interval]	conf.
d_COP L4.	-0.0552681	0.0836563	-0.66	0.509	-0.21923	0.108695
CCPIM L4.	-0.2331265	0.2906331	-0.8	0.422	-0.80276	0.336504
d_USCPIM L4.	1.511345	1.371366	1.1	0.27	-1.17648	4.199174
d_EUCPIM L4.	-2.599133	1.557853	-1.67	0.095	-5.65247	0.454203
_cons	0.6132786	0.7597314	0.81	0.42	-0.87577	2.102325

Based on the table above, the VAR model for international crude oil prices can be written as:

$$P_t^{O,m} = 0.6132786 - 0.2331265\, I_{t-i}^{c,m} - 0.0552681 P_{t-i}^{o,m} - 2.599133 I_{t-i}^{E,m} + 1.511345 I_{t-i}^{U,m} + 0.7597314 \qquad 4.2\text{-}4$$

where:

$P_t^{O,m}$ represents the lagged value of the international oil price.

$I_{t-1}^{c,m}$ represents the lagged value of China's inflation rate.

$I_{t-1}^{E,m}$ represents the lagged value of the EU inflation rate.

$I_{t-1}^{U,m}$ represents the lagged value of the EU inflation rate.

The coefficients (Coefficients) represent the effect of the independent variables (lagged inflation rate and crude oil price) on the dependent variable (crude oil price in the current period). (Std. err.) then provides information on the accuracy of the coefficient estimates. The presence of large standard errors usually means that the coefficient estimates are less precise.

Based on the above results, we can find that for every unit increase in China's inflation rate in the last period, the current period's international crude oil price is expected to decrease by 0.2331265 units. But this effect is not statistically significant (P=0.422>0.1).

For the EU's inflation rate, according to the table, for every unit increase in the EU's inflation rate in the previous period, the current period's international crude oil price is expected to decrease by 2.599133 units. This coefficient is close to the level of significance (P=0.095<0.1), implying that the impact caused by the EU's inflation rate is statistically significant at the 10% significance level.

In summary, China's inflation rate adversely affects international crude oil prices. Additionally, the inflation rate within the EU also negatively influences international crude oil prices, with a more pronounced effect.

B. World inflation Rate VAR Model Estimated Coefficients

Table 7 WI VAR Model Estimated Coefficients

WIY	Coefficient	Std. err.	z	P>|z|	[95% interval]	conf.
WIY L4.	0.0040159	0.596447	0.01	0.995	-1.165	1.173031
WGDPGRL4.	0.477047	0.518915	0.92	0.358	-0.54001	1.494101
CCPIY L4.	-0.1412089	0.37233	-0.38	0.704	-0.87096	0.588545
EUCPIY L4.	0.880803	0.716785	1.23	0.219	-0.52407	2.285677
USCPIY L4.	-0.3830878	0.911749	-0.42	0.674	-2.17008	1.403907
_cons	1.316812	1.609765	0.82	0.413	-1.83827	4.471893

Based on the table above, the VAR model of world inflation can be written as:

$$I_t^{w,y} = 1.316812 + \ 0.0040159I_{t-i,}^{w,y} - 0.1412089I_{t-i}^{C,y} + 0.880803I_{t-i}^{E,y} - 0.3830878I_{t-i}^{U,y} + 0.477047G_{t-i}^{w,y} + 1.609765 \quad 4.2\text{-}5$$

Based on the equation 4.2-5, the coefficient of the lagged value of $I_{t-i}^{E,y}$,which is the EU inflation rate, is the highest at 0.88083, i.e., it indicates that the EU inflation rate in the past period has the largest positive impact on the world inflation rate in the current period.

The coefficient of the lagged value of China's inflation rate on world inflation is -0.1412089. i.e., an increase in Chinese inflation rate in the past period may lead to a decrease in the world inflation rate in the current period if all else remains constant. The likely reason for this phenomenon is that, as the global second largest economy, if rising inflation in China leads to a slowdown in its economic growth, this could slow down global economic activity and reduce global demand, which would have the effect of lowering global inflation.

C. World GDP Growth Rate VAR Model Estimated Coefficients

Table 8 WGDPGR VAR Model Estimated Coefficient

WGGDPR	Coefficient	Std. err.	z	P>|z|	[95%conf.	interval]
WIY L4.	0.0833394	0.718071	0.12	0.908	-1.32405	1.490732
WGGDPRL4.	0.46636	0.624729	0.75	0.455	-0.75809	1.690805
CCPIY L4.	-0.1745031	0.448253	-0.39	0.697	-1.05306	0.704057
EUCPIY L4.	1.59744	0.862948	1.85	0.064	-0.09391	3.288786
USCPIY L4.	-1.36233	1.097667	-1.24	0.215	-3.51372	0.789057
_cons	1.261593	1.938017	0.65	0.515	-2.53685	5.060037

Based on the table above, we can find that the VAR model of global GDP growth rate can be written as：

$$G_t^{w,y} = 1.261593 + 0.0833394I_{t-i,}^{w,y} - 0.1745031I_{t-i}^{C,y} + 1.59744I_{t-i}^{E,y} - 1.36233I_{t-i}^{U,y} + 0.46636G_{t-i}^{w,y} + 1.938017 \quad 4.2\text{-}6$$

We can find that the coefficient of the EU inflation rate has the largest impact on global GDP growth, with a coefficient of 1.59744. This means that if the EU inflation rate rises by one unit, global GDP growth is expected to rise by 1.59744 units.

The coefficient of China's inflation rate on global GDP growth is -0.1745031. This means

that, all else being equal, if China's inflation rate had risen by one unit in the past period, global GDP growth would have been expected to fall by about 0.1745031 units. This suggests that Chinese inflation has a negative impact on global GDP growth.

4) Impulse Response Analysis

Impulse response analysis is used within a vector autoregressive (VAR) framework to look at the path of the response of one economic variable to a shock (i.e., an "impulse") to another variable over time. It does not directly test for causality, but rather describes how the variable adjusts back to equilibrium over time given a system shock.

A. Impulse response analysis for CCPIM and COP

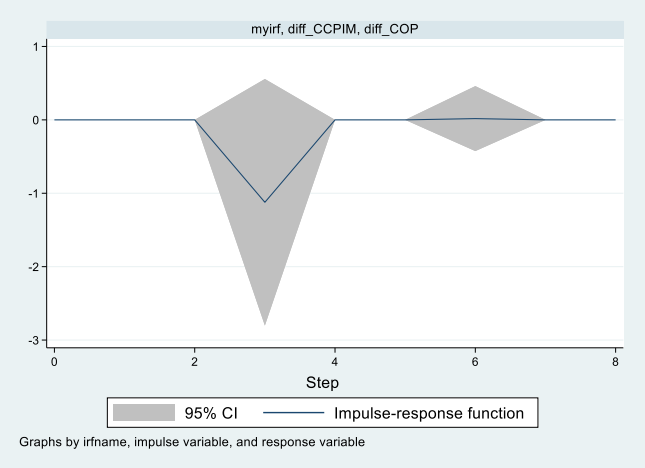


Figure 10 impulse-response function(CCPIM and COP)

As shown in Figure, in the impulse response plot, we observe the shock response of the primary difference data of Chinese inflation (diff_CCPI) to the primary difference data of international crude oil price (diff_COP). The initial response is a significant negative impact, suggesting that a sudden increase in Chinese inflation could lead to a short-term decline in international crude oil prices. This effect is strongest in the first and second steps, with a shock value close to -3, and then the strength of the response rapidly diminishes, converging to zero near the fourth step, which may indicate that the effect of the inflation shock is short-lived. However, because the 95% confidence intervals are initially wide, this suggests that there is a large degree of uncertainty in the shock response.

Based on this impulse plot, we can simply judge that changes in China's inflation may affect international crude oil prices through some channels, but the effect is short-term and

very weak.

B. Impulse analysis of CCPIY and WI, CCPIY and GGDPGR

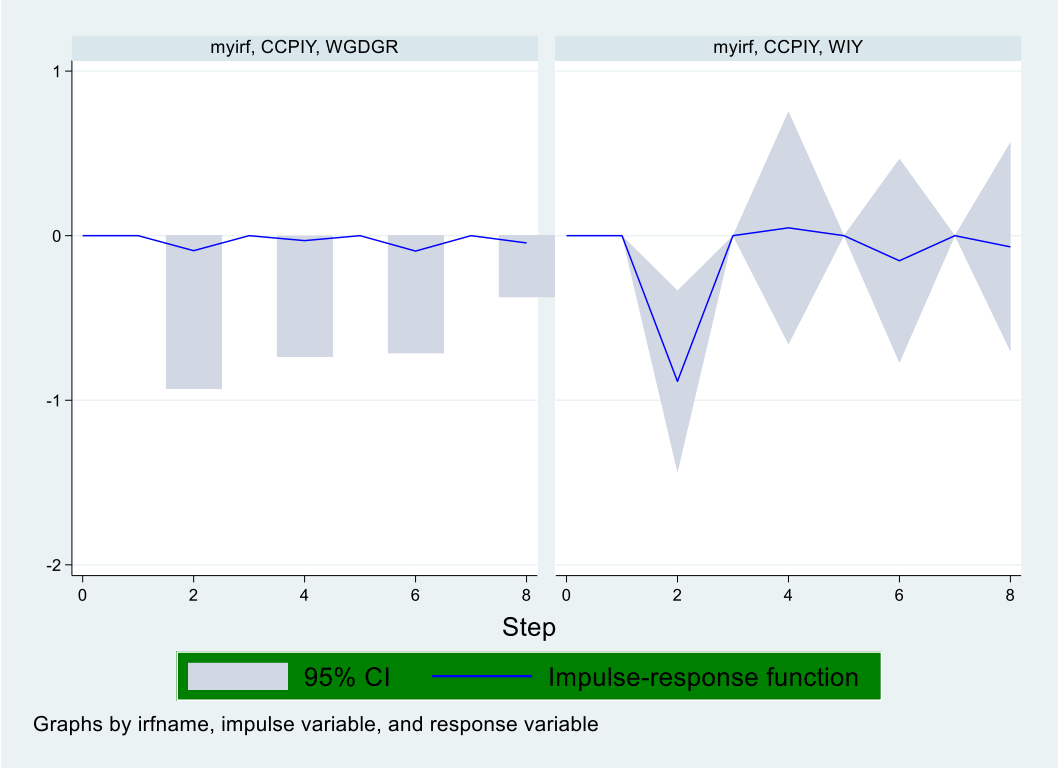


Figure 11 impulse-response function(CCPIY and WGDGR, WI)

The figure presented illustrates the response to shocks on two axes: the horizontal axis charts the progression of time in units, while the vertical axis quantifies the extent of change triggered by the shock. The left-hand graph displays the reaction of China's inflation rate (CCPIY) to a perturbation in global GDP growth (WGDGR), indicating an initial negative response that gradually levels off over time. This suggests that a surge in China's inflation could adversely affect global GDP growth in the short term, although this influence does not persist. Conversely, the right-hand graph examines how China's inflation rate (CCPIY) responds to fluctuations in the global inflation rate (WI), showcasing a different dynamic.

This chart shows that a rise in Chinese inflation initially has a marked negative effect on global inflation. However, this influence becomes more erratic and less predictable in the following periods.

Taking these two graphs together, changes in China's inflation rate may have some

negative impact on the global economy in the short term, but this impact is not long-lasting and the impact on global GDP growth and world inflation rate weakens and may become less pronounced over time. In addition this conclusion is subject to uncertainty, and the light grey area in the figure above shows the uncertainty in the estimation of the shocks, which is more probable than not from the figure.

4.2.5 Chapter summary

This chapter examined the evolving relationship among China's inflation, international commodity prices (with a particular focus on international crude oil prices), the global inflation rate, and the global GDP growth rate through the application of a vector autoregressive model (VAR model).

After building the VAR model in this chapter, the smoothness of the selected variables is confirmed by ADF unit root test, while the optimal lag order is 4, and then the next step of testing is carried out.

The results of Granger causality test show that for Chinese inflation rate and international crude oil price, Granger causality is not significant. However, for China's inflation rate and global inflation rate, the results indicate that China's inflation rate is able to predict the change of global inflation rate to some extent.

The coefficients derived from the VAR model for international crude oil prices indicate that China's inflation rate negatively impacts international crude oil prices, although this impact is not statistically significant (P=0.422). Conversely, the inflation rate in the EU demonstrates a more substantial negative effect on international crude oil prices, with a significance level of P=0.095.

In the global inflation rate VAR model, the negative impact of China's inflation rate is not significant (P=0.704), while the EU inflation rate has a positive impact, but not particularly significant (P=0.219).

The global GDP growth rate VAR model shows that the negative impact of China's inflation rate is insignificant (P=0.697), while the EU inflation rate has the largest positive

impact on the global GDP growth rate (P=0.064), which is close to the significance level.

Impulse response analysis shows that the impact of China's inflation rate on international crude oil prices is negative, but the effect is short-lived and uncertain. The shocks to global GDP growth and world inflation were also initially negative, but the effects weakened over time, suggesting that there may be a negative effect in the short term, but it is not persistent.

Results and Discussion

Previous studies have shown that China, as the second largest economy around the world, plays a pivotal role in international trade, especially in the demand and supply of energy commodities, such as crude oil market(Blanchard, 2003; Ciurlău, 2013; Bi and Xin, 2021). Furthermore, according to Friedman's (1996) quantity theory of money, in the long run, changes in the money supply are eventually reflected in the inflation rate. This implies that inflation in China, one of the global largest producers and consumers of goods and services, has a potential impact on international crude oil prices and global GDP growth.

According to the results of two VAR models in this article, the direct impact of China's inflation on the international crude oil price is insignificant ($p>0.1$), while the negative impact on the EU inflation rate is more significant ($p<0.1$), probably because of the important role of regional economic conditions on price volatility in resource-intensive commodity markets. In addition this could again be due to the fact that there are other variables at play in the market, such as OPEC's production decisions, geopolitical factors, etc. (Kaufmann and Ullman, 2009; Kilian, 2009). From another perspective, inflation in China may indirectly affect international crude oil prices through a cost-push effect, i.e., as production costs rise in China, it may trigger higher costs in the global supply chain.

For global inflation, according to Ciccarelli and Mojon (2010), globalisation has made inflation in different countries more susceptible to global economic conditions. Inflation in China may affect global inflation through commodity trading channels and the synchronisation of economic cycles. The empirical results support this view, especially in the VAR model for world inflation, where the lagged variable of China's inflation rate has a negative, albeit statistically insignificant, effect on global inflation.

For global GDP growth, the direct impact of China's inflation rate on the global economy appears to be more limited. This may reflect the fact that global economic growth is subject to a combination of more factors, such as trade policies, financial market conditions and the macroeconomic strategies of other major economies. The impact of China's economic activity and inflation on global GDP may be indirect, for example through its impact on international commodity markets or through the role of global supply

chains.

Although not statistically significant, in the context of economic globalisation, the indirect impact of Chinese inflation on international crude oil markets and the global economy may work through complex economic and financial channels. For example, changes in China's demand for energy and raw materials as the world's factory may indirectly affect global markets through commodity prices and trade balances (Bacon, 1991; Kaufmann and Ullman, 2009; Kilian, 2009; Hamilton, 2009). Particularly in the context of volatile resource prices, China, as a major consumer and producer, may have an impact on the international price of crude oil, although this impact may not be directly reflected in the statistics.

Conclusion

The conclusions we can draw from the above research are:

a. China's inflation has a negative but not significant impact on international crude oil prices, and it is worth mentioning that the EU inflation rate has a more significant negative impact on international crude oil prices.
b. China's inflation has a negative but insignificant effect on global inflation.
c. China's inflation has a negative but insignificant effect on global GDP growth rate. However, the positive effect of EU inflation on global GDP growth rate is close to the level of significance.

Based on the above conclusion we can also answer the hypothesis proposed at the very beginning of this paper: When China's inflation increases, crude oil prices in the international market will also decrease, but not significantly. An increase in China's inflation will lead to a decrease in global inflation, but also not significantly.

In addition, there are some limitations to the analyses in this paper:

- The conclusions of the VAR model depend on the selected variables and sample period, and may ignore certain other important factors that affect inflation and GDP growth.

- international crude oil prices are affected by a number of complex factors and a single inflation rate may not be sufficient to fully explain their volatility.

- The time horizon of this study may not be able to fully capture the long-term trends and cyclical fluctuations in the impact of China's inflation on the global economy.

Future studies should extend the time period of analysis and make use of longer time-series data in order to more accurately assess and understand the long-term dynamics between these economic variables.

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List of Equations, Tables and Figures

8.1 List of tables

8.2 List of graphs

8.3 List of abbreviations

United Nations Conference on Trade and Development (UNCTD)

IMF-International Monetary Fund

NBSC-National Bureau of Statistics of China

GDP- Gross Domestic Production

PPI- Producer Price Index

New York Mercantile Exchange (NYMEX)

Dubai Exchange (DX)

WB-World Bank

OECD- Organization for Economic Cooperation and Development

CPI-Consumer Price Index

West Texas Intermediate (WTI)

Intercontinental Exchange (ICE)

Energy Information Administration (EIA).

8.4 list of equations

Appendix

Original Data set:

TIME	EUCPIM	USCPIM	CCPIM	CPM	TIME（Year	USCP	CCPIY
2009-01	1.60	0.00	1.00	41.71	2001	2.83	0.72
2009-02	1.60	0.20	-1.60	39.09	2002	1.59	-0.73
2009-03	1.10	-0.10	-1.20	47.94	2003	2.27	1.13
2009-04	1.10	0.00	-1.50	49.65	2004	2.68	3.82
2009-05	0.60	-0.20	-1.40	59.03	2005	3.39	1.78
2009-06	0.40	-0.10	-1.70	69.64	2006	3.23	1.65
2009-07	0.00	-0.30	-1.80	64.15	2007	2.85	4.82
2009-08	0.40	-0.20	-1.20	71.05	2008	3.84	5.93
2009-09	0.20	-0.20	-0.80	69.41	2009	-0.36	-0.73