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Analysis of International Coordination of Chinese and US Monetary Policies under the COVID-19 Pandemic

In Partial Fulfillment of the Requirements

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by

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Abstract

Against the backdrop of COVID-19, many countries have introduced extremely loose monetary policies to deal with the crisis. This paper will compare the monetary policy coordination between China and the United States, and explore the present and future of China's monetary policy coordination through the comparative analysis of China and the United States. This paper studies the current situation of international coordination of Sino-US monetary policy based on classical game theory.

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1.Introduction

As of June 2020, 87 per cent of international trade was settled in us dollars and 7 per cent in euros, according to SWIFT. Us monetary policy is closely linked to global markets. As the world's largest trading nation and exporter, China's currency policy directly affects global trade markets. It can be said that the economic policies of the world's two largest trade organizations largely determine the state of the world trade market. Unlike in the past, the COVID-19 pandemic has greatly affected the world's economic growth and the stability of financial markets, and countries led by the United States are adopting unprecedented loose monetary policies in the hope of responding to the crisis. In an increasingly interconnected world, monetary policy in one country often has broad implications for global markets. Therefore, monetary policy coordination was formally studied in the last century (Taylor, 2013). It means that monetary authorities of different economies take joint measures to intervene in domestic and foreign interest rates, exchange rates and other operational objectives through formal or informal coordination mechanisms, in order to achieve the optimal multi-policy objectives at home and abroad. Compared with going their own way, international monetary policy coordination can efficiently achieve policy goals while avoiding problems such as competitive currency devaluation and currency crisis in emerging markets. Hamada (1976) introduced the method of game theory to analyze such problems. Simply put, currency coordination helps to get rid of "prisoner

competition" between countries, promote the equilibrium point to move to cooperative equilibrium, and achieve a Pareto improvement.

From the classic game theory of international coordination of monetary policies, the coordination of monetary policies of various countries is insufficient in the face of the impact of the epidemic, and the meaning of non-cooperative equilibrium is obvious. The few monetary policy coordination also has problems such as insufficient execution power and obvious bias of major countries. In view of the current situation, there is still a lot of room for progress in international policy coordination to benefit the multilateral parties involved in cooperation.

In addition to playing the role of a coordination bridge between developed countries and emerging market countries on the existing platforms such as IMF and G20, China should participate in and promote the coordination process through technical cooperation among central banks and other measures. It should also establish a long-term monetary policy coordination mechanism under the framework of the belt and Road Initiative similar to the United States.

Explore the consequences of different monetary policies between China and the United States, and what efforts China and the United States have made to coordinate monetary policies internationally. This is an important part of this research to help understand the interaction between the central banks of China and the US, what keeps the two countries competitive in the context of COVID-19, and the say in international coordination of the monetary policies of these two powers.

2.Literature Review

This paper refers to many literatures about the US participating in the international coordination of monetary policies and the Financial markets in China and the US during the COVID-19 pandemic. However, English literatures about China's international coordination of monetary policies are very limited, so I will cite some data sources from China later.

2.1 International Coordination of Monetary Policies

2.1.1 The Necessity of Monetary Policy Coordination

The necessity of monetary policy coordination stems from the spillover effects of monetary policy. In 1960, the research on the open macro economy made the theoretical circle realize the spillover effect of monetary policy in a relatively comprehensive way (Fleming, 1962) Cooper (1969) proposed that, based on the spillover effect of monetary policy, the stronger the economic dependence, the more important the international coordination of monetary policy will be. Nowadays, the international coordination of monetary policy is paid more and more attention by people.

2.1.2 Monetary Policy Coordination and Game Theory

At present, the mainstream analysis framework is that Hamada introduced the game theory method into the international coordination analysis of monetary policy in 1976, and established the classic game theory analysis framework. And derived from the two models.

1. Simple game model (Cournot model), in which the two equal countries make decisions at the same time, because they clearly know that the other party will choose the self-interested strategy, the final result will be similar to the prisoner's dilemma (Nash, 1953), and the final game can only achieve Nash equilibrium. But the real economy is far more complex than that.

In reality, the world's monetary system is not an idealized collection of peer economies. It is a structure dominated by large economies, led by the United States, with other countries participating. Dominant economic policies have a first-mover advantage, and other countries can only respond according to the established policies of the United States. This leads to the second model

2. Starkberg model, in which developed countries as "leaders" first decide their own monetary policies, while other countries as "followers" decide monetary policies. Canzoneri (1985) proposed that stackberg equilibrium and fixed exchange rate were both ways to improve Nash equilibrium to achieve better overall welfare when cooperative equilibrium could not be achieved. This is also the fact that in 2004 and 2014, when the Federal Reserve raised interest rates, the world almost synchronised

into the interest rate hike cycle.

Neither of the two game models can reach the optimal solution. In the case of long-term game, both parties are more likely to reach cooperation to seek a higher overall welfare level.

2.1.3 History of Monetary Policy Coordination

Taylor(2013) pointed out that with the adoption of more transparent and open monetary policies by central banks of various countries, such as inflation targeting, monetary policies play a good role at home and there is no need to worry about spillover effects. In the late 1990s, central banks in many emerging market economies also adopted more disciplined policies to achieve long-term price stability. Each country chooses the monetary policy that is best for it during this period, and assumes that other countries do too. Over the past 20 years, that balance has been eroding, as the United States has experienced a financial crisis in Yaan and a great recession around the world. International monetary coordination and spillover effects have again emerged as major policy issues. The policies of developed countries have always had an adverse effect on the monetary policies of other countries.

2.2 Monetary Policies and Current Situation of Various Countries

The spillover effect of the United States to other countries has become more obvious

due to the financial crisis. In the global pandemic of COVID-19, the global recession has become more obvious and uncontrollable. In the early stages of the pandemic, Asian stock markets fell, which had spillover effects on European and American markets. After the intermediate stage of the epidemic, European and American stock markets in turn had spillover effects on Asian markets (Heetal, 2020). These evidences repeatedly show that the close connection between regions enables the capital market to quickly respond to changes anywhere in the world. All the major advanced economies have unleashed unprecedented monetary stimulus. In the US, for example, M2 increased after the outbreak by more than the us printed money in the previous five years combined. In April 2020, the Fed printed $3 trillion and will print another $2.8 trillion in 2021. As the leading country of the international monetary system, the United States implements radical monetary policy easing, which brings policy spillover impact to other major developed countries. , (Angel 2021) Alessandro's (2021) policy of quantitative easing for developed countries confirms this point of view. On average, during COVID-19, developed economies announced a larger devaluation of quantitative easing than emerging markets. Coupled with the multiple pressures of the epidemic and economic recession, other countries have also begun to implement loose monetary policies. The international monetary policy of developed and emerging economies is moving towards the Starkberg equilibrium. This may not be the worst-case scenario, as the COVID-19 pandemic is weakening the effectiveness of monetary policy transmission to financial markets. The risk posed by the high degree of uncertainty over policies introduced during COVID-19 makes

market participants less responsive to monetary policy than during the policy period. (Xiaoyun, 2021)

2.3 Status Quo of International Coordination of Monetary Policy

During COVID-19, the Federal Reserve took steps in March 2020 to provide US dollar liquidity through swap arrangements with other central banks and through repurchase mechanisms for financial institutions as a result of selling of local currencies in other countries during the pandemic due to increased global demand for us dollar safe assets. To alleviate the dollar liquidity shortage by establishing a temporary repurchase agreement arrangement (FIMA). Such technical monetary policy coordination benefits many parties. Joshua (2021) believes that such an agreement alleviates the DOLLAR liquidity gap of other countries and at the same time ensures the export benefits of the US to these partner economies. Thus currency swaps remain more of a technical collaboration, essentially initiated by the Federal Reserve in support of its domestic policy goals. Can be thought of as a partial solution in an unbalanced cooperative environment.

2.4 The Cross-cutting Effects of Chinese and American Monetary Policies

Because of the dollar's dominance in global markets, China is inevitably exposed to the spillover effects of America's ultra-loose monetary policy. However, according to

the dynamic relationship study from 1993 to 2018, the impact of US monetary policy on bilateral trade is asymmetrical. At the same time, American monetary policy is also affected by China's monetary policy. (Su Dinh,2020) The analysis of sino-US monetary policy model and monetary policy coordination in the period of COVID-19 belong to the contents of this paper. No further analysis will be made in this section.

3.Research Design

This paper will use Mei Pengjun's (2008) model to analyze the internationally coordinated monetary policy game between China and the United States, and verify the reliability of the model through empirical analysis of data in the later stage. Specifically, the possibility of Pareto optimality is found through game situations in different states. Actual data will be introduced later to study differences under COVID-19. The data cited are from the WIND database and public data statistics from central banks.

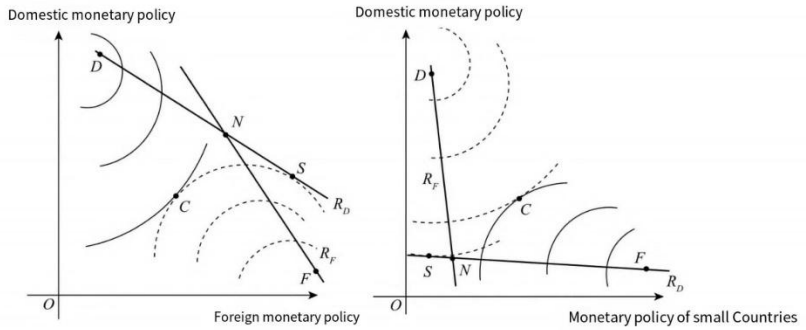


FIG. 1 Monetary policy game

The left chart shows the monetary policy game when the economy is contracting, and the right chart shows the monetary policy game when the economy is overheating. D and F are the domestic and foreign advantages respectively, Rd. And Rf are the domestic and foreign policy response lines respectively, N is the Nash equilibrium of the two countries' monetary policies, S is the Starkberg equilibrium of the two countries' monetary policies, and C is the cooperative equilibrium of the two countries' monetary policies.

3.1 The Assumptions of the Underlying Theoretical Model

1. This paper focuses on the interaction between the monetary policies of China and the US and the impact of COVID-19 on the monetary policy game between the two countries. Ignoring the influence of other countries' monetary policies on the monetary policies of China and the United States, we assume that there are only two countries in this system: China and the United States

2. Further derivation: since there are only two countries in the system, it is inevitable that the sum of changes in international reserves of the two countries is zero, that is,

the surplus of international reserves of one country is equal to the deficit of the other country

3. Assume that there are no trade barriers between the two countries, that goods flow freely and that purchasing power parity holds.

4. It is assumed that the monetary policy goal of the two countries is to maintain price stability and international balance of payments, and maintaining price stability is the primary goal. When two objectives conflict, balance of payments objectives may be adjusted to achieve the overarching objective.

3.2 Basic Model

The two countries are denoted by $k_i(i = 1,2)$, K1 is the United States, K2 is China

$D_i + R_i = M_i^d$ i=1,2 (1)

$P_1 = EP_2$ (2)

$\frac{M_i^d}{P_i} = L_i(Y_i, r_i)$, $\frac{\partial L_i}{Y_i} > 0$, $\frac{\partial L_i}{r_i} < 0$ i=1,2 (3)

(1) represents the equilibrium of domestic money market, that is, money supply = money demand. The money supply consists of two components: domestic credit expansion (D) and the money supply formed by international reserves (R), which are converted into local currencies at exchange rates. International reserves take the US dollar as the reserve currency, and M_i^drepresents the nominal total monetary demand.

(2) represents the existence of purchasing power parity between the two countries.

Pi represents the price level in Ki and E represents the exchange rate between RMB and US dollar

(3) is the expression of the real money demand function, which is represented by $\frac{M_i^d}{P_i}$ and is a function of national income Yi and interest rate RI. Positively correlated with national income and negatively correlated with interest rates

3.3 Variables Structure

The five monetary policy objectives of the two central banks are currency stability (or price stability), full employment, economic growth, balance of payments and financial stability. Here the author chooses price stability and international balance of payments as the main measurement objective. Because of their simple and direct connection with monetary policy, the response is also the most sensitive. In order to achieve the monetary policy goal, the central bank uses monetary policy tools to control the domestic credit expansion scale and thus affect the total money supply. Therefore, we construct three variables respectively to measure the realization of monetary policy objectives and the implementation of monetary policy tools

$\pi = \frac{\dot{P}_i}{P_i}$, i=1,2 (4)

$z_i = \frac{\dot{R}_i}{M_i^d}$ (5)

$x_i = \frac{\dot{D}_i}{M_i^d} - \eta_i \frac{\dot{Y}_i}{Y_i}$, i=1,2 (6)

π in (4) represents the inflation rate, which is an important indicator of price stability. Z in (5) represents the actual growth rate of international reserves, that is, the ratio of

the growth of international reserves and distribution to the money demand, which is used to measure the realization of the central bank's international balance of payments policy target.

X in (6) represents the growth rate of excess credit expansion in China, which is only the part where credit expansion rate $\frac{\dot{D}_i}{M_i^d}$ exceeds the product of national income growth rate $\frac{\dot{Y}_i}{Y_i}$ and income elasticity of money demand η_i.And $\eta_i = \frac{Y_i}{L^i}\frac{\partial L^i}{\partial Y_i}$ X is used to measure the use of monetary policy tools, that is, the specific actions of the central bank to expand or tighten money.

3.4 Relationship Analysis of Model Variables

Sum up K_i's credit expansion, international reserve and currency demand, and get the total credit expansion D, total international reserve R and total currency demand M^d.w_i is the share of K_i's currency demand in total currency demand M^d, which is called the money demand weight and can also represent the relative share of the two countries' economic aggregates:

$D = D_1 + ED_2$,$R = R_1 + ER_2$, $M^d = M_1^d + EM_2^d$

$w_1 = \frac{M_1^d}{M^d}$,$w_2 = \frac{M_2^d}{M^d}$

$w_i > 0, \sum_{i=1}^{2} w_i = 1$, i=1, 2

The actual total growth rate of international reserves is defined as $G_R = \sum_{i=1}^{2} w_i z_i = \frac{\dot{R}}{M^d}$,i=1, 2. According to hypothesis 2, the sum of changes in international reserves

between the two countries is 0, that is, $\dot{R}$=0, which can be obtained

$$G_R = w1z1 + w2z2 = 0 \quad (7)$$

Further derivation can be obtained

$$\pi_1 = \sum_{i=1}^{2} w_i x_{i+} w_2 \varepsilon \, , i = 1,2 \quad (8)$$

$$\pi_2 = \sum_{i=1}^{2} w_i x_{i+} w_1 \varepsilon \, , i = 1,2 \quad (9)$$

$$z_1 = \sum_{i=1}^{2} w_i x_i + w_2 \varepsilon - x_{1,} \; i = 1,2 \quad (10)$$

$$z_2 = \sum_{i=1}^{2} w_i x_i + w_1 \varepsilon - x_{2,} \; i = 1,2 \quad (11)$$

(8) (9) indicates that the inflation level of China and the United States depends on the weighted average of the growth rate of excess credit expansion in China and the United States and the exchange rate changes between the two countries. (10) (11) indicates that the actual growth rate of international reserve in China and the United States depends not only on the excess credit expansion at home, but also on the excess credit expansion at home of another country. It can be seen from the above analysis that the monetary policies of China and the United States have spillover effects. Inflation levels and changes in international reserves of the two countries are not only affected by their own monetary policies, but also by the cross-influence of another country's monetary policies.

This paper assigns the same form of monetary policy utility function to China and the United States (12).

$$U^i(\pi_i, z_i) =- [(\pi_i - a_i)^2 + c_i(z_i - b_i)^2], i = 1,2 \quad (12)$$

(a_i, b_i) represents the combination of monetary policy targets of the two countries, where a is the inflation target, b is the international reserve growth rate target.

The US has been playing a leading role in the international financial system. The US dollar is the most important international reserve currency, and the US pays far less attention to international reserves than China. So it can be assumed that $c_1<c_2$,c is constant.

In the economic operation, the greater the deviation between the actual inflation rate and the inflation target, the greater the economic damage. Similarly, the greater the deviation between actual international reserve and monetary policy, the greater the loss of monetary policy effectiveness. Actually expressed as

$$\frac{\vartheta U^i}{\vartheta \pi_i}(\frac{<}{>})0 \text{ , when } \pi_i \left(\frac{<}{>}\right) a_i, i = 1,2 \quad (13)$$

$$\frac{\vartheta U^i}{\vartheta z_i}(\frac{<}{>})0 \text{ ,when } z_i \left(\frac{<}{>}\right) b_i, i = 1,2 \quad (14)$$

Therefore, $U^i(\pi_i, z_i)$ is a strictly concave function on π and z, and (a,b) is the combination of policy objectives at the first-order condition that optimizes the utility function. · Central banks of China and the United States try to achieve monetary policy objectives and maximize the effectiveness of monetary policy by using monetary policy tools.

3.5 Game Analysis on Different Situations of Chinese and American Monetary Policies

3.5.1 Monetary Policy Non-cooperative Game -- Cournot Equilibrium

If the monetary authorities of China and the United States have complete information about the strategies and return functions of each other's monetary policies, and both countries simultaneously play a non-cooperative game. The game will eventually form cournot equilibrium, and the equilibrium point is the intersection of the monetary policy response function of the two countries. In the case of monetary policy instrument X_j ($j \neq i$) on the other side of the game, the country adopts the optimal monetary policy.

As for maximizing x_i $U^i(\pi_i, z_i)$, it can be deduced that:

$$\pi_1 = \alpha\varepsilon + \beta\gamma, \pi_2 = \pi_1 - \varepsilon, 0 < \alpha < 1, \beta > 0 \quad (15)$$

When the exchange rates between China and the United States are fixed, the two countries' inflation rates are equal, and the inflation rate is determined by the total growth rate of excess international reserves between the two countries.

When $\varepsilon=0, \pi_1=\pi_2$, $\pi_1=\beta y$

$$\gamma > 0, G_R > w_1 b_1 + w_2 b_2 \Leftrightarrow \pi_1 = \pi_2 > 0$$

$$\gamma < 0, G_R < w_1 b_1 + w_2 b_2 \Leftrightarrow \pi_1 = \pi_2 < 0$$

$$\gamma = 0, G_R = w_1 b_1 + w_2 b_2 \Leftrightarrow \pi_1 = \pi_2 = 0$$

There is a big gap between China and the United States in financial and economic strength. The two countries also have different strategies and policy objectives on the balance of payments. In normal times, the US prefers to export dollars, $b_1<0$ so as to obtain seigniorage and strengthen the dependence of other countries on its economy by exporting DOLLARS; China, on the other hand, tends to maintain a certain amount of US dollar reserves and adapt the growth of international reserves to economic growth, that is, B2> 0. When two countries have the same inflation target, different reserve growth target will lead to different game results.

If the exchange rate between China and the United States could float, when y> 0the output of US dollars exceeds China's target demand, and excessive US dollars will lead to RMB appreciation, ε> 0, the policy game leads to the increase of π_1 inflation rate in the United States, while the increase of π_2 inflation rate in China is partially reduced by currency appreciation. When y< 0, it's the opposite. Only when y=0, the output of US dollar just meets China's target demand, the two countries have stable prices and exchange rates, and realize internal and external equilibrium.

3.5.2 The Non-cooperative Game of Monetary Policy -- The Starkberg equilibrium

The United States is in a leading position in the international financial system. In The Stackberg game, the United States is in a leading position and has a first-mover advantage. China is in the position of follower under this condition. In the Stackberg dynamic game, the optimal choice of US monetary policy is at the tangent of the utility function $U^1(\pi_1, z_1)$, and the response function R_2 of China's monetary policy.

Through deduction, it can be concluded that:

$$\pi_1 = \alpha^{'}\varepsilon + \beta^{'}\gamma, \pi_2 = \pi_1 - \varepsilon, 0 < \alpha^{'} < 1, \beta^{'} > 0 \quad (16)$$

It can be seen from Equation (16) that the results of Starkberg's game and Cournot's game in both countries are basically the same, and the inflation level caused by the game only depends on the combination of the international reserve growth rate target b_1, b_2 and exchange rate ε of the two countries. Therefore, when the monetary policies of the two countries carry out The Starkberg game, the game results are consistent with the analysis of cournot equilibrium: the difference between the international balance of payments goals of the two countries leads to the imbalance of international reserves between the two countries ($y \neq 0$), and the imbalance of international reserves will lead to the deviation of the price level from the policy goals of the two countries; Only when the monetary policy objectives of the two countries are complementary, namely the international reserve balance ($y=0$), can both countries simultaneously achieve the objective of maintaining price stability.

3.5.3 Monetary Policy Cooperation Game-- Pareto Optimality

Under the fixed exchange rate system, the monetary policy coordination of the two countries keeps the price level of the two countries stable. Under floating exchange rate system, monetary policy coordination eliminates the influence of excess international reserve supply on the price level. Inflation rates in both countries depend only on exchange-rate fluctuations. Monetary policy coordination can also reduce exchange rate volatility, thus reducing the likelihood of inflation (deflation). Therefore, the cooperative game equilibrium of monetary policy coordination is pareto optimal state.

3.6 Conclusion the Model

A comparison of the results of non-cooperative boben and cooperative game							
		non-cooperative game				cooperative game	
		Cournot equilihrium		Starkberg equilibrium		Pareto Optimality	
		Probability of occurrence	Game result	Probability of occurrence	Game result	Probability of occurrence	Game result
fixed exchange rate	y>0	large	Inflation occurred simultaneously in both countries	large	Inflation occurred simultaneously in both countries	never	
	y<0	large	Deflation occurred simultaneously in both countries	large	Deflation occurred simultaneously in both countries	never	
	y=0	by chance	Prices are stable in both countries	by chance	Prices are stable in both countries	always	Prices are stable in both countries
	y>0	large	insulated by China's exchange rate appreciation	large	insulated by China's exchange rate appreciation	never	
	y<0	large	Us deflation China's devaluation insulates some deflation	large	Us deflation China's devaluation insulates some deflation	never	
floating exchange rate	y=0	by chance	The two countries have stable exchange rates and stable prices	by chance	The two countries have stable exchange rates and stable prices	always	The two countries have stable exchange rates and stable prices

(table 1)

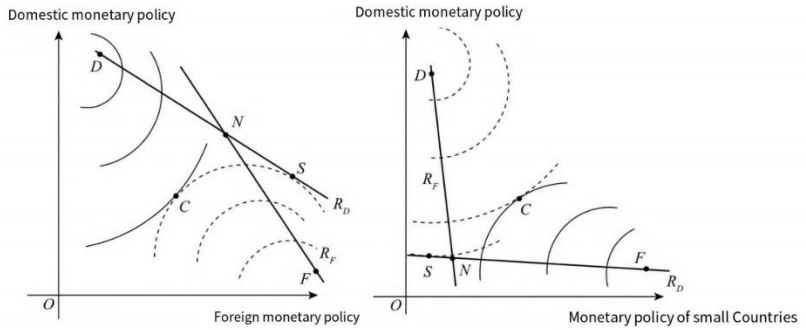


FIG. 1 Monetary policy game

If the US is assumed to be the game leader, its optimal policy choice is the point at which its indifference curve is tangent to Rf. The Starkberg equilibrium (S point); Cournot equilibrium point N and Starkberg equilibrium point S are stable equilibrium points. If monetary policy changes make domestic credit expansion deviate from equilibrium point, the game will force it to return to equilibrium point. Monetary policy coordination makes the game equilibrium point at C· match, and the corresponding inflation rate is zero. Both countries simultaneously achieve the policy goal of price stability. If the monetary policies of the two countries are not coordinated, cournot equilibrium POINT G and Starkberg equilibrium point S tend to deviate from C, and the policy game makes the two countries either in inflation or deflation, and the policy goal cannot be realized. (figure 1)

In short, the results of cooperative game of monetary policy are better than those of non-cooperative game under either fixed exchange rate system or floating exchange rate system (Table 1), and the return improvement of cooperative game exists for a long time. Under normal conditions, our model shows that a country achieves its policy objectives better in policy coordination than in Starkberg equilibrium, so policy

coordination is a better choice for a country. According to the game theory, in the Case of Stackberg game, the decision of cooperation is in the hands of the follower, so the better choice of policy coordination is an achievable choice for the country. To sum up, judging from the conclusion of the model, it is necessary for China and the United States to coordinate monetary policies.

4.1 Data Collection

Wind has a complete and accurate large-scale financial engineering and financial data warehouse with financial securities data as the core. Covering stocks, bonds, funds, foreign exchange, financial derivatives, bulk commodities, macroeconomics, and other fields. This article uses the inherent resources provided by WKU online library to visit WIND. Data were collected from a series of macro data concerning monetary policies in China and the US since March 31, 2015. To compare the situation before and after COVID-19 and up to now (2015Q1-2019Q4).

China	China	China	China	America	America	America	America
Gross Domestic Product	Base Currency and Currency Multiplier (Quarterly)	RMB exchange rate (day)	Money supply (month)	GDP (year)	Consumer Price Index (CPI) (Year)	Money supply (month)	Base money and money multiplier
GDP: Current Price	Base Currency Balance	Central parity rate: USD/RMB	M2: Seasonal adjustment	US: GDP: Current Price	US: CPI: YoY	US: M2: Quarterly	US: Base Currency: No Quarterly Adjustment
Quarter	Ji	Day	Month	Quarter	Month	Month	Month
Billion yuan	Billion yuan		Billion yuan	Billions of dollars	%	Billions of dollars	Millions of dollars
M0001395	M0010129	M0000185	M0046637	G0000007	G0000039	G0003383	G1137352
1952:2020	1998-10:2021-09	1994-08-31:2021-11-02	2001-12:2021-03	1929:2020	1914:2020	1959-01:2021-09	1959-01:2021-09
National Bureau of Statistics	The People's Bank of China	The People's Bank of China	The People's Bank of China	United States Bureau of Economic Analysis	United States Department of Labor	The Federal Reserve	The Federal Reserve
'2021-10-19	'2021-10-19	'2021-11-02	'2021-08-23	'2021-09-24	'2021-02-18	'2021-10-29	'2021-10-29
13288.38	295,752.6300	6.1422	1,259,597.0000	17280.6	-0.3	11,888.1000	4,030,632.0000
14727.54	288,779.5500	6.1136	1,306,496.0000	17380.9	0	12,002.9000	3,919,649.0000
15347.89	279,677.2400	6.3613	1,363,750.0000	17437.1	-0.3	12,154.6000	4,028,486.0000
16983.29	276,377.4900	6.4936	1,400,459.0000	17462.6	0.4	12,340.1000	3,835,810.0000
16176.05	283,376.5800	6.4612	1,438,584.0000	17565.5	0.5	12,616.6000	3,898,431.0000
17998.8	289,070.8200	6.648	1,467,367.0000	17618.6	0.7	12,830.6000	3,825,451.0000
18860.72	290,706.6700	6.6718	1,517,730.0000	17724.5	1.1	13,027.4000	3,735,888.0000
20568.08	308,979.6100	6.945	1,558,730.0000	17812.6	1.8	13,214.2000	3,531,565.0000
17315.95	302,387.3300	6.8872	1,589,410.0000	17896.6	2.1	13,428.6000	3,856,287.0000
19259.43	303,771.5700	6.7809	1,610,591.0000	17996.8	1.2	13,564.7000	3,762,780.0000
20164.83	306,044.1939	6.6528	1,656,244.0000	18126.2	1.9	13,714.4000	3,874,490.0000
21976.82	321,870.7638	6.5068	1,688,864.0000	18296.7	1.7	13,854.8000	3,850,969.0000
18519	321,350.1600	6.2755	1,718,695.0000	18436.3	1.9	13,971.2000	3,800,608.0000
20590.55	318,471.1854	6.621	1,738,695.0000	18590	2.4	14,125.8000	3,650,485.0000
21509.88	317,918.3479	6.8688	1,779,392.0000	18679.6	1.9	14,228.4000	3,559,828.0000
23410.83	330,956.5200	6.8785	1,836,845.0000	18721.3	1.5	14,373.9000	3,400,747.0000
19680.28	303,711.0300	6.7121	1,877,569.0000	18833.2	1.5	14,533.5000	3,381,455.0000
21819.06	313,085.9800	6.8668	1,911,095.0000	18982.5	1.3	14,787.0000	3,274,825.0000
22768.36	305,881.9889	7.0729	1,952,932.0000	19112.7	1.4	15,026.6000	3,202,668.0000
24762.78	324,174.9500	6.9762	1,995,729.0000	19202.3	1.8	15,325.8000	3,426,464.0000
18344.99	317,806.7200	7.0851	2,060,460.0000	18952	1.1	16,011.4000	3,883,155.0000
22506.46	308,338.5500	7.0795	2,124,229.0000	17258.2	0.4	18,175.7000	5,001,978.0000
23894.56	315,643.2800	6.8101	2,163,429.0000	18560.8	1.4	18,601.6000	4,880,300.0000
26374.52	330,428.1400	6.5249	2,197,843.0000	18767.8	1.5	19,129.5000	5,206,500.0000
24516.05	326,956.1600	6.5713	2,252,951.0000	19055.7	2.8	19,913.4000	5,839,000.0000
26832.74	324,494.1400	6.4601	2,317,788.0000	19368.3	5.4	20,417.7000	6,027,000.0000
27841.91	324,341.2400	6.4854	2,342,829.0000	19465.2	5.3	20,982.9000	6,388,900.0000

These data are taken from -- Wind. It includes a variety of China-us macro data from 2015 to 2021.

4.2 Empirical Test of The Model and Find

The theoretical model in this paper mainly compares the utility of the central bank, while the utility function has a strong subjective parameter setting, so it is difficult to conduct empirical test directly. There are two kinds of empirical tests of game theory models: one is to verify the assumptions of the model, and the other is to empirically test the key formulas or equations in the model. The second type of empirical test of the model.

We will conduct the second type of empirical test on the model in this paper, that is, empirical test on the key formulas and equations in the model by analyzing the economic indicators of major economies. Here, we verify the key equations (8) and (9) of the model in this paper based on the data from the USand China respectively, that is, examine whether inflation in one country will have a positive spillover effect on the output of another country. That is, whether the level of inflation is cross-influenced.

Regression relationship between base money balance and CPI in China and US

Before COVID-19 2015Q1-2019Q4			
explaining variable	explained variable	regression	Prob
China's base money balance	CHINA CPI	0.406666	0.075176
	US CPI	0.766739	8.03E-05
US base money balance	CHINA CPI	-0.66674	0.001325
	US CPI	-0.50195	0.024123
The COVID-19 outbreak has so far 2020Q1-2021Q3			
explaining variable	explained variable	regression	Prob
China's base money balance	CHINA CPI	-0.69117	0.085478
	US CPI	0.52455	0.226771
US base money balance	CHINA CPI	-0.81668	0.024972
	US CPI	0.820777	0.023655

China's monetary issuance from 2015 to 2019 has kept pace with that of the United States, as a result of the convergence of monetary policies. At the same time, the growth of the monetary base also shows spillover effects on other countries. But America's aggressive QE policy has not led to significant inflation. For some special reasons, the base money generated by QE is not enough converted into money supply. After the financial crisis in 2008, bank credit channels were constantly tightened, which made money not flow to the real sector and led to the bubble of financial assets. This was also the reason why inflation was negatively correlated despite the increase of money stock.

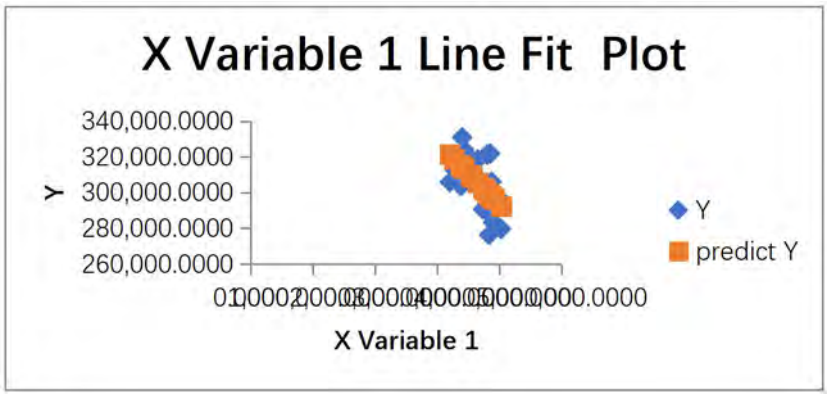
After the outbreak of the new champions league, it is completely different exchange rate directly affects the import and export trade, ensure that the price of domestic enterprises to export competitiveness is one reason the synchronicity of monetary policy If other countries' currencies currency appreciation, leads to wider trade deficit

We analysis that in 3.5.1 track of movements in exchange rates will be cut off part of the transmission of inflation Compared with the United States, China's monetary policy is more restrained. From the perspective of guiding loan issuance, China's monetary policy has a higher transmission efficiency. Under the effective control of the epidemic,CPI quickly fell back to the normal level.

Most importantly, due to the particularity of the epidemic, the world has yet to resume work and production in 2020-2021. China is the first country in the world to complete epidemic control. In 2020, China's total import and export of goods reached 32.2 trillion yuan, up by 1.9%, making It the only major economy in the world to achieve positive trade growth Because of this, the competitiveness in the international market is no longer dominated by the exchange rate, and the scarcity of production capacity gives China a unique advantage in the global value chain and supply chain

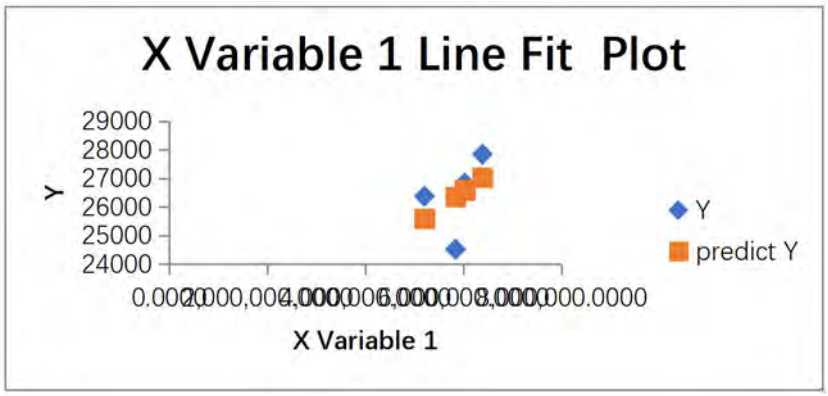
SUMMARY OUTPUT		Synchronicity of currency issuance 2015-2019						
Regression Statistics								
Multiple R	0.555201							
R Square	0.308248							
Adjusted R Square	0.269817							
Standard error	13516.56							
Observed Value	20							
Analysis of variance								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression analysis	1	1.47E+09	1.47E+09	8.020876	0.011049			
Residual error	18	3.29E+09	1.83E+08					
Total	19	4.75E+09						
	Coefficients	*andard erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*er Limit 95*	*per limit 95.*
Intercept	434496.2	46135.02	9.417927	2.23E-08	337570.2	531422.3	337570.2	531422.3
X Variable 1	-0.03531	0.012468	-2.83212	0.011049	-0.0615	-0.00912	-0.0615	-0.00912

(table2)



SUMMARY OUTPUT		Currency synchronization for the last 4 quarters						
Regression Statistics								
Multiple R	0.431084							
R Square	0.185833							
Adjusted R Square	-0.22125							
Standard error	1538.697							
Observed Value	4							
Analysis of variance								
	df	*SS*	*MS*	*F*	*ignificance F*			
Regression analysis	1	1080804	1080804	0.4565	0.568916			
Residual error	2	4735179	2367589					
Total	3	5815983						
	Coefficients	*andard erro*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*er Limit 95*	*er limit 95.*
Intercept	19278.84	10554.95	1.826521	0.209304	-26135.5	64693.15	-26135.5	64693.15
X Variable 1	0.001213	0.001795	0.675648	0.568916	-0.00651	0.008935	-0.00651	0.008935

(table3)

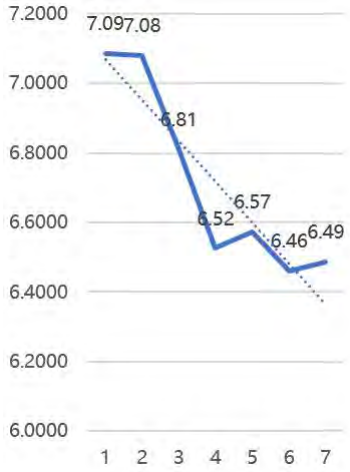


The advantages of the real economy make the policy of RMB begin to break away from the control of the dollar system, which is most directly reflected in the synchronicity of currency issuance.

This has led to dramatic changes in exchange rates.

Exchange rate changes from 15 to 19 years

Exchange rate changes over the last 7 quarters



Post-covid-19 monetary policies of the two countries have not shown significant spillover effects. But he fits a different pattern in the model. Cut off the spillover effects between the two countries through exchange rate changes. At the same time, we can see that the yuan is gradually moving away from the status of stackberg's equilibrium follower and playing a greater role in world markets.

4.3 Conclusion of Empirical Test

Empirical tests show that the correlation between monetary policies and inflation has changed in a trend before and after COVID-19. After the COVID-19 outbreak, monetary policy coordination of major economies no longer shows a simple linear correlation, but due to exchange rate changes, the RMB and THE US dollar show their independence. In the wake of COVID-19, the RMB has gone from passive acceptance to active participation. China's currency policy is increasingly having an impact on other countries. Interactive relations to the direction of equal game change.

5.1 Conclusion

1. The conclusion that international coordination of monetary policy has positive welfare effect is of important practical significance. Generally speaking, the different status of monetary policy coordination between developed economies and emerging market economies is not entirely due to the difference in economic scale, but also due to political influence and economic development degree Today, large emerging economies like China are approaching or surpassing developed economies in size, but since the global monetary system is still dominated by the DOLLAR, reserve currency issuing countries have a natural advantage in coordinating monetary policy In this case, the reserve currencies can choose monetary policy, while other countries can only choose to coordinate or not harmonious And according to the results of the model analysis, when developed economies monetary authorities take monetary

policy operation, for emerging economies, is the rational choice is to coordinate, so as to obtain benefits maximization.

2.The deepening spread of COVID-19 has changed the game structure of China-us monetary policy. China is shifting from the role of a unilateral follower, and China's monetary policy can take more initiative in the post-COVID-19 era For emerging economies, whether it is before with developed economies (such as in the United States of America in the interaction between monetary policy in a follower of the position, now and in the future, as China's rising importance in the global monetary system, which makes the interaction between shift towards the direction of the game (Nash equilibrium) equality, emerging economies should seek international monetary policy coordination As a result, monetary policy co-ordination is all the more necessary.

3. Monetary policy belongs to a country's economic sovereignty, and there are many costs in monetary policy coordination. Pareto optimality is very difficult to achieve in reality. Especially for China and the United States. However, imitating the United States and conducting monetary policy coordination among countries with close economic ties is an important tool That China can use in the future. Meanwhile, China and the United States conduct dialogue on the basis of equality and mutual trust. Seeking to establish a long-term mechanism of monetary policy coordination between the two countries, which is beneficial for both countries to achieve the best effect of monetary policy.

5.2Limitations and Contributions

The limitations of using this model are unavoidable. The complexity of the real world, and building such a model to help us understand the game between the two countries ignores many other factors that exist in the real world. Such as the existence of trade barriers and the pandemic's impact on transport and manufacturing around the world. The impact of other countries' monetary policies on China and the United States and on world markets. Also, in dynamic games, the actual process is much more complex than described in this paper.

The contribution of this paper lies in the study of International coordination of China's monetary policy through the popular game of monetary policy response under Starkberg. Can we better analyze how China can use its advantages during COVID-19 and better use monetary policy coordination in the Asia-Pacific region to gain more benefits for China and its neighbors At the same time, it provides some theoretical evidence for monetary policy coordination. Monetary policy coordination was not considered effective in the 1990s, but its role will be gradually amplified in 2021 In such an exceptional global environment, this could be a way to avoid competitive inflation and lead the world out of crisis.

6.1 The future of Monetary Policy Coordination in China

1. The current international coordination mechanism of monetary policy led by developed countries. Emerging markets are either excluded or unable to express themselves effectively. As the only major economy to achieve positive growth in 2020, China has made a significant contribution to global economic recovery and epidemic

prevention and control. It would certainly be incomplete to ignore monetary policy co-ordination in emerging markets. The global financial market turmoil and economic recession brought about by COVID-19 once again prove that the world economy is closely linked, and no country or region can be immune from the global crisis. Countries should carry out closer international cooperation and coordinate response policies to pull out of the crisis together.

2. As a big country, China has the necessity and ability to participate in and promote international coordination of monetary policies. Explore the potential of monetary policy coordination with countries along the Belt and Road. The countries along the Belt and Road are mostly emerging economies with similar economic growth environment and domestic monetary policy goals as China. Therefore, China and countries along the Belt and Road have a more solid foundation of common interests to promote monetary policy coordination. China can work with belt and Road countries to explore rules for international coordination of monetary policies, work together to offset the adverse impact of the epidemic and expand the influence of the RMB in its neighboring regions. In the long run, the Belt and Road cooperation framework is expected to become one of the platforms for international economic policy coordination.

3. Actively participating in global multilateral policy coordination mechanisms. International financial organizations and forums such as IMF, World Bank and G20 provide a good consultation platform for global monetary policy coordination, and are the window for China to carry out monetary policy coordination with developed

countries. Developed countries still play an important role in policy coordination. China needs to use these platforms to play a bridge role, deepen the communication between the central banks of emerging market countries and those of major developed countries, seek common ground while shelving differences, and promote the monetary policy coordination of countries at different stages of development.

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