HOW ARE INTERNATIONAL COMMODITY PRICES AFFECTED BY U.S. DOLLAR EXCHANGE RATE

[1]FANGYUAN ZHAO, [2]YING KONG

Ph.D. Candidate at Tsinghua University, Professor at Tsinghua University
Email: farrahzfy@gmail.com, kongying@sz.tsinghua.edu.cn

Abstract— Since the 21st century, the international commodity prices have experienced an unprecedented volatility. Since U.S. Dollar is the pricing and settlement currency of world's major commodities, the impact of its exchange rate on commodity prices is particularly important. This paper firstly analyzes the existing studies to obtain a basic proposition: In the long run, the exchange rate of dollar shows an obvious negative correlation with commodity prices. Then in the part of empirical study, the paper test the relationship between the exchange rate of dollar and prices of different types of international commodities by VECM model basing on monthly data from the year of 2000 to 2013. The results confirmed that the exchange rate of dollar is not always the reason for changes of commodity prices, and that these two variables are simultaneous results of changes in macroeconomic. In addition, the paper attempt to explain the mechanism behind the effects and proposes policy suggestions.

Index Terms—international commodity price, dollar's real effective exchange rate, VECM model

I. INTRODUCTION

International commodities are the basic resource of industrial raw materials, energy and the necessary food sources of life. Since the 21st century, the prices of international commodities have experienced dramatic fluctuations, in terms of both frequency and magnitude. In recent years, the commodity markets are showing a clear financial property. It's difficult to explain the price fluctuations only by the relationship of supply and demand, which has led to the discussion of the driving factors of international commodity prices. Concluded from relevant literature and research, the factors can be classified into the following categories: fundamental factors, including supply factors and demand factors; monetary factors, including interest rates, exchange rates, global liquidity and monetary policy; financial market factors, including speculation and the financialization of commodity markets.

The United States began to implement quantitative easing monetary policy from 2008, from that time commodity prices continue to rise. Studies have shown that loose monetary policy will push up commodity prices, while tight monetary policy will lead commodity prices to fell. As the pricing and settlement currency of international commodities trading, the US dollar should be closely related to commodity prices. However, how and to what extend does the dollar exchange rate can impact the price of different types of commodities still need further exploration. In addition, there is no evidence of causal relationship between the dollar exchange rate and commodity prices. In order to accurately determine the role of dollar exchange rate in the international commodity prices changes and to figure out the transmission of the impact, empirical research and testing is required.

Basing on the economical and speculative factors, this paper chose G5 and China 's representative variables as control variables to study the impact of the US dollar exchange rate on prices of different kinds of international commodities.

II. LITERATURE REVIEW

The dollar exchange rate is usually considered to be an important reason for the volatility of commodity prices. Different methods based on different types of commodities and sample range have been used to study the relationship, basically confirming this conclusion.

Akram (2009) selected data from the first quarter of 1990 to the fourth quarter of 2007 to establish a VAR model based on the real effective exchange rate of US dollars, the US short-term real interest rate, OECD industrial output, and real prices of crude oil, metals, raw materials and food. The impulse response analysis shows that the dollar exchange rate changes have a negative impact on commodity prices and the dollar is a strong signal of commodity prices.

Cabrales, Castro and Joya (2011) established a VAR model, incorporating commodity prices, the real effective exchange rate of the US dollar, the federal funds interest rate and the weighted average GDP of the United States M2 and the main economy entities. They used the restrictive matrix of structural residual to identify the impact of monetary policy, finding that monetary policy can explain the fluctuations of commodity prices to a great extent.

Gospodinov and Jamali (2013) had a regression analysis of commodity prices changes, expected monetary policy changes and convenience yields, showing that 25 points monetary policy shock would result in a 0.83% change in the Reuters CRB Commodity Price Index.

Yubo Zhang, Lijuan Xin and Xin Shang (2013) examined the correlation between the US dollar and the commodity prices by calculating the dynamic correlation coefficient. The results show that the exchange rate of the US dollar has a negative correlation with commodity prices in most years, while the case of positive correlation only occurs a few times when the US dollar appreciates.

Kaiyao Wu and Rong Li (2013) conducted empirical research and found that the trend of dollar exchange rate and the international commodity prices have a negative correlation in general. Besides that, there is a Granger causal relationship between crude oil and gold prices and the dollar index.

Xiaoli Zhang and Sai Ma (2013) used a multivariable co-integration model, an error correction model and the impulse response function to analyze the relationship between the RMB-dollar exchange rate and the price of agricultural commodities in China. The empirical results show that here is a positive correlation between the appreciation of RMB and the price rise of agricultural commodities, that is, the depreciation of the dollar may lead commodity prices to rise.

The literatures related to international commodity prices mainly focus on supply-demand factors and speculative factors. A small part of them pay attention to monetary factors and most of these researches study the impact of interest rate, while the study of impacts of dollar exchange rate are limited-some of them examine the US monetary policy instead of the dollar exchange rate and some fail to explore the mechanisms behind the correlation.

This paper conducted a empirical study using monthly data from 2000 to 2013, which covers the periods before and after the financial crisis. After quantitative analysis of the results, it further explored the transmission mechanism of the impact of the dollar exchange rate on commodity prices from both theoretical and empirical views.

III. THE EMPIRICAL STUDY BASED ON VECM MODEL

A. Variables selection and data pre-processing

The dependent variable are commodity prices. We selected 2005-based price indexes of four categories of commodities, including food and beverage price index, energy (crude oil, natural gas and coal) price index, metal (iron ore, copper, aluminum, tin, nickel, zinc, lead and uranium) price index and agricultural raw materials (wood, cotton, wool, rubber) price index.

The independent variable is the US dollar exchange rate, where we chose the real effective exchange rate of US dollar.

Control variables include economic variables - global industrial output, liquidity indicators - global money supply and speculative indicators - open interest volume. In order to construct the variable M as global money supply to imply the global liquidity level, this paper choose G5 (US, Canada, UK, Eurozone, Japan) and China's money supply as the sample. We adopt the generalized index of money supply of these countries or districts – M2 of China, U.S. and Japan, M3 of Eurozone, M2+ of Canada, M4 of U.K. Then the global liquidity index M is constructed by averaging these money supply indexes weighted by GDP, which could eliminate the impact of economic scale differences on liquidity measures.

Four models are built basing on these variables. The first model includes agricultural raw material price index (ARM), the real effective exchange rate of dollar (ER), the global money supply (M), the global industrial output (IP) and open interest volume (OI). The second model includes food and beverage price indices (FB), ER, M, IP and OI. The third model includes the metal price index (MT), ER, M, IP and OI. The fourth model includes the energy price index (FU), ER, M, IP and OI.

This paper collects monthly data from January 2000 to December 2013 to fit the variables. The international commodity price index is from the official website of the Federal Reserve Bank of St. Louis; the real effective exchange rate of the US dollar comes from the Board of Governors of the Federal Reserve System; the global industrial output data from the CPB World Trade Monitor; money supply data of China, the United States and the Eurozone comes from “International Financial Statistics” of International Monetary Fund (IMF); money supply data and national GDP data of Canada, Japan and UK is from the Organization for Economic Co-operation and Development; open interest volume data is from “Futures Trading Position Report (COT Report)” of the US Commodity Futures Trading Commission (CFTC). Seasonal adjustment is adopted to these data.

B. The analysis of single factor trend and correlation

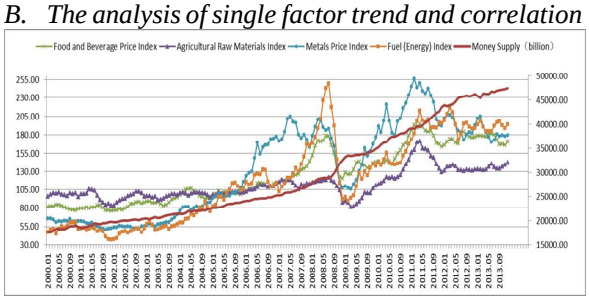


Fig.1 Money supply and commodity prices

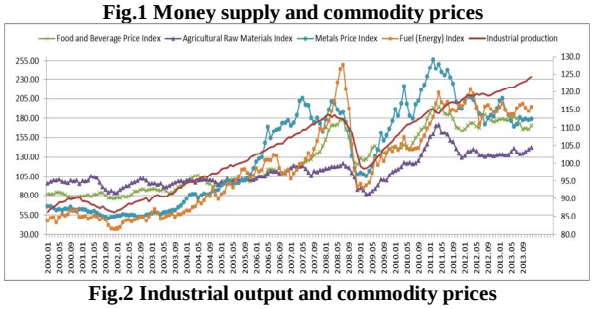


Fig.2 Industrial output and commodity prices

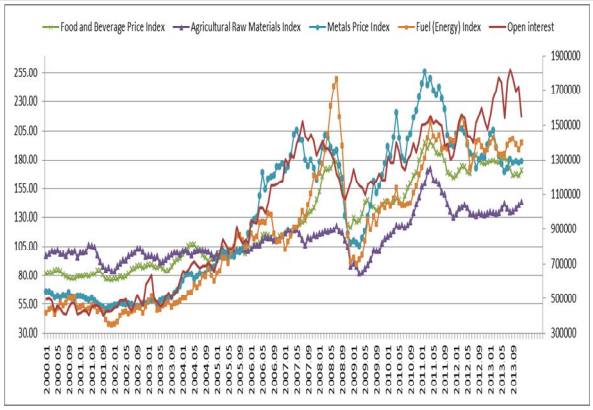


Fig.3 Speculative factors and commodity prices

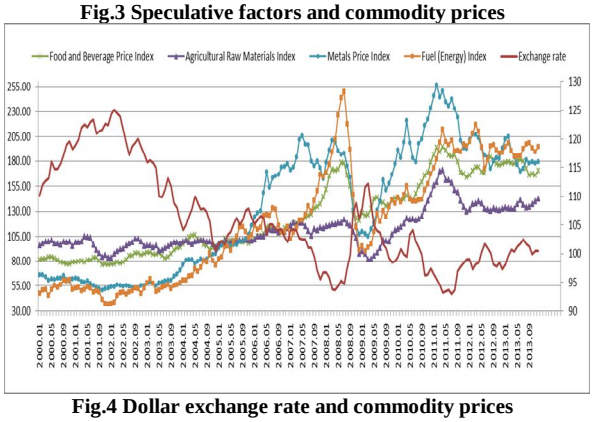


Fig.4 Dollar exchange rate and commodity prices

From the graphs, the trend of commodity prices can be summarized as following: from January 2000 to July 2001, commodity prices fluctuated slightly; from July 2001 to July 2008, the price rose rapidly; from August 2008 to December 2008, commodity prices seriously frustrated due to the severe global finance crisis; as the crisis gradually fading and the global economic recovering, the upward trend of commodity prices occur during January 2009 to 2011, reaching or even exceeding the peak level before the crisis; after that round of rising, the commodity price index fell slightly and gradually stabilized. During the whole sample period, the money supply rose steadily, and the trend of industrial output as well as the open interest volume was basically the same as the price movements, and the exchange rate trend was basically contrary to the price.

Tab.1 The correlation coefficients

	ARM	FB	MT	FU
ER	-0.71025	-0.84271	-0.87586	-0.86269
IP	0.837173	0.93799	0.922842	0.95339
M	0.791188	0.921108	0.800002	0.853715
OI	0.782209	0.926501	0.933054	0.917886

The correlation coefficients between prices of different commodities and the potential driving factors are considerably high. The signs of correlation coefficients are in accordance with economic theory, that is, the exchange rate of the US dollar is negatively correlated with commodity prices, and the other three factors are positively correlated with commodity prices.

C. Stationarity test and lag order selection

Tab.2 The stationarity testing results of time series

	Original time series			First order difference series		
Time series	Test form	ADF-Statistic	Stationarity	Test form	ADF-Statistic	Stationarity
M	(0,0,4)	4.405748	Reject	(C,0,2)	-5.113116	Accept
IP	(0,0,2)	1.530322	Reject	(0,0,1)	-4.296831	Accept
OI	(0,0,0)	0.971075	Reject	(0,0,0)	-12.5578	Accept
ER	(0,0,2)	-0.618561	Reject	(0,0,1)	-9.13734	Accept
FB	(0,0,1)	0.631678	Reject	(0,0,0)	-7.797654	Accept
ARM	(0,0,1)	0.455135	Reject	(0,0,0)	-9.178301	Accept
FU	(0,0,1)	0.014188	Reject	(0,0,0)	-7.877091	Accept
MT	(0,0,1)	0.172223	Reject	(0,0,0)	-9.40113	Accept

In order to avoid non-stationary time series resulting in invalid "pseudo-regression" results, we test the stationarity of time series data before the establishment of VAR model. This paper adopted the ADF unit root test method, in which the lag order is chosen by SIC criteria within the maximum lag order of 12 and constant and trend items are determined by the trend of the variables.

According to the test results, all of the time series are non-stationary at 90% confidence level, while the first order difference of all of them are stationary at 90% confidence level, which means that all of the time series are first order integration I (1).

Tab.3 Lag selection of model Ⅰ

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-5303.457	NA	4.52e+22	66.35572	66.45181	66.39474
1	-3929.688	2644.51	2.16e+15	49.49610	50.07270	49.73024
2	-3849.082	150.129	1.08e+15	48.80103	49.85812*	49.23027*
3	-3820.247	51.904	1.03e+15*	48.75308*	50.29067	49.37744
4	-3800.488	34.3302	1.10e+15	48.81860	50.83669	49.63808
5	-3780.263	33.8777	1.18e+15	48.87828	51.37686	49.89287
6	-3766.707	21.8584	1.37e+15	49.02134	52.00041	50.23104
7	-3732.997	52.25133*	1.25e+15	48.91246	52.37203	50.31727
8	-3720.169	19.0818	1.48e+15	49.06461	53.00467	50.66453

Table 3 shows the results of the lag selection of model Ⅰ. According to majority criteria, we choose lags P = 3 for model Ⅰ. Similarly, we choose P = 2 for model Ⅱ, P = 3 for model Ⅲ and P = 2 for model Ⅳ

D. Cointegration test

In order to determine whether there is a long-term equilibrium relationship between the time series, this paper adopts the Johansen cointegration test on each model. According to the lag selection results, the lag of P-1 is chosen for the Johansen test.

Tab.4 Integration testing results

Model	Ho	Trace test		Eigenvalue test	
		Statistic	Probability	Statistic	Probability
Model Ⅰ	γ=0	85.7520	0.0016	40.8144	0.0064
	γ<1	44.9376	0.0916	27.1237	0.0572
	γ<2	17.8139	0.5799	13.2448	0.4300
	γ<3	4.5692	0.8527	4.3994	0.8150
	γ<4	0.1698	0.6803	0.1698	0.6803
Model Ⅱ	γ=0	72.3190	0.0312	37.5882	0.0172
	γ<1	34.7308	0.4623	18.1174	0.4854
	γ<2	16.6133	0.6684	11.3796	0.6094
	γ<3	5.2338	0.7835	4.5227	0.8005
	γ<4	0.7111	0.3991	0.7111	0.3991
Model Ⅲ	γ=0	83.7067	0.0026	38.9163	0.0115
	γ<1	44.7904	0.0943	34.8209	0.0049
	γ<2	9.9696	0.9808	6.8371	0.9600
	γ<3	3.1325	0.9606	3.0251	0.9450
	γ<4	0.1073	0.7432	0.1073	0.7432
Model Ⅳ	γ=0	102.9849	0.0000	42.3903	0.0038
	γ<1	60.5946	0.0021	37.2933	0.0021
	γ<2	23.3013	0.2316	16.7179	0.1857
	γ<3	6.5834	0.6265	5.1651	0.7209
	γ<4	1.4183	0.2337	1.4183	0.2337

The results of cointegration test conformed that each model has at least one long-term cointegration relationship at 95% of the confidence level, meaning we can build error correction (VECM) models.

E. Construction of VECM based on cointegration

After the stationarity test, we found that the time series have the same order of integration and there exist a cointegration relationship, fulfilling the requirement for building a vector autoregressive error correction (VECM) model. The endogenous variables include ARM, FB, MT, FU, ER, M, IP and OI. The lag is determined as the P-1 period according to the lag of the VAR model. Since the individual coefficients estimated by the VECM model cannot reflect the influence and duration of a variable change on other variables within the system, they are not meaningful in economic. Hereby the specific estimation results are not presented here, instead the impulse response and variance decomposition of the model are conducted for further analysis.

a) Impulse response analysis

The AR roots graphs of four models show that the reciprocal of the eigenvalues of all the variables in these models are within the unit circle, proving that the VECM models are stable, which is the premise of impulse response. Figure 5 shows the results of the impulse response analysis of each model, individually describing the responses of the prices of agricultural raw materials, food and beverages, metal and energy to the shock of the real effective exchange rate of the US dollar (ER), the global currency amount (M), the global industrial output (IP) and the open interest volume (OI).

The impulse response function describes the dynamic impact of a shock on the system. It can be seen from the results that the impact directions of all the factors on commodity prices are in line with the theory—the industrial output, currency amount and speculative factors have positive impact on commodity prices and the dollar exchange rate has negative impact, meaning that a unit standard deviation positive shock of the exchange rate results in the decrease of commodity prices. The negative responses of the first three commodity prices to US dollar shock last longer and agricultural raw material and metal prices are influenced to more degree than that of food and beverage. The impact of the dollar exchange rate on energy prices is shorter, reaching peak at the third period. The main reason for this phenomenon is that the supply elasticity of energy commodities is large and the elasticity of demand is small. When the price falls, the exporting country rapidly starts to control the export volume, thus restricting the supply of the market and reducing the impact of appreciation of the dollar to the energy price.

From the impact level, the influence of dollar exchange rate is weaker than that of the industrial output on all commodity prices except for food and beverage, while it's higher than the currency amount and speculative factors. The industrial output has small impact on food and beverage prices, given that industrial output cannot directly influence family consumptions. In general, the economic factors and supply-demand factors are the dominant factors for the volatility of commodity prices.

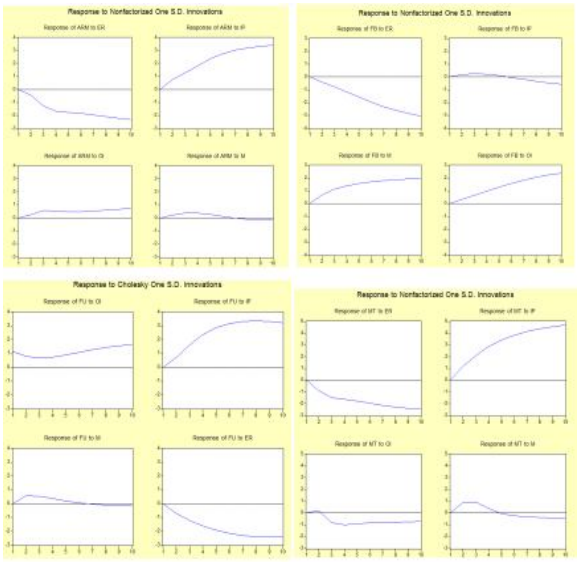


Fig.5 Impulse response analysis of four models

The positive impact of speculative factors on metal prices is very short, due to the well-developed metal market is more easily to escape the speculation.

b) Variance decomposition

Variance decomposition is the method to figure out the contribution of each structural shock on endogenous variables' responses. The change of endogenous variables is usually measured by variance, and the variance decomposition can determine the relative importance of each random disturbance term to variables in the VECM model. We select the 8th period of variance decomposition results of four

models for analysis, while we only show the result of model in Table 5 to save space.

Tab.5 Variance decomposition results of the 8th period

Period 8	S.E.	ER	IP	M	OI	ARM
ARM	5.4841	15.05254	17.74914	0.376879	1.135849	65.6856
FB	6.101944	32.81272	0.407279	0.444767	4.367312	61.96792
MT	5.426557	32.68942	15.62112	1.819479	1.780568	48.08941
FU	148831.5	11.89054	21.25532	0.47226	3.179519	63.20236

According to the results, the contribution rates of each variable to agricultural raw material price are: the dollar exchange rate (15.05%), industrial output (17.75%), currency amount (0.38%) and speculative factor (1.14%). The contribution rates of each variable to food and beverage price are: the dollar exchange rate (32.81%), industrial output (0.41%), currency amount (0.45%) and speculative factor (4.37%). The contribution rates of each variable to metal price are: the dollar exchange rate (32.69%), industrial output (15.62%), currency amount (1.82%) and speculative factor (1.78%). The contribution rate of each variable to energy price are: the dollar exchange rate (11.89%), industrial output (21.26%), currency amount (0.47%) and speculative factor (3.18%).

The results show that the US dollar exchange rate has a higher degree of interpretation for food and beverage and metal price fluctuations, and a lower one for agricultural raw materials and energy price fluctuations, while industrial output has a higher one for agricultural raw materials and energy price fluctuations. Compared with other commodities, the prices of these two types are more influenced by the economy and supply-demand factors, slightly influenced by the dollar.

The contribution rate of the US dollar exchange rate to metal price is significantly higher than that of other commodities, due to the strong financial properties of the metal market. In addition to the existence of financing metal, metals are generally priced globally, making metal commodities more like financial assets and have an opposite trend with the dollar.

The contribution rate of the US dollar exchange rate to food and beverage prices is also high, and the prices are barely affected by the industrial output. It is not difficult to understand this result, since food and beverage is consumed by the residents, the impact of industrial output is indirect, correspondingly improving the relative importance of the US dollar's impact.

Compared with the currency amount and speculative factors, the dollar exchange rate has more impact on the international commodity price volatility, indicating that the dollar exchange rate is indeed an important factor affecting commodity prices.

F. Grainger causality test

Tab.6 Grainger causality test results

Null hypothesis	F	Prob	Conclusion
M does not Granger Cause MT	0.93	0.40	Accept
OI does not Granger Cause MT	0.78	0.46	
ER does not Granger Cause FB	0.78	0.46	
ER does not Granger Cause MT	1.38	0.25	
IP does not Granger Cause FB	5.41	0.01	Refuse
M does not Granger Cause FB	7.55	0.00	
OI does not Granger Cause FB	6.33	0.00	
IP does not Granger Cause MT	3.93	0.02	
ER does not Granger Cause FU	4.73	0.01	
IP does not Granger Cause FU	14.84	0.00	
ER does not Granger Cause ARM	5.60	0.00	
IP does not Granger Cause ARM	14.61	0.00	
M does not Granger Cause ARM	4.50	0.01	
OI does not Granger Cause ARM	3.71	0.03	
M does not Granger Cause FU	4.73	0.01	
OI does not Granger Cause FU	9.92	0.00	

The correlation between independent and control variables and commodity prices are demonstrated by previous results, while a correlation does not mean a causal relationship, which calls for Granger causality test. Since there is a first order integration between sequences, the Granger causality test can be performed.

According to the test results shown in table 6, the US dollar exchange rate is the reason for the prices fluctuations of agricultural raw materials and energy, but not the reason for food and beverage prices or metal prices fluctuation. However, we should be cautious about the causal relationship. The results can only show that there is a statistical causal relationship between the dollar exchange rate and some commodity prices, while the truth behind it is that the dollar exchange rate has different extent and mechanisms to impact different commodities. We can also conclude that industrial output, money supply and speculative factors are significant reasons for prices of all the commodities except for the metal, which further illustrates the fluctuations of commodity prices are more dependent on economic factors and supply-demand factors. The dollar exchange rate impacts prices through monetary factors by activating or restricting trading volume.

IMPACT MECHANISM ANALYSIS

According to the test results and analysis, we can find that supply and demand changes are the fundamental changes in commodity prices. While the dollar affects commodity prices through impacting directly supply and demand and indirectly the expectation of future supply-demand relationship.

If international commodities are considered as an equivalent of investment object of the dollar, we can generate the following logic. When people expect the demand for commodities will reduce and holding it would be unprofitable, they will sell the goods and turn to investing in dollars, which increases the demand for the dollar and push the dollar exchange

rate up. On the contrary, when people are bullish on commodities, they will be in exchange for commodities in dollars, resulting in increased supply of the dollar then depreciation. Since commodity prices are dollar-denominated, they will rise rapidly. At the same time, the depreciation of the dollar will lead to international financial capital to invest in commodities, which is a store of value, leading to increased demand for commodities and higher prices. Thus, the dollar and commodity prices are negatively correlated-the decline in the dollar is generally accompanied by a rise in commodity prices, while the rise in the dollar is generally accompanied by a decline in commodity prices.

The impact mechanism can also be explained from the perspective of international trade. On the one hand, the depreciation of the dollar pushing up other countries' import demand of US commodities. On the other hand, the exporters' profit is cut down when it is exchanged to domestic currency, leading to less supply of commodities for U.S. Increased demand and decreased supply jointly push up commodity prices. This is the situation of the depreciation of the dollar, while appreciation of the dollar is just the opposite.

Basing on these analysis, we can conclude that the dollar exchange rate does have impacts on commodity prices, but this effect is actually very limited. Firstly, from the perspective of the impact on supply side, dollar value changes can barely affect production cost of commodities in the short term. Even in the long term, the production cost changes only can weakly impact the supply, especially for commodities with lower marginal costs. Secondly, from the perspective of the impact on demand side, according to the statistical study, the price elasticity of international commodities demand is relatively small. In the case of 10% change in the dollar, the demand for all kinds of commodities will change within 2%, showing that the dollar exchange rate fluctuations only slightly change the demand for commodities. In addition, the exchange rate systems of many countries are anchored to the dollar, thus the appreciation and depreciation effect of the dollar is relatively small.

CONCLUSION

According to the research, there is a certain correlation between the US dollar and the international commodity prices, but they are not simply negatively correlated. After examining the economic logic behind the relationship, we found that the dollar exchange rate is not the reason for the volatility of all commodity prices, while accurately they are simultaneous-produced results of changes in macroeconomic. However, as an economic signal, the dollar exchange rate can help us expect the commodity prices trend to some extent.

The volatility of the US dollar is closely related to the US monetary policy. At the beginning of the 21st century, the United States began to implement quantitative easing monetary policy. Other countries also adopted similar monetary policies in order to maintain financial stability and stabilize capital flows and exchange rate movements. The linkage between US and other countries' monetary policy operations amplifies the impacts of US monetary policy shocks on global liquidity and currency values, thereby amplifying the impacts of US dollar exchange rate on commodity prices.

In order to effectively cope with the negative impacts of international commodity prices volatility, China needs to adjust its economic structure, change the economic growth mode, and strive for its power in commodity pricing as a resource-demanding country. At the same time, China should pay close attention to the spillover effects of monetary policy of developed countries on commodity markets. Seeking for diversification of foreign exchange assets and thinking carefully when making monetary policy is also required.

In this paper, we use a similar model to examine the impact of the US dollar exchange rate on the prices of four commodities. However, different pricing mechanisms of different commodities should be considered separately for the special factors affecting each commodity price. Further work will include these special pricing mechanisms into data processing and modelling. The period from 2000 to 2013 is analyzed together is this paper, while the financial crisis in 2008 has had a great impact on the US economy and monetary policy, which should be analyzed specifically.

ACKNOWLEDGEMENT

The research is supported by Tsinghua-Berkeley Shenzhen Institute, Tsinghua University.

REFERENCES

[1] Akram, Q. Farooq. "Commodity prices, interest rates and the dollar." Energy economics 31.6 (2009): 838-851.

[2] Cashin, Paul, and C. John McDermott. "The long-run behavior of commodity prices: small trends and big variability." IMF staff Papers 49.2 (2002): 175-199.

[3] Deaton, Angus, and Guy Laroque. "On the behaviour of commodity prices." The Review of Economic Studies 59.1 (1992): 1-23.

[4] Anzuini, Alessio, Marco J. Lombardi, and Patrizio Pagano. "The impact of monetary policy shocks on commodity prices." (2012).

[5] Arteaga Cabrales, Carolina, Joan Granados Castro, and Jair Ojeda-Joya. The Effect of Monetary Policy on Commodity Prices: Disentangling the Evidence for Individual Prices. Banco de la Republica de Colombia, 2011.

[6] Arteaga Cabrales, Carolina, Joan Granados Castro, and Jair Ojeda-Joya. The Effect of Monetary Policy on Commodity Prices: Disentangling the Evidence for Individual Prices. Banco de la Republica de Colombia, 2011.

[7] Boivin, Jean, Marc P. Giannoni, and Ilian Mihov. "Sticky prices and monetary policy: Evidence from disaggregated US data." The American Economic Review 99.1 (2009): 350-384.
[8] Trostle, Ronald. Global agricultural supply and demand: factors contributing to the recent increase in food commodity prices. Washington, DC: US Department of Agriculture, Economic Research Service, 2008.
[9] Slade, Margaret E. "Trends in natural-resource commodity prices: an analysis of the time domain." Journal of Environmental Economics and Management 9.2 (1982): 122-137.
[10] Harri, Ardian, Lanier Nalley, and Darren Hudson. "The relationship between oil, exchange rates, and commodity prices." Journal of Agricultural and Applied Economics 41.02 (2009): 501-510.
[11] Chen, Yu-Chin, Kenneth S. Rogoff, and Barbara Rossi. "Can exchange rates forecast commodity prices?." The Quarterly Journal of Economics 125.3 (2010): 1145-1194.
[12] Gilbert, Christopher L. "The impact of exchange rates and developing country debt on commodity prices." The Economic Journal 99.397 (1989): 773-784.

★★★