



# The impact of international crude oil price fluctuation on the exchange rate of petroleum-importing countries: a summary of recent studies

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## Abstract

Oil is an important energy resource. Fluctuation in international crude oil prices affects all aspects of the economy. The exchange rate is one of the important channels for the international crude oil price shock to pass to the real economy and financial markets. The impact of international crude oil price fluctuation on the exchange rate of oil-importing countries has attracted more and more attention. The US dollar is the main invoice and settlement currency of the international oil market. The change of the US dollar exchange rate will inevitably affect the international crude oil price. By combing the relevant classic literature and recent literature, the relationship between international crude oil prices and the exchange rate of oil-importing countries is discussed. Due to the different methods of use, the relationship between the two is not conclusive. This paper probes into the impact paths of national crude oil price fluctuation on the exchange rate of oil-importing countries, but the influence level depends on the relative degree of each country affected by oil prices, which cannot be generalized. The article summarizes the methods of studying the relationship between oil prices and exchange rates, most of which are studying the causal relationship between the two and their mutual influence, nonlinear structure, and volatility spillover effects. Through reviewing and summarizing the relevant literatures, this paper argues that exploring the inherent laws of oil price volatility buffer under different exchange rate regimes and studying the transmission mode and intensity of oil price fluctuations on exchange rate effects can be the focus of future research.

**Keywords** International crude oil price · Exchange rate · Influence channel

## 1 Introduction

Oil is one of the most widely used sources of energy and one of the most important commodities in the global economy. As a major energy resource in industrialized countries, oil plays a pivotal role in production activities. In fact, it has been proven over the past few

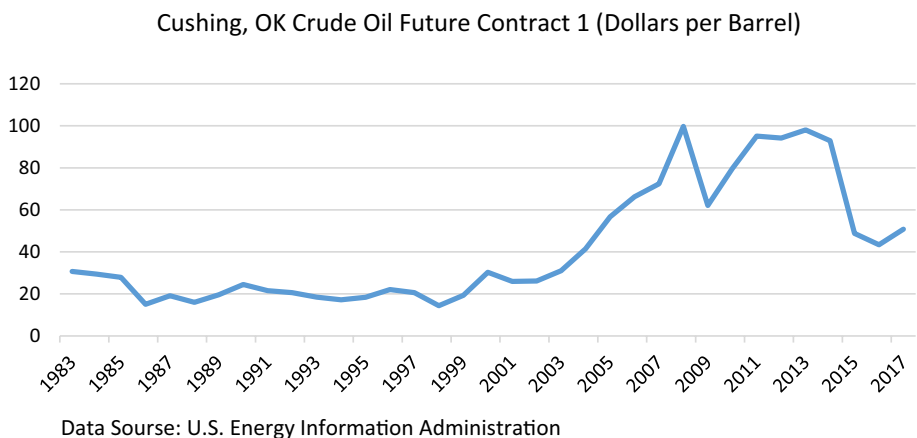
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decades that oil is still an indispensable source of energy even in the context of constant calls for alternative energy sources. The impact of changes in international crude oil prices on the global economy is also increasing. Changes in international crude oil prices may affect all aspects of the economy through various transmission channels (i.e., direct and/or indirect transmission channels). Especially with the improvement of the oil futures market and the use of petroleum derivatives, the financial attributes of oil are increasingly prominent, and fluctuations in oil prices will have an impact on the real economy and the virtual economy (Ding et al. 2017; Liu et al. 2017). International crude oil price volatility has an important impact on a country's economic stability. According to the Energy Information Administration, oil prices have fluctuated significantly over the past 35 years. Figure 1 shows the Cushing, OK crude oil futures prices from 1983 to 2017. In July 2008, Cushing, OK crude oil futures prices once surged to an all-time high of \$133.48 per barrel and fell to \$64.29 in July 2009. Crude oil prices have also fallen since 2013. Oil has the dual nature of economy and politics. It is closely connected with politics. Oil has become an important bargaining chip in contemporary international political, military, and diplomatic relations. The fierce competition and conflicts between countries in order to obtain oil around a specific region of the world have never stopped. This is known as oil geopolitics. One consequence of geopolitical changes is that international crude oil prices may be viewed as an exogenous random phenomenon that is strong enough to threaten the US economy and thus affect the dominance of the dollar.

Oil is priced in dollars, and the dollar is still the most widely used international currency. It plays an important role in the valuation of crude oil and various other commodities. The US dollar is the main invoice and settlement currency of the international oil market. The change of the US dollar exchange rate will inevitably affect the international crude oil price. In recent years, the exchange rate of the US dollar has also undergone frequent and uncertain changes, which in turn has an impact on oil-importing and oil-exporting countries. If the dollar appreciates, the purchasing power of the oil-importing country's currency will be weakened (except the US dollar). As the purchasing power of the currency of the oil-importing country changes, the weakening of the purchasing power of money will affect the exchange rate of a country, and vice versa. The exchange rate is a key transmission variable. In the context of economic globalization, the impact of exchange rates on



**Fig. 1** Cushing, OK crude oil futures prices from 1983 to 2017

international trade and international financial quotas is also increasing. Financial market prices are adjusted at a faster rate, and exchange rates are highly sensitive to such price fluctuations. Oil prices are closely related to economic growth (gross domestic product). Existing research has highlighted how international crude oil prices change with changes in macroeconomic variables such as GDP growth, unemployment, inflation, and stock prices. International crude oil prices affect the exchange rate by affecting the transfer of income from oil-exporting countries to oil-importing countries through trade. As an important economic variable, what is the relationship between the fluctuation of international crude oil price and exchange rate, and what is the influencing mechanism between them? Many scholars have conducted extensive research on these problems. This paper discusses the influence of international crude oil price on the exchange rate of oil-importing country. Oil is undoubtedly one of the most traded commodities in today's international energy market. Part of the reason for the volatility in oil trading is the changing exchange rate. Therefore, it is vital for investors and policymakers to understand the dynamic changes in the relationship between currency exchange rate and crude oil.

The second part analyzes the impact paths of international crude oil prices on the exchange rate of oil-importing countries, the third part introduces the relationship between oil price fluctuations and exchange rates, the fourth part summarizes commonly used methods, and the fifth part gives conclusions and future prospects.

## 2 The relationship between oil price fluctuations and exchange rates

Since the pioneering work of Hamilton (1983), international crude oil price has been closely related to macroeconomy and has been extensively studied. The relationship between oil price and exchange rate has attracted many scholars' attention. There are a large number of empirical studies currently demonstrating this relationship. The researchers find a different relationship between oil prices and exchange rates in oil exports and oil importers. Reboredo (2012) investigate the different influences of oil-exporting and oil-importing countries and report the inconsistency between the combined movement of oil-exporting countries and oil-importing countries.

### 2.1 Unidirectionality from exchange rate to oil price

Blomberg and Harris (1995) explain the potential impact of exchange rates on oil prices through a price rule: Since oil is homogeneous and is an international trade commodity priced in dollars, the depreciation of the dollar increases the purchasing power of foreigners, and oil demand in turn has pushed up the price of crude oil in the US dollar. Since the US dollar is the main settlement currency of the international oil market, the exchange rate of the local currency against the US dollar is a key channel for the oil price shock to be transmitted to the real economy of oil-importing and oil-exporting countries. Therefore, the reaction of monetary policy to oil price fluctuations may amplify the international crude oil price shock. Since the US dollar is the main invoice currency for the international crude oil market, fluctuations in the US dollar exchange rate are considered to be the basis for crude oil price volatility (Benhmad 2012). On the contrary, crude oil-importing countries will be adversely affected by the overvaluation of the US dollar (Reboredo 2012).

The appreciation of the dollar tends to reduce the actual income of countries with unstable incomes and curb their demand for oil. Therefore, through this slowing demand effect,

the appreciation of the US dollar will help lower oil prices and thus increase the external competitiveness of oil importers. When it comes to supply, the appreciation of the dollar tends to be inflationary, and it increases the purchasing power of oil-producing countries and increases their actual disposable income, especially for drilling. The appreciation effect of the US dollar on oil supply is positive. All in all, a stronger dollar will curb demand and increase oil supply, both of which will cause international crude oil prices to fall.

Therefore, these supply and demand effects have a negative impact on the causal relationship from the US dollar to the international crude oil price. Basher et al. (2012) study the dynamic relationship among oil prices, exchange rates, and emerging market stock prices, and find that a positive impact on oil prices will lower market exchange rates in the short term. Tantatape et al. (2014) investigate the relationship between US crude oil prices and exchange rates, indicating that in the short term, exchange rates will lead to higher crude oil prices. Jammazi et al. (2015) study the relationship between the dollar exchange rate and the price of crude oil in 18 currencies. The author emphasizes that in the short term and long term, the asymmetric conduction of exchange rate to oil price indicates that the impact of negative exchange rate shock on oil price is greater than positive impact.

## 2.2 Unidirectionality from oil price to exchange rate

The link between oil prices and exchange rates is very important because exchange rates are one of the important channels through which international crude oil price shocks are passed to the real economy and financial markets. Changes in oil prices will affect the exchange rate. Increasing international crude oil prices creates a current account surplus for oil-exporting countries (such as Organization of the Petroleum Exporting Countries) and a current account deficit for oil-importing countries, leading to a redistribution of wealth that could affect the exchange rate. The study of the relationship between crude oil exchange rates is based on the early theoretical predictions of Krugman (1983), Golub (1983) and Rogoff (1991), which are classical theories. They believe that oil-exporting (oil-importing) countries may experience exchange rate appreciation (depreciation) when oil prices rise and depreciation (appreciation) when oil prices fall. The decline in crude oil prices and the sharp depreciation of the ruble are examples. Chen and Chen (2007) use the monthly panel data from January 1972 to October 2005 to examine the relationship between the actual international crude oil price and the real exchange rate in the G7 countries and study the relationship between actual oil prices the real exchange rates in G7 country samples. It is found that oil prices may be the main source of exchange rate changes, and there is a cointegration relationship between oil prices and exchange rates.

On the other hand, Krugman (1983) believes that the initial impact of rising international crude oil prices on the real exchange rate is different from its long-term effects. The former is appreciation and the latter is depreciation. Three models are further proposed to explain the impact of oil shocks on the exchange rate. These models show that oil shocks affect all countries, but their impact on exchange rates depends on the asymmetry between economies. On the other hand, Golub (1983) studies an inventory/flow model that examines the impact of oil shocks on exchange rates and concludes that this impact depends on the direction in which countries truly determine their wealth after the global financial crisis. Most studies have found a positive correlation between oil prices and the US dollar exchange rate. They find a one-way causal relationship between oil prices and exchange rates. Therefore, oil price shocks during the study period will seriously affect exchange rate fluctuations. However, some studies have suggested that there is no such causal relationship

between the exchange rate of the US dollar and the appreciation of oil prices. The link between the oil exchange rates may be positive or negative, or it may change from one period to another. Turhan et al. (2013) examine the dynamic relationship between oil prices and exchange rates in G20 countries and find a negative correlation between oil prices and exchange rates. Ju et al. (2014) study the macroeconomic effects of China's international crude oil price shocks and empirically find that oil price shocks have a negative impact on China's GDP and exchange rate, but have a positive impact on China's consumer price index.

When international crude oil prices soar, oil-exporting countries hoard more external assets, causing their exchange rates to rise. On the contrary, oil-importing countries have fallen into poverty, leading to asset decline and currency depreciation. The oil market also plays a key role when it comes to trading terms. In all the same circumstances, rising international crude oil prices will reduce the external competitiveness of oil-importing economies. In particular, the rise in international crude oil prices is comparable to that of oil-exporting countries, which makes their currencies have no adverse effects in trade accounts; on the contrary, oil importers have to depreciate their currencies as trade conditions deteriorate. Therefore, as oil prices rise, terms of trade and external assets have the same effect on exchange rates: an appreciation of the currency of the oil-exporting country and a devaluation of the net importer. Zhang et al. (2008) find that causality moved from the US dollar exchange rate to oil prices and prove that the depreciation of the US dollar is a key factor driving up international crude oil prices. Chen and Chen (2007), Coudert et al. (2008), Lizardo and Mollick (2010) and recently by Basher et al. (2012) report the one-way Granger causality of international crude oil prices and exchange rates. Turhan et al. (2013) find that the rise in international crude oil prices leads to significant appreciation of emerging economies against the US dollar.

The rise in international crude oil prices has led oil-importing countries to transfer wealth to oil-exporting countries. The impact of this shift on the exchange rate depends on the short-term investment preference of oil-importing countries. But in the long run, the exchange rate depends on the import preferences of countries. They further find that oil-exporting countries, usually the Organization of Petroleum Exporting Countries, have strong preferences for dollar-denominated assets rather than US goods. Therefore, oil prices will rise to the dollar's appreciation in the short term, but will not affect them for a long time.

### 2.3 Two-way influence relationship between oil price and exchange rate

However, recent researches have shown that the relationship between oil prices and exchange rates is both time–frequency and two-way. Based on these studies, Tiwari and Albulescu (2016) analyzes the lead–lag relationship between the oil price return series and the Indian rupee against the US dollar. Using continuous wavelets, this method can be used to see the direction and intensity of Granger causality and the lead–lag relationship of variables over time and frequency. In addition, by applying Continuous Wavelet Transform (CWT), we are able to identify periodic and anti-periodic relationships, as well as periodic fluctuations/jumps and structural interruptions. Uddin et al. (2013) strike a balance between the time domain and the frequency domain of the data. Using the wavelet analysis method, it is found that there are differences in the time span between the real effective exchange rate and the oil price growth return.

Groen and Pesenti (2009) attempt to use the exchange rate to explain the predictions of oil (and other commodities); interestingly, Amano and van Norden (1998) argue that if the model combines oil prices, exchange rate prediction will improve. Yousefi and Wirjanto (2004), Krichene (2006), and Zhang et al. (2008) find that this relationship ranges from exchange rates to international crude oil prices, while Benassy-Quere et al. (2007), Chen and Chen (2007), and Coudert et al. (2008) provide evidence supporting the direction of the relationship from international crude oil prices to exchange rates. Ding and Vo (2012), among others, find a two-way association. Empirical studies of oil price–exchange rate linkages between Amano and van Norden (1998), Chaudhuri and Daniel (1998), etc., show evidence of mixed effects.

There has been a large body of literature examining the relationship between oil price volatility and exchange rates, but the relationship between the two is currently inconclusive. On the one hand, Basher et al. (2012), Jammazi et al. (2015), and others have shown that exchange rate fluctuations will affect oil prices. On the one hand, Chen and Chen (2007), Turhan et al. (2013), and others found that oil price volatility is a key factor to explain exchange rate fluctuations. However, Ding and Vo (2012) and others have discovered the two-way influence relationship between oil price and exchange rate.

### **3 Analysis on the impact path of international crude oil price on the exchange rate of oil-importing country**

#### **3.1 Relative inflation rate channel**

The rise in international crude oil prices has directly increased the price of petroleum products and the economic costs of oil-related industries, resulting in an increase in relative price levels. The rise in international crude oil prices has been transmitted to the labor market and the production market, which ultimately affects the commodity market, and promotes the growth of commodity prices, resulting in an increase in the price level. Petroleum, as a basic energy source, is widely used. Its price increase not only pushes up the price of related products, but also increases the cost of products such as synthetic rubber and other downstream industrial products. Higher oil prices will also raise the price of alternative energy sources, such as gas, coal, and electricity. Changes in oil prices will eventually affect every aspect of the national economy. However, it should be noted that this influence also depends on the degree of dependence of a country's economic structure on oil. If international crude oil prices fluctuate for a long time, then oil price increases will be transmitted to commodity price and cause inflation. First, when inflation occurs in a country, the cost of exporting goods in the country will increase, which in turn will affect international prices, thereby weakening competitiveness in the international market and causing a decline in export foreign exchange earnings. At the same time, the import cost is relatively decreased, the quantity of imported goods is increased, and the import profit will increase according to the rising domestic price, which will promote the import of goods and increase the foreign exchange expenditure. In the case of a decrease in foreign exchange earnings from exports and an increase in foreign exchange expenditures, the exchange rate of foreign currency will rise and the exchange rate of the local currency will fall. Second, inflation will reduce the country's real interest rates, causing capital outflows, hindering capital inflows, causing the deterioration of capital account revenues and expenditures, and ultimately leading to the depreciation of the national currency. Moreover,

inflation means a decline in the value of the country's currency, and the reduction of the internal value must affect its external value. Investors will reconsider the exchange rate trend of the country and convert the currency held by the country into other currencies, which will lead to a fall in the exchange rate.

Darby (1982) believes that the rise in international crude oil prices leads to the rise in aggregate prices and the decline in production. As inflation increases, domestic interest rates may rise to offset the impact of inflation. A response to rising domestic interest rates could lead to inflows of foreign capital and appreciation of the currency.

Interest rates may also affect oil prices through inflation. Unexpected inflation erodes the real value of investments such as stocks and bonds. The central bank can respond to deflationary pressures by raising interest rates. International investors seeking better investment in the economic era may be more inclined to invest in re-investment portfolios like oil, which will push up international crude oil prices and further increase investment pressure.

### 3.2 International payment channel

For oil-importing countries, rising oil prices need to pay more foreign exchange reserves for oil imports, resulting in a decline in foreign exchange reserves and an increase in the current account deficit. The balance of payments situation will directly affect the supply and demand of the country's foreign exchange market, which in turn will affect exchange rate changes. Generally speaking, if a country has a balance of payments deficit, it will encounter a situation of insufficient foreign exchange supply in the foreign exchange market, thus contributing to the rise of the foreign exchange rate and the devaluation of the local currency. But the impact of the balance of payments on exchange rates will take a long time. Chen and Chen (2007) explain that if the country is more dependent on imported oil, then a real oil price will make the price of domestic tradable goods higher than that of foreign countries, resulting in the actual depreciation of the national currency. In addition, in order to improve competitiveness, when the oil price shocks increase the terms of trade, the country will have to raise the nominal exchange rate, which will lead to further actual depreciation. If the country accumulates foreign assets, its exchange rate will appreciate. The change has not hindered the country's current account balance, as capital income has taken over the loss of revenues from declining competitiveness. Changes in international assets may affect exchange rates as changes in international crude oil prices affect the balance of foreign trade in all countries.

### 3.3 Speculative trading channel

Oil prices are also heavily affected by speculators' behavior. The increasing financialization of commodity markets may play a role in explaining the link between two stakeholder variables. As fund managers are increasingly arbitrage between commodity and financial hedging, the depreciation of the dollar has caused US asset prices to fall, causing them to turn to oil and thereby increase their prices. Finally, US monetary policy may also provide an indirect channel for transmission between oil prices and the US exchange rate, since narrow monetary policy may lead to a rise in the dollar and a fall in international crude oil prices.

Commodity futures are increasingly being used by these financial operators to diversify their portfolios. While oil dominates commodity contracts, more and more investors are using oil futures as a diversified portfolio.

### 3.4 Expected channel

In today's highly developed international financial market, the expected impact on the exchange rate should not be underestimated. Whether it is oil supply, demand, price expectation, or geopolitical, new oil field development, new exploitation technology and climate change mitigation policies (Zhifu and Meng 2017; Zhifu et al. 2018), it will directly or indirectly affect the exchange rate through the international crude oil price.

In terms of supply, oil prices are related to the basic investment in production. As a result, rising oil prices have led to an increase in production costs, resulting in a decline in spending power. This will reduce the demand for non-traded goods that can trigger price declines, resulting in a real exchange rate depreciation. Papers by Amano and van Norden (1998), Chen and Chen (2007), Benassy-Quere et al. (2007), and Lizardo and Mollick (2010) support this view. The rise in oil prices will also affect the country's wealth by shifting the income of oil-importing countries to oil-exporting countries in the form of trade balance. The imbalance in trade balance leads to exchange rate fluctuations.

It can be seen that the impact of rising international crude oil prices on exchange rate levels cannot be generalized. It depends on the relative extent of the impact of oil prices in individual countries and which channels have a greater impact on the country.

## 4 Empirical research methods for the impact of international crude oil price fluctuations on oil-importing countries

### 4.1 Methods for studying causality

In the literature on the macroeconomic effects of oil price shocks, the vector autoregressive (VAR) approach is popular because it is suitable for capturing dynamics and interdependencies between macroeconomic variables. And the impact on international crude prices can be identified by imposing restrictions. One problem with this approach is that it only considers the general international crude oil price shock, but as Kilian (2009) points out, international crude oil prices are driven by different structural supply and demand factors in the world oil market. Huang and Guo (2007) study the impact of oil price shocks and other three potential economic shocks on China's real exchange rate trends by constructing a four-dimensional structural VAR model. Rautava (2004) uses VAR and cointegration techniques to analyze the impact of international oil prices and real exchange rates on the Russian economy and its fiscal policies. It is concluded that the oil price is related to the actual depreciation of the long-term ruble. Lizardo and Mollick (2010) find that real oil price increases cause the dollar to depreciate sharply against the currencies of net oil exporters such as Canada, Mexico, and Russia. On the other hand, when the actual oil price rises, the currencies of oil-importing countries such as Japan depreciate against the US dollar.

The vector error correction model (VECM) can be used to observe the long-term equilibrium relationship between variables. The MS-VECM model is very helpful in dealing with data driven by external events. Beckmann and Czudaj (2013) use Markov switching



vector error correction models to analyze the long-term and time-varying short-term dynamic relationships between oil prices and the US dollar exchange rate using monthly data from various oil-exporting and oil-importing countries. The results show that although there are differences between the observed economies, the most important causal relationship is from the exchange rate to the oil price, and the depreciation of the dollar triggers the rise in oil prices. Chen and Chen (2007) use monthly panel data from 1972 to examine the relationship between actual oil prices and real exchange rates in G7 countries. The results show that the actual oil price may be the main source of exchange rate changes, and there is a link between the actual oil price and the real exchange rate. But this approach applies to symmetric limits on prices and nominal exchange rates, ignoring potential dynamics.

#### 4.2 Methods for studying the effects of oil price fluctuations

This type of empirical research mostly uses the univariate and multivariate generalized autoregressive conditional heteroskedasticity (GARCH) methods to study the volatility spillover effect. Aloui et al. (2013) use the copula-GARCH method to study the condition-dependent structure between crude oil prices and the US dollar exchange rate. It is also found that there is a significant and asymmetric relationship between oil and exchange rate between 2000 and 2011, and the rise in oil prices is considered to be related to the depreciation of the dollar. Ding and Vo (2012) use multivariate stochastic volatility (MSV) and multivariate GARCH (MGARCH) models to study the volatility interaction between the oil market and the foreign exchange market. The results show that when the market is relatively calm, the oil and foreign exchange markets respond to shocks almost simultaneously and are very effective in dealing with information. However, during the turbulent period, there is a two-way wave of interaction between the two. Mensi et al. (2017) use the copula method to examine the average and tail dependence of the two financial time series between the short- and medium-term oil and foreign exchange markets in 25 countries. The results show that there is a significant time-varying and high-average (tail) dependence between oil revenues and the foreign exchange market (i.e., net oil deliverers) in the short and medium term. But the dynamic dependence between oil and the currency of the net receiving country is relatively low.

#### 4.3 Methods for studying nonlinear structure

The last type of empirical research uses a nonlinear model such as wavelet correlation and multifractal detrended cross-correlation analysis (MF-DCCA) method to study the nonlinear structure of the relationship between petroleum and exchange rate markets. Oil price volatility has become one of the main sources of macroeconomic fluctuations such as economic activity and inflation (Hamilton 1996, 2003, 2008). However, the linear model fails to address the potential asymmetry between oil price volatility and the impact of the business cycle phase (Hamilton 2011). Although most empirical studies dealing with causality focus on linear relationships, in view of the increasing evidence of nonlinear dynamics of oil prices and exchange rates and other financial time series indicators, there is growing interest in time-based nonlinear causality. Several well-known studies have shown that the traditional Granger causality test (designed to detect linear causality) is ineffective in revealing certain nonlinear causal relationships. So nonlinear causality tests are gradually welcomed (Wang and Wu 2012). Bal and Rath (2015) solve this research problem in the context of India and China. By applying

the nonlinear Granger causality test of Hiemstra and Jones (1994) to VAR residuals, the study finds that there is a significant two-way nonlinear Granger causal relationship between oil prices and exchange rates. The results of the study show that regardless of the exchange rate system, the nonlinearity of international crude oil prices will affect the exchange rate. In China, oil prices may not lead to exchange rates in a nonlinear manner, because the Central Bank of China has actually linked its currency to the US dollar, while in India, two-way nonlinear factors seem to capture the real situation in the country.

Using wavelet analysis to decompose time series on different timescales, we can study the relationship between sequences on a daily scale. The non-stationary characteristics of time series cause some problems, which can be alleviated by wavelet transform. The main benefit of wavelet analysis is that it can decompose macroeconomic time series into a set of time components, each of which clarifies the temporal development of the signal at a particular observed scale. The relationship between crude oil price and exchange rate market is analyzed by wavelet multiresolution analysis.

Reboredo et al. (2014) analyze the oil exchange rate dependence by using the detrended correlation analysis to determine the differences and changes of the oil exchange rate relationship in different timescales. The results show that after the global financial crisis on all timescales, the negative dependence between the currency and the US dollar increases, providing evidence of contagion and interdependence between oil prices and exchange rates. Jammazi et al. (2015) explain crude oil price changes by using a wavelet-based nonlinear autoregressive distribution lag model (W-NARDL). This model is suitable for detecting extreme motion and eliminating noise in raw data. Aloui and Jammazi (2015) use three wavelet-based models (wavelet EGARCH with dynamic conditional correlation, wavelet Copula, and wavelet extremum) for crude oil prices and US dollar exchange rate data. The results show that the wavelet-based model improves the accuracy of the combination of oil price and expected short-term oil exchange rate. Tiwari and Albuлесcu (2016) use the wavelet method to study the linear and nonlinear causal relationship between the real effective rupee exchange rate gain and the oil price return in the time frame, and find that the causal relationship between the rupee exchange rate and the oil price is frequency-dependent. At lower timescales (high frequencies), no causal relationship is found; but in a higher range (low frequency), a causal relationship can be found. Most empirical literature examines the relationship between oil prices and exchange rates through different models. These models measure the relationship between the two on a timescale of both long term and short term and often cannot observe the common motion of these variables on different timescales. Muntazir Hussain et al. (2016) use a detrended cross-correlation approach (DCCA) to investigate the common changes in international crude oil prices and exchange rates in 12 Asian countries. This model is more robust in the presence of unit roots.

VAR is suitable for capturing dynamics and interdependencies between macroeconomic variables, but it only considers the general international crude oil price shock. VECM can be used to observe the long-term equilibrium relationship between variables. GARCH model takes into account the persistence in the variances of oil price and exchange rate and is suitable to study the volatility spillover effect. Compared with the standard time series recording model, wavelet method allows time series to study frequency component and time information. At the same time, the multiresolution decomposition of wavelet transform can be used to identify the infectivity and mutual dependence between markets.

## 5 Conclusions and prospects

As an important economic resource, frequent fluctuations in international oil prices have an important impact on a country's economic stability. Among them, the exchange rate is a key transmission variable. The exchange rate changes have brought great financial risks to oil companies, which has seriously affected the cost control and profit growth of oil companies. The risks brought about by fluctuations in international oil prices will inevitably have a greater impact on the development of a country's economy. Understanding the relationship between oil price fluctuations and exchange rate, and sorting out the influence path between oil price and exchange rate is conducive to oil price risk management and plays an important role in the steady development of national economy.

This paper reviews the relevant classical theories and recent achievements in the research field in detail. At the same time, this paper combs in detail the impact of international crude oil prices on the exchange rate of oil-importing countries and the relationship between oil price fluctuations and exchange rates. At the end of the paper, the methods commonly used in empirical analysis are summarized. The conclusions are as follows:

1. This paper first analyzes the relationship between international crude oil price volatility and the exchange rate of oil-importing countries and summarizes the relationship between international crude oil prices and exchange rates from multiple perspectives. Due to the different methods of use, the relationship between the two is not conclusive. Long-term and short-term factors should be considered in this area of research.
2. By exploring the impact path of international crude oil price fluctuations on the exchange rate of oil-importing countries, it is found that international crude oil price fluctuations can affect the exchange rate of oil-importing countries through relative inflation rate, balance of payments, speculative trading, and expected channels, but their impact levels cannot be generalized.
3. There are many methods used in empirical research. Multivariate models such as VAR, VECM are used to describe the causal relationship between crude oil prices and exchange rates and their mutual influence. Univariate and multivariate GARCH models are suitable to study the volatility spillover. Nonlinear models such as wavelet correlation and MF-DCCA method are used to study the nonlinear structure of the relationship between petroleum and exchange rate markets.

Finally, the possible research directions in the future are proposed:

1. The inherent law of oil price fluctuation buffer under different exchange rate system

Considering the inherent law of oil price fluctuation buffer from the perspective of exchange rate system, this will help to promote and improve the existing exchange rate system selection theory and comprehensively enhance the theoretical value of existing oil price impact exchange rate research. At present, the research on this issue has been carried out on the empirical level, but there is a lack of unified theoretical analysis frame. The ability of different exchange rate regimes to resist oil price shocks remains to be further studied. Most previous studies have analyzed the relationship between international crude oil prices and exchange rates in developed countries, while research in small open economies and emerging countries is relatively rare.

## 2. Transmission mode and intensity of oil price fluctuations on exchange rate

It is possible to reveal the mechanism of the impact of new oil price fluctuations on the exchange rate by looking for oil market and foreign exchange market information transmission mode and tracking information transmission intensity. The exchange rate is an important proxy variable for the stability of the national economy. Studying the information transmission mode of oil price fluctuations not only can grasp the mode and intensity of information transmission between markets in real time, but also strengthen the risk management in the oil market and foreign exchange market and rational allocate of foreign exchange assets. At the same time, it has important practical significance and policy value for monetary authorities to improve the effectiveness of market intervention.

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