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CO-MOVEMENT OF DYNAMIC RESPONSES OF EXCHANGE RATES TO OIL PRICE

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ABSTRACT

With globalisation and financialisaton, exchange rates could be sensitive to oil price shocks. Due to differences of exchange rate policy, oil-dependence status, and other factors, the responses of exchange rates to oil price shocks could be either similar or heterogeneous. Therefore, in this paper, we integrate a hybrid research framework to investigate the co-movement of responses to oil price shocks of four major exchange rate of currencies included in the Special Drawing Rights basket from January 2000 to September 2018 from a time varying aspect and considering the asymmetric effect of the oil price shocks. The main results are as follows: compared with the general oil price shocks, unexpected oil price shocks could have greater influence on currency markets over time; pairwise exchange rates tend to move in either a negatively or a positively similar way, rather than in an unrelated manner; in 50% of the sampled market time, the co-movement situation of exchange rates' response could be captured by specific small numbers of co-movement modes, with the Euro/US dollar (USD) and Great British Pound/USD tending to co-move in more stable manner and having the potential to serve as an early warning of risk, while other pairwise exchange rates are characterised by time varying features.

Keywords: oil price, exchange rate, responses, co-move, time varying

1. INTRODUCTION

We aim to investigate the co-movement of dynamic responses of exchange rates against the US Dollar (USD) of currencies included in the Special Drawing Rights (SDR) basket, namely, the Euro (EUR), the Great British Pound (GBP), the Japanese Yen (JPY), and the Chinese Yuan (CNY), to different types of oil price shocks, from a time-varying aspect during January 2000 to September 2018.

Why does the co-movement of exchange rates' responses to oil prices shocks over time deserve our attention? The international crude oil trade and its price changes can trigger fluctuations of exchange rates globally since it can redistribute world wealth and disrupt the equilibrium among countries involved in the crude oil trade and one way to turn back towards a new equilibrium is changes of exchange rates [1]. Meanwhile, almost all the international crude oil trade is invoiced in USD [2], and this was especially the case before the launch of Shanghai INE crude oil futures, therefore most countries involved in the crude oil trade need a currency exchange between their domestic currencies and USD, which enhances the interaction between crude oil prices and exchange rates against USD [3]. Even more, with the globalisation and the financialisaton of the crude oil market, portfolio managers, and investors increasingly brought the crude oil into their currency portfolio, strengthening the co-movement between the crude oil market and currency markets [4]. In this situations, especially for the countries that are deeply involved in the crude oil trade and integrated within the global market, the currencies could be sensitive to changes in the crude oil trade. However, due to differences of exchange rate policies [5], oil dependence status, and financial market efficiency [6], among other factors, the responses of exchange rates of different countries to the oil price shocks may be heterogenous, which means that exchange rates in different countries could respond to the oil price in either similar or different ways. With the profound influence of oil price shocks, the design of portfolio and risk reduction strategies involving currencies are at the forefront of increasing challenges and difficulties. For example, exchange rates moving similarly after oil price shocks being chosen in one portfolio could easily increase the possibility of loss of the investment. In contrast, portfolios consisting of exchange rates that move differently when attacked by oil price shocks will have greater ability to diversify the risks brought by the oscillations of the oil price. Therefore, accurate estimation of similarities of co-movement of exchange rates' dynamic responses to oil prices could provide specific information to help

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stakeholders' decision-making to diversify the risk and pick the references for risk early warning.

Given the importance and complexity of the interactions between oil price and exchange rates, many studies have sought to add relevant theoretical and empirical evidence. We distinguish our work from previous studies in two respects. To our best knowledge, this paper is the first paper that tries to examine the similarities of responses of exchange rates to the oil price shocks; previous studies have focused mainly on the specific impact of the oil price on the exchange rate and paid less attention to how similarly of differently the examined exchange rates respond to oil prices shocks. From previous studies, we have good knowledge of how specific exchange rates respond to oil price shocks; however, we do not have accurate information about the responses of exchange rates to oil price shocks compared with each other, whether they are similar or different and to what extent. Moreover, we do not know how these similarities or differences evolve over time. Therefore, to deepen our understanding of oil price–exchange rate nexuses, specifically, our understanding of the responses of exchange rates after oil price shocks. we integrated several effective approaches into a research framework to examine whether exchange rates' responses move in either a similar or a heterogenous manner over time after oil price shocks occur.

2. METHODS AND DATA

2.1 Methods

In this paper, we examine how co-movements of responses of four major exchange rates to oil price shocks evolve over time. To this end, we first divide the whole sample period into sub-periods using the sliding window technique. Then, build a pairwise VAR model for four pairs of exchange rate and oil price shocks in each subsample period and estimate the responses of exchange rates to oil price shocks. Thus, in each subsample period, there are four response series of exchange rates. We further calculate the correlation coefficient of any two response series and form a correlation matrix. The correlation matrix can also could be defined as a co-movement mode; over time, there can be a sequence of co-movement modes. Taking co-movement modes as nodes and the transferring between co-movements over time as edges, the co-movement mode sequence can be constructed as an evolution network model. Exploration of the features of the evolution network can help in attaining more explicit information concerning the interaction between four major exchange rates and oil price shocks. The research framework stated above is displayed in Figure 1. In the following sub-section, more details of the methods used and data for this study are described.

2.2 Data

The data in this paper consist of the daily closing spot price of Brent crude oil benchmark and USD nominal exchange rates of the four major currencies included in the SDR basket from January 2000 to September 2018; these are the EUR, the GBP, the JPY, and the CNY. The Brent oil price is obtained from the US Energy Information Administration, and major exchange rates are obtained from the Federal Reserve..

3. RESULTS

3.1 Dynamic responses of exchange rates over time

We examine the dynamic impulse response of exchanges to oil price shocks (op and sop) in subsample periods and identify the maximum value of the response series in each sub period (Figure 1). The maximum response values of all exchange rates swing between positive and negative values, which indicates that the oil price shocks' impacts on exchange rates are not always consistent in terms of directions over time.

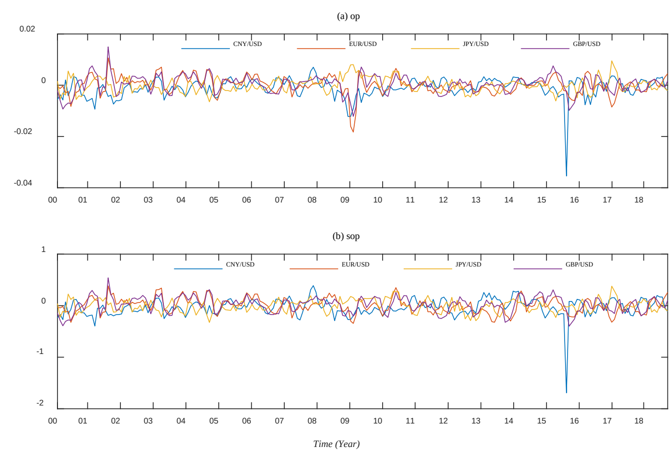


Figure 3. Maximum response values of four exchange rates to oil price shocks (op and sop) over time

The trends of the maximum response values of the four exchange rates for op and sop generally move in similar manners, except for some occasions, such as the financial crisis period. In particular, EUR/USD and GBP/USD move in exactly the same way, which can be attributed to closer linkages between the two economies and their floating exchange rate systems. On closer inspection, the maximum responses values for sop are much stronger than are those of op, especially the response value of CNY/USD in the middle of 2015. Thus, we infer that the oil price shocks tend to have a greater influence on the exchange rates when the oil price changes are unexpected than when the oil price changes are more stable.

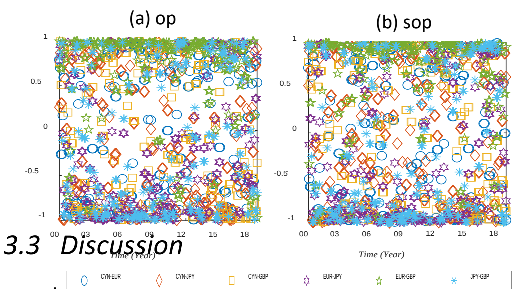
As for the extreme impact of the oil price shocks on exchange rates, responses of CNY/USD in the middle of 2015 is much greater than the responses of other exchange rates or its own responses at other periods. In 2015, the CNY underwent strong depreciation, and it recovered slowly and toughly after reaching its lowest point historically; meanwhile, the Brent oil price declined dramatically. Hence, it seems that the oil price stimulated significant depreciation of CNY/USD. However, other factors are also worth attention. Chinese exchange rate system takes a basket of currencies as reference in 2015, which allowed wider oscillation range of CNY exchange rate. At the same time, the US recovered gradually from the global financial crisis and began to increase the interest rate. Consequently, the USD tended to appreciate and the interest rate difference between CNY and USD become much small , which puts great pressure to CNY. Thus, in this situation, the fluctuations of the oil prices could shock the CNY exchange rate against US dollar in a negative manner dramatically with the help of the appreciation USD and its own adjust system.

3.2 Evaluation of co-movement among exchange rates' impulse responses

Co-movements of the impulse responses of exchange rates to oil price shocks are estimated through the correlation coefficients of pairwise impulse responses of exchange rates to oil price shocks. In Figure 6, it is obvious that the correlation coefficients between any two impulse responses of exchange rates has higher possibility to be the value closing to -1 or 1, which proved by the histogram with a clearer view (Figure 2).

The correlation coefficient of two exchange rates' impulse responses to oil price shocks indicates the similarity of movement or changes of two exchange rates when they are shocked by oil price changes. The fact that the correlation coefficients are close to 1 means that the two exchange rates move in a very similar way after the oil price shocks. Thus, when the impulse responses of two exchange rates move in a similar manner, it would be a good idea for these two currency markets to consider each other as representing an early warning of risk. When one currency market is shocked by oil price changes, the other currency market also has a high possibility of being influenced by the oil price shocks. Thus, information of the direction and amplitude of fluctuation of the currency market having similar response to the oil price shocks could be valuable for each other for strategy designing of avoiding risk and taking precautions against exogenous oscillations.

The correlation coefficients being either equal or close to -1 means that the two exchange rates move in opposite direction in response to an oil price shock. In this situation, two currency markets whose correlation coefficient is negative meaning their responses to oil price shocks could be considered as the diversification choice for risk hedging.



3.3 Discussion

In this section, we model the co-movement of exchange rates' impulse responses for 6 types of oil price shocks with 6 separated network models (Figure 8). The whole sample period is divided into 230 sub periods, with a sliding window size of 60 days and a step length of 20 days. Correspondingly, the 230 nodes in each co-movement evolution network could, in theory, be any one out of 729 (36), but the actual number of nodes in each co-movement evolution network is much smaller than 230, since there is repeated appearance of co-movement modes. The number (types) of co-movement modes in all evolution network models is approximately 60, and the number of edges ranges from 139 to 153. Considering the practical market situation, the repeated appearance of co-movement modes reflects the fact that, in our sample period, certain correlation modes appear frequently, and exchange rates' responses to oil price often behave in a persistent manner. This information could facilitate identification of a market situation that occurs more often than do other market situations associated with interactions between oil price shocks and currency markets, and it could also be used to help specific currency markets reduce the risk related to oil price shocks.

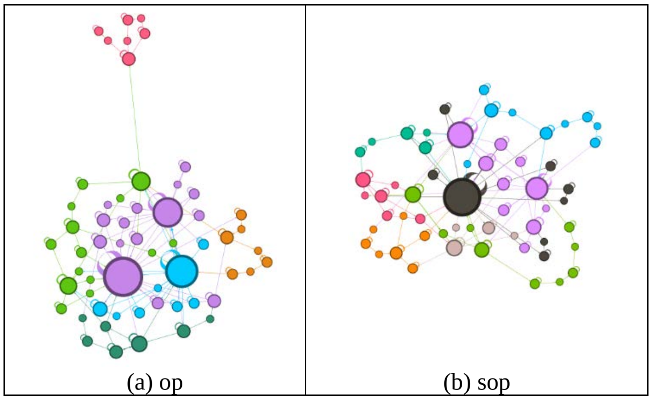


Figure 3. Evolution network model of co-movements of impulse responses of exchange rates

The basic network features show that transferring among co-movement modes may not be very easy for any two modes. So, is this caused by the fact that transferring of co-movements happens mainly among certain numbers of modes? The cumulative percentage of weighted out-degree for each network model reveals that the above inference could be true, since the weighted out-degree measures the number of co-movement modes that one given mode could transfer to. To be specific, approximately 10 co-movements in each network model are major co-movement modes. In other words, during 60% of the sample period, 10 co-movements take a dominant role, and 30 modes out of approximately 60 co-movement modes determine the market status during 80% of the sample time (Figure 9). Therefore, in the co-movement evolution networks, a certain amount of co-movement modes play dominant roles and can also be considered as a proxy for the normal currency market co-movement situation when they are shocked by the oil price.

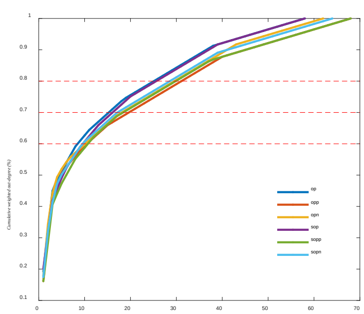


Figure 9. Cumulative percentage of weighted out-degree of co-movement modes

4. CONCLUSIONS

Due to different exchange rate regulation policies, oil dependency status and economy openness extent, etc. Different currency markets may respond to the oil price shocks in different manner. Therefore, it is necessary to investigate the similarity or co-movement of major exchange rates' responses to oil price shocks to obtain more accurate information for currency markets to design specific strategies to lower the risk arising from oil price shocks.

Through integrating the sliding window method and the VAR model, we have carried out dynamic observation of the responses of four exchange rates to oil price shocks in terms of response direction and amplitude. We find that, in respect of the response direction, there is no significant difference between the op and sop, whereas the amplitude of the response of the exchange rate to sop is greater than is that of the response to op. Thus, unexpected oil price shocks could have greater influence on currency markets over time.

In estimating the correlation coefficients of pairwise exchange rate responses, we define the co-movement mode that reflects the similarity of the responses of the four exchange rates to oil price shocks, when they come. Based on primary observation, we find that generally pairwise exchange rates tend to move in either a similar or a positive way, rather than in an unrelated manner; for example, JPY/USD and GBP/USD tend to respond to various oil price shocks in opposite ways, and they could act as effective hedging choices for each other.

With the network model we transform the co-movement modes over time into the evolution network model. Given the repeated appearance of certain co-movement modes, there are approximately 60 kinds of co-movement modes for 230 subsample periods. And we find that, during nearly 50% of the sampling period. In this situation, the co-movement of exchange rates' responses is quite stable over a certain short period. The Euro/USD and the Great British Pound/USD are similarity for 50% of the sample time; thus, they could consider each other as early warnings of risk. The co-movement status of other pairwise exchange rates is characterised by time varying features, when choose hedge choice and risk reference should be more careful.

In summary, within the framework of our combined model, we examine the dynamic evolution of similarities in the responses of exchange rates to oil price shocks and present more specific information, using four sampled exchange rates, as to how to protect against fluctuations arising from oil price shocks.

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