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Divisia Decomposition Method and Its Application to Changes of Net Oil Import Intensity*

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Abstract: The existing oil import dependence index cannot exactly measure the economic cost or scales, and it is difficult to describe the economical aspect of oil security. To measure the foreign dependence of one country's economy and reflect its oil economic security, this paper defines the net oil import intensity as the ratio of net import cost to GDP. By using Divisia Index Decomposition, the change of net oil import intensity in five industrialized countries and five newly industrialized countries during 1971—2010 is decomposed into five factors: oil price, oil intensity, oil self-sufficiency, domestic price level and exchange rate. The result shows that the dominating factors are oil price and oil intensity; moreover, the newly industrialized countries have higher net oil import intensity than industrialized countries.

Keywords: net oil import intensity; Divisia index; decomposition method

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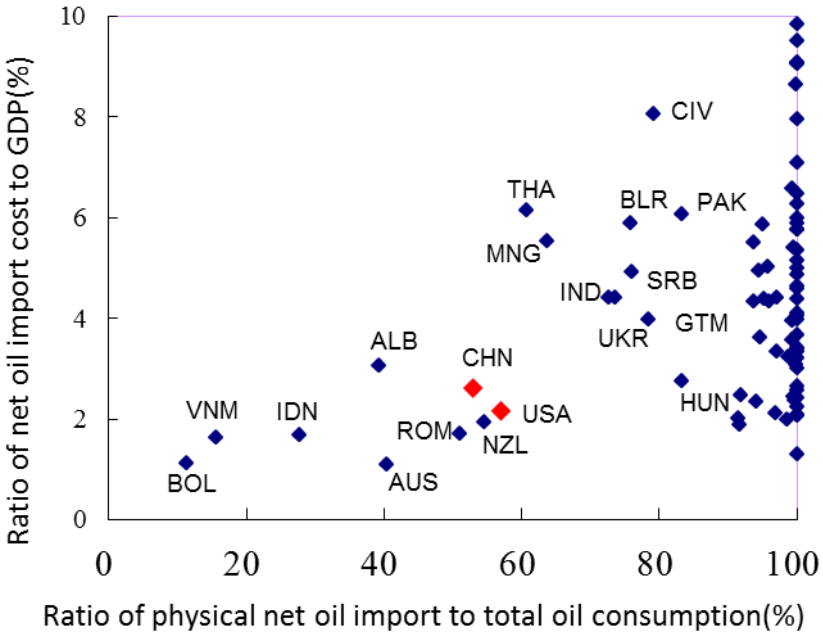
The oil foreign dependence ratio is a common index to measure oil security, and it is usually measured by the physical net import oil divided by total oil consumption. Generally, it is believed that for countries with oil import dependence higher than 50%, the more oil security is influenced by the international market, the higher the risk and insecurity. However, this index can only reflect one aspect of oil security, and it is incomplete to measure the oil economic security alone. As shown in Fig. 1, where data are from World Bank (WB), International Energy Agency (IEA) and authors' calculation, the oil import dependences are nearly close, but the ratios of net oil import cost to GDP are greatly different [1]. Although some countries have very high oil import dependences (even nearly 100%), their actual consumption scale is very small, the ratio of oil consumption to their total energy consumption is very low, and the ratio of net oil import cost to GDP is also low. For these countries, oil security is probably not a critical problem. Note that the oil foreign dependence ratio and volume of net oil import are both calculated based on physical quantities, which cannot reflect the economic cost.



ALB—Albania；AUS—Australia；BLR—Belarus；BOL—Bolivia；CHN—China；CIV—Cote d'Ivoire；GTM—Guatemala；HUN—Hungary；IDN—Indonesia；IND—India；MNG—Mongolia；NZL—New Zealand；PAK—Pakistan；ROM—Romania；SRB—Serbia；THA—Thailand；UKR—Ukraine；VNM—Vietnam

Fig.1 Foreign dependence of net oil importing countries in 2010

As another commonly index, oil vulnerability is multidimensional and contains various effect factors of oil security. According to ESMAP[1] and APERC[3], the main influences are summarized into three aspects: market risk, supply risk and environmental risk, which are equal to

the influence of the price fluctuation to the macroeconomic in oil market, the influence that the oil supply discontinuity brings, and the environmental problems such as environmental pollution and global warming brought by oil consumption, respectively. Gupta [4] selected 26 oil importing countries and decomposed market risk and supply risk into 7 indicators by principal component analysis. The factors of these literatures do not consider relative weightings, therefore they may involve some double counting. Accordingly, Bacon and Kojima [1],[5] adopted Laspeyres index to decompose the main influence factor of oil vulnerability. Moreover, Kojima [6], Yépez-García and Dana [7] researched on countries in different zones. The above literature mostly consider oil importing countries and oil exporting countries together, but in fact, the negative effect on oil importing countries is much more serious.

This paper defines the ratio of net oil import cost to GDP as net oil import intensity. This index connects oil import with economic development directly, and analyzes the influence of oil import to a country's economy from the aspect of cost. The value quantity is the monetization of physical quantity, which highlights its economic attribute instead of its natural attribute. Compared with the physical quantity, the value quantity can reflect the economic problems more directly.

1. Model introduction

Index Decomposition Analysis has been widely used in fields such as productivity accounting and energy intensity; however, the application in the aspect of oil import and oil security is little [8]. Bacon and Kojima [1]] used Laspeyres index decomposion method to explain a country turning from net oil exporter to net importer. Because it is difficult to Divisia index decomposition when the sign of variable may change, this paper only considers the main net oil importers in the world. Ang [9] proposed the logarithmic mean Divisia index approach, which is a priority in the present decomposion methods. With lots of decomposition factors involved in this paper, the additive decomposition is adopted.

The energy security proposed by IEA in 1974[10] refers to the energy supply that is available, affordable and uninterrupted, and it stresses the influence brought by energy output changes, energy price fluctuation and energy supply discontinuity. When the net oil import intensity is decomposed, the above three aspects need to be considered. In this paper, oil price effect, oil intensity effect, oil self-sufficiency, domestic price effect and exchange rate effect are chosen to explain the net oil intensity in both security and economic aspects.

The model is derived as follows:

$$\begin{aligned} I = N / G \cdot &= P \cdot \frac{O_{\mathrm{c}} - O_{\mathrm{p}}}{O_{\mathrm{c}}} \cdot \frac{O_{\mathrm{c}}}{G_{\mathrm{rl}}} \cdot \frac{G_{\mathrm{rl}}}{G_{\mathrm{cl}}} \cdot \frac{G_{\mathrm{cl}}}{G} \\ &= P \cdot \frac{O_{\mathrm{c}}}{G_{\mathrm{rl}}} \cdot \frac{G_{\mathrm{rl}}}{G_{\mathrm{cl}}} \cdot \frac{G_{\mathrm{cl}}}{G} - P \cdot \frac{O_{\mathrm{p}}}{O_{\mathrm{c}}} \cdot \frac{O_{\mathrm{c}}}{G_{\mathrm{rl}}} \cdot \frac{G_{\mathrm{rl}}}{G_{\mathrm{cl}}} \cdot \frac{G_{\mathrm{cl}}}{G} \end{aligned} \tag{1}$$

where I is net oil import intensity; N is net oil import value; G, G_{rl} and G_{cl} are GDPs in current US dollar, constant local currency with base year and countries differing, and current local currency, respectively; P is international crude oil average spot price; and O_{c}, O_{p} are oil consumption and oil production, respectively.

For the convenience of calculation, Eq. (1) is simplified as follows,

$$I = I_{\mathrm{C}} - I_{\mathrm{P}} = \mathrm{PR} \cdot \mathrm{OI} \cdot \mathrm{PI} \cdot \mathrm{ER} - \mathrm{PR} \cdot \mathrm{SS} \cdot \mathrm{OI} \cdot \mathrm{PI} \cdot \mathrm{ER} \tag{2}$$

where PR is oil price; SS is the ratio of oil production volume to oil consumption volume, i.e., oil self-sufficiency rate; OI is the ratio of oil consumption volume to GDP, i.e., oil intensity; PI is the ratio of GDP in constant local currency to GDP in current local currency, i.e., domestic price level; ER is the ratio of GDP in current local currency to GDP in current US dollar, i.e., the international exchange rate.

By differentiating both sides of Eq. (2) with respect to time, we have:

$$\begin{aligned} I' = &(\mathrm{PR}' \cdot \mathrm{OC} \cdot \mathrm{PI} \cdot \mathrm{ER} + \mathrm{PR} \cdot \mathrm{OC}' \cdot \mathrm{PI} \cdot \mathrm{ER} + \mathrm{PR} \cdot \mathrm{OC} \cdot \mathrm{PI}' \cdot \mathrm{ER} + \mathrm{PR} \cdot \mathrm{OC} \cdot \mathrm{PI} \cdot \mathrm{ER}') \\ &-(\mathrm{PR}' \cdot \mathrm{SS} \cdot \mathrm{OC} \cdot \mathrm{PI} \cdot \mathrm{ER} + \mathrm{PR} \cdot \mathrm{SS}' \cdot \mathrm{OC} \cdot \mathrm{PI} \cdot \mathrm{ER} + \mathrm{PR} \cdot \mathrm{SS} \cdot \mathrm{OC}' \cdot \mathrm{PI} \cdot \mathrm{ER} \\ &+\mathrm{PR} \cdot \mathrm{SS} \cdot \mathrm{OC} \cdot \mathrm{PI}' \cdot \mathrm{ER} + \mathrm{PR} \cdot \mathrm{SS} \cdot \mathrm{OC} \cdot \mathrm{PI} \cdot \mathrm{ER}') \end{aligned} \tag{3}$$

The curvilinear integral of Eq. (3) is as follows:

$$\begin{aligned} \int_{\Gamma} I' dt = &(\int_{\Gamma} I_{\mathrm{C}} \cdot d \ln \mathrm{PR} + \int_{\Gamma} I_{\mathrm{C}} \cdot d \ln \mathrm{OI} + \int_{\Gamma} I_{\mathrm{C}} \cdot d \ln \mathrm{PI} + \int_{\Gamma} I_{\mathrm{C}} \cdot d \ln \mathrm{ER}) \\ &-(\int_{\Gamma} I_{\mathrm{P}} \cdot d \ln \mathrm{PR} + \int_{\Gamma} I_{\mathrm{P}} \cdot d \ln \mathrm{SS} + \int_{\Gamma} I_{\mathrm{P}} \cdot d \ln \mathrm{OI} + \int_{\Gamma} I_{\mathrm{P}} \cdot d \ln \mathrm{PI} \\ &+\int_{\Gamma} I_{\mathrm{P}} \cdot d \ln \mathrm{ER}) \end{aligned} \tag{4}$$

where Γ is the integral path, and it shows the curved section in time interval (0, T). Under the linear homogeneous condition, curvilinear integral is irrelevant to integral path [11], i.e.,

$$\begin{aligned} I_{\mathrm{T}} - I_0 = &(\int_0^T I_{\mathrm{C}} \cdot d \ln \mathrm{PR} + \int_0^T I_{\mathrm{C}} \cdot d \ln \mathrm{OI} + \int_0^T I_{\mathrm{C}} \cdot d \ln \mathrm{PI} + \int_0^T I_{\mathrm{C}} \cdot d \ln \mathrm{ER}) \\ &-(\int_0^T I_{\mathrm{P}} \cdot d \ln \mathrm{PR} + \int_0^T I_{\mathrm{P}} \cdot d \ln \mathrm{SS} + \int_0^T I_{\mathrm{P}} \cdot d \ln \mathrm{OI} + \int_0^T I_{\mathrm{P}} \cdot d \ln \mathrm{PI} \\ &+\int_0^T I_{\mathrm{P}} \cdot d \ln \mathrm{ER}) \end{aligned} \tag{5}$$

Therefore, the absolute magnitude change of net oil import intensity ΔI can be decomposed into oil price effect ΔI_{p}, oil self-sufficiency effect ΔI_{ss}, oil intensity effect ΔI_{oi}, domestic price effect ΔI_{pi} and exchange rate effect ΔI_{er}, with ΔI_{rsd} being the residual part and approaching 0.

$$\Delta I = I_{\mathrm{T}} - I_0 = \Delta I_{\mathrm{p}} + \Delta I_{\mathrm{ss}} + \Delta I_{\mathrm{oi}} + \Delta I_{\mathrm{pi}} + \Delta I_{\mathrm{er}} + \Delta I_{\mathrm{rsd}} \tag{6}$$

Because the actual data are discrete, the numerical value of each effect during each period can be roughly estimated according to the integral mean value theorem. The Sato-Vatria index method for logarithmic mean evaluation is adopted here, i.e.,

$$\Delta I_{\mathrm{p}} = \frac{(I_{\mathrm{C}} - I_{\mathrm{P}})_{\mathrm{T}} - (I_{\mathrm{C}} - I_{\mathrm{P}})_0}{\ln(I_{\mathrm{C}} - I_{\mathrm{P}})_{\mathrm{T}} - \ln(I_{\mathrm{C}} - I_{\mathrm{P}})_0} (\ln \mathrm{PR}_{\mathrm{T}} - \ln \mathrm{PR}_0) \tag{7}$$

$$\Delta I_{\mathrm{oi}} = \frac{(I_{\mathrm{C}} - I_{\mathrm{P}})_{\mathrm{T}} - (I_{\mathrm{C}} - I_{\mathrm{P}})_0}{\ln(I_{\mathrm{C}} - I_{\mathrm{P}})_{\mathrm{T}} - \ln(I_{\mathrm{C}} - I_{\mathrm{P}})_0} (\ln OI_{\mathrm{T}} - \ln OI_0) \tag{8}$$

$$\Delta I_{\text{pi}} = \frac{(I_{\text{C}} - I_{\text{P}})_{\text{T}} - (I_{\text{C}} - I_{\text{P}})_0}{\ln(I_{\text{C}} - I_{\text{P}})_{\text{T}} - \ln(I_{\text{C}} - I_{\text{P}})_0} (\ln PI_{\text{T}} - \ln PI_0) \tag{9}$$

$$\Delta I_{\text{er}} = \frac{(I_{\text{C}} - I_{\text{P}})_{\text{T}} - (I_{\text{C}} - I_{\text{P}})_0}{\ln(I_{\text{C}} - I_{\text{P}})_{\text{T}} - \ln(I_{\text{C}} - I_{\text{P}})_0} (\ln ER_{\text{T}} - \ln ER_0) \tag{10}$$

$$\Delta I_{\text{ss}} = \frac{(I_{\text{P}})_{\text{T}} - (I_{\text{P}})_0}{\ln(I_{\text{P}})_{\text{T}} - \ln(I_{\text{P}})_0} (\ln SS_{\text{T}} - \ln SS_0) \tag{11}$$

2. Variable choice and data processing

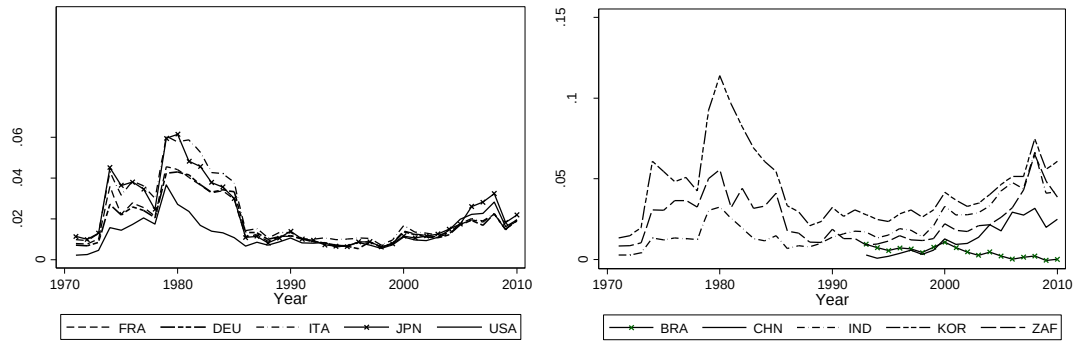
Several net oil importing countries are chosen as research objects in this paper, including five large-scale industrialized countries（i.e., USA, Japan, Germany, France and Italian）, and five newly industrialized countries（i.e., China, Brazil, India, South Africa and Republic of Korea）. World's total oil import volume was 3.30 billion tons in 2011, with the above ten countries accounting for 57.08%. Their GDP was 42.59 trillion US dollars, accounting for 60.86% of world's total GDP value in 2011 (current price). The period of 1971—2010 is selected, during which the world saw such important historical events as three oil crises, Iraq War and Financial Crisis. Because of the availability of data, China's data are chosen from 1993 to 2010, and Brazil's start in 1994. Before 1990, the data of Germany are the sum of East Germany and West Germany.

As three biggest standard crude oil prices, WTI, Brent, and Dubai can account for the oil price changes in North America, Europe and Asia, respectively. The prices are different from each other, because their densities and sulfur content are different. To avoid interference of different markets and different crude oil prices, this paper uses the average spot price of international crude oil calculated by WTI, Brent and Dubai.

The data of WTI, Brent and Dubai crude oil prices come from British Petroleum (BP). The data of net oil import volume and oil consumption come from IEA, where oil production volume is approximately equal to the sum of oil consumption and net oil import. The data of GDP come from WB.

3. Decomposition result

In general, the net oil import intensity fluctuated greatly during the First and Second Oil Crisis and it tended to be steady after 1990-2000 and went into an ascending trend in the 21st century, then came down after the Financial Crisis in 2008. With regard to the five industrialized countries, their changing trends of net oil import intensity were similar. However, those of the newly industrialized countries differed greatly: the net oil import intensity of Republic of Korea stayed high, with South Africa and India following closely; Brazil was on a declining curve, and China was fluctuant in an ascending trend, as shown in Fig.2.



(a)Industrialized countries (b)Newly industrialized countries

BRA—Brazil; DEU—Germany; FRA—France; IND—India; ITA—Italy; JPN—Japan; KOR—Republic of Korea; ZAF—South Africa

Fig.2 Change of net oil import intensity during 1971—2010

The decomposition result of changes of net oil import intensity is shown in Tab.1 and Fig.3. It can be seen that the oil price effect has the greatest contribution, and the oil intensity effect is in the next place. The rise of oil price effect and oil intensity effect can enlarge the net oil import intensity. However, the oil self-sufficiency effect, price effect and exchange rate effect can reduce the net oil import intensity.

Tab.1 Decomposition result of changes of net oil import intensity during 1971-2010

Country	Net oil import intensity	Oil price effect	Oil intensity effect	Price effect	Exchange rate effect	Self-sufficiency effect
France	1.116	4.932	-1.304	-2.296	-0.136	-0.080
Germany	1.252	4.790	-1.231	-1.216	-1.069	0.023
Italy	0.954	5.523	-1.431	-4.178	1.241	-0.200
Japan	1.040	6.323	-1.811	-1.202	-2.278	0.008
USA	1.786	3.074	-0.745	-1.173	0.000	-0.540
Brazil	-0.891	0.507	0.009	-1.654	1.314	1.245
China	2.227	1.632	-0.635	-0.839	-0.179	-2.258
India	3.930	5.509	-0.121	-4.205	2.590	-0.144
South Africa	3.126	8.240	-0.859	-9.157	4.984	-0.083
Republic of Korea	4.967	12.428	-0.606	-10.937	3.888	0.194

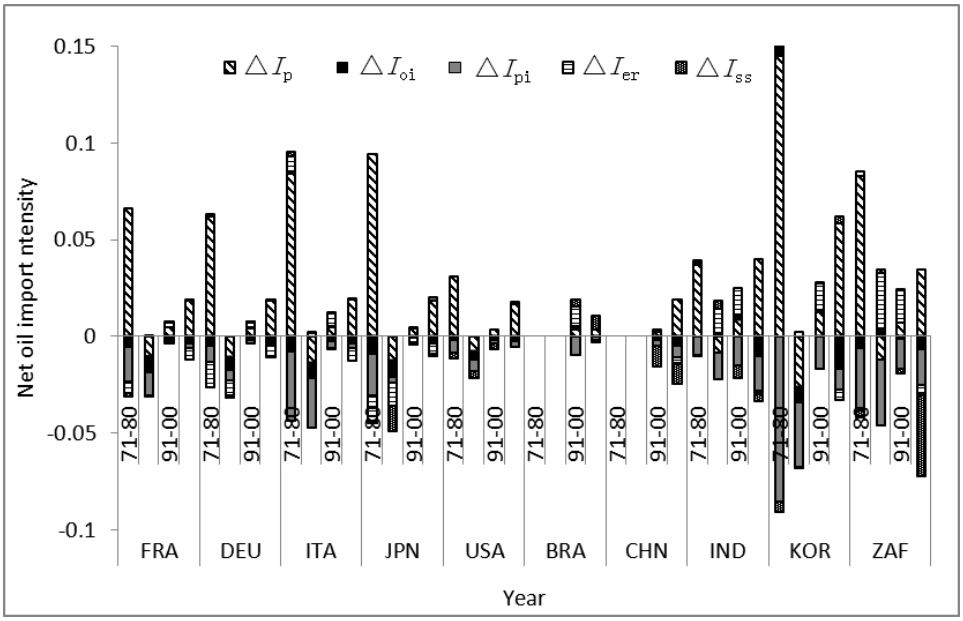


Fig.3 Comparison of each effect that influenced changes of net oil import intensity during 1971—2010

3.1Oil price effect

Hamilton [12] proposed that the energy price fluctuation is one of the key factors that influence USA's economy. We also found that oil price effect is the fundamental factor that influences the net oil import intensity. As Fig.3 shows, the impact of oil price effect for every country is more obvious than other effects. The output of oil resources has been growing rapidly since it was exploited in the middle 19th century, and the oil price has kept cheap and steady. The First Oil Crisis made international crude oil price rise by 4 times from 3.28 US dollars per barrel. After the Second Oil Crisis, the oil price skyrocketed to 36.83 US dollars per barrel (data from BP and authors' calculation). During the two oil crises, the net oil import intensity rose to the peak value. From 1980 to 1990, the oil price was in a declining stage and maintained at a lower level, and the net import intensity also decreased. After entering the 21st century, the global economy was progressively recovered, and the oil price also went up once more. And since the Financial Crisis in 2008, the international oil price has met with the wavy period of rising and falling suddenly and sharply, while the net import intensity and oil price effect have also been sharply changed.

3.2 Oil intensity effect

As show in Fig.4, we can see that the oil intensity effect is declining, and for industrialized countries, this phenomenon is much less obvious than newly industrialized countries. Owing to the heavy losses that the First Oil Crisis brought to the world economy, various countries started to develop policies to encourage the oil substitute from 1973. According to BP[13], the ratio of oil to primary energy consumption will go down from 46% in 1973 to 18.4% by 2030. Different energy production and consumption structures will cause different oil consumption volumes. As big oil importing countries with high foreign oil dependence, France and Japan took great effort to develop nuclear energy after the Second Oil Crisis for the sake of economic security. By the end of 1980s, the nuclear power of these two countries accounted for 70% of their energy production, and thereby their oil intensities were reduced. Furthermore, the old industrialized countries with

large oil import, such as USA and Japan, have accomplished the process of industrialization, so their demand of oil consumption is decreasing step by step. And under the influence of Financial Crisis in 2008, they began to reduce the oil import one after another. The newly industrialized countries are in the stage where industrialization and urbanization are being developed, and the industrial departments are comparatively energy-intensive, resulting in relatively high oil consumption demand. For example, China's economic growth increased by 10% during the period of 1990-2010; meanwhile, its oil consumption also increased by 33%. Obviously, the reduction of oil intensity can reduce the net oil import intensity.

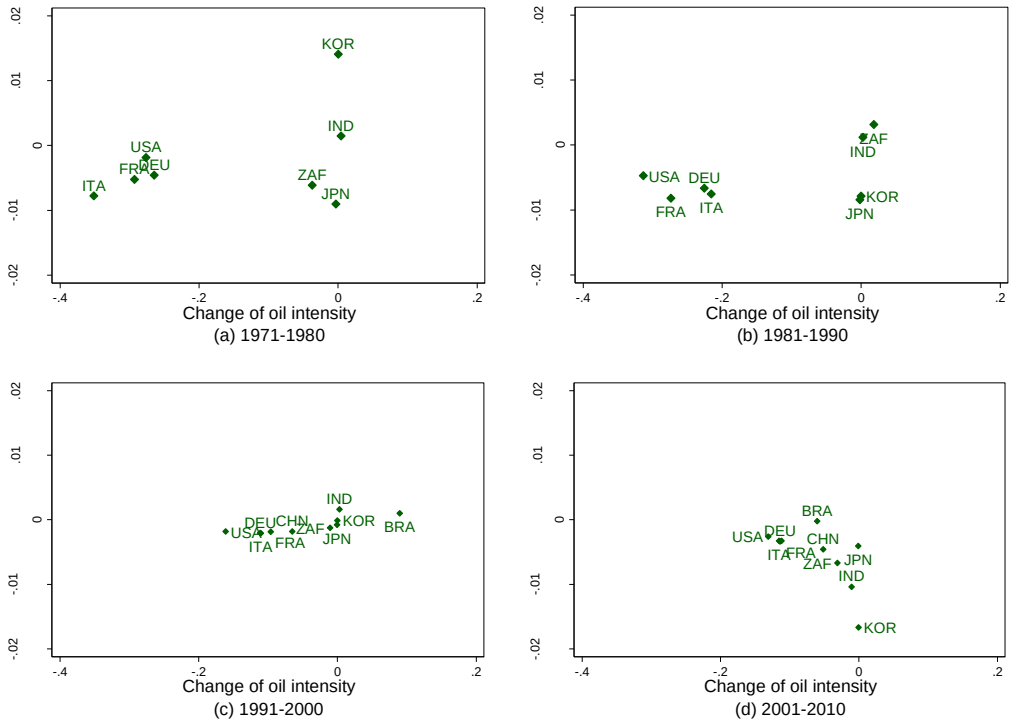


Fig.4 Impact of net oil import intensity on change of oil intensity

3.3 Oil self-sufficiency effect

The higher the self-sufficiency rate, the higher the domestic oil output, i.e., the fewer the oil import volume, the less the import cost. The exploitation of light tight oil and shale gas leads to the rising output of USA's oil and natural gas, and this has undoubtedly stimulated the its economy recovery, and makes the international oil trade turn to Asian market. On the contrary, the oil foreign dependence intensifies in countries such as China and India, due to unfavorable conditions such as inadequate present oil field recoverable reserves, difficulty in the exploration of reserve oil field and the high cost of exploiting. From 1971—2010, China's oil self-sufficiency rate decreased 62%. In recent years, along with the discovery of new oil field, the oil output growth of Brazil cannot be neglected. According to BP [13], Brazil will become the oil exporting country with the fastest acceleration besides the OPEC by 2030. With the rising of oil self-sufficiency rate, the net oil import intensity of Brazil is reduced by 0.9.

3.4 Domestic price effect

It is known that the GDP price deflator is an important indicator to measure a nation's

economy level, and its reciprocal is defined as price level in this paper. The reduction of domestic price effect can increase the net oil import intensity. During 1971—2010, the price was growing globally, as shown in Fig.5. Newly industrialized countries were more vulnerable, especially South Africa and Republic of Korea. The former increased 72 times and the latter increased 29 times. The decline of price level means the rising of domestic price, i.e., the disposal income of people decreases, and then results in the reduction of overall consumption, resulting in the reduction of net oil import intensity.

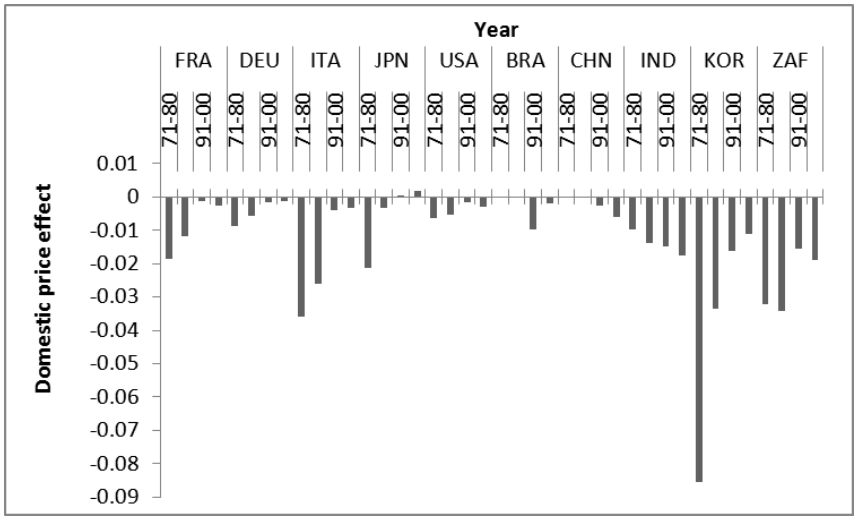


Fig.5 Impact of domestic price effect

3.5 Exchange rate effect

Fig.6 shows that the exchange rate effect during different periods, and it can be seen that newly industrialized countries are affected much more easily. The changes of France, Germany and Italy were due to the introduction of Euro, while for other countries they were related to depreciation of US dollar. Oil is the biggest commodity in international trade, and its import cost is also under the influence of international foreign exchange market [14]. The rise of oil price means that more foreign exchange needs to be paid for oil import, which influences the balance of international payment and thereby changes the foreign exchange market. When the exchange rate of local currency to US dollar rises, the local currency appreciates. As the oil market uses US dollar as the money of account, the unit cost of oil import actually decreases. With the development of energy financialization, energy market will interweave with currency market, foreign exchange market and futures market, therefore the inter-market linkage effect has obviously amplified the uncertainty in oil market [15], and thereby the change of net oil import intensity will also been enlarged.

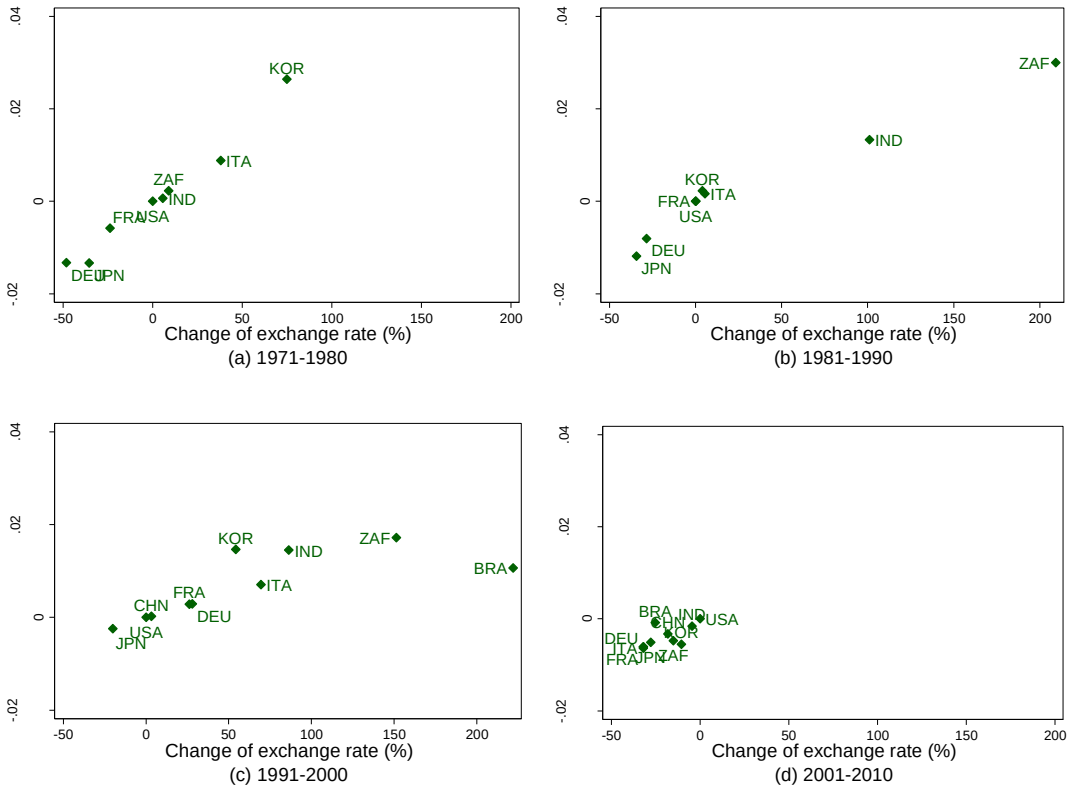


Fig.6 Impact of exchange rate effect on change of exchange rate

4. Conclusions

The changing trends of net oil import intensity for industrialized countries and newly industrialized countries are similar; however, the newly industrialized countries have higher net oil import intensities. The net oil import intensity is difference in different stages of economic development, and the impact of every effect is also difference in different countries.

As far as China is concerned, it has experienced two significant changes. During the 1950s and 1960s, the exploitation of oil fields such as Daqing and Shengli marked the era of "oil for foreign exchange". Yet since the reform and opening-up, China's oil consumption has increased sharply along with the rapid economic development. Because of the technological restriction, the growth of output is slow, and China becomes a net oil importer once more. At present, it is the second largest net oil importer in the world, only next to the USA. According to EIA, China will surpass the USA by the end of 2013[15]. The reduction of self-sufficiency has largely enlarged net oil import intensity. China's energy consumption accounted for 20.3% of world's total consumption in 2010, and becomes the biggest energy consumption state in the world instead of the USA. The oil consumption of China accounted for 10.6% of the world's total amount, while its oil production accounted for 5.2% only, which implies that half of the oil consumption depended on import [13]. High oil intensity and foreign dependence ratio also undoubtedly enlarge the intensity of net oil import. China should reduce the net oil import intensity by adjusting the energy production and consumption structure, e.g., taking efforts to develop clean energy such as natural gas and wind. The lack of market-oriented oil pricing mechanism makes the oil price cannot react to the change of domestic demand; on the contrary, it is directly influenced by the international

financial market, which makes the price security situation far from being optimistic. Therefore，related energy policy and improved market structure are necessary.

References

[1] Bacon R, Kojima M. Vulnerability to Oil Price Increases: A Decomposition Analysis of 161 Countries [R]. Working Paper, 48422, World Bank, Washington , USA,2008.

[2] Energy Sector Management Assistance Program. The Vulnerability of African Countries to Oil Price Shocks-Major Factors and Policy Options: The Case of Oil Importing Countries[R]. ESMAP Formal Report, 308/05. ESMAP, Washington, USA, 2005..

[3] Asia Pacific Energy Research Centre. A Quest for Energy Security in the 21st Century: Resources and Constraints[R]. APERC, Tokyo, Japan, 2007.

[4] Gupta E. Oil vulnerability index of oil-importing countries [J]. *Energy Policy*, 2008, 36 (3): 1195–1211.

[5] Bacon R, Kojima M. Oil price risks: Measuring the vulnerability of oil importers [J]. *Viewpoint*, 2008, 320: 1-3.

[6] Kojima M. Vulnerability to Higher Oil Prices: Decomposition Analysis of 158 Countries between 2003 and 2008 [R]. Working Paper. World Bank, Washington, USA, 2011.

[7] Yépez-García RA, Dana J. Mitigating Vulnerability to High and Volatile Oil Prices Power Sector Experience in Latin America and the Caribbean[R]. Working Paper, 69944. World Bank, Washington, USA, 2012.

[8] Liao H, Wang C, Zhu Z S *et al*. Structural decomposition analysis on energy intensity changes at regional level [J]. *Transactions of Tianjin University*, 2013, 19(4): 287-292.

[9] Ang B W. Decomposition analysis for policymaking in energy: Which is the preferred method? [J]. *Energy Policy*, 2004, 32(9): 1131-1139.

[10] IEA. Oil Supply Security: Emergency Response of IEA Countries 2007. [EB/OL]. http://www.iea.org/publications/freepublications/publication/oil_security.pdf, 2007.

[11] Wei Y M, Liao H. *China Energy Report (2010): Energy Efficiency Research* [M]. Science Press, Beijing, China, 2010 (in Chinese).

[12] Hamilton J D. Nonlinearities and the macroeconomic effects of oil prices [J]. *Macroeconomic Dynamics*, 2011, 15(s3): 364-378.

[13] BP. BP Energy Outlook 2030. [EB/OL]. http://www.bp.com/content/dam/bp/pdf/statistical-review/BP_World_Energy_Outlook_booklet_2013.pdf,2011.

[14] Cabalu H, Manuhutu C. Vulnerability of natural gas supply in the asian gas market [J]. *Economic Analysis & Policy*, 2009, 39(2):255-270.

[15] Wei Y M, Wu Gang, Liang Q M *et al*. *China Energy Report (2012): Energy Security Research* [M]. Science Press, Beijing, China, 2012 (in Chinese).

[16] EIA. China Poised to Become the World’s Largest Net Oil Importer Later this Year[EB/OL]. http://www.eia.gov/todayinenergy/detail.cfm?id=12471, 2013.