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Oil price crisis response: Capability assessment and key indicator identification

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ABSTRACT

China has become the second largest oil consumer and oil importer since 2008. In the context of sustained highly frequent fluctuating oil price, China's oil price crisis response system has been seriously threatened. Twelve indicators of four domains called economic stability, political stability, oil import dependence, as well as oil consumption dependence are used to construct "OPCVI (Oil Price Crisis Vulnerability Index)" system, to estimate China's response capability of oil price crisis. MDEA (Multiplicative Data Envelopment Analysis) is used to identify the weights of each indicator and appraise the OPCVI values between 1993 and 2013. Results show that, oil consumption intensity, GDP(Gross Domestic Product) per capita and the ratio of oil import expenditure to GDP are the three key indicators for China's oil price crisis response capability. China's OPCVI became weak since 2000. This is mainly because that the contribution of positive indicators to OPCVI gradually reduced while the contributions of negative indicators increased. Additionally, the contributions of the key indicators of OPCVI are so concentrated and lack of flexibility that it can easily make China's oil price crisis response capability fall into a dangerous situation. Finally, policy recommendations for enhancing the oil price crisis response capability of China are given.

1. Introduction

International crude oil price has been fluctuating frequently since 1970 (See Fig. 1), which has been greatly impacting the global economy and society. Sustained high oil price seriously threatens the oil price crisis response system of major oil importing countries. As the second largest oil consumer and the second largest oil importer,[1] China has become more vulnerable to high oil price. In that case, oil price crisis response capability assessment and key indicators identification are of great significance to China.

IEA (International Energy Agency) is the first organization to propose oil emergency response system [1]. After several serious oil price crises, study of oil price crisis response system has attracted more attention. Christos et al. [2] compare oil supply security of the 27 European Union member countries during 1995–2007. Eshita [3] assess the relative oil vulnerability of 26 net oil-importing countries for the year 2004. Se-Hoon [4] uses SCCT (situational communication crisis communication theory) and Weiner's attribution theory to explain the public's responses to a corporation that caused by an oil spill accident. Ju et al. [5] investigate the relationship between different oil price shocks and China's macroeconomy. In addition to that, index system for evaluating energy system security and the price of oil security has gradually become the focus of research. Benjamin [6] presents an energy security index which measures national performance on energy security over time. Stephen & Hillard [7] examine the relevant features of the world oil market and provide estimates of U.S. oil security premiums. Based on a survey of 104 studies from 2001 to June 2014, Ang et al. [8] find that the definition of energy security is contextual and dynamic in nature, and the scope of energy security has also expanded, with a growing emphasis on dimensions such as environmental sustainability and energy efficiency. In China, most of the existing studies are established as a review of foreign researches [9–11].

At the stage of data aggregation, the applicability of MCDA (multiple criteria decision analysis) methods has been world investigated [12–22]. A critical issue in applying MCDA aggregation

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[1] Data source: BP statistical of world energy, 2015.

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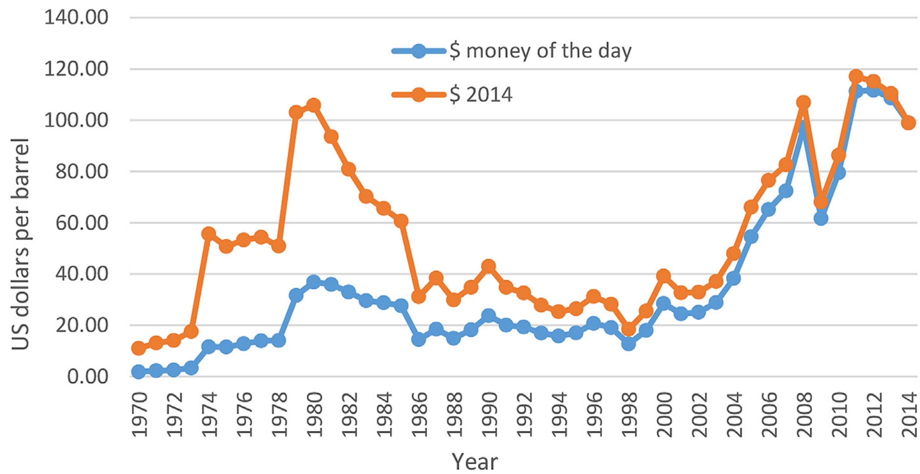

Fig. 1. Oil price since 1970. Source: BP statistical review of world energy, 2015.

methods to construct a CI (composite index) is the subjectivity in assigning weights for the underlying sub-indicators, since different weight combinations may lead to different ranking results. It is unlikely that all entities would easily reach a consensus in determining an appropriate set of weights, in addition, it may not be easy to obtain the expert information for deriving the weights. Although the use of equal weights seems to be a relatively fair choice [23], some entities still have different opinions since they have their particular preferences [24]. Fortunately, the development of modern operational research has provided us an excellent tool called MDEA (Multiplicative Data Envelopment Analysis) which can be used to derive objective weights for use. In addition to MDEA, some statistical methods as PCA (Principal Component Analysis) and FA (Factor Analysis) can also be used to derive the objective weights [17]. However, MDEA does not require any prior assumptions on data while statistical methods do. Furthermore, MDEA can be used to carry out the weighting and aggregation tasks at the same time.

2. Literature review of existed similar researches

There have been some similar researches existed, which are listed in Table 1. It is obviously that, the existed researches are focus on three topics: CI construction [3,26], energy (including oil) price vulnerability [3,11,25–27], and energy security-related researches within certain countries/regions [3,11,25,27]. According to the indicators selections, we can see that some important macroeconomic data (such as GDP per capita, economic growth rate, etc.), energy supply and demand data (such as oil import dependence, oil share in total energy supply, diversification of supply source, etc.), and energy intensity data (such as energy intensity, acceptability of energy, etc.) are chosen for different research targets. Meanwhile, most researches are carried out under statistical methods, mainly for developed or industrialized countries. Note that, statistical models are often built upon some strong assumptions, which are hardly satisfied due to the uncertain nature of oil prices crisis response capability assessment process, thus information loss is inevitable.

To fill this gap and reference to the existed researches, 12 indicators from 4 dimensions called economic stability, political stability, oil imports degree, as well as oil consumption degree to construct a composite indicator, called “OPCVI (Oil Price Crisis Vulnerability Index)” to assess China's oil price crisis response capability from 1993 to 2013. MDEA method is used to identify the weights of each indicator, and appraise the dynamic OPCVI values.

Table 1
Similar studies of various researchers.

Literature	Methods	Indicators	Countries/regions (years)
Eshita G. (2008) [3]	Principal component analysis technique	• Ratio of value of oil imports to GDP • Oil consumption per unit of GDP • GDP per capita • Oil share in total energy supply • Ratio of domestic reserves to oil consumption • Net oil import dependence • Diversification of supply source • Political risk • Market liquidity	26 net oil-importing countries (2004)
Gnansounou (2008) [25]	Euclidian distance	• Energy intensity • Oil and gas import dependency • Electricity supply weaknesses • Non-diversity in transport fuels	37 industrialized countries (2003)
Kruyt et al. (2009) [26]	Model-based scenario analysis	• Four dimensions of energy security that relate to the availability, accessibility, affordability and acceptability of energy	Worldwide (up to 2050)
Gnansounou and Dong (2010) [11]	Logic-based model (LBM)	• Three energy scenarios: Ordinary effort, Promoting Sustainability, Green Growth. • Key drivers of the scenarios: population and urbanization growth, economic growth, integration into the global economy, ….	China (Case study)
Stephen and Hillard (2015) [27]	Welfare-analytic approach	• Three different types of oil-dependence premiums	U.S. (2010–2035)