Physics and Chemistry of the Earth xxx (2017) 1–14

Contents lists available at ScienceDirect

Physics and Chemistry of the Earth

journal homepage: www.elsevier.com/locate/pce

Estimating policy pressure for China's cultivated land use protection based on an extended index

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ARTICLE INFO

Article history:
Received 15 March 2017
Received in revised form
18 April 2017
Accepted 1 May 2017
Available online xxx

Keywords:
Policy pressure index
Cultivated land use
Second model of the LMDI decomposition method
Group decomposition

ABSTRACT

Based on existing references, using the decomposition technique of the second model of the logarithmic mean Divisia index (LMDI) decomposition method and the principle of "jointly created and equally distributed" of the Refined Laspeyres (RL) index, this paper developed a new policy pressure index and applied it to estimate the policy pressure for China's cultivated land use protection. The results indicated that, first, the policy pressure for China's cultivated land use protection experienced an inverted U−shaped evolution from 1997 to 2014 and that the status of cultivated land use protection policy pressure in each province was related mainly to local economic development and industrial structure. Second, agricultural production efficiency and industrial structure exerted positive influences on policy pressure for cultivated land use protection, but economic scale exerted negative influences on it. Third, the differences among areas with different policy pressures were explained mainly by two factors: the economic scale and agricultural production efficiency. The former exerted a positive and the latter a negative influence.

1. Introduction

Natural resources are the key input factors to ensure the development of social economy and human welfare. As human activities expand, the exploitation and protection of natural resources have been receiving extensive attention from governments all over the world (Schilling and Chiang, 2011; Economou and Mitoula, 2013; Su et al., 2016). A series of quantitative methods and indexes has emerged to facilitate the appropriate use of natural resources and evaluate the implementation of related policies (Fernandez, 2006; Alfsen and Greaker, 2007; Stevovic et al., 2014). Using the DMSP stable lights data and regression−adjusted remote sensing technique, Gibson et al. (2015) evaluated the land−protection policy approach, especially for cultivated land, used during the urbanization process in India. Kim et al. (2015) analyzed the impact of fragmented local governance on water resource protection in the United States based on the panel data econometric regression model. To measure the effect of the forest protection policy on the improvement in China's environmental quality in the 20th century, Bone (2016) constructed a complex adaptive system method.

These methods and indexes are chosen for three main purposes: offering information on relevant policies to enable policymakers to evaluate the severity of these problems, recognizing the main factors influencing the achievement of policy objectives in order to enable policymakers to carry out related measures, and evaluating the effects of policy implementation (Bosch et al., 1999). In general, although the actual effect of most natural resource protection measures may fall short of expectations, policymakers themselves can considerably narrow the gap between reality and expectations (Billgren and Holmen, 2008; MacDonald et al., 2013; Cobbinah, 2015). Some scholars believe that this can be achieved by improving the efficiency of natural resource use and relative protection institution and policy. Gutzler et al. (2015) used multiple indexes and proposed the positive impact of intensive agricultural production on regional agricultural production efficiency in Germany. Using the ecological network analysis method, Kharrazi et al. (2016) evaluated the efficiency of water resource use in the Heihe River area of China. Koskela (2015) calculated the mining efficiency of forest resources in Finland based on the Delphi panel and ecological efficiency indicator.

The previous research undoubtedly gives objective standards to evaluate those natural resource protection policies. However, the

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http://dx.doi.org/10.1016/j.pce.2017.05.002
1474-7065/

Please cite this article in press as: Chen, J., et al., Estimating policy pressure for China's cultivated land use protection based on an extended index, Physics and Chemistry of the Earth (2017), http://dx.doi.org/10.1016/j.pce.2017.05.002

path of narrowing the implementation effect between actual and expected outcomes is not unique. If policymakers place a greater emphasis on the protection work of relative natural resources, they would develop and implement protection measures strictly, and bear greater policy pressure. Then, the relative natural resource would be better protected, and the improvement of expected goals would require a higher efficiency of current protection measures. Contrariwise, if policymakers do not concern themselves with protecting a certain natural resource, from, for instance, severe drainage and unbalanced distribution, they fail to develop and implement protection measures strictly, and bear little policy pressure, leading to a lack of protection for the natural resource. After all, reducing the expected goal would lower the efficiency of existing protection measures. Unfortunately, the methods and indexes in existing references do not quantify the amount of policy pressure for natural resource protections that policymakers face.

Recently, Chen et al. (2016a) tried to address this situation. They judged the degree of care in emissions reduction policies and quantified the carbon emissions reduction pressure faced by policymaker by constructing a carbon emissions reduction index (CERI) model. They argued that the carbon emissions reduction policy pressure was not only an objective reflection but also a subjective restriction on policymakers. Considering this situation, Chen et al. (2016a) did not discuss the calculation of the efficiency of fossil energy use and carbon emissions by multiple efficiency evaluation methods as previous (Chen et al., 2015; Alkaff et al., 2016; Suzuki and Nijkamp, 2016) and then judged the carbon emissions reduction policies, but considered the problem from the policymakers' standpoint. Obviously, the perspective in Chen et al.'s (2016a) work had greatly changed. Through induction, they considered that any policy objective would concentrate on two key problems: scale control and distribution optimization. Therefore, Chen et al. (2016a) integrated these two aspects into a unified policy evaluation framework of carbon emissions reduction, analyzing them through a CERI model. The CERI model measures the distribution optimization of carbon emissions reduction policy objectives using a Gini coefficient; thus, Chen et al. (2016a) adopted Gini coefficient incremental decomposition theory to decompose the distribution optimization of the CERI model and identified the influences from changes in per capita scale, population share, and regional ranking.

Chen et al.'s (2016a) work is of theoretical and practical importance; however, the application of the CERI model requires that two key problems be urgently solved: the decomposition of the scale control aspect of policy pressure and the group decomposition of different degrees of policy pressure. The main purpose of decomposition analysis is to determine the driving factors influencing index changes (Ang, 2015; Chen et al., 2016b; Wang et al., 2017a). Chen et al. (2016a) had started promisingly, with their decomposition of the CERI model, but their work was insufficient, as their decomposition analysis of the CERI model involved only distribution optimization. The current CERI model will fail to recognize key driving factors when policymakers are paying special attention to the scale control of a policy objective, and will thus fail to offer policymakers appropriate suggestions for institutional arrangements. Moreover, appropriately explaining and quantifying the disparity between areas with strong policy pressure and those with weak policy pressure is particularly important. If areas with weak policy pressure are regarded as benchmarks, the key goal for policymakers in areas with strong policy pressure is to identify the main factors causing the policy pressure gap and address the situation using the appropriate measures. The factors influencing each area's policy pressure are also influencing the policy pressure disparities. Therefore, this key problem is a continuation of the former problem. However, the main factors causing changes in policy pressure may not be the main factors in the changes in policy pressure disparities among areas. Thus, a further decomposition of the disparities among different policy pressure groups using a special decomposition technique has important practical implications. However, Chen et al. (2016a) had not pursued these two issues.

This paper aims to solve the two problems discussed above and offers guidelines for the application of this index. Decomposition analysis is widespread in the fields of natural resources and energy economics (Ang, 2015; Chen et al., 2016b; Wang et al., 2017a). Decomposition approaches in this field can be divided into structure decomposition and index decomposition (Hoekstra and Van der Bergh, 2003). As the latter has a variety of setting modes and suffers less from data limitations than the former, it has become widespread in recent years. Developing over more than 30 years, the LMDI decomposition model is becoming the most popular index decomposition method (Ang and Zhang, 2000; Xu and Ang, 2013; Ang, 2015). Ang (2015) explained the progress of LMDI's development in detail and divided the LMDI decomposition method into eight models. Every model has a corresponding and special application angle and data. The second and fourth models of the LMDI decomposition method are used to decompose the changes of scale indexes expressed as fractions. These two models meet the decomposition need for scale control in the CERI model. We can thus insert the two models into the CERI model and identify the factors influencing the scale variations of a policy objective and the changes in policy pressure index. Because the fourth model cannot achieve “consistency in aggregation” that the second model can (Ang and Liu, 2001), we adopt the second model of the LMDI decomposition method. Even so, the LMDI decomposition technique cannot decompose the CERI model by groups directly because the CERI model is composed of two parts, and only scale control aspect can conform to the division fraction form. To solve this problem, we need to find other group decomposition techniques. In the field of natural resource and energy economics, there exist many kinds of index decomposition methods. Despite limitations, each can be applied to suitable application scenarios. Sun (1998) proposed a method, which was called “Refined Laspeyres (RL) index” by later scholars (Zhang and Ang, 2001; Albrecht et al., 2002; Diakoulaki and Mandaraka, 2007), to decompose the changes of an index unconstrained by certain forms of products. The key to this decomposition is the principle of “jointly created and equally distributed,” whereby every factor influencing the index variation should be treated equally, and their mutual influence should be distributed equally. Albrecht et al. (2002) queried this approach concerning the decomposition residual term and argued that the rationality of this hypothesis could not be proven. For the CERI model, however, treating distribution optimization and scale control equally has practical advantages: whether scale or distribution, policymakers will not emphasize one thing at the expense of another. Therefore, we can use the decomposition technique of the RL index to decompose the CERI model by group and then determine the factors influencing the disparity variation among the different policy pressure groups.

Cultivated land, as a type of natural resource, is related to national welfare and people's livelihoods. Many countries have carried out preservation policies (Jayne et al., 2014; Ali and Suleiman, 2016; Galinato and Galinato, 2016), but maintaining stable economic growth while conducting both appropriate exploitation and preservation of cultivated land simultaneously is not easy. As Wise et al. (2009) argued, the main challenge in the 21st century was allocating scarce land resources appropriately. On the one hand, increasing industrialization and urbanization require more cultivated land resources (Prajanti, 2014; Salata, 2014; Deng et al., 2015), though the annual expansion in the scale of the world population means that more cultivated land is required to maintain food