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A system dynamics model of coordinated development of central and provincial economy and oil enterprises

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HIGHLIGHTS

- Chinese provincial government should share more oil enterprises' income tax.
- Diversifying sources of investment is able to boost provincial economic development.
- Compensation for environment relieves provincial governments' financial pressure.
- People's welfare hinges on oil enterprises, provincial governments and tax reform.

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ABSTRACT

Based on the characteristics of oil exploration and development and the inherent rule of a coordinated development of central and provincial economy and oil enterprises in oil producing provinces, this paper addresses the principal questions that determine the coordinated development of the central economy, provincial economy and oil enterprises, and establishes a dynamic model for the above three variables. The research takes Shaanxi Province as an example and makes analogue simulation of the situations from 2006 to 2020. The results indicate that China's provincial governments need to share more tax income, reform some taxes on oil enterprises, and China's oil industry needs to be open to both provincial state-owned enterprise and private enterprise. Meanwhile, this research also provides policy proposals for the coordinated development of central and provincial economy and oil enterprises regarding taxation and sustainable development in China's market-oriented economy.

1. Introduction

The coordinated development of economy, energy and environment is a hot issue in the field of energy economy study and has drawn a lot of research attention by scholars of systematic science. For example, Yuan (1998) use nonequilibrium system theory to analyze self-organization and organization mechanism from the perspective of synthesized system coordination (i.e. the "ecology–society–economy" coordination). According to the large system theory, they propose ways for synthesized system coordination and management. Bai and Han (1999) make a deep analysis of regional synthesized system coordination featuring "economy, energy and environment". Most existing papers on the relation between economy and oil enterprises are using qualitative analysis as a major method, and most of them are about the relations between petroleum exporting countries and its petroleum industry. Alim and Wang (2004) demonstrate the coordinated development of economy and oil from the perspective of economy recession prevention after resource exhaustion in resource-oriented cities, while Liu (2007) researches the same issue from energy security perspective. Milani (2009) thinks that the impact of oil prices on production and inflation is not as great as people think in the first place. Some scholars even believe it has positive impacts. In terms of applying system dynamics to oil issues, most of these researches are confined to only one aspect of the oil industry, such as Tan's (2009) discussion on oil refining production capacity, Liu (2009) oil price forecast research, and Tang's (2010) prediction on China's oil production. With the method of definition coordination and system dynamics, Zhang (2009) probes into the issue of coordinated development of resources and society, but he does not mention the development of oil industry per se and the interests' of all the parties concerned.

Economy and oil enterprises are interdependent. In the process of industrialization, both economic development and the improvement of people's living standard call for a lot of energy resource consumption. With the rise of the proportion of oil in energy consumption, its influence on economy is on the increase. The other way around, the economic condition influences the demand

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for oil and, consequently, impacts the income of oil and gas enterprises. As oil is a rare resource, the exploration and development of oil field is an industry that may bring in a lot of actual benefits. This will inevitably brings about a clash of interests between different sides. The interests of oil enterprises and provincial government are contradictory with each other, and the same is true of central and local governments, though in some cases the latter two have common interests. When provincial revenue reduces, the investment in cultivating provincial economic growth points, living standard improvement and environment protection will decrease accordingly. This will aggravate the provincial economic growth and investment environment, and hinder the sustainable development of provincial economy. A rational allocation of the income from oil field development will not only ensure the interests of all the parties involved, but also conduce to the development of both economy and oil and gas enterprises. A sustainable development of energy, environment, economy and society offers a guarantee for the coordinated development of economy and oil and gas enterprises. It also helps to improve the living standard of people in oil producing regions, push the construction of a harmonious society and deepen the implementation of the Scale Development of the Western Regions in China. However, little study has been done in this aspect yet.

This study, based on the deep analysis of the interest relation among central, provincial economy and oil and gas enterprises, attempts to research into the interdependency and the mutual waxing and waning relationships, and tries to find the internal laws and motivations for the development of all parities. By applying system dynamics, this study sets up a model for the coordinated development of central, provincial economy and oil and gas enterprises, which takes into consideration energy, environment, science and technology development, governmental policy, etc. It also adopts computer emulation to examine how capital investment and taxation policy affects the sustainable development of central and provincial economy and oil and gas enterprises. The study takes the case in Shaanxi Province as an example, and tries to work out a solution that coordinates all the parties concerned. It is hoped that this case study will shed some light on the coordinated development of central, provincial economy and oil and gas enterprises.

2. System structure analysis

2.1. Output prediction

In 2009, the production and consumption of crude oil in China are 189 million tons and 380 million tons respectively, and oil import dependency is as high as 50%. The newly proved reserve of the year was 1.12 billion tons, and the remaining exploitable reserve is 2.949 billion tons. Oil production is a basic source of enterprise income and national revenue. To analyze the growth of one certain oil enterprise or one certain oil field, one has to examine the internal law governing the gradual growth and/or recession of oil exploration, the development pattern of oil enterprises (the market players) and their needs. The output of oil is determined by the production capacity of oil enterprises, while production capacity is determined by the unexplored reserve and exploration and development investment. The scale of production capacity, on one hand is determined by decision maker's exploration strategy, and on the other, hinges upon the resource endowment and the scale of investment. The amount of discovered resource is decided by the investment in exploration. The investment in exploration and development is decisively influenced by enterprises' investment capability, national industry policy and investor's investment intention. Under the circumstances of market economy, the major sources of investment capital are the enterprises' own money and loans from banks. As long as the total asset's profit margin is higher than the interest rate of bank loan, a project is worth doing. But an enterprise also has to have considerable amount of disposable funds for investment, as it is not feasible to rely on bank loans alone. The disposable funds can be newly added share capital, or the funds raised from the share market, but they have to be capital obtained in accord with corporate law and securities law. Ultimately, the investment funds of an enterprise come from the accumulation of profits after tax.

Production capacity is also affected by law of diminishing, enterprise's production environment, science and technology, etc. The diminishing output results from the fall of oil field's pressure. The reduction of a single oil well output brings down the total output of a whole oil field. The advancement of an enterprise's science and technology will cut down the cost and lengthen the life span of oil field and hence increase the recovery ratio. The production environment of an enterprise will also influence its cost of exploration.

In this paper, the researchers examine the resource reserve and actual exploration capacity to predict the oil enterprises' production capacity, and then predict the output of the enterprises.

2.2. The central government's gains from oil and gas development

According to the constitution of PRC, central government is the owner of mineral resources and the major investor of oil enterprises. Fossil fuel bears characteristics such as being rare, exhaustible and non-renewable. Oil development can bring in considerable gains, but at the same time, it causes environmental pollution and unfair distribution of benefits. The cost for combating environment pollution is usually borne by the state. Thus, it is understandable that the state get the lion's share apart from taxes on oil enterprises. The central government's gains from oil development include: special gains fee for oils, added value tax, income tax, resource compensation fee, profit and dividend. Taxes and fees are important tools for the government to carry out macro control, realize resource allocation, and reduce energy consumption and carbon emission.

2.3. Provincial governments' gains from oil and gas development

Provincial governments' gains from oil development include added value tax, provincial enterprise income tax, resource tax, resource compensation fee, urban construction and maintenance fee, additional education fee, and dividend from provincial enterprises. The increase of central government's revenue can push the development of provincial economy through direct investment and financial refund, but it is not as effective as cultivating the self-development potential of provincial governments. Provincial finance may invest in public facilities, which can promote employment, improve environment, and raise local people's welfare standard. The provincial governments' investment not only betters investment atmosphere and attracts other investment, but also helps local economy come into a benign recycle. The improvement of local investment environment will also cut down the cost of oil enterprises. In addition to tax burdens, environment pollution and negative yield resulting from shortage of oil will do harm to the sustainable development of provincial economy.

The exploration and development of oil brings about pollution of groundwater and surface water, damage to vegetation, soil and water loss, and environmental problems such as project trashes and waste gas. Clashes may occur between oil enterprises and local residents if land seizure issue is not properly handled. At present, oil exploration is mainly carried out by the central government, so if the provincial government and people of oil producing regions cannot benefit from oil exploration, they will