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Design and impact estimation of a reform program of China's tax and fee policies for low-grade oil and gas resources

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Abstract: With China's rapid economic development, it is important to formulate reasonable and feasible tax and fee policies to promote the development and utilization of low-grade oil and gas resources to guarantee China's energy supply security. In this paper, by analyzing major problems of China's current tax and fee policies for oil and gas resources, a reform program for low-grade oil and gas resources is designed from the aspects of tax/fee items and tax/fee rates. The impacts of this reform program on China and China's oil companies during the "Twelfth Five-Year Plan" are investigated according to the related data in 2008. The results show that the proposed tax and fee reform program will lower the tax burden of oil companies, promote the development of low-grade oil and gas resources, and increase China's GDP and national fiscal revenue. Besides that, it will bring positive social effects by increasing employment opportunities.

Key words: Low-grade, oil and gas resources, tax and fee policies, reform program, impact estimation

1 Introduction

"Low-grade" oil and gas resources are a related concept to the "high-grade" oil and gas resources that have been found with large-scale reserves, high abundance and high-quality resources, as well as high yields from single wells. Meanwhile, it is closely related to technological and economic conditions and management modes (Zha, 2004). Generally speaking, low-grade oil and gas resources are referred to the proved geological reserves which can not be economically (profitably) exploited by existing technology and conventional management under current systems and certain market conditions (such as oil price) (Lei et al, 2011b).

As show in Table 1, China's potential low permeability oil and gas resources is large. In a word, with the enhancing exploration and the growing demand for oil and gas resources, the low-grade oil and gas resources will be the main targets of China's oil and gas exploration and development whether from the analysis of remaining resources or from the development trend. Also, exploration and development of the low-grade oil and gas resources will be the mainstream and inevitable development trend of the petroleum industry (Hu, 2009). It is necessary to expand the exploration and development of China's low-grade oil and gas resources to ensure oil and gas supply security.

Tax and fee policies are important leverage tools to adjust the production and consumption of oil and gas (Berkhout et al, 2004). Overseas scholars have conducted many investigations into tax and fee policies for oil and gas resources from the aspects of its status (Kemp, 1992; 1994; Cawood, 2010), design of tax and fee policies (Mariano and La, 2007; Bleischwitz and Bader, 2010), and impact estimation of tax and fee policies (Hallwood, 2007; Nakhle, 2007; Postali, 2009; Koethenbuerger and Poutvaara, 2009). China's scholars also have conducted many studies of tax and fee policies for oil and gas resources by comparing China's tax and fee policies with other countries', analyzing the problems of China's current tax and fee policies and proposing corresponding suggestions (Lei and Lai, 2001; Wu and Hu, 2007; Zhang and Ma, 2007; Li et al, 2008). At present, China is preparing to conduct a tax and fee reform for oil and gas

Table 1 China's potential low permeability oil and gas resourcel

	Low permeability oil resources		Low permeability gas resources	
	Quantity, billion tonnes	Proportion of oil resources %	Qquantity, trillion cubic meters	Proportion of gas resources %
Prospective reserves	53.7	49	24	42.8
Proved reserves	14.1	–	4.1	–
Recoverable reserves	18.9	–	2.37	–
Remaining reserves	43.1	54	24.8	51
Production	0.71	37.6	0.032	42.1

Source: Hu (2009)

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resources as the international oil and gas market changes. The resource tax reform was firstly started in Xinjiang on June 1, 2010 and then implemented in twelve provinces of northwest China from July 6, 2010, which indicates the deepening of resource tax reform (Jiang, 2010).

In previous studies of China's tax and fee policies for oil and gas resources, qualitative methods have always been adopted, while quantitative analysis is seldom used, and the impact estimation of proposed reform programs is rarely found in the literature. In this paper, through analyzing the problems existing in China's current tax and fee policies for oil and gas resources, a reform program is systematically designed on the basis of theories concerned with property, rent, sustainable development and national income distribution, and the impacts of the proposed reform program during the "Twelfth Five-Year Plan" are estimated. The results would help to promote the exploration and development of China's low-grade oil and gas resources and provide a reference for further study of tax and fee policies for oil and gas resources.

2 Major problems of China's current tax and fee policies for oil and gas resources

Presently, China's taxes and fees for oil and gas resources mainly consist of mineral royalty, resource tax, compensation fee for mineral resources, special oil gain levy, fees for the use of petroleum exploration and production rights, as well as the costs for petroleum exploration and production rights. However, from the aspects of theoretical analysis and practical implementation, the China's current tax and fee policies for oil and gas resources have problems, such as repetitive levy, separation of tax from price, negligible regulation of differential resource income, and insufficient encouragement for low-grade oil and gas resources development.

1) Repetitive levy

In China's current tax and fee system of oil and gas resources, mineral royalty is only aimed at offshore projects and Sino-foreign cooperative development of oil and gas resources. Its purpose is to protect the owner's interests of oil and gas resources (the state is the owner of oil and gas resources in China) (Wang and Li, 2005). China's resource tax is collected based on the principle of "general collection, and regulation of differential resource income". Its purpose is to adjust the differential benefits of oil and gas resources, which reflects the state's interests as oil and gas resources owner (Zhang and Ma, 2007). As a part of a paid exploitation system, the purpose of compensation fee for mineral resources is also to protect the owner's property rights and interests (Wang et al, 2000). Therefore, from the perspective of levying purpose, China's current mineral royalty, resource tax and compensation fee for mineral resources are levied repetitively.

2) Separation of tax from price

Since the resource tax reform in 1986, the tax basis for oil and gas resources in China has been changed from the sales income to the production of oil and gas. That is, the larger the production, the greater the resource tax; the smaller the production, the lower the resource tax becomes (Wang and Jing, 2006). However, low oil and gas production does not mean the owner's interests are necessarily small. When there are premium oil and gas prices, the owner's interests should increase with rising oil and gas prices. While when there is depreciation of oil and gas price, the owner's interests may decrease with falling price. In other words, the owner's interests should be linked to the oil and gas price, and reflect the price change. Therefore, as a part of the owner's interests, the resource tax should reflect the price change of oil and gas. However, China's current resources tax is based on oil and gas production, leading to the separation of resource tax from oil and gas price. Hence as the owner of oil and gas resources, the state's interests can not be guaranteed especially when resource price is rising.

3) Small difference of resource tax

China's current resource tax is regulated in terms of different producing regions, and the resource tax rate of unit crude oil is divided into seven levels from 14 to 30 RMB yuan per tonne; the resource tax rate of unit natural gas is divided into five levels from 7 to 15 RMB yuan per thousand cubic meters. That is, for crude oil, the maximum differential rate of the resource tax for different producing regions is 16 RMB yuan per tonne, and for natural gas, it is 8 RMB yuan per thousand cubic meters. As the differential tax for adjusting benefits, China's resource tax is designed with the consideration of influence of different resource statuses, exploitation conditions, locations and other factors on resource income. However, the current resource tax does not consider such factors as the resource differences, exploitation cost changes at different exploitation phases in the same producing region, and so on. Actually, the exploitation condition, resource endowment, quality, as well as geological or geographical condition and even climate of oil and gas resources in different producing regions in China are very different, that is, the difference between oil and gas resources is very large. So the differential rate of the current resource tax is too small to reflect the differential benefits of oil and gas resources in different regions, and to encourage the exploration and development of low-grade oil and gas resources, hence restricting the increase of oil and gas production.

4) Special oil gain levy imposed on non-excess profits

A special oil gain levy is imposed on oil companies to adjust excess profits brought by soaring oil prices. According to China's current policy, the special oil gain levy is collected when oil price exceeds 40 US dollars per barrel. However, the current exploitation cost of oil resources in China is close to or more than 40 US dollars per barrel in some oil fields, and far more than 40 US dollars per barrel for low-grade oil and gas resources. In this situation, there is no special gain. The special oil gain levy is imposed while oil companies do not get excess profits. This will affect oil companies' development. Particularly, when oil companies need a large amount of funds for exploration and development activities, the heavy tax burden will affect these oil companies' sustainable development and is not favorable to guarantee the national energy security of China.

5) Insufficient encouragement for development of low-grade oil and gas resources

In China's current petroleum tax system, there are some policies to encourage low-grade oil and gas resource development, but the level of encouragement is far from adequate. High cost and low benefits prevent oil companies from developing low-grade oil and gas resources and will worsen the shortage of oil and gas supply.

3 A reform program designed for China's tax and fee policies for low-grade oil and gas resources

Because of high cost, high technologic requirement and difficulty in development of low-grade oil and gas resources, more systematic and comprehensive support from tax and fee policies is required. Based on the tax and fee policies for conventional oil and gas resources, a reform program is designed for low-grade oil and gas resources in view of tax/fee items and tax/fee rates.

3.1 Adjustment of tax/fee items

Oil and gas are important national strategic materials. Tax and fee policies for oil and gas resources have attracted attention worldwide from governments, academics and industries. The Canadian government has enacted policy for development of oil and gas resources from the perspective of sustainable development (Hilson, 2000). The European Union has enacted its mineral development policy to guarantee a secure supply of raw materials (Tiess, 2010). From the aspect of economic development of resource-rich regions, O'Faircheallaigh (1998) proposed that rational taxes and fees of oil and gas resources should meet local economic development. From the view of protecting the environment, Bleischwitz and Bader (2010) suggested that the optimal tax and fee policies for oil and gas resources should internalize the negative externalities caused by oil and gas resources development. According to rent theory, Cawood (2010) discussed the theoretical basis of oil and gas resources' royalty in South Africa. Yang (2007) analyzed the relationship of China's current taxes and fees from the aspect of property rights. Gao (2009) analyzed the income distribution of oil and gas resources based on China's current taxes and fees. Besides that, many other scholars have studied of taxes and fees of oil and gas resources from other points of view (Osmundsen and Tveteras, 2003; Mariano and La, 2007).

Most existing studies of tax and fee policies for oil and gas resources have conducted from a single perspective. However, the tax and fee policies for oil and gas resources are related to resource exploration and development, income distribution, economic and social development, and many other aspects. So the tax and fee system would have some shortcomings (such as failing to be systemic and comprehensive) if it is set up from a single theory. Therefore, we proposed a theoretical model of taxes and fees for oil and gas resources from the theories concerned with property, land rent, sustainable development and national income distribution (lei et al, 2011a). According to this theoretical model, taxes and fees of oil and gas resources consist of royalty, costs of petroleum exploration and production rights, special oil gain levy, resource depletion compensation fee, ecological compensation fee, as well as fees for the use of petroleum exploration and production rights, as shown in Fig. 1.

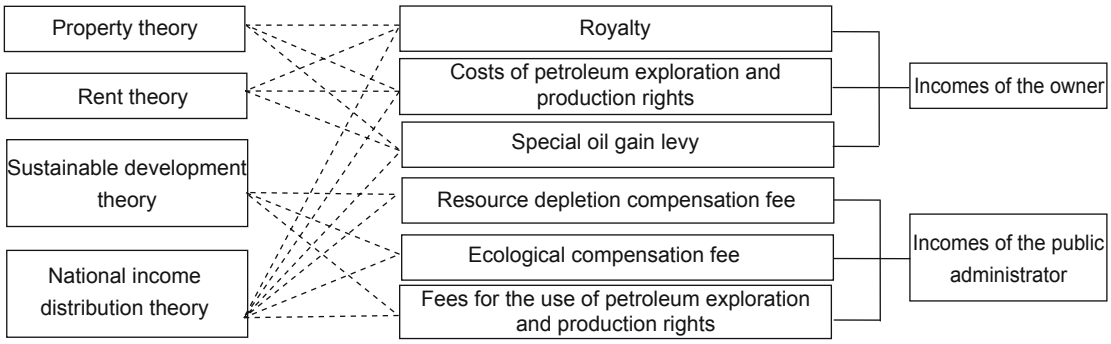

Fig. 1 A theoretical model of taxes and fees for oil and gas resources

Aimed at the existing problems of China's current tax and fee policies for oil and gas resources, many scholars have conducted studies and proposed some suggestions. For example, Lei and Lai (2001) suggested a mineral royalty levy instead of resource tax and compensation fee for mineral resources, setting differential mineral royalty rates in accordance with different oil and gas resources. Gao (2008) and Li and Liu (2008) proposed merging current mineral royalty, compensation fee for mineral resources, resource tax and special oil gain levy into an ad valorem resource tax, with an increasing tax rate and sliding scale rate. Li et al (2008) suggested increasing the rates of resource tax and compensation fee for mineral resources and setting the mineral royalty rate in terms of water depth. Wu and Hu (2007) proposed to set dynamic rates for the special oil gain levy so as to timely and reasonably adjust the interest relationship between oil companies and the state (as the oil and gas resources owner). Zhang and Ma (2007) suggested that the environmental cost should be considered in design of oil resource tax (or fee), and that a compensation system for resource depletion should be established.

According to the theoretical model in this paper and on the basis of previous study results, a tax/fee items reform program for low-grade oil and gas resources is proposed aiming at major problems of China's current

tax and fee policies for oil and gas resources (see Fig. 2). It includes merging current mineral royalty, resource tax and compensation fee for mineral resources into royalty; adding a resource depletion compensation fee and ecological compensation fee; and keeping the special oil gain levy, fees for the use of petroleum exploration and production rights, as well as costs of petroleum exploration and production rights unchanged.

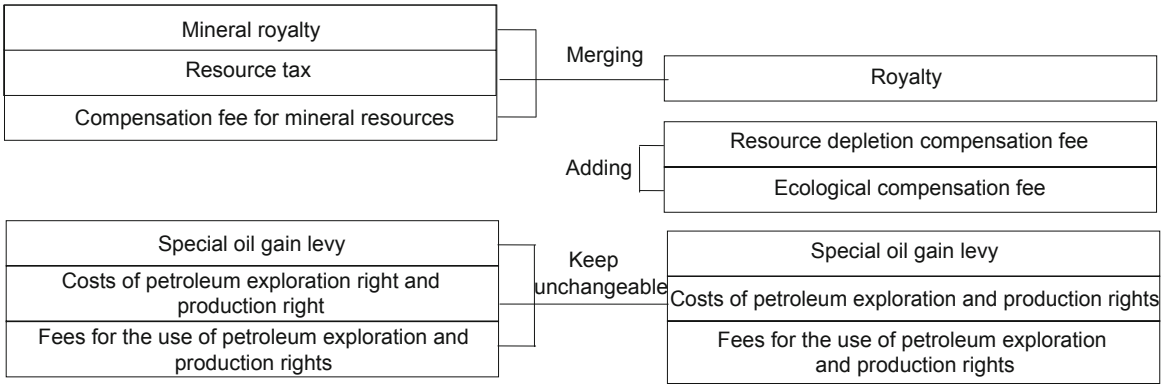

Fig. 2 A tax/fee items adjustment program for low-grade oil and gas resources

3.2 Estimation of tax/fee rates

Based on the oil and gas resources development data of the PetroChina Company Limited (PetroChina) in 2008, the effects of different tax/fee rates on oil and gas resources development costs are estimated. According to the processed data from the 2008 Annual Report of PetroChina Company Limited, the full costs of unit oil and gas are US $46.86 per barrel. The full costs of oil and gas are the costs included in current profit and loss during oil and gas production process, including production costs, exploration costs, depreciation and depletion and amortization, long-term asset impairment losses, general and administrative expenses and finance expenses. Of the 46.86 US dollars per barrel, the taxes and fees are 19.28 US dollars per barrel (PetroChina, 2009). According to our knowledge, the full costs of low-grade oil and gas resources are 20% to 40% higher than those of conventional oil and gas resources. To facilitate the analysis and calculation, 30% is adopted in this paper, that is, the full costs of unit low-grade oil and gas is about 60 US dollar per barrel (excluding corporate income tax).

In the rest of this paper: P is the crude oil price; Q is the crude oil production; $\overline{c}$ is full costs of unit low-grade oil and gas resources; P=87.55 US dollars per barrel, which is the crude oil average price of PetroChina in 2008; $\overline{c}$=60 US dollars per barrel; figures are converted at the rate of 1 ton of crude oil=7.1 barrels and 7 RMB yuan =1 US dollar.

According to the tax/fee items adjustment program for low-grade oil and gas resources, taxes and fees (C_T) of low-grade oil and gas resources should consist of royalty (C_{t1}), resource depletion compensation fee (C_{t2}), ecological compensation fee (C_{t3}), special oil gain levy (C_{t4}), costs of petroleum exploration and production rights (C_{t5}), as well as fees for the use of petroleum exploration and production rights (C_{t6}), that is,

$$C_T = C_{t1} + C_{t2} + C_{t3} + C_{t4} + C_{t5} + C_{t6} \quad (1)$$

1) Royalty

Based on property theory, royalty is the rent from ownership and paid to the owner for exploration or development of oil and gas resources. It reflects the state's interests in China as the owner of oil and gas resources. According to rent theory, royalty should embody the absolute rent and differential rent I of oil and gas resources. To materialize the absolute rent, royalty should be levied on all oil fields, as long as oil and gas resources are exploited. To materialize differential rent I, royalty rates should be set differently in terms of the grades of oil and gas resources. The royalty based on production will lead to the separation of tax from price and be not favorable to the development and utilization of oil and gas resources. To reflect the influence of oil/gas price on oil and gas benefits, an ad valorem royalty should be adopted. The formula is as follows:

$$C_{t1} = T_1 \times Q \times P \quad (2)$$

where, T_1 is the royalty rate and set in terms of the grades of oil and gas resources; The rates of current resource tax and compensation fee for mineral resources are less than 2% of sales income in China (as shown in Table 2), too low to reflect the state's ownership of oil and gas resources, so it is necessary to increase the royalty rate. Meanwhile, the differential rate of China's current taxes and fees for different oil and gas resources is too small, so the differential royalty rate should reflect differential rent I more accurately. The royalty rate is about 10% of sales income in most foreign resource countries, for example, it is 12.5% in the United State. Using the experience of other countries for reference, the royalty rate is temporarily set from 2% to 10% in terms of the grades of oil and gas resources in this paper. Because the full costs of unit oil and gas for low-grade oil and gas resources is 60 US dollars per barrel, we suggest that the royalty rate could be reduced to 1% or even exempted when oil price falls to 50 US dollars per barrel or even lower to encourage the development of oil and gas resources (the specific criteria for royalty rate needs to be further studied).

The royalties of different rates under different oil prices are calculated and compared with China's current taxes and fees, as shown in Table 2.

As shown in Table 2, the royalty rate is from 2% to 10%,

Table 2 Comparison of royalty with China's current taxes and fees under different oil prices

Tax/feei tems		Oil price, US dollars/barrel						
		40-50	50-60	60-70	70-80	80-90	90-100	100-110
China's current taxes and fees								
Resource tax[i], US dollars/barrel		0.44	0.44	0.44	0.44	0.44	0.44	0.44
Compensation fee of mineral resources[ii], US dollars/barrel		0.45	0.55	0.65	0.75	0.85	0.95	1.05
The sum of current taxes and fees[iii], US dollars/barrel		0.89	0.99	1.09	1.19	1.28	1.38	1.48
The proportion of (iii) in sales income, US dollars/barrel		1.98%	1.80%	1.68%	1.59%	1.51%	1.45%	1.41%
The royalties of different rates under different oil prices								
Adjusted royalty[iv], US dollars/barrel	With a minimum rate of 2%	0.45[v]	1.1	1.3	1.5	1.7	1.9	2.1
	With a middle rate of 5%	2.25	2.75	3.25	3.75	4.25	4.75	5.25
	With a maximum rate of 10%	4.5	5.5	6.5	7.5	8.5	9.5	10.5
Differential royalty[vi] after adjustment , US dollars/barrel		4.05	4.4	5.2	6	6.8	7.6	8.4

Notes: i) The basis of the current resource tax is the production of oil. The resource tax of unit crude oil changes from 14 to 30 RMB yuan per ton, that is, from 0.28 to 0.60 US dollars per barrel, so the average rate of current resource tax is 0.44 US dollars per barrel.
ii) The rate of current compensation fee for mineral resources is 1% of sales income, the average oil price is adopted in calculation.
iii) Current mineral royalty is only levied on offshore projects and Sino-foreign cooperative development of oil and gas resources, so it accounts for very little in the total taxes and fees of oil and gas resources and is not calculated in Table 2. Therefore, the sum of current taxes and fees is equal to the resource tax plus compensation fee for mineral resources.
iv) The adjusted royalty is the combination of current resource tax, compensation fee for mineral resources and mineral royalty.
v) The adjusted royalty rate is 1% when oil price is less than 50 US dollars per barrel.
vi)The differential of adjusted royalty is the difference between royalty with 10% rate and royalty with 2% rate under the same oil price.

much higher than the proportion (less than 2%) of current resource tax and compensation fee for mineral resources in sales income; the adjusted royalty can reflect the effect of oil price on taxes and fees, which will help to protect the owner's interests of oil and gas resources; the royalty differential is increased from 0.28 to 0.60 US dollars per barrel to more than 4.05 US dollars per barrel. Moreover, the royalty differential increases with rising oil price, which can fully reflect the differential rent I. For example, the royalty differential between low-grade and high-grade oil and gas resources is 7.004 US dollars per barrel according to the average oil price (87.55 US dollars per barrel) of PetroChina in 2008.

2) Resource depletion compensation fee

$$C_{t2} = T_2 \times Q \times P \tag{3}$$

where T_2 is the rate of resource depletion compensation fee. The resource depletion compensation fee is a new item to adjust regional economic development. Since the big fluctuation of oil price, the resource depletion compensation fee should be collected by adopting the ad valorem mode to change the resource advantages into a economic advantage to promote the development of oil- and gas-producing regions. In other words, to develop oil and gas resources, resource depletion compensation fee must be levied to make up for the consumption of non-renewable resources and is used for maintaining the economic sustainable development in oil- and gas-producing regions. In this paper, the rate of the resource depletion compensation fee is set to 0.5%. In 2008, China's crude oil production was 1349 million barrels (National Bureau of Statistics of China, 2009), then the resource depletion compensation fee was about 590.52 million US dollars.

3) Ecological compensation fee

$$C_{t3} = T_3 \times Q \times P \tag{4}$$

where T_3 is the rate of ecological compensation fee. The ecological compensation fee is a new item, and used for recovering the ecological environment damaged in the process of oil and gas resources exploitation. The rate of ecological compensation fee is set to 0.5% in this paper. According to China's crude oil production (1349 million barrels) in 2008 (National Bureau of Statistics of China, 2009), the ecological compensation fee is about 590.52 million US dollars in 2008.

4) Special oil gain levy

$$C_{t4} = \left[(P - b) \cdot T_4 - \theta \right] \cdot Q \tag{5}$$

where, T_4 is the rate of special oil gain levy; b is the tax threshold; θ is the quick deduction. The tax threshold of the current special oil gain levy is 40 US dollars per barrel and the current rate of special oil gain levy is from 20% to 40%. The special oil gain levy is a windfall profit tax. However, the full costs of low-grade oil resources are about 60 US dollars per barrel, which means that there is no windfall profit when oil price is less than 60 US dollars per barrel. Therefore, it is unreasonable to impose special oil gain levy when the oil

price is less than 60 US dollars per barrel. The tax threshold of the special oil gain levy for low-grade oil should be raised to 60 US dollars per barrel under present conditions, as shown in Table 3.

Table 3 The rate and quick deduction of the special oil gain levy for low-grade oil

Crude oil price, US dollars/barrel	Rate	Quick deduction, US dollars/barrel
60-65	20%	0
65-70	25%	0.25
70-75	30%	0.75
75-80	35%	1.5
More than 80	40%	2.5

Note: * Average oil price is adopted in calculation.

Fig. 3 shows the comparison of the current special oil gain levy for oil and the adjusted special oil gain levy for low-grade oil under different oil prices. It can be seen that when the oil price is less than 60 US dollars per barrel, there is no special oil gain levy for low-grade oil. When the oil price rises above 60 US dollars per barrel, the special oil gain levy for low-grade oil increases non-linearly. When oil price is higher than 80 US dollars per barrel, the gap between current special oil gain levy for oil and the adjusted special oil gain levy for low-grade oil is 8 US dollars per barrel. Because the special oil gain levy accounts for a large proportion of total taxes and fees, so raising the tax threshold of the special oil gain levy can greatly lower low-grade oil taxes and fees. For example, in 2008, PetroChina's average taxes and fees of crude oil was 19.23 US dollars per barrel, of which the special oil gain levy was 15.97 US dollars per barrel (PetroChina, 2009). If the adjusted special oil gain levy for low-grade oil is implemented, the taxes and fees will be lowered by 8 US dollars per barrel, that is, the total taxes and fees of low-grade oil will be reduced by 40%.

5) Fees and costs for the use of petroleum exploration and production rights

According to China's "Measures on management of fees and costs for the use of petroleum exploration and production rights", the fee for the use of exploration right is measured on the basis of exploration year and block size, and paid year by year. From the first to the third exploration year, the fee for the use of exploration right is 100 RMB yuan per square kilometer annually; from the fourth exploration year, the fee for the use of exploration right increases by 100 RMB yuan per square kilometer annually, but it is not more than 500 RMB yuan per square kilometer annually. The fee for the use of production right is paid year by year on the basis of mining area. It is 1000 RMB yuan per square kilometer annually. However, the fees and costs for the use of petroleum exploration and production rights is very low that they are less than 1% of total taxes and fees of oil and gas resources, that is, they are less than 0.024 US dollars per barrel on average. Therefore, the fees and costs for the use of petroleum exploration and production rights are not discussed in detail in this paper.

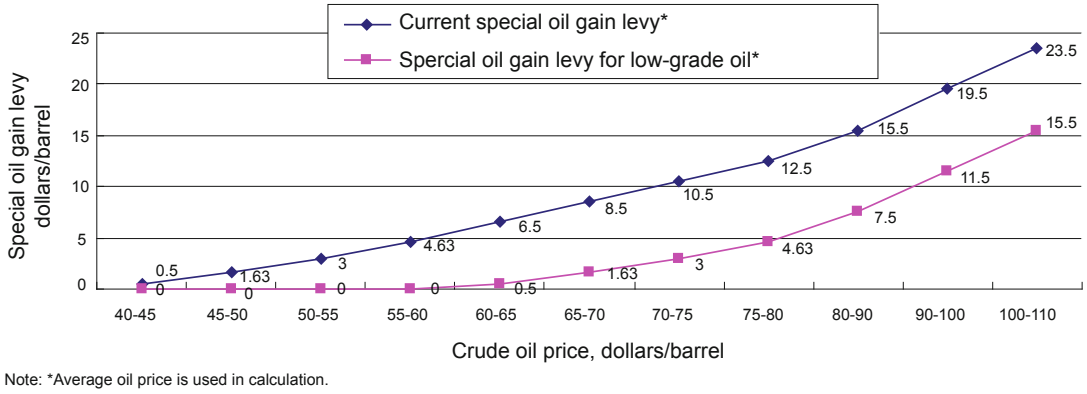

Fig. 3 Comparison of the current special oil gain levy for oil and the adjusted special oil gain levy for low-grade oil

Consideration of the adjustment of tax/fee items and tax/fee rates, the reform program of taxes and fees for low-grade oil and gas resources is illustrated in Table 4.

4 Effect of the reform program on main stakeholders during the "Twelfth Five-Year Plan"

Domestic and oversea scholars have conducted a large number of studies at the effects of taxes and fees reform of oil and gas resources. Dismukes et al (2006) and Hallwood (2007) estimated the impacts of royalty relief on oil and gas production. Blake and Roberts (2006), Nakhle (2007) and Plourde (2010) discussed the impacts of taxes and fees change on oil companies' interests and government revenue. Otto et al (2006) analyzed the impacts of different royalties on investment, civil society, the market and government. Besides that, some other scholars studied the impacts of taxes and fees of oil and gas resources on petroleum industry, regional economic development, welfare, and etc (Melo et al, 1989; Postali, 2009; Koethenbuerger and Poutvaara, 2009; Frestad, 2010). The state, oil companies and indigenous people are the main stakeholders of oil and gas resources during the process of development and utilization (Qi et al, 2009). The taxes and fees reform of oil and gas resources will bring direct effects

Table 4 The reform program of taxes and fees for low-grade oil and gas resources

Tax/fee items	Tax/fee collection modes	Tax/fee rates adjustment or reform
Royalty	Ad valorem: $C_{t1}=T_1\times Q\times P$	From 2% to 10% (1% or exempted when oil price is less than 50 US dollars per barrel)
Compensation fee for resource depletion	Ad valorem: $C_{t2}=T_2\times Q\times P$	0.5%
Ecological compensation fee	Ad valorem: $C_{t3}=T_3\times Q\times P$	0.5%
Special oil gain levy	Ad valorem and excess progressive rates: $C_{t4}=\left[(P-b)\cdot T_4-\theta\right]\cdot Q$	The tax threshold (b) is raised to 60 US dollars per barrel. Other factors of special oil gain levy are kept unchanged.
Fees for the use of petroleum exploration and production rights	Based on exploration year and block size, and paid year by year.	Keep current program unchanged.
Costs of petroleum exploration and production rights	Based on the appraised price which is recognized by the department of mineral resources, and sold by the ways of market competition, such as biding, auction and listing.	Improve the cost system of petroleum exploration and production rights

on oil companies' taxes and fees and resource exploitation costs of unit oil and gas, and may cause impacts on oil and gas production, thus bring effects on national energy security, foreign exchange reserves, Gross Domestic Product (GDP), national fiscal revenue, and social employment.

4.1 Impacts on oil companies' interest

During the "Twelfth Five-Year Plan", the impacts of the proposed reform program on oil companies are embodied in oil and gas production, resources exploitation cost of unit oil and gas, as well as total taxes and fees of oil companies.

1) Oil and gas production

In recent years, China's oil and gas production has grown steadily. As shown in Fig. 4, the oil production is nearly linear, so the linear regression method is adopted to forecast China's crude oil production during the "Twelfth Five-Year Plan".

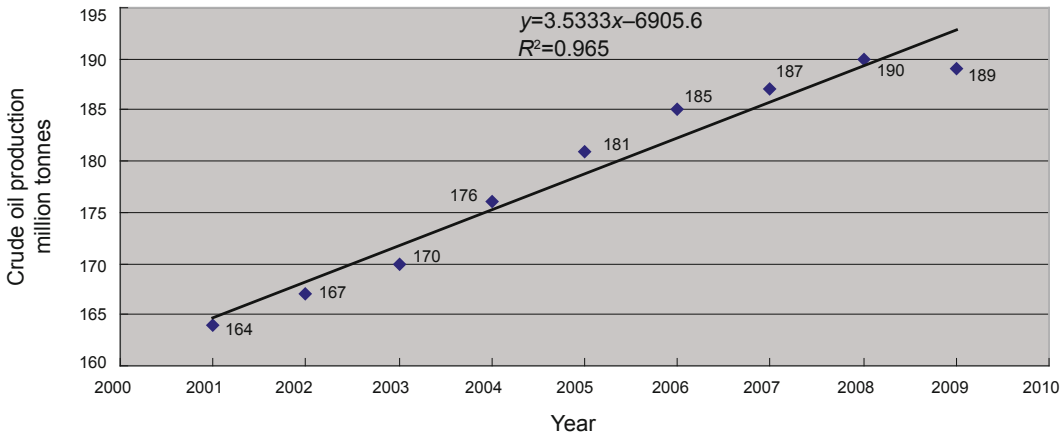

Fig. 4 China's crude oil production and its trend from 2001 to 2009

Source: National Bureau of Statistics of China, http://www.stats.gov.cn/tjsj/ndsj/

The linear regression equation for China's crude oil production with production year (as shown in Fig. 4) is

$$y = 3.5333x - 6905.6 \tag{6}$$

where y is the yearly production of crude oil, x is the production year. R^2=0.956 means that 95.6% of the dependent variable (y) difference can be explained by the linear regression equation, indicating that the linear regression equation fits well and has good reliability of interpretation.

As shown in Eq. (6), the average annual growth rate of crude oil production in China is 3.53%. In other words, the crude oil production increases by 3.53 million tonnes every year, about 25.1 million barrels per year. According to the equation, China's crude oil production in the "Twelfth Five-Year Plan" is forecast and shown in Table 5.

Table 5 The forecast of China's crude oil production during the "Twelfth Five-Year Plan"

Year	2011	2012	2013	2014	2015
Crude oil production, million tonnes	193.2	196.8	200.3	203.8	207.4

2) Resources exploitation cost of unit oil and gas

Taxes and fees form an important part of the production cost of oil and gas resources, accounting for about one third (PetroChina, 2009). Under the same economic and technological conditions, the effect of taxes and fees reform on exploitation cost is mainly reflected in the change of resource taxes and fees of unit oil and gas. The comparison between current and reformed resource taxes and fees of unit oil and gas is shown in Table 6.

Table 6 The comparison between current and reformed resource taxes and fees of unit oil and gas

Taxes and fees		Oil price, US dollars/barrel										
		40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-90	90-100	100-110
China's current taxes and fees of unit oil and gas resources												
Current resource tax, US dollars/barrel		0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
Current compensation fee for mineral resources, US dollars/barrel		0.425	0.475	0.525	0.575	0.625	0.675	0.725	0.775	0.85	0.95	1.05
Current special oil gain levy, US dollars/barrel		0.5	1.625	3	4.625	6.5	8.5	10.5	12.5	15.5	19.5	23.5
Total of current taxes and fees of unit oil and gas resources, US dollars/barrel		1.365	2.54	3.965	5.64	7.565	9.615	11.665	13.715	16.79	20.89	24.99
The reformed taxes and fees of unit oil and gas resources												
Royalty, US dollars/barrel	T_1=2%	0.425	0.475	1.05	1.15	1.25	1.35	1.45	1.55	1.7	1.9	2.1
	T_1=5%	2.125	2.375	2.625	2.875	3.125	3.375	3.625	3.875	4.25	4.75	5.25
	T_1=10%	4.25	4.75	5.25	5.75	6.25	6.75	7.25	7.75	8.5	9.5	10.5
Compensation fee for resource depletion, US dollars/barrel	T_2=0.5%	0.2125	0.2375	0.2625	0.2875	0.3125	0.3375	0.3625	0.3875	0.425	0.475	0.525
Ecological compensation fee, US dollars/barrel	T_3=0.5%	0.2125	0.2375	0.2625	0.2875	0.3125	0.3375	0.3625	0.3875	0.425	0.475	0.525
Special oil gain levy for low-grade oil, US dollars/barrel	b=40	0	0	0	0	0.5	1.625	3	4.625	7.5	11.5	15.5
Total of reformed taxes and fees of unit oil and gas resources, US dollars/barrel	T_1=2%	0.85	0.95	1.575	1.725	2.375	3.65	5.175	6.95	10.05	14.35	18.65
	T_1=5%	2.55	2.85	3.15	3.45	4.25	5.675	7.35	9.275	12.6	17.2	21.8
	T_1=10%	4.675	5.225	5.775	6.325	7.375	9.05	10.975	13.15	16.85	21.95	27.05

Notes: i) Current mineral royalty is only levied on offshore projects and Sino-foreign cooperative development of oil and gas resources, so it accounts for very little in the total taxes and fees of oil and gas resources and not be calculated in Table 6.

ii) Fees and costs for the use of petroleum exploration and production rights are unchanged in the reformed program, that is, the amount of current fees and costs for the use of petroleum exploration and production rights is the same with that of the reformed ones, and the amount is so little that not calculated in Table 6.

As shown in Table 6, for conventional oil and gas resources (a royalty rate of 10% is adopted in the reform program), the gap between reformed and current taxes and fees is in the range from -0.69 to 3.31US dollars per barrel; For low-grade oil and gas resources (a royalty rate of 2% is adopted in the reform program), the gap is in the range from (-6.675) to (-0.515) US dollars per barrel. In other words, the reform program has a small effect on taxes and fees for conventional oil and gas resources, but greatly reduces taxes and fees for low-grade oil and gas resources. Thus, the reform program can help to promote the development of low-grade oil and gas resources.

3) Total taxes and fees for oil companies

Variation of the resource exploitation cost per unit of oil and gas will lead to a change of total taxes and fees of oil companies. Adopting the forecast production of China's crude oil in 2013, that is, 200.3 million tons (about 1422 million barrels) as the production, and 5% as the royalty rate, thus change of total taxes and fees of oil companies is shown in Table 7.

Table 7 Change of total taxes and fees of oil companies

Taxes and fees	Oil price, US dollars/barrel										
	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-90	90-100	100-110
(1) Current resource taxes and fees of unit oil and gas, US dollars/barrel	1.37	2.54	3.97	5.64	7.57	9.62	11.67	13.72	16.79	20.89	24.99
(2) Reformed resource taxes and fees of unit oil and gas , US dollars/barrel	2.55	2.85	3.15	3.45	4.25	5.68	7.35	9.28	12.60	17.20	21.80
(2)-(1) ,S Udlars/barrel	1.18	0.31	-0.82	-2.19	-3.32	-3.94	-4.32	-4.44	-4.19	-3.69	-3.19
Change of total taxes and fees for oil companies, million US dollars	1678	441	-1166	-3114	-4721	-5603	-6143	-6314	-5958	-5247	-4536

As shown in Table 7, compared to current taxes and fees, the reform program will reduce the total taxes and fees of oil companies, and the total taxes and fees of oil companies will change by between -6314 to 1678 million US dollars depending on the oil price.

During the "Twelfth Five-Year Plan", China's crude oil production will increase by 3.53 million tonnes annually, about 25.1 million barrels. The reform program will greatly lower the resource taxes and fees of unit oil and gas for low-grade oil and gas resources, with 6.675 US dollars per barrel at most. Meanwhile, the reform program has little effect on resource taxes and fees for conventional oil and gas resources. For oil companies, the total taxes and fees will change by between -6314to 1678 million US dollars according to the reform program. Therefore, the reform program for taxes and fees of oil and gas resources is favorable to lower taxes and fees for low-grade oil and gas resources, which will encourage oil companies to develop low-grade oil and gas resources.

4.2 Impacts on the state's interest

During the "Twelfth Five-Year Plan", the changes in foreign exchange reserves, GDP, national fiscal revenue and social employed population of China are estimated to reflect the impacts of the reform program on the state's interest.

1) Change in foreign exchange reserves

"Change in foreign exchange reserves" in this paper means that the reform program will influence the oil and gas production in China, which will impact China's imports of oil and gas, and subsequently impact foreign exchange reserves for importing oil and gas. Foreign exchange reserves are impacted by three factors, namely the consumption of oil and gas, the domestic production of oil and gas, as well as international oil and gas prices. As the consumption of oil and gas remains unchanged , the change in foreign exchange reserves is affected by the change of domestic production of oil and gas and the international oil and gas prices, that is,

$$\Delta R = \Delta Q \times P_1 \tag{7}$$

where ΔR is the change in foreign exchange reserves caused by the reform program; ΔQ is the production change of oil and gas in China; P_1 is the international oil and gas price.

China's crude oil production is forecast increase by about 25.1 million barrels every year. According to the reform program, the foreign exchange reserves will change in the range of 1067-2636 million US dollars by Eq. (7), as shown in Table 8.

Table 8 Change of foreign exchange reserves with oil price caused by fee and tax reform program

Oil price, US dollars/barrel	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-90	90-100	100-110
Change of foreign exchange reserves, million US dollars	1067	1192	1318	1443	1569	1694	1820	1945	2134	2385	2636

2) Change of GDP

With high correlation and a long industrial chain, the petroleum and petrochemical industry can promote national economy development. "Change of GDP" in this paper refers to the change in total production of oil and gas related industries and the entire national economy, which is caused by the change of oil and gas production due to taxes and fees reform. The change of GDP mainly includes two parts: one is the GDP change caused by petroleum and petrochemical industry due to the change of oil and gas production; the other is the GDP change caused by other industries because of the change of oil and gas production. Thereby,

$$\Delta GDP = a \times \Delta Q \times P \times \delta + (1-a) \times \Delta Q \times P \times \xi \tag{8}$$

where ΔGDP is the change of GDP caused by taxes and fees reform of oil and gas resources; ΔQ is the production change of oil and gas; P is the price of oil and gas; a is the proportion of oil as raw material in petrochemical industry; δ is the GDP growth rate of petrochemical industry caused by unit oil as raw material; ξ is the GDP growth rate of other industries caused by unit oil as energy.

China's crude oil production is forecast to increase by about 25.1 million barrels annually, that is, ΔQ=25.1 million barrels. According to China Energy Statistical Yearbook 2008, the proportion of oil as raw material in petrochemical industry is about 7% (National Bureau of Statistics of China, 2009), that is, a=7%. The value-added ratio of crude oil to refined oil products and then to ethylene or other chemical products is 1:2:4. If the crude oil is further processed to consumer goods, the value-added ratio will reach 10 times or even more (Hu and Jiao, 2007). In this paper, the value-added ratio is conservatively set, that is, δ=2. The pulling effect coefficient of petroleum and petrochemical industries to other industries is about 1:50 (Xu, 2004), so ξ=50. Based on Eq. (8) and related data, the impact of the reform program on GDP is shown in Table 9. Because of the driving effect of oil and gas energy, the GDP will increase in the range of 49753-122920 million US dollars during the "Twelfth Five-Year Plan".

3) Change of national fiscal revenue

"Change of national fiscal revenue" refers to the change of taxes and fees in oil-and-gas-related industries and energy consumer industries with changing production of oil and gas. Change of national fiscal revenue is mainly caused by two aspects: one is the oil and gas industries; the other is the oil-and-gas-related industries. Thereby,

$$\Delta T = \Delta T_{oil} + \Delta T_{other} = \Delta T_{oil} + \Delta GDP \times \theta \tag{9}$$

where ΔT is the change of national fiscal revenue caused by

the taxes and fees reform of oil and gas resources. ΔT_{oil} is the change of total taxes and fees of oil companies, as shown in Table 7; ΔT_{other} is the change of total taxes and fees of oil-and-gas-related industries. ΔGDP is the change of GDP caused by taxes and fees reform of oil and gas resources, as shown in Table 9; θ is the fiscal revenue of unit GDP in the national economy. According to China Statistical Yearbook 2008, China's GDP is 31.4 trillion RMB yuan and the revenue is 5.42 trillion RMB yuan in 2008 (National Bureau of Statistics of China, 2009), thus the national fiscal revenue of unit GDP is 0.173, that is, θ=0.173. Based on Eq. (9) and related data, the impact of the reform program on national fiscal revenue is in the range of 7937-16729 million US dollars, as shown in Table 10.

Table 9 Change of GDP with oil price caused by fee and tax reform program

Oil price, US dollars/barrel	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-90	90-100	100-110
ΔGDP, million US dollars	49753	55607	61460	67313	73167	79020	84873	90726	99506	111213	122920

Table 10 Change of national fiscal revenue with oil price caused by tax and fee reform program

Oil price, US dollars/barrel	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-90	90-100	100-110
ΔT_{oil}, million US dollars	1678	441	-1166	-3114	-4721	-5603	-6143	-6314	-5958	-5247	-4536
ΔT_{other}, million US dollars	8607	9620	10633	11645	12658	13670	14683	15696	17215	19240	21265
ΔT, million US dollars	10285	10061	9467	8531	7937	8067	8540	9382	11257	13993	16729

4) Change of social employed population

The growth of GDP requires the investment of human resources, so the reform program will change the social employed population.

$$\Delta L = \Delta GDP \times \lambda \tag{10}$$

where ΔL is the change of social employed population caused by the taxes and fees reform of oil and gas resources; λ is the employed population of unit GDP. According to China Statistical Yearbook 2008, China's employed population is 774 million in 2008 (National Bureau of Statistics of China, 2009), then the average employed population of unit GDP is 2.46×10^{-5}, that is, $\lambda=2.46\times10^{-5}$. Based on Eq. (10) and related data, the social employed population will increase in the range of 8.59−21.23 million annually during the "Twelfth Five-Year Plan", as shown in Table 11.

In conclusion, during the "Twelfth Five-Year Plan", the

Table 11 Change of social employed population caused by tax and fee reform program

Oil price, US dollars/barrel	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-90	90-100	100-110
ΔGDP, million US dollars	49753	55607	61460	67313	73167	79020	84873	90726	99506	111213	122920
ΔL, million people	8.59	9.60	10.61	11.63	12.64	13.65	14.66	15.67	17.18	19.21	21.23

taxes and fees reform of oil and gas resources will increase the foreign exchange reserves in the range of 1067-2636 million US dollars, promote the growth of GDP in the range of 49753-122920 million US dollars, and increase the national fiscal revenue in the range of 7937-16729 million US dollars. Therefore, the taxes and fees reform will help to guarantee China's energy security and increase the foreign exchange reserves, GDP and national fiscal revenue, thus it is helpful for the state to invest in public services and facilities, such as education, health and environmental protection. Besides that, the reform will bring a lot of employment opportunities.

5 Conclusions and future work

Based on the analysis of major problems of China's current taxes and fees for oil and gas resources, a reform program is proposed from tax/fee items and tax/fee rates, and the impacts on oil companies and state are investigated during the "Twelfth Five-Year Plan". Three conclusions are drawn and there are still many issues need to be studied in future.

5.1 Conclusions

1) There still exist some problems in China's current tax and fee policies of oil and gas resources. And these problems discourage low-grade oil and gas resources development, including: repetitive levy, separation of tax from price, small difference of resource tax, special oil gain levy imposed on non-excess profits and insufficient encouragement policies for development of low-grade oil and gas resources.

2) Targeting the problems, a reform program is proposed, including: (i) merging current mineral royalty, resource tax and compensation fee for mineral resources into royalty, adopting the ad valorem collection mode and setting the royalty rate from 2% to 10% in terms of the grades of oil and gas resources under current oil price (when the oil price is less than 50 US dollars per barrel, the royalty rate can be

reduced to 1% or exempted); (ii) adding a resource depletion compensation fee and ecological compensation fee, adopting the ad valorem collection mode and presently setting both of the rates to 0.5%; (iii) improving the threshold of special oil gain levy to 60 US dollars per barrel for low-grade oil and gas resources and keeping other factors of special oil gain levy unchanged; (iv) keeping other taxes and fees of oil and gas resources unchanged.

3) By the analysis of the main stakeholders' interests of oil and gas resources, impacts of the reform program on oil companies and the state are estimated. The results show that: during the "Twelfth Five-Year Plan", the implementation of the proposed low-grade tax and fee policies in this paper will increase oil and gas production, which will be helpful to protect China's oil and gas supply security; because of the linkage effect of oil and gas industry, the reduction of taxes and fees for low-grade oil and gas resources will increase the GDP and national fiscal revenue; Meanwhile, the growth of GDP will increase the employment opportunities and improve people's living standards in China. Therefore, the proposed reform program will not only help to promote the development and utilization of low-grade oil and gas, but also increase the main stakeholders' benefits, especially improving China's energy security level.

5.2 Future work

Because of the fluctuation of international oil price, different resource endowments, exploitations and economic development characteristics of different regions, the following issues still need to be further studied.

1) The royalty rate. The rates of China's current taxes and fees of oil and gas resources are too low to materialize the state's interest as the owner, so referencing to royalty rates of foreign countries, the royalty rate of the proposed reform program is set from 2% to 10% in terms of the grades of oil and gas resources. When oil price is less than 50 US dollars per barrel, the royalty rate is reduced to 1% or even exempted. However, the specific criteria of royalty rate still needs to be further studied.

2) Rates of the resource depletion compensation fee and ecological compensation fee. In this paper, the rates of the resource depletion compensation fee and ecological compensation fee are set to 0.5%. However, the rates may need to be set in different grades considering oil price fluctuations and ecological compensation features in different oil and gas-producing regions. It is a huge work to comprehensively investigate the economic development, impacts of oil and gas development on regional economy, and compensation standards for resource depletion and economic development in different oil and gas-producing regions. So rate problems of the resource depletion compensation fee and ecological compensation fee need to be further researched.

3) Estimating with more detailed data. Restricted by the confidentiality of financial data of oil companies, the estimation of this paper is based on our investigation data and the data from 2008 Annual Report of PetroChina. It is necessary to study with more oil companies to estimate on more accurate and detailed data in the future.

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