Scale Determinants of Fiscal Investment in Geological Exploration: Evidence from China

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Abstract

With the continued growth in demand for mineral resources and China’s efforts in increasing investment in geological prospecting, fiscal investment in geological exploration becomes a research hotspot. This paper examines the yearly relationship among fiscal investment in geological exploration of the current term, that of the last term and prices of mining rights over the period 1999–2009. Hines and Catephores’ investment acceleration model is applied to describe the scale determinants of fiscal investment in geological exploration which are value-added of mining rights, value of mining rights and fiscal investment in the last term. The results indicate that when value-added of mining rights, value of mining rights or fiscal investment in the last term moves at 1 unit, fiscal investment in the current term will move 0.381, 1.094 or 0.907 units respectively. In order to determine the scale of fiscal investment in geological exploration for the current year, the Chinese government should take fiscal investment in geological exploration for the last year and the capital stock of the previous investments into account. In practice, combination of government fiscal investment in geological exploration with its performance evaluation can create a virtuous circle of capital management mechanism.

Introduction

China’s investment mechanism on geological exploration contributes to a special investment scenario that fiscal investment occupies a substantial proportion of the total investment. For instance, fiscal investment in geological exploration accounts for 15.4% in 2009 [1]. The investment mechanism of China’s geological exploration differs from that of the western market economies. In western market economies, central government usually only invests on public geological survey while private funds invest in commercial mineral exploration. Chinese government invests in public geological survey and commercial mineral exploration as well for it sets up geological exploration funds to share the risk of some of the commercial investors for China has not established risk capital market of exploration yet [2]. Therefore, the new mechanism of geological exploration investment is being implemented in practice, which is “public capital goes first, exploration funds play a convergent role, commercial capital follows up, be fully equipped to exploration and make a breakthrough” [3].

Most literatures on geological exploration investment shed light on the economic impact evaluation of the total investment [4], [5]; however, scarce literatures practically analyze the internal relations of fiscal investment in geological exploration. Some observers notice that China’s fiscal funds investing in geological exploration have been declining gradually [5]–[8] and private capital has been entering that field [6], [9]. Despite some discussion on fiscal investments scale on geological exploration [10]–[12], there is still little research on the scale determinants and relevant policies. In the long run, since China’s fiscal funds will still play an important role in geological exploration investment due to its centralized governance structure and the concern of sharing risk for private investors, the corresponding fiscal policies need to be further studied.

On the basis of the literature review, the investment acceleration model is applied to analyze the scale determinants of fiscal investment in geological exploration and corresponding policy suggestions have been given with future research directions being proposed.

Literature Review

Keynes [13] created a true sense of research on public investment and economic growth in “General Theory”. He believes that for the role of monetary policy is highly weak, the state should adopt fiscal policies to strengthen the main socio-economic intervention and the range of expenditure should be expanded to economic spending such as infrastructure in addition to traditional government spending. For issues related to fiscal investment, research literature can be inspected from the following aspects, such as capital structure, size, effects and institutional issues [14]–[21]. However, few studies attempt to determine the optimal scale of fiscal expenditure by economic growth [22]. Barro [16] firstly developed the theoretical framework of optimal scale of government expenditure via endogenous growth model. Further, Barro proposed the “Barro Rule”-the government services are “optimally provided” when the marginal product of government consumption equals unity. Steven P. Cassou and Kevin J. Lansing...
[23] develops a quantitative theoretical model for the optimal provision of public capital. Using the theoretical framework of Barro, the optimal scale of government services and fiscal expenditure in the process of economic growth was investigated [22], [24]–[25]. Using panel data, the “Barro rule” for 118 countries and European economies has been examined respectively [24]–[25]. G. Karras finds that all government services are productive in the sense that their marginal product is positive and significantly different from zero [25]. Gnanal and Guizhan [22], using annual data from 1990 to 2001 for 20 transition countries, find empirical evidence supporting the hypotheses that government services are productive, and the optimal government scale is estimated to be 17.3 percent (±3 percent) for the average transition country.

Though research on domestic fiscal investment started late, a number of fiscal policy recommendations under China’s national conditions have been created [26]–[33]. Xiaoming LI [34] developed a two-region game theoretical model to argue that the prospective financial reforms will subject local governments’ investment decision making to the indirect regulations of monetary policy. Yehua WEI [35] investigates China’s changing fiscal system and the prospective financial reforms will subject local governments’ investment decision making to the indirect regulations of monetary policy. Ziran Z. [12] details the policies and conditions have been created [26]–[33]. Xiaoming LI [34] developed a two-region game theoretical model to argue that the prospective financial reforms will subject local governments’ investment decision making to the indirect regulations of monetary policy.
The simplified form is as follows.

\[ I_t = \beta_1 \Delta Y_{t-n} + \beta_2 Y_{t-n-1} + \beta_3 I_{t-1} + \beta_4 I_{t-2} + \varepsilon \quad (8) \]

Where \( I_t \) = investment for each term, \( \Delta Y_{t-n} = \) output capital value-added for each term, \( Y_{t-n-1} = \) output capital for each term, \( I_{t-1} = \) investment for the last term, \( I_{t-2} = \) investment for the last second term. \( \beta_1, \beta_2, \beta_3, \beta_4 \) denote the impact parameter of \( \Delta Y_{t-n}, Y_{t-n-1}, I_{t-1}, I_{t-2} \) respectively. \( \varepsilon \) denotes random disturbance term.

**Data Description**

In this paper, data from 1999 to 2009 comes from [1]. Hong Kong, Macao and Taiwan Province are not included in those national statistics. In equation (8), \( I_t \) represents fiscal investment in geological exploration at industry level, \( \Delta Y_{t-n} \) denotes output capital (denotes prices of mining rights) value-added for previous term, \( Y_{t-n-1} \) denotes output capital (denotes prices of mining rights) for previous term, and \( I_{t-1} \) as well as \( I_{t-2} \) represent fiscal investment in geological exploration for the last term and the last second term respectively. The mining rights include prospecting and mining rights. Since there is only data on prices of mining rights which are the collaborative outcome of fiscal and social funds, we can obtain separate data on prices of mining rights.

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**Figure 1. Estimation of investment function model.** Estimation of investment function model includes analysis of variance and parameter estimates towards variables \( \Delta Y_{t-n}, Y_{t-n-1}, I_{t-1}, I_{t-2} \) (data from [1]).

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which are the outcome of fiscal funds by multiplying the total prices of mining rights with the percentage of fiscal funds. Here the premise needs to be set beforehand, that is, the investment efficiency of fiscal funds is the same as social funds for the funds have the same properties as currency and capital. Fiscal funds include the fiscal funds from central government and local governments. The above data is on the base year 1999, taking inflation into account, deflated with the GDP index.

Data Analysis

This statistical analysis, with SAS 8.11 software and OLS method, can estimate the Hines and Catephores investment acceleration model considering \( \beta_1, \beta_2, \beta_3, \beta_4 \). The regression equation is obtained as follows:

\[
I_t = 0.382\Delta Y_{t-n} + 1.060Y_{t-n-1} + 0.933I_{t-1} - 0.007I_{t-2} + \varepsilon 
\]

(9)

\( (6.54) \quad (5.98) \quad (7.93) \quad (-0.32) \)

\[
R^2 = 0.996, \quad F_2 = 0.9993, \quad D.W. = 2.353, \quad MSE = 35030
\]

The P-values of variables \( \Delta Y_{t-n}, Y_{t-n-1}, I_{t-1}, I_{t-2} \) are 0.0006, 0.0010, 0.0002, 0.7596, which indicates the first three variables are significant while \( I_{t-2} \) is not.

From the above result (as in Fig. 1), it can be inferred that the model is significant while \( I_{t-2} \) is not significant. Why the model is significant while one of the variables is not? Simply removing \( I_{t-2} \) from the model is not logical. The insignificance of \( I_{t-2} \) is possibly caused by other variables. Which of the variables should we choose and maintain while removing the rest? Therefore, it is needed to compare the difference of variables’ significant contribution and discuss the reasonability of the model by stepwise regression.

Through the stepwise regression (as in Figure 2), we can figure out that \( I_{t-2} \) is the least significant variable among the four ones. It needs to be removed to ensure the reasonability of the model. Then the model can be adjusted as follows.

After removing \( I_{t-2} \), the model is significant at the significant level of 10% (as in Fig. 3). The adjusted regression equation is obtained as follows:

\[
I_t = 0.381\Delta Y_{t-n} + 1.094Y_{t-n-1} + 0.907I_{t-1} + \varepsilon 
\]

(7.00) (8.36) (11.38)

\[
R^2 = 0.9995, \quad F_2 = 0.9993, \quad D.W. = 2.211, \quad Root MSE = 32708
\]

Four parameters in the equation (10) at the 5% significance level were significant, reflecting that value-added of mining rights, value of mining rights and fiscal investment in the last term have long-run equilibrium relationship and positive correlation with fiscal investment in the current term. Value of mining rights and fiscal investment in the last term has greater influence on fiscal investment in the current term than value-added of mining rights.

The coefficient of \( \Delta Y_{t-n} \) is 0.381, which indicates when value-added of mining rights in the last term moves 1 unit, fiscal investment in the current term will move 0.381 units positively. Similarly, when value of mining rights in the last term or fiscal investment in the last term moves 1 unit, fiscal investment in the current term will move 1.094 or 0.907 units respectively.

The equation (10) describes the scale determinants of fiscal investment in geological exploration, which are value-added of mining rights, value of mining rights in the last term and fiscal investment in the last term. Among those three determinants, value-added of mining rights and value of mining rights in the last term reflect the monetary value attribute and characteristics of investment behavior, and the fiscal investment in the last term reflects historical retrospective which is consistent with China’s current fiscal management method.

Conclusion, Discussion and Future Research Directions

Conclusion

The paper applies Hines and G. Catephores’ investment acceleration model with the latest information to determine the scale of fiscal investment in geological exploration. The conclusions can be drawn as follows. (1) Fiscal investment in the current term will move 0.381 units positively when value-added of mining rights in the last term moves 1 unit. (2) Fiscal investment in the current term will move 1.094 units correspondingly when value of mining rights in the last term moves 1 unit. (3) Fiscal investment in
the current term will move 0.907 units correspondingly when fiscal investment in the last term moves 1 unit.

Discussion

Because of China’s unique investment mechanism of geological exploration, public finance not only needs to bear the cost of public geological work, but also needs to give financial and administrative support to the growing commercial geological work accompanied by market failures, economic externalities, presence of incomplete markets. With the injection of fiscal funds, pulling effect of social capital into the geological survey and mining industry is obvious [59]. Volume of social capital in geological survey is enormous, indicating that the future profit potential from geological prospecting and exploration has a strong attraction to social capital and social capital is willing to invest in geological prospecting and following mining industry. For the volume of fiscal investment in geological work is more stable than that of social capital and social capital is usually pulled by fiscal funds, one of the critical methods to strengthen the budget management of the geological exploration investment is to determine the reasonable size of fiscal investment in geological exploration. The conclusions of the paper can be beneficial to work out the fiscal investment budget for geological exploration, which reveals the following:

1) Define budget implementation of fiscal investment in geological exploration in the previous year as a factor to determine financial investment in geological exploration in the current year.

Figure 3. Estimation of adjusted investment function model after removing $I_{t-2}$. Estimation of adjusted investment function model includes analysis of variance and parameter estimates towards variables $\Delta Y_{t-n}$, $Y_{t-n-1}$ and $I_{t-1}$ (data from [1]).

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People’s Republic of China’s implementation of the national budget in 2010 and national budget in 2011 (Draft) [60] provides the overall requirements of financial budgeting and financial work. In 2011, for example, China continued to implement the proactive fiscal policy, to make efforts in optimizing the investment structure, to strengthen the weak points in economic and social development, to support economic restructuring and coordinated regional development and to promote economic development mode’s alteration. In budget implementation of 2010, land resources and meteorological services expenditures, 45.489 billion RMB, rose up by 22.9 percent than that of 2009, in order to enhance mineral exploration, mine geology and environmental recovery and conservation and comprehensive utilization of mineral resources. It can be inferred that increasing the state’s geological exploration input is an important measure of fiscal investment in recent years, which effectively promotes the prosperity of mining and economic development. Appropriate scale of investment is not only the scale that adapts to economic, technological and social development but also the one that can be afforded by the government in a period of time. For geological exploration is performance-oriented, in order to ensure appropriate investment in geological exploration, it is particularly necessary to determine a reasonable investment budget. Model (10) shows that, the amount of financial investment in a geological exploration for the last term is an important basis to determine the amount for the current term, which is consistent with our current budget system. On March 22, 1994, the second meeting of the Eighth National People’s Congress adopted “Budget Law of the People’s Republic”, which indicates that the budget year is from January 1, to December 31 in the Gregorian calendar. The central budget and local government budgets at all levels, should refer to the budget implementation of the previous year and revenue forecast of the current year.

2) Define the capital stock of the previous investment in geological exploration as a factor to determine the current fiscal investment

Model (10) shows that mining output levels, signified by mining rights’ prices and value-added, reflect the latest expectations of capital stock, which should also be included in the fiscal budget considerations. Fiscal funds for geological exploration come from “one tax, two prices, three charges” (i.e., resource tax, the prices of prospecting and mining rights, compensation fee of mineral resources, exploration royalties and mining royalties), the geological survey fund and other special charges. The capital stock of fiscal investment in geological exploration, part of prospecting and mining rights’ prices, participates in the new round of investment fiscal investment in geological exploration, part of prospecting and mining rights’ prices, participates in the new round of investment while the dynamic market and government behavior also has something to do with the latter. The dynamic market and government behavior can cause the price change of mineral resources and fluctuation of mining rights, which can be embodied in the change of value and value-added of mining rights. Those factors have been already taken into account in investment acceleration model.

Future research directions

This study is based on fiscal investment in geological exploration at industry level. In order to examine the problem more comprehensively, we have three main directions in further studies: (1) To measure the influence of the dynamic market and government behavior on the fiscal investment in geological exploration respectively can rationalize the investment mechanism. (2) To discuss the mechanism of budget implementation of fiscal investment in geological exploration specifically can ensure the validity of the fiscal policy. (3) To discuss the scale of fiscal investment in geological exploration in priority provinces and priority minerals can promote the rational allocation of financial resources for geological exploration.

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Author Contributions

Conceived and designed the experiments: YL. Performed the experiments: LL. Analyzed the data: LL. Contributed reagents/materials/analysis tools: LL. Wrote the paper: LL. Participated in the revision of the manuscript: YL.

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Fiscal Investment on Geological Exploration

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