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# Does Private Investment Help Improve Natural Resource Utilization Efficiency?

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Using panel data from 30 Chinese provinces (excluding Tibet, Hong Kong, Macao, and Taiwan) over the 2006 to 2016 period, this research analyzes the impact of private investment on natural resource utilization efficiency. We find that private investment improves natural resource utilization efficiency both directly and via technological innovation.

## 1. Introduction

In this paper, we examine the impact of private investment on the efficiency of natural resource utilization. Our hypothesis is that private investment will have a positive impact on natural resource utilization efficiency—a relation that is motivated by the theory of new public management proposed by Hood (1990). According to this theory, the successful management method of private sector should be adopted, and market competition should be introduced in public sector management.

This hypothesis test is important because natural resources are important for economic, social, and environmental development (Chen et al., 2019; Peck & Parker, 2016), and their allocation and utilization efficiency are affected by factors such as green technology innovation, investment scale, and research and development expenditure (Miao et al., 2017; Syverson, 2011). The withdrawal of state-owned capital and the entry of private investment may improve the efficiency of natural resource utilization, as shown by Malaga-Toboła et al. (2015).

In the market economy, the advantages of capital and technology can effectively improve the efficiency of natural resources (such as water resources, land resources, and ecological farmland) utilization (Gu & Sun, 2017; Malaga-Toboła et al., 2015). Social capital plays a vital role in economic growth and resource allocation (Khan & Einhart, 1990; Su & Bui, 2017; Zhang & Li, 2020). Kelly et al. (2017) believe that social capital and ownership consciousness are the theoretical foundations that affect the effectiveness of community management. Social capital is conducive to water commission elections, resource mobilization, and information sharing. Encouraging and guiding private capital to invest in the construction of ecologically clean watersheds can also effectively make up for the shortcomings of insufficient financial investment and strengthen the protection of water resources (Li et al., 2015). In land resource management, the impact of different types of social capital is also different, as most farmers prefer to use the mass mobilization method to concentrate social capital to achieve soil and water conservation (Teshome et al., 2016).

We employ Chinese provincial level data covering 30 provinces for the 2006-2016 period and find that private investment can significantly improve the efficiency of natural resource utilization. Private-owned investment, company with limited liability investment and stock corporation investment all effectively improve natural resource utilization efficiency in the eastern, central, and western regions of China. The impact of private investment in the eastern region is significantly higher compared to the other two regions. These results pass robustness tests, such as empirical models that: (a) utilize data which excludes outliers, (b) include lag explanatory variable (that captures persistency), and (c) account for standard error clustering.

These findings make two contributions to the literature. The first is that only a few studies empirically analyze the change in natural resource utilization efficiency from the perspective of private investment. We examine private investment and natural resource utilization efficiency and offer a discussion of how private investment influences natural resource utilization efficiency. The second contribution is that we study the differences in the impact of private investment on natural resource utilization efficiency for different types of investments (such as private-owned, company with limited liability, and stock corporation, among others) in order to observe the heterogeneity effect of the various types of private investment.

## 2. Data and model

To empirically analyze the impact of private investment on natural resource utilization efficiency, this paper proposes the following model:

$$ENR_{it} = \alpha + \beta_1 \ln PI_{it} + \beta_2 \ln RGDP_{it} + \beta_3 \ln TIA_{it} + \beta_4 \ln GI_{it} + \beta_5 \ln RD_{it} + \beta_6 \ln FDI_{it} + \beta_7 \ln IM_{it} + \delta_{it} \quad (1)$$

where  $\alpha$  is the intercept term,  $\delta_{it}$  is the stochastic disturbance team, and  $\beta_s$  are the model coefficients to be estimated.

The dependent variable in Equation (1) is the natural resource utilization efficiency ( $ENR$ ), which measures the economic and ecological benefits generated in the process of natural resource utilization. This paper uses the value

of natural resource utilization efficiency following Mei and Mao (2008). Using their evaluation index system of natural resource utilization efficiency, this paper selects the following indicators to measure such efficiency: energy consumption standard volume ( $X1$ ), fixed asset investment ( $X2$ ), water consumption ( $X3$ ), and construction land area ( $X4$ ) are input indicators. We then take the ratio of GDP to industrial waste gas emissions ( $X5$ ), industrial wastewater emissions ( $X6$ ), and solid waste emissions ( $X7$ ) as output indicators.

This paper uses Shannon's Entropy model to determine the weight of each indicator and employs a simple linear weighting method to make a comprehensive evaluation of the natural resource utilization efficiency of 30 provincial administrative regions in China (excluding Tibet, Hong Kong, Macao, and Taiwan) for the 2006 to 2016 period.<sup>1</sup> The optimal score is 1, and the closer the score is to 1, the greater is the natural resource utilization efficiency.<sup>2</sup>

The explanatory variables are as follows. We select private investment ( $PI$ ) as the model's explanatory variable and express it in terms of the amount of private investment (Ari et al., 2020). The amount of private investment is the difference between the social fixed asset investment of domestic-funded enterprises and state-owned fixed asset investment. Private investment is composed of multiple parts, including 7 components of investments: private-owned ( $PO$ ), company with limited liability ( $LC$ ), stock corporation ( $SC$ ), collective economy ( $CE$ ), individual ( $IC$ ), shareholding cooperative ( $JSP$ ), and investments in associates ( $AE$ ).

We also employ several control variables following Xu and Tan (2020). Economic development ( $ECD$ ): gross domestic product ( $GDP$ ) is used to measure economic development level. Industrial structure ( $TIA$ ): the proportion of the tertiary industry in GDP is used to measure whether industrial structure is reasonable. Government investment ( $GI$ ): the amount of state-owned fixed asset investment is used to represent the status of government investment. Technological innovation ( $RD$ ): we use research and development expenditure to represent the status of technological innovation. Foreign direct investment ( $FDI$ ): it is expressed in terms of the actual use of foreign direct investment. Imports ( $IM$ ): the import trade value is the exchange rate of the US dollar against the RMB in that year multiplied by the import value expressed in US dollars. These factors are important in influencing the efficiency of natural resource utilization.

Data come from the China Energy Statistical Yearbook, the China Statistical Yearbook and the China Science and Technology Statistical Yearbook.

### 3. Results

Results in Table 1 show that private investment can significantly improve the efficiency of natural resource utilization. The coefficient of influence for private investment on natural resource utilization efficiency is 0.172. The main component of private investment is small- and medium-sized enterprises ( $SMEs$ ) that have flexible operations and can better adapt to market changes including innovations.

Private investment in natural resource ventures helps revitalize those resources through mortgage, transfer, and valuation, among others. Private investment helps increase the financial attributes and economic value of natural resources; thereby, improving natural resource utilization efficiency.

We note that  $LC$  and  $PO$  significantly improve natural resource utilization efficiency, while  $JSP$  and  $AE$  have a significant negative effect on efficiency. The impacts of several other types of investments are insignificant. The reason is that the change in  $LC$  is small, the internal cohesion and the coordination of shareholders are relatively strong, and thus they have higher operating efficiency. The private-owned investments are more flexible, and so they make a stronger contribution to efficiency, as seen by capital investment efficiency being relatively high. However, the management efficiency of shareholding cooperative enterprises and associate enterprises is relatively low, and technological innovation capability is insufficient, thus making it difficult for such investments to take an active role in the use of natural resources.

From Table 2,  $SC$ ,  $LC$ , and  $PO$  all effectively improve natural resource utilization efficiency in the eastern, central, and western regions of China. The impact in the eastern region is significantly higher than that of the other two regions. The reason may be because the eastern coastal area has a highly open and developed economy, its market is active, and the private economy has entered a wide range of fields and has a good foundation for development, thus forming a batch of large-scale and specialized private economic industrial clusters. In addition, the eastern region can better undertake the technology transfer of developed countries and regions by virtue of its geographical advantage (Zhang et al., 2020) and pay more special attention to technological innovation, management innovation, and institutional innovation. Overall, the development trend of the private economy and the overall quality and investment efficiency of enterprises are significantly better than those in the central and western regions, providing a significant spillover effect of knowledge and technology.

We see in the eastern, central, and western regions, private investment has a significantly positive impact on natural resource utilization efficiency, but private investment in the eastern region has the largest positive effect. Second, private investment has a greater positive effect on the efficiency of natural resource utilization in areas with low state-owned investment and high levels of industrial development.

Looking at the role of technological innovation, after analyzing the direct effect of private investment on natural resource utilization efficiency, we employ the mediated effect model to explore the transmission effect of such innovation. The study finds that private investment can significantly improve the current natural resource utilization status and improve resource utilization efficiency by promoting technological innovation. Technological innovation accounts for 39.71% of the mediated effect of private investment on natural resource utilization efficiency.

1 According to the criteria of the National Bureau of Statistics, China is divided into the eastern region (Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan), the central region (Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan) and the western region (Inner Mongolia, Chongqing, Sichuan, Guizhou, Yunnan, Guangxi, Tibet, Shaanxi, Gansu, Ningxia, Qinghai and Xinjiang).

2 Primary energy consumption data are currently only updated to 2016.

**Table 1: Regression results of private investment affecting natural resource utilization efficiency**

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnPI	0.172*** (0.029)							
lnLC		0.071*** (0.012)						
lnPO			0.047*** (0.010)					
lnIC				0.018 (0.013)				
lnJSP					-0.027*** (0.005)			
lnSC						0.001 (0.011)		
lnCE							-0.004 (0.006)	
lnAE								-0.017*** (0.004)
<i>Control variable</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Cons</i>	-0.457*** (0.043)	-0.158*** (0.050)	-0.053 (0.062)	-0.236*** (0.053)	-0.224*** (0.049)	-0.221*** (0.056)	-0.222*** (0.052)	-0.250*** (0.051)
<i>Obs</i>	330	330	330	330	330	330	330	330
<i>R</i> <sup>2</sup>	0.522	0.635	0.615	0.591	0.625	0.588	0.589	0.610

This table reports the regression results of private investment affecting natural resource utilization efficiency (the dependent variable). Column (1) contains regression results when private investment is the explanatory variable. Columns (2) - (8) are the regression results when each of the seven different types of private investment is used as an explanatory variable. These variables include: private-owned (PO), company with limited liability (LC), stock corporation (SC), collective economy (CE), individual (IC), shareholding cooperative (JSP), and investments in associates (AE). The standard error is given in parenthesis. Finally, \*\*\*, \*\*, and \* represent 1%, 5%, and 10% significance levels, respectively.

#### 4. Robustness test

In order to exclude the influence of outliers in the data and to test the robustness of the main results, we use a quantile regression model to analyze the impact of private investment on natural resource utilization efficiency at the quantiles of 0.25, 0.50, and 0.75. At different quantiles, private investment has a significantly (at the 1% level) positive effect on natural resource utilization efficiency.

If there is a causal relationship between the explanatory variable and the explained variable, it may lead to inconsistency in simultaneous equations and the estimation of regression results. In order to solve this problem, we take the explanatory variable lagged one period as the pre-determined variable for the regression. If the lag variable is significantly positive, then this corroborates previous findings. After lagging the explanatory variable by one period, the regression coefficient is still significant at the 1% level and retains its positive sign.

When there is a correlation between the random disturbance term of individuals in the sample period, the standard error of the regression coefficient may be underestimated. The investment behavior of private enterprises may

be affected by the investment behavior of previous years, and thus a standard error clustering treatment can reduce regression errors. After standard error clustering, the impact of private investment on natural resource utilization efficiency is still significant and positive.

#### 5. Conclusion

This paper uses a panel dataset consisting of 30 provincial-level regions in China for the 2006 to 2016 period to analyze the impact of private investment on natural resource utilization efficiency. The study finds that private investment can significantly improve natural resource utilization efficiency with results robust even after accounting for endogeneity. This study hence recommends that China should actively expand the scope of private capital investment, improve the quality of private investment, focus on improving the independent innovation capabilities of private enterprises, take advantage of the scale of large private enterprises, and establish an investment transformation mechanism for SMEs.

This study offers a useful reference for improving natural resource utilization efficiency, but the research still has

Table 2: Sample regression results of the three main types of private investment

Variable	(1)			(2)			(3)		
	Eastern	Central	Western	Eastern	Central	Western	Eastern	Central	Western
InPO	0.074*** (0.021)	0.039*** (0.013)	0.015 (0.013)						
InLC				0.104*** (0.024)	0.057*** (0.018)	0.026* (0.014)			
InSC							0.061** (0.031)	0.028* (0.017)	0.028** (0.012)
<i>Control Variable</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Cons</i>	-0.122 (0.140)	0.014 (0.089)	-0.255*** (0.073)	-0.189 (0.131)	-0.126* (0.073)	-0.328*** (0.051)	-0.280* (0.142)	-0.406*** (0.131)	-0.143** (0.061)
<i>Obs</i>	121	88	121	121	88	121	121	88	121
<i>R</i> <sup>2</sup>	0.633	0.766	0.698	0.651	0.770	0.783	0.588	0.596	0.675

This table reports the regression results of the three main types of private investment, namely private-owned (PO), company with limited liability (LC), stock corporation (SC). Columns (1) - (3), respectively, show the impact of three types of private investment on natural resource utilization efficiency in the eastern, central and western regions. The standard error is given in parenthesis. Finally, "\*", "\*\*", and "\*\*\*" represent 10%, 5%, and 1% significance levels, respectively.

some limitations. Natural resource utilization efficiency in this paper is a comprehensive index, and it is impossible to observe the change in utilization efficiency of each kind of natural resource. Future studies can, thus, calculate the

utilization efficiencies of land, water, and other natural resources in order to improve our understanding on this topic.



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