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Resource endowment, market-oriented reform, and industrial transformation: Empirical evidence from Chinese cities

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ABSTRACT

Industrial transformation is the key to urban transformation. It is also considered to be one of the important ways to reduce resource consumption and improve environmental quality. However, industrial transformation is often constrained by local resource endowments. Based on the panel dataset of 283 China's cities. This paper analyzed the effect of resource endowment on industrial transformation under the background of market-oriented reform by using several econometric methods. We found that resource endowments have a nonlinear impact on the industrial structure under different marketization levels. We confirm that resource endowment has lock-in effect on industrial transformation, and China's market-oriented reform can alleviate such lock-in effect. Based on these findings, we propose several target policy suggestions to promote industrial transformation.

Keywords: Resource endowment; Market-oriented reform; Industrial transformation; China

1. INTRODUCTION

Over the past four decades of China's reform and opening-up, China's economy has achieved world-renowned achievements, but this is at the cost of huge resource consumption and serious environmental pollution (Yao et al., 2018). Industrial transformation is considered to be one of the important ways to reduce resource consumption and improve environmental quality (Chen et al., 2013). Adjusting industrial structure can not only reduce the proportion of high-pollution and energy-intensive industries, and control pollution generation and emission from fountainhead (Hou et al., 2018); it can also improve technological progress, and increase the proportion of intelligence or technology-intensive industries. However, industrial transformation is often constrained by local resource endowments. The "Dutch disease" effect can explain this well.

Resource-rich regions are more likely to choose a resource-based economic system on their development path (Li and Xu, 2018; Lin and Zhu, 2019). From the perspective of comparative advantage theory, resource-rich regions have certain advantages in the heavy industry such as extraction industry, which is conducive to the development of resource-intensive industries. However, long-term reliance on resource-based industries will lead to shrinking of the manufacturing industry, resulting in the industrial structure dominated by heavy industry, and ultimately induces path-dependence and lock-in effect, causing "Dutch disease" (Li et al., 2013; Long et al., 2013). In the 1960s, the Netherlands vigorously developed resource industries such as oil and natural gas, which greatly promoted its economic development. However, behind the rapid economic growth, the development of resource-based industries has severely squeezed agriculture and manufacturing sectors. In the 1980s, the Netherlands economy declined, and suffered many serious problems such as inflation, rising unemployment and falling manufacturing exports. In addition to the Netherlands, Mexico, Australia and other countries have also experienced varying degrees of "Dutch disease".

There are many cities in China that are suffering from "Dutch disease" due to their abundant resources. According to the list of resource-based cities published by Chinese government in 2013, 67 cities are identified

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as resource-exhausted cities, including 24 prefecture level cities and 22 county-level cities. One remarkable feature of these cities is single industrial structure, but in addition natural resource depletion, backward economic development, severe environmental pollution, and so on. It motivates us to investigate whether the resource endowment is really one main reason to form a "high pollution, high energy consumption" industrial structure? If so, is China's market-oriented reform helpful to alleviate the industrial lock-in effect caused by resource endowment?

Since 1978, China's market-oriented reform has gone through more than four decades. Market-oriented reform involves the relationship between the government and the market, the development of the non-state economy, the development degree of product market, the development degree of factor market, the development of intermediary organizations, and the legal system environment (Wang et al., 2019). Although the degree of marketization in the eastern coastal areas of China has been improved significantly, but this value in the less developed areas such as the central and western regions is still at a low level. Differences in marketization level could lead to large differences in resource inputs, resource outputs, and resource utilization efficiency across regions, which in turn lead to uncoordinated development of industries.

Generally speaking, the impact of resource endowment on industrial transformation will change with the promotion of market-oriented reform, which can be explained as follows: (1) Since the industrial competition is fiercer in areas with relatively high degree of marketization, survival of the fittest could force production firms to improve their technological level and production efficiency, this could benefit to form a market environment for industrial transformation. (2) Market-oriented reform can accelerate the flow of production factors, improve regional factors allocation efficiency (Lin and Du, 2015; Fan et al., 2007), and therefore could alleviate the industrial lock-in effect caused by resource endowments. (3) The resource-intensive industries are mainly state-owned enterprises with high degree of government intervention. However, with the increase of the degree of marketization, the market construction could become more complete, which suggests that the market competition order is more perfect, and the government intervention is less. Thus, the improvement of marketization level can serve economic diversification. To this end, we could conclude that the impact of resource endowment on industrial transformation is associated with the market-oriented reform. In general, a higher degree of marketization is always accompanied by more complete market construction and freer flow of production factors, thus the "Dutch disease" effect of resource endowment on industrial structure could be alleviated.

Based on this, this paper attempts to investigate the impact of resource endowment on industrial transformation under the background of China's market-oriented reform. We mainly discuss the following questions: (1) Does resource endowment make the industrial structure sink into the "Dutch Disease" effect? In other words, whether cities with abundant resources are more inclined to form a "high-pollution and high-energy consumption" industrial structure. (2) If yes, does China's market-oriented reform play a regulatory role to alleviate the lock-in effect of resource endowment on industrial structure? This paper adopts several econometric models to answer these questions.

This paper speaks to several strands of literature. Firstly, most of the existing studies focused on China's "resource curse" phenomenon, i.e., the impact of resource abundance on regional economic growth, limited studies analyzed the relationship between resource endowment and industrial transformation. Based on China's city-level data, this paper provides rigorous empirical evidence on this topic and identifies the complex influence of resource endowment on industrial transformation, which is a useful supplement to existing studies. Secondly, existing literature ignored the role of marketization when discussing the relationship between resource endowment and industrial transformation. This paper regards the degree of marketization as a regulatory variable and adopts the partially linear functional-coefficient panel data model to identify the key role of market-oriented reform in industrial transformation, which can avoid model misspecification in traditional linear model (An et al., 2016; Li et al., 2019). Thirdly, the results of this paper clarify the important role of market-oriented reforms in industrial transformation. We find that market-oriented reform is benefit to alleviate the "Dutch disease" effect caused by resource endowments, which has important policy implications for the transformation of China's resource-based cities.

The rest of this paper is organized as follows. Section 2 reviews the literature on resource endowment, market-oriented reform, and industrial transformation. Section 3 introduces econometric models and dataset. Section 4 provides the empirical analysis of the impact of

resource endowment on industrial transformation by considering the role of market-oriented reform. Section 5 concludes this paper with some policy suggestions.

2. PAPER STRUCTURE

2.1 Model specification and data description

(1) *Model specification*

In order to explore the relationship between resource endowment and industrial transformation, this paper conducts the following empirical model:

$$IS_{it} = \alpha + \beta mining_{it} + \gamma X_{it} + \mu_i + \nu_t + \xi_{it} \quad (1)$$

Where $\mathrm{IS_{it}}$ and $\mathrm{mining_{it}}$ represents the industrial transformation and resource endowment for the i-city at period t, respectively. $\mathrm{X_{it}}$ is a set of control variables affecting industrial transformation, which will be introduced later. μ_i and ν_t denote the city fixed effect and year fixed effect, respectively. ξ_{it} is the random error.

As we discussed above, the effect of resource endowment on industrial transformation is affected by China's market-oriented reform. In order to examine the impact of the marketization on such effect. We initially consider the following empirical model:

$$IS_{it} = \alpha + \beta mining_{it} + \lambda(mining_{it} \times ln\,Marketization) + \gamma X_{it} + \mu_i + \nu_t + \xi_{it} \quad (2)$$

In this case, the impact of resource endowment on industry transformation is a linear function of the degree of marketization, i.e., $\partial \mathrm{IS_{it}}/\partial \mathrm{mining_{it}} = \beta + \lambda \ln \mathrm{Marketization}$. However, it should be noted that we may obtain a biased estimation result because of model misspecification caused by linear function assumption. Thus, we further consider other non-liner regression models.

The panel threshold model proposed by Hansen (1999) has been widely adopted in prior studies to explore the non-linear relationship. In order to verify whether there is a non-linear impact of resource endowment on industry transformation under different marketization level, we consider the following model:

$$IS_{it} = \alpha + \beta_1 mining_{it} \cdot I(ln\,Marketization \leq \theta) + \beta_2 mining_{it} \cdot I(ln\,Marketization > \theta) + \gamma X_{it} + \mu_i + \nu_t + \xi_{it} \quad (3)$$

Eq. (3) are standard single threshold panel regression models. Where $\mathrm{I}(\cdot)$ is an indicator function, θ is the threshold value. $\mathrm{I}(\cdot)$ equals to 1 if the condition in brackets is satisfied, otherwise has a value of 0. We can use the LR test proposed by Hansen (1999) to determine whether the threshold values exist. Similarly, the multi-threshold panel regression model such as the double threshold values model is expressed as follow:

$$IS_{it} = \alpha + \beta_1 mining_{it} \cdot I(ln\,Marketization \leq \theta_1) + \beta_2 mining_{it} \cdot I(\theta_1 < ln\,Marketization \leq \theta_2) + \beta_3 mining_{it} \cdot I(ln\,Marketization > \theta_2) + \gamma X_{it} + \mu_i + \nu_t + \xi_{it} \quad (4)$$

However, the threshold panel regression model assumes that there is a linear relationship in intervals between different threshold values, which is also likely to suffer from model misspecification.

Thus, we further consider the following partially linear varying coefficient panel data model. We assume that the resource endowment enters the model with the coefficients being nonparametric functions of the degree of marketization:

$$IS_{it} = \alpha + \beta(ln\,Marketization) mining_{it} + \gamma X_{it} + \mu_i + \nu_t + \xi_{it} \quad (5)$$

Where $\beta(\ln \mathrm{Marketization})$ is the coefficient of $\mathrm{mining_{it}}$, which is a function of the degree of marketization $\ln \mathrm{Marketization}$. Eq. (5) reveals that the coefficient of resource endowment is changed with the degree of marketization. The partially linear varying coefficient panel model relaxes the linear function assumption, which can be more flexible to capture the non-linear effect. We use the series method proposed by An et al. (2016) to estimate Eq. (5).

(2) *Data description*

Dependent variable

Industry transformation. We use the proportion of secondary industry and the proportion of tertiary industry to represent the industry transformation. According to the industry development law of developed countries, when the economy is gradually transformed from the secondary to the tertiary industry, it can realize the advanced transformation of industrial structure. Thus, the changes of the secondary industry (or tertiary industry) can reflect the industry transformation.

Key explanation variables

Resource endowment (mining): Generally, previous studies used the resource reserves, the proportion of resource industry employees in total employees, and proportion of resource industry output value in GDP to measure resource endowment. Limited to the data at the city level, this paper adopts the proportion of employees in mining industry to represent the resource endowment (Qian et al., 2019). The mining industry includes coal, oil, natural gas and other industries directly related to natural resource, thus, the development of mining industry is an important feature to measure resource endowment.

The degree of marketization (Marketization): Since this paper attempts to explore the impact of resource endowment on industry transformation under different

degree of marketization. Thus, the choose of this indicator is important. Wang et al. (2019) have issued the marketization index of China's provinces from 2008-2016, similar indicator has been widely adopted in prior studies (Li et al., 2019; Ang et al., 2014). We match China's provincial data to 283 prefecture level or above cities in each year. Since the cities is one part of the province, our treatment can support us to investigate the impact of resource endowment on city industry transformation under the big background of provincial market-oriented reform. Fig. 1 shows the kernel density of the degree of marketization in China's provinces, it can be noted that the distribution of the annual kernel density shits to the right side with year, indicating that China's marketization level has gradually improved in the last nine years.

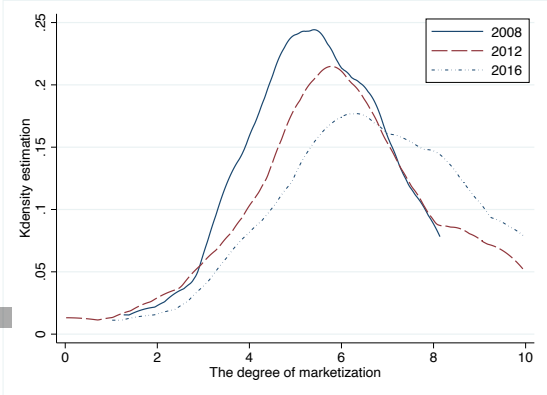

Fig. 1. Kernel density of the degree of marketization in China's provinces

Control variables

Trade openness (fdi). We use the proportion of foreign direct investment in GDP to measure the trade openness. China has been implementing reform and opening-up policy for more than 30 years. Open economy facilitates the redistribution of production factors across countries and ultimately promotes industrial transformation.

Fiscal spending of local government (fiscal spending). Fiscal spending is an important means for the government to intervene in the economy. Generally speaking, fiscal spending is closely related to the relevant policies implemented by the government, such as industrial policy and economic policy. Thus, change in fiscal spending has large correlation with industrial transformation. fiscal spending is measured by the proportion of government fiscal spending in GDP.

Expenditure on R&D and education (R&D_edu). The expenditure on R&D process is of great significance for promoting technological innovation and technological progress, while the expenditure on education is conducive to improving the level of regional human capital (Lin and Zhu, 2019). As a result, increasing expenditure on R&D and education can drive industrial transformation to tertiary industry. This paper uses the proportion of government fiscal spending on R&D and education to measure R&D_edu.

Investment (fai). This paper uses the proportion of fixed asset investment in GDP to measure investment level (Xie and Zhai, 2020). As one of the "troikas" of economic development, investment is an important source of capital formation. At this point in China's development, a steady stream of investment is needed to ensure economic growth, infrastructure construction, elimination of backward production capacity, and technological innovation. Therefore, giving full play to the key role of investment is of great significance for industrial transformation.

Due to the limitations of the marketization index, the data range for this paper is 2008-2016, including 283 Chinese prefecture-level or above cities. The data are collected from annual China City Statistical Yearbook, and the Marketization Index of China's Provinces: NERI Report 2018 (Wang et al., 2019).

2.2 Empirical analysis

(1) Estimation results of linear regression model

Table 1 presents the estimation results of fixed effect panel data model based on Eq. (1) and (2). Where column 1 and 3 are the estimation results without considering the impact of marketization. We note that the estimation coefficient of resource endowment (mining) is significantly positive at 1% level when regarding the proportion of secondary industry as the dependent variables, while the coefficient is significantly negative when treating the proportion of tertiary industry as dependent variable. Thus, the results suggest that richer resource endowments are unfavorable for the adjustment of industrial structure to the tertiary industry.

With regard to the control variables, we observe that the coefficient of fdi are 0.229 and -0.186 and significant at 1% level in column 1 and column 3, respectively, indicating that the trade openness inhibits the upgrading of industrial structure to the tertiary industry. The increase of fiscal spending could promote the transformation of industrial structure to the tertiary industry, which has the coefficients of -0.216 and 0.131 in column 1 and column 3, respectively. A possible explanation is that the fiscal spending is closely related

to the current industrial structure transformation policy. Expenditure on R&D and education (R&D_edu) has significant coefficients of -0.142 and 0.127, which has the same influence directions as expected. The coefficients of fixed asset investment (fai) are 0.298 and -0.128 in column 1 and column 3 and significant at 1% level, suggesting that increase of fixed asset investment could hinder the upgrading of industrial structure.

Table 1. Estimation results of fixed effect model

	Proportion of secondary		Proportion of tertiary	
	(1)	(2)	(3)	(4)
mining	0.145***	1.487***	-0.118***	-0.818***
	(3.95)	(13.62)	(-4.129)	(-9.430)
fdi	0.229***	0.320***	-0.186***	-0.233***
	(2.70)	(3.90)	(-2.817)	(-3.581)
fiscal spending	-0.216***	-0.205***	0.131***	0.125***
	(-7.875)	(-7.733)	(6.14)	(5.96)
R&D_edu	-0.142***	-0.148***	0.127***	0.131***
	(-3.785)	(-4.094)	(4.38)	(4.56)
fai	0.298***	0.374***	-0.128***	-0.168***
	(5.51)	(7.13)	(-3.055)	(-4.038)
mining × ln Marketization		-0.833***		0.434***
		(-12.994)		(8.53)
constant	52.895***	52.451***	32.808***	33.040***
	(46.86)	(48.15)	(37.35)	(38.19)
Year fixed effect	Yes	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes	Yes
Observations	2547	2547	2547	2547
R^2	0.332	0.379	0.534	0.549

Note: t statistics in parentheses; ***p < 0.01, **p<0.05, *p<0.1.

Column 2 and column 4 present the estimation results of Eq. (2), which include the interaction term of resource endowment and marketization level ($\text{mining} \times \ln \text{Marketization}$) into the regression model. We note that the coefficient of the interaction term is -0.833 in column 2; thus, the effect of resource endowment on the proportion of secondary industry is $1.487 - 0.833 \ln \text{Marketization}$, which is a linear decreasing function of the degree of marketization. Moreover, we also observe that the interaction term has a significantly positive coefficient with the value of 0.434; thus, the effect of resource endowment on the proportion of tertiary industry is $-0.818 + 0.434 \ln \text{Marketization}$. In contrast, it is an increasing function of degree of marketization. Overall, the results suggest that the impact of resource endowment on industrial transformation is correlated with marketization level. To be specified, the adverse effect of resource endowment on industrial structure upgrading to tertiary industry will be reduced with the increase of marketization level.

(2) Estimation results of panel threshold regression model

In order to further investigate the non-linear relationship between resource endowment and industrial transformation under different marketization level, we further consider the panel threshold regression model. This paper chooses the degree of marketization as the threshold variables. We use the bootstrap method proposed by [3] to test the threshold effect by repeated 300 times simulation. The results are presented in Table 2 and Table 3, respectively. The results confirm that there are double threshold number for the proportion of secondary industry and the proportion of tertiary industry. The threshold values are 1.3137 and 1.6351, all of them are significant at least 1% level. We hence adopt the double threshold values model.

Table 2. Threshold effect test for the proportion of secondary industry

Threshold variable	Threshold number	F-statistics	p-Value	Threshold value	95% Confidence intervals
ln Marketizatio	Single	142.92	0.000	1.6351	[1.6283, 1.6390]
	Double	79.36	0.003	1.3137	[1.3002, 1.3507]

Table 3. Threshold effect test for the proportion of tertiary industry

Threshold variable	Threshold number	F-statistics	p-Value	Threshold value	95% Confidence intervals
ln Marketizatio	Single	74.61	0.003	1.3137	[1.3002, 1.3507]
	Double	49.26	0.007	1.6351	[1.6163, 1.6390]

The estimation results are shown in Table 4. Column 1 is the estimation results with the proportion of secondary industry as the dependent variable. We note that the impact of resource endowment on the proportion of secondary industry are different at different threshold interval. To be specified, the estimated coefficient of mining is 0.534 when $\ln\text{Marketization} \leq 1.3137$, but this effect decreases with the increase of marketization level. When $1.3137 < \ln\text{Marketization} \leq 1.6351$, the estimated coefficient decreases to 0.234; moreover, this effect even becomes insignificant when $1.6351 < \ln\text{Marketization}$.

Column 2 shows the estimation results with the proportion of tertiary industry as the dependent variable. We observe an opposite result to column 1. The results suggest that the negative effect of resource endowment on the proportion of tertiary industry is decrease with the increase of marketization level. Overall, the results of threshold effect model indicate that China's market-oriented reform could alleviate the adverse effects of resource endowment on industrial transformation.

Table 4. Estimation results of threshold effect model

	Proportion of	Proportion of
fdi	0.277***	-0.213***
	(3.40)	(-3.298)
fiscal spending	-0.198***	0.121***
	(-7.490)	(5.79)
R&D_edu	-0.152***	0.128***
	(-4.206)	(4.48)
fai	0.354***	-0.162***
	(6.79)	(-3.921)
mining (lnMarketization ≤ 1.3137)	0.534***	-0.385***
	(10.22)	(-9.299)
mining (1.3137 < lnMarketization ≤ 1.6351)	0.234***	-0.152***
	(6.33)	(-5.188)
mining (1.6351 < lnMarketization)	0.04	-0.061**
	(1.01)	(-2.103)
constant	48.144***	40.197***
	(40.47)	(42.63)
Year fixed effect	Yes	Yes
City fixed effect	Yes	Yes
Observations	2547	2547
R^2	0.38	0.55

Note: t statistics in parentheses; ***p < 0.01, **p<0.05,

(3) Estimation results of partially linear functional-coefficient panel model

An important feedback of the linear regression model and the threshold model is that the model assumptions are too strict. Therefore, this paper attempts to use the partially linear functional-coefficient panel model to further explore the impact of resource endowment on industrial transformation. Because the model can consistently estimate the nonlinear part at the standard nonparametric rate [1], it relaxes the general assumptions of the linear model or the threshold model, and can better reveal the non-linear relationship between resource endowment and industrial transformation under different marketization level.

The estimation results of Eq. (6) are presented in Table 5 and Fig. 2. Where, Table 5 shows the linear part while Fig. 2 presents the non-linear part. We can observe that the significant level of the control variables in Table 5 is similar to those in Table 1 and Table 4, suggesting the robustness of the estimation results. Moreover, Fig.2 confirms that there is a nonlinear relationship between resource endowment and industry transformation under different marketization level as shown in Fig.1. The 95% confidence interval reveals that the effect is not significant when the degree of marketization lies in low and high level. Overall, Fig. 2 suggests that with the increase of marketization level, the positive impact of resource endowment on secondary industry, as well as the negative effect on tertiary industry could decrease, indicating that the market-oriented reform can alleviate the hindrance of resource endowment on industrial transformation.

Table 5. Estimation results of partially linear functional-coefficient panel model

	Proportion of secondary industry	Proportion of tertiary industry
fdi	0.188**	-0.140**
	(2.450)	(-2.114)
fiscal spending	-0.120***	0.121***
	(-5.788)	(6.792)
R&D_edu	-0.066***	0.063***
	(-3.044)	(2.922)
fai	0.132***	-0.002
	(2.676)	(-0.047)
Year fixed effect	Yes	Yes
City fixed effect	Yes	Yes
Observations	2264	2264
R^2	0.305	0.394

Note: t statistics in parentheses; ***p < 0.01, **p<0.05, *p<0.1.

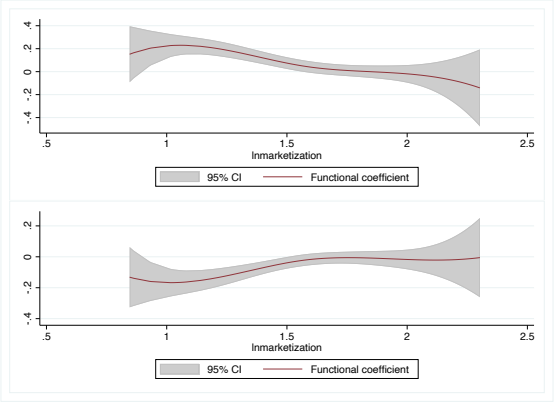

Fig. 2 Functional coefficient estimates.

2.3 Conclusion and Policy Implications

Despite extensive studies on the relationship between resource endowment and economic growth, the impact of resource endowment on industrial transformation is largely unknow. Whether abundant resources could cause "lock-in" industrial structure dominated by secondary industry, and whether market-oriented reform will help alleviate such "lock-in effect", these topics are always ignored in the existing literature, but are the foci of this paper.

Based on the panel data of Chinese cities from 2008 to 2016, this paper analyzes the impact of resource endowment on industrial transformation under the market-oriented reform by using multiple linear models and nonlinear models, including fixed effect model, panel threshold model, and partially linear functional coefficient panel data model. The combination of such models can help us to overcome the possible shortcomings of the traditional linear model. We obtain the following conclusions.

(1) The linear regression results indicate that resource abundance is indeed an important factor that causes the industrial structure to be dominated by the

secondary industry, in other words, resource endowment will cause the industrial structure to have a lock-in effect similar to the "Dutch Disease". After adding the interaction item term of resource endowment and marketization level, we find that the lock-in effect on the proportion of the secondary industry is a decreasing linear function of the marketization level, but an increasing linear function for the proportion of the tertiary industry.

(2) The estimation results of threshold model show that the influence of resource endowment on industrial transformation is different in different intervals of marketization levels. Specifically, the positive impact of resource endowment on the proportion of the secondary industry is smallest when the degree of marketization locates in the highest interval, opposite finding is recognized for the proportion of the tertiary industry. This suggests that the market-oriented reform is benefit to alleviate the industrial lock-in effect caused by resource endowment.

(3) The estimation results of the partially linear functional-coefficient panel data model suggest that resource endowments have a nonlinear impact on the industrial structure under different marketization levels. That is, the positive impact of resource endowment on the proportion of the secondary industry gradually decreases with the improvement of the degree of marketization, such impact even become insignificant when marketization level reaches to a certain point. As for tertiary industry, we observe a gradually decreasing negative impact of resource endowment on the proportion of the tertiary industry, and this impact also become insignificant when marketization level reaches to a certain point. To this end, we confirm that resource endowment has lock-in effect on industrial transformation, and China's market-oriented reform can alleviate such lock-in effect.

The findings of this paper reach the following policy implications: First, local governments should pay attention to the regulatory role of market-oriented reform in alleviating the lock-in effect of resource endowments on the industrial structure, and fully explore and utilize the key role of market-oriented reform in industrial transformation. Specifically, local governments should actively promote market-oriented reforms, increase the vitality of the factor market, break the system and mechanism barriers to the free flow of factors, and promote the rational allocation of resource factors across regions. Secondly, considering the large differences in resource endowments across regions, in order to achieve a win-win situation of industrial transformation and market-oriented reform, the government should take into account local conditions when promoting market-oriented reform, distinguish the focus of reform that tailoring to regional levels, and effectively exert the regulatory role of market-oriented reform.

Finally, the findings of this paper are of great significance to the transformation of resource-based cities. According to the list of resource-based cities published in 2013, there are still more than 67 cities in China belonging to resource-exhausted cities. At present, some cities have formed an economic development mode of "path dependence" on resources. How to avoid the "Dutch disease" through transformation is important for the sustainable development of these cities. This paper suggests that local governments should reduce their intervention in the market, highlight their own role on policy guidance and service functions, and gradually reduce resources dependence by encouraging the entry of service industries and high-tech industries, so as to promote the transformation of the city.

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