Research on the Relationship Between Economic and Environmental Problems in Inner Mongolia under Industrial Transfer: An Analysis Based on EKC

Xiaodong Pei (xdpeiucas@126.com)  
University of the Chinese Academy of Sciences

Pengxu Yuan  
Beijing Technology and Business University

Chelimuge Bao  
Beijing Technology and Business University

Junbo Xue  
Chinese Academy of Sciences  https://orcid.org/0000-0002-7598-0416

Ningning Sun  
Beijing Technology and Business University

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Abstract

In order to promote the economic development of the autonomous region, Inner Mongolia actively undertakes the industrial transfer in the eastern developed areas. In the process of promoting the economic development of Inner Mongolia, industrial transfer has also brought some environmental problems. In order to explore the relationship between industrial transfer, economic growth and the environment of Inner Mongolia, this paper selects the time series data of Inner Mongolia Autonomous Region from 2001 to 2016, and conducts an empirical analysis by establishing an Environmental Kuznets Curve (EKC) model. The study found that industrial transfer has brought the economic growth and the upgrading of industrial structure to Inner Mongolia, but also brought about environmental problems. Therefore, this paper proposes that Inner Mongolia should increase investment in R&D, strengthen investment in environmental governance, and make full use of the advantages of geography, labor force and natural resources to achieve high-quality economic development and industrial structure optimization and upgrade.

Introduction

Inner Mongolia is one of the biggest provinces/autonomous region in China. As an autonomous region with the boundary line of more than 4200 kilometers, Inner Mongolia stretches across the northeast, north China and northwest, also is adjacent to eight provinces and regions, and borders with Russia and Mongolia. From the domestic perspective, Inner Mongolia is an important ecological security barrier of northern China, a nationally important energy base, a new chemical industry base, a production and processing base of non-ferrous metals, and a production and processing base of green agricultural, animal products. Meanwhile, it is also an important bridgehead of Chinese opening to the north. To promote high-quality economic development, Inner Mongolia must focus on the transformation and upgrading of the industrial structure and make the real economy stronger and better. This put forward new requirements for the economic development of Inner Mongolia. Inner Mongolia has taken active measures to implement the development requirements, such as actively undertaking industrial transfer in the eastern region. In addition, one of an important channel for Inner Mongolia to achieve the optimization and upgrading of industrial structure is to undertaking the industrial transfer of Beijing, Tianjin, Hebei and the eastern region.

Judging from the current economic growth situation, Inner Mongolia is one of the provinces, cities and regions with the fastest economic development in China. In 2005, the GDP of the whole autonomous region more than doubled over that of 2000, and the per capita GDP(RGDP) exceeded the average level of mainland China. By 2016, the per capita GDP was 52465 yuan\(^1\). At the same time, the environmental pollution in Inner Mongolia has also increased significantly. In 2001, the discharge amounts of solid wastes, waste gas and wastewater were 23.055 million tons, 495.892 billion cubic meters and 209.595 million tons respectively, while in 2016, the discharge amounts of the three were 185.166 million tons, 3031.950 billion cubic meters and 242.000 million tons respectively--all the discharge amounts increased significantly over time. From the perspective of technology and economic structure, the secondary
industry[1] is an industry that emits more pollutants, especially waste gas and wastewater. The relationship between industrial transfer, economic growth and environmental pollution in Inner Mongolia, and how to take measures to deal with that in the future are important practical problems worth studying. Some data used in this research are presented in Table 1.

Table 1 Descriptive statistics of the used variables

| variables     | unit          | Max     | Min     | Mean    | Standard Deviation |
|---------------|---------------|---------|---------|---------|--------------------|
| GDP           | billion yuan  | 1318.96 | 170.38  | 667.36  | 379.77             |
| RGDP          | yuan          | 52464.72| 7165.19 | 27026.36| 14975.87           |
| solid waste   | million tons  | 191.14  | 23.06   | 97.60   | 56.27              |
| waste gas     | billion cubic meters | 3611.65  | 495.89 | 2161.25 | 1011.17            |
| wastewater    | million tons  | 395.36  | 209.60  | 296.62  | 65.10              |

Data Source: Inner Mongolia Statistic Yearbook from 2002 to 2017

The structure of this paper is as follows: Section 2 is the literature review of environment and economic growth. Section 3 is the empirical analysis of industrial transfer and economic growth—using the Granger causality test to investigate the relationship between industry transfer and economic growth. Section 4 is the model setting and empirical analysis of the relationship between economic growths and environmental pollution. Section 5 is the conclusion and suggestions.

**Literature Review**

The most common way of studying environmental pollution and economic growth is to establish the environmental Kuznets curve model (EKC model for short). In 1955, the famous American economist Kuznets put forward an important concept in development economics that the curve of income distribution changes with the process of economic development - "inverted U curve", also known as Kuznets Curve(Kuznets 1955). Considering the problem that the American worried about the free trade would worsen the environment of Mexico and affect the environment of the United States in the North American Free Trade Agreement negotiations, Grossman and Krueger(1992) for the first time empirically studied the relationship between environmental quality and per capita income. They pointed out that the relationship between pollution and per capita income was that "Pollution increases with the increase of per capita GDP at the low income level and decreases with the increase of GDP at the high income level". The World Bank's World Development Report 1992 with the theme "development and environment" expanded the impact of studies on the relationship between environmental quality and income. By using the inverted "U" curve between per capita income and income inequality defined by Kuznets in 1955, Panayotou(1993) for the first time called the relationship between environmental quality and per capita
income the Environmental Kuznets Curve (EKC for short). EKC reveals that environmental quality would deteriorate with the increase of income in the beginning, and then improves with the increase of income after the income rises to a certain extent. Therefore, it shows an inverted U-shape relationship between environmental quality and income. Dasgupta et al. (2002), Rothman (1998), Unruh and Moomaw (1998) carried out research on EKC and verified the existence of inverted "U" curve. On the contrary, the EKC curves of different countries have different shapes due to the differences in economic development levels and resource endowments. Using panel data and time series data, Elif and Akbostanc (2009) made an empirical study on the relationship between Turkey's economic growth and environmental quality, concluding that there was not an inverted "U" EKC curve in Turkey. Abandoning the traditional method of using single pollutant as an indicator of environmental quality, Caviglia-Harris et al. (2009) and some scientists used the ecological footprint index to verify the existence of EKC and found there was no inverted "U" relationship between the ecological footprint and economic growth.

The existence of EKC has been proved in some areas of China, such as Beijing, Shanghai and Jiangsu (Wu et al. 2002; Yang et al. 2003; Gao et al. 2004). Fan and Gao (2017) analyzed the changing trend of industrial pollution and key pollution factors in China from 1993 to 2014, and conducted EKC analysis. They draw a conclusion that the relationship between the situation of industrial pollution and gross industrial output value presented an inverted "U" curve, which was on the left of the "inflection point" of the adjacent environmental Kuznets curve. Chen et al. (2012) carried out research on the Kuznets relationship between environmental pollution level and economic growth in Inner Mongolia. In addition, they draw a conclusion that the main correlative factors of urban environmental pollution in Inner Mongolia included industrial structure, total GDP, energy consumption per unit GDP, and the proportion of urban population. Based on the data from 1985 to 2004, Guang (2008) made an empirical study on the environmental Kuznets curve of Inner Mongolia, concluding that the total degree of economic growth and environmental pollution in Inner Mongolia didn't completely conform to the typical EKC (inverted "U" type) characteristic, but showed an upward trend in fluctuations. Tian and Xie (2017) made a study from the perspective of carbon emission and concluded that the relationship between agricultural carbon emission and economic growth in China conformed to the environmental Kuznets curve hypothesis. Ren, Zhao carried out an empirical study on the environmental Kuznets curve of typical cities in Inner Mongolia. They concluded that the coupling law between economic development and total discharge amount of major industrial pollutants was affected by many aspects, which did not conform to the theory of the environmental Kuznets curve based on the improvement of environmental pollution after the high-speed economic development (Ren and Zhao 2012). Yang (2007) and Shao et al. (2009) respectively established EKC models on the economic and environmental problems of Inner Mongolia and Ningxia, and concluded that EKC curves were not necessarily inverted "U" type. Li et al. (2017) used the EKC theory and grey prediction model to analyze the characteristic of Kuznets curve between pollutant concentration and economic growth, and the result showed that EKC in the atmosphere did not conform to the inverted "U" type relationship, but belonged to the "N" type cubic curve relationship. By constructing the evaluation index system of regional competitiveness of undertaking industrial transfer, Ye (2014) made use of principal component analysis method evaluated and synthetically ranked the industrial transfer
competitiveness of 18 provinces (cities and regions) in the central and western regions of China. He concluded that the distribution of competitiveness showed the characteristic of great spatial and temporal differences, and regional circle layers. Wang(2013), Tian and Jiao(2006) regarded Foreign Direct Investment (FDI) as the index of industrial transfer, and concluded respectively that industrial transfer was positively correlated with large external pollution and negatively correlated with small external pollution, also concluded that environmental regulation had an obvious inhibitory effect on the transfer of polluting industries. There are two different views on the impact of industrial transfer on the environment in China. Some scholars believe that industrial transfer has a negative impact on the environment, while others believe that industrial transfer has a positive impact on the environment. Based on the dynamic panel data model, Su and Zhou (2010) concluded that FDI inflows did exert obvious negative effects on the environment of China by analyzing the annual data of 30 provinces in China. Through using FGLS estimation method, Chen (2010) conducted an empirical study based on industry panel data, concluding that industrial transfer can reduce the intensity of the industrial pollution emission in China, and protect the environment in a certain extent.

The connotation of industrial transfer can be divided into two parts: narrow sense and broad sense. In a narrow sense, industrial transfer refers to the phenomenon that enterprises transfer part or all of their production functions from the original place of production to other regions. However, in a broad sense, industrial transfer refers to the result of re-selection of industrial location caused by the change of the growth and decline of inter-regional industrial competitive advantage in a certain period of time (Liu et al. 2014). In this research, industrial transfer refers to the former.

Industrial transfer is induced by the unbalanced development of industrial technology and the expansion and replacement of industrial production. It is an effective way for the less less-developed area to achieve economic growth in underdeveloped areas, optimize and upgrade industrial structure, and shorten the distance of economic growth with developed areas. Industrial transfer is of great significance to the adjustment of regional economic structure and the optimization of regional economic relations. However, industrial transfer may be accompanied by environmental pollution, so how to better choose the industrial transfer with less pollution must be considered. In this study, Inner Mongolia, which is a key region for industrial transfer, is selected as representative. This paper will investigate the empirical relationship between economic growth and environment in Inner Mongolia under the superposition of industrial transfer based on EKC model, which is innovative in terms of research ideas.

In order to make an empirical analysis on industrial transfer from the perspective of EKC, this paper firstly selects the time series data of “three wastes” emission and economic growth in Inner Mongolia Autonomous Region from 2001 to 2016, and secondly tests the relationship between industrial transfer and economic growth by using Granger causality with E-views 7.2 measurement software, and thirdly verifies the relationship between environmental Kuznets curve (EKC) and economic growth through SPSS19 statistical software (Zhu et al. 2018) and finally investigates the relationship between industrial transfer and environmental pollution. As an undertaking place of industrial transfer, Inner Mongolia must not only consider the economic benefits of undertaking industrial transfer, but also the impact of
undertaking industries on the environment. If the economic benefits are lower than the losses caused by environmental pollution, the undertaking place will need more fund to repair the environmental pollution brought by the pursuit of economic benefits in the future. This has the important reference significance to the future choice of industrial development pattern and the economic development of Inner Mongolia Autonomous Region.

Empirical Analysis Of Industrial Transfer And Economic Growth

There are two common indicators to measure industrial transfer. One is using Foreign Direct Investment (FDI) to measure industrial transfer. Although FDI is direct and simple method, it has great limitations. It can only be used in the measurement of international industrial transfer, but not to the measurement of inter-regional industrial transfer. The other is measured by the coefficient of industrial competitiveness. Although this index is simple to calculate and can compare different regions and different industrial sectors, it is a relative value without considering the absolute value. The change of industrial transfer volume can reflect the spatial change of the regional industrial transfer in China in a certain extent, so this paper obtains the accounting formula of industrial transfer according to the calculation formula of industrial transfer volume proposed by Feng and Yang (2012). Define the amount of industrial transfer of region $i$ in the period $j$ as $IR_{ij}$, and the calculation formula is shown as equation (1):

$$IR_{ij} = (IAV_{ij} / IAV_j - IAV_i, j - 1 / IAV_j - 1)IAV_j$$  \hspace{1cm} (1)

where $IAV_{ij}$ denotes the industrial added value of region $i$ in the period $j$; $IAV_j$ denotes the national industrial added value in the period $j$; $IAV_{i,j-1}$ denotes the industrial added value of region $i$ in the period $j-1$; $IAV_{j-1}$ denotes the national industrial added value in the period $j-1$. If $IR_{ij} > 0$, it means that there will be industry inflows of region $i$ in the period $j$, vice versa.

Industrial transfer not only drives the economic development in the undertaking regions of industrial transfer, but also helps to optimize and upgrade the industrial structure. Environmental pollution caused by industrial transfer is mainly due to the pollution of industrial emissions, so this paper chooses the proportion of secondary industry in GDP of this region to measure the industrial structure. This paper selects the time series data of Inner Mongolia Autonomous Region from 2001 to 2016, and takes the industrial transfer amount $IR$ as the measure index of industrial transfer, meanwhile, takes the regional per capita GDP $Y$ as the measure index of economic growth. As for the time series data, stationarity test should be carried out first. Conducting a regression analysis when time series is not stable perhaps leads to spurious regression and affects the accuracy of the analysis. In order to eliminating the possible heteroscedasticity and enhance the stability of the time series, this paper firstly takes logarithms of IR and $Y$, and then uses the measurement software E-views 7.2 to carry out the Augmented Dickey-Fuller(ADF) test. The test results are shown in Table 2.

**Table 2** ADF test results of the time series
Table 2 shows that the original series of $\ln IR$ and $\ln Y$ columns are stable. To explore the causal relationship between the two series, Granger causality test is necessary for further analysis. The Granger causality test results are shown in Table 3.

**Table 3** Granger causality test results

| Null Hypothesis: | $F$-Statistic | Prob.  |
|------------------|---------------|--------|
| $\ln Y$ is not the Granger Cause of $\ln IR$ | 6.4204 | 0.0185 |
| $\ln IR$ is not the Granger Cause of $\ln Y$ | 3.7209 | 0.0664 |

In Table 3, the P-value 0.0185<0.05 and the P-value 0.0664<0.1, that is, $\ln Y$ is the cause of $\ln IR$ at 5% significance level, and $\ln IR$ is also the cause of $\ln Y$ at 10%. So we can see that economic growth is the cause of industrial transfer, meanwhile, industrial transfer is also the cause of economic growth-the two have the causal relationship with each other. Hence, we can infer that industrial transfer boosts economic growth; meanwhile, economic growth promotes industrial transfer.

From the trend chart of industrial transfer amount (Figure 1), it can be seen that the industrial transfer amount (IR) is positive, indicating that Inner Mongolia is the undertaking region of industrial transfer. The amount of industrial transfer undertaken by Inner Mongolia increased significantly from 2001 to 2010, while after 2012, the amount declined significantly with a continuous downward trend. This is consistent with Yao's conclusion (2016) that from 2003 to 2013, through comparing the changes of the national shares of nine pollution-intensive industries in different regions, the pollution-intensive industries have transferred into 11 provinces, such as Anhui, Shaanxi, Guangxi, Inner Mongolia and Jilin.

From 2001 to 2010, the number of mining and manufacturing enterprises in Inner Mongolia increased significantly, and slowly increased after 2010. Overall, the gross industrial output value of mining and manufacturing industry has been rising, rising significantly from 2001 to 2013, and slowly after 2013, with a sustained upward trend (see Table 2 for relevant data). As we can see from Figure 2, the growth rate of mining and manufacturing industries increased significantly from 2001 to 2005, slowly from 2007 to 2016, and exceeded the growth rate of secondary industries except for individual years. Moreover, to some extent, Inner Mongolia can be regarded as the undertaking region of industrial transfer from 2001 to 2016.

As shown in Figure 3, we can see that the proportion of primary industry in GDP has declined significantly, from 20.9% in 2001 to 5.8% in 2016. The proportion of tertiary industry in GDP began decline slowly in 2003, 40.6% in 2003, and 33.43% in 2013, while it had an upward trend since 2014.
Correspondingly, since 2003, the proportion of secondary industry in GDP has continued to rise significantly when it began to exceed the proportion of tertiary industry in GDP, but it had a slight downward trend since 2015. The changes of primary industry and tertiary industry are slow and small, while the change of secondary industry is rapid and relatively large. From this, we can conclude that the industrial structure of Inner Mongolia is changing, and from the proportion of the secondary industry in GDP, we can see that Inner Mongolia mainly undertakes the secondary industry, in other words, undertakes the transfer of industrial enterprises. Although this is accompanied with environmental pollution, it has changed the industrial structure of Inner Mongolia, and promoted the optimization and upgrading of the industrial structure transferred from the second industry to the tertiary industry and the adjustment of the industrial structure of Inner Mongolia.

Model Setting and Empirical Analysis of the Relationship between Economic Growth and Three Wastes

Model Setting

According to the Granger causality test in Section 3, we know that undertaking industrial transfer has driven the economic growth of Inner Mongolia. By using the Kuznets curve of economic growth and "three wastes", the relationship between economic growth and environmental pollution can be obtained, and the relationship between industrial transfer and environmental pollution can be obtained indirectly.

This paper selects the classical time series model to analyze economic growth and environmental pollution. The basic model setting is shown as equation (2):

\[ m_t = \alpha + \beta_1 \times RGDP_t + \beta_2 \times RGDP_t^2 + \beta_3 \times RGDP_t^3 + \varepsilon_t \]  \hspace{1cm} (2)

where \( m_t \) denotes the environmental pollution during in the period \( t \), and the indicator variables are the discharge amounts of industrial waste gas, wastewater and solid wastes; \( RGDP_t \) is the per capita GDP in the period \( t \); \( \beta_1, \beta_2 \) and \( \beta_3 \) are the estimated parameters; \( \alpha \) is the constant term; \( \varepsilon_t \) is the random perturbation term.

The curve relationship between environment and economy are determined by the symbols of \( \beta_i \).

Economic growth and environmental pollution show a N-type relationship if \( \beta_1>0, \beta_2<0 \) and \( \beta_3>0 \).

Economic growth and environmental pollution show an inverted N-type relationship if \( \beta_1<0, \beta_2>0 \) and \( \beta_3<0 \).

Economic growth and environmental pollution show a linear relationship with monotonous rise if \( \beta_1>0 \), and \( \beta_2=\beta_3=0 \).

Economic growth and environmental pollution show a linear relationship with monotonous decline if \( \beta_1<0 \), and \( \beta_2=\beta_3=0 \).
Economic growth and environmental pollution show a U-type relationship if $\beta_1>0$, $\beta_2<0$ and $\beta_3=0$.

Economic growth and environmental pollution show an inverted U-type relationship if $\beta_1<0$, $\beta_2>0$ and $\beta_3=0$.

**Data sources and descriptions**

In this paper, the discharge amounts of industrial waste gas, wastewater and solid wastes from 2001 to 2016 are the indicators of environmental pollution, while the per capita GDP is regarded as an indicator to measure economic growth. All the data are from the Statistical Yearbook of the Statistical Bureau of Inner Mongolia Autonomous Region (2002-2017). And the data is excluded the price factor and converted to a data series which was based on 2000 year.

**EKC Regression Analysis**

In order to investigate whether there is a characteristic of environmental Kuznets curve between the discharge of industrial "three wastes" and economic growth, based on the early research in the existing literatures and the analysis on section 3 of this paper, a better fitting cubic curve model is used for regression. The test results are shown in Table 4:
From the fitting results, it can be seen that the characteristic of the environmental Kuznets curve in Inner Mongolia from 2001 to 2016 does not conform to the traditional inverted "U" type characteristic, but presents the monotonous increasing, inverted "U" type curve and "U+N" type characteristic.

The relationship between the discharge amount of solid waste and per capita GDP is shown in Figure 4. It shows a linear relationship and a continuous upward trend. With the development of industrial production, the discharge amount of industrial waste is increasing day by day. Industrial waste is huge in quantity[1] and complex in composition, so it is very difficult to be disposed of. Nowadays, only few kinds of industrial wastes are full utilized, such as iron and steel slag in the United States, Sweden and other countries, fly ash and coal slag in Japan, Denmark and other countries. Due to the complicated treatment process, high cost and limited utilization of industrial waste, the discharge amount of solid waste in Inner

| Table 4 The EKC fitting results of pollutants and per capita GDP |
|---------------------------------|----------------|----------------|
|                                 | Model 1        | Model 2        |
|                                 | (solid waste)  | (waste gas)    | Model 3     |
|                                 |                | (waste water)  |
| Constant term                  | 117.504        | -4121.452***   | 28099.262*  |
|                                 | (0.121)        | (-1.947)       | (4.683)     |
| RGDP                           | 0.357*         | 1.445*         | -1.286      |
|                                | (11.329)       | (8.143)        | (-1.549)    |
| RGDP²                          | -1.395E-05*    | 8.53E-05**     |
|                                | (-4.614)       | (2.687)        |
| RGDP³                          |                | -1.17E-09*     |
|                                |                | (-3.259)       |
| R²                             | 0.902          | 0.964          | 0.841       |
| Adjust R²                      | 0.895          | 0.959          | 0.801       |
| F-test                         | 128.357        | 175.775        | 21.157      |
| Shape                          | upward         | Inverted U type |
| Trend                          |                | U+N type       |

Notes: *, ** and *** denote coefficient is checked at the 1%, 5% and 10% respectively.
Mongolia is still increasing. Therefore, Inner Mongolia should avoid introducing industries that produce more solid waste when they undertake industrial transfer.

The relationship between the discharge amount of industrial waste gas and per capita GDP is shown in Figure 5, which shows an inverted U-shaped relationship and a declining trend. First, the discharge amount of waste gas in Inner Mongolia conformed to the inverted U characteristic of the environmental Kuznets curve, and with the continuous development of the economy, the discharge amount of waste gas also increased, but with the further development of the economy, it began to decline. Then, due to the economic growth and the continuous change of industrial structure, the proportions of the three industries in GDP in 2001 were 20.9% in the primary industry, 37.9% in the secondary industry and 41% in the tertiary industry, respectively; by 2016, they were 5.8%, 61.7% and 33.5% respectively. In addition, investment in the environment has been increasing. In 2001, the total investment in environmental pollution control was 267 million yuan, and by 2016, it was 88.648 billion yuan and the discharge amount of waste gas began to decrease year by year.

The relationship between the discharge amount of industrial wastewater and per capita GDP is shown in Figure 6, which shows a "U+N"-shaped relationship, that is, first decreasing, then rising, and finally beginning to decline. In 2001, the industrial development of Inner Mongolia was relatively low, thus the discharge amount of industrial wastewater was relatively low. However, with the development of Inner Mongolia's industrial economy, more and more industries began to be transferred into Inner Mongolia, and the discharge amount of wastewater also increased. When the discharge amount of wastewater increased to a certain extent, it attracted the attention of relevant departments. In 2001, Inner Mongolia invested 174.4 billion yuan in pollution control of industrial enterprises, while in 2016, it invested 4.062 billion yuan-the investment in environmental pollution increased significantly. And by introducing advanced technologies, such as wastewater purification treatment process in Inner Mongolia Weilastuo Mining Area to maximize the recovery and utilization of tailings backwater, and save the amount of new mine water, resolved many problems such as tailings pond dust pollution and tailings seepage-the technical effect has been produced and made the discharge amount of wastewater reduce consequently.

For example, as shown in Figure 7, the GDP of Inner Mongolia increased from 170.380 billion yuan to 1318.958 billion yuan in 2001-2016, and the total discharge amounts of wastewater, waste gas and solid waste increased from 209.595 million tons, 495.892 billion cubic meters and 23.055 million tons, to 242.000 million tons, 3031.950 billion cubic meters and 185.166 million tons respectively. Although the total discharge amounts of industrial "three wastes" are increasing, the discharge amounts of industrial "three wastes" per unit GDP are decreasing. It indicated that technological progress and the adjustment of industrial structure have produced obvious environmental effects. The investment in environmental pollution control in Inner Mongolia increased relatively slowly from 267.09 million yuan in 2001 to 3116.14 million yuan in 2011, and had a significant increase after 2011, reaching 88648.00 million yuan in 2016. Therefore, we can see that Inner Mongolia pays more and more attention to environmental protection.
Conclusion And Discussion

Industrial transfer has brought about an increase in the discharge amount of pollution in Inner Mongolia Autonomous Region, but also economic growth and upgrading of industrial structure. It is inevitable that economic growth is accompanied by environmental pollution. The key is to reduce pollution emissions to the greatest extent as much as possible and make rational use of effective means such as science and technology and institutional policies, for achieving a win-win situation between economic growth and environmental pollution control. The regional competitiveness of undertaking industrial transfer in Inner Mongolia Autonomous Region ranked eighth in the 18 provinces in the central and western regions of China in 2006, with a score of 1.127, and eighth in 2011, with a score of 1.1092 (Ye Qi, 2014). From this point of view, the competitiveness of undertaking industrial transfer in Inner Mongolia has changed little during the last decade. The competitiveness coefficient of undertaking industrial transfer has always remained in the top 8 or so, indicating that Inner Mongolia has a good competitiveness of undertaking industrial transfer. As shown in Figures 7 and 8, from 2001 to 2015, the total discharge amounts of industrial waste gas, wastewater and solid waste in Inner Mongolia are increasing, but the discharge amounts of "three wastes" per unit GDP are decreasing, which shows that significant technical effects have been produced.

Based on the above research, the following suggestions are made for Inner Mongolia to undertake industrial transfer and environmental protection:

According to the change of environmental Kuznets curve, except for the increase of discharge amount of industrial solid waste, the discharge amounts of wastewater and waste gas in Inner Mongolia are decreasing, and at the decline stage. Therefore, when undertaking industrial transfer, Inner Mongolia should choose carefully and have some preferences to reduce the amount of the industries that discharge more solid waste, and avoid further deterioration of the solid waste emission. In addition, the Beijing-Tianjin-Hebei Ecological Synergy Circle, that is, the ecological space of Beijing-Tianjin-Hebei synergistic development strategy, includes all the three province and cities of Beijing, Tianjin and Hebei, as well as eastern Shanxi, southern central Inner Mongolia, southwestern Liaoning and northwestern Shandong, radiating to the Taihang Mountains, Yanshan, Bashang Plateau and Bohai Bay areas. In terms of forestry construction, the environmental capacity should be expanded, the regional ecological quality gradient should be reduced, and the ecological carrying capacity should be improved; in terms of afforestation, the transition zone of Beijing-Tianjin Bao core area should be taken as the key to build forests, water conservation forests and wind-proof sand-fixing forests. Therefore, Inner Mongolia can reduce the regional gradient of ecological quality and improve the ecological carrying capacity with the help of Beijing-Tianjin-Hebei Ecological Synergy Circle.

From the perspective of Inner Mongolia's industrial structure, the proportion of secondary industry in Inner Mongolia is obviously more than that of primary industry and tertiary industry. The main driving force of economic development is the secondary industry and the contribution rate of the secondary industry in Inner Mongolia to economic growth was 38.6% in 2001 and 66.6% in 2014, declining from 2014 and
reaching 49% in 2016. This shows that the industrial structure of Inner Mongolia is changing and moving towards the tertiary industry. Therefore, it is necessary to further improve fiscal and taxation policies, innovate financial services, and strengthen the cultivation and construction of talent team, so as to further promote the transfer of the secondary industry to the tertiary industry and achieve the optimization and upgrading of the industrial structure.

The ratio of the secondary industry to regional GDP in Inner Mongolia is relatively much higher than tertiary industry. However, the discharge of pollution in secondary industry is commonly higher tertiary industry. Therefore, in order to reduce the total amount the pollution, first of all, the industrial structure should be adjusted rationally to create favorable conditions for the development of the tertiary industry. Secondly, the structural optimization and promotion of the secondary industry will increase the demand for modern services such as finance, bonds, science and technology, research and development et al. Thirdly, with the increase of residential income level and the change of consumption concept, the demand for high level consumption will increase, such as education, culture, sports, health care and so on. Therefore, the government should take measures to meet the demand for the service sectors. Finally, accelerating the process of urbanization promotes the specialization of division of labor within the city, and further promotes the development of the tertiary industry.

What's more, we should make it clear that the production of pollution is not necessarily equal to the emission of the pollution. Under the high efficiency and strict governance, the polluters would try their best to dispose and make full use of the waste water, solid waste and waste water. Therefore, a perfect environmental governance system is needed, especially for a developing region in China. AS we all know, a less develop region always are too eager to improve the economy to put an eye on the environmental issues. As for the Inner Mongolia administrator, they should put more attention to the environmental governance during the industry transferring. When the environmental governance is in the scope of consideration of regional government, pollutant discharge permit system, environmental tax and a vertical supervisory system are good options for them. Only in this way, can the less development region get a good economic development and enjoy a good environment meanwhile.

The limitation of this paper is that it does not subdivide the pollutant indicators, only analyzing from a wide range, which is, taking the discharge amounts of industrial wastewater, waste gas and solid waste as the indicators to measure environmental pollution, which may lead to inadequate explanation of the relationship between environmental pollution and economic growth. In addition, the division of industries is not detail enough. Although secondary production is the main industry of pollutant emission, there are also great differences in the generation and emission of "three wastes" within secondary production, and the unified analysis is a little rough. In addition, this paper only considers the final emission of pollutants, and lacks a more comprehensive analysis of the introduction of corresponding treatment technologies and the technical effects brought about by them in the process of undertaking industrial transfer in Inner Mongolia. In the further research, more detailed industries and pollutants are needed. It is better to combined with the technical effects hide in the environmental Kuznets curve.
Declarations

Ethical Approval  Not applicable

Consent to Participate  Not applicable

Consent for Publish  Not applicable

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Figures

![Figure 1](image_url)
Industrial transfer amount of Inner Mongolia from 2001 to 2016 (100 million yuan) Data Source: Calculated by the data of National Bureau of Statistics and the Statistical Yearbook of Inner Mongolia from 2002 to 2017

![Diagram showing growth rate of mining, manufacturing, and secondary industries in Inner Mongolia from 2001 to 2016.]

**Figure 2**

The growth rate of mining, manufacturing and secondary industries in Inner Mongolia Data Source: Calculated by the data of National Bureau of Statistics and the Statistical Yearbook of Inner Mongolia from 2002 to 2017
Figure 3

The proportion of three industries output to GDP in Inner Mongolia. Data Source: Inner Mongolia Statistical Bureau and the Statistical Yearbook of Inner Mongolia in 2017.
Figure 4

The relationship between solid waste and per capita GDP Data Source: Inner Mongolia Statistic Yearbook from 2002 to 2017
Figure 5

The relationship between waste gas and per capita GDP Data Source: Inner Mongolia Statistic Yearbook from 2002 to 2017
Figure 6

The relationship between wastewater and per capita GDP Data Source: Inner Mongolia Statistic Yearbook from 2002 to 2017
Figure 7
The trend chart of discharge amounts of three wastes in Inner Mongolia Data Source: Statistical Bureau of Inner Mongolia Autonomous Region, Inner Mongolia Statistic Yearbook from 2002 to 2017

Figure 8
The trend chart of discharge amounts of three wastes in Inner Mongolia Data Source: Statistical Bureau of Inner Mongolia Autonomous Region, Inner Mongolia Statistic Yearbook from 2002 to 2017
The trend chart of discharge amounts of three wastes per unit GDP Data Source: Calculated by statistical data of Inner Mongolia Autonomous Region Statistical Bureau