Environmental Analysis of New Economy Based on Energy Consumption and International Trade

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Abstract. The advent of the era of globalization has led to an increasing number of factors affecting the environment. For most countries, the pursuit of large-scale economic growth has led them to a huge international trade market. With the large-scale economic growth, energy demand in most countries has surged, and emissions have also increased significantly. To mitigate environmental pollution, researchers are focusing on the links between energy consumption, economic growth, and environmental pollution. Based on this research background, the thesis uses the validity method of the environmental Kuznets curve theory, which can make an enough contribution to the research on the dynamic relationship between energy consumption, international trade and environmental pollution.

1. Introduction
In recent years, China's rapid economic growth has brought about a sharp increase in energy consumption and CO₂ emissions. China is a developing country with relatively scarce per capita energy resources, and its per capita energy resources are less than half of the world average. In 1992, China became a net oil importer [1]. In 2003, China became the second largest energy importer after the United States. It is predicted that China's crude oil gap will increase to more than 250 million tons in 2020. The scarce energy resources have become one of the bottlenecks restricting China's economic development. Solving the problem of high energy consumption and achieving sustainable and coordinated development of economy, resources, and the environment have become important issues that must be resolved in the process of building a harmonious society [2].

2. Establishment of energy input-output model
The energy consumption pathway can be divided into two main aspects: direct energy consumption and indirect energy consumption. Direct energy consumption refers to the energy consumption caused by the consumption of other products in the production of energy products or energy-carrying products; indirect energy consumption refers to the energy products or energy-carrying products that need to consume other products in the production process. It also needs to consume related products, and the energy consumption formed by this chain reaction. Some scholars have proposed the concept of "virtual energy consumption" to represent the sum of direct and indirect consumption of energy.

Miller and Blair's Hybrid model is often used to estimate the energy intensity of a country's economy. Before applying the Leontief inverse matrix to this model, the energy represented by the
input-output table in the form of value was replaced with physical objects, and various energy conversion coefficients were used to calculate the conversion of various energy sources into standard coal.

\[ Q = (I - A)^{-1} \cdot Y \]

Among them, Q is the complete output matrix, I is the identity matrix, A is the direct consumption coefficient matrix, and Y is the final demand matrix.

\[ \beta = Q^{-1} \cdot (I - A)^{-1} \cdot F \]

Among them, if F is an energy product, 0 is taken, and if F is a non-energy product, 1 is taken. The calculated \( \beta \) is the energy intensity, which represents the energy consumed by the products of each sector's unit output value.

Since the data requirements in formula (2) are strict and difficult to obtain, the author extends the Hybrid model of Miller and Blair. According to the actual situation in China, the following I-O model is obtained.

\[ \beta = \alpha \cdot (I - A)^{-1} \]

Where \( \alpha \) represents the amount of energy directly consumed by the products of each sector's unit output value. Combining \( \beta \) from the I-O model with foreign trade data can yield the following trade model:

\[ M_{exp} = \beta \cdot E_s \]
\[ M_{imp} = \beta \cdot I_n \]
\[ M = M_{exp} - M_{imp} = \beta \cdot E_s - \beta \cdot I_n \]
\[ e = \sum_{i} \beta_i w_i^e / \sum_{i} \beta_i w_i^m \]

Among them, \( M_{exp} \) is the total energy consumption in the products of each sector exported; \( M_{imp} \) is the total energy consumption in the products of each sector imported; \( E_s \) is the total product exports of each sector, which is a n * 1 matrix; \( I_n \) is the product of each sector The total imports is a n * 1 matrix; M is the net export energy consumption of each sector's products. When the total energy consumption of the exported goods is greater than the import, M > 0; otherwise, M < 0; e represents the total of all products. Total terms of trade; \( w_i^e \) indicates the proportion of the export trade of the i sector of the total exports; \( w_i^m \) indicates the proportion of the import trade of the i sector of the total imports.

3. Empirical research

3.1. Research methods
A country's foreign trade mainly affects energy consumption through the import and export of energy products and energy-carrying products. There are three ways to influence energy consumption: direct energy consumption, direct energy consumption, and indirect energy consumption, as shown in Figure 1.
With regard to the determination of import and export sectors that have an important impact on energy consumption, this article considers that the import and export of all energy sectors (primary and secondary energy sectors) have an important impact on energy consumption; referring to the research conclusions in [2], In the non-energy sector (energy-carrying products), the import and export sectors that have an important impact on energy consumption in 1992 include: (1) metal mining and dressing; (2) construction materials and other non-metallic mineral products; (3) Transportation, storage, post and telecommunications; 1997 and 2002 include: (1) construction materials and other non-metallic mineral products; (2) metal smelting and rolling processing industry; (3) chemical industry.

3.2. Data source and processing
The data in this article are from 1998, 2008, and 2018 input-output table data, and China Energy Statistical Yearbook for related years. Divide the departments in the annual input-output table sector into three parts: the primary energy sector, the secondary energy sector, and other sectors. Since thermal power generation is secondary energy, and hydropower and nuclear power are primary energy sources, the “electricity, "Steam and hot water production and supply industry" is divided into two departments: "hydropower, nuclear power" and "thermal power, steam, hot water production and supply industry". Percentage of total power generation. According to the "Energy Consumption by Industry" in the China Energy Statistical Yearbook, the various departments in the annual input-output table were re-integrated, and finally the 24-department input-output tables were integrated.

The unit of measurement of the energy sector (including the primary energy sector and the secondary energy sector) of the input-output table is physical quantity (10,000 tons of standard coal); the unit of measurement of the non-energy sector is value (10,000 yuan). The conversion of the unit of measurement in the energy sector from the quantity of value to the quantity of material is based on the calculation method in [3].

The value data of the non-energy sector in the input-output table are adjusted based on 1998. Among them, agriculture, construction, transportation, warehousing, post and telecommunications, wholesale and retail trade and catering industries use their respective GDP total indexes; each sub-industry of industry also uses a unified industrial GDP total index for adjustment; other service industries The tertiary industry’s GDP index is used for adjustment.
3.3. Results analysis

3.3.1 The most direct impact of net exports of energy products on energy consumption. The net export volume of energy products directly represents the increase in domestic energy consumption; according to formula (1), that is, according to the energy intensity and net export value of energy products, the most direct change in energy product net exports to energy consumption can be calculated influences. The results are shown in Table 1.

Table 1. Import and export of energy products and their energy consumption (net export: 10,000 yuan; energy consumption: 10,000 tons of standard coal)

| Product Type                        | 1998          | 2008          | 2018          |
|-------------------------------------|---------------|---------------|---------------|
| Coal mining and dressing industry   | Impact of net exports on energy consumption | Impact of net exports on energy consumption | Impact of net exports on energy consumption |
| 210.34 4822.50                      | 359.71 2868.83 | 300.88 3363.56 |
| Oil and gas extraction              | -158.3 -1781.47 | -113.4 -3835.79 | -39.54 -284.29 |
| Petroleum processing industry       | -137.1 -801.63 | -255.1 -2536.5 | -657.9 -1763.39 |
| Hydropower, nuclear power           | -8.03 -78.02  | 120.68 77.52  | 18.88 59.36   |
| Thermal power and steam hot water production and supply industry | -37.58 -265.99 | 527.45 318.36 | 80.01 167.77 |
| Coking, gas and coal products       | 21.93 267.16  | 0.00 0        | 0 0          |
| total                               | -108.8 2162.55 | -269.8 -3107.58 | -297.6 1543.01 |

Table 1 shows that in 1998, 2008, and 2018, coal products have been in a situation where exports are greater than imports, and because the energy intensity coefficient of the coal industry is relatively large, the increase in China's energy consumption is also relatively large. The large volume of coal exports during this period was mainly since the price of coal in China was far below the level of the world coal market at that time.

The import volume of petroleum, natural gas and petroleum processing products in 1998, 2008 and 2018 has always been greater than the export volume, which indicates that petroleum, natural gas and petroleum processing products are China's main imported energy products. The amount is favourable. But at the same time, a large amount of imported oil is also prone to energy security problems [4].

China's electric power has changed from a negative net export in 1998 to a positive net export in 2008 and 2018. The main reason is that China was in a period of rapid economic development in 1998 (Figure 2), and its energy demand increased rapidly; from 2008 to 2018 This year is a period of relatively slow economic growth in China (Figure 2), so the demand for energy has decreased.
3.3.2 Analysis of China’s indirect energy export volume. Because China uses the domestic technical coefficient to calculate the energy content of imports, the net export energy content is not the actual net export energy content. This result represents the energy and environmental impact of foreign trade from another perspective, that is, the relationship between increased energy consumption and reduced energy consumption in China due to foreign trade. From statistical data, China's direct energy import volume in 1998 was 97 million tons of standard coal, its export volume was 755 million tons of standard coal, and its net import volume was 22 million tons of standard coal. During the same period, China indirectly imported 324 million tons of standard coal through non-energy product imports. That is, if China did not import these non-energy products from abroad, domestic production and provision of these products would require an increase of 324 million tons of standard coal. At the same time, China also exported 338 million tons of standard coal through exports of non-energy products, which is higher than the energy content of imports. Therefore, although China imports more energy directly through trade than it exports, the amount of energy indirectly imported through non-energy trade is smaller than the amount of energy indirectly exported [5].

With the development of China's international trade, China's indirect energy imports and exports through non-energy products trade have also increased. Due to the trade surplus, China is a net exporter of energy, and the size of its net exports continues to expand as the surplus increases. In 2018, China's direct energy import volume increased to 350 million tons of standard coal, and its export volume increased slightly to 0.997 billion tons of standard coal, with a net import volume of 253 million tons of standard coal. However, during the same period, China indirectly imported 1.024 billion tons of standard coal through non-energy products imports, which is far smaller than the export of non-energy products (1.375 billion tons of standard coal). The net energy export is 350 million tons of standard coal. Due to the trade surplus, many non-energy commodities are exported, especially high-energy-consuming commodities. China indirectly sends a large amount of energy to foreign countries, but CO₂ emissions and pollution emissions generated during the energy consumption process remain in China. The demand for energy in the output value of units in all sectors has
generally risen, and the increase is large, and the formulation of energy-saving measures for products is urgent.

![Figure 3](image.png)

**Figure 3.** Chinese exports from 1998 to 2018.

Figure 3 shows the import and export of energy in China's non-energy sector from 1998 to 2018. It can be seen from the industrial distribution of energy import and export that the manufacturing sector is the main carrier of energy import and export, and its energy import and export account for more than 70% of the total. Among them, ferrous metal smelting and rolling processing industry and metal products industry, two resource-intensive high-energy-consuming industries, implied energy exports are China's main energy-exported industries. This shows that China not only exported a large amount of embedded energy through these two industries, but also indirectly exported a large amount of natural resources such as iron and copper, resulting in the export of embedded resources. The textile industry and the clothing, footwear, and hat manufacturing industries, two industries with relatively low direct energy intensities, have a relatively high total energy intensity compared to other industries due to the large amount of energy consumed in the production process of intermediate inputs [6].

4. **Conclusion**

Foreign trade policies should be combined with industrial and energy policies to jointly promote the coordinated development of China's foreign trade and energy conservation. There are two key ways to reduce the energy-carrying capacity of China's foreign trade export commodities: First, adjust the structure of export commodities, reduce the export of energy-intensive products, and promote the export of high-tech products. Second, improve energy efficiency in the production of export commodities. The improvement of energy efficiency mainly depends on technological progress. Broadly speaking, technological progress includes not only pure technological progress (referring to the introduction of new processes and the invention of new products), but also management methods (improving economies of scale, changing organizational models, and energy demand side Management, etc.) improvement brought about by technological progress. These policies will help reduce the carrying capacity of China's exported goods. At the same time, due to the increase in the technological content of products, it will help promote the international competitiveness of these products, thereby achieving the coordinated development of China's foreign trade and energy conservation.
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