



## Analysis of physical flows in primary commodity trade: A case study in China

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### Abstract

How globalization and international trade affect sustainable development and environment has attracted worldwide attention. Associated with the import and export of primary commodities, ecologically important materials have been exchanged among regions and countries. China, having the largest population in the world and the highest economic growth rate in last decades, may have an important influence on global sustainable development through the trade of primary commodities. Using the data from *Almanac of China's Foreign Economic Relations and Trade*, we analyzed material flows in the trade of primary commodity in China from 1950 to 2001. Our analysis shows that: (1) China has turned from a net exporter of primary commodities to a net importer; (2) minerals and fuels have been the major imports of primary commodities since 1992, just as well as foods and minerals did in 1980s; (3) most of the net imported primary commodities come from Oceania, Africa and Latin America.

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## 1. Introduction

The expansion of international trade has raised questions concerning the relationship between trade and environment. The most frequently discussed issues are environment externality and comparative advantage (D'Arge and Kneese, 1972; Koo, 1974); Environmental Kuznets Curve (Grossman and Krueger, 1995; Radetzki, 1992); relocation of 'dirty' industries, trans-boundary environmental issues (Batra et al., 1998; Birdsall and Wheeler, 1992; Copeland and Taylor, 1995; Siebert, 1992); environmental regulations and standards (Jayadevappa and Chhatre, 2000; Krutilla, 1991; McGuire, 1982; Pethig, 1976); globalization and sustainable development (Beckerman, 1992; Borghesi and Vercelli, 2003; Chenery, 1961). In recent studies of ecological footprint, more attention has been paid to the relationship between trade and trans-boundary sustainable development (Proops et al., 1999; Van den Bergh and Verbruggen, 1999). Some countries have ecological footprint deficits, while they can preserve domestic ecological capital through importing primary commodities from overseas (Andersson and Lindroth, 2001). Primary commodities are jointed products that unify (natural and human production). The consumption on primary commodities may accelerate the unsustainable use of natural resources through international trade and impact environmental quality (Matsuoka, 1993).

With a population of more than 1.28 billion, China is the third biggest trade country in the world and has attracted worldwide attention for its rapidly growing economy. In January 2003, China had its first monthly trade deficit (US\$ 1.25 billion) of past 4 years because of the import increase of primary commodities. For example, the import of crude oils increased by 77.7%, iron ores by 46.4%, paper pulps by 15.6%, and logs by 12.3% compared with that in the same period of previous year. Here, the question is that whether China is accelerating exploiting the resources from other countries. On 11 December 2001, China officially became a member country of WTO, and has built a close trade relationship with the rest of the world since then. Through international trade, China may affect the ecological environment as well as the economic development of other regions and countries. Questions such as what a role does China play in global primary commodity trade, what is the relationship between China and other continents in primary commodities trade, and what has changed in China's trade structure of primary commodities in past years, have to be answered. We will address these issues by analyzing physical trade flows of primary commodities.

## 2. The method and data sources

It is commonly accepted in ecological economics that it is not sufficient to quantify relationships between natural and economic subsystems in terms of money. While the trade between two countries may be balanced in monetary terms, it may at the same time be characterized by a substantial inequality with respect to flows of natural resources (Proops et al., 1999). This physical flow is an important indicator to show whether the economy of a country is dependent on resource import from other countries and to what extent the domestic material consumption depends on resources extracted domestically and imported from abroad.

According to Standard Industrial Trade Classification (SITC), primary commodities are grouped into five categories: food and living animals (SITC0); beverages and tobacco (SITC1); crude materials inedible except fuels (SITC2); mineral fuels, lubricants and related materials (SITC3); animal and vegetable oils; and fats and waxes (SITC4). In this paper, the data of primary commodities only include SITC0, SITC2 and SITC3. Other two categories are not included, partly due to their small share (less than 0.5%) and partly due to data availability.

Trade data were compiled from *Almanac of China's Foreign Economic Relations and Trade* (published annually by China Statistics Press, from 1980 to 2002). The data of physical trade during the period of 1950–2001 are grouped according to regions of the world (different continents) and product types (SITC categories).

### 3. Results

#### 3.1. Material flows in the trade of primary commodities

Fig. 1 shows that both imports and exports of primary commodities have been increasing since 1950s. From 1950 to 2001, exports have increased by 35 times and imports by 573 times. There existed two deficits of physical trade in the period. The first deficit occurred during 1961–1966 when an extreme climatic abnormality and other factors caused serious food shortage. As a result, China began importing grains from Canada and other American countries. In 1993, China became a net oil importer. The imports of primary commodities exceeded exports dramatically and the second deficit occurred. Fig. 2 describes an inverted-U curve ( $y = -0.59x^2 + 8.62x - 10.30$ ,  $R^2 = 0.94$ ) to mirror the change of physical trade balance of primary commodities. If the trend of trade continues, the net imports would increase to 165 million tonnes by 2005 and 285 million tonnes by 2010.

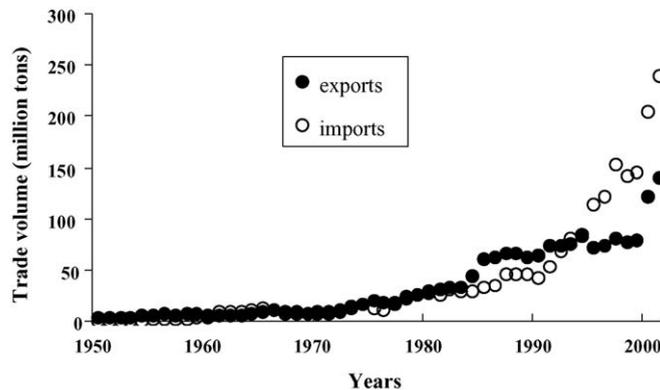


Fig. 1. Physical exports and imports of primary commodities in China (1950–2001).

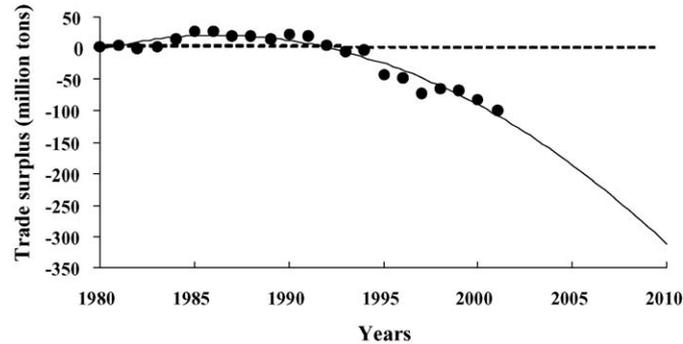


Fig. 2. Physical trade surplus of primary commodities in China (1980–2010).

### 3.2. Change of trade structure in primary commodities

Fig. 3 shows that the trade patterns of different primary commodities are different. During the studied period, China net exported SITC3 (mineral fuels) in most time, especially before 1997. For SITC2 (crude materials), a physical trade deficit always existed and the amount increased quickly. The trade of SITC0 (food and living animals) showed surpluses and deficits in different years.

From 1980 to 2001, the total volume of exports increased by 3.7 times, and imports by 7.3 times. The export structure of primary commodities was relatively stable but a great change occurred in import, as shown in Figs. 4 and 5. Since 1992, minerals and fuels have become the major imports of primary commodities, just as well as foods and minerals did in 1980s. The share of foods in imports declined to less than 10% in 2001.

### 3.3. Trade between China and different regions of the world

The trade structures between China and six continents in 2001 are shown in Table 1. The export structure could be broadly divided into two types: (1) foods and fuels to Africa;

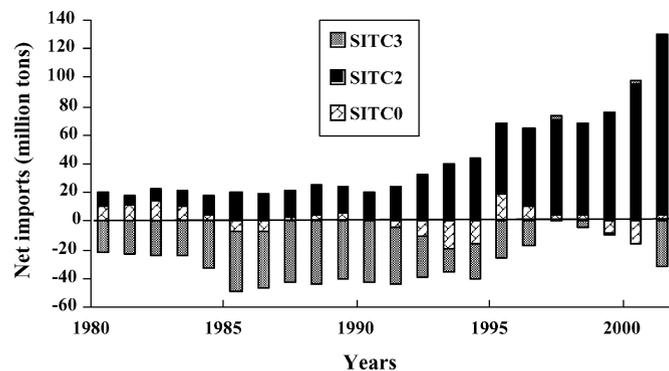


Fig. 3. Net imports of primary commodity trade in China by product groups (1980–2001).

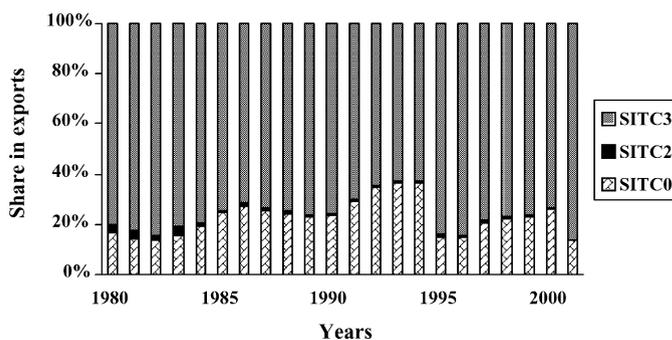


Fig. 4. Export structure of primary commodities (China, 1980–2001).

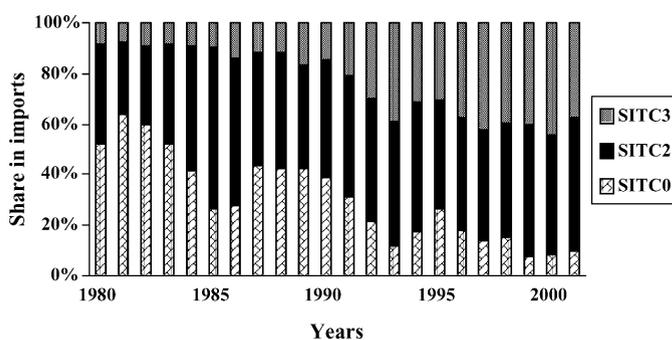


Fig. 5. Import structure of primary commodities (China, 1980–2001).

(2) fuels to other continents. SITC2 (inedible materials) had a small share in exports. The import structure was relatively more complicated and could be classified into four types: (1) foods from North America; (2) inedible materials from Oceania and Latin America; (3) fuels and inedible materials from Africa; (4) fuels from Europe and Asia.

Fig. 6 shows that most of the imports came from Asia (43%), Oceania (20%), Latin America (17%) and Africa (11%), while most of the exports flowed to Asia (85%) and

Table 1  
The trade structure of primary commodities between China and other regions<sup>a</sup> (2001)

Regions	Share in imports (%)			Share in exports (%)		
	SITC0	SITC2	SITC3	SITC0	SITC2	SITC3
Asia	3.4	29.3	67.3	12.6	0.4	87.0
Europe	11.8	14.5	73.7	14.0	0.1	86.0
Latin America	24.2	74.6	1.2	10.5	0 <sup>b</sup>	89.5
Africa	0.2	45.5	54.3	59.5	0 <sup>b</sup>	40.5
Oceania	3.4	92.2	4.4	7.1	0 <sup>b</sup>	92.8
North America	70.7	26.0	0.03	17.5	0 <sup>b</sup>	82.5

<sup>a</sup> By trade volume.

<sup>b</sup> The share is less than 0.1%.

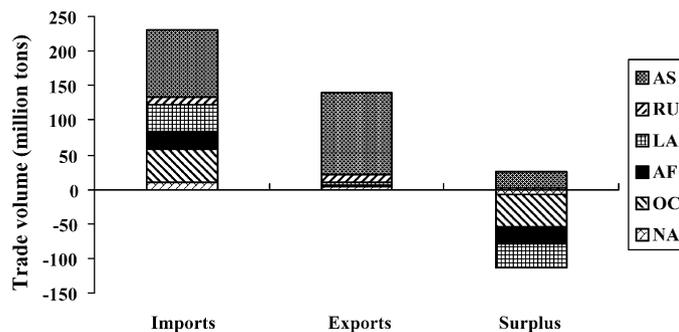


Fig. 6. Trade flows of primary commodities between China and other regions in 2001 (NA, North America; OC, Oceania; AF, Africa; LA, Latin America; EU, Europe; AS, Asia).

Europe (8%). China had a physical balance with Europe, a surplus to Asia and deficits from other continents. Most of net imports came from Oceania, Africa and Latin America.

#### 4. Discussion

##### 4.1. Inverted-U curve of primary commodity trade

The balance of physical trade of primary commodities after 1980 shows an inverted-U curve (Fig. 2), indicating that along with economy development, the physical surplus gradually increased to a peak, then leveled off and shifted to an increasing deficit. At the early stage of economy development, industries of China were far behind developed countries and the competitive ability of finished products on international market was weak. China has no comparative advantage in natural resources as its reserve of resources per capita is less than that of most countries (Zhong, 1999). China has to earn hard currency through exporting primary commodities in order to pay for importing technologies and equipments that are urgently needed. After this early stage, some manufacturing industries developed quickly and produced products more competitive on world market. Then, some finished products were exported and a large amount of resources were imported to develop the industries of import-substitute and export-substitute. This inverted-U curve not only indicates the change of trade structure, but also describes a classical pattern of industrialization in which government encourages export through importing primary commodities.

##### 4.2. Hidden troubles posed by primary commodities imports

The dependence of economy on importing fuels and grains may threaten the safety of a country, including political, economic and ecological safety. In 1993, China became a net oil importer. Currently, 60% of imported crude oils are from Middle East, the political stability of this region and the unobstructed transport through the straits of Malacca and Indian Ocean may directly influence the safety of Chinese oil supply.

Trade of Genetically Modified Organism (GMO) products is another issue that should be addressed. The import of transgenic agricultural products increased from 80 000 tonnes in 1996 to 2.83 million tonnes in 1999, accounting for 5.2% of the total trade of transgenic products in world market. Most of these imports were transgenic soybeans (Xia et al., 2001). Importing GMO products may bring health and environmental problems to China in the future. Recently Chinese government has realized the potential risks of GMO products and issued several laws and regulations for bio-safety. However, the implementation of these laws and regulations are difficult at present, and further legislations are needed.

In addition, risks of biological invasion increase along with import of livestock, fruits, vegetables and other goods (Lövei, 1997). Invasion of exotic species is one of major threats to China's biodiversity, and it might also threaten public health, agriculture, forest and other industries. These species are carried in by ships and their ballast water, airplanes, trucks and containers or hitch a ride with livestock, fruits, vegetables and other goods (Everett, 2000). For example, a vicious weed *Sorghum halepense* arrived in China through contaminated crop seeds (wheat and soybeans) (Zhou and Du, 2001). Chinese customs have intercepted *Hylurgus ligniperda* in pine logs, *Stephanopachys rugosus* in wood packages from USA, *Tilletia indica* in shipping wheat. Due to its diverse climates and ecosystems, China is susceptible to alien species invasions.

China has enormously benefited from international trade, which is unfortunately overshadowed by the environmental problems caused by the foreign trade. Therefore, environment and development is a double-edged sword and neither of them could be ignored.

#### 4.3. Ecologically unequal trade

The analysis of the physical balance of China's primary trade carried out in this paper reveals that China has a substantial trade deficit of primary commodities with other countries and regions, and is heavily dependent on resource import from other countries, especially that from Oceania, Latin America and Africa. The physical trade deficit clearly illustrates that the economy of China is, indeed to some extent, exploiting ecological capacity from other regions. From the view of biophysical flows, the trade relationship between China and the rest of the world can, therefore, be characterized as "ecologically unequal". These results raise some important questions: (1) How important is the role of physical imports from other regions of the world for the competitive development of Chinese economy? (2) What are the consequences of ecologically unequal trade, in terms of both economic development potentials and environmental impacts, for those countries providing natural resources?

#### 4.4. Importing raw material versus exporting products

China is a trade surplus country in recent years, and processing for export has been the major form of China's foreign trade. Although China has been a major importer of primary commodities, most of imported raw materials are exported again in the form of products. It is a challenge to estimate the amount of a specific material embodied in exported products, and it is even more difficult to estimate all raw materials because it is still a blank to count natural resources in industrial products in China. It will be an interesting area to estimate

the net change in the stock of raw materials in order to calculate the raw materials used in and by China.

In addition, we should pay more attention to the special form of China's trade. Processing trade was the major form of foreign trade of China in recent years. In 2004, exports and imports related to processing trade increased by 35.7 and 36.1%, respectively. Processing export accounted for 55.3% of China's total exports. Massive processing of raw materials will cause serious environmental and ecological problems such as water and air pollution, loss of biodiversity, increased emission of greenhouse gas. China may have earned processing fees at the cost of damaging its environmental quality and carrying capacity. How to achieve a balance between trade and environment is important for China's sustainable development in future.

## 5. Conclusions

In this paper, we analyzed the physical flows in China's primary commodity trade from 1950 to 2001 and found an inverted-U type trend of net material flows. The trade structures between China and six continents were different. Minerals and fuels are major primary commodities imported. Most imports came from Asia, Oceania, Latin America and Africa, while most exports flowed into Asia and Europe. Most of the net imports came from Oceania, Africa and Latin America. The dependence of economy on importing resources may threaten political, economic and ecological safety of China. Processing for export has been the major form of China's foreign trade. More evidence is required to conclude whether China is grabbing the world's resources.

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