sustainability

MDPI

Article

The Contribution of China's Outward Foreign Direct Investment (OFDI) to the Reduction of Global CO_2 Emissions

Tao Ding, Yadong Ning * and Yan Zhang

Key Laboratory of Ocean Energy Utilization and Energy Conservation of Ministry of Education, School of Energy and Power Engineering, Dalian University of Technology, Dalian 116024, China; dingtao.129@hotmail.com (T.D.); zhang.yan@dlut.edu.cn (Y.Z.)

* Correspondence: ningyd@dlut.edu.cn; Tel.: +86-411-84706795

Academic Editors: Ning Zhang, Peng Zhou and Liexun Yang

Received: 28 February 2017; Accepted: 29 April 2017; Published: 4 May 2017

Abstract: Under economic globalization, with the intensification of China's reform and opening up, China's outward foreign direct investment (OFDI) has continuously gained momentum, but CO_2 emissions caused by the OFDI have not been given due attention. As one China is of the world's leading CO_2 emitters, it is necessary to conduct thorough research into the CO_2 emission problem caused by China's OFDI. Thirty-four host countries were selected as the objects of this study, including some European countries, Australia, India, Indonesia, Brazil, Canada, Japan, Korea, Mexico, Russia, and the USA. Their CO_2 emissions as caused by China's OFDI were calculated using the input-output model with non-competitive imports, the data of China's OFDI flows, and their own energy consumption and CO_2 emissions from 2000 to 2011. Then a comparative analysis was performed taking China as the comparative object. CO_2 emission transfer of China's OFDI was studied quantitatively. Finally, CO_2 emissions from China's OFDI were discussed from the perspective of industry selection and location selection. The results showed that China's OFDI could achieve the aim of reducing global carbon emissions with reasonable industry and location selection.

Keywords: outward foreign direct investment; CO_2 emissions; input-output model; CO_2 emission transfer

1. Introduction

Foreign direct investment (FDI) outflow from developing countries has increased dramatically in recent years. It accounted for 33.8% of global outward FDI (OFDI) in 2014, up 7.6% from 2000 [1]. China, as the world's second largest economy, has attracted much attention. Though China has been known as a destination of global investment, OFDI from China surged to USD 123.1 billion in 2014 [1], approximately at the same level of inward FDI to China. Three primary motivations behind international investments of firms, market seeking, efficiency seeking, and resource seeking, are suggested in traditional theories [2,3]. In the case of emerging economies such as China, more specialized applications of the theory are needed. This has generated considerable interest in the motivations and drivers of Chinese international investment [4–9]. The institutional environment and policies of the Chinese government are likely to have far-reaching and profound effects on the investment behavior of Chinese multinational corporations (MNCs) [7]. Policy liberalization has a positive influence in stimulating China's OFDI [4]. The "open door" policy of the late 1970s resulted in the emergence of China's OFDI from 1980s. In early 21st century, China's entry into the WTO and the "go global" strategy announced in China's long-term, innovation-oriented development plan encouraged Chinese firms to invest abroad. Promoted by the proposals of the Silk Road Economic

Belt and 21st Century Maritime Silk Road (Belt & Road) in early 2010s, the countries covered by the Belt & Road initiative have the potential to create new markets for China's OFDI. More specifically, since the 1990s there have been some dramatic changes in the geographical distribution and industrial distribution of China's OFDI. In 2014, Asia received USD 85.0 billion, accounting for 69.0% of the total China's OFDI. The four major industries accounting for 71.1% were mining, wholesale and retail trade, finance, and renting and business services. Under such circumstances of policy liberalization and government encouragement, especially when Chinese OFDI is attracted to large markets [9], what are the impacts of the huge amount of China's OFDI on the host countries' environment, as well as the global environment?

The growing literature on foreign trade and the environment suggests a potentially high level of interaction between trade liberalization and carbon emissions. Currently, there are two main aspects for this study. One focuses on the carbon embodied in import and export trade, while the other is the empirical study of the impact of FDI on carbon emissions. Numerous studies concerned about the relationship between FDI and pollution in developing countries are related to the pollution haven hypothesis [10–15]. As one of the largest host countries receiving inward FDI flows, more attention had been placed on China's rapidly increasing inward FDI and growing environmental pollution [15–19]. However, there are still debates about the pollution haven hypothesis [20], and studies have been inconclusive regarding to the relationship between FDI and pollution [21]. Some studies show that FDI inflows lead to an increase in carbon emissions [12,17,18,22]. However, others show that FDI inflows are a contributory factor to the reduction of carbon emissions [16,23–25]. To resolve the theoretical ambiguity, this study turned to an empirical analysis of the pattern of foreign direct investment. Inevitably, the industrial development promoted by the inward FDI will require energy consumption and thus result in carbon emissions. The relationship between FDI and carbon emissions aside, this study's primary work is to calculate carbon emissions caused by FDI quantitatively.

The input-output analysis has been extensively used to calculate the carbon emissions embodied in the trade for many countries. The input-output analysis was theorized and developed by Leontief [26,27], and its theoretical framework and extended application were systematically detailed by Miller and Blair [28]. Sectors in an economy are connected to each other by the supply-demand relationship. Given the Leontief inverse matrix, the input-output analysis can be easily utilized to calculate the total (direct and indirect) energy inputs and the associated carbon emissions of a sector, regardless of the length and complexity of the production process. Using the input-output analysis, CO_2 emissions embodied in international trade of countries have been studied, such as Austria [29], Brazil [30], China [31,32], Denmark [33], Italy [34], Japan [35], Norway [36], Spain [37], and Sweden [38]. Most of the studies were focused on the estimation of CO_2 emissions embodied in international trade, and few analysts took notice of CO_2 emissions caused by capital transfer during the investment. Fu [39] identified quantitatively the volume of energy consumption and carbon emissions driven by domestic investment in China in 2007, assuming that domestic investment and foreign investment are substitutable, meaning FDI acts the same way as the domestic investment in the host countries. When the host countries attract China's OFDI to expand production and meet domestic needs, CO_2 is released in their own yards. The IPCC designed greenhouse gas inventories containing emissions within national territory from the perspective of producer. Based on this hypothesis and principle, CO_2 emissions in the host countries caused by China's OFDI can be calculated with the input-output analysis and their related data.

The impact on CO_2 emissions from host countries caused by the dramatically increasing China's OFDI has not been well addressed. In addition, a distinct and well established problem with international trade in the Kyoto Protocol is the possibility for "carbon leakage" [40]. The IPCC defines carbon leakage as "the increase in emissions in Non-Annex B countries resulting from implementation of reduction in Annex B (which includes most developed countries) emissions" [41]. Carbon constraint nations are likely to import from nations with lower environmental standards and as a result end up uncompetitive in an industry with pollution-concentrated products. Thus, non-carbon constrained countries gain the upper hand in pollution intensive industries relative to carbon constrained countries [42]. Simultaneously, carbon leakage through international trade might not reduce global emissions as much as expected and could even raise them [43]. In the process of international capital flows, the location and industry selection of foreign direct investment have the same problem due to the different environmental regulation. China has a critical role in global emissions mitigation in the post-Kyoto period as the largest emitter of CO_2. Even as a Non-Annex B country, China has taken actions to achieve a peak of CO_2 emissions around 2030 and to lower CO_2 per unit of GDP [44]. Considering that China partly transferred its redundant production capacity to other countries due to the comparative advantage of its MNCs, China's OFDI would probably bring about an issue similar to carbon leakage and increase global CO_2 emissions. Although previous empirical studies have already covered CO_2 emissions embodied in import and export trade of China, few analysts have focused on CO_2 emissions caused by China's international capital flow. Particularly, how much CO_2 emissions are caused by China's OFDI, does China's OFDI result in carbon leakage, and what contribution has China made to the global CO_2 emissions as a home country of FDI? All of these fundamental questions are quite notable. In this paper, 34 host countries were selected, and their CO_2 emissions caused by China's OFDI were calculated on the basis of the input-output model using non-competitive imports assumption from 2000 to 2011. Formulas were then built to analyze the CO_2 emission transfer caused by China's OFDI. The differences between host and home CO_2 emissions were discussed against China for the first time. Finally, based on the results of 34 host countries, the contribution of China's OFDI to global CO_2 emission reduction was evaluated.

2. Methodology

The foundation of input-output analysis involves input-output tables, which represents monetary transactions between supply chains in mathematical form. According to the treatment of imports, the input-output model can incorporate either the competitive or the non-competitive imports assumption [45]. The competitive imports assumption treats imported products as the same as those produced domestically, while the non-competitive assumption removes imports from intermediate and final use. The standard input-output model using competitive imports assumption can be formulated as,

$$x = (I - A)^{-1} y \tag{1}$$

where x is the column vector of total output, I is the unit matrix, A is the $n \times n$ matrix of direct requirement coefficient, n represents industrial sector, and y is the column vector of final demand. $(I - A)^{-1}$ represents the Leontief inverse matrix. Its element α_{ij} represents the amount of output of the industry i required directly and indirectly to produce one unit of final demand from industry j.

Su and Ang [46] found that the transitions of emissions embodied in imports to those in the exports accounted for a considerable percent of total emissions if the competitive imports assumption is used. To avoid overestimating, we adopt the input-output model with non-competitive imports to calculate CO_2 emissions caused by FDI. The standard input-output model using non-competitive imports assumption can be formulated as,

$$x = (I - A^{\mathrm{d}})^{-1} y^{\mathrm{d}} \tag{2}$$

where A^{d} is the matrix of domestic direct requirement coefficient, y^{d} is the vector of domestic final demand.

CO_2 emissions from domestic final demand can be formulated from Equation (2) as,

$$c = fE(I - A^{\mathrm{d}})^{-1}y^{\mathrm{d}} \tag{3}$$

where f is the $1 \times m$ row vector of emission factor representing CO_2 emissions per unit of energy consumption, m represents energy type, E is the $m \times n$ energy intensity matrix representing the energy consumption per unit of value of industry output, n represents industrial sector in the input-output table.

The final demand includes final consumption, gross capital formation and exports. Therefore, CO_2 emissions from domestic investment of the host country (which receives China's OFDI) also can be calculated by Equation (3). As mentioned above, it is assumed that China's OFDI acts in the same way as the domestic investment of host country. CO_2 emissions from domestic consumption of the host country due to receiving China's OFDI can be calculated by the following equation:

$$c_v = fE(I - A^{\mathrm{d}})^{-1}v \tag{4}$$

where v is the column vector of China's OFDI flows to the host country. When the vector v is diagonalized to the matrix $\hat{v}$, CO_2 emissions from each sector of the host country due to receiving China's OFDI can be calculated individually.

To study carbon transfer caused by China's OFDI, another assumption that the amount and distribution of OFDI flows are unaffected by related factors of the host country and home country was established. When China's OFDI is assumed to be invested in sectors of China, it has the same properties as that received by the host country. Based on this assumption, home (China invests as a home country) CO_2 emissions were calculated using input-output tables with non-competitive imports, energy consumption and emission factors replaced by corresponding data of China. Home CO_2 emissions can be formulated as,

$$c'_v = f'E'(I - A'^{\mathrm{d}})^{-1}v \tag{5}$$

where f' is the row vector of China's emission factor, E' is the matrix of China's energy intensity, $(I - A'^{\mathrm{d}})^{-1}$ represents China's Leontief inverse matrix.

The impact of China's OFDI on global CO_2 emission reduction can be quantified by the difference between host and home CO_2 emissions with Formula (6). The similar calculation principle was used to quantify the impact of international trade on national and global CO_2 emissions [42,47].

$$\Delta c_v = c'_v - c_v \tag{6}$$

When $\Delta c_v > 0$, the contribution of China's OFDI to global CO_2 emission reduction is positive. This indicates that China's OFDI reduces global CO_2 emissions. When $\Delta c_v < 0$, the impact of China's OFDI to global CO_2 emission reduction is negative with increasing global CO_2 emissions. When Δc_v = 0, China's OFDI makes no contribution to global CO_2 emission reduction.

3. Data Sources and Processing

The input-output tables with non-competitive imports of China and host countries from 2000 to 2011 are derived from World Input-Output Database (WIOD) [48]. The data of CO_2 emissions and relevant energy consumption with the same industrial structure as input-output tables are provided in WIOD from 2000 to 2009. CO_2 emission factor can be calculated by dividing CO_2 emissions by relevant energy consumption. The energy consumption of China and host countries in 2010 and 2011 are derived from Energy Statistics Database (UNSD) [49]. The corresponding CO_2 emissions are obtained by applying CO_2 emission factors adopted from IPCC (2006) [50] to the energy consumption.

According to WIOD data coverage, there are 35 industrial sectors and 26 energy types. The industrial sectors are combined to 12 categories, while taking account of the industrial sectors of China's OFDI flows. There are 14 types of energy that generate CO_2 emissions. Detail industrial sectors and energy types are given in Tables 1 and 2.

Table 1. Industrial sectors of China's outward foreign direct investment (OFDI) flows.

Industries	
Agriculture	Hotels and restaurants
Mining	Transport, post and telecommunications
Manufacturing	Finance
Electricity, gas and water supply	Real estate
Construction	Renting and business services
Wholesale and retail trade	Others

Table 2. Emission relevant energy types.

Energy Types	
Hard coal	Light fuel oil
Brown coal	Heavy fuel oil
Coke	Naphta
Crude oil	Other petroleum
Diesel	Natural gas
Gasoline	Other gas
Jet fuel	Waste

In the case of OFDI data, the form of flow has no lag compared to stock, and therefore the OFDI flows can reflect the development and change of the current economic situation more effectively. It is more reasonable and accurate to calculate host CO_2 emissions with China's OFDI flow data. China's OFDI flows are derived from World Investment Report (UNCTAD) [1] and Statistical Bulletin of China's Outward Foreign Direct Investment (MOFCOM) [51]. On the base of countries in the coverage of WIOD's data, 34 countries are chosen as host countries receiving China's OFDI. Because of the lack of data, Estonia, Lithuania, Slovenia, Portugal, and Taiwan are not included. China's OFDI flows to the 34 host countries from 2000 to 2011 are presented in Table 3. China's OFDI flows to the 34 host countries accounted for 20.4% of the total in 2011, and they consist of both developed and developing countries. It is representative to study CO_2 emissions from China's OFDI with these 34 host countries.

Table 3. China's OFDI flows by region, 2000–2011 (millions of USD).

Regions	Abbreviation	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Australia	AUS	10.2	10.1	48.6	30.4	125.0	193.1	87.6	531.6	1892.2	2436.4	1701.7	3165.3
Austria	AUT	0.0	0.2	0.9	0.4	0.0	0.0	0.0	0.1	0.0	0.0	0.5	20.2
Belgium	BEL	0.0	1.0	0.0	0.3	0.1	0.0	0.1	4.9	0.0	23.6	45.3	35.9
Brazil	BGR	0.0	0.0	0.0	0.4	0.4	1.7	0.0	0.0	0.0	−2.4	16.3	53.9
Bulgaria	BRA	21.1	31.8	9.3	6.7	6.4	15.1	10.1	51.1	22.4	116.3	487.5	126.4
Canada	CAN	31.7	3.5	1.2	−7.3	5.1	32.4	34.8	1032.6	7.0	613.1	1142.3	554.1
Cyprus	CYP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	89.5
Czech Republic	CZE	2.3	0.2	0.0	0.0	0.5	0.0	9.1	5.0	12.8	15.6	2.1	8.8
Germany	DEU	1.6	3.5	2.8	25.1	27.5	128.7	76.7	238.7	183.4	179.2	412.4	512.4
Denmark	DNK	0.0	0.0	0.0	73.9	−7.8	10.8	−58.9	0.3	1.3	2.6	1.6	5.9
Spain	ESP	0.1	0.0	1.8	0.0	1.7	1.5	7.3	6.1	1.2	59.9	29.3	139.7
Finland	FIN	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	2.7	1.1	18.0	1.6
France	FRA	0.0	0.0	11.4	0.5	10.3	6.1	5.6	9.6	31.1	45.2	26.4	3482.3
United Kingdom	GBR	6.3	3.1	0.0	2.1	29.4	24.8	35.1	566.5	16.7	192.2	330.3	1419.7
Greece	GRC	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.4
Hungary	HUN	2.0	0.0	0.3	1.2	−0.1	0.7	0.4	8.6	2.2	8.2	370.1	11.6
Indonesia	IDN	8.0	0.6	3.7	26.8	62.0	11.8	56.9	99.1	174.0	226.1	201.3	592.2
India	IND	3.1	2.6	2.3	0.2	0.4	11.2	5.6	22.0	101.9	−24.9	47.6	180.1
Ireland	IRL	0.0	0.0	0.0	0.1	0.0	0.0	25.3	0.2	42.3	−1.0	32.9	16.9
Italy	ITA	5.8	3.9	7.8	0.3	3.1	7.5	7.6	8.1	5.0	46.1	13.3	224.8
Japan	JPN	0.3	1.7	18.2	7.4	15.3	17.2	39.5	39.0	58.6	84.1	338.0	149.4
Republic of Korea	KOR	4.2	0.8	83.4	153.9	40.2	588.8	27.3	56.7	96.9	265.1	−721.7	341.7
Luxembourg	LUX	0.0	0.0	0.9	0.0	0.0	0.0	0.0	4.2	42.1	2270.5	3207.2	1265.0
Latvia	LVA	0.0	0.0	0.0	1.6	0.0	0.0	0.0	−1.7	0.0	0.0	0.0	0.0
Mexico	MEX	19.8	0.2	2.0	0.0	27.1	3.6	−3.7	17.2	5.6	0.8	26.7	41.5
Malta	MLT	0.0	0.0	0.0	0.0	0.4	0.0	0.1	−0.1	0.5	0.2	−2.4	0.3
Netherlands	NLD	0.0	0.0	0.1	4.5	1.9	3.8	5.3	106.8	92.0	101.5	64.5	167.9
Poland	POL	0.0	0.0	0.0	1.6	0.1	0.1	0.0	11.8	10.7	10.4	16.7	48.7
Romania	ROU	−0.3	4.9	0.4	0.6	2.7	2.9	9.6	6.8	12.0	5.3	10.8	0.3
Russia	RUS	13.9	12.4	35.4	30.6	77.3	203.3	452.1	477.6	395.2	348.2	567.7	715.8
Slovak Republic	SVK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	5.9
Sweden	SWE	0.0	0.0	1.0	0.2	2.6	1.0	5.3	68.1	10.7	8.1	1367.2	49.0
Turkey	TUR	0.0	2.0	0.0	1.5	1.6	0.2	1.2	1.6	9.1	293.3	7.8	13.5
United States	USA	23.1	53.7	151.5	65.1	119.9	231.8	198.3	196.0	462.0	908.7	1308.3	1811.4

4. Results and Discussion

4.1. Host CO_2 Emissions

CO_2 emissions of these 34 host countries can be calculated by Equation (4), and the results are shown in Table 4. CO_2 emissions were comparatively low in most of host countries before 2005, mainly because the scale of China's OFDI was very small in those years. Host CO_2 emissions have had continuously gained momentum with the growth of China's OFDI since 2006. CO_2 emissions in some countries fluctuated from year to year due to the large difference between annual FDI flows. China's OFDI flows were short of continuation and stability. CO_2 emissions of few host countries in certain years were negative value because of the negative OFDI flow. The OFDI flow is obtained by subtracting contrary investment from FDI enterprises to domestic investors from the total foreign direct investment in the current period. FDI enterprises refer to foreign enterprises that directly owned or have 10% voting rights or equivalents controlled by domestic investors. When the contrary investment in the current period is larger than the total foreign direct investment, the OFDI flow will be negative. The top four countries in terms of host CO_2 emissions were USA, Indonesia, Australia, and Russia in 2011, emitting 1135.0, 937.2, 729.4, and 601.7 kt CO_2 respectively. Moreover, India, France, Germany, and Korea also emitted over 200 kt CO_2. During 2000 to 2011, Indonesia had the largest cumulative host CO_2 emissions with 3872.7 kt, followed by Russia emitting 3268.6 kt. The cumulative CO_2 emissions of Australia and USA also reached over 2000 kt during the period.

Table 4. Host CO_2 emissions from China's OFDI (kt).

Regions	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AUS	6.8	7.4	31.1	17.8	55.1	69.7	30.1	151.1	488.0	577.6	353.7	729.4
AUT	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
BEL	0.0	0.3	0.0	0.1	0.0	0.0	0.0	0.7	0.0	2.2	3.2	1.9
BGR	0.0	0.0	0.0	0.3	0.3	1.3	0.0	0.0	0.0	−0.7	16.2	127.5
BRA	10.1	18.0	5.5	3.6	2.9	5.1	2.5	10.3	4.3	22.7	135.4	24.9
CAN	14.3	1.6	0.6	−3.0	1.8	10.3	9.6	273.7	1.1	137.0	237.8	180.8
CYP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	22.9
CZE	5.0	0.3	0.0	0.0	0.3	0.0	5.0	1.2	4.0	13.0	1.3	39.1
DEU	0.6	1.4	1.0	7.5	0.2	13.8	22.9	41.2	57.1	41.3	126.4	236.9
DNK	0.0	0.0	0.0	2.9	−1.9	6.5	−11.8	0.1	0.5	0.4	0.1	0.6
ESP	0.0	0.0	0.5	0.0	0.4	0.9	1.6	3.3	0.3	20.7	3.8	16.9
FIN	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.3	0.1	2.6	−0.2
FRA	0.0	0.0	1.6	0.1	0.6	0.5	0.8	0.9	2.2	2.9	2.9	272.7
GBR	7.2	3.9	0.0	2.2	17.5	10.1	5.4	119.1	2.8	83.9	31.2	421.6
GRC	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	2.1
HUN	0.5	0.0	0.0	0.2	0.0	0.1	0.1	2.1	0.3	2.2	278.4	0.9
IDN	80.1	6.7	31.1	191.4	394.2	74.8	303.4	476.3	767.8	332.4	277.1	937.2
IND	7.8	6.6	5.3	0.3	0.7	19.8	5.1	32.5	142.7	−49.3	99.8	468.7
IRL	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.5	−0.1	2.0	0.4
ITA	1.2	0.8	1.5	0.1	1.2	2.6	1.5	1.5	−0.5	7.0	2.0	24.9
JPN	0.0	0.3	3.2	1.2	1.9	4.1	21.9	5.7	5.8	23.5	98.6	40.4
KOR	3.0	0.6	55.8	92.1	13.9	247.9	18.4	38.6	37.5	186.8	−348.5	217.8
LUX	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.4	2.8	183.2	224.0	78.4
LVA	0.0	0.0	0.0	0.5	0.0	0.0	0.0	−0.2	0.0	0.0	0.0	0.0
MEX	9.8	0.1	0.9	0.0	9.6	1.1	−0.8	4.3	1.2	0.2	5.4	7.7
MLT	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	−0.3	0.1
NLD	0.0	0.0	0.0	−0.2	1.2	0.9	0.6	14.8	76.4	57.9	−12.5	30.7
POL	0.0	0.0	0.0	2.1	0.1	0.1	0.0	5.8	5.2	5.8	19.4	40.3
ROU	−0.3	5.7	0.4	0.5	1.7	1.5	4.3	2.2	3.1	1.3	7.4	0.3
RUS	52.6	40.7	105.6	67.7	133.2	286.3	518.3	434.0	280.8	321.1	426.7	601.7
SVK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.9
SWE	0.0	0.0	0.3	0.0	−0.1	0.1	0.7	6.3	0.9	0.6	45.6	0.1
TUR	0.0	1.6	0.0	0.9	0.6	0.1	0.3	0.4	2.6	212.0	8.7	19.2
USA	10.7	24.9	65.1	26.3	44.2	79.8	62.8	62.4	83.7	224.3	306.9	1135.0

The difference between host CO_2 emissions is significant, but it is not associated only with the amount of China's FDI flows. CO_2 emissions per unit foreign direct investment (CEPI) is calculated to further analyze the difference between host CO_2 emissions. CEPIs of the leading 13 host countries from 2000 to 2011 are shown in Figure 1. The CEPI of Indonesia stayed at a high level above the other countries during most of the period. It peaked the highest value of 10.5 kg/USD in 2001, and then dropped to 1.6 kg/USD in 2011. The CEPI of India reduced from 2.5 kg/USD in 2000 to the lowest value of 0.9 kg/USD in 2006, and then increased to 2.6 kg/USD higher than other countries in 2011. The CEPI of Russia reached a relatively high level, declining from 3.8 kg/USD to 0.8 kg/USD during the period. The cumulative OFDI flows to Indonesia, India, and Russia ranked 10th, 16th, and 6th respectively among the 34 host countries. However, their cumulative host CO_2 emissions ranked the first, 6th and second places due to their high CEPIs. CO_2 emissions per unit foreign direct investment were not only affected by energy structure, production process and technology level of host countries, but also restricted by industry selection of China's OFDI. In terms of the industrial distribution of China's OFDI in Indonesia, the FDI flows were allocated in the industry of electricity, gas and water supply. In Russia, agriculture, mining and manufacturing received most of China's OFDI. Higher energy consumption and higher emissions of primary industries led to higher CEPIs. Because the proportion of China's OFDI received by mining and manufacturing in Korea increased after 2005, its CEPI correspondingly rose in a small amplitude. The reason that why CEPIs of UK were higher than 1.0 kg/USD in previous years was also associated to the high proportion of China's OFDI received by energy industries. Consequently, the industry selection of China's OFDI has influence on host CO_2 emissions. The higher proportion of OFDI to resource intensive and energy intensive industries will certainly result in larger host CO_2 emissions.

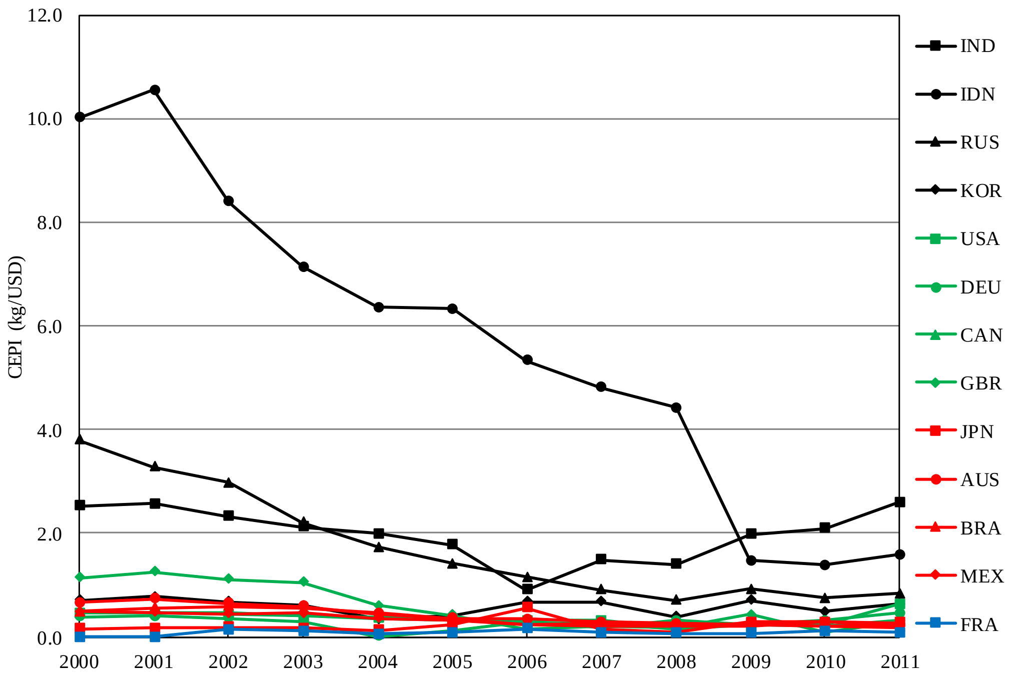

Figure 1. CO_2 emissions per unit of foreign direct investment, 2000–2011.

Apart from the five host countries mentioned above, mining in Australia topped other industries and received the majority of China's OFDI, and manufacturing also received a considerable portion of China's OFDI in other host countries. Nevertheless, CEPIs of the other eight host countries were lower than 1.0 kg/USD, e.g., CEPIs of France and Japan mostly maintained in the range of 0.1~0.2 kg/USD. Lower CEPIs were not only related to industry selection of China's OFDI, but mainly due to the higher level of technology and management, more equitable economic technical interrelation among industries in these host countries. Therefore, the emission conduction effect of location selection during the process of China's outward foreign direct investment is not inconsiderable.

4.2. Home CO_2 Emissions

The results of home CO_2 emissions calculated by Equation (5) are shown in Table 5. The issue of global CO_2 emission reduction caused by China's OFDI can be further investigated by the comparison between home and host CO_2 emissions. Most of host CO_2 emissions were lower than home CO_2 emissions during most of the years (if the emission is negative, it needs to be measured in absolute value). Except Bulgaria, Greece, India, Malta and Russia, cumulative host CO_2 emissions in all of other countries were lower than their cumulative home CO_2 emissions. The comparison results indicate that China's OFDI contributed to global CO_2 emission reduction in the process of carbon transfer. Based on the definition and hypothesis of home CO_2 emissions, the reason for lower host CO_2 emissions in most countries than their home CO_2 emissions is greatly different s in energy structure and economic technical interrelation between these host countries and China. For example, though China's OFDI flows to Australia were concentrated in mining accounting for above 60%, Australia's host CO_2 emissions were just about 20% of its home CO_2 emissions. In Australia's mining industry, natural gas accounted for about 60% of its energy consumption, and the rest were mainly oil fuels. While in China's mining industry, coal accounted for above 60%.

Table 5. Home CO_2 emissions from China's OFDI (kt).

Regions	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AUS	23.2	22.0	104.1	67.1	262.6	378.7	158.6	840.4	2566.8	3283.3	2521.8	4121.3
AUT	0.0	0.4	2.5	1.1	0.0	0.0	0.1	0.1	0.0	0.0	0.6	16.8
BEL	0.0	2.2	0.0	0.6	0.0	0.0	0.3	5.9	0.0	15.9	32.0	21.6
BGR	0.0	0.0	0.0	0.5	0.4	2.0	0.0	0.0	0.0	−1.7	16.6	71.6
BRA	73.7	103.2	29.4	17.8	16.5	36.2	28.0	77.1	28.7	155.4	768.4	190.6
CAN	59.7	6.2	2.1	−12.2	8.2	48.1	46.1	1164.7	4.0	515.9	1160.0	775.0
CYP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	130.2
CZE	8.4	0.5	0.0	0.0	0.9	0.0	10.5	3.8	15.8	30.9	2.0	35.8
DEU	3.5	7.2	5.6	50.1	32.3	110.8	91.2	210.3	213.1	191.7	409.0	514.6
DNK	0.0	0.0	0.0	79.9	−8.8	30.0	-50.2	0.3	1.9	1.4	0.7	5.9
ESP	0.1	0.0	2.6	0.0	3.1	5.9	8.5	21.4	2.2	160.3	27.2	118.0
FIN	0.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	6.8	0.3	19.5	−1.0
FRA	0.0	0.0	14.2	0.6	−1.8	7.7	7.6	8.7	26.4	26.9	37.9	5536.8
GBR	46.1	21.3	0.1	14.4	109.0	64.6	33.7	940.2	20.2	519.0	236.0	2948.8
GRC	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.0	0.9
HUN	1.9	0.0	0.3	1.0	−0.1	0.9	0.4	14.5	1.9	15.6	1014.8	2.3
IDN	89.8	6.6	37.9	281.7	535.9	92.5	477.3	676.6	952.2	472.6	588.0	1456.0
IND	7.6	5.9	5.2	0.3	0.7	20.4	6.4	32.6	119.2	−37.6	74.8	314.5
IRL	0.0	0.0	0.0	0.2	0.0	0.0	55.4	0.2	7.6	−0.6	15.4	11.5
ITA	10.1	6.3	12.2	0.5	10.1	23.2	13.0	11.1	−3.9	57.1	18.4	215.4
JPN	0.3	1.9	19.8	7.8	12.4	10.7	64.4	22.9	24.9	68.4	68.4	27.5
KOR	7.7	1.4	137.5	252.7	40.7	570.0	29.6	66.0	76.2	222.4	−714.5	333.7
LUX	0.0	0.0	1.0	0.0	0.0	0.0	0.0	2.4	26.2	1401.7	2178.1	870.9
LVA	0.0	0.0	0.0	2.1	0.0	0.0	0.0	−1.6	0.0	0.0	0.0	0.0
MEX	43.2	0.5	3.9	0.1	45.8	5.3	−4.8	19.5	5.5	0.7	27.8	40.1
MLT	0.0	0.0	0.0	0.0	0.5	0.0	0.1	−0.1	0.4	0.2	−2.4	0.4
NLD	0.0	0.0	0.0	−0.6	5.2	5.0	2.7	77.8	445.8	442.2	−127.1	215.4
POL	0.0	0.0	0.0	4.3	0.2	0.2	0.0	12.9	13.2	13.5	28.3	64.3
ROU	−0.4	7.0	0.5	0.8	3.4	3.4	10.2	6.1	9.2	3.7	11.1	0.4
RUS	15.6	13.2	36.8	31.3	74.2	179.4	354.7	310.3	215.7	191.9	502.8	721.4
SVK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.2	9.1
SWE	0.0	0.0	3.4	0.6	−2.7	1.0	10.5	85.4	15.6	5.8	270.3	−16.2
TUR	0.0	4.8	0.0	3.6	2.7	0.3	1.5	1.7	9.4	630.2	16.5	30.4
USA	43.6	94.6	257.1	109.0	192.2	343.5	263.2	221.1	266.0	764.7	1328.5	2533.7

Similarly, in the energy structure of Indonesia's electricity, gas, and water supply industries, anthracite accounted for about 30% and natural gas accounted for 40%. The energy structure of the electricity industry was relatively cleaner compared to 95% of coal in China's electricity industry, and therefore the cumulative host CO_2 emissions of Indonesia were notably lower than its cumulative home CO_2 emissions. In most of the host countries, because production technology is superior, energy use is more efficient, the energy structure is dominated by fuels with lower emission (e.g., oil and natural gas), and CO_2 emission reduction target constraint is stricter. Therefore, the host CO_2 emissions from China's OFDI of most host countries were considerably lower than their home CO_2 emissions.

China's OFDI flows to Russia were allocated in agriculture, mining, and manufacturing. Russia's energy structure was reasonably cleaner than China, in which natural gas accounted for more than 60% and solid fuels like coal and coke accounted for less than 20%. However, except for 2010 and 2011, host CO_2 emissions of Russia were higher than home CO_2 emissions. The energy efficiency in Russia was so low that energy intensities of the three main industries receiving China's OFDI were more than twice those of China. The energy intensities of other industries in Russia were likewise generally higher than China. While Russia received China's OFDI, the same amount of FDI would burn more fuels through economic technical interrelation of industries, and the cleaner energy structure could not offset the higher CO_2 emission caused by the lower energy efficiency.

4.3. CO_2 emissions Transfer

Outward foreign direct investment brings about industry transfer, capital transfer, and CO_2 emissions transfer. According to the research framework of this paper, CO_2 emissions transfer caused by China's OFDI has been quantitatively analyzed by calculating host CO_2 emissions, and the contribution of China's OFDI to global CO_2 emission reduction can be evaluated by the difference between host and home CO_2 emissions using Equation (6). The cumulative host and home CO_2 emissions of 34 countries from China's OFDI are shown in Figure 2. The cumulative home CO_2 emissions were larger than host CO_2 emissions in most countries. This implies that China's OFDI flows to most host countries did not cause such serious carbon leakage, but instead made a positive contribution to global CO_2 emission reduction. Among these 34 countries, Australia reduced the largest global CO_2 emissions totally, followed by France and the USA. The cumulative home CO_2 emissions were 11,832.1, 5379.7, and 4291.2 kt larger than host CO_2 emissions, respectively. In addition, the cumulative home CO_2 emissions of some developed countries such as Canada, Germany, the UK, and Luxembourg were significantly higher than their host CO_2 emissions, achieving fairly large CO_2 emission reductions. The difference between host and home CO_2 emissions was insignificant in Japan and Korea, so the contribution to global CO_2 emission reduction was negligible. Among these 34 countries, the cumulative home CO_2 emissions were 1794.3 kt larger than host CO_2 emissions in Indonesia compared to the other developing countries, while its cumulative host CO_2 emissions were the largest. For developing countries, Brazil made a CO_2 emissions reduction of 1279.6 kt among the BRICS nations (Brazil, Russia, India, China, and South Africa). In the case of India and Russia, both of their cumulative home CO_2 emissions were lower than host CO_2 emissions. China's OFDI flows to these two countries respectively increased 189.9 and 621.3 kt of global CO_2 emissions. It should be noted that Hong Kong received the largest amount of China's OFDI, and the investment mainly flowed to renting and business services, wholesale and retail trade, finance, and other service industries. Though energy intensity and CO_2 emission intensity of these industries mentioned above were relatively low, it is believed that relatively large CO_2 emission reductions could be achieved due to the huge scale effect of China's OFDI. Moreover, how to account for investment flows through tax havens and the influence on CO_2 emissions is important for a complete understanding of Chinese FDI. Nonetheless, CO_2 emissions of Hong Kong caused by China's OFDI were not calculated or analyzed in this paper by the lack of input-output tables and relevant energy consumption and CO_2 emissions. This part of work will be supplemented and improved in the further study.

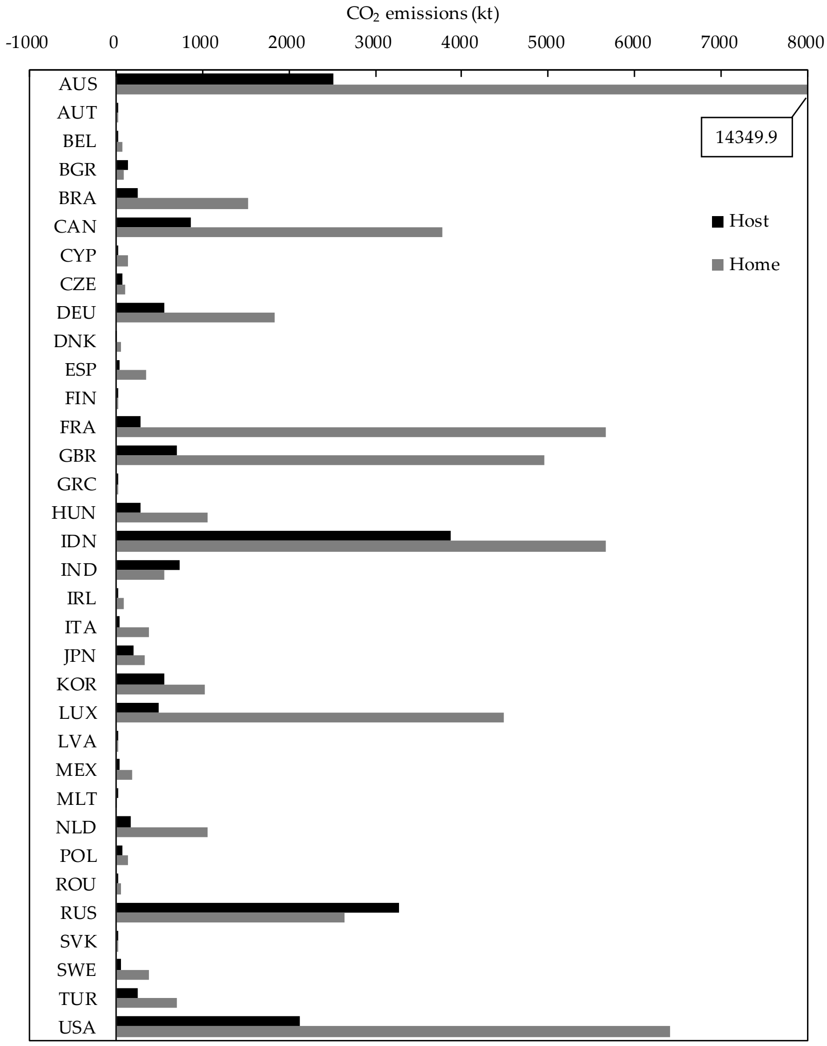

Figure 2. The cumulative host and home CO_2 emissions from China's OFDI.

The contribution to global CO_2 emission reduction of China's OFDI flows to the 34 countries from 2000 to 2011 are shown in Figure 3. The annual contribution was positive, namely China's OFDI contributed to global CO_2 emission reduction from 2000 to 2011. The annual amount of CO_2 emission reduction was about 1000 kt from 2000 to 2006. It increased rapidly from 3143.8 kt in 2007 to 15,638.3 kt in 2011. The cumulative contributions to global CO_2 emission reduction of China's OFDI amounted to a considerable 40,454.2 kt from 2000 to 2011 on the whole.

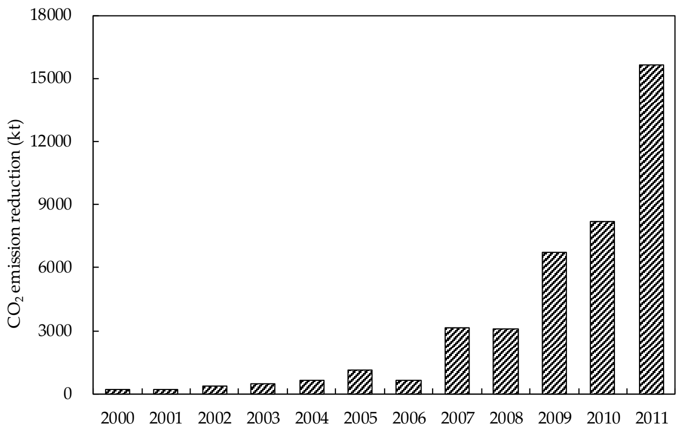

Figure 3. Contributions to global CO_2 emission reduction of China's OFDI, 2000–2011.

5. Conclusions

Considering low-carbon economic development and the rapid growth of China's OFDI, CO_2 emissions in host countries caused by China's OFDI were calculated using input-output analysis from 2000 to 2011. Under the hypothesis of home CO_2 emissions, CO_2 emission transfer caused by China's OFDI was also analyzed for the first time. An evaluation model was established to investigate the contribution of China's OFDI to the global CO_2 emission reduction. Combining the results of 34 selected host countries, our results suggest that China's OFDI had a positive influence on the global CO_2 emission reduction as a whole. And other conclusions are as follows:

Host CO_2 emissions of 34 host countries mostly showed an increasing trend with the rapid growth of China's OFDI. The cumulative host CO_2 emissions of Indonesia was the largest, reaching 3872.7 kt, followed by Russia and Australia with 3268.6 and 2517.8 kt. The industry selection of China's OFDI had a distinct influence on host CO_2 emissions. The higher proportion of OFDI to resource intensive and energy intensive industries would certainly result in larger host CO_2 emissions. The large difference between CEPIs of 34 host countries shows that the location selection also played an important role in global CO_2 emission when Chinese OFDI was mainly attracted to resources and market.

Furthermore, the difference between host and home CO_2 emissions shows that China's OFDI indeed resulted in "carbon leakage" in some countries e.g., India and Russia. China's OFDI flows to these two countries increased 189.9 and 621.3 kt of global CO_2 emissions during the study period. When investing abroad, China should consider the capacity of the environment in the host country. The optimization of industry selection could be an effective measure to reduce host CO_2 emissions in such countries with higher CEPIs.

The comparison between host and home CO_2 emissions indicates that home CO_2 emissions of most host countries were larger than their host CO_2 emissions: China's OFDI contributed to global CO_2 emission reduction. The cumulative CO_2 emission reduction achieved by China's OFDI was 40,454.2 kt from 2000 to 2011, in which Australia made the largest contribution of 11,832.1 kt, followed by France of 5379.7 kt and the USA of 4291.2 kt. China's OFDI could significantly reduce global CO_2 emissions while the priority of location selection is placed to those countries with higher levels of technology and management, cleaner energy structures, and more efficient energy use.

Acknowledgments: This study was supported by the Natural Science Foundation of China (71573029).

Author Contributions: Y.N. conceived and designed the study, and also performed the analytical model. Y.Z. reviewed and edited the paper. T.D. collected the data, conducted the data analysis and drafted the article. All authors discussed the results and implications and commented on the paper at all stages.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. United Nations Conference on Trade and Development (UNCTAD). *World Investment Report*; United Nations Publication: Geneva, Switzerland, 2015.
2. Dunning, J.H. *Trade, Location of Economic Activity and the MNE: A Search for an Eclectic Approach*; Palgrave Macmillan UK: London, UK, 1977; pp. 395–418.
3. Dunning, J.H. *Multinational Enterprises and the Global Economy*; Addison-Wesley: Berkshire, UK, 1993.
4. Buckley, P.J.; Clegg, L.J.; Cross, A.R.; Liu, X.; Voss, H.; Zheng, P. The determinants of Chinese outward foreign direct investment. *J. Int. Bus. Stud.* **2007**, *38*, 499–518. [CrossRef]
5. Deng, P. Why do Chinese firms tend to acquire strategic assets in international expansion? *J. World Bus.* **2009**, *44*, 74–84. [CrossRef]
6. Cheung, Y.W.; Qian, X. *The Empirics of China's Outward Direct Investment*; CESifo Working Paper Series No. 2621; 2009. Available online: https://ssrn.com/abstract=1392186 (accessed on 29 April 2017).
7. Zhang, X.; Daly, K. The determinants of China's outward foreign direct investment. *Emerg. Mark. Rev.* **2011**, *12*, 389–398. [CrossRef]
8. Berning, S.C.; Holtbrügge, D. Chinese outward foreign direct investment—A challenge for traditional internationalization theories? *J. für Betriebswirtschaft* **2012**, *62*, 169–224. [CrossRef]
9. Kolstad, I.; Wiig, A. What determines Chinese OFDI? *J. World Bus.* **2012**, *47*, 26–34. [CrossRef]
10. Grossman, G.M.; Krueger, A.B. *Environmental Impacts of a North American Free Trade Agreement*; National Bureau of Economic Research Working Paper Series, No. 3914; National Bureau of Economic Research, Inc.: Cambridge, MA, USA, 1991; Available online: https://www.nber.org/papers/w3914 (accessed on 29 April 2017).
11. Letchumanan, R.; Kodama, F. Reconciling the conflict between the "pollution-haven" hypothesis and an emerging trajectory of international technology transfer. *Res. Policy* **2000**, *29*, 59–79. [CrossRef]
12. Smarzynska, B.K.; Wei, S.J. *Pollution Havens and Foreign Direct Investment: Dirty Secret or Popular Myth?* National Bureau of Economic Research Working Paper Series, No. 8465; National Bureau of Economic Research, Inc.: Cambridge, MA, USA, 2001; Available online: https://www.nber.org/papers/w8465 (accessed on 29 April 2017).
13. Xing, Y.; Kolstad, C.D. Do lax environmental regulations attract foreign investment? *Environ. Resour. Econ.* **2002**, *21*, 1–22. [CrossRef]
14. Eskeland, G.S.; Harrison, A.E. Moving to greener pastures? Multinationals and the pollution haven hypothesis. *J. Dev. Econ.* **2003**, *70*, 1–23. [CrossRef]
15. He, J. Pollution haven hypothesis and environmental impacts of foreign direct investment: The case of industrial emission of sulfur dioxide (SO_2) in Chinese provinces. *Ecol. Econ.* **2006**, *60*, 228–245. [CrossRef]
16. Mielnik, O.; Goldemberg, J. Foreign direct investment and decoupling between energy and gross domestic product in developing countries. *Energy Policy* **2002**, *30*, 87–89. [CrossRef]
17. Cole, M.A.; Elliott, R.J.R.; Zhang, J. Growth, foreign direct investment, and the environment: Evidence from Chinese cities. *J. Reg. Sci.* **2011**, *51*, 121–138. [CrossRef]
18. Zhang, Y.J. The impact of financial development on carbon emissions: An empirical analysis in China. *Energy Policy* **2011**, *39*, 2197–2203. [CrossRef]
19. Hao, Y.; Liu, Y.M. Has the development of FDI and foreign trade contributed to China's CO_2 emissions? An empirical study with provincial panel data. *Nat. Hazards* **2014**, *76*, 1079–1091. [CrossRef]
20. Lan, J.; Kakinaka, M.; Huang, X. Foreign direct investment, human capital and environmental pollution in China. *Environ. Resour. Econ.* **2012**, *51*, 255–275. [CrossRef]
21. Zhang, C.; Zhou, X. Does foreign direct investment lead to lower CO_2 emissions? Evidence from a regional analysis in China. *Renew. Sustain. Energy Rev.* **2016**, *58*, 943–951. [CrossRef]
22. Al-mulali, U. Factors affecting CO_2 emission in the Middle East: A panel data analysis. *Energy* **2012**, *44*, 564–569. [CrossRef]
23. List, J.A.; Co, C.Y. The effects of environmental regulations on foreign direct investment. *J. Environ. Econ. Manag.* **2000**, *40*, 1–20. [CrossRef]
24. Tamazian, A.; Chousa, J.P.; Vadlamannati, K.C. Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. *Energy Policy* **2009**, *37*, 246–253. [CrossRef]

25. Al-mulali, U.; Chor, F.T. Investigating the validity of pollution haven hypothesis in the gulf cooperation council (GCC) countries. *Energy Policy* **2013**, *60*, 813–819. [CrossRef]
26. Leontief, W.W. Quantitative input and output relations in the economic systems of the United States. *Rev. Econ. Stat.* **1936**, *18*, 105–125. [CrossRef]
27. Leontief, W.W. Environmental repercussions and the economic structure: An input-output approach. *Rev. Econ. Stat.* **1970**, *52*, 262–271. [CrossRef]
28. Miller, R.E.; Blair, P.D. *Input-Output Analysis: Foundations and Extensions*; Cambridge University Press: Cambridge, UK, 2009.
29. Muñoz, P.; Steininger, K.W. Austria's CO_2 responsibility and the carbon content of its international trade. *Ecol. Econ.* **2010**, *69*, 2003–2019. [CrossRef]
30. Machado, G.; Schaeffer, R.; Worrell, E. Energy and carbon embodied in the international trade of Brazil: An input-output approach. *Ecol. Econ.* **2001**, *39*, 409–424. [CrossRef]
31. Lin, B.; Sun, C. Evaluating carbon dioxide emissions in international trade of China. *Energy Policy* **2010**, *38*, 613–621. [CrossRef]
32. Ning, Y.; Ding, T.; Li, X. Character of China embodied carbon emissions within the trade. *Smart Sci.* **2015**, *3*, 108–116. [CrossRef]
33. Munksgaard, J.; Pade, L.L.; Minx, J.; Lenzen, M. Influence of trade on national CO_2 emissions. *Int. J. Glob. Energy Issues* **2005**, *23*, 324–336. [CrossRef]
34. Mongelli, I.; Tassielli, G.; Notarnicola, B. Global warming agreements, international trade and energy/carbon embodiments: An input-output approach to the Italian case. *Energy Policy* **2006**, *34*, 88–100. [CrossRef]
35. Kondo, Y.; Moriguchi, Y.; Shimizu, H. CO_2 emissions in Japan: Influences of imports and exports. *Appl. Energy* **1998**, *59*, 163–174. [CrossRef]
36. Peters, G.P.; Hertwich, E.G. Pollution embodied in trade: The Norwegian case. *Glob. Environ. Chang.* **2006**, *16*, 379–387. [CrossRef]
37. Sánchez-Chóliz, J.; Duarte, R. CO_2 emissions embodied in international trade: Evidence for Spain. *Energy Policy* **2004**, *32*, 1999–2005. [CrossRef]
38. Kander, A.; Lindmark, M. Foreign trade and declining pollution in Sweden: A decomposition analysis of long-term structural and technological effects. *Energy Policy* **2006**, *34*, 1590–1599. [CrossRef]
39. Fu, F.; Ma, L.; Li, Z.; Polenske, K.R. The implications of China's investment-driven economy on its energy consumption and carbon emissions. *Energy Convers. Manag.* **2014**, *85*, 573–580. [CrossRef]
40. Peters, G.P.; Hertwich, E.G. Post-Kyoto greenhouse gas inventories: Production versus consumption. *Clim. Chang.* **2008**, *86*, 51–66. [CrossRef]
41. Metz, B. *Climate Change 2001: Mitigation: Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*; Cambridge University Press: Cambridge, UK, 2001.
42. Jayanthakumaran, K.; Liu, Y. Bi-lateral CO_2 emissions embodied in Australia-China trade. *Energy Policy* **2016**, *92*, 205–213. [CrossRef]
43. Wyckoff, A.W.; Roop, J.M. The embodiment of carbon in imports of manufactured products. *Energy Policy* **1994**, *22*, 187–194. [CrossRef]
44. National Development and Reform Commission (NDRC). Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions, 2015. Available online: http://www4.unfccc.int/Submissions/INDC/PublishedDocuments/China/1/China'sINDC-on30June2015.pdf (accessed on 29 April 2017).
45. United Nations (UN). *Handbook of Input-Output Table Compilation and Analysis*; Studies in Methods, Handbook of National Accounting, Series F, No. 74; United Nations Publication: New York, NY, USA, 1999.
46. Su, B.; Ang, B.W. Input-output analysis of CO_2 emissions embodied in trade: Competitive versus non-competitive imports. *Energy Policy* **2013**, *56*, 83–87. [CrossRef]
47. Guo, J.; Zou, L.L.; Wei, Y.M. Impact of inter-sectoral trade on national and global CO_2 emissions: An empirical analysis of China and US. *Energy Policy* **2010**, *38*, 1389–1397. [CrossRef]
48. Timmer, M.P.; Dietzenbacher, E.; Los, B.; Stehrer, R.; Vries, G.J. An illustrated user guide to the world input-output database: The case of global automotive production. *Rev. Int. Econ.* **2015**, *23*, 575–605. [CrossRef]
49. United Nations Statistics Division (UNSD). Energy Statistics Database. Available online: http://unstats.un.org/unsd/ (accessed on 29 April 2017).

50. Intergovernmental Panel on Climate Change (IPCC). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*; Institute for Global Environmental Strategies: Hayama, Japan, 2006.
51. Ministry of Commerce, PRC (MOFCOM). 2003~2015 Statistical Bulletin of China's Outward Foreign Direct Investment. Available online: http://hzs.mofcom.gov.cn/article/Nocategory/201512/20151201223578.shtml (accessed on 29 April 2017).