Impacts of China Coal Import Tariff against US on Global Economy and CO2 Emissions

Mustika Septiyas Trisilia and Tri Widodo

Master and Doctoral Program, Economics Departement, FEB ,
Gadjah Mada University

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by:

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and
Tri Widodo

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Abstract

This paper examines the impacts of China coal import tariff against US on global economy and CO_2 emissions. Using Global Trade Analysis Project Environmental (GTAP-E) model, coal import tariff was found to generate trade deflection and trade depression phenomena. Then, US and China's would have welfare loss, but Indonesia and Australia would seem gainers from this tariff war. Furthermore, skilled and unskilled labor will decline in coal's industry in US and increase in China. Finally, it is also found evidence that China coal import tariff was not good policy because not only the global economy, the environment would be disadvantaged by increasing CO_2.

Keywords: Import tariff, Coal, Carbon dioxide emissions, GTAP
JEL Classification: F18, Q54

1. Introduction

China has long been a target of trade barriers, especially from US. It is because the growth rate and the level of China's exports which increase continuously and put pressure on the main export markets in North America and Europe (Dong and Whalley, 2012). Concerns over the possibilities of trade confrontations (Dong and Whalley, 2012) make bilateral trade retaliation between United States (US) and China has long been observed by researchers, such as Dong and Whalley (2012), Chandra and Long (2013), Chandra (2016), Rosyadi and Widodo (2017).

Trade war between the two countries is increasingly worrying when Donald J. Trump was elected as US' 45th president because he included some controversial trade protectionism plan in his campaign (Rosyadi and Widodo, 2017). As proof, US imposed various import tariffs to China, one of them was implementation a 25 percent tariif on 333 goods originating from China, including semiconductors, chemicals, plastics, motorbikes and electric scooters (Wong and Koty, 2018). This provoked China to implement tariff retaliation to US by imposing 25 percent tariff on 333 goods from the US, including coal, copper scrap, fuel, buses and medical equipment (Wong and Koty, 2018). Dong and Whalley (2012) predicted that bilateral trade retaliation on tariff only would harm US and benefit China, but Rosyadi and Widodo (2017) predicted tariff war would hurt both of them because of welfare loss.

Imposing of China coal import tariff against US is possible not only having an impact on welfare, but also on carbon dioxide (CO_2) emissions because of strong correlation between coal and CO_2 emissions. China Power (2018) shows that since 2004 China has had the world's largest carbon footprint and was responsible for 27.6 percent of global CO_2 emissions in 2017 which about 70 percent of China's CO_2 emissions results from coal. Anderson and McKibbin (2000) found that subsidy and protectionism would improve CO_2 emissions and removal both of them would impact on greenhouse gas abatement. Limited research on the impacts of coal import tariff on CO_2 emissions motivates this paper to investigate the impacts.

In this paper, I try examining the impacts of China coal import tariff not only on global economy, but also on CO_2 emissions. Using Global Trade Analysis Project Environmental (GTAP-E) model, I find evidence of trade deflection phenomena which China coal import tariff leads to decline in US coal export to China and increase in US export to its third trading partners. Then, it also is found evidence of trade depression which US reduces import for similar product from its trading partners. The second finding is tariff war between US-China is found to generate a decline in welfare not only both of them, but also impact on their trading partners. Indonesia and Australia seem gainers from this bilateral tariff war, but India will has a welfare loss. Futhermore, skilled and unskilled labor will decline in coal's industry of US and increase in China. Finally, based on overall evidences is concluded that China coal import tariff is not good policy because not only the global economy, the environment will also be disadvantaged by increasing CO_2.

The rest of this paper is structured as follows. Section 2 presents several previous studies. Section 3 describes the data, model, and scenario used in this study. Then, results and discussion will be elaborated in Section 4. Finally, Section 5 concludes.

2. Literature Review

Trade war between US and China has been observed by a number of previous researchers, such as Rosyadi and Widodo (2017), Chandra (2016), Chandra and Long (2013), and Dong and Whalley (2012). A large of previous literature tended to focus on the impact of US trade barrier against China using import tariff, temporary trade barriers (TTBs), and anti-dumping (AD). Rosyadi and Widodo (2017) found that US import tariff led to a decrease in GDP and welfare for US and China. However, different finding was generated by Dong and Whalley (2012) who found that US-China bilateral trade retaliation caused an increase in China's welfare and decrease in US' welfare. Tariff war was beneficial to China because it would reduce the trade surplus and then improve China's welfare, but it was not a good policy for the US (Dong and Whalley, 2012).

Impact of import tariff is not only observed for US-China, but also for the other countries. Mahadevan et al. (2017) used a dynamic computable general equilibrium model to examine the impact of protectionism (import tariff and mineral export taxes) in Indonesia. They found that protectionism lead to a fall in GDP growth caused by substantial decline in real household consumption expenditure. Moreover, unilateral protectionism would enhance welfare gains in the short run, but in the long run the gains would dissapear and the country would be worse off (Chauvin and Ramos, 2013).

Using a standard computable general equilibrium model, Elsheikh et al. (2015) proved that improving of wheat import tariff in Sudan had negative impact on its imports, encouraged its domestic production for self-sufficiency with less efficiency, and reduced GDP. Negative impact of trade barrier on import also was found by Staiger and Wolak (1994). They used data in the United States over the period 1980-1985 and found that imposed AD led to a reduction in import flow.

In addition to decline in import, trade restriction was also deflect exports flows from countries imposed by tariff to third country market called "trade deflection" (Rosyadi and Widodo, 2017; Chandra, 2016; Dong and Whalley, 2012; Bown and Crowley, 2007; Prusa, 2001). Rosyadi and Widodo (2017) predicted steep decline in bilateral trade between the two countries and increasing export towards their third trading partners because of import tariff. The growth of Chinese exports to other countries increased as US trade barriers was imposed to

China (Chandra, 2016). Prusa (2001) indicated that countries were targeted with the US AD duty had 30-50% decline in imports, but about one-third of the decrease was substituted by an increase in imports from non-named countries.

Dong and Whalley (2012) used a conventional Armington trade model with five regions, the US, China, EU, Japan, and the Rest of the World to analyze potential consequences of US-China bilateral retaliation. They suggested as the bilateral tariff rates are very high, EU and Japan would seem gainers from preferential access to US and Chinese markets. Similarly, imposition of a US AD duty led to a 5-7% average increase in Japanese exports to a non-US trading partner (Bown and Crowley, 2007). Trade deflection improved exports to the existing third country markets and decreased to newer and more volatile markets (Chandra, 2016).

Actually, not only trade deflection, Bown and Crowley (2007) also found trade depression phenomena. As the output produced by firms in country i could not be sold in the US, but was sold domestically, they suggested it crowded out country i's imports of the same product from Japan. They indicated an average 5-19% decline in Japanese exports to the third country in the same product category. On the other hand, Chandra (2016) did not find any evidence of trade depression.

Futhermore, trade restriction was indicated to impact productivity (Chandra and Long, 2013; Li and Whalley, 2015). Chandra and Long (2013) showed that US AD duties led to a substantial decrease in the productivity of Chinese exporting firms. They evidenced less benefit from economy of scale caused AD lowered output level and thus reduced firms' productvity (Chandra and Long, 2013). They also concluded firms that had higher initial export intensity before the imposition of the AD duty were most affected for these effects, while new exporters would have positive impacts..

Otherwise, using dynamic system GMM estimator and industrial panel data, Li and Whalley (2015) found that AD actions by developed and developing countries improved labour productivity. They argued that a Chinese industry or the firm may reach in various ways as faced with an AD measures; refocusing production on domestic markets, increased exports to other countries, producing something else, fighting the action, or close down production an exit the market. Moreover, they suggested improvement of labour productivity were due to firms decreased their prices and profits, reduced employment to lower costs, but try to maintain exports and output as faced AD, so as negative impact on employees larger than on output.

Most of the above papers examine impact of trade restriction on global economy, none of them explore impact on CO_2 emissions. In fact, trade is mechanism to move goods and service produced in one place to be consumed in another place (Ekins et al., 1994). If export commodities are produced in more non-environmentally friendly way than commodities destined for domestic consumption, then producing accommodate for trade may increase environmental damage (DeBellevue et al., 1994; RØpke, 1994 in Ekins et al., 1994). On the other hand, the proponents of free trade argues that free trade protects the environment through economic growth that will increases the demand for environmental protection and provides the resources necessary for it (GATT, 1992 in Ekins et al., 1994).

Impact of trade barrier on emissions has been tried examining by Anderson and McKibbin (2000). Anderson and McKibbin (2000) used a simple theoretical partial equilibrium approach and the turn to some empirical results (using G-Cubed) to investigate impact of trade barriers and reducing coal subsidies on greenhouse gas abatement. They observed that with the help of coal trade barriers, several industrial countries applied coal mining subsidies and many developing and former socialist countries applied coal burning subsidies, which coal mining and coal burning are pollute. They found that removed distortions to coal markets in developing and transition economies and removed production subsidies in the OECD could potentially reduce global emissions of carbon dioxide.

Emission reduction could also be done through coal consumption restrictions, such as found by Riker (2012) and Barbe (2017). Riker (2012) argued countries would have abundant coal production capacity if reduce their coal consumption. The abundant coal production capacity would impact on domestic consumption, export, and then CO_2 emissions. Therefore, Riker (2012) tried analyzing impact of restrictions coal consumption in the US and several other large countries on global coal consumption, trade, and industry employment. Using an econometric model to annual data panel that include 53 countries period 1999-2008, they found a decrease in CO_2 emissions was due to coal consumption restriction decreased US consumption. They also found a decline in US consumption caused increase in US coal exports, and thus increase in coal consumption in countries that did not participate. Futhermore, the coal consumption restriction would reduce US coal industry employment.

The similar finding found by Barbe (2017) who used a modified version of the GTAP-E model to stimulate the impact of US coal consumption restrictions. He argued that coal consumption restriction in one country would incentive the export of coal to non-abating foreign countries and improve coal consuming industries to move their production to these countries. Although they found a negligible effect on foreign emissions, but restriction on coal consumption in the US had a substantial effect on foreign welfare.

3. Methodology

3.1. Database

The GTAP-E model and version 9 of the GTAP database are implemented to simulate the impacts of China coal import tariff. The benchmark year used in database version 9 is 2011 including 140 regions, 57 sectors, and 8 factors of production (Aguiar et al., 2016). Moreover, bilateral trade in goods and services, intermediate inputs among sectors, and taxes and subsidies imposed by governments are included in database (Aguiar et al., 2016).

3.2. Model

The GTAP model is a multi-region multi-sector comparative static computable general equilibrium (CGE) model of the world economy (Barbe, 2017). Established in 1992, GTAP presented conducting quantitative analyses of international economic issues in an economy wide framework (Hertel, 1997).

Futhermore, the GTAP-E model is the approach implemented as an extended version of the GTAP that associates carbon emissions from the combustion of fossil fuels and a mechanism to trade these emissions internationally (Burniaux and Truong, 2002).

This implementation of GTAP-E was aggregated to 8 sectors. Coal, oil, electricity, and petroleum and coal products were mapped into 1-to-1 mapping, while the other were mapped into groups, such as natural gas extraction, energy intensive industries, etc (see Appendix for details). To see trade deflection phenomena, the countries were mapped into 1-to-1 mapping for country with top suppliers coal import into China and top destination of US coal exports, such as Australia, Indonesia, United States, Mongolia, etc (see Appendix for details). Then, the rest were mapped into some groups, such as Oceania, East Asia, Southeast Asia, South Asia, North America, Latin America, European Union 28, Middle East and North Africa, Sub-Saharan Africa, and rest of world. Finally, factors of production were mapped into some category, such as land, skilled labor, unskilled labor, capital, and natural resources (see Appendix for details).

After agggregation, the next step was simulation to get final solution. Both GTAP-E database and GTAP-E model were run using RunGTAP 3.6.9.0 and GEMPACK software. To provide maximum result accuracy, *Gragg's* 4-6-8 steps solution method with automatic accuracy was used (Horridge, 2001 in Rosyadi and Widodo, 2017).

3.3. Scenario

Before conducting simulation, the scenario must be determined first. The chosen scenario is China's decision to impose 25 percent import tariff on 333 goods from United States, one of the commodities is coal. This was done in retaliation for the action previously taken by United States. With scenario focus on coal import tariff, the model will be run to investigate the impacts on global economy and CO_2 emissions.

4. Results and Discussions

China coal import tariff has impact not only on US-China bilateral trade, but also on global trade. The impact on global trade is summarized in Table 1. The result implies that with imposing China import tariff to US, bilateral trade between US-China leads to a 73.9% decline in US export to China and China import from US. The decrease in US export causes US has a coal stock surplus and therefore US has to divert this excess stock to US' third trading partners. This phenomena is called trade diversion. This finding is in line with Rosyadi and Widodo (2017), Chandra (2016), Dong and Whalley (2012), Bown and Crowley (2007), and Prusa (2001).

Similar with Bown and Crowley (2007), Table 1 also shows phenomena called trade depression. There is a coal stock surplus not only makes US has to deflect their trade, but also sells the surplus domestically. Hence, US has to reduce its import for similar product. However, this phenomena is not supported by Chandra (2016).

Table 1. Coal Export and Import (in percentage change)

Region	China Export	US Export	China Import	US Import
China	1.104	-73.924	1.104	-0.155
US	-0.155	0.178	-73.924	0.178
Australia	-0.032	0.285	1.122	-0.147
Indonesia	0.072	0.406	1.016	-0.238
Russia	-0.138	0.182	1.153	-0.119
Mongolia	0.272	0.607	0.364	-0.978
Canada	-0.171	0.140	1.151	-0.118
Korea	-0.004	0.305	1.178	-0.092
New Zealand	-0.014	0.327	1.120	-0.155
Vietnam	0.034	0.371	1.055	-0.227
Malaysia	0.036	0.369	1.162	-0.103
Iran	-0.053	0.289	1.077	-0.191
Kyrgyzstan	-0.087	0.256	1.190	-0.079
Laos	0.014	0.358	1.150	-0.119
Germany	-0.136	0.193	1.197	-0.073
UK	-0.085	0.244	1.191	-0.079
India	-0.007	0.301	1.180	-0.090
Netherlands	-0.065	0.260	1.194	-0.075
Japan	-0.008	0.299	1.176	-0.094
Brazil	-0.140	0.179	1.198	-0.072
Oceania	-0.022	0.288	1.181	-0.088
EastAsia	0.037	0.364	0.968	-0.323
SEAsia	0.053	0.370	1.137	-0.132
SouthAsia	-0.013	0.330	1.176	-0.093
NAmerica	-0.097	0.219	1.195	-0.074
LatinAmerica	-0.096	0.220	1.187	-0.082
EU 28	-0.082	0.241	1.191	-0.078
MENA	-0.117	0.202	1.194	-0.076
SSA	-0.046	0.273	1.146	-0.133
Rest of World	-0.110	0.222	1.193	-0.077

Source: GTAP-E model simulation output (2018), processed

Futhermore, this study also examines impact import tariff on welfare. Based on Table 2 is noted that trade barrier between US-China only makes both of them lose their welfare, supported by Rosyadi and Widodo's finding (2017). Trade barrier leads to a US $ 43.98 million decrease in China's welfare and US $ 111.02 million decrease in US' welfare. Even though causes welfare loss, actually China coal import tariff generates welfare gain for its third trading partners, such as Indonesia (US $ 25.43 million increase in welfare) and Australia (US $ 17.04 million increase in welfare). Through World's Top Exports site, Workman (2018) shows that Australia and Indonesia are the top coal suppliers to China with import value of US $ 9.8 billion (Australia) and $ 2.5 billion (Indonesia). On the other hand, the top destination of US coal export with shares of total coal export in 2017 of 11.8% (US Energy Information Administration, 2018), India gets welfare loss of US $ 4.6 million.

Table 2. Equivalent Variation (in $ US million)

Region	EV
China	-43.979
US	-111.023
Australia	17.042
Indonesia	25.433
Russia	2.749
Mongolia	9.015
Canada	6.607
Korea	-2.258
New Zealand	0.123
Vietnam	2.970
Malaysia	-0.585
Iran	0.399
Kyrgyzstan	-0.032
Laos	0.008
Germany	4.033
UK	0.831
India	-4.605
Netherlands	0.589
Japan	-3.070
Brazil	2.936
Oceania	-0.110
EastAsia	0.373
SEAsia	-1.008
SouthAsia	-0.734
NAmerica	2.015
LatinAmerica	3.465
EU 28	2.863
MENA	5.253
SSA	2.969
Rest of World	2.378

Source: GTAP-E model simulation output (2018), processed

As Dong and Whalley (2012), this result suggests that bilateral trade retaliation on tariff will harm US. Not only gets higher welfare loss, US also will lose coal's industry labor. Table 3 shows US' skilled and unskilled labor of coal's industry will decrease by 0.676%. Otherwise, China's skilled labor of coal's industry will increase by 0.195 % and unskilled labor increase by 0.189%.

Table 3. Demand for Coal's Industry Labor (in percentage change)

Region	Skilled Labor	Unskilled Labor
China	0.195	0.189
US	-0.676	-0.676

Source: GTAP-E model simulation output (2018), processed

Unlike the impacts on the global economy, the impact China coal import tariff on carbon dioxide emissions is less obvious (Table 4). Although only small percentage, import tariff leads to an 0.033% increase in China's CO_2 and 0.007% increase in US' CO_2. A rise of CO_2 is in accordance with finding from Anderson and McKibbin (2000) who found that government distortions (subsidies and import tariff) to the world's coal market increased global emissions of carbon dioxide.

5. Conclusion

Based on the results of this paper it can be concluded that China coal import tariff againts US is not a good policy. It is because not only detrimental to the global economy, but also to the environment. China coal import tariff leads to decline in US and China's welfare. US will get more hurt because of a decline in labor while China will experience an increase in labor. Then, imposing import tariff will also impact on US and China's trading partners. Through trade deflection and trade depression phenomena, Indonesia and Australia will has welfare gain, but India will has welfare loss. The worst side is US and China will have an increase in carbon dioxide emissions due to this policy.

Table 4. Carbon Dioxide Emissions (in percentage change)

Region	CO_2
China	0.033
US	0.007
Australia	-0.001
Indonesia	-0.009
Russia	-0.000
Mongolia	0.009
Canada	-0.001
Korea	-0.003
New Zealand	-0.001
Vietnam	-0.010
Malaysia	-0.003
Iran	0.000
Kyrgyzstan	-0.000
Laos	0.001
Germany	0.001
UK	-0.000
India	0.006
Netherlands	-0.000
Japan	-0.002
Brazil	0.000
Oceania	0.000
EastAsia	-0.009
SEAsia	-0.002
SouthAsia	-0.001
NAmerica	0.000
LatinAmerica	0.000
EU 28	-0.000
MENA	0.000
SSA	-0.003
Rest of World	0.000

Source: GTAP-E model simulation output (2018), processed

However, this study has some limitations. First, the benchmark year of database used in this model based on 2011. It can lead the biased results which trade deflection and depression cannot be drawn obviously: we do not know who is the gainers and the losers. Second, China coal import tariff is not the right policy if it is intended to reduce coal consumption and is expected to reduce carbon dioxide emissions. If the country wants to reduce carbon dioxide emissions, the right policy is through coal consumption restrictions, as has been done Barbe (2017). Futhermore, the country can remove the import tariff with an optimal consumption tax to get optimal carbon dioxide emissions reduction, as suggested by Anderson and McKibbin (2000).

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Appendix

Regional Aggregation Mapping

Regions	Members
China	China
Australia	Australia
Indonesia	Indonesia
Russia	Russian Federation
Mongolia	Mongolia
Canada	Canada
US	US
Korea	Korea
NewZealand	NewZealand
Vietnam	Vietnam
Malaysia	Malaysia
Iran	Iran
Kyrgyzstan	Kyrgyzstan
Laos	Laos
Germany	Germany
UK	UK
India	India
Netherlands	Netherlands
Japan	Japan
Brazil	Brazil
Oceania	Rest of Oceania
EastAsia	Hong Kong, Taiwan, Rest of East Asia
SEAsia	Brunei Darassalam, Cambodia, Philippines, Singapore, Thailand, Rest of Southeast Asia
SouthAsia	Bangladesh, Nepal, Pakistan, Sri Lanka, Rest of South Asia
NAmerica	Mexico, Rest of North America
LatinAmer	Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago, Caribbean
EU_28	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Bulgaria, Croatia, Romania
MENA	Bahrain, Israel, Jordhan, Kuwait, Oman, Qatar, Saudi Arabia, Turkey, United Arab Emirates, Rest of Western Asia, Egypt, Morocco, Tunisia, Rest of North Africa
SSA	Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambiwue, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, South Africa, Rest of South African Customs
Restofworld	Switxerland, Norway, Rest of EFTA, Albania, Belarus, Ukraine, Rest of Eastern Europe, Rest of Europe, Kazakhstan, Rest of Former Soviet Union, Armenia, Azerbaijan, Georgia, Rest of the World

Source: Author's specification from GTAP 9 Database

Sector Aggregation Mapping

Aggregation Name	**Group Description**	**GTAP Code**	**Disaggregated Sectors**
Coal	Coal mining	coa	Coal
Oil	Crude oil	oil	Oil
Oil_pcts	Refined oil products	p_c	Petroleum, coal products
Gas	Natural gas extraction	gas gdt	Gas Gas manufacture, distribution
Electricity	Electricity	ely	Electricity
En_Int_ind	Energy intensive industries	omn crp nmm i_s nfm	Minerals nec Chemical, rubber, plastic prods Mineral products nec Ferrous metals Metals nec
Agr	Primary agriculture, forestry, and fishing	pdr wht gro v_f osd c_b pfb ocr ctl oap rmk wol frs fsh	Paddy rice Wheat Cereal grains nec Vegetables, fruits, nuts Oil seeds Sugar cane, sugar beet Plant-based fibers Crops nec Cattle, sheep, goats, horses Animal products nec Raw milk Wool, silk-worm cocoons Forestry Fishing
Oth_ind_ser	Other industries and other services sector	cmt omt vol mil pcr sgr ofd b_t tex wap lea lum ppp fmp mvh otn ele ome omf wtr cns trd otp wtp atp cmn	Meat: cattle, sheep, goats, horse Meat products nec Vegeable oils and fats Dairy products Processed rice Sugar Food products nec Beverages and tobacco products Textiles Wearin apparel Leather products Wood products Paper products, publishing Metal products Motor vehicles and parts Transport equipment nec Electronic equipment Machinery and equipment nec Manufactures nec Water Construction Trade Transport nec Sea transport Air transport Communication

	ofi	Financial services nec
	isr	Insurance
	obs	Business services nec
	ros	Recreation and other services
	osg	PubAdmin/Defence/Health/Education
	dwe	Dwellings

Source: Author's specification from GTAP 9 Database

Factors of Production Aggregation Mapping

Factor of Production	**Aggregation Group**	**Factor Mobility**
Land	"Land"	Sluggish (ETRAE = -1)
Technicians, Associates, Professionals Officials and Managers	Skilled Labor "SkLabor"	Mobile
Agricultural and Unskilled Clerks Service/ Shop Workers	Unskilled Labor "UnSkLabor"	Mobile
Capital	"Capital"	Sluggish (ETRAE = -1)
Natural Resources	Natural Resources "Natres"	Sluggish (ETRAE = -0.001)

Source: Author's specification from GTAP 9 Database