The impact of antidumping on value-added generated by trade: A case study on the PV products trade dispute between the EU and China

Kailan Tian, Cuihong Yang

Abstract: With China's deepening engagement in global trade, there are more and more antidumping(AD) investigations and measures targeting at China's exported goods. China also launched more AD investigations into imported goods since its first case in 1997. However, trade remedies may generate lose-lose consequences, even cause negative effects on domestic economy. AD investigation certainly will restrict the export of the targeted country, but it may also make the AD sponsor suffer loss since the manufacturing country may import raw materials and other relevant products as intermediate input from the AD user when producing a product. Furthermore, AD investigation may affect all the countries which are on the chain of production. This paper aims at studying bilateral effect of antidumping in terms of domestic value added generated by exports through case study. We choose a representative case: photovoltaic products trade dispute between the EU, U.S. and China. We use monthly export data of photovoltaic products from China Customs over the 2007-2013 period. Then we establish econometrical models to estimate the impact of AD investigation on trade value. Finally, national input-output models are used for estimating the change of value-added in trade. Considering the high share of processing trade in China's trade pattern, we use the DPN model, where the processing trade is separated from the domestic production, to study the value-added in China's exports. Our preliminary results show that AD cause the value of China's photovoltaic export fall by 30 to 40 percent and 20.35 percent loss of China's value-added. We also point out the decrease of Chinese PV products export certainly will reduce imported intermediate input of related materials and products. Whereas quite a part of these intermediate input come from the AD sponsor. Thus, the AD users may not only suffer tremendous welfare loss, but also reduction of relevant products export to the targeted country.

Keywords: Antidumping; Photovoltaic products; DPN model; Value-added

1. Introduction

Despite the increasing prosperity of international trade due to rounds of tariff reductions and other liberalization commitments, we have witnessed the increasing use of trade protection policies[1][2][3]. Antidumping measures are perhaps the most widely used policies. Although most economists view antidumping(AD) as economically baseless, governments around the world have resorted to AD policies to protect their domestic relevant industries. While it is certainly not the only tool of protectionism, antidumping is an easy-to-access one. It is also increasingly one of the few WTO-consistent instruments of protection that remains available to policymakers as more and more countries bind their import tariffs under the WTO and take on other liberalization commitments. The widespread use of AD measures has spurred economists to study its use and consequences. There will be many insights to be gained from examining its use. An additional benefit to study antidumping is that it is a measurable and relatively transparent policy whose use has spread to many developed and developing countries.

Existing research generally focuses on the impact of AD investigations and measures on protected firms and industries. Konings *et al.*[4] estimated the effect of antidumping protection on the productivity of domestic import-competing firms. Their results revealed that domestic firms with relatively low initial productivity-laggard firms-have productivity gains during protection, while firms with high initial productivity-frontier firms-experience productivity losses during protection. Pierce *et al.*[5][6]showed that increases in prices and markups artificially inflate the effect of antidumping duties on revenue productivity, while physical productivity actually falls. Moreover, antidumping duties allow low-productivity plants to continue producing protected products, slowing the reallocation of resources from less productive to more productive uses. There are also some researchers caring about the corresponding impacts of AD measures on affected foreign exporters. A few papers look at how antidumping duties affect foreign exporters' pricing behavior[7], export-destination diversification[8][9] and Foreign Direct Investment(FDI) strategies for serving foreign markets[10]. Except the inhibitory effects of AD measures, diversion effects, revenge effects and welfare costs also attracted many researchers' attention. Gallaway *et al.*[11] present evidence from a study of the cumulative effects of U.S. imposed antidumping that it was the second most costly trade policy program in terms of lost U.S. economic welfare in 1993 at $3 billion, trailing only the Multi-Fiber Arrangement. Thus, despite any given antidumping measure only covering a handful of imported products and the fact that imposed measures are infrequently revoked once implemented, the cumulative impact of the policy can be substantial for lost economic welfare.

Different from all these existing studies, this paper not only focus on the effect of AD investigations on trade value, but also the change of value-added induced by exports change. AD investigation certainly will restrict the export of the targeted country, but it may also make the AD sponsor suffer loss since the manufacturing country may import raw materials and other related products as intermediate input from the AD user when producing a product. The export reduction of the product under investigation will make the yield fall and the decrease of intermediate input follows. Thus, the AD sponsor suffers reduction of export of related raw materials and other products. Furthermore, with the growing international fragmentation of production, the production process for products has been separated into different steps that are performed in different countries. The final exporter of a product may just play a role of intermediate processing. The fall in yield of this product would affect the value-added of all countries which are on the whole chain of production since the value-added are shared by many countries and regions instead of the final exporters. It is impossible for us to research these deep-seated influence if we just focus on trade volume. Therefore, it is really important to study the effect of AD investigations on bilateral trade from the perspective of value-added.

On the other hand, current international trade statistics just record the volume and value of exports and imports. The rule of origin in current trade statistics fails to describe the entire production process that can be separated and performed in different countries. This led to double-counting to varying degrees and distorted the actual imbalance in bilateral trade, and may also result in misjudgment about trade decisions or macroeconomic policies. This problem becomes even more serious for countries with large processing trade, such as China. Just as the former WTO Director-General Pascal Lamy said in Geneva on 6 June 2011, "*by focusing on gross values of exports and imports, traditional trade statistics give us a distorted picture of trade imbalances between countries. ... The picture would be different if we took account of how much DVA is embedded in these flows.*" Economists and economic policymakers are very concerned with value-added generated by trade and those trade policies that might affect the global value chain.

In this paper, We choose the U.S. and EU's antidumping investigations against China's photovoltaic products exports as our study cases. The United States and European Union initiated AD investigation against photovoltaic products originated in China separately in November, 2011 and September, 2012. According to export data from China Customs, China's photovoltaic products export value to America and European Union fell 30.53%, 46.54% over levels of a year ago in 2012 and 12.95%, 60.82% in 2013, separately. We use monthly export data of photovoltaic products from China Customs and establish time series models to analyse the effect of AD investigations on export volume. Then, in order to measure the change of value-added generated by trade reduction, we use China's non-competitive input-output table capturing processing trade.

Since China's accession to WTO, half of China's exports are contributed by processing trade, for which most of the raw materials and components are imported from other countries. China is responsible for processing and assembling these components and re-exporting the goods. As a result, the value-added of the processing trade is relatively low. Generally, China is at the low end of the global value chain and the economic benefits generated per unit of exports are far below those of developed countries and some developing countries. Therefore, it is really significant to capture processing trade when researching China's trade. As for our case, 32 percent of

China’s photovoltaic products exports to European markets are contributed by processing trade. Thus, this paper uses the 2010 non-competitive input-output table with 65 sectors capturing China’s processing trade(referred to as the DPN table), which was compiled by some researchers from Academy of Mathematics and Systems Science, Chinese Academy of Sciences(CAS) to measure the change of value-added. Moreover, we can measure the change of imported goods as intermediate input to draw some insights of the effect of AD investigations on bilateral trade.

The rest of the paper is organized as follows. Section 2 gives a brief summarization of historic foreign use of antidumping against China’s exporters and introduces the photovoltaic trade dispute. Detailed methods and empirical results are presented in Section 3. The paper discusses and concludes with Section 4.

2. Antidumping aganist China’s exports

2.1 Antidumping aganist China’s exports

Prior to China’s accession to the WTO in 2001, existing members were unconstrained by WTO rules for how to treat imports from China. It meant that a country could simply unilaterally raise tariff rates applied against imports from China prior to its 2001 accession without being in violation of any multilateral rules. Nevertheless, a number of countries chose to limit China’s exports by resorting to the most common form of of administered protection policies-antidumping. According to WTO AD data[13], an increasing share of the WTO members, including a number of developing countries, use AD investigations as import-restricting policies against China’s goods since China’s accession to WTO. Meanwhile, China itself has grown up to a major new user and initiate more investigations.

WTO AD data reveal that Chinese exports attracted 916 new AD investigations (22 percent of new investigations initiated by all WTO members) in the 1995 to 2012 period. Especially, the number of new cases maintained at a high level since 2001(shown in figure 1). In 2008 and 2009, there are 76 and 77 new cases(up to 40 percent of new cases initiated by all WTO members that year) against Chinese exports. The top seven users of AD against Chinese exports in the 1995 to 2012 period are India(154 cases), the United States(112 cases), the European Union(111 cases), Argentina(89 cases), Brazil(62 cases), Turkey(61 cases) and Australia(37 cases). Figure 1 also illustrates China’s growing use of antidumping since 1997, the year China implemented its antidumping law. Since 2001, the number of Chinese new requests for AD import restrictions has grown from the first three cases to between twenty and thirty per year in the 2002 to 2005 period. Then, it has fallen to a relatively low level in these recent years. The top four targeted countries are the United States(36 cases), Japan(34 cases), South Korea(32 cases) and the European Union(20 cases).

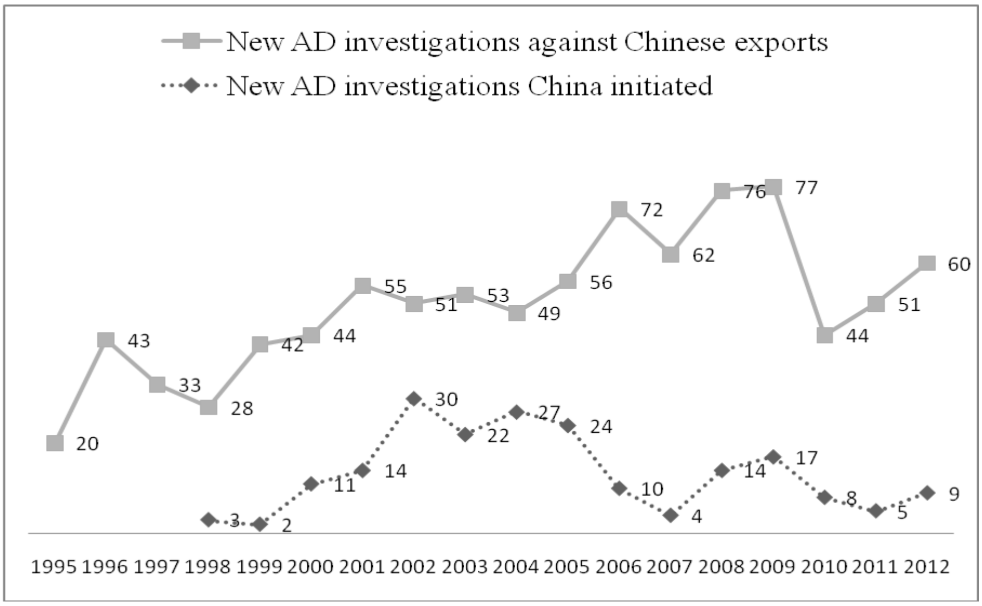

Figure 1 New AD investigations against Chinese exports and China initiated, 1995-2012

Next we switch perspectives from the users of antidumping to its primary target-exporting firms from China. According to WTO data for the use of AD by sector[13], a substantial share of the investigations targeting Chinese products have been in the base metals(25 percent of all the 916 cases) and industrial chemicals(20 percent) categories, which are the traditional sectoral users of antidumping across using countries. The third largest share of investigations target was machinery and electrical equipment(12 percent). Prior to 2004, Chinese textile and apparel exports were not yet a substantial target of developed-economy antidumping-for the most part because these user countries were able to limit imports through other trade policy instruments such as the WTO Agreement on Textiles and Clothing. The total investigations against Chinese textile and apparel exports are 78 cases(8.5 percent of all) in the 1995 to 2012 period.

2.2 Antidumping aganist China's photovoltaic exports

The photovoltaic(PV) domain mainly consists of the following ranges: solar cell, silicon wafer and related module. Chinese PV industry is a new developing and export-oriented industry. More than ninety-eight percent of solar cell originated in China were exported to foreign markets-mostly European and American markets. Chinese exports data showed that Chinese foreign trade value in PV products was nearly 35.8 billion dollars in 2011, more than seventy percent of which were induced by European markets. Therefore, it was reported as the largest scale of trade dispute-covering 22 billion euros when the European Union initiated antidumping and countervailing investigations against Chinese PV goods in 2012.

Next we briefly review the whole process of the PV exports disputes between China and the USA and EU. In response to requests of USA solar cell manufacturer *Solar World*, the Department of Commerce(DOC) determined to initiate AD investigations against Chinese crystalline PV cell in November, 2011. In the survey period, the DOC determines whether an imported product under investigation is sold in the U.S. at less than its “fair value”, while the International Trade Commission determines whether the imported product has materially injured the relevant U.S. domestic industries. The DOC made a preliminary determination-imposing 31.14%～249.96% dumping duties on May, 2012 and made a final determination-imposing 18.32%～249.96% dumping duties on involved Chinese PV enterprises on October, 2012.

On July, 2012, the European Union of PV manufacturers *EUProSun* issued a statement announcing that they had submited a petition against Chinese PV producers to the European Commission(EC) and the EC agreed to initiate AD investigations in September and announced to impose 11.8% temporary dumping duties on June, 2013. After that, Chinese Electromechanical chamber of Commerce conducted a series of negotiations with the EU and tried to avoid lose-lose consequences. Finally, China and the EU reached an friendly agreement on the lowest price of Chinese PV products on European markets on July, 2013 and the investigation was terminated.

3. Methods and results

3.1 Measure the reduction of Chinese PV products

According to Chinese Electromechanical chamber of Commerce, six kinds of PV products(classified at the Chinese HS-8 product category) were involved in AD investigations. Solar cell covered the largest proportion of them. In 2010, the proportion of solar batteries in PV products exported to the EU accounted for 83%.

Figure 2 and 3 show China’s photovoltaic products export value to America and European Union fell sharply after the trade disputes(in 2012 and 2013). In order to measure the reduction induced by AD investigations, we use monthly export data of PV products before the investigation and establish time series model(see Appendix A) to forecast the future export value of the next three months. Comparing the predicted value with the actual, we got the fall range-30~40 percent reduction induced by the investigation.

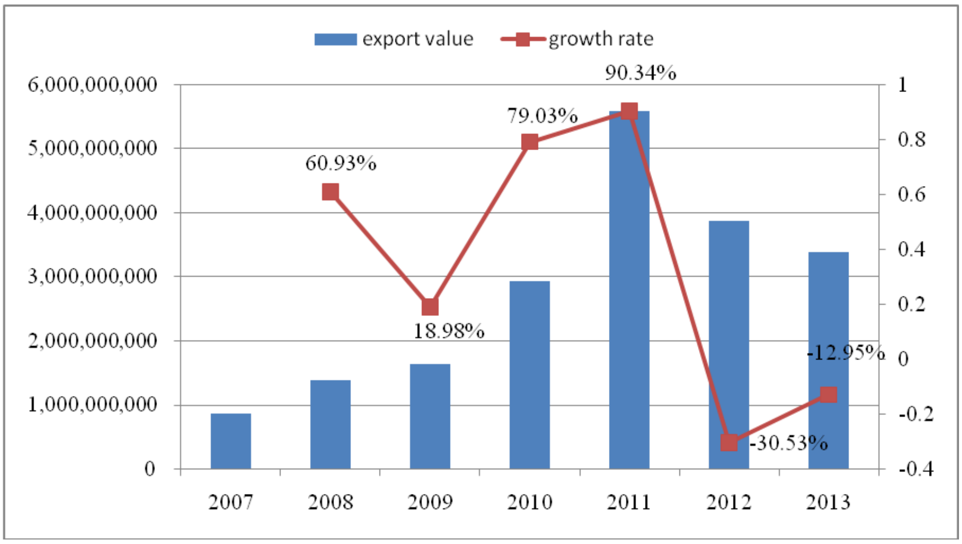

Figure 2. China’s PV products export to USA,2007-2013

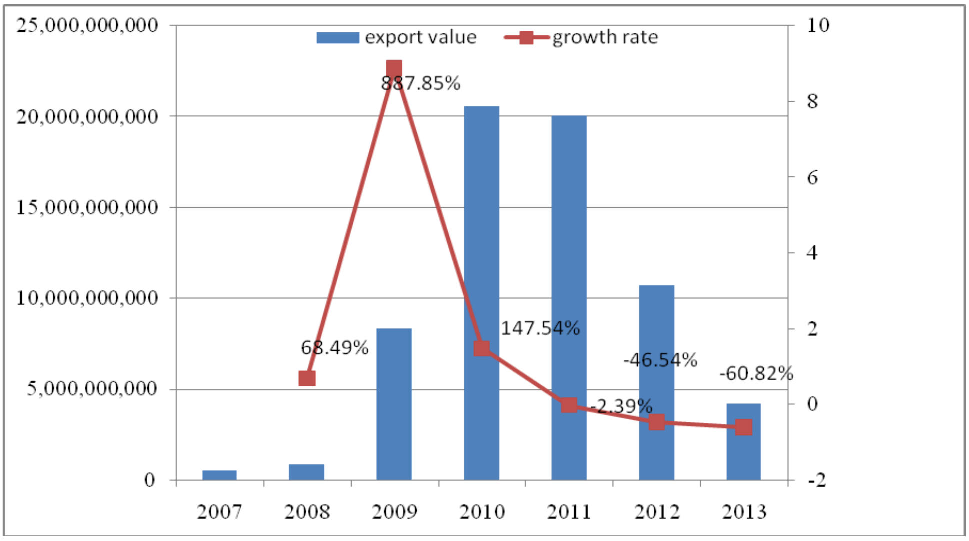

Figure 3. China's PV products export to EU,2007-2013

3.2 Measurement method for the change of value-added induced by the change of exports under the DPN model

The framework of the non-competitive input-output table capturing processing trade (also called the DPN model) is shown in Table 1. The total domestic production activity in China is divided into three parts in the DPN model shown in Table 1: D, the production for domestic use; P, the production for the exports of processing trade; and N, the exports of non-processing trade and others.

Table 1. Non-competitive Input-occupancy Output Table Capturing Processing Trade (DPN Table)

			Intermediate use			Final use					Total output or import
			D	P	N	Consumption	Gross capital formation	Export	Other capital	Total of final use	
Input	Intermediate input of domestic products	D	Z^{DD}	Z^{DP}	Z^{DN}	F^{DC}	F^{DI}	0		F^{D}	X^{D}
		P	0	0	0	0	0	F^{PE}		F^{P}	X^{P}
		N	Z^{ND}	Z^{NP}	Z^{NN}	F^{NC}	F^{NI}	F^{NE}		F^{N}	X^{N}
	Imported products intermediate input		Z^{MD}	Z^{MP}	Z^{MN}	F^{MC}	F^{MI}			F^{M}	X^{M}

	Total of intermediate input									
	Value-added	V^D	V^P	V^N						
	Total input	X^D	X^P	X^N						
Occupancies	Capital foreign capital	K^D	K^P	K^N						
	Labor	L^D	L^P	L^N						
	Resources land water									

Note: The superscripts D, P, and N denote the production for domestic use, production for the exports of processing trade and non-processing trade, and the production by foreign-invested enterprises for domestic demand (called the exports of non-processing trade and others for brevity), respectively. The superscript DD means the domestic products for domestic use; DP means the domestic products for the processing export; and DN means the domestic products for the exports of non-processing trade and other uses.

If we define the row vector of value-added as $v=[v^D\ v^P\ v^N]$, where v^D, v^P, and v^N represent the row vectors of value-added for production of D, P, and N, respectively. Then the row vector of value-added coefficients of D, P, and N can be written as $A_v = v(\hat{X})^{-1} = [A_v^D, A_v^P, A_v^N]$, and we can measure the domestic value-added generated by gross exports (i.e., the value-added by exports) as follows:

$$V^E = A_v X^E = A_v \bar{B} E \tag{1}$$

where $\bar{B} = (I-\bar{A})^{-1} = \begin{bmatrix} (I-A^{DD}) & -A^{DP} & -A^{DN} \\ 0 & I & 0 \\ -A^{ND} & -A^{NP} & (I-A^{NN}) \end{bmatrix}^{-1}$ is the extended Leontief inverse matrix. $E=\begin{bmatrix} 0 \\ F^{PE} \\ F^{NE} \end{bmatrix}$ is the column vector of exports. A^{DD}, A^{DP}, A^{DN}, A^{ND}, A^{NP} and A^{NN} represent the direct consume coefficient matrices and they are defined as $A^{DD}=[A_{ij}^{DD}]=[Z_{ij}^{DD}/X_j^D]$, $A^{DP}=[A_{ij}^{DP}]=[Z_{ij}^{DP}/X_j^P]$, $A^{DN}=[A_{ij}^{DN}]=[Z_{ij}^{DN}/X_j^N]$, $A^{ND}=[A_{ij}^{ND}]=[Z_{ij}^{ND}/X_j^D]$, $A^{NP}=[A_{ij}^{NP}]=[Z_{ij}^{NP}/X_j^P]$ and $A^{NN}=[A_{ij}^{NN}]=[Z_{ij}^{NN}/X_j^N]$.

F^{PE} is the column vector of the products of processing trade for the exports. F^{NE} represent the column vector of the products of N as exports.

After diagonalizing the vector of value-added coefficients, we can calculate the change of different sector's value-added induced by exports change as follows:

$$\Delta V = \begin{bmatrix} \hat{A}_v^D & 0 & 0 \\ 0 & \hat{A}_v^P & 0 \\ 0 & 0 & \hat{A}_v^N \end{bmatrix} (I - \bar{A})^{-1} \Delta E \tag{2}$$

where ΔE is the column vector of exports change and ^ means diagonalization.

Similarly, we can calculate the change of imported goods as follows:

$$\Delta M = \begin{bmatrix} A^{MD} & A^{MP} & A^{MN} \end{bmatrix} (I - \bar{A})^{-1} \Delta E \tag{3}$$

where ΔM is the vector of imported goods change. A^{MD}, A^{MP} and A^{MN} are defined as $A^{MD} = [A_{ij}^{MD}] = [Z_{ij}^{MD} / X_j^D]$, $A^{MP} = [A_{ij}^{MP}] = [Z_{ij}^{MP} / X_j^P]$ and $A^{MN} = [A_{ij}^{MN}] = [Z_{ij}^{MN} / X_j^N]$.

3.3 Results

When the research group compiled the 2010 DPN table with 65 sectors, PV products(mostly solar cell) were classified into the 37th sector-Other electric machinery and equipment. In 2010, China's PV products export value to the EU accounted for 42% of the export of the 37th sector. Therefore, EU's initiation of antidumping resulted in 16.8% reduction of the 37th sector's export(40% reduction of PV products mentioned above).

In 2010, the ratio of PV products processing and non-processing export value to the 37th sector's processing and non-processing export value are 31.10% and 45.12%, respectively. We assume the PV products are homogeneous no matter they are produced from processing or non-processing trade industries. So both the PV products processing and non-processing export fall by 40% as the PV total export. Then, we can calculate the decreasing amplitude of PV processing and non-processing export as 12.44% and 18.05%, separately. With these ratios and equation(1), our calculation show that the loss of value-added induced by the reduction of 1000 dollars PV products exports is 669 dollars and 40% reduction of PV products export lead to 20.35% reduction of value-added. Using equation(2), we can also get the top ten sectors affected most(shown in figure 4).

Figure 4 shows the 37th sector itself is the most affected one in the 65 sectors which produce for exports of non-processing trade and others(N part). The export reduction of PV products lead to 3.04% loss of its value-added. The following are some manufacturing industries which have tight consumption relationship with the 37th sector: Nonferrous metal smelting and pressing(0.19% loss), Electronic element and device(0.17% loss) etc. As for the P part, it is only the 37th sector into which PV products are classfied that suffer 1.85% loss because the production for the exports of processing trade require no input from other industries.

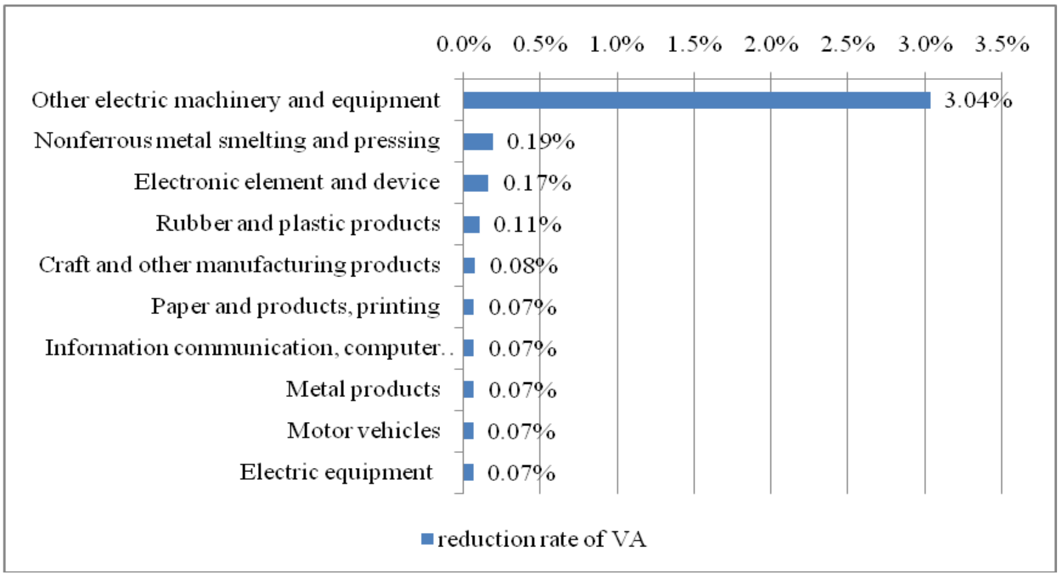

Figure 4. The top ten sectors affected most of value-added in N part

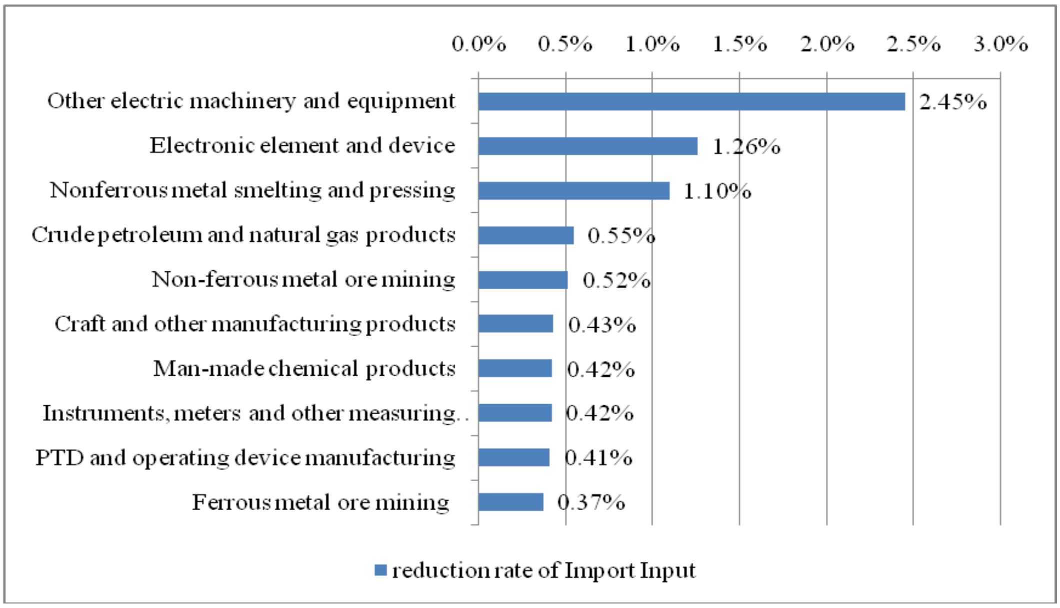

Figure 5. The top ten sectors affected most of import imput

The sharply decrease of Chinese PV products export certainly will reduce import of related intermediate material and products. DPN model can measure the reduction of imported products as intermediate input. Figure 5 shows intermediate input the 37th sector requires decrease 2.45% and Electronic element and device decline 1.26%. Imported input of other manufacturing industries also decrease at different degrees. Whereas quite a part of these intermediate material and products come from the AD sponsor-the EU. According to 2010 import data from China Customs, 10.98, 19.42 and 23.63 percent of the 37th , the 45th and the 35th sector's import come from the EU(shown in table 2), respectively. It is obvious that chinese reduction of intermediate input will generate the EU's loss of related raw materials and other products export to China.

Table 2. Import ratio from EU

IO Sector	Description	Import ratio from EU
37	Other electric machinery and equipment	10.98%
40	Electronic element and device	2.78%
26	Nonferrous metal smelting and pressing	7.76%
3	Crude petroleum and natural gas products	0.05%
5	Non-ferrous metal ore mining	2.75%
45	Craft and other manufacturing products (incl. scrap and waste)	19.42%
19	Man-made chemical products	9.51%
43	Instruments, meters and other measuring equipment	8.91%
35	PTD(power transmission and distribution) and operating device manufacturing	23.63%
4	Ferrous metal ore mining	0.25%

4. Discussion and conclusion

Antidumping investigations have become a popular tool enabling governments to protect their domestic firms and industries. Much insight has been gained from a large and growing literature on how effective antidumping are in restricting trade volume. An overlooked issue is how antidumping investigations affect the value-added, the understanding of which should help us gain more insight of the impact of such investigations.

In this paper, we choose the PV trade dispute between the EU and China as our study case. We use monthly export data of PV products from China Customs before and after the AD initiation to measure the impact of AD on trade value. We find that, on average, AD cause the value of China’s PV export fall by 30-40 percent. To identify the effects of AD on value-added, we use the 2010 non-competitive input-output table capturing processing trade and we find that 40% reduction of PV products result in 20.35% loss of China’s value-added.

Moreover, our findings point out the sharply decrease of Chinese PV products export certainly will reduce import of related intermediate material and products. Whereas quite a part of these intermediate material and products come from the AD sponsor. Therefore, the AD users may not only suffer tremendous welfare loss, but also reduction of related products export to the AD targeted country. Furthmore, the value-added in the sponsor country will also be affected. Lose-lose consequences will come up. At present, our research group are embedding China’s DPN table into the international input output table. After it is done, we can use it to measure the change of value-added induced by AD investigations both in the targeted country and the AD sponsor. We can also do deeper research on the effect of AD investigations on those countries which are on the whole chain of production.

References

[1] Prusa, Thomas, 2001. On the spread and impact of antidumping. Can. J. Econ. 34, 591–611.

[2] Zanardi, Maurizio, 2006. Antidumping: a problem in international trade. Eur. J. Polit. Econ.22, 591–617.

[3] Bown, Chad P., 2011. Taking stock of antidumping, safeguards and countervailing duties,1990–2009. World Econ. 34, 1955–1998.

[4] Konings, Jozef, Vandenbussche, Hylke, 2008. Heterogeneous responses of firms to trade protection. J. Int. Econ. 76, 371–383.

[5] Pierce, Justin R., 2011. Plant-level responses to antidumping duties: evidence from U.S. manufacturers. J. Int. Econ. 85, 222–233.

[6] Pierce, Justin R., Schott, Peter, 2012. The surprisingly swift decline of U.S. manufacturing employment. Working Paper.

[7] Blonigen, BruceA., Park, Jee-Hyeong, 2004. Dynamic pricing in the presence of antidumping policy: theory and evidence. Am. Econ. Rev. 94, 134–154.

[8] Bown, Chad P., Crowley, Meredith A., 2006. Policy externalities: how US antidumping affects Japanese exports to the EU. Eur. J. Polit. Econ. 22, 696–714.

[9] Bown, Chad P., Crowley, Meredith A., 2007. Trade deflection and trade depression. J. Int.Econ. 72, 176–201.

[10] Blonigen, Bruce A., 2002. Tariff-jumping antidumping duties. J. Int. Econ. 57, 31–49.

[11] Gallaway, Michael P., Blonigen, Bruce A., Flynn, Joseph E., 1999. Welfare costs of the U.S. antidumping and countervailing duty laws. J. Int. Econ. 49, 211–244.

[12] Zanaradi, Maurizio. 2004. Antidumping: What are the numbers to discuss at Doha? The World Economy 27 (3): 403–33.

[13] http://www.wto.org/english/tratop_e/adp_e/adp_e.htm

[15] Bown, Chad P., 2010. "Global Antidumping Database", The World Bank. available at http://econ.worldbank.org/ttbd/gad/.

[16] Chen, X., Cheng, L. K, Fung K C and Lau L J. The Estimation of Domestic Value-added and Employment Induced by Exports: An Application to Chinese Exports to the United States. Working Paper, Department of Economics, Stanford University, Stanford, California 94305, 2001.

[17] Lawrence J. Lau, Xikang Chen, Leonard K. Cheng, K. C. Fung, Jiansuo Pei, Yun-Wing Sung, Zhipeng Tang, Yanyan Xiong, Cuihong Yang and Kunfu Zhu (2006), Estimates of U. S.-China Trade Balances in Terms of Domestic Value-Added, Stanford Center for International Development, Working Paper No. 295.

[18] Yang, C. H., Dietzenbacher, E., Pei, J. S., Chen, X. K., The Bias in Measuring Vertical Specialization*[N]*, Working Paper in 17th International Input Output Conference, 2009.07.

[19] Duan Yu wan, Jiang Xumei, Wang Yujing, Chen Xikang, Yang Cuihong, The impact of Sino-EU Trade on Bilateral Economy and Employment, Journal of International Trade, 2012(4): 58-63.

[20] Lau, L. J., Chen Xikang, Yang Cuihong, Cheng, L. K.Fung, K. C., Sung, Y. W.,

Zhu Kunfu, Pei Jiansuo, Tang Zhipeng, The Non-competitive Input-occupancy-output Model and Application (J). Social Sciences in China, 2007(5): 91-103.
[21] Mu Zhirui, Yang Cuihong. Comparative Analysis on the Impact of Sino-Japan Trade on Bilateral Economies. Journal of Management Reviews, 2010,12.
[22] Zhu Kunfu, The Non-competitive Input-occupancy-output Model Theory and Application. Doctoral dissertation, Chinese Academy of Sciences, 2008.
[23] Zhu Kunfu, Tang Zhipeng, Pei Jiansuo, Chen Xikang, Yang Cuihong, Analysis of the Contribution of Exports to China's Economic Growth [J]. Journal of Management Review. 2007(9):42-45.

Appendix A: ARMA models to forecast the PV products export

Dependent Variable: TONGBI
Method: Least Squares
Date: 03/24/14 Time: 14:11
Sample (adjusted): 2007M10 2011M11
Included observations: 50 after adjustments
Convergence achieved after 15 iterations
MA Backcast: 2007M01 2007M09

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.325955	1.219992	1.086855	0.2830
AR(1)	0.740375	0.044042	16.81058	0.0000
AR(7)	-0.216829	0.040935	-5.296965	0.0000
AR(9)	0.167523	0.038481	4.353397	0.0001
MA(7)	0.647950	0.078046	8.302187	0.0000
MA(9)	-0.351787	0.079522	-4.423750	0.0001

R-squared	0.945798	Mean dependent var	3.532198
Adjusted R-squared	0.939639	S.D. dependent var	7.491233
S.E. of regression	1.840481	Akaike info criterion	4.170097
Sum squared resid	149.0442	Schwarz criterion	4.399540
Log likelihood	-98.25243	Hannan-Quinn criter.	4.257470
F-statistic	153.5567	Durbin-Watson stat	2.156962
Prob(F-statistic)	0.000000		

Notice: We use stationary year-on-year ratio rather than the actual export value to eliminate seasonal factors.