

## INTERNATIONAL TRADE IMPACT ON GLOBAL WARMTH IN TEXTILE AND CLOTHING INDUSTRY

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In the last decade we can observe changes in the fashion industry due to the rising demand of textile and clothing products in Europe. We investigate its sustainability implications by re-calculating carbon emissions and addressing each countries responsibility rather than current traditional way of calculating CO<sub>2</sub> emissions. A multi-regional input-output model is built to calculate carbon emissions embodied in trade in EU textile and clothing industry from 2000 to 2016. World Input-Output Database and other databases are used for the recounting of CO<sub>2</sub> emissions embodied in EU textile and clothing international trade. The results show that 1) Germany and United Kingdom were biggest EU CO<sub>2</sub> emission importers in 2000 and 2016 what makes them biggest contributors to global CO<sub>2</sub> pollution in textile and clothing industry in Europe. 2) India and China has big direct emission coefficients and perform under low energy efficiency levels compared to Turkey 3) Higher direct carbon emission coefficient result in a higher CO<sub>2</sub> imports. 4) Increasing textile and clothing products imports result in higher CO<sub>2</sub> emission imports. Therefore in order to reduce carbon emissions producing countries should invest in “low-carbon” industries and might regulate textile and clothing products imports.

*Keywords: international trade, carbon emissions, textile and clothing industry, globalization.*

### INTRODUCTION

Majority of developed countries have reported decreasing CO<sub>2</sub> emissions and officially fulfilling their emission reduction commitments. However after the use of a new highly detailed accounting system of emissions embodied in international trade we investigate this phenomenon called emissions leakage, and find that carbon emissions of developed countries in textile and clothing industry have increased, not decreased and the growth in global CO<sub>2</sub> emissions from 2000 to 2016 has remained strong. This happened because of the production shift from developed to developing countries in which carbon emission coefficients are much higher. The reduction of world trade quotas in textile and clothing products allowed the geographical shift of production and pollution.

As a result, despite the efforts of strong regulatory policies global air pollution have increased not decreased. If these policies do not include in the accounting embodied emissions in imports, global carbon emissions will increase no matter how strong national carbon emission targets will be. Using highly detailed global economy accounting system we were able to confirm earlier studies that pollution shifting is a growing problem. If we look to the traditional statistics and reports - from 2000 to 2016 carbon emissions in Europe have decreased while in Asia have more than doubled. Studies suggest that the decrease of CO<sub>2</sub> emissions in Europe was partially because of the growing imports from Asia.

Developing international trade, production and consumption is now separated. Hundreds of studies have been examining how international trade affects emissions in trade. These high level studies conclude that international trade has shifted pollution from developed to developing countries (Peters et al., 2011; Kanemoto, 2014). Many studies have estimated carbon emissions via trade by using input-output tables in order to properly reflect each country's responsibility. To estimate the CO<sub>2</sub> emissions via international trade we apply a multi-regional input-output model (Peters, G. P., 2011).

Some previous studies show that one of the cases, when due to international trade, pollution has shifted from developed to developing countries, is textile and clothing industry (Peters et al., 2011). Moreover, EU textile and clothing retailers refresh the product lifetimes more and more often with low price leading to increasing consumption (Francois et al., 2007; Morris and Barnes, 2008; Schor, 2005).

Most than half of European trade partners in textile and clothing products consisted of China (34%), Turkey (11%) and India (6,6%) in 2016. This leads to a conclusion that most global CO<sub>2</sub> embodied in European consumption comes from China, as well as Turkey and India. The EU trade analysis shows that EU textile and clothing products import increased from 5676 million USD in 2000 to 33344 million USD in 2016 in China. The major reason for this probably was the second stage of removal of trade quotas on world trade in textile and clothing in 2001. After 2001, EU textile and clothing import from China increased dramatically. This was driven by the increase of consumption. We can see that the

growth of import never stopped until 2008. After 2008 the EU import of textile and clothing products decreased from 30851 million USD to 37855 million USD. This probably was caused by recession which caused the fall of consumption in EU.

The aim of this study is to measure carbon emissions embodied in trade in EU textile and clothing industry.

Objectives:

1. Identify the main carbon emission trade partners in EU textile and clothing industry;
2. Calculate the carbon emission coefficients in China, India and Turkey for textile and clothing industry;
3. Estimation of EU textile and clothing industry carbon emissions import;
4. Identify the major carbon emission importers by country in EU textile and clothing industry.

## METHODOLOGY AND DATA

### *Mathematical form of carbon calculation input-output model*

The input-output method has been often employed to analyse environmental and economic issues and shows the relationship between industries and environmental pollution and is especially used on the trade-implicit carbon research (Xu et al. 2017). As Wiedmann (2009) explains the environmental impacts caused by consumption in one region can be traced to a specific regions production sector using the inter-regional supply chain. Multi-region input-output tables, has been usually applied to assess economic interdependence and the impacts embedded in economic activities such as energy use, greenhouse gas emissions (Peters and Hertwich, 2008), water use and land displacement (Han et al. 2017). Global multi-regional input-output tables capture world's economy through international and domestic trade networks of different countries (Mair et al. 2016).

The table contains data of inter-regional input-output tables covering 27 EU countries and 13 other big economies during 1995-2011, and the data of carbon emissions during 1995-2009. Since the environmental data tables of the WIOD only provides CO2 emission data until 2009, for the forecasting we calculated emissions data for later periods.

The structure of the input-output table in World Input Output Database can be obtained as Eq. (1), as the equilibrium relation between the horizontal rows. Assuming there are r regions (countries) and each region has n sectors. The balance of production in each region (country) is expressed as total output equals the output used in intermediate production plus output used in final consumption.

$$X^r = A^{rr} X^r + \sum_{s \neq r} A^{rs} X^s + Y^{rr} + \sum_{s \neq r} Y^{rs} \quad (1)$$

Where,  $X^r$  represents the column vector, which is the total amount of productions in country r;  $A^{rr}$  is a coefficient matrix of direct consumption, which shows domestic product amount of intermediate use in country r;  $A^{rs}$  is a cross-regional direct consumption coefficient matrix, and the inputs come from country r and the outputs from country s;  $Y^{rr}$  represents a column vector of final use demand for the domestic products in country r;  $Y^{rs}$  represents a column vector of products exported from country r to country s in final use part.

Account balance equation (1) can be transformed as bellow as Eq. (2) (Peters et al., 2011):

$$X^* = A^* X^* + Y^* \quad (2)$$

Eq. (2) can be rearranged into:

$$X^* = (I - A^*)^{-1} Y^* \quad (3) \text{Where}$$

The MRIO model let us analyse relationships between CO2 emissions, industry production and final demand. Total CO2 emissions to meet final demand Y, can be calculated as follows:

$$\theta_i^r = \frac{P_i^r}{X_i^r} \quad (4) \text{Here}$$

$$\lambda = \theta (I - A^*)^{-1} \quad (5)$$

After calculating total carbon emissions coefficient (Eq. 5) and multiplying it by the trade volume, the volume of traded CO2 emissions is received. The CO2 emissions embodied in exports and imports can be calculated as follows:

$$CE = c(I - A)^{-1} Y^{ex} \quad (6)$$

$$CI = \sum c^* (I - A^*)^{-1} Y^{im} \quad (7)$$

Where CE stands for the volume of carbon emissions embodied in exports, and CI stands for carbon emissions import.

## RESULTS

In this section, we use the multi-regional input-output model to calculate the emission coefficients of China, India and Turkey in textile and clothing industry and we recalculate the embodied carbon in trade in EU Textile and clothing industry from the world input-output table by country in 2000-2016.

### Recalculating carbon emissions embodied in trade of EU Textile and Clothing Industry

In this part multi-regional input-output model is used to measure carbon emissions embodied in trade in EU textile and clothing industry with 3 trade partners with larger volume – China, and India and Turkey which are the three countries with largest magnitude of the embodied carbon in trade in EU Textile and Clothing industry between 2000 and 2016. In 2000 the top countries with the highest emissions in trade were China (2548 kiloton), Turkey (1632 kiloton) and India (1299 kiloton). In 2016, the top three countries were China (5677 kiloton), India (1358 kiloton) and Turkey (2062 kiloton). The biggest growth of carbon emissions embodied in trade with EU was in China. Research input-output model show that major impact on this have been the increasing import of textiles and clothing products due to the increased demand and consumption.

In Figure 1, we can observe a growing trend of carbon emissions embodied in trade in China until 2008. Then during the crisis in 2008-2009 have dropped, and then from 2009 until 2010 rose again. From 2010 to 2016 we can observe an overall decrease trend which might be due to the increasing awareness of environmental policies.

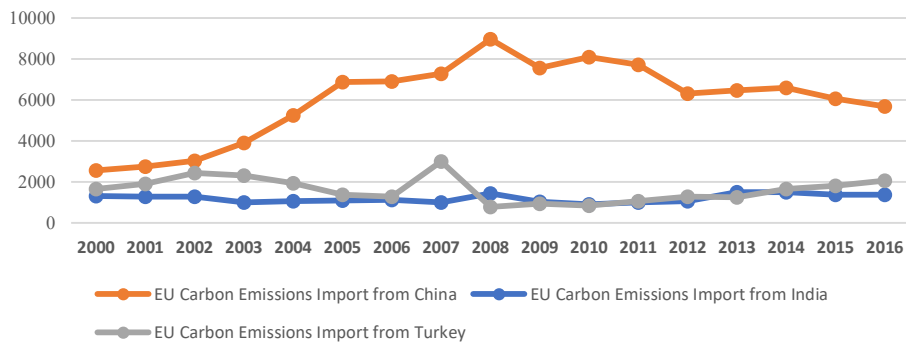


Figure 1. EU imported CO2 emissions from China, India and Turkey in textile and apparel industry in 2000-2016 (Unit: kilotons)

Besides a strong growth in international trade, the structure of international trade has changed as well. We can observe this from different emission intensities in different regions and the changes in international trade structure and volume, which indicate location regional shifts of emissions caused by production of textiles and clothing goods and the location of consumption.

**Direct CO2 emissions coefficient and total CO2 emissions coefficient**

Carbon emission coefficients are needed to calculate carbon emissions embodied in trade which we use for EU textile and clothing industry. In Figure 2 and Figure 3 direct CO2 emission coefficients and total carbon emission coefficients of China, Turkey and India from 2000 to 2016 are displayed. The direct carbon emission coefficients, which denote the CO2 emissions produced by intermediate inputs used in the production process, are shown in Figure 2, from which we can see that, India’s direct carbon emission coefficients were highest almost during all analysed period.

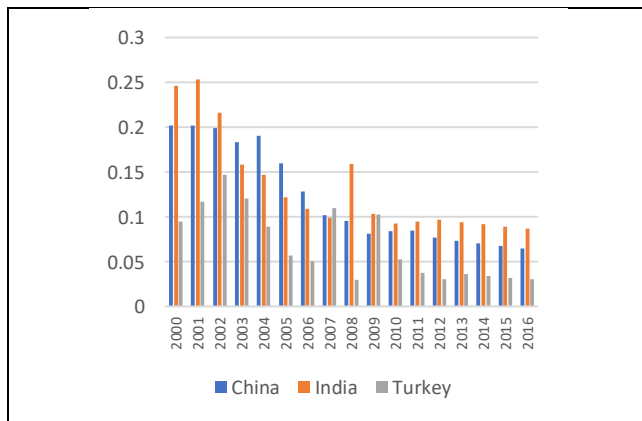


Figure 2. Direct carbon emission coefficient of China, India and Turkey in textile and apparel industry 2000-2016 (Unit: kilotons/millions of USD)

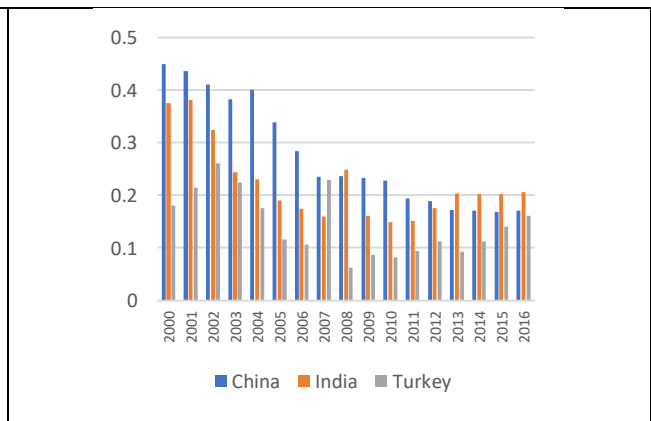


Figure 3. Total carbon emission coefficients of EU import from China, India and Turkey in textile and apparel industry 2000-2016 (Unit: kilotons/millions of USD)

It shows that in textile and clothing industry, from the 3 biggest EU trade partners, India’s textile and clothing industry is the most carbon-intensive industry with 0,245 kilotons/millions of USD in 2000 and 0,087 kilotons/millions of USD in 2016. We can see that China’s direct emission coefficients were also high compared to Turkey’s, which from 2003 to 2006 exceeded India’s, which indicates that both India as well as China has backward technology for production processes and perform under low energy efficiency levels.

We can see that even china’s direct carbon emission coefficient is lower that India’s in the analysed period, its total carbon emission coefficients are higher than India’s. In other words, China has lower direct and higher total emission

coefficients, and India has higher direct and lower total emission coefficients. In summary, the higher the carbon coefficient, the bigger amounts of carbon emissions within the production process.

**Analysis of trade implicit EU carbon emissions by country**

Firstly, we can see that the biggest carbon emissions importers and causers to the global CO2 are United Kingdom and Germany. During the analyzed period imported carbon emissions increased drastically from 2000 to 2016 in United Kingdom and Germany, as well as Italy, France and Spain, which contributed a significant amount of carbon emissions. EU imported 2548 kilotons of carbon emissions in 2000 and 5677 kilotons of carbon emissions in 2016 from China. Biggest contribution of carbon emissions in textile and clothing industry was caused by United Kingdom (561 kilotons), Germany (532 kilotons), France (374 kilotons) and Italy (289 kilotons) in 2000. In 2016 biggest contribution of carbon emissions in EU textile and clothing industry was caused by United Kingdom (1636 kilotons) and Germany (1021 kilotons).

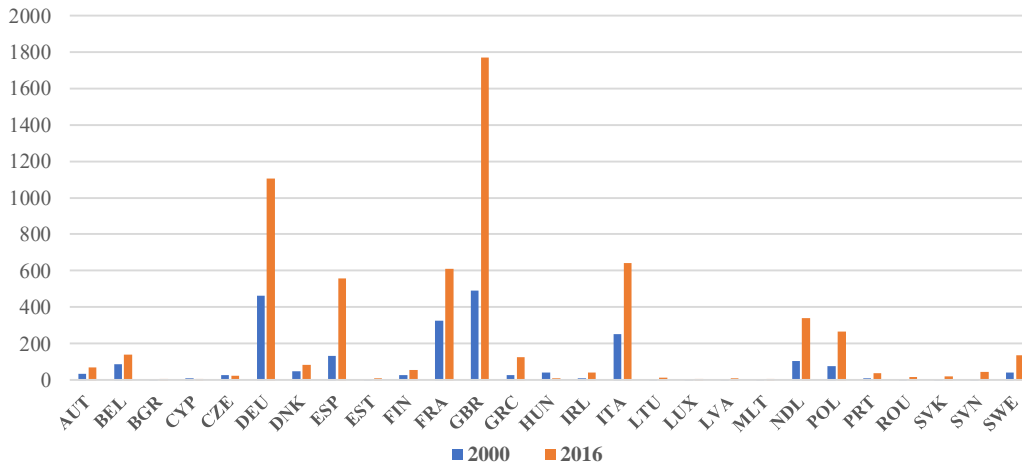


Figure 4. CO2 emissions import by country from China in textile and apparel industry in 2000 and 2016 (Unit: kilotons)

From figure 5 we can see EU imported emissions from India by country. We find out that the top importers and causers of global CO2 emissions in Europe in textile and clothing industry in 2000 and 2016 are United Kingdom and Germany. In 2000 EU imported 1299 kilotons of carbon emissions and 1358 kilotons of carbon emissions in 2016 from India. United Kingdom from India imported 347 kilotons of carbon emissions in 2000 and 413 kilotons of carbon emissions in 2016.

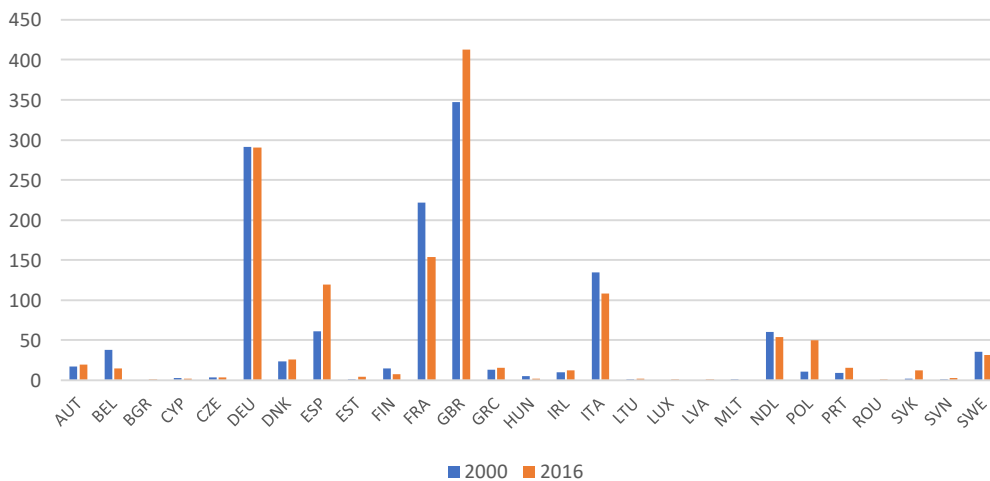


Figure 5. EU CO2 emissions import by country from India in textile and apparel industry in 2000 and 2016 (Unit: kilotons)

Differently than in India and China case, the top European countries to which Turkey exported most of its emissions was Germany with 792 kilotons of emissions in 2000 and 581 kilotons of emissions in 2016. Second significant carbon emissions causer was United Kingdom with 300 kilotons of emissions in 200 and 440 kilotons of emissions in 2016.

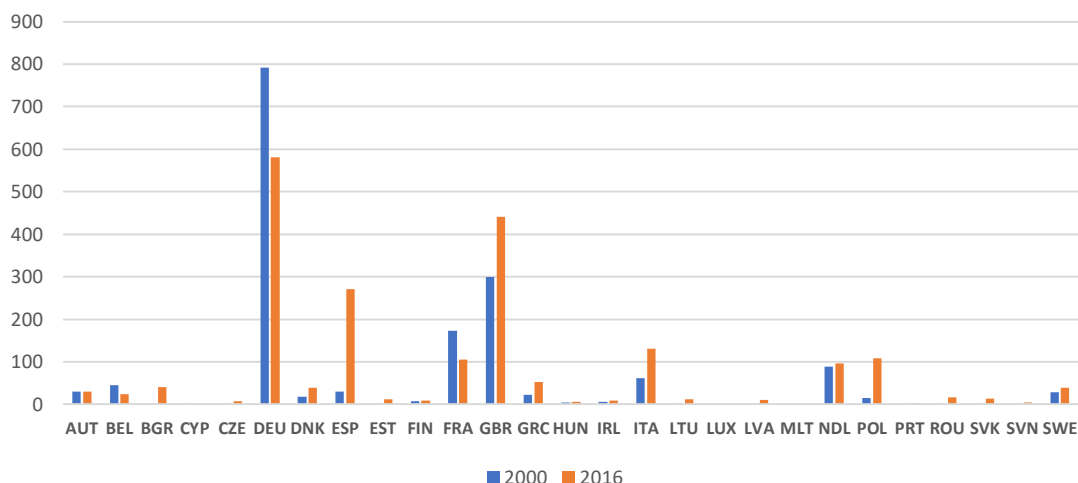


Figure 6. EU CO2 emissions import by country from Turkey in textile and apparel industry in 2000 and 2016 (Unit: kilotons)

Germany and United Kingdom has more embodied carbon in imports, and China, India and Turkey has more embodied carbon in exports. Therefore the producers – China, India and Turkey, responsible for carbon reduction will cause carbon emissions leakage problem (Schaeffer and Sà, 1995). Therefore United Kingdom, Germany and other EU countries with significant amounts of imported carbon emissions avoids CO2 emissions reduction responsibility by replacing domestic production with product import. This weakens the effectiveness of carbon emission reduction policies (Peter and Hertwich, 2008).

## CONCLUSIONS AND SUGGESTIONS

In this study the multi-regional input-output model is constructed and used to calculate and estimate global CO2 embodied in trade of European consumption of textiles and clothing goods during 2000-2016.

The empirical results showed that:

The top country with the most carbon emissions embodied in exports to Europe in textile and clothing industry during 2000-2016 was China. Second biggest export partners with most carbon embodied in trade were India and Turkey.

The top 2 countries in Europe with the most CO2 embodied in import in textile and clothing industry were Germany and United Kingdom. According to the study results, major factor of the increase of CO2 emissions embodied in trade is the increase of trade. Therefore it is important adjusting import and export structure to reduce carbon emissions. We suggest Germany and United Kingdom should strengthen cooperation between China and India dealing with pollution in textile and clothing industry. As Germany and United Kingdom are major causes of increasing global emissions in textile and clothing industry, since they are biggest importers of CO2 emissions from China, India and Turkey, therefore they should help reducing carbon in these developing countries through emission efficiency improvements. The main changes of China's and India's CO2 emissions embodied in trade are caused by the import and export. If the import increases and China and India do not reduce carbon emissions per unit of output by investing in environmental control of pollution, the problem will become more and more serious.

In 2000 and 2016, the country with the highest total CO2 emissions coefficient in EU trade in textile and clothing industry was China and with the highest direct CO2 emissions coefficient was India. As study results showed, the reduction of direct carbon emission coefficient results in a decrease of carbon emission embodied in trade. Therefore in order to reduce global CO2 emissions in textile and clothing industry, India and China should reduce CO2 emissions per unit of output and develop low carbon industry. In other words China and India should develop energy saving and emission reduction technology in order to reduce embodied carbon emissions in trade. Moreover, we suggest increase renewable energy sources in the structure of energy consumption, as main cause of CO2 emissions is energy consumption. We conclude that to ensure progress towards global CO2 emissions reduction, countries should estimate emissions via international trade.

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