A multi-regional Input-Output analysis of ozone precursor emissions embodied in Spanish international trade

Román, Rocío[a*]; Cansino, José M.[a]; Rueda-Cantuche, José M.[b]

[a] Universidad de Sevilla (Spain) and Universidad Autónoma de Chile (Chile).
University of Seville.
Facultad de CC. Económicas y Empresariales
Avda Ramon y Cajal 1
41018 Sevilla

[b]European Commission, DG Joint Research Centre
Edificio EXPO, Inca Garcilaso, 3,41092- Seville
E-mail: josem.rcantuche@ec.europa.eu

*Corresponding author:
Rocio Román
University of Seville.
Facultad de CC. Económicas y Empresariales
Ramon y Cajal 1
41018 Sevilla
Spain
+34 954551657
rroman@us.es

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1. Introduction

Many countries and international organizations are concerned about the effects that critical levels of ozone have on human health and the environment, and therefore the links between greenhouse gases and air pollution.[1] Both issues share common sources of emissions — primarily from fuel combustion in industry and households, transport and agriculture — but also through cross-issue pollutant effects. Rypdal et al. (2005) advised on the need to include tropospheric ozone and aerosol precursors into climate agreements.

At present, ozone is one of the most problematic pollutants in European Union (EU) in terms of harm to human health. High levels of ozone cause respiratory and cardiovascular health problems and lead to premature mortality. According to the European Environment Agency EEA (2014), around 14-17% of the urban population in the EU is exposed to ozone concentrations above EU reference levels (120 µg/m^3 per eight-hour period) during 2010-2012. However, these figures are worse when the World Health Organization (WHO) reference levels are considered, as they are stricter than EU target values. In that case, more than 95% of the urban population in Europe is exposed to ozone concentrations above WHO reference levels (100 µg/m^3 per eight-hour period) (WHO, 2006). In order to provide the European Commission (EC) with evidence-based advice on the health aspects of air pollution, the report published by the WHO/Europe (2013) in relation to the effects of air pollution on health concludes that, in the case of ozone, the harmful effects for health can occur at air pollution concentrations lower those established by the WHO 2005 Guidelines (WHO, 2006). For this reason, the WHO report recommends a revision of the European Union Air Pollution policy that updates the limits of the main pollutants that are harmful to health.

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[1] The strong dependence of ozone levels on atmospheric conditions suggests that the projected changes in climate leading to warmer temperatures could also result in increased ground-level ozone concentrations in many regions.

In EU, the Air Quality Directive (2008/50/EC), which replaced nearly all the previous EU air quality legislation, — complemented by Directive 2004/107/ EC — set legally binding limits for ground-level concentrations of outdoor air pollutants. Also, the National Emissions Ceiling Directive (NEC Directive), adopted on 23 October 2001, sets upper limits for each Member State for the total emissions in 2010 of the four main pollutants responsible for acidification, eutrophication and ground-level ozone pollution.

Additionally, ozone pollution is considered a global problem as it has been dealt with by the Convention on Long-range Transboundary Air Pollution. In fact, the Hemispheric Transport of Air Pollution -HTAP- Task Force has recently shown that intercontinental transport contributes significantly to air pollution in terms of ozone emissions concentration. Therefore, the level of ozone pollution at any given location depends not only on local and regional sources, but also on sources from other continents (UNECE, 1999; 2007).

Effective international commitments must be supported by rigorous measures of pollutant emissions by country. This idea was set out in Article 4 of United Nations Framework Convention on Climate Change (UNFCCC) (UN, 1992) within the context of global warming. This article establishes that countries have both common and different responsibilities regarding this issue. Countries put pressure on global ozone emissions concentrations not only because of their domestic production but also because of their domestic consumption. However, actual international ozone emissions commitments are based on the production perspective (emissions inventories) and not on the consumption-based perspective, that is, the emissions embodied in the consumption of imported and domestically produced goods and services by the residents of one specific country.

Some previous papers consider one or both of these two perspectives for analyzing the emissions embodied in the trade of one country or area , i.e. Weber et al. (2008), Marin et al. (2012), Homma et al. (2012), Dieztzenbacher et al. (2012) or Sato (2012), but they are mainly focused on the greenhouse gas emissions or just on CO_2 emissions. However, as far as we know, there is no previous literature analyzing the ozone precursor emissions from these two perspectives for the case of Spain.

As pointed out recently by the European Environment Agency (EEA,2014), further studies are needed to properly allocate the air emissions produced in the EU to EU and non-EU countries. In fact, the health effects of ozone precursor emissions are becoming one of the priority issues in the governments' agenda (WHO, 2007). Effects on agriculture are also of interest for recent literature (see Kumar et al., 2011 for California-USA, Oksanen et al., 2013 for India and Yi et al., 2016 for China).

The aim of this paper is to analyze the ozone precursor emissions by sectors for Spain in 2009, embodied in Spanish international trade with i) the EU and ii) the rest of the world (non-EU countries). The interest in focusing on Spain is twofold, Spain is the EU Member State with the highest level of non-methane voltaic organic compounds emissions (one of the main ozone precursor) and Spain did not comply with the emission ceiling for this pollutant in 2010, despite the EU commitments on ozone precursor emissions set out in the National Emissions Ceilings Directive (NEC Directive). The results will lead us to provide some policy recommendations focused on the most polluting sectors from the Spanish international trade perspective.

As the literature suggests, multi-regional input-output models (MRIO) are the most appropriate tool for the calculation to account for emissions to air, either from the production perspective or from the consumption perspective (Miller and Blair, 2009, Wiedmann, 2009, Zhou and Imura, 2011, Su and Ang, 2014, Zhang et al., 2015, Hong et al, 2016, Brizga et al. 2016 and Jiang et al., 2016). To the best of our knowledge, the only previous paper on ozone precursor emissions using a multi-regional input output model is Arto et al. (2012). This paper contributes to the literature in three areas. Firstly, the paper is focused on the Spanish economy, offering more detailed information about sectors and countries involved in the ozone precursor emissions embodied in Spanish international trade. Secondly, the most recent available version of environmental accounts of World Input-Output Database (WIOD) has been used, i.e. 2009 (Arto et al., 2012, used the year 2008). And thirdly, some general policy recommendations are provided based on the results.

The article is structured as follows. Section 2 explains the methodological approach and briefly describes the database, i.e. WIOD. The results are reported by type of ozone precursor gas and by area in Section 3. The results are discussed in Section 3. The conclusions and recommendations for policy analysis are given in Section 4.

2. Methodology

2.1 Input-output analysis

Input-output analysis (IOA) revolves around the so called input-output tables, which reflect the supply and demand of the economy in terms of products, industries and final users. IOA is a useful method to better understand and account for the links between consumption and production sectors (Leontief, 1970). By using the so-called Leontief quantity model (Rueda-Cantuche, 2010), the total output of an economy X can be broken down into final and intermediate demand, as indicated in (1):

$$X = AX + Y \qquad (1)$$

where X is the total industry output vector for n industries (n x 1); $Z = AX$ is a matrix describing the intermediate products of industries; A is a matrix (n x n) of input-output coefficients showing the inputs needed per unit of output by each industry; and Y stands for a final demand matrix (n x 1) showing the consumption, investment and exports of all goods and services. Within this framework, industry-by-industry IO tables from the WIOD database have been used (Dietzenbacher et al., 2013) with the same number of industries and commodities (n).

Reordering (1), it yields:

$$X = (I - A)^{-1} \cdot Y = L \cdot Y \qquad (2)$$

where I is the identity matrix (n x n) and $(I\text{-}A)^{-1}$ is the so-called Leontief inverse matrix, L (n x n), which shows the total requirements of the economy for the production of goods and services to satisfy a certain level of final demand.

Leontief-style IOA accounting has become an increasingly active area of research for a variety of environmental indicators, including CO_2 (Kanemoto et al., 2014; Chen & Zhang, 2010). The Environmental Input-Output (EIO) model allows us to analyze the link between emissions, productive sectors and the final demand. By multiplying both sides of equation (2) by the emission coefficients (*C*), which are the emissions per unit of output, the following equation results:

$$c = \widehat{C} \cdot (I - A)^{-1} \cdot Y = \widehat{C} \cdot L \cdot Y \qquad (3)$$

where *c* is an n x 1 vector representing the total emissions sector and $\hat{C}$ is a diagonal matrix n x n that represents the emission coefficients of the economic sectors. These emission coefficients have been calculated as the total emissions of each industry over the total output.

2.2 Multi-regional input-output analysis

The multi-regional input-output analysis is based on a set of interconnected input-output tables of various countries (Miller & Blair, 2009). While equation (3) refers to one single country with *n* industries, similar equation for a three-region model with *n* industries in each region, namely: Spain (u), rest of the EU (r) and rest of the world (w) is shown as follows:

$$\begin{pmatrix} c_u \\ c_r \\ c_w \end{pmatrix} = \begin{pmatrix} \hat{C}_u & 0 & 0 \\ 0 & \hat{C}_r & 0 \\ 0 & 0 & \hat{C}_w \end{pmatrix} \cdot \begin{pmatrix} L^{uu} & L^{ur} & L^{uw} \\ L^{ru} & L^{rr} & L^{rw} \\ L^{wu} & L^{wr} & L^{ww} \end{pmatrix} \cdot \begin{pmatrix} Y_{uu} & Y_{ur} & Y_{uw} \\ Y_{ru} & Y_{rr} & Y_{rw} \\ Y_{wu} & Y_{wr} & Y_{ww} \end{pmatrix} = \widehat{C}_i \cdot L^{ij} \cdot Y_{js} \qquad (4)$$

i being the region where the intermediate products have been produced; *j* the region that has imported the intermediate products and has incorporated them into final production and *s* the region where the final products are consumed.

The equation (4) is redefined allowing for a fully-fledged decomposition of the final demand by region.

$$
\begin{pmatrix} c_u \\ c_r \\ c_w \end{pmatrix} = \begin{pmatrix} \hat{C}_u L^{uu} Y_{uu} & \hat{C}_u L^{ur} Y_{ru} & \hat{C}_u L^{uw} Y_{wu} \\ \hat{C}_r L^{ru} Y_{uu} & \hat{C}_r L^{rr} Y_{ru} & \hat{C}_r L^{rw} Y_{wu} \\ \hat{C}_w L^{wu} Y_{uu} & \hat{C}_w L^{wr} Y_{ru} & \hat{C}_w L^{ww} Y_{wu} \end{pmatrix} + \begin{pmatrix} \hat{C}_u L^{uu} Y_{ur} & \hat{C}_u L^{ur} Y_{rr} & \hat{C}_u L^{uw} Y_{wr} \\ \hat{C}_r L^{ru} Y_{ur} & \hat{C}_r L^{rr} Y_{rr} & \hat{C}_r L^{rw} Y_{wr} \\ \hat{C}_w L^{wu} Y_{ur} & \hat{C}_w L^{wr} Y_{rr} & \hat{C}_w L^{ww} Y_{wr} \end{pmatrix} +
$$

$$
+ \begin{pmatrix} \hat{C}_u L^{uu} Y_{uw} & \hat{C}_u L^{ur} Y_{rw} & \hat{C}_u L^{uw} Y_{ww} \\ \hat{C}_r L^{ru} Y_{uw} & \hat{C}_r L^{rr} Y_{rw} & \hat{C}_r L^{rw} Y_{ww} \\ \hat{C}_w L^{wu} Y_{uw} & \hat{C}_w L^{wr} Y_{rw} & \hat{C}_w L^{ww} Y_{ww} \end{pmatrix} = \begin{pmatrix} gdom_u^u \\ gimp_r^u \\ gimp_w^u \end{pmatrix} + \begin{pmatrix} g\exp_r^u \\ gdom_r^r \\ g\exp_r^w \end{pmatrix} + \begin{pmatrix} g\exp_w^u \\ g\exp_w^r \\ gdom_w^w \end{pmatrix} \quad (5)
$$

This equation (5) allows us to calculate the following figures.

a) $gdom_u^u$ is equal to the emissions embodied in Spanish final and intermediate products that are consumed by Spanish residents and is calculated as follows:

$$
gdom_u^u = \hat{C}_u L^{uu} Y_{uu} + \hat{C}_u L^{ur} Y_{ru} + \hat{C}_u L^{uw} Y_{wu} \quad (6)
$$

b) $gexp_r^u$ is equal to the emissions embodied in Spanish final and intermediate products that are consumed by EU countries and is calculated as follows:

$$
g\exp_r^u = \hat{C}_u L^{uu} Y_{ur} + \hat{C}_u L^{ur} Y_{rr} + \hat{C}_u L^{uw} Y_{wr} \quad (7)
$$

c) $gexp_w^u$ is equal to the emissions embodied in Spanish final and intermediate products that are consumed by non-EU countries and is calculated as follows:

$$
g\exp_w^u = \hat{C}_u L^{uu} Y_{uw} + \hat{C}_u L^{ur} Y_{rw} + \hat{C}_u L^{uw} Y_{ww} \quad (8)
$$

Therefore, the total emissions produced in region u, Spain, (PE_u) are:

$$
PE_u = gdom_u^u + g\exp_r^u + g\exp_w^u \quad (9)
$$

Additionally, equation (6) allows us to calculate the following items:

d) $gimp_r^u$ is equal to the emissions embodied in EU final and intermediate products that are consumed by Spanish residents and is calculated as follows:

$$gimp_r^u = \widehat{C}_r L^{ru} Y_{uu} + \widehat{C}_r L^{rr} Y_{ru} + \widehat{C}_r L^{rw} Y_{wu} \tag{10}$$

e) $gimp_w^u$ is equal to the emissions embodied in non-EU countries final and intermediate products that are consumed by Spanish residents and is calculated as follows:

$$gimp_w^u = \widehat{C}_w L^{wu} Y_{uu} + \widehat{C}_w L^{wr} Y_{ru} + \widehat{C}_w L^{ww} Y_{wu} \tag{11}$$

Then, the emissions footprint of region u, Spain, (EF_u) is calculated as the total emissions embodied in all final and intermediate products consumed by Spanish residents:

$$EF_u = gdom_u^u + gimp_r^u + gimp_w^u \tag{12}$$

Furthermore, the difference between equations (9) and (12) is the so-called emission trade balance (ETB) which is the difference between the emissions actually produced in Spain (9) and the Spanish footprint (12). As mentioned before, the ETB is nothing more than the difference between the emissions embodied in exports (EEE) minus the emissions embodied in imports (EEI).

$$\begin{aligned} ETB_u &= PE_u - EF_u = gdom_u^u + g\exp_r^u + g\exp_w^u - (gdom_u^u + gimp_r^u + gimp_w^u) = \\ &= g\exp_r^u + g\exp_w^u - gimp_r^u - gimp_w^u = EEE - EEI \end{aligned} \tag{14}$$

A positive ETB value means that the EEE are larger than the EEI and, therefore, the country's emissions due to its national exported production are greater than the country's emissions provoked by its imported production. Meanwhile, a negative ETB value means that the emissions provoked by the national exported production are lower than the emissions embodied in imported production.

Moreover, the total emissions embodied in trade for region u, Spain, (TET_u) allow us to calculate the total emissions involved in the international trade of one region (u), including those from exports and imports of final and intermediate products. The TET allows us to determine the global emissions generated by the international trade of one country or area. The TET can be calculated as follows:

$$TET_u = g\exp_r^u + g\exp_w^u + gimp_r^u + gimp_w^u = EEE + EEI \quad (15)$$

2.3. Database

The data used in this paper come from the World Input-Output Database (WIOD), as described in Dietzenbacher et al. (2013) and Timmer et al. (2015). This is a free database financed by the European Union and developed with the aim of analyzing the effects of globalization on trade patterns, environmental pressures and the socioeconomic development of a large group of countries.

The data include world input-output tables for the 27 European Union countries and 13 other non-EU economies and also the corresponding national IO tables. The WIOD currently covers the period 1995-2013 and includes 35 industries and 59 commodities. However, data on energy and emissions have not been updated up to 2013 yet so the analysis has been carried out for the most recent year, i.e. 2009 that were available the environmental data. In fact, the precursor gases of tropospheric ozone considered have been: nitrogen monoxide (NO_X), non-methane voltaic organic compounds (NMVOC), methane (CH_4) and carbon monoxide (CO).

3. Results

The analysis has been carried out in detail for 35 sectors, distinguishing the emissions embodied in the Spanish trade with the EU-27 and non-EU countries separately and considering the four ozone precursors (see Tables 1 and 2). The non-EU countries considered have been Australia, Brazil, Canada, China, India, Indonesia, Japan, Korea, Mexico, Russia, Turkey, Taiwan and United States.

Insert here Table 1

Insert here Table 2

The main sectors that are responsible for the TET emissions of four ozone precursors (TET*) are quite similar in Table 1 and Table 2. Considering the four sectors more pollutant, in Table 1, are Agriculture, Basic Metals, Chemicals and Inland transport sectors and in Table 2, are Coke, Agriculture, Mining and Basic Metals sectors.

However, some differences arise when the ETB is analyzed. In the case of Spanish trade with the EU-27 countries, Agriculture and Basic Metals sectors show positive values (with the exception of CH_4 for Basic Metals). Therefore, these two sectors are increasing the Spanish emissions of ozone precursors in the EU area from the production perspective.

When the emissions embodied in Spanish trade with non-EU countries are considered, the ETB of the main pollutant sectors show negative values. Therefore, these sectors such as Coke, Agriculture, Mining, Basic Metals and Inland transport sectors are contributing to increase the emissions attributed to Spain from the consumption perspective but not from the production perspective. In this case, the emissions embodied in Spanish exports with non-EU countries are lower than that incorporated in the Spanish imports.

A more detailed analysis of these results are carried out in the following sections in order to distinguish the different behavioral of ozone precursors embodied in Spanish trade with EU-27 countries and non-EU countries.

3.1 Ozone precursor emissions embodied in Spanish trade with EU countries

Spain ranked first in NMVOC emissions and fourth in emissions of methane, NO_X and CO in the EU. In 2009, one out of four tonnes of NMVOC emissions in the EU was produced in Spain while one out of ten tons of methane, NO_X and CO emissions produced in the EU also came from Spain (WIOD, 2012).

The total emissions embodied in the Spanish trade (TET) with EU countries, which are the emissions embodied in exports plus the emissions embodied in imports of four ozone precursors (see TET* in last column of Table 1) allows us to order all sectors of production since the highest to the lowest TET*. The most pollutant sectors due to the four precursors are: Agriculture, Basic Metals, Chemicals, Inland Transport and Community Services.

Additionally, the TET by pollutant (see Table 1) are approximately the following: NMVOC (485 000 tons), CO (498 000 tons), NO_X (299 000 tons) and CH_4 (536 000 tons). These data show that CH_4 is the most important, followed by CO and NMVOC, and finally by NO_X.

The analysis of the %TET by pollutant and by sectors provides us with some additional information on which are the most polluting sectors involved in the emissions embodied in the Spanish trade within the EU.

The NMVOC emissions are mainly due to the Agriculture sector (58%) and, additionally, the Chemicals and Chemical products sector (9%), Rubber and plastics sector (6%) and Transport equipment sector (6%) are also noteworthy. These four sectors are responsible for 79% of the NMVOC emissions provoked by Spanish trade with EU countries.

The CO emissions linked to Spanish trade within the EU are generated by the Basic Metals and Fabricated Metal sector (50%) and the Agriculture sector (26%). Both of these make up 76% of these emissions.

The NO_X emissions are more diversified and are provoked by the Agriculture sector (21%), Inland transport sector (13%), Electricity, gas and water supply sector (10%) and Water and Air transport sectors (9% each). These four sectors contribute 62% of the NO_X emissions embodied in Spanish trade with EU countries.

Finally, in the case of CH_4, the Agriculture sector is responsible for the 75% of the emissions while the Other Community, Social and Personal sector contributes an additional 11%. Therefore, both sectors make up 86% of the CH_4 emissions provoked by Spanish trade with EU countries.

In addition to the above information, the results also show separately the emissions embodied in the Spanish exports to the EU and Spanish imports from the EU by pollutant (see Table 1).

The emissions embodied in the Spanish intermediate and final products consumed by the EU countries, i.e. the EEE in the EU, are the following by pollutant: NMVOC (373 000 tons), CO (285 000 tons), NO_X (165 000 tons) and CH_4 (287 000 tons). In fact, the Spanish Government should be particularly keen to control the emissions of

NMVOC as it is one of the main precursors of tropospheric ozone and Spain, which is responsible for 24% of the total EU NMVOC emissions produced in 2009, is the EU's biggest polluter (WIOD, 2012).

In contrast, the emissions embodied in the EU final and intermediate products consumed by Spanish residents, i.e. the EEI in the EU, are the following: NMVOC (111 000 tons), CO (213 000 tons), NO_X (132 000 tons) and CH_4 (248 000 tons). In this case, the most important pollutant is CH_4.

The difference between the emissions embodied in Spanish exports to the EU and the emissions embodied in Spanish imports from EU countries, i.e. the emission trade balance (ETB), is always positive in the case of the four pollutants (see last row in Table 1). This difference shows that there is still room for Spain to develop strategies to reduce the emissions embodied in its production, either in the final or intermediate products.

Spain should focus on those sectors responsible for the major emissions generated by EU trade. The analysis of the ETB provides some further information for the sectors and pollutants involved in Spanish trade with the EU. The biggest differences appear in the case of the NMVOC and CO emissions which mean that the emissions embodied in Spanish exports to the EU are higher than those embodied in Spanish imports from the EU.

The ETB related to NMVOC and CO emissions shows that the highest positive values are mostly in the Agriculture and Basic Metals sectors. In the case of NMVOC emissions, the positive differences in the case of the Rubber and Plastic and Transport Equipment sectors are also important while, in the case of CO emissions, the Other non-metallic mineral sector is also important. On the other hand, in the case of both pollutants, the highest negative differences are shown in the Chemicals and Chemical Products sector. And for CO emissions, positive differences are also shown in the Inland Transport sector.

3.2 Ozone precursor emissions embodied in Spanish trade with non-EU countries

The total emissions embodied in the Spanish trade (TET) with non-EU countries, i.e. the emissions embodied in exports plus the emissions embodied in imports of four pollutants (see last column of Table 2) allows us to order all sectors of production since the highest to the lowest TET*. In this case, the five most pollutant sectors considering the four precursors are: Coke, refined petroleum, Agriculture, Mining, Basic Metals and Inland Transport.

Additionally, the TET by pollutant (see last row in Table 2), are the following: NMVOC (1.28 million tons), CO (4.35 million tons), NO_X (625 miles tons) and CH_4 (1.9 million tons). These data show that CO is the most important, followed by CH_4, NMVOC and finally by NO_X.

The analysis of the %TET with non-EU countries by sector provides us with some additional information on which are the most polluting sectors involved in the emissions embodied in Spanish trade by pollutant.

The NMVOC emissions are mainly due to the Coke, Refined Petroleum sector (53%), Chemicals and Chemical products sector (12%) and Agriculture sector (10%). These three sectors make up 75% of the NMVOC emissions provoked by Spanish trade with non-EU countries.

The CO emissions involved in Spanish trade within non-EU countries are generated by the Coke, Refined Petroleum sector (59%) and Basic Metals sector (11%). Both of them contribute 70% of these emissions.

The NO_X emissions are provoked by the Agriculture sector (25%), Electricity, Gas and Water supply (16%) and Inland transport sector (15%). These three sectors make up 56% of the NO_X emissions embodied in Spanish trade with non-EU countries.

Finally, in the case of CH_4, the Agriculture, Hunting, Forestry and Fishing sector is responsible for 44% of the emissions while Mining and Quarrying shows an additional 37%. Therefore, both sectors are responsible for 81% of the CH_4 emissions provoked by Spanish trade with non-EU countries.

In addition to the above information, the results also show separately the emissions embodied in the Spanish exports to the non-EU countries and Spanish imports from the non-EU countries by pollutant, i.e. the EEE and EEI respectively (see Table 2).

The emissions embodied in the Spanish production exported to non-EU countries, i.e. EEE in Table 2, are the following by pollutant: NMVOC (166 000 tons), CO (203 000 tons), NO_X (140 000 tons) and CH_4 (117 000 tons). Meanwhile, the emissions embodied in Spanish imports from non-EU countries, i.e. EEI in Table 2, are the following: NMVOC (1.1 million tons), CO (4.1 million tons), NO_X (485 000 tons) and CH_4 (1.8 million tons).

The Spanish emission trade balance (ETB) with non-EU countries is always negative in the case of the four pollutants (see last row in Table 2). This difference shows that there is still room for Spain to develop strategies to reduce the emissions embodied in its consumption of goods from non-EU countries.

Spain should focus on those sectors responsible for the major emissions involved in the international trade with non-EU countries. The analysis of the ETB provides some further information by sector and by pollutant. The figures in Table 2 show that the biggest ETB differences appear in the case of CO (-3.9 million tons) and CH_4 (-1.7 million tons) emissions.

The ETB related to CO emissions shows that the highest negative values are mostly in the Coke, Refined petroleum sector. In the case of CH_4 emissions, the negative differences that are shown in the Agriculture and Mining sectors are also important. The only sector that shows significant positive ETB values is Agriculture in the case of NMVOC emissions.

4. Discussion

The Spanish emission trade balance (ETB) shows a positive balance in the case of international trade within the EU. In this case, the sectors that cause NMVOC emissions are mainly the Agriculture, Chemicals, Rubber and Transport equipment sectors; the CO emissions are linked to the Agriculture and Basic Metals sectors; the NOx emissions are provoked by Agriculture, Inland Transport, Electricity and water and air transport and finally, the CH_4 emissions are due to Agriculture and Community services. Therefore, in those sectors that pollute more, Spanish authorities might implement policies that mitigate the emissions embodied in production in order to reduce the total emissions embodied in Spanish trade.

In contrast, the Spanish emission trade balance (ETB) is negative in the case of Spanish international trade with non-EU countries. The main sectors that increase the emissions of NMVOC are Agriculture, Coke and Chemicals; those that provoke CO emissions are Coke and Basic Metals; the NOx emissions are due to Agriculture, Electricity, Inland Transport and Water Transport and finally, the CH_4 emissions are due to Agriculture and Mining. In this case, Spanish authorities have the possibility to work on the Spanish consumption habits in order to reduce total emissions.

Table 3 summarizes the information on emissions embodied in Spanish international trade by sector. This table shows the most polluting sectors considering the Spanish TET with EU and non-EU countries. Additionally, because of its relevance for the Spanish Government, Table 3 shows those sectors that show a positive value in the Spanish ETB, i.e. those where the EEE are larger than the EEI. In these latter cases, authors consider that there is still room for the Spanish regulation in order to reduce the emissions embodied in Spanish production.

Table 3. The main polluting sectors considering the total emissions involved in Spanish trade (TET) with EU and non-EU countries

	NMVOC	**CO**	**NO_X**	**CH_4**
EU countries	- Agriculture* - Chemicals - Rubber* - Transport equipment*	- Agriculture* - Basic Metals*	- Agriculture* - Inland Transport* - Electricity* - Water/Air Transport	- Agriculture* - Other Community services*
Non-EU countries	- Agriculture* - Coke and refinun - Chemicals	- Coke and refinun - Basic Metals	- Agriculture - Electricity - Inland Transport - Water Transport.	- Agriculture - Mining

*These are the sectors that show positive results for the emission trade balance.

In light of the major findings mentioned above, the results are discussed by sectors. Firstly, the Agriculture sector is considered apart from the rest due to the importance for the Spanish economy. Then, the rest of the sectors are discussed distinguishing on one hand, those that are now implementing several measures for reducing emissions and on the other hand, those without current policy measures and therefore, some policy recommendations are provided. In both of cases, paper focus on new measures mitigation oriented.

The Agriculture sector is one of the main polluting sectors considering the results for the four ozone precursors. This sector contributes notably to the increase in the emissions embodied in Spanish trade (TET) with EU and non-EU countries. In fact, the results show that the emissions embodied in Spanish final and intermediate products of the Agriculture sector exported (EEE) are higher than those imported from the EU countries (EEI) and therefore the ETB is positive. In the case of EU countries, the Agriculture sector contributes most of the emissions embodied in Spanish trade (TET) for NMVOC, CH_4 and NO_X. However, when non-EU countries are considered, the emissions embodied in the final and intermediate products of the Agriculture sector consumed by Spanish residents (EEI) are higher than for those produced in Spain and exported (EEE) to non-EU countries (with the exception of NMVOC emissions).

These results show that the Agriculture sector should be the main focus of Spanish environmental policies. Firstly, the agricultural sector is the main methane emitter due to livestock farming. Mitigation policies in the agricultural sector would not only impact on emission levels but also on guaranteeing food resources to people. Additionally, it should be borne in mind that critical levels of O_3 could damage plants and lead to a reduction in agricultural crops yields. For example, China -the main emitter globally- has recently developed well-oriented measures in the agricultural sector to mitigate methane emissions. In particular, cleaner production technologies have been widely promoted, encouraging the improvement of farming practices, rational application of fertilizer and the adoption of diversified crop systems (Gan et al., 2011). Therefore, the Chinese Twelfth (2011-2015) and Thirteenth (2016-2020) Five-Year Plans have focused efforts on such good practices.

Actions in the Agriculture sector are also necessary to avoid NOx emissions, as the results show. In response to the problems caused by nitrogen emissions from agriculture, the European Union adopted the Nitrate Directive in 1991 and many countries started to develop polices to reduce nitrogen emissions. Taxes on fertilizers were used in some countries but were finally abandoned, as was the case for Austria, Finland and Norway. Although taxes might be an effective instrument in reducing nitrogen emissions, the problem of nitrate pollution from agriculture is a classic example of how difficult it is to address such diffuse pollution through 'first-best' instruments. Taxing nitrate itself is not an efficient solution since the problem which the instrument seeks to address – emissions to various media – is related to the application of nitrate in rather complex ways: the method of cultivation, the crop being cultivated (and the timing thereof), the type of soil and the weather. Instead of taxes, alternative policies have been implemented in some countries such as codes of good practice in the use of fertilizers. These codes are oriented to mitigate not only NO_X emissions but also other ozone precursors, such as methane, NMVOC and CO. For example, the adoption of these codes of environmental practices has been a pressure measure in several industries such as Chemical sector (King and Lenox, 2000). Therefore, this practice should be considered by the Spanish Government due to the Spanish agricultural sector appearing as a key sector in the results obtained in Section 4.

Additionally, there are other effective tools that can also exert pressure via consumers and the general public such as certification (for internal processes) and eco-labels (for final products). The adoption of these practices serves as a way to legitimize externally the firms' environmental behavior. When these tools are implemented, the group of leader companies are motivated to certificate their processes or/and final products and therefore, the rest of competitors try to imitate them in a short/medium term. These tools are not only effective in the case of the Agriculture sector but also in other sectors such as chemicals, basic metals or transport sector. Any case, literature highlighted the difficulty of creating self-regulation without explicit sanctions (King and Lenox, 2000).

The EU authorities did not regulate the use of pesticide products from an environmental protection perspective until 2009 (European Union, 2009). However, these measures did not enter into force in Spain until 2012 (Spanish Royal Decree, 1311/2012). This regulation establishes the way that fertilizers should be handled and mixed in order to minimize emissions. Additionally, this regulation obliges the producers to manage the containers as if they were hazardous waste and details how they should discharge polluted water resulting from washing the containers. Furthermore, the regulation limits the sale of these products only to those producers that exhibit the handler card and the treatments must be recorded in the exploitation register of each farm. Also, there is a system of inspection and sanction in the event that producers do not follow the regulation. Therefore, Spanish legislation is now going in the right direction considering the importance of the agricultural sector in terms of ozone precursor emissions as the results show in this paper.

After recommending the measures mentioned above, a reflection on its feasibility should be done. Exports from agriculture sector shared 10% of total export up to 2013 - last available data (INE, 2016a and ICEX, 2012). This sector employed 4.3 % of total Spanish workers at the end of 2015 (INE, 2016 b) and contributed to 2.3 % of GDP up to 2014 (INE, 2016c). The profitable contribution of agriculture products to Spanish exports/imports balance could replace or even obscure the environmental objective of reducing the negative emissions of this sector.

Transport sector (mainly inland and air transport), energy sector and refinery industry might receive great attention from Spanish authorities although mitigation policies linked with their activities were put in force in the past. Regarding policy agenda for the next years some policy recommendations are exposed below. Other sectors like Community services and the basic metals sector received less attention in the past. We refer to them at the end of this section.

The Inland transport sector is relevant for NOx emissions, and, to a lesser extent, the air and water transport sector. In the case of inland transport, the replacement of traditional materials by lightweight polymers in automobile construction reduces the fuel consumption per kilometer and therefore the emissions. Also, the inclusion of chemical additives in fuels such as ad-blue (i.e., urea) can improve efficiency and reduce the generation of pollutants. Ferrón-Vilchez et al. 2015) conducted a mini case study focused on a Spanish road freight transport industry. They founded that managers decided to introduce ad-blue to reduce NOx in the exhaust system of trucks benefiting from economies of scale in purchasing this component internalisating environmental costs. In fact, thanks mainly to chemicals, a current car emits just 10% of the pollutants emitted in 1950 (Interempresas, 2009).

Together with enhancing materials used in a vehicle's design, lower levels of NO_X emissions generated by road transport could be achieved using two pillars. The first is the right use of NO_X absorber devices, mainly in cars powered by diesel. Such devices allow the reduction of oxides of nitrogen (NO and NO2) emissions from a lean-burn internal combustion engine by means of adsorption. Although these devices are becoming common in developed countries they are not generally in widespread use globally. The second pillar consists of increasing the use of electric vehicles or hybrid vehicles (powered with electricity, petrol and natural gas or hydrogen), all of which are lower emitters.

Air transport should also be analyzed for its contribution to NOx emissions. Aircraft emit gases and particles directly into the upper troposphere and lower stratosphere, at altitudes located between 9 km and 13 km, altering their composition and concentration of gases. The harmful effects of these emissions have largely been studied as one of the ozone precursors (MAGRAMA, 2015) promoting global warming and photochemical smog (Berend, 2015). Improvements in some of the structural components of aircraft have shown that it is possible to reduce NO_X emissions by 50%. This has happened with the SMART Fixed Wing Aircraft (SFWA) program aimed at developing new products related to the wings of the aircraft (CSJU, 2008). The leading aircraft manufacturers - Boeing Co. and Airbus Group- have begun to evolve their most successful models in that direction -B737 (Max version) and A320 (a Neo version) (Airbus Group, 2015). The reduction of NO_X emissions associated with air transport would be greater if, in addition to the introduction of this improvement to the wings of aircraft, airports imposed stricter emissions requirements on the aircraft that operate out of them.

Another sector that might receive political attention is the energy sector. The Electricity sector is particularly relevant for the NOx emissions involved in Spanish trade. Due to foreign energy dependency and in order to avoid larger NO_X emissions, higher shares of non-fossil fuel sources in the energy matrix might be a solution. For many countries, mainly in the EU and of course in Spain, this would imply a more intensive use of renewable energy sources due to legal decisions against nuclear power deployment. However, this is not the only recommendation in the field of energy policy. Literature shows that there is room for enhancing energy efficiency in terms of energy conversion from primary to secondary energy. This is true not only for developed countries but also for developing ones (Chikkatur, 2008; Remme et al., 2011).

The Refinery industry is also revealed as another driver of NMVOC and CO emissions. This industry has already shown significant results in reducing emissions of some greenhouse gases. This has been the case of SO_X for example by the installation of desulphurization devices in refinery plants. These plants recover the sulphur and convert it into a co-product that is then sold to the copper industry, and used for the extraction of this mineral by the solvent extraction method (SX-EW).

In the case of emissions of ozone precursor agents, recommendations for the refining industry should go in two directions; improving energy efficiency and changing the type of fuel used. In the case of Spain, since the 1990s, refiners have reduced energy consumption by 16% (Spanish Environment Department, 2004). However, the most important change is the replacement of the use of liquid fuels by gaseous fuels.

In traditional technology, the gases generated in the refining process are used as fuel in the internal processes of industrial plants. Now the technology allows the refining industry to use the fuel gas generated in the refining oil process for powering the turbines and electricity without using water. Therefore, it is now possible to capture and reduce the residual fuel gas by using it as a by-product. By combining the refinery fuel gas reformulated without steam or water, the new technology reduces emissions of NO and NO2 among other gases (Interempresas, 2015). This rute should become a priority action.

The Community services sector should receive policy attention because it not only provokes the main methane emissions besides the Agriculture sector, but also other relevant pollutant emissions such as landfill gas (LFG). This gas is created from the decomposition of organic matter in landfills for municipal solid waste (MSW). This gas consists of approximately 99% CH_4 and CO_2, and a small amount of different organic compounds to methane (NMVOC). Therefore, the policy regulation should be oriented to capture, convert and use this gas as an energy source. For example, the use of LFG helps to reduce odours and other hazards associated with LFG emissions and helps prevent the methane from migrating into the atmosphere. It also prevents the local smog increasing and mitigates global climate change.

The Basic Metals sector is relevant when considering the CO emissions embodied in Spanish trade with the EU. In fact, this industry includes two important activities: cement and lime production. Cement is a basic material for building and civil engineering construction and lime and its derivatives are used as a binder in building and construction. This explains why the construction sector appears as an important emitter of NMVOC. As suggested by JRC (2013), some policy recommendations could be put into force. Starting with the cement industry, a technique to reduce the industry's energy use and emissions, expressed per unit mass of cement product, is to reduce the clinker content of cement products. This can be done by adding fillers and additives, for example, sand, slag, limestone, fly ash and pozzolana, in the grinding step. This technique would reduce emissions to air. In Europe, the average clinker content in cement is 80–85%.

Additionally, the electrical energy use can be minimized in the Basic metal sector through the installation of power management systems and the utilization of energy-efficient equipment such as high-pressure grinding rolls for clinker comminution and variable speed drives for fans as well as, in some cases, replacing old raw material mills with new mills. These power management systems could result in the saving of resources and reduction of emissions and waste. The clinker burning process is usually optimized to reduce the heat consumption, to improve the clinker quality and to increase the lifetime of the equipment (the refractory lining, for example) by stabilizing process parameters. Reduction of emissions, such as NOx and dust, is a secondary effect of this optimization.

Focusing now on the Lime industry, because of the wide range of exhaust gas conditions, a variety of dust collectors are used, including cyclones, wet scrubbers, fabric filters, electrostatic precipitators and gravel bed filters. For example, typical cyclones remove about 90% of the dust from lime kilns. Therefore, dust collectors should be recommended.

All previous policy recommendations would impact on the supply side of markets, forcing industries to adopt mitigation practices. But the demand side of the market might also receive attention in order to contribute to mitigate the ozone precursor emissions. Obviously, action is needed to enhance the general knowledge about the problems caused by ozone, for example the ozone precursor footprint could be included in food products labels in order to drive consumer decisions and change their patterns towards cleaner products.

5. Concluding remarks

The main conclusions that can be drawn from the analysis of the results are the following:

a) The Agriculture sector seems to be the most relevant one considering the total emissions embodied in Spanish trade within the EU. This sector contributes 75%, 58% and 26% of CH_4, NMVOC and CO emissions respectively. Despite of this, mitigation measures feasibility would depend on the way in which a debate about environmental versus economic objectives is solved.

b) In terms of the ETB, Spanish trade with the EU shows that the NMVOC and CO emissions embodied in Spanish exports are much higher than those embodied in Spanish imports from this area. Again, the Agriculture sector seems to be related to these emissions, as is the Basic metal sector. Current regulation in relation to the use of pesticide products in Spain seems to deal with this problem. However, more active environmental regulations focused on the Agriculture sector are needed, such as the introduction of codes of good practice in the use of fertilizers and the promotion of cleaner production technologies.

c) The most important sector that contributes to the total emissions embodied in Spanish trade within the non-EU area is the Coke, Refined Petroleum sector which accounts for 59% and 53% of CO and NMVOC emissions respectively. Additionally, the Agriculture sector is also relevant in terms of CH_4 (44%) and NO_X (25%) emissions.

In terms of the ETB, Spanish trade with the non-EU area shows that Spanish regulation should focus on the national consumption pattern in order to reduce Spanish pressure on ozone precursor emissions worldwide, especially in the case of CO and CH_4 emissions. Certification or eco-labels mentioned have room for further deployments in Spain.

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Table 1: Emissions embodied in Spanish trade with EU countries in 2009 (t)

Productive sectors	NMVOC					CO					NOX					CH4					
	EEE	EEI	ETB	TET	%TET	EEE	EEI	ETB	TET	%TET	EEE	EEI	ETB	TET	%TET	EEE	EEI	ETB	TET	%TET	TET*
Agriculture, Hunt. Forestry. Fish	265938	14817	251121	280755	58%	102687	25481	77206	128169	26%	47968	15781	32188	63749	21%	231616	170940	60676	402556	75%	875228
Basic Metals. Fabricated Metal	12705	5589	7116	18294	4%	135850	113338	22512	249187	50%	8247	5702	2545	13948	5%	1957	3176	-1219	5133	1%	286563
Chemicals and Chemical Products	12571	30646	-18075	43217	9%	4415	13415	-9001	17830	4%	6414	9021	-2607	15435	5%	4936	9024	-4088	13959	3%	90441
Inland Transport	3162	2421	741	5583	1%	5029	11255	-6226	16284	3%	22692	15720	6973	38412	13%	590	1162	-572	1753	0%	62031
Community, Soc.& Pers. Serv.	1190	975	215	2165	0%	236	497	-261	733	0%	168	631	-463	799	0%	32884	24699	8186	57583	11%	61280
Electricity, Gas and Water Supply	881	1242	-361	2122	0%	1558	4896	-3338	6454	1%	17788	12360	5427	30148	10%	2317	7763	-5446	10080	2%	48804
Air Transport	2036	1394	642	3430	1%	10219	7849	2369	18068	4%	12063	13776	-1713	25839	9%	31	83	-52	113	0%	47450
Other Non-Metallic Mineral	1019	1555	-537	2574	1%	10377	5959	4418	16336	3%	12553	7642	4911	20194	7%	845	274	571	1119	0%	40224
Transport Equipment	19758	11483	8275	31241	6%	1956	1190	766	3145	1%	2763	1009	1753	3772	1%	820	49	771	869	0%	39028
Mining and Quarrying	87	4326	-4239	4413	1%	229	1571	-1342	1799	0%	1215	4109	-2894	5323	2%	5735	21669	-15934	27404	5%	38940
Coke, Ref. Petroleum and Nuclear	3421	7597	-4176	11018	2%	3816	3224	592	7040	1%	9451	5566	3885	15017	5%	1460	3623	-2163	5083	1%	38159
Water Transport	673	861	-188	1534	0%	288	2505	-2217	2793	1%	7535	18606	-11071	26141	9%	13	28	-15	41	0%	30509
Rubber and Plastics	19407	7882	11525	27289	6%	444	680	-236	1125	0%	726	536	191	1262	0%	238	28	209	266	0%	29941
Food, Beverages and Tobacco	7100	4641	2460	11741	2%	2002	1716	287	3718	1%	3331	2381	950	5712	2%	1275	1014	261	2289	0%	23460
Pulp, Paper, Paper, Printing	5595	3365	2230	8960	2%	1300	2875	-1575	4176	1%	2360	4427	-2067	6787	2%	1534	1355	178	2889	1%	22812
Textiles and Textile Products	2280	360	1921	2640	1%	1771	989	781	2760	1%	3101	1055	2046	4156	1%	693	264	430	957	0%	10513
Manufacturing, Nec; Recycling	4434	2172	2262	6605	1%	191	1757	-1566	1949	0%	481	1176	-696	1657	1%	195	72	123	268	0%	10478
Electrical and Optical Equipment	3154	1595	1559	4749	1%	163	3356	-3193	3520	1%	291	1350	-1059	1641	1%	82	65	17	147	0%	10056
Wood. Products of Wood. Cork	289	2349	-2059	2638	1%	397	1102	-705	1499	0%	923	704	219	1628	1%	78	2089	-2010	2167	0%	7931
Other Supporting and Aux.Transp.	1083	674	409	1756	0%	362	737	-375	1100	0%	1119	2342	-1223	3461	1%	253	121	133	374	0%	6691
Wholesale Trade and Com. Trade	95	644	-549	738	0%	503	1371	-867	1874	0%	1966	1832	134	3798	1%	4	65	-61	69	0%	6479
Renting of M&Eq. Other Business	5	609	-604	614	0%	54	2685	-2632	2739	1%	50	2689	-2640	2739	1%	9	74	-65	83	0%	6175
Machinery, Nec	1436	1034	402	2470	1%	353	1130	-777	1483	0%	585	892	-307	1478	0%	135	53	83	188	0%	5618
Sale, Maintenance and Repair	1923	959	964	2883	1%	181	614	-433	795	0%	457	428	30	885	0%	45	363	-318	408	0%	4971
Leather, Leather and Footwear	2106	1094	1012	3200	1%	168	119	48	287	0%	347	102	246	449	0%	57	83	-26	139	0%	4075
Construction	902	830	72	1732	0%	209	611	-402	820	0%	711	680	31	1391	0%	3	12	-9	15	0%	3957
Retail Trade, Except Motor Veh.	25	212	-188	237	0%	147	737	-590	885	0%	390	1129	-739	1520	1%	3	47	-45	50	0%	2692
Post and Telecommunications	19	91	-72	110	0%	97	493	-396	590	0%	134	735	-600	869	0%	4	8	-4	12	0%	1581
Financial Intermediation	3	45	-42	48	0%	34	357	-323	390	0%	22	196	-174	218	0%	7	12	-4	19	0%	676
Public Admin and Defence	1	40	-39	41	0%	15	240	-225	254	0%	10	106	-96	116	0%	3	138	-135	142	0%	553
Real Estate Activities	0	56	-56	56	0%	2	144	-141	146	0%	3	117	-113	120	0%	1	8	-7	9	0%	331
Hotels and Restaurants	1	25	-24	26	0%	6	121	-115	127	0%	21	117	-96	137	0%	1	12	-11	13	0%	303
Education	0	11	-11	11	0%	0	45	-45	46	0%	1	37	-36	38	0%	0	7	-7	7	0%	101
Health and Social Work	1	8	-6	9	0%	9	22	-13	30	0%	26	17	9	43	0%	1	2	-1	3	0%	85
Private Househ. Employed P.	0	0	0	0	0%	0	1	-1	1	0%	0	0	0	0	0%	0	0	0	0	0%	1
TOTAL	**373300**	**111600**	**261700**	**484900**		**285069**	**213083**	**71986**	**498151**		**165192**	**132970**	**32222**	**298162**		**287824**	**248380**	**39444**	**536204**		**1817418**

Table 2: Emissions embodied in Spanish trade with non-EU countries in 2009 (t)

Productive sectors	NMVOC					CO					NOX					CH4					
	EEE	EEI	ETB	TET	%TET	EEE	EEI	ETB	TET	%TET	EEE	EEI	ETB	TET	%TET	EEE	EEI	ETB	TET	%TET	TET*
Coke, Ref. Petroleum and Nuclear	6004	674970	-668966	680974	53%	6697	2551358	-2544661	2558055	59%	16652	11743	4908	28395	5%	2562	8991	-6429	11553	1%	3278977
Agriculture, Hunt. Forestry. Fish	82392	52354	30039	134746	10%	31814	100387	-68573	132202	3%	14970	139894	-124924	154864	25%	71759	772352	-700593	844111	44%	1265923
Mining and Quarrying	112	61988	-61876	62100	5%	292	228154	-227862	228446	5%	1465	32409	-30944	33874	5%	7325	688660	-681335	695986	37%	1020406
Basic Metals. Fabricated Metal	12109	33449	-21341	45558	4%	129474	331220	-201746	460694	11%	7667	16988	-9320	24655	4%	1865	5279	-3414	7144	0%	538051
Inland Transport	3212	16156	-12944	19368	2%	5108	198452	-193343	203560	5%	22869	71175	-48306	94045	15%	600	96334	-95734	96933	5%	413905
Chemicals and Chemical Products	11656	140371	-128715	152027	12%	4093	126748	-122654	130841	3%	5676	23340	-17664	29016	5%	4576	11376	-6800	15952	1%	327836
Electricity, Gas and Water Supply	680	11665	-10984	12345	1%	1204	126910	-125706	128114	3%	13467	85592	-72125	99060	16%	1791	50474	-48683	52265	3%	291784
Community, Soc.& Pers. Serv.	791	2641	-1850	3432	0%	157	8756	-8599	8912	0%	107	1610	-1502	1717	0%	21860	148964	-127105	170824	9%	184885
Rubber and Plastics	14135	30877	-16742	45011	4%	324	124362	-124039	124686	3%	527	13337	-12810	13865	2%	173	439	-266	612	0%	184173
Water Transport	2059	6054	-3995	8113	1%	882	50683	-49801	51565	1%	23275	24899	-1623	48174	8%	39	374	-335	413	0%	108265
Air Transport	1295	4427	-3132	5723	0%	6502	71839	-65337	78341	2%	7764	14272	-6509	22036	4%	19	56	-36	75	0%	106175
Other Non-Metallic Mineral	1021	12405	-11384	13427	1%	10404	42335	-31930	52739	1%	12537	15331	-2794	27868	4%	847	780	68	1627	0%	95661
Textiles and Textile Products	1844	8771	-6927	10615	1%	1432	29229	-27797	30661	1%	2510	4812	-2302	7322	1%	561	235	325	796	0%	49393
Food, Beverages and Tobacco	3257	18860	-15604	22117	2%	918	14721	-13803	15639	0%	1534	4225	-2691	5759	1%	585	384	201	968	0%	44483
Electrical and Optical Equipment	2659	7372	-4713	10032	1%	138	26866	-26729	27004	1%	222	3809	-3587	4031	1%	69	110	-41	179	0%	41246
Manufacturing, Nec; Recycling	3130	6834	-3704	9964	1%	135	27438	-27303	27573	1%	324	2966	-2642	3290	1%	138	217	-79	355	0%	41181
Renting of M&Eq. Other Business	4	6961	-6957	6965	1%	38	23292	-23254	23331	1%	24	4153	-4129	4178	1%	6	397	-391	403	0%	34876
Pulp, Paper, Paper, Printing	4345	3768	577	8113	1%	1010	8899	-7890	9909	0%	1820	3660	-1840	5481	1%	1191	310	881	1501	0%	25003
Transport Equipment	8325	1560	6765	9885	1%	824	4134	-3310	4958	0%	1162	1007	155	2169	0%	346	67	278	413	0%	17426
Other Supporting and Aux.Transp.	935	2636	-1701	3571	0%	313	8201	-7888	8514	0%	963	1651	-688	2613	0%	219	203	16	422	0%	15120
Wholesale Trade and Com. Trade	76	2329	-2253	2405	0%	402	7642	-7240	8045	0%	1561	1383	178	2944	0%	3	73	-69	76	0%	13470
Machinery, Nec	1574	2152	-578	3726	0%	387	6763	-6376	7150	0%	621	1346	-725	1967	0%	148	76	73	224	0%	13066
Wood. Products of Wood. Cork	220	1907	-1687	2128	0%	303	6483	-6181	6786	0%	692	1077	-385	1769	0%	60	107	-47	167	0%	10849
Hotels and Restaurants	1	2136	-2135	2136	0%	5	7362	-7357	7368	0%	16	1152	-1136	1168	0%	0	45	-45	46	0%	10717
Retail Trade, Except Motor Veh.	17	1895	-1878	1912	0%	101	6648	-6547	6749	0%	266	1019	-753	1285	0%	2	31	-29	33	0%	9979
Leather, Leather and Footwear	1443	848	594	2291	0%	115	3012	-2897	3126	0%	237	423	-186	660	0%	39	32	7	71	0%	6148
Post and Telecommunications	15	949	-934	964	0%	79	3123	-3045	3202	0%	107	559	-452	666	0%	3	19	-16	22	0%	4854
Financial Intermediation	5	988	-983	993	0%	53	3100	-3047	3153	0%	33	605	-572	638	0%	11	31	-19	42	0%	4826
Construction	711	1386	-675	2096	0%	165	1325	-1160	1490	0%	541	427	115	968	0%	2	12	-10	15	0%	4568
Sale, Maintenance and Repair	1579	410	1169	1989	0%	149	1381	-1233	1530	0%	373	235	138	607	0%	37	45	-8	82	0%	4208
Public Admin and Defence	1	610	-608	611	0%	14	2108	-2094	2122	0%	9	350	-341	359	0%	3	40	-37	43	0%	3135
Real Estate Activities	0	311	-311	311	0%	2	993	-991	995	0%	1	186	-185	187	0%	1	16	-16	17	0%	1510
Health and Social Work	1	175	-174	176	0%	6	630	-624	636	0%	18	93	-76	111	0%	1	10	-10	11	0%	934
Education	0	124	-124	124	0%	0	417	-416	417	0%	0	73	-73	73	0%	0	5	-5	5	0%	619
Private Househ. Employed P.	0	0	0	0	0%	0	0	0	0	0%	0	0	0	0	0%	0	0	0	0	0%	0
TOTAL	165608	**1120337**	**-954730**	**1285945**		**203540**	**4154972**	**-3951432**	**4358512**		**140013**	**485801**	**-345788**	**625813**		**116841**	**1786543**	**-1669702**	**1903384**		