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Abstract

Two databases are constructed on GHG emissions associated with Argentina's international trade between 2000 and 2017, emissions derived from the production of exported goods and those associated with the international transport of exports and imports. Food, beverages, and tobacco, and agriculture, hunting, and related activities, followed by manufactures of metal and chemical products, are the main sectors that explain GHG emissions linked to exports. Petroleum, gas, and mining became less significant. The same sectors explain most of the CO2 emissions linked to the international transportation of exports. For emissions linked to the transportation of imports used in the production of exports, the main contributing sectors are those relating to industrial manufacturing. A decomposition exercise reveals that for emissions linked to the production of exports, the scale effect contributed more significantly in 2000–2011 than in 2012–2017, although in both cases its effect was positive. The composition effect was much less significant. For the emissions associated with international transportation, the main drivers were the scale, sector, and partner effects. Changes in the sector structure of exports appear to have caused more emissions between 2000 to 2011, but the opposite was observed between 2011 and 2017. In the case of emissions from international transportation, changes in the sector structure increased pollution in the case of the transportation of exports, while the opposite was the case for the transportation of imports.

JEL Codes : F10, F18
Keywords: Greenhouse gas emissions, exports, Argentina

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1. Introduction

Since World War II, international trade has grown faster than production, a trend that is expected to continue in the future. This process led to an increase in the share of greenhouse gas (GHG) emissions associated with international trade, which has prompted the emergence of a large body of literature that focuses on the contribution of international trade to GHG emissions. This literature has dealt with methodology issues, such as the most appropriate way to account for GHG emissions and allocate them among the different global economies. Great efforts have also been made to quantify the emissions associated with international trade. As pointed out by Cadarso et al. (2010), the literature has mainly focused on the measurement and allocation of responsibilities for the environmental consequences of imported goods and exports.

More recently, the growth in international trade has been driven by the process of international production-sharing, in which production is broken down into activities and tasks that are performed in different countries, leading to the emergence of so-called global value chains (GVCs). The growing importance of GVCs in the context of international trade means that more transportation services are required to achieve the same level of trade, leading to a foreseeable increase in the contribution of the latter to GHG emissions. However, although considerable efforts have been devoted to quantifying the contribution of international trade to GHG emissions, these have not been matched by studies examining the role of emissions from the international transportation associated with international trade (Cadarso et al., 2010; Cristea et al., 2013).

The limited literature available on this matter seeks to improve the estimations associated with alternative transportation methods (Cadarso et al., 2010). As pointed out by Cristea et al. (2013), this literature has been limited in scope and typically focused on a particular product and geographic market. As these authors note, a large part of the literature focuses exclusively on maritime and air transportation, overlooking road and rail transportation, which may represent a significant fraction of international trade for partners sharing land borders. For many countries, these trade relationships have gained importance as an increasing share of international trade is between countries involved in some sort of regional integration scheme. Martinez et al. (2014) point out that trade liberalization has an impact on global trade patterns and also on the nature of goods trade and transportation costs, thus influencing the volume of freight and the choice of modes of transportation and routes.

The reasons for the relative absence of studies on the contribution of international trade-related transportation to GHG emissions include the lack of systematic data on trade by mode of transportation (Cristea et al., 2013), as well as the difficulties in estimating the transportation component of international trade (Martinez et al., 2014), particularly with sufficient detail.

Drawing on the spirit and methodology of Cristea et al. (2013), we construct a database to account for CO_2 emissions associated with Argentina's foreign trade in which emissions are identified at the individual trade-flow level; product–destination–mode of transportation, in the case of exports; and product–origin–provenance-mode of transportation, in the case of imports. An important factor in constructing the database was the effort spent on calculating maritime transportation distances, as this is the most important alternative mode of transportation for international trade. As pointed out by Martinez et al. (2014), the use of the great-circle formula precludes considerations of geographical specificities and the availability of transportation networks, which can produce significant biases in calculations. We improve on the approach of Cristea et al. (2013) and take Argentina's considerable geographic size into account by working with different ports of departure/arrival for exports, depending on the products being traded. One issue highlighted by Martinez et al. (2014) that we do not take into account is the reduction of fixed costs with distance, which are often important for maritime transportation.

One additional database was also constructed, reporting the emissions associated with the production of Argentina's exports. In this case, the database includes both CO_2 and non-CO_2 gases.

Finally, it is important to note that the construction of the databases follows what could be viewed as an accounting criterion. In this regard, we did not consider which of the emissions associated with Argentina's international trade should be attributed to the country itself and which to its trading partners.[3]

The remainder of this study is organized as follows. Section 2 describes the steps followed to construct the databases. Section 3 includes a description of Argentina's trade trends, focusing on the main products traded, commercial partners, and associated modes of transportation. Section 4 presents a descriptive analysis of the evolution of GHG emissions associated with Argentina's exports. In section 5 different decomposition exercises are carried out trying to identify the main drivers behind the changes in emissions. Section 6 summarizes the main findings.

2. Database of GHG Emissions Associated with Argentina's International Trade

2.1 Production of Argentina's Exports

First, we will describe the construction of the database of emissions associated with the production of Argentina's exports. To obtain data at the 6-digit level of the 1996 version of the Harmonized System (HS), the database was constructed in two steps. We used data from the Global Trade Analysis Project (GTAP), which provides information on emissions associated with production by sector.

We used the GTAP 10.1 database, which has information for 2004, 2007, 2011, and 2014 for both CO_2 and non-CO_2 emissions (converted to CO_2 equivalents). Specifically, in the case of CO_2 emissions, we used GTAP data on "emissions from intermediate usage of domestic product" and "emissions from intermediate usage of imports."[4] For non-CO_2 emissions, we included "non-CO_2 emissions associated with output,"[5] "emissions associated with interim use of FFs," "emissions associated with interim use of non-FFs," and "non-CO_2 emissions associated with endowment."[6] The reason for including the emissions associated with endowments in non-CO_2 emissions is because they explain most (about 60%) of the latter in Argentina.

In the first step, to account for the emissions embedded in intermediate domestic inputs, we followed Li (2020). For example, in the case of CO_2 emissions, the vector of total (direct and indirect) emissions to produce one unit of final demand is given by the following expression:

$$CO2^{FD} = F'_{CO2}\left(I - A^{d}\right)^{-1} \qquad (2.1)$$

In equation (2.1), F'_{CO2} is the vector of direct emission intensities; for sector s, emission intensity is given by $F_{CO2,s} = \frac{P_{CO2,s}}{Q_S}$, where $P_{CO2,s}$ is total CO_2 emissions in sector s and Q_S is total output in US dollars. A^d is the matrix of direct domestic requirements, so $\left(I - A^{d}\right)^{-1}$ is the Leontief matrix of direct and indirect requirements that represent the domestic supply chain. The emissions associated with total exports of sector s are given by:

$$CO2T_s^X = CO2_s^{FD} \times X_s \qquad (2.2)$$

where X_s are exports of sector s measured in US dollars.

[3] The two options here are the production-based and consumption-based approaches.

[4] These emissions are those generated by fossil fuel combustion: coal extraction (COA), crude oil (OIL), natural gas extraction (GAS), petroleum products (P_C), and gas manufacture and distribution (GDT).

[5] Non-CO_2 emissions are nitrous oxide (*NO_2*), methane (*CH_4*), and fourteen fluorinated gases (*F-GAS*), as well CO_2 emissions from non-fossil fuel combustion.

[6] Emissions linked to endowments as emissions drivers are included here, but they do not include land use activities per se. The reason for proceeding in this way is that emissions from land use are not directly allocated to GTAP drivers. See Chepeliev (2020) for more details on GTAP non-CO_2 GHG emissions.

The above procedure assumes that the technology used for domestic products sold on the domestic market is the same as for the production of exports.

Once we had obtained the emissions associated with exports, we combined this information with data on exported quantities (measured in kilograms[7]) to distribute sector emissions among the different HS codes for each of the sectors defined in GTAP and calculate the intensity of emissions, measured in Mt per 1,000,000 kilograms:

$$intk\_CO2_{s,t} = \frac{CO2T^{X}_{s,t}}{\sum_{h \in s} K_{h,t}} \times 1{,}000{,}000 \qquad (2.3)$$

where the subscript *h* indexes products at the HS 6-digit level corresponding to sector s, and $K_{h,t}$ are kilograms of product *h* exported in year *t*. For all products *h* corresponding to a given sector *s*, we assume they have the same intensity:

$$intk\_CO2_{h,t} = intk\_CO2_{s,t} \;\; for\ all\ h \in s \qquad (2.4)$$

For years for which no GTAP information is available, we used the intensities corresponding to the closest year for which there is such data.[8]

Once we had obtained (observed and imputed) emissions intensities for each product *h*, we were also able to calculate emissions intensities in terms of export values, measured in Mt per US$1,000,000:

$$intv\_CO2_{h,t} = \frac{intk\_CO2_{h,t} \times K_{h,t}}{X_{h,t}} \times 1{,}000{,}000 \qquad (2.5)$$

where $X_{h,t}$ are export free-on-board (FOB) values of product *h* in year *t*.

It is important to stress that the way we work means that emissions intensities in terms of quantities exported are the same for all products *h* corresponding to a given sector *s* and are also constant for those years for which the same GTAP database was used, but the same is not true for emission intensities in terms of exported values: $intv\_CO2_{m,t} \neq intv\_CO2_{n,t}$ for $m, n \in s$ and $m \neq n$, and $intv\_CO2_{m,t} \neq intv\_CO2_{m,t-1}$ for $m \in s$.

The procedure explained above is also used with non-CO_2 emissions.

2.2 International Transportation

This section presents the methodology we followed to construct the database on emissions associated with every origin-destination-product trade flow.

To start with, we collected product-level data on the value and weight of Argentina's trade and modes of transportation (i.e., road, sea, rail, and air) with every trading partner. Using this data, we calculated the number of transportation services involved in a particular trade flow, by mode. We combined this with information on CO_2 emissions produced per kilogram-kilometer (kg-km) by each mode of transportation. Thus, as in Cristea et al. (2013), we used a bottom-up approach in our accounting of the emissions associated with the international transportation of Argentina's trade.

When constructing the database, we took into account the fact that emissions depend on the mode of transportation employed and on the weight transported, not the value. Furthermore, the various modes of transportation—road, sea, rail, and air—entail significantly different CO_2 emissions, and the use of different modes varies widely across trade flows. For example, 1 kg of cargo flown 1 km on a plane generates between 50 and 200 times the emissions of that same kg-km on a bulk cargo carrier (Cristea et al., 2013).

[7] The data used on exports, values in US$, and kilograms comes from the Latin American Integration Association (ALADI) and the National Institute of Statistics and Census of Argentina (INDEC).

[8] The intensities of 2004 are used for 2000–2003 and 2005; those of 2007 for 2006 and 2008–2009; those of 2011 for 2010 and 2012; and those of 2014 for 2013 and 2015–2017.

Thus, CO_2 emissions associated with the international transportation of good g from origin o to destination d using transportation m in period t are calculated considering the quantity of the flow in kilograms, the type of transportation used, and the distance traveled between points o and d considering the chosen mode of transportation. This is done by considering the CO_2 emissions produced by transporting a common unit of the good (one kilogram of cargo transported one kilometer). In notational terms, the calculation of emissions associated with international trade transportation could be expressed as follows:

$$CO2_{g,m,t}^{o,d} = k_{g,m,t}^{o,d} \times dist_m^{o,d} \times\ intk\_CO2_m \tag{2.6}$$

where $CO2_{g,m,t}^{o,d}$ represents the CO_2 emissions associated with the transportation of good g from origin o to destination d using transportation m in period t; $k_{g,m,t}^{o,d}$ is the quantity, in kilograms; $dist_m^{o,d}$ refers to the distance in kilometers between the points of origin and the destination when mode of transportation m is used; and $intk\_CO2_m$ refers to the emissions for transporting the good via the specific mode of transportation measured in kg-km.

As mentioned in Cristea et al. (2013), there are some limitations and issues to consider when calculating emissions associated with trade flow transportation using this formula. On the one hand, it is assumed that emissions are linear to the distance and weight transported, as well as that emissions per type of transportation are the same regardless of the product transported and the pairs of countries considered in the equation. This issue leads to two sources of heterogeneity. First, transportation by type of product may require different types of ships or aircraft which emit different amounts of CO_2 per kg-km transported. Second, there are emissions associated with fixed costs of transportation that are incurred regardless of the distance and kilograms transported, such as port time for ships or higher emissions in the case of take-offs and landings for airplanes.[9]

Furthermore, another important issue that needs to be taken into account is the role of domestic transportation in international trade—specifically, whether the production and subsequent dispatch of goods to the trading partner imply that the goods are transported over long distances within the country. Considering the vast distances that may exist in Argentina between the places where goods are produced and the customs offices of departure, this is an important point to consider.

In the next section, we describe the main components of export data needed to calculate CO_2 emissions for the international transportation of products from Argentina each year. We then go on to calculate the CO_2 emissions associated with the international transportation of products imported by Argentina.

a) Exports

To construct the database, we need information on three main dimensions: i) export data (kilograms), ii) mode of transportation and distance, and iii) CO_2 emissions associated with each mode of transportation for a common unit of the good (1 kg-1 km).

Regarding the data for Argentina's exports by mode of transportation, we have used datasets from the Latin American Integration Association (ALADI) and the National Institute of Statistics and Census of Argentina (INDEC), which report trade by air, sea, rail, road, and other modes at the product level.

i. Trade data

The ALADI and INDEC databases provide information on the destination (trading partner) for each exported product at the 8-digit level of Argentina's customs code. To maintain consistency, our database converts this information to the HS 6-digit level using the 1996 version. The export data for each product is measured in s value and kilograms for each destination partner.

[9] In this case, Cristea et al. (2013) provide calculations that suggest that although these problems are significant for short distances, they become negligible over international transportation distances.

ii. Distance and mode of transportation

To calculate the distance traveled by each product toward its respective destination, we have taken into account the different modes of transportation reported in the databases.

The database we have constructed only contains data concerning road, sea, rail, and air transportation since these are the only modes of freight transportation for which CO_2 emissions data is available and they represent more than 98% of the FOB value exported, on average.

It is important to note that the distance a product must travel to a trading partner will vary depending on the mode of transportation used. For example, using the great-circle distance formula would be very inaccurate for shipping since routes are affected by the distribution of land masses and weather conditions, not just economic criteria. Below we explain the criteria used to calculate transportation distances depending on the mode of transportation specified in the ALADI database.

The Centre d'Etudes Prospectives et d'Informations (CEPII) database was used for products that were transported by road, rail, and air. Here, bilateral distances between country pairs are calculated by applying the great-circle formula, which uses the latitude and longitude of the most important city in each country.[10,11]

For road transportation, we also drew on the ALADI and INDEC databases: these are more detailed and provide information about the customs offices of exit within Argentina (a significant consideration given that the country's northern- and southern-most points are around 3700km apart). Thus, road transportation distances were calculated in two alternative ways. First, we used the distances listed in the CEPII database, which were constructed using the latitudes, longitudes, and population of the main agglomerations.[12] Second, we used a weighted average of the distances from the customs offices that the different products are cleared from.

There are some inconsistencies in the ALADI database concerning the recording of the means of transportation and the corresponding export destination. Specifically, for several observations, the export destination refers to a distant country to which road transportation is impossible (e.g., Spain). In these cases, we modified the means of transportation recorded by ALADI. Our strategy was to consider the main mode of transportation (in terms of the FOB value, net weight, and frequency) used to get the product to different destinations.[13]

In the case of air transportation, almost all exports leave from Ezeiza airport (Buenos Aires), so the distances were calculated using the CEPII database (great-circle method), taking Buenos Aires as the point of origin of Argentina's exports. Tucumán airport ranks second, far above other airports in the country, due to blueberry exports. In Argentina, most commercial flights are operated by mixed-use aircraft (passenger and cargo)—the Airbus A320, the Boeing B-777, and the Boeing B-737 are among the most widely used aircraft of this type.[14]

To obtain travel distances for maritime transportation, we used the sea-distances.org calculator, which estimates the distance between ports, speed measured in knots, and associated travel times. The shortest of the alternative routes proposed was chosen. Significantly, the INDEC database for exports contains detailed information regarding the port of departure in Argentina to the different destinations.[15] As

[10] http://www.cepii.fr/cepii/en/bdd_modele/presentation.asp?id=6.
[11] When the CEPII database does not provide the corresponding distances for specific partners, we used the great-circle calculator distance provided by http://www.marinewaypoints.com/learn/greatcircle.shtml.
[12] For road transportation, the great-circle formula used in the CEPII database incorporates some domestic transportation (Cristea et al., 2013).
[13] For more detailed data, please contact the corresponding author.
[14] Informes de Cadenas de Valor de la Secretaría de Política Económica Subsecretaría de Programación Microeconómica and Empresa Argentina de Navegación Aérea (EANA).
[15] However, the INDEC database does not provide information about the ports of arrival in the destination countries. In this case, the main port of each destination country was assumed to be the destination. In the case of

mentioned above, the distance between Argentina's northern- and southern-most points is considerable, so the distances between ports and trading partners can vary greatly. For this reason, the distances by sea were calculated in two alternative ways. First, we used the port of Buenos Aires as the point of departure for exports. Second, we used a weighted average of distances from Argentina's ports.[16]

Finally, while the ALADI database provided data on international trade by mode of transportation for 2008–2017, for the remaining years we have imputed the main mode of transportation used for the product-partner combination for 2008–2017 in the ALADI database. The main mode of transportation for a product to a specific destination was identified using a combination of observations/FOB value/net weight value. There are certainly some drawbacks to this imputation method since we are assuming that the mode of transportation is constant for the imputed years, and also because sometimes a product-partner combination was not observed in the available period provided by the ALADI database.[17]

iii. CO_2 intensities

The data on CO_2 emissions by mode of transportation comes from different sources. It identifies CO_2 emissions in grams per ton-km transported by the different modes of transportation identified in the ALADI database.

We have paid particular attention to maritime emissions, not only because this is the main mode used for Argentina's exports but also because of the significant differences in emissions among types of vessels. Different types and sizes of ships are used to transport different types of products from Argentina to various destinations.[18] For example, Handymax carriers are mainly used to transport grain to Africa, Latin America, and the Middle East, while the Panamax is used for grain exports to other destinations. Ro-Ro ships are used for vehicle exports while refrigerated cargo can either be transported in specialized containers or the bulk holds of dedicated refrigerated cargo ships.[19]

Based on this information, we assigned CO_2 emission intensities to the product exported taking these different types of vessels and destinations into account. To do so, we used the GTAP classification for 57 sectors.[20]

Most air transportation emissions (62%) come from international flights (ITF, 2015). However, air transportation only accounts for a small percentage of Argentina's exports (3.5% on average in 2008–2017). We use the simple average of the emission intensities corresponding to the most frequently used aircrafts (Airbus 320, Boeing B-777, and Boeing B-737).[21]

Table 2.1 presents CO_2 emissions by mode of freight transportation compiled from different sources.

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destination countries that do not have a coast (landlocked countries), trip distance to the nearest port was calculated. For the list of commercial ports used in distance calculations, please contact corresponding author.

[16] Data on customs exits is only available for 2003 to 2006.

[17] In this case, the means of transportation to the product-trading partner was assigned by searching for the main mode used to move the product in question, this time at the HS 4-digit level with the respective trading partner.

[18] Informe Tendencia de Flota Naval de Cargas Argentinas a Granel. https://www.argentina.gob.ar/sites/default/files/infome_tendencia_de_flota_cargas_argentinas_a_granel_v2web.pdf. We are also grateful for the information provided by Dario Gonzales Marjetko (former advisor to the Ministry of Transportation and head of the Federal Waterway Special Projects Unit at the General Port Authority) and Gustavo Deleersnyder (former National Director of Fluvial and Maritime Transportation at the Ministry of Transportation).

[19] As an initial approximation, this study assumes that all refrigerated cargo is shipped in refrigerated containers. Until the introduction of the integrated reefer container in the 1970s, seaborne temperature-controlled transportation predominantly took place in reefer ships: dedicated ships with cooled cargo holds which products are loaded into as break bulk or on pallets (Arduino et al., 2015, and Thanopoulou, 2012). The use of reefer ships has declined over time (Dynamar, 2017).

[20] For more detailed data, please contact the corresponding author.

[21] We are grateful to Brandon Graver at the ICCT for sharing his estimations on CO_2 emissions by airplane type (Graver et al., 2019).

Table 2.1. Emissions Per Ton-Km of Transportation Services, by Mode

Mode of transportation	CO_2 grams per ton/km	Source
Maritime emissions by vessel type		
Dry bulk—Handymax	6.3	IMO (2014) and Psaraftis and Kontovas (2008)
Dry bulk—Panamax	4.7	
General cargo	13.6	
Container	12.1	
Reefer	23.7	
Ro-Ro	19.7	
Oil tanker—mainly crude	5	
Chemicals	10.1	
LNG	16.3	
LPG	12.7	
Conventional reefer ships	23.7	
Reefer containers	17	Fitzgerald et al.(2010)
Land emissions by mode of transportation		
Road	119.7	Giannouli and Mellios (2005)
Rail	22.7	
Air emissions by plane type		
Boeing 747	552	Cristea (2013)
Airbus 320	650	Graver et al. (2020)
Boeing 737	1010	
Boeing 777	920	

b) Imports

Our data source for Argentina's imports by mode of transportation was the ALADI dataset, which reports trade by air, sea, rail, and road. Modal use for Argentina's imports is reported at the HS 8-digit level.

i. Trade data

The ALADI database contains information on Argentina's imports at the 8-digit level of Argentina's customs code by origin (the place from which the product is imported), provenance (the place where the product leaves for Argentina), CIF and FOB values, and kilograms. As with exports, with the objective of consistency, the data was expressed at the HS 6-digit level using the 1996 version.

ii. Distance and mode of transportation

The same sources and methodology explained above for Argentina's exports were used to compute the distance between the origins and provenances of its imports. For rail, road, and air transportation, we used the CEPII database. For imports transported by ship, we calculated the distance between ports using the sea-distance.org tool.

The ALADI database contains information about the origin and provenance of imports. Specifically, the country of origin is the country where goods are produced or manufactured based on the revised Kyoto Convention. Likewise, the country of provenance is the country from which the goods were initially shipped to the importing country without any commercial transaction in the countries in between.

We can assume the following path for the transportation of an imported product: country of origin–country of provenance–Argentina. The ALADI database only records the mode of transportation used for the provenance–Argentina leg. Thus, to calculate the kilometers traveled by an imported good more accurately, we should impute a type of transportation for the origin–provenance leg and calculate the distance in kilometers traveled between those two points, which will of course depend on the mode of transportation imputed to the origin–provenance leg and that one declared in the ALADI database for the provenance–Argentina leg.[22,23]

Data on modes of transportation is available for 2000, 2005, and 2008–2017. For the remaining years, we imputed the modes of transportation following the same procedure as with exports.

We detected some inconsistencies in the transportation registry provided by ALADI for the provenance–Argentina leg, specifically in the records for road transportation. That is, the ALADI database indicated land transportation for the provenance–Argentina leg in cases where this would have been impossible (e.g., Belgium–Argentina). In these cases, we corrected the entries and imputed the mode of transportation in the same way as with the export database.

iii. CO_2 intensities

The same sources mentioned above were used to compute the CO_2 emissions associated with each mode of transportation.

3. Trade Trends and Modes of Transportation

The descriptive analysis that follows considers data provided by ALADI for 2000, 2005, and 2008–2017, the years for which information on the mode of transportation of Argentina's trade is available. In the case of exports, the data on mode of transportation for 2000 and 2005 was imputed according to the methodology indicated in section 2.

The description will focus on the data concerning modes of transportation and will show some examples of the information that can be obtained from the database we have constructed. Most of the summary statistics will be presented in monetary terms (FOB values) and as quantities (kilograms)—the latter is needed to calculate transportation emissions as monetary value and weight do not necessarily go hand-in-hand.

For the descriptive trade trend analysis, we used the ISIC Rev. 3 nomenclature. First, we converted the HS codes to the ISIC Rev. 3 2-digit level. Then we grouped the 2-digit ISIC Rev. 3 sectors into ten broader sectors (see appendix): (i) agriculture, hunting, and related service activities; (ii) forestry, logging, and related service activities; (iii) fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing; (iv) petroleum, gas, and mining; (v) food, beverages, and tobacco; (vi) textiles; (vii) manufactures of wood and related products; (viii) manufactures of metal and chemical products; (ix) manufactures of machinery and equipment; (x) Manufactures of motor vehicles, transportation equipment, and parts.

As we can observe from table 3.1, the surpluses in the trade balance of goods are mainly explained by the food, beverages, and tobacco and agriculture sectors. On the other hand, the deficits are mostly from the machinery and vehicles sectors. The reversal in the balance of trade is explained by a steady increase in these deficits. The overall deficit by the end of the period was mainly due to the negative balances in the machinery and vehicles sectors, which reached negative values of US$17,600 million and US$ 8,120 million, respectively. On the other hand, the petroleum sector shows a significant reversal in its trade balance.

[22] For detailed data concerning the imputation methodology for modes of transportation, please contact the corresponding author.

[23] Just as imported goods may pass through an intermediate country before arriving in Argentina, the same can happen with exports, which do not always go directly to the country of destination. However, the information available for exports only provides data on the latter and not on any intermediate stops that may have taken place. These characteristics mean that in the case of exports, the distances calculated may underestimate the distances actually traveled.

Exports

More than 77% of Argentina's export basket is concentrated in three of the broad sectors defined above: food, beverages, and tobacco, with an average share of 37% for 2008–2017; agriculture, hunting, and related service activities, with 20%; and manufactures of metal and chemical products, with 21%. On the other hand, in 2000 and 2005, the share of the petroleum, gas, and mining sector was also significant (13% and 10%, respectively) but this fell to 2% in 2017.

Within each of these broad sectors, Argentina's exports are concentrated in a few products. Agriculture and hunting exports are mainly explained by just four products: soybean; maize (corn); wheat and meslin; and barley. More than 70% of the country's food, beverages, and tobacco exports are concentrated in eight products, of which soybean oil cake is the most important (40%). On the other hand, exports from the manufactures of metal and chemical products sector are more diversified: almost 40 products explain 70% of sales abroad. The most significant of these are natural/cultured pearls, precious stones and metals (silver and gold); mineral fuels, mineral oils, and products of their distillation (petroleum oil and petroleum gases); and miscellaneous chemical products (chemical products and preparations of the chemical or allied industries).

Table 3.1. Evolution of Trade Balance at FOB Value, by Broad Sectors. Millions of US$

Year	Agriculture	Fishing	Food, beverages, and tobacco	Forestry	Metal and chemical	Petroleum, gas, and mining	Textiles	Machinery	Vehicles	Wood	Total trade balance
2000	3,929	3	6,100	-25	-2,057	2,884	36	-6,928	-576	-1,072	2,294
2005	6,208	4	11,459	-27	901	3,377	359	-6,851	-994	-298	14,138
2008	12,228	0	21,631	-38	-4,070	1,289	-277	-12,247	-3,089	-1,058	14,367
2009	6,404	0	19,563	-28	-212	3,120	-188	-8,207	-133	-775	19,544
2010	11,812	-5	20,339	-33	-3,988	2,824	-138	-12,686	-2,744	-1,197	14,184
2011	16,109	-12	25,060	-48	-7,684	589	-684	-16,240	-3,813	-1,667	11,610
2012	15,168	-9	24,362	-67	-6,229	1,191	-485	-14,765	-3,249	-1,398	14,518
2013	14,567	-21	24,605	-66	-9,253	-1,338	-445	-16,224	-5,091	-1,438	5,296
2014	11,079	-23	24,244	-65	-7,747	-1,558	-214	-14,627	-91	-1,268	9,730
2015	10,927	-26	21,228	-66	-8,258	-1,663	-620	-16,044	-3,437	-1,512	528
2016	12,410	-38	21,740	-49	-5,768	148	-964	-14,470	-5,461	-1,561	5,987
2017	11,051	-43	20,887	-52	-6,676	-709	-1,109	-17,629	-8,104	-1,670	-4,056

Source: Authors based on ALADI.

Exports of manufactures of motor vehicles are concentrated in just a few products (5 products explain 70%): motor cars and other motor vehicles principally designed for the transportation of persons and motor vehicles for the transportation of goods are the products that explain most exports in this sector (73%). Autoparts are important, too, with the three main products being gear boxes, engines, and drive-axles with differential.

In terms of the kilograms transported, Brazil is the main destination for Argentina's exports for every year of the period considered here. The United States and Chile followed in the ranking until 2007, when China moved into second place. In recent years, Vietnam[24] and India have also emerged as major destinations for sales of Argentina's products.

When the analysis is carried out at the product level for the ten main products (2-digit HS) exported to the main trading partners, in the case of Brazil, cereals and vehicles and auto parts represent almost 50% of sales to this country. Petroleum oils and petroleum gases are the products exported most to Chile,

[24] The emergence of Vietnam as a major destination, especially for agricultural products, may be explained by the fact that the country is an intermediate destination before exports reach their final destination. However, the available information does not allow us to verify this hypothesis.

along with animal or vegetable fats and oils and their cleavage products. In the case of the USA, petroleum oils (crude and preparations) and aluminum are among the best-selling products. China mainly buys soybeans and soybean oil and its fractions; while animal or vegetable fats and oils and their cleavage products account for 67% of the average sales to India (see table A.3.1 in the appendix for the complete picture).

Table 3.2 shows the evolution of the modes of transportation used for Argentina's exports.[25] The main mode is maritime, both in terms of FOB values and kilograms transported. Since 2000, there has been a sustained increase in the use of ships and a fall in the share of road transportation (trucks). This pattern could be explained by the decline in South America as a destination for Argentina's exports and the increase in the share of more distant countries (East Asia, for example).

Considering FOB values, in 2008–2017, an average of 77% of the products that Argentina sold to the rest of the world were transported by sea, followed by road (17%) and air (6%). The amount of international trade transported by rail is irrelevant. These percentages change if the analysis is based on the number of kilograms transported: maritime transportation accounts for even a higher percentage (92% on average for the period considered) and road transportation falls to 8%.

Table 3.2. Exports. Share of Mode of Transportation. FOB Values and Kilograms

Year	% FOB Values				% Kilograms			
	Airplane	Ship	Train	Truck	Airplane	Ship	Train	Truck
2000*	5.81	73.57	0.02	20.60	0.51	88.14	0.05	11.30
2005*	3.44	78.25	0.04	18.28	0.54	84.61	0.09	14.75
2008	3.68	80.42	0.14	15.76	0.10	91.63	0.18	8.09
2009	5.33	77.26	0.14	17.27	0.09	89.67	0.28	9.96
2010	6.27	76.33	0.15	17.25	0.08	90.91	0.25	8.75
2011	5.95	77.76	0.14	16.15	0.08	91.12	0.27	8.54
2012	6.04	77.08	0.11	16.77	0.08	91.32	0.20	8.40
2013	5.53	75.95	0.10	18.42	0.08	91.51	0.17	8.24
2014	5.79	76.67	0.09	17.45	0.08	91.64	0.16	8.12
2015	7.91	75.77	0.03	16.29	0.06	92.16	0.07	7.71
2016	5.77	79.15	0.05	15.02	0.06	93.73	0.11	6.11
2017	7.26	76.79	0.07	15.87	0.06	93.42	0.15	6.37

Notes: * Imputed data. Source: Authors based on ALADI.

Shipping is the main mode of transportation used to export products to Argentina's major destinations. Table 3.3 presents examples of the country's main trade partners and products exported. For neighboring countries (Chile and Brazil), trucks play an important role in transportation for almost every product except for cereals and mineral fuels, where the most frequently used mode of transportation is again maritime.

[25] The data on mode of transportation for 2000 and 2005 was imputed according to the methodology presented in section 2.

Table 3.3. Exports. Mode of Transportation Used for Main Products Exported to Main Destinations. Average 2008–2017. Kilograms

Partner	Product code	Transportation	%	Product description
Brazil	10	Train	0.43	Cereals
		Sea	96.67	
		Road	2.9	
	27	Sea	98.62	Mineral fuels, mineral oils and products of their distillation, etc.
		Train	0.12	
		Road	1.26	
	87	Road	42.8	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
		Sea	57.12	
		Air	0.09	
Chile	10	Sea	90.01	Cereals
		Road	9.99	
	15	Sea	1.24	Animal or vegetable fats and oils and their cleavage products, etc.
		Road	98.76	
	27	Train	0.04	Mineral fuels, mineral oils, and products of their distillation, etc.
		Sea	77.43	
		Road	22.53	
United States	20	Sea	99.94	Preparations of vegetables, fruit, nuts, or other parts of plants
		Air	0.06	
	27	Sea	100	Mineral fuels, mineral oils, and products of their distillation, etc.
	76	Sea	99.99	Aluminum and articles thereof
		Air	0.01	
China	12	Sea	100	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.
	15	Sea	100	Animal or vegetable fats and oils and their cleavage products, etc.
	27	Sea	100	Mineral fuels, mineral oils, and products of their distillation, etc.
India	10	Sea	99.95	Cereals
		Air	0.05	
	15	Sea	100	Animal or vegetable fats and oils and their cleavage products, etc.
	27	Sea	99.99	Mineral fuels, mineral oils, and products of their distillation, etc.
		Air	0.01	
Vietnam	10	Sea	100	Cereals
	15	Sea	100	Animal or vegetable fats and oils and their cleavage products, etc.
	23	Sea	100	Residues and waste from the food industries; prepared animal fodder

Source: Authors based on ALADI.

Imports

Argentina's imports are strongly concentrated in just some of the broad sectors defined above. If we consider the FOB values, manufactures of machinery and equipment, manufactures of metal and chemical products, and manufactures of motor vehicles account for almost 85% of annual imports, on average. Looking at kilograms transported, manufactures of machinery and equipment and manufactures of motor vehicles are no longer significant. Instead, manufactures of metal and chemical products and petroleum, gas, and mining account for almost 82% of the average annual total.

If we consider both FOB and kilograms, Brazil is the main origin of Argentina's imports for every year of the study period. The United States and European countries were next in the ranking until 2007, when second place was occupied by China. In recent years, Bolivia and Paraguay have also emerged as major origins for Argentina's imports (especially considering kilograms of imported products).

When we analyze Argentina's imports from its main trading partners in kilograms (2-digit HS), we observe that for Brazil, ores, slag, and ash and iron and steel together represented almost 59% of imports. Mineral fuels, mineral oils, and products of their distillation are the main products imported from Nigeria, Trinidad and Tobago, Russia, and the USA. Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit and edible fruit and nuts are among the most important products from Bolivia (74%). Fertilizers are among the top ten most imported products from different trading partners (Trinidad and Tobago, Russia, China, Nigeria, and the United States). Finally, vehicles and parts are mainly imported from Brazil, Spain, Germany, and China (see appendix, table A.3.2 for more details).

Our analysis of the modes of transportation that are associated with Argentina's imports is also limited to 2000, 2005, and 2008–2017, the years for which ALADI reports mode of transportation by trade flow. Table 3.4 shows how the means of transportation for Argentina's imports have changed.[26] The main means of transportation is maritime. In terms of FOB values, an average 66% of Argentina's imports from the rest of the world are transported by sea, less than the percentage reported for exports. Next in order of importance is air (17.35%), followed by road (16.72%), while the share of rail as a mode of transportation for international trade is irrelevant. When imports are analyzed in terms of kilograms transported, the percentages change, and shipping comes to account for an even larger share—88% on average for the period analyzed—road transportation falls to 12%, and the share of air transportation becomes irrelevant.

Looking at the sector level, and considering kilograms transported, sea transportation is the main means used for the products that make up most of the broad sectors defined. Food, beverages, and tobacco and wood products transported by road were also important, and road transportation stands out for manufactured vehicles and forestry products. This is because a large share of imports from these sectors come from neighboring countries, especially Brazil.

Finally, when we look at the means of transportation used to bring Argentina's major imports from their main origins, shipping once again stands out (see table 3.5) although trucking also plays an important role in the transportation of some products from bordering countries.

[26] As noted above, the ALADI database provides information on the means of transportation for imports for the provenance–Argentina leg, but this is not the same as the origin of imports. Therefore, the analysis in the following section considers the means of transportation for the leg for which ALADI information is available. However, the percentage of imports for which the country of origin is the same as the country of provenance is 84% on average in terms of FOB values and 94% on average in terms of kilograms.

Table 3.4 Imports. Share of Mode of Transportation. FOB Values and Kilograms

Year	% FOB Values				% Kilograms			
	Airplane	Ship	Train	Truck	Airplane	Ship	Train	Truck
2000	24.39	57.24	0.54	17.83	0.63	84.03	0.88	14.47
2005	19.54	59.72	0.49	20.25	0.45	82.72	1.03	15.81
2008	14.80	67.95	0.41	16.83	0.52	86.47	0.70	12.31
2009	19.08	61.59	0.30	19.04	0.58	82.68	0.59	16.16
2010	16.45	63.63	0.34	19.59	0.65	85.34	0.59	13.41
2011	14.96	67.04	0.37	17.62	0.59	88.09	0.45	10.86
2012	16.28	66.20	0.27	17.25	0.55	87.64	0.47	11.34
2013	16.56	67.03	0.19	16.23	0.54	88.59	0.40	10.47
2014	18.07	66.98	0.16	14.79	0.61	89.71	0.32	9.35
2015	21.06	63.32	0.04	15.57	0.62	89.22	0.20	9.96
2016	18.90	66.07	0.04	14.98	0.58	89.25	0.14	10.04
2017	17.32	67.34	0.01	15.32	0.56	88.29	0.05	11.10

Source: Authors based on ALADI.

4. Evolution of GHG Emissions Associated with Argentina's Exports

In this section, we briefly present the evolution of GHG emissions associated with Argentina's exports. As described in the previous section, two databases are available: one for GHG emissions associated with the production of exports and the other for CO_2 emissions associated with the international transportation of exports and imports. Since our focus here is emissions relating to Argentina's exports, the only imports we are interested in are those used in the production of exportable goods.

To impute the emissions corresponding to these imports, we used the information provided by GTAP on the import input-output matrix. For each sector *s*, the proportion of imports of products that correspond to that sector and that are then incorporated into the exports of the sector *s* itself, as well as into the exports of other sectors, is calculated as follows:

$$sh_s = \frac{\sum_j m_{sj}\frac{X_j}{Q_j}}{M_s} \qquad (4.1)$$

where m_{sj} are imports of goods produced by sector *s* used as inputs in the domestic production of sector *j*; X_j and Q_j are, respectively, exports and production of sector *j*; and M_s are total imports of goods that belong to sector *s*. For each registry in the database on CO_2 emissions linked to the international transportation of imports, and using the correspondence between the HS and GTAP classifications, we can obtain the emissions associated with the international transportation of imports that are then used in the production of exports.[27] Since GTAP data is only available for 2004, 2007, 2011, and 2014, for the remaining years we follow the same approach we used to calculate the GHG emissions associated with export production.

As described in section 2, the GTAP 10.1 database was used to calculate emissions, which provides information for four reference years: 2004, 2007, 2011, and 2014. For the remaining years, emissions were imputed under the assumption that the emissions intensities per kilogram exported for a given year correspond to those of the nearest year. For CO_2 emissions linked to the international transportation of Argentina's exports and imports, information is available for 2000, 2005, and 2008 to 2017.

[27] This procedure means that for all products *h* of the HS that correspond to a given GTAP sector *s*, the same *shs* proportion is applied.

Table 3.5. Imports. Mode of Transportation Used for Main Products Imported from Main Origins. Average 2008–2017. Kilograms.

Partner	Product code	Transportation	%	Product description
Brazil	26	Sea	99.22	Ores, slag, and ash
		Train	0.60	
		Road	0.18	
	28	Sea	86.21	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.
		Road	10.39	
		Train	3.39	
	72	Sea	79.34	Iron and steel
		Road	17.07	
		Train	3.59	
United States	27	Sea	99.96	Mineral fuels, mineral oils, and products of their distillation, etc.
		Road	0.04	
	29	Sea	99.65	Organic chemicals
		Air	0.22	
		Road	0.13	
	31	Sea	99.99	Fertilizers
		Road	0.01	
China	29	Sea	96.99	Organic chemicals
		Air	2.59	
		Road	0.42	
	31	Sea	100.00	Fertilizers
	84	Sea	88.09	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof
		Air	10.72	
		Road	1.18	
		Train	0.01	
Bolivia	8	Road	99.99	Edible fruit and nuts; peel of citrus fruit or melons
		Sea	0.01	
	12	Road	51.44	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.
		Sea	48.55	
	26	Sea	70.20	Ores, slag, and ash
		Road	29.80	
Paraguay	12	Sea	99.91	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.
		Road	0.09	
	25	Road	98.52	Salt; sulfur; earths and stone; plastering materials, lime, and cement
		Sea	1.48	
	69	Road	100.00	Ceramic products
Germany	48	Sea	99.62	Paper and paperboard; articles of paper pulp, of paper, or of paperboard
		Road	0.21	
		Air	0.17	
	72	Sea	99.67	Iron and steel
		Road	0.28	
		Air	0.05	
	87	Sea	98.97	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
		Road	0.62	
		Air	0.42	

Source: Authors based on ALADI.

As can be seen in figure 4.1, GHG emissions associated with the production of Argentina's exports exhibit an upward trend until 2005 and then behave more erratically, albeit on a downward trend. There is a slight upward trend over the entire period. When we distinguish between CO_2 and non-CO_2 emissions, the former represent around 40%, although these shares vary somewhat over time.

In figure 4.2, we report the CO_2 emissions from the international transportation of Argentina's exports and the imports that are used to produce these exports. Around 95%–98% of the total emissions are explained by the transportation of export products. Likewise, if we look at the total emissions associated with the production of exports and their international transportation, production accounts for 82%–87% (figure 4.3).

We explore the main sources of emissions from two different aspects: sector (figure 4.5) and trading partner (figure 4.6). In each case, we distinguish between emissions that are linked to the production of exports and those associated with the international transportation of these exports and of imports used as inputs.

Figure 4.1. Emissions Sources for Argentina's Export Production

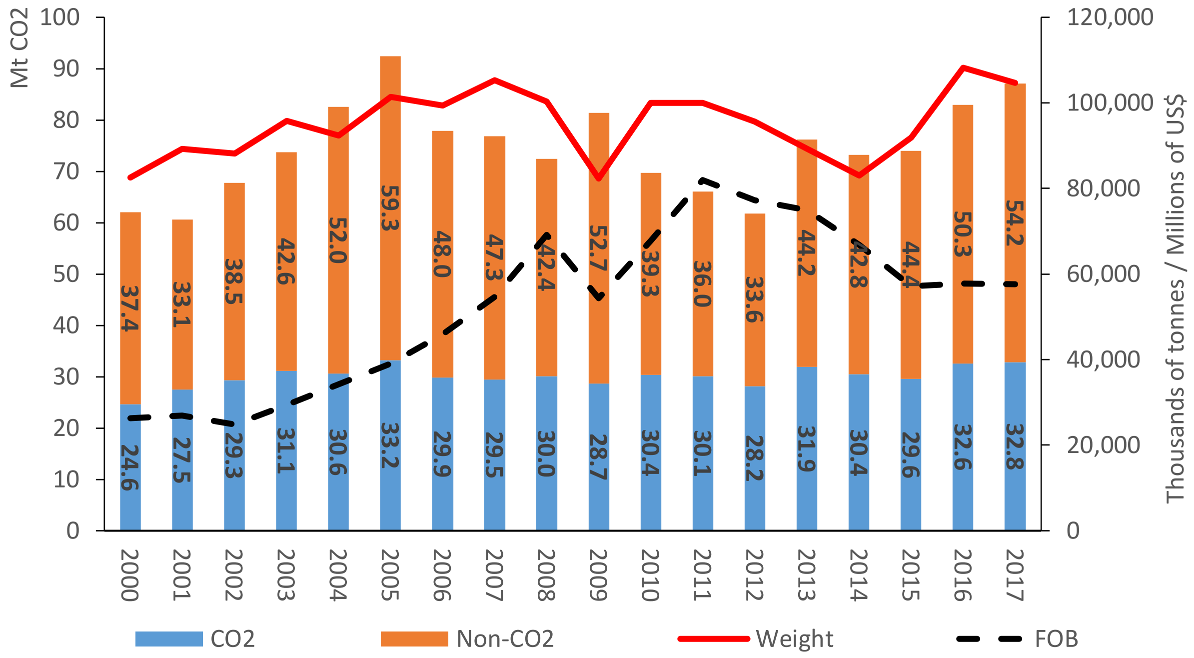


Figure 4.2. CO_2 Emissions Associated with the International Transportation of Argentina's Exports

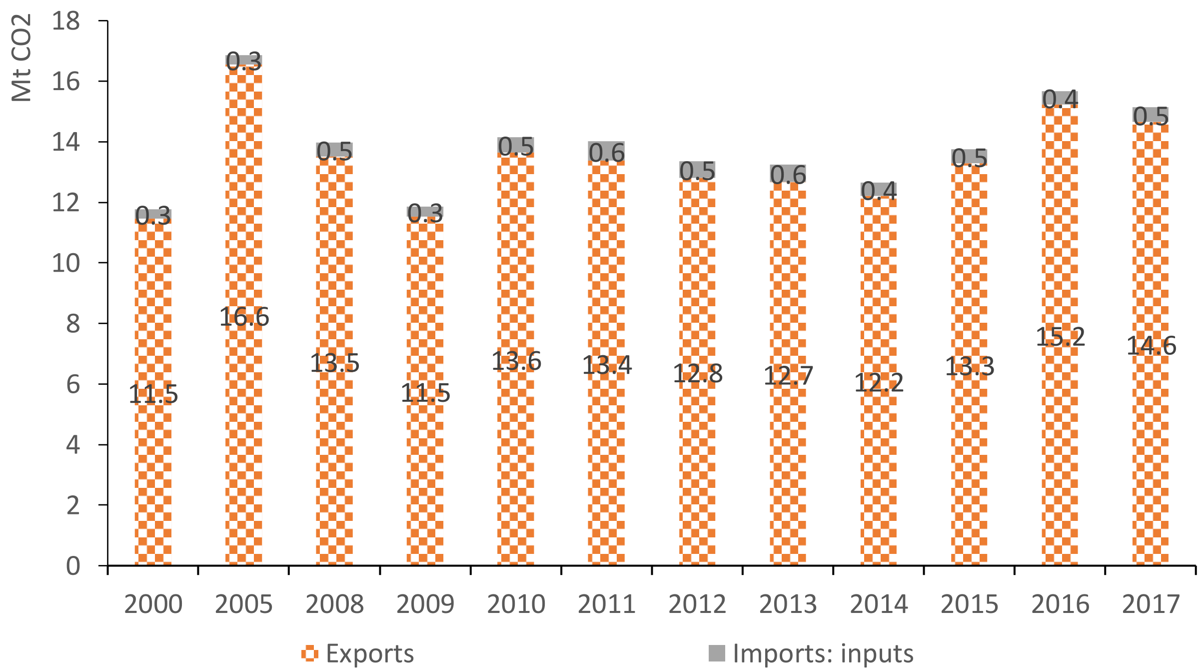


Figure 4.3. Sources of GHG Emissions Associated with Argentina's Exports

Not surprisingly, the main sectors that contribute to the GHG emissions associated with the production of exports are those that contribute most to these exports: food, beverages, and tobacco, and agriculture, hunting, and related activities. Another important sector is manufactures of metal and chemical products. Two sectors that were significant at the beginning of the study period but whose shares have shrunk are textiles and, more importantly, petroleum, gas, and mining. The decline in the latter's share is particularly interesting and is explained by the drastic reduction in exports as a result of a policy that favored the domestic market.

As might be expected, the same main sectors explain most of the CO_2 emissions linked to the international transportation of exports. However, the share of the two main contributing sectors (food, beverages, and tobacco, and agriculture, hunting, and related activities) is greater: together they account for almost 90% by the end of the period. Once again, the share of petroleum, gas, and mining decreased considerably.

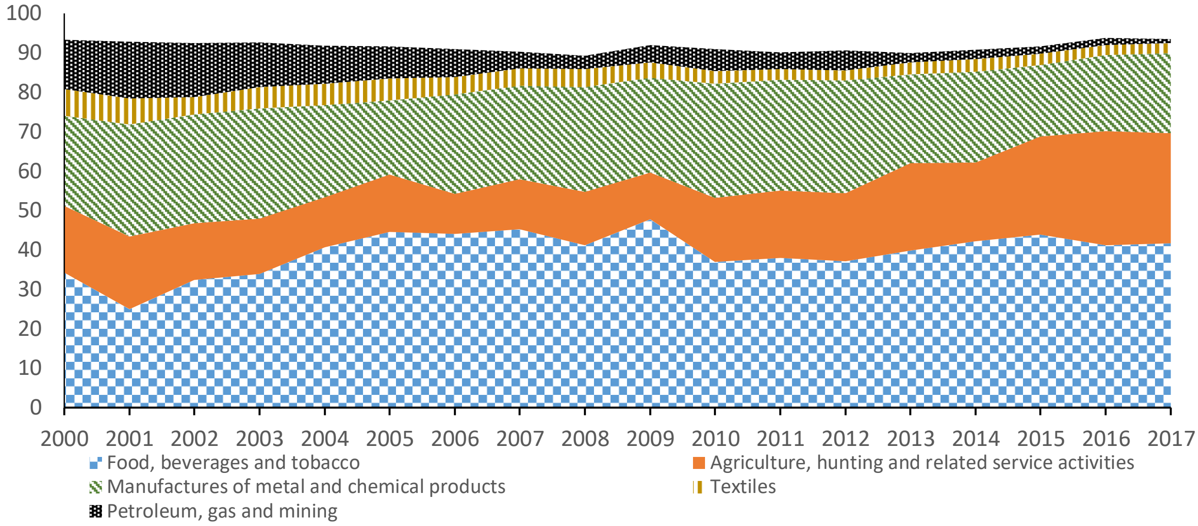
Turning to emissions originating in the transportation of imports used in the production of exports, the main contributing sectors relate to industrial manufacturing, in contrast to those based on agricultural commodities, which explain most emissions in the case of exports. One sector stands out: metal and chemical manufactures. The following two sectors are machinery and equipment manufactures and oil, gas, and mining. The increase experienced by the latter sector went hand-in-hand with its decline on the export side due to the growing import needs that Argentina faced during most of the study period.[28]

When we shift the focus to trading partners, the picture is more homogeneous. Three regions are present in each of the types of emissions considered here: South America, Western Europe, and East Asia. The first two are longstanding trading partners of Argentina, while the latter is gradually becoming more important. The ranking of the different regions varies depending on the type of activity that generates the emissions in question.

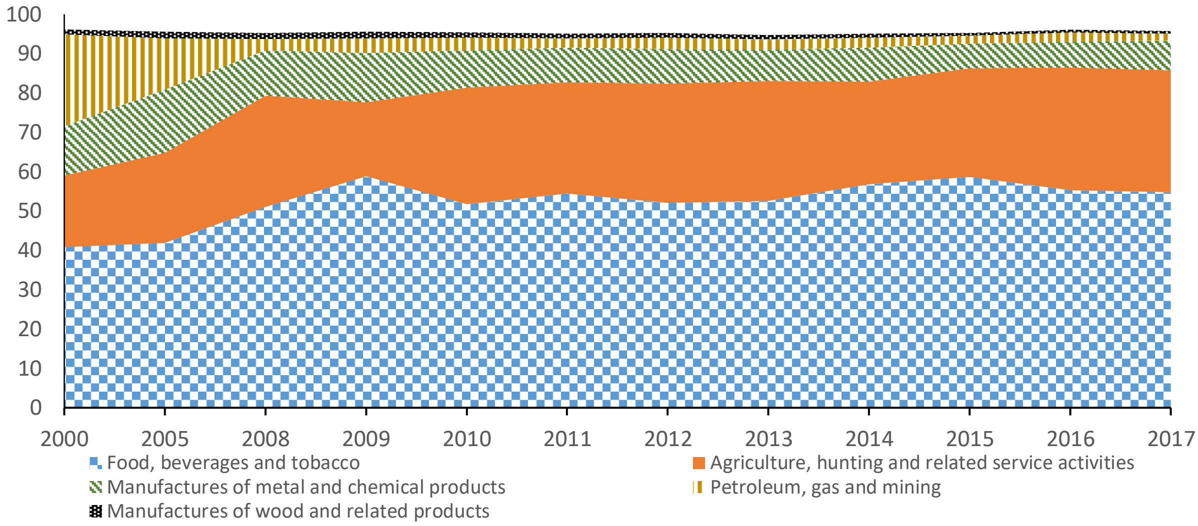
[28] The oil, gas, and mining sector becomes even more important if we consider the country's total imports.

Figure 4.5. Emissions: Main Contributing Sectors

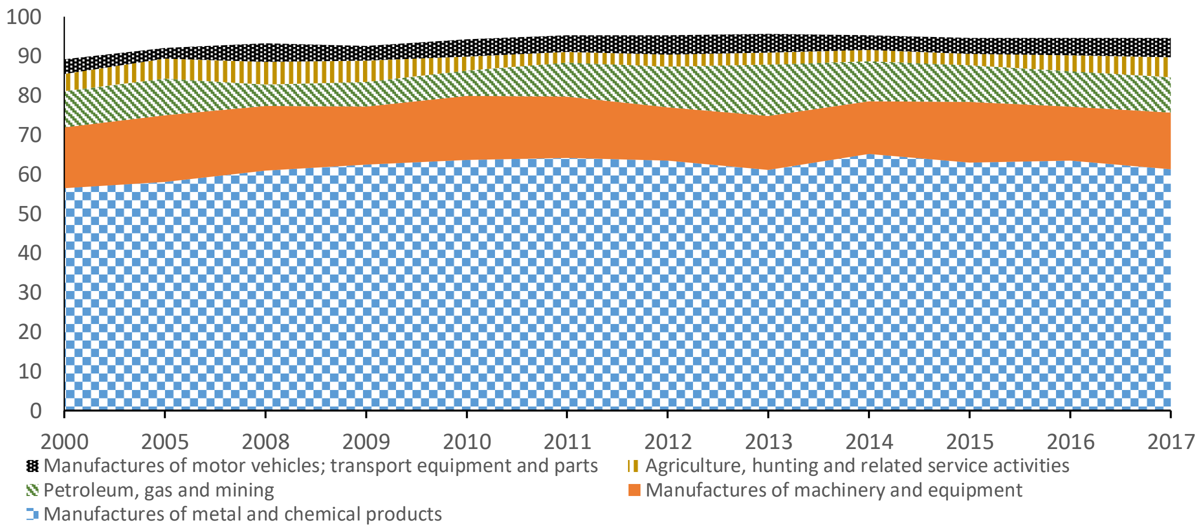
a) Production of Exports: CO_2 and Non-CO_2 Emissions



b) International Transportation of Exports: CO_2 Emissions



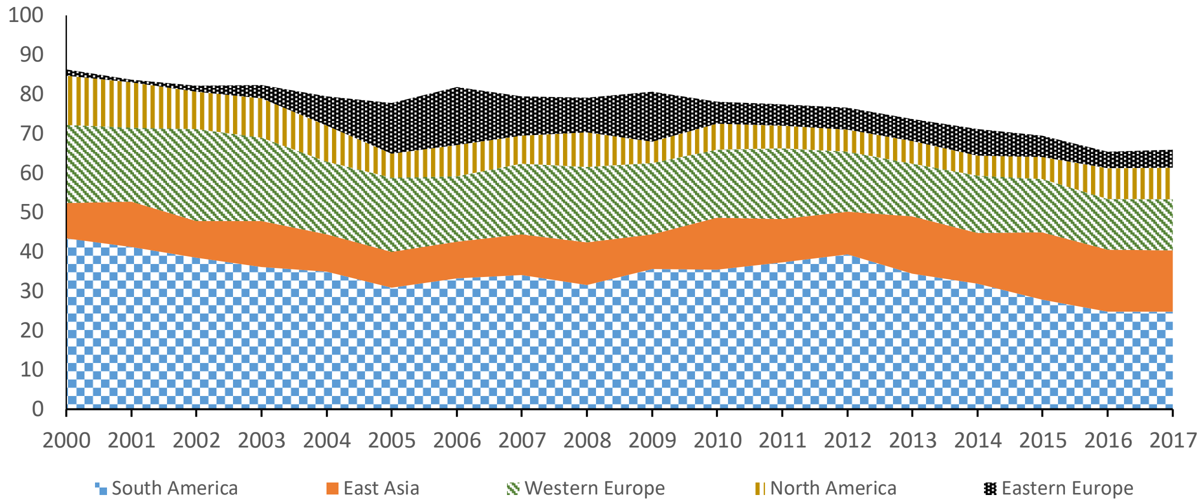
c) International Transportation of Imported Inputs Used in Exports: CO_2 Emissions



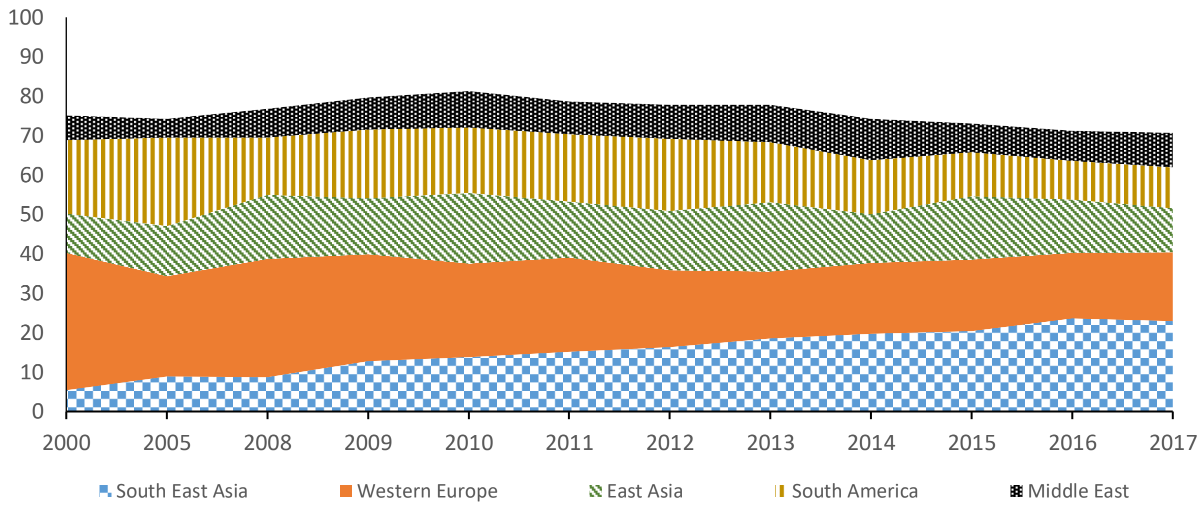
Note: Sectors were selected based on their overall share during the entire period analyzed.

Figure 4.6. Emissions: Main Contributing Partners

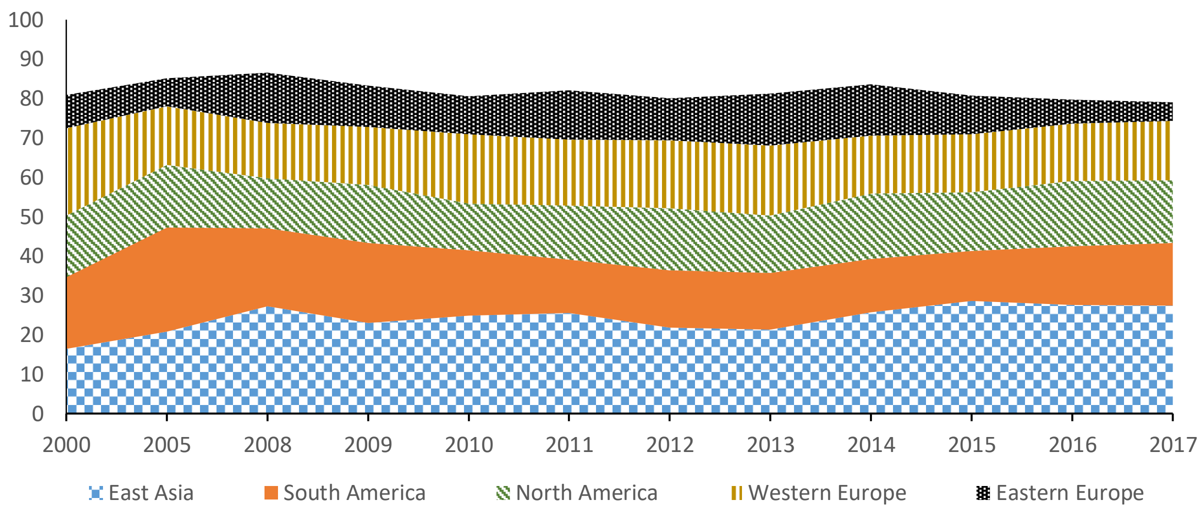
a) Production of Exports: CO_2 and Non-CO_2 Emissions



b) International Transportation of Exports: CO_2 Emissions



c) International Transportation of Imported Inputs Used in Exports: CO_2 Emissions



Note: Regions were selected based on their overall share during the entire period analyzed.

While South America ranks first in terms of GHG emissions deriving from the production of exports due to its importance as a destination for Argentina's external sales, it falls to fourth and second places when considering the CO_2 emissions associated with the transportation of exports and imported inputs, respectively. These changes are partly explained by geographical proximity, although, as was mentioned above, the average intensity of transportation emissions is higher because of the significance of trucking as a mode of transportation for trade within the region. East Asia is also an important player, because of the growing shares of Argentina's exports to this destination and its imports from it. There was a relative downturn in the share of regions that were once major trading partners for Argentina, and in some cases still are: South America, Western Europe, and North America. Besides East and Southeast Asia, other regions that have gained importance, sometimes in relation to specific products, are the Middle East, North Africa, and the Pacific.

5. Decomposition of the Changes in GHG Emissions Associated with Argentina's Exports

This section presents the results of alternative decomposition exercises that aim to identify the drivers of changes in GHG emissions associated with Argentina's exports.

For the emissions associated with the production of exports, total CO_2 emissions are given by:

$$CO2T_t^X = \sum_h kilos_{h,t} \times intk\_CO2_{h,t} \quad (5.1)$$

where $kilos_{h,t}$ is the exported quantity of product *h* during time *t*, and $intk\_CO2_{h,t}$ is the emission intensity of production.

Operating over (5.1), we can re-express this as follows:

$$CO2T_t^X = \sum_h kilos_t \times \frac{kilos_{h,t}}{kilos_t} \times intk\_CO2_{h,t} \quad (5.2)$$

The first term on the right-hand side of equation (5.2) can be identified as a scale effect, the second as a product composition effect, and the third as the technology effect. A similar analysis can be performed for the decomposition of non-CO_2 emissions.

The CO_2 emissions from international transportation are given by the following equation, taking exports as an example:

$$CO2T_t^{TX} = \sum_h \sum_d kilos_{h,t}^d \times dist_{h,t}^d \times intk\_CO2_{h,t}^d \quad (5.3)$$

where superscript *d* refers to the destination of exports.

Since a certain product *h* can be exported to a given partner *d* using more than one mode of transportation *m*, $intk\_CO2_{h,t}^d$ and $dist_{h,t}^d$ are weighted averages, defined as:[29]

$$intk\_CO2_{h,t}^d = \sum_m intk\_CO2^m \times dist^{d,m} \times \frac{kilos_{h,t}^{d,m}}{kilos_{h,t}^d} \quad (5.4)$$

$$dist_{h,t}^d = \sum_m dist^{d,m} \times \frac{kilos_{h,t}^{d,m}}{kilos_{h,t}^d} \quad (5.5)$$

where, as defined in section 2, $intk\_CO2^m$ is the emission intensity of using mode *m* and $dist^{d,m}$ is the distance to destination *d* when using mode of transportation *m*.

[29] For exports, in any given year, between 23% and 30% of the product–destination combinations involved the use of more than one mode of transportation. For imports, and taking into account the provenance–Argentina segment, the percentages vary between 37% and 42%.

While $intk\_CO2^{d}_{h,t}$ in (5.3) and $intk\_CO2^{m}$ in (5.4) are both measured in terms of emissions of one kilogram transported one kilometer (1 kg-1 km), $intk\_CO2^{m}$ is strictly a technological measure of emission intensity associated with mode of transportation *m* (as defined in table 2.1 in section 2), $intk\_CO2^{d}_{h,t}$ is a weighted average of the emissions associated with the different modes of transportation used when exporting good *h* to destination *d* in time *t*. A similar issue applies to the cases of $dist^{d}_{h,t}$ and $dist^{d,m}$.

Operating over (5.3) we can obtain:

$$CO2T^{TX}_{t} = \sum_{h} \sum_{d} kilos_{t} \times \frac{kilos_{h,t}}{kilos_{t}} \times \frac{kilos^{d}_{h,t}}{kilos_{h,t}} \times dist^{d}_{h,t} \times intk\_CO2^{d}_{h,t} \qquad (5.6)$$

In equation (5.6), the terms on the right-hand side are, respectively, the scale, product composition, partner composition (within each product), distance, and intensity effects. However, because emission intensities and distances are closely correlated since both depend on the chosen mode of transportation,[30] the distance and intensity effects will be considered together when discussing the results.

To obtain the different contributions of each component or driver to the change in total emissions, we use the formula proposed by Bennet (1920).[31,32]

Let us assume, without loss of generality, that we have three factors (as in the case of the emissions associated with the production of exports), and for each one, we observe a series of realizations $f^{t}_{h,i}$, for *h=1,2,3* and *i=1,…,N*, at a given moment of time *t*, such that: $F^{t} = \sum_{i=1}^{N} f^{t}_{1,i} \times f^{t}_{2,i} \times f^{t}_{3,i}$.

The objective is to express the change in F as an additive expression of the changes in the three factors $\Delta F^{(t,t-j)} = \Delta F^{(t,t-j)}_{1} + \Delta F^{(t,t-j)}_{2} + \Delta F^{(t,t-j)}_{3}$. By applying Bennet's decomposition, we obtain the following expressions:

$$\Delta F^{(t,t-j)}_{1} = \frac{1}{3}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{1,i} f^{t-j}_{2,i} f^{t-j}_{3,i} + \frac{1}{6}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{1,i} f^{t-j}_{2,i} f^{t}_{3,i} + \frac{1}{6}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{1,i} f^{t}_{2,i} f^{t-j}_{3,i} + \frac{1}{3}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{1,i} f^{t}_{2,i} f^{t}_{3,i} \qquad (5.7)$$

$$\Delta F^{(t,t-j)}_{2} = \frac{1}{3}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{2,i} f^{t-j}_{1,i} f^{t-j}_{3,i} + \frac{1}{6}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{2,i} f^{t-j}_{1,i} f^{t}_{3,i} + \frac{1}{6}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{2,i} f^{t}_{1,i} f^{t-j}_{3,i} + \frac{1}{3}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{2,i} f^{t}_{1,i} f^{t}_{3,i} \qquad (5.8)$$

$$\Delta F^{(t,t-j)}_{3} = \frac{1}{3}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{3,i} f^{t-j}_{1,i} f^{t-j}_{2,i} + \frac{1}{6}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{3,i} f^{t-j}_{1,i} f^{t}_{2,i} + \frac{1}{6}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{3,i} f^{t}_{1,i} f^{t-j}_{2,i} + \frac{1}{3}\sum_{i=1}^{N} \Delta f^{(t,t-j)}_{3,i} f^{t}_{1,i} f^{t}_{2,i} \qquad (5.9)$$

A similar analysis, involving slightly more complex expressions, can be applied for the decomposition of emissions associated with transportation where there are more than three factors or drivers at play.

In the analysis that follows, for the emissions associated with the production of exports, the unit of observation for each year is the product (defined at the HS 6-digit level), while it is the product–destination combination in the case of exports, and the product–origin–provenance combination in that of imports.

[30] In the extreme case that a good *h* sold to a destination *d* is always transported using the same mode of transportation *m*, $dist^{d}_{h,t}$ and $intk\_CO2^{d}_{h,t}$ would remain constant between periods.

[31] See de Boer and Rodrigues (2020) for an interesting and illustrative summary of the different alternatives available for decomposition analysis.

[32] An alternative formula is the logarithmic mean Divisia Index (LMDI) applied in Li (2020). However, as the name of the index indicates, it implies taking the logarithm of some variables/expressions, which could become a problem when working with significant levels of detail, as in our case, due to the presence of null values for which the logarithm is not defined. The LMDI and Bennet decompositions produce almost identical results when there is no logarithm problem.

Figure 5.1 reports the decomposition of the different types of emissions associated with the production of Argentina's exports, distinguishing the drivers behind the changes. We divide 2000–2017 into two subperiods: 2000–2011, during which Argentina experienced significant export growth and benefited from rising agricultural commodity prices, and 2012–2017, when exports declined sharply before stabilizing at around $58 billion in 2014. When total emissions are considered, the scale effect contributed more significantly during 2000–2011 than during 2012–2017, although in both cases it did so positively. The contribution of the technology effect was negative during 2000–2011, but became positive in 2012–2017, and its relative weight was significant in both cases. Finally, the composition effect behaved in the opposite way to the technology effect, but its role was much less important. If we distinguish between CO_2 and non-CO_2 emissions, the former follows a pattern similar to that of total emissions, except that the composition effect is much more significant. In the case of non-CO_2 emissions, the difference arises in the role of the composition effect, which, although smaller in magnitude, contributes in the opposite direction to CO_2 emissions.

When we look at the CO_2 emissions generated by international transportation (figures 5.2 and 5.3), in the case of exports the main drivers are the scale, sector, and partner effects, while the combined distance/intensity effect only plays a minor role. The difference in the signs of the sector component between the two periods being compared might be linked to the drop in the share of CO_2 emissions relating to the transportation of oil, gas, and mining products. While in 2000 and 2005 these had a share of 24% and 13%, respectively, in the total emissions relating to the transportation of exports, in 2012–2017 that share was 2.4% on average (in this case, the fall in emissions is related to the sharp drop in the volume in kilograms of exports of these products). The partner component goes from making a negative contribution in 2000–2011 to a positive one in 2012–2017. This is in line with the significant increase in the participation of more distant trading partners—East Asia, South Asia, and South East Asia—and the fall in the share of South American countries as a destination for Argentina's exports.

In the case of the transportation of imported inputs, the product, scale, and partner effect prevail in 2000–2011, while in 2012–2017 the distance/intensity effect emerges also as an important driver, together with the product and partner effects. The difference in the importance of the distance/intensity effect between the two sub-periods could be related to the drop in South America's share as an origin of imports, which, in addition to implying imports from more distant countries, implied changes toward less polluting means of transportation per kg/km. Specifically, in the last part of the period analyzed, shipping became more significant, to the detriment of trucking. Road transportation is the second-most polluting form of transportation after air, a fact that is in line with the change of sign in the intensity component between the two periods.

In figures 5.4 to 5.6, we perform an alternative exercise to identify the effects on GHG emissions of changes in the structure of Argentina's foreign trade. The analysis is of the "what if" type, in which all but one dimension are maintained at their 2017 values while the remaining dimensions take on the values for 2000 or 2011. The year 2000 is the first year for which data is available before Argentina benefited from the boom in agricultural commodity prices, while 2011 is the year that Argentina's exports peaked. Average emission intensities are always those of 2017.

For the emissions associated with the production of exports, the analysis is only carried out in terms of sector structure, since they originate from the production of goods and not from their destinations. As figure 5.4 shows, changes in the sector structure of exports appear to have had a more polluting profile between 2000 and 2011 and then decreased between 2011 and 2017. In 2017, if the export structure had been that of 2000, total emissions would have reached 86.9 Mt CO_2 compared with 91.9 Mt CO_2 if the sector structure had been that of 2011; however, actual emissions in 2017 were 84.4 Mt CO_2. Beyond the overall behavior, it is possible to identify certain heterogeneity across sectors of activity. Among the four main contributing sectors (which explain around 90% of GHG emissions), agriculture, hunting, and related services and food, beverages, and tobacco stand out as the sectors that have contributed to an increase in emissions. Manufactures of metal and chemical products and petroleum, gas, and mining contributed to a reduction in GHG emissions.

Figure 5.1. Decomposition of GHG Emissions Associated with the Production of Exports

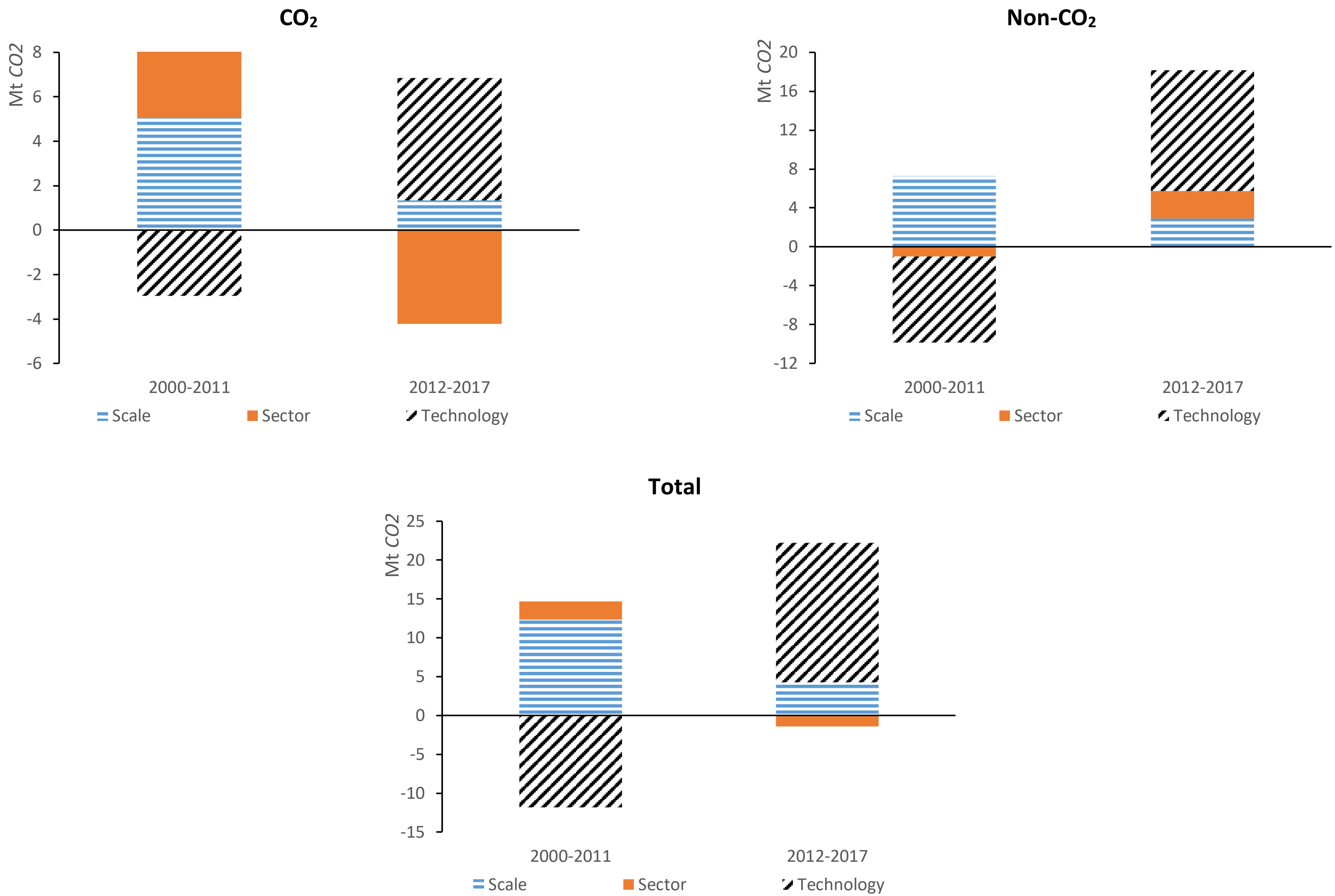


Figure 5.2. Decomposition of CO_2 Emissions Associated with the International Transportation of Exports

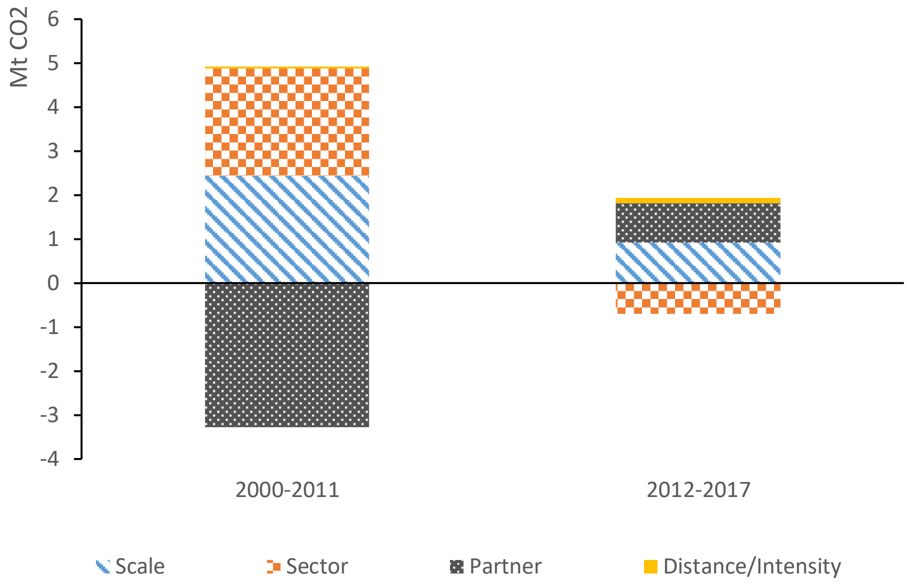
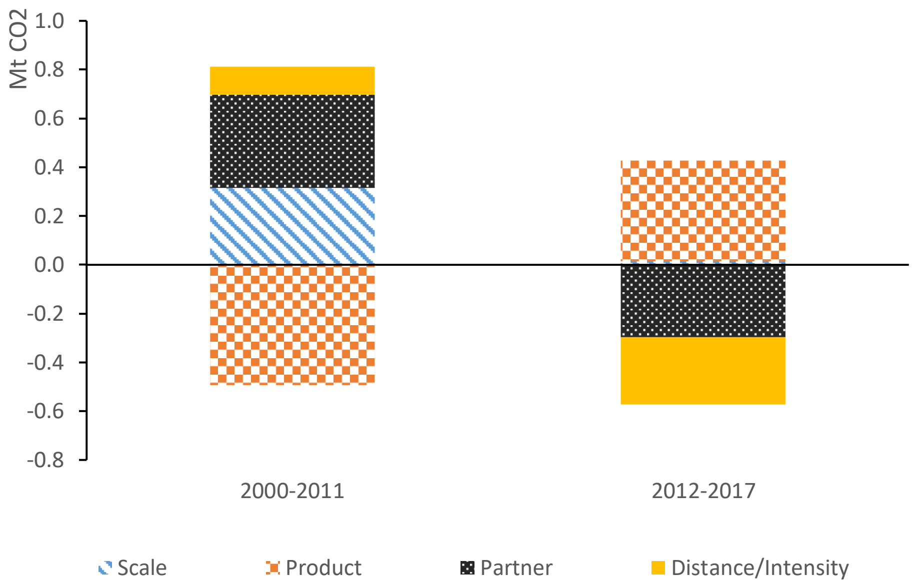


Figure 5.3. Decomposition of CO_2 Emissions Associated with the International Transportation of Imported Inputs Used in Exports: CO_2 Emissions



In figures 5.5 and 5.6 we report the results for the CO_2 emissions linked to the international transportation of Argentina's exports. Since in this case there are two dimensions—sector and partner structures (in addition to emission intensities, which are always those of 2017)—we perform two separate simulations. On the left of figures 5.5 and 5.6, the partner structure is held constant to 2017, so the simulated emissions are obtained by varying the sector shares. On the right of figures 5.5 and 5.6, the sector structure is held constant to 2017, and the partner shares are varied.

When looking at how changes in the sector structure contributed to changes in CO_2 emissions, it appears they have led to more pollution in the aggregate for the transportation of exports, while the opposite is true for the transportation of imports. Differences can also be identified between the main sectors contributing to emissions. For exports, agriculture, hunting, and related services and food, beverages, and tobacco once again contributed positively. The opposite is true for manufactures of metal and chemical products and petroleum, gas, and mining, especially the latter. For the transportation of imported inputs, the main sectors that contributed to a reduction in emissions were manufactures of machinery and equipment, manufactures of metal, and chemical products, and petroleum, gas, and mining. Agriculture, hunting, and related service activities and manufactures of motor vehicles, transportation equipment, and parts had the opposite effect.

In the case of changes in partner structure, these clearly contributed to increased emissions in the case of transportation of exports, while in the case of imported inputs, there was a reduction between 2011 and 2017, but almost no change can be identified between 2000 and 2017. For exports, the main drivers for the increase have been East Asia, South East Asia, and North Africa, while North America, South America, and Western Europe—three historically important regions for Argentina's exports—have contributed negatively to the changes in transportation-related CO_2 emissions. For the emissions associated with the transportation of imported inputs, East Asia, North America, and South America are the main positive contributors, while the opposite is true of Eastern Europe, Western Europe, and Sub-Saharan Africa.

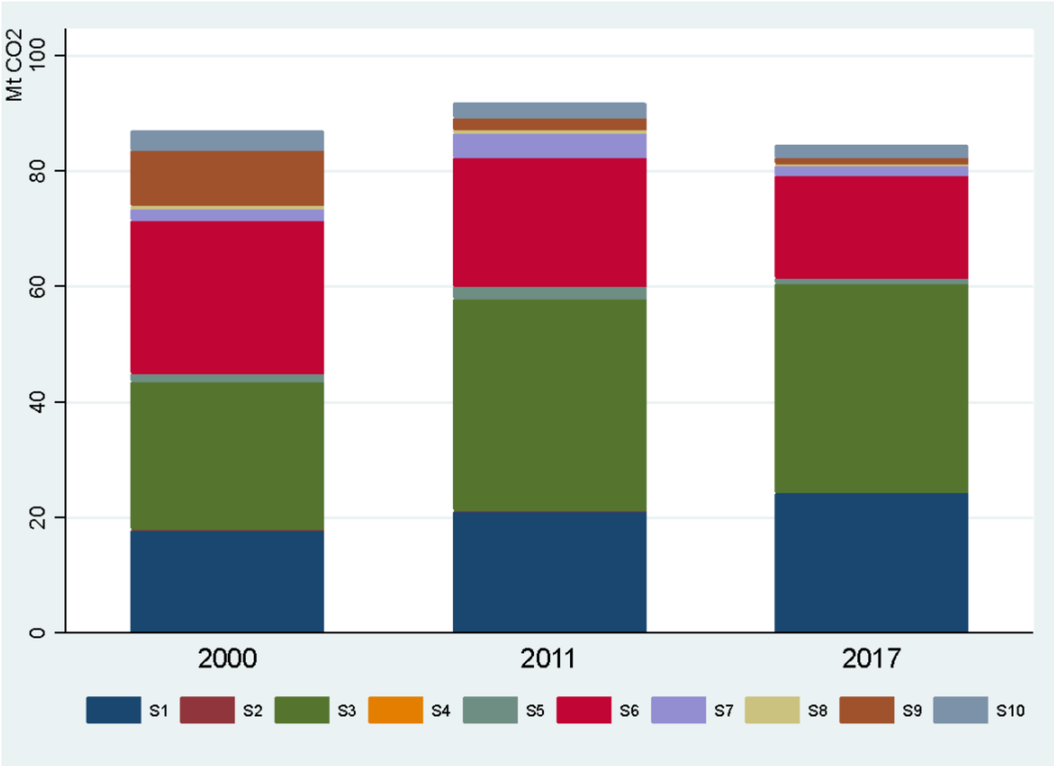
Finally, an alternative decomposition is to look at the intensive and extensive margins of the changes in emissions. As defined at the beginning of this section, the unit of analysis for the emissions linked to the production of exports is the product defined at the HS 6-digit level. For the emissions associated with international transportation, the unit of analysis is the product–destination combination in the case of exports, while for imports it is the combination of product–origin–provenance. Taking these units of analysis, we define three possible cases or situations: one in which there are positive trade flows in two consecutive years, one in which trade is positive in the current year but null in the previous one, and finally one in which trade is null in the current year but was positive the year before. The second and third cases would approximate the changes explained by the extensive margin ("Ext. Marg. +"and "Ext. Marg.-" respectively), while the first would explain the intensive margin ("Int. Marg."). Figure 5.7 shows the results for the two sub-periods, looking at the total CO_2 and non-CO_2 emissions linked to the production of exports. Figure 5.8 shows the CO_2 emissions associated with international transportation. For the emissions linked to the production of exports, the extensive margins explain most of the change in 2000–2011, while the intensive margin was almost the only driving force in 2012–2017. In contrast, for the emissions associated with international transportation, the extensive margins prevail in both sub-periods, especially for imports in 2012–2017.[33]

[33] One factor that plays a role in explaining the greater prevalence of the extensive margins for the emissions associated with international transportation is the greater level of detail or refinement of the unit of analysis in relation to emissions linked to the production of exports.

Figure 5.4. Simulation of GHG Emissions from the Production of Exports in 2017

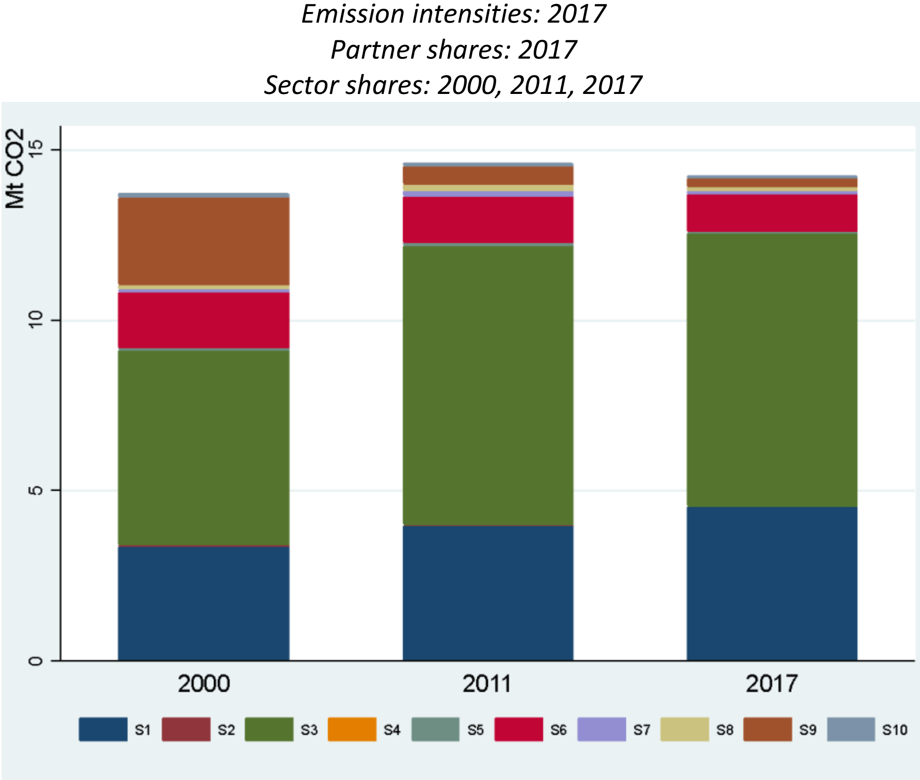
Emission intensities: 2017

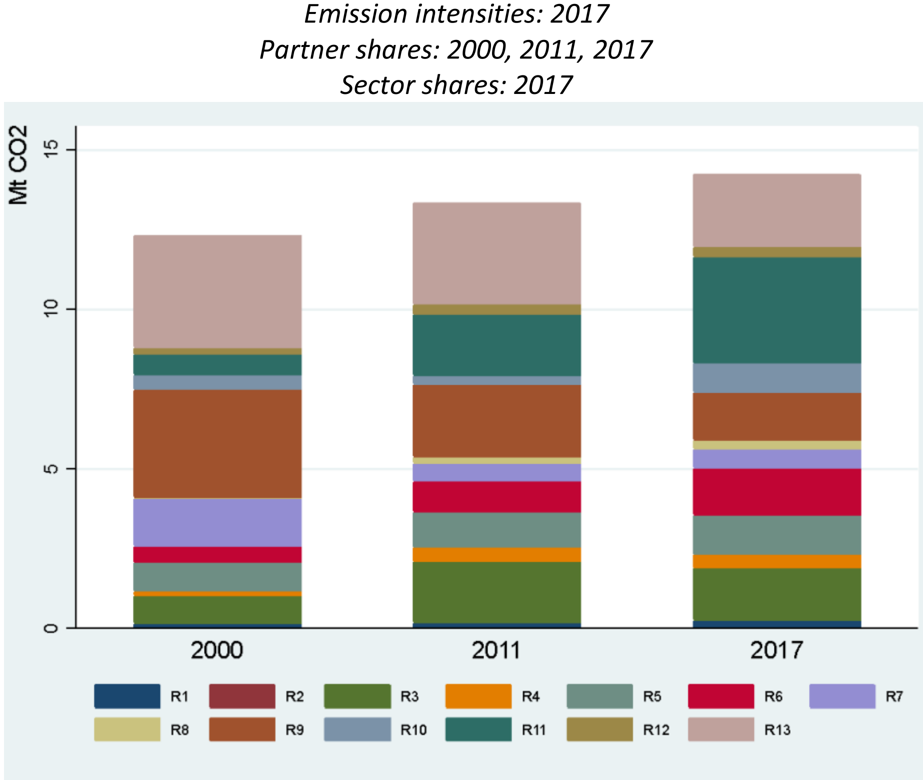
Sector shares: 2000, 2011, 2017



Notes: S1: Agriculture, hunting, and related service activities. **S2:** Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing. **S3:** Food, beverages, and tobacco. **S4:** Forestry, logging, and related service activities. **S5:** Manufactures of machinery and equipment. **S6:** Manufactures of metal and chemical products. **S7:** Manufactures of motor vehicles, transportation equipment, and parts. **S8:** Manufactures of wood and related products. **S9:** Petroleum, gas, and mining. **S10:** Textiles.

Figure 5.5. Simulation of CO_2 Emissions Linked to the International Transportation of Exports in 2017





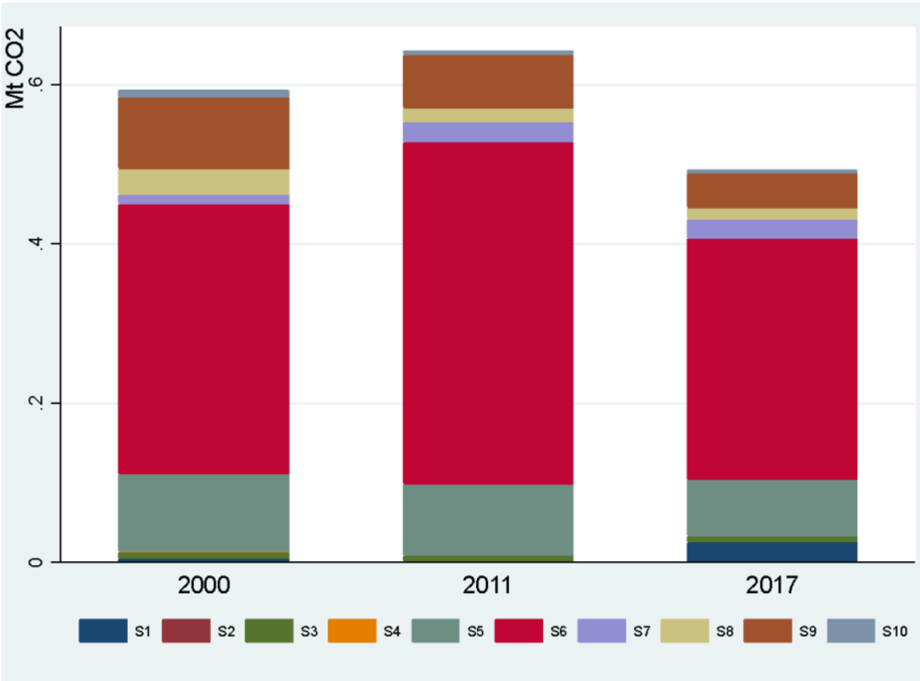
Notes:

S1: Agriculture, hunting, and related service activities. **S2:** Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing. **S3:** Food, beverages, and tobacco. **S4:** Forestry, logging, and related service activities. **S5:** Manufactures of machinery and equipment. **S6:** Manufactures of metal and chemical products. **S7:** Manufactures of motor vehicles, transportation equipment, and parts. **S8:** Manufactures of wood and related products. **S9:** Petroleum, gas, and mining. **S10:** Textiles.

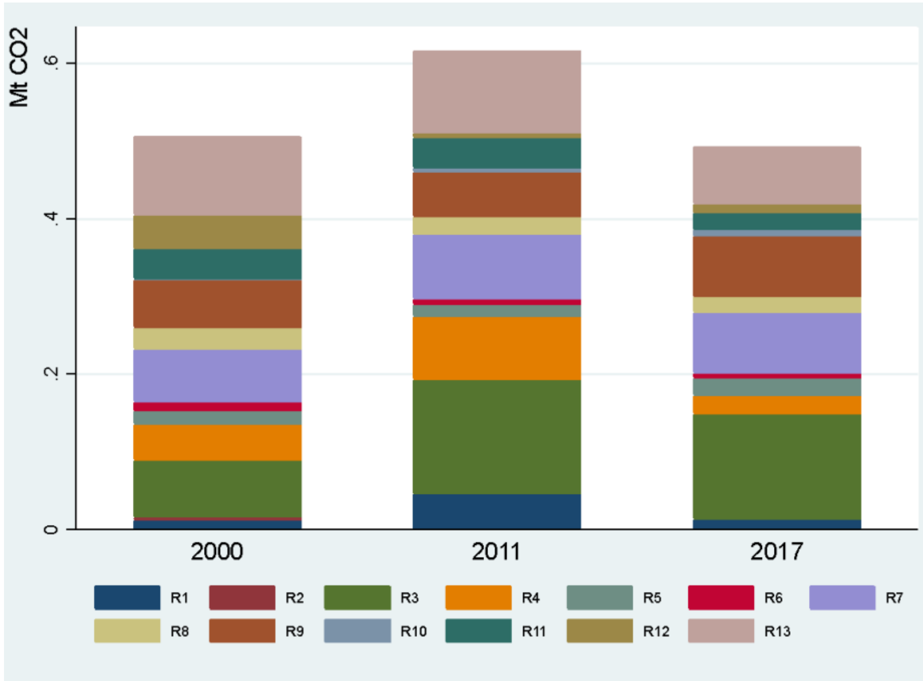
R1: Central America and The Caribbean. **R2:** Central Asia. **R3:** East Asia. **R4:** Eastern Europe. **R5:** Middle East. **R6:** North Africa. **R7:** North America. **R8:** Pacific. **R9:** South America. **R10:** South Asia. **R11:** South East Asia. **R12:** Sub-Saharan Africa. **R13:** Western Europe.

Figure 5.6. Simulation of CO_2 Emissions Linked to the International Transportation of Imported Inputs Used in Exports in 2017

Emission intensities: 2017
Partner shares: 2017
Sector shares: 2000, 2011, 2017



Emission intensities: 2017
Partner shares: 2000, 2011, 2017
Sector shares: 2017

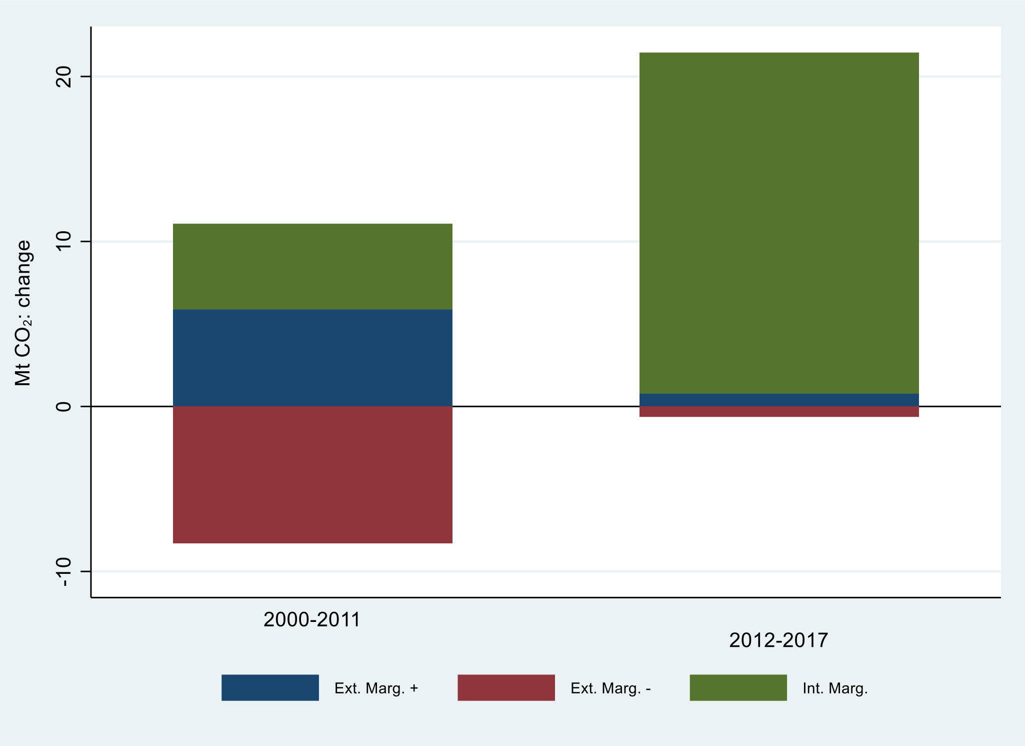


Notes:

S1: Agriculture, hunting, and related service activities. **S2:** Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing. **S3:** Food, beverages, and tobacco. **S4:** Forestry, logging, and related service activities. **S5:** Manufactures of machinery and equipment. **S6:** Manufactures of metal and chemical products. **S7:** Manufactures of motor vehicles, transportation equipment, and parts. **S8:** Manufactures of wood and related products. **S9:** Petroleum, gas, and mining. **S10:** Textiles.

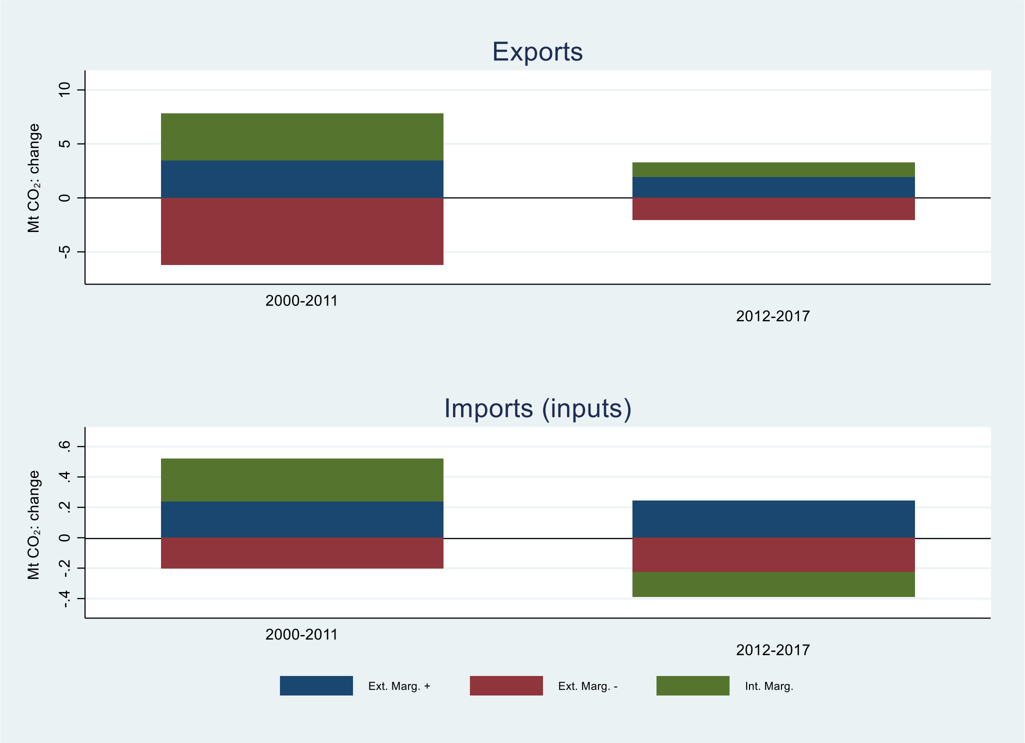
R1: Central America and The Caribbean. **R2:** Central Asia. **R3:** East Asia. **R4:** Eastern Europe. **R5:** Middle East. **R6:** North Africa. **R7:** North America. **R8:** Pacific. **R9:** South America. **R10:** South Asia. **R11:** South East Asia. **R12:** Sub-Saharan Africa. **R13:** Western Europe.

Figure 5.7. Contributions to Changes in GHG Emissions Associated with the Production of Exports: Intensive and Extensive Margins



Ext. Marg. +: a given trade flow is null in year *t-j* and positive in year *t*. **Ext. Marg.-**: a given trade flow is positive in year *t-j* and null in year *t*. **Int. Marg.**: a given trade flow is positive in years *t-j* and *t*.

Figure 5.8. Contributions to Changes in CO_2 Emissions Associated with the International Transportation of Exports: Intensive and Extensive Margins



Ext. Marg. +: a given trade flow is null in year *t-j* and positive in year *t*. **Ext. Marg.-**: a given trade flow is positive in year *t-j* and null in year *t*. **Int. Marg.**: a given trade flow is positive in years *t-j* and *t*.

6. Summary

More than 77% of Argentina's export basket is concentrated in three of the broad sectors defined above: food, beverages, and tobacco; agriculture, hunting, and related service activities; and manufactures of metal and chemical products. Brazil is the main destination for Argentina's exports in terms of kilograms transported. The United States and Chile were initially next in the ranking, but from 2007 onward, China has occupied second place. In recent years, Vietnam and India have also emerged as major destinations for sales of Argentina's products. The main mode of transportation for exports is maritime, both in terms of FOB values and kilograms transported. From 2000 onwards, there has been a sustained increase in the use of sea transportation for exports and a fall in the share of land transportation (trucks). This pattern could be explained by the decline of South America as a destination for Argentina's exports and the increase of distant countries (in East Asia, for example).

Argentina's imports are concentrated in only some of the broad sectors defined above. When we analyze imports in terms of kilograms transported, manufactures of metal and chemical products and petroleum, gas, and mining account for almost 82% of the average annual kilograms of products transported. In terms of both FOB values and kilograms, Brazil is the main origin of Argentina's imports. The United States and European countries were next in the ranking until 2007, when China moved up to second place. In recent years, Bolivia and Paraguay have also emerged as significant origins for Argentina's imports (especially in terms of kilograms of imported products). The main mode of transportation for imports is maritime, both in terms of FOB values and kilograms transported. Some 88% of the kilograms of imported products are transported by sea and 12% by road, while the share of air transportation is irrelevant.

GHG emissions associated with the production of Argentina's exports follow an upward trend until 2005 and then behave more erratically but follow a downward trend. There is a slight upward trend over the period as a whole. CO_2 emissions represent around 40% of the total, while the remainder is explained by non-CO_2 emissions. CO_2 emissions from the international transportation of Argentina's exports and of imports used to produce these exports represent around 13%–18% of the GHG emissions linked to Argentina's exports. In line with Argentina's limited integration into GVCs, the emissions produced by the international transportation of imported inputs embedded in the country's exports are not particularly relevant.

The main sectors that explain GHG emissions linked to exports are food, beverages, and tobacco, and agriculture, hunting, and related activities. Another important sector is manufactures of metal and chemical products. As the result of policies that favored the domestic market over exports, the sector of petroleum, gas, and mining became less significant over the study period. The same main sectors explain most of the CO_2 emissions linked to the international transportation of exports. In terms of emissions linked to the transportation of imports used in the production of exports, the main contributing sectors are those relating to industrial manufacturing, as opposed to those based on agricultural commodities, as in the case of exports.

Exports to South America, Western Europe, and East Asia explain most of the emissions linked to the country's exports. The first two regions are longstanding trading partners of Argentina, while East Asia has become more important over time. Three regions that traditionally accounted for most of Argentina's exports have lost importance: South America, Western Europe, and North America.

Different decomposition exercises revealed that in the case of emissions linked to the production of exports, the scale effect contributed more significantly in 2000–2011 than in 2012–2017, although in both cases its effect was positive. The technology effect went from making a negative contribution to a positive one. The composition effect is much less significant, however. For the emissions associated with international transportation, the main drivers were the scale, sector, and partner effects, while the distance/intensity effect only played a minor role.

Changes in the sector structure of exports appear to have caused more emissions between 2000 to 2011, but the opposite was observed between 2011 and 2017. The changes are explained by the positive contributions of agriculture, hunting, and related services and food, beverages, and tobacco, while manufactures of metal and chemical products and petroleum, gas, and mining contributed to a reduction in GHG emissions. In the case of emissions from international transportation, changes in the sector structure increased pollution in the case of the transportation of exports, while the opposite was the case for the transportation of imports.

Finally, for the emissions linked to the production of exports, the extensive margins explain most of the change in 2000–2011, while the intensive margin was almost the only driving force in 2012–2017. For the emissions associated with international transportation, the extensive margins prevailed in both sub-periods.

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Appendix

Table A.1. Definitions of Regions

Country Name	ISO Code
Central America and the Caribbean	
Antigua and Barbuda	ATG
Aruba	ABW
Barbados	BRB
Belize	BLZ
Costa Rica	CRI
Cuba	CUB
Dominica	DMA
Dominican Republic	DOM
El Salvador	SLV
Grenada	GRD
Guatemala	GTM
Haiti	HTI
Honduras	HND
Jamaica	JAM
Mexico	MEX
Netherlands Antilles	ANT
Nicaragua	NIC
Panama	PAN
Puerto Rico	PRI
St. Kitts and Nevis	KNA
St. Lucia	LCA
St. Vincent and the Grenadines	VCT
The Bahamas	BHS
Trinidad and Tobago	TTO
Virgin Islands	VIR
Central Asia	
Kazakhstan	KAZ
Kyrgyz Republic	KGZ
Tajikistan	TJK
Turkmenistan	TKM
Uzbekistan	UZB
East Asia	
China	CHN
Hong Kong SAR, China	HKG
Japan	JPN
Korea	KOR
Macao SAR, China	MAC
Mongolia	MNG
Taiwan	TWN

Country Name	ISO Code
South Asia	
Afghanistan	AFG
Bangladesh	BGD
Bhutan	BTN
India	IND
Maldives	MDV
Nepal	NPL
Pakistan	PAK
Sri Lanka	LKA
South East Asia	
Brunei	BRN
Cambodia	KHM
Indonesia	IDN
Lao PDR	LAO
Malaysia	MYS
Myanmar	MMR
Philippines	PHL
Singapore	SGP
Thailand	THA
Vietnam	VNM
Sub-Saharan Africa	
Angola	AGO
Benin	BEN
Botswana	BWA
Burkina Faso	BFA
Burundi	BDI
Cabo Verde	CPV
Cameroon	CMR
Central African Republic	CAF
Chad	TCD
Comoros	COM
Congo	COG
Côte d’Ivoire	CIV
Dem. Rep. Congo	COD
Equatorial Guinea	GNQ
Eritrea	ERI
Eswatini	SWZ
Ethiopia	ETH
Gabon	GAB
Ghana	GHA

Eastern Europe	
Albania	ALB
Armenia	ARM
Azerbaijan	AZE
Belarus	BLR
Estonia	EST
Georgia	GEO
Latvia	LVA
Lithuania	LTU
Moldova	MDA
Russia	RUS
Turkey	TUR
Ukraine	UKR
Middle East	
Bahrain	BHR
Iran	IRN
Iraq	IRQ
Israel	ISR
Jordan	JOR
Kuwait	KWT
Lebanon	LBN
Libya	LBY
Oman	OMN
Qatar	QAT
Saudi Arabia	SAU
Syrian Arab Republic	SYR
United Arab Emirates	ARE
West Bank and Gaza	PSE
Yemen	YEM
North Africa	
Algeria	DZA
Djibouti	DJI
Egypt	EGY
Malta	MLT
Morocco	MAR
Tunisia	TUN
North America	
Canada	CAN
United States	USA
Pacific	
American Samoa	ASM
Australia	AUS
Fiji	FJI
Marshall Islands	MHL
New Zealand	NZL
Papua New Guinea	PNG

Guinea	GIN
Guinea-Bissau	GNB
Kenya	KEN
Lesotho	LSO
Liberia	LBR
Madagascar	MDG
Malawi	MWI
Mali	MLI
Mauritania	MRT
Mauritius	MUS
Mozambique	MOZ
Namibia	NAM
Niger	NER
Nigeria	NGA
Rwanda	RWA
São Tomé and Principe	STP
Senegal	SEN
Seychelles	SYC
Sierra Leone	SLE
Somalia	SOM
South Africa	ZAF
South Sudan	SSD
Sudan	SDN
Tanzania	TZA
The Gambia	GMB
Togo	TGO
Uganda	UGA
Zambia	ZMB
Zimbabwe	ZWE
Western Europe	
Andorra	AND
Austria	AUT
Belgium	BEL
Bosnia and Herzegovina	BIH
Bulgaria	BGR
Croatia	HRV
Cyprus	CYP
Czech Republic	CZE
Denmark	DNK
Finland	FIN
France	FRA
Germany	DEU
Gibraltar	GIB
Greece	GRC
Hungary	HUN
Iceland	ISL

Solomon Islands	SLB
Tonga	TON
Tuvalu	TUV
Vanuatu	VUT
South America	
Bolivia	BOL
Brazil	BRA
Chile	CHL
Colombia	COL
Ecuador	ECU
Guyana	GUY
Paraguay	PRY
Peru	PER
Suriname	SUR
Uruguay	URY
Venezuela	VEN

Ireland	IRL
Italy	ITA
Liechtenstein	LIE
Luxembourg	LUX
Monaco	MCO
Montenegro	MNE
Netherlands	NLD
North Macedonia	MKD
Norway	NOR
Poland	POL
Portugal	PRT
Romania	ROM
San Marino	SMR
Serbia	SRB
Slovak Republic	SVK
Slovenia	SVN
Spain	ESP
Sweden	SWE
Switzerland	CHE
United Kingdom	GBR
Vatican City State	VAT

Table A.2. Definitions of Broad Sectors of Activity

Sector	ISIC Rev 3.1—2 digits
Agriculture, hunting, and related service activities	01
Forestry, logging, and related service activities	02
Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing	05
Petroleum, gas, and mining	10 11 13 14
Food, beverages, and tobacco	15 16
Textiles	17 18 19
Manufactures of wood and related products	20 21 22 36
Manufactures of metal and chemical products	23 24 25 26 27 28
Manufactures of machinery and equipment	29 30 31 32 33
Manufactures of motor vehicles, transportation equipment, and parts	34 35

Table A.3.1. Main Products Exported to Main Trading Partners. Average Percentage Share 2008–2017. Kilograms.

Partner	HS96 2D	%	Product description	Partner	HS96 2D	%	Product description
Brazil	10	41.42	Cereals	Chile	27	26.80	Mineral fuels, mineral oils, and products of their distillation, etc.
Brazil	27	15.19	Mineral fuels, mineral oils, and products of their distillation, etc.	Chile	10	18.75	Cereals
Brazil	11	8.13	Products of the milling industry, malt, starches, inulin, wheat gluten	Chile	23	11.85	Residues and waste from the food industries, prepared animal fodder
Brazil	87	4.57	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	Chile	25	11.33	Salt; sulfur; earths and stone; plastering materials, lime and cement
Brazil	39	3.65	Plastics and articles thereof	Chile	15	4.97	Animal or vegetable fats and oils and their cleavage products, etc.
Brazil	7	3.38	Edible vegetables and certain roots and tubers	Chile	11	3.73	Products of the milling industry, malt, starches, inulin, wheat gluten
Brazil	8	2.14	Edible fruit and nuts; peel of citrus fruit or melons	Chile	17	2.51	Sugars and sugar confectionery
Brazil	20	1.81	Preparations of vegetables, fruit, nuts or other parts of plants	Chile	12	1.99	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.
Brazil	44	1.74	Wood and articles of wood; wood charcoal	Chile	28	1.57	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.
Brazil	29	1.71	Organic chemicals	Chile	48	1.44	Paper and paperboard; articles of paper pulp, of paper, or of paperboard
Netherlands	23	61.58	Residues and waste from the food industries, prepared animal fodder	China	12	73.19	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.
Netherlands	38	7.25	Miscellaneous chemical products	China	15	9.33	Animal or vegetable fats and oils and their cleavage products, etc.
Netherlands	15	6.15	Animal or vegetable fats and oils and their cleavage products, etc.	China	27	9.30	Mineral fuels, mineral oils, and products of their distillation, etc.
Netherlands	10	4.76	Cereals	China	26	1.96	Ores, slag, and ash
Netherlands	8	4.32	Edible fruit and nuts; peel of citrus fruit or melons	China	10	1.17	Cereals
Netherlands	12	4.12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.	China	23	0.79	Residues and waste from the food industries, prepared animal fodder
Netherlands	20	3.66	Preparations of vegetables, fruit, nuts or other parts of plants	China	2	0.59	Meat and edible meat offal
Netherlands	27	2.99	Mineral fuels, mineral oils, and products of their distillation, etc.	China	44	0.56	Wood and articles of wood; wood charcoal
Netherlands	29	2.35	Organic chemicals	China	3	0.52	Fish, crustaceans, molluscs, and other aquatic invertebrates
Netherlands	22	0.54	Beverages, spirits and vinegar	China	29	0.40	Organic chemicals
Germany	23	37.05	Residues and waste from the food industries, prepared animal fodder	India	15	64.63	Animal or vegetable fats and oils and their cleavage products, etc.

Partner	HS96 2D	%	Product description	Partner	HS96 2D	%	Product description
Germany	26	23.36	Ores, slag, and ash	India	27	14.01	Mineral fuels, mineral oils, and products of their distillation, etc.
Germany	10	8.55	Cereals	India	10	13.13	Cereals
Germany	38	3.76	Miscellaneous chemical products	India	17	2.77	Sugars and sugar confectionery
Germany	2	3.63	Meat and edible meat offal	India	26	1.06	Ores, slag, and ash
Germany	87	2.91	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	India	7	0.74	Edible vegetables and certain roots and tubers
Germany	12	2.30	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.	India	29	0.42	Organic chemicals
Germany	4	2.20	Dairy prod; birds' eggs; natural honey; edible prod nes	India	39	0.40	Plastics and articles thereof
Germany	8	2.18	Edible fruit and nuts; peel of citrus fruit or melons	India	89	0.35	Ships, boats and floating structures
Germany	44	2.02	Wood and articles of wood; wood charcoal	India	72	0.25	Iron and steel
Spain	23	53.03	Residues and waste from the food industries, prepared animal fodder	Vietnam	23	56.50	Residues and waste from the food industries, prepared animal fodder
Spain	38	12.63	Miscellaneous chemical products	Vietnam	10	38.59	Cereals
Spain	10	11.75	Cereals	Vietnam	12	1.77	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.
Spain	15	4.35	Animal or vegetable fats and oils and their cleavage products, etc.	Vietnam	15	1.35	Animal or vegetable fats and oils and their cleavage products, etc.
Spain	89	3.23	Ships, boats and floating structures	Vietnam	44	0.32	Wood and articles of wood; wood charcoal
Spain	3	3.19	Fish, crustaceans, molluscs, and other aquatic invertebrates	Vietnam	41	0.32	Raw hides and skins (other than furskins) and leather
Spain	8	2.74	Edible fruit and nuts; peel of citrus fruit or melons	Vietnam	72	0.19	Iron and steel
Spain	26	2.24	Ores, slag, and ash	Vietnam	3	0.19	Fish, crustaceans, molluscs, and other aquatic invertebrates
Spain	7	1.98	Edible vegetables and certain roots and tubers	Vietnam	52	0.13	Cotton
Spain	44	0.85	Wood and articles of wood; wood charcoal	Vietnam	2	0.09	Meat and edible meat offal
United States	27	45.01	Mineral fuels, mineral oils, and products of their distillation, etc.	Uruguay	23	13.22	Residues and waste from the food industries, prepared animal fodder
United States	38	9.33	Miscellaneous chemical products	Uruguay	10	9.74	Cereals
United States	29	4.77	Organic chemicals	Uruguay	11	9.67	Products of the milling industry, malt, starches, inulin, wheat gluten
United States	10	4.08	Cereals	Uruguay	27	6.27	Mineral fuels, mineral oils, and products of their distillation, etc.
United States	73	3.77	Articles of iron or steel	Uruguay	31	4.64	Fertilizers
United States	20	3.71	Preparations of vegetables, fruit, nuts or other parts of plants	Uruguay	38	4.14	Miscellaneous chemical products

Partner	HS96 2D	%	Product description	Partner	HS96 2D	%	Product description
United States	76	3.17	Aluminum and articles thereof	Uruguay	89	3.85	Ships, boats, and floating structures
United States	22	2.97	Beverages, spirits and vinegar	Uruguay	39	3.83	Plastics and articles thereof
United States	26	2.74	Ores, slag, and ash	Uruguay	72	3.26	Iron and steel
United States	72	2.68	Iron and steel	Uruguay	68	3.02	Articles of stone, plaster, cement, asbestos, mica or similar materials

Source: Authors based on ALADI.

Table A.3.2. Main Products Imported from Main Trading Partners. Average Percentage Share 2008–2017. Kilograms

Partner	HS96 2D	%	Product description	Partner	HS96 2D	%	Product description
Brazil	26	51.17	Ores, slag, and ash	United States	27	57.09	Mineral fuels, mineral oils, and products of their distillation, etc.
Brazil	72	7.57	Iron and steel	United States	31	10.85	Fertilizers
Brazil	28	6.60	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.	United States	29	9.39	Organic chemicals
Brazil	87	6.32	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	United States	39	5.31	Plastics and articles thereof
Brazil	27	4.65	Mineral fuels, mineral oils, and products of their distillation, etc.	United States	28	3.77	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.
Brazil	48	3.95	Paper and paperboard; articles of paper pulp, of paper, or of paperboard	United States	25	1.84	Salt; sulfur; earths and stone; plastering materials, lime and cement
Brazil	39	3.38	Plastics and articles thereof	United States	38	1.73	Miscellaneous chemical products
Brazil	29	2.53	Organic chemicals	United States	84	1.64	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof
Brazil	84	1.37	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof	United States	48	1.62	Paper and paperboard; articles of paper pulp, of paper, or of paperboard
Brazil	40	0.84	Rubber and articles thereof	United States	32	0.93	Tanning or dyeing extracts; tannins and their derivatives, dyes, pigments, paints, putty etc.
Bolivia	12	40.58	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.	China	84	10.70	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof
Bolivia	8	32.68	Edible fruit and nuts; peel of citrus fruit or melons	China	31	9.99	Fertilizers
Bolivia	26	8.90	Ores, slag, and ash	China	29	9.26	Organic chemicals
Bolivia	25	5.47	Salt; sulfur; earths and stone; plastering materials, lime and cement	China	85	8.00	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, etc.
Bolivia	44	2.77	Wood and articles of wood; wood charcoal	China	28	6.67	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.
Bolivia	27	2.46	Mineral fuels, mineral oils, and products of their distillation, etc.	China	68	5.95	Articles of stone, plaster, cement, asbestos, mica or similar materials
Bolivia	22	1.65	Beverages, spirits and vinegar	China	87	4.91	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
Bolivia	69	1.50	Ceramic products	China	39	4.20	Plastics and articles thereof
Bolivia	23	1.18	Residues and waste from the food industries, prepared animal fodder	China	73	3.80	Articles of iron or steel
Bolivia	20	0.92	Preparations of vegetables, fruit, nuts or other parts of plants	China	27	3.23	Mineral fuels, mineral oils, and products of their distillation, etc.

Partner	HS96 2D	%	Product description	Partner	HS96 2D	%	Product description
Nigeria	27	98.15	Mineral fuels, mineral oils, and products of their distillation, etc.	Trinidad and Tobago	27	85.99	Mineral fuels, mineral oils, and products of their distillation, etc.
Nigeria	31	1.75	Fertilizers	Trinidad and Tobago	72	6.13	Iron and steel
Nigeria	39	0.05	Plastics and articles thereof	Trinidad and Tobago	26	4.97	Ores, slag, and ash
Nigeria	40	0.04	Rubber and articles thereof	Trinidad and Tobago	31	2.81	Fertilizers
Nigeria	41	0.01	Raw hides and skins (other than furskins) and leather	Trinidad and Tobago	29	0.09	Organic chemicals
Nigeria	13	0.00	Lac; gums, resins and other vegetable saps and extracts	Trinidad and Tobago	28	0.01	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.
Nigeria	18	0.00	Cocoa and cocoa preparations	Trinidad and Tobago	87	0.00	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
Nigeria	84	0.00	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof	Trinidad and Tobago	84	0.00	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof
Nigeria	12	0.00	Oil seeds and oleaginous fruits; miscellaneous grains, seeds, and fruit, etc.	Trinidad and Tobago	22	0.00	Beverages, spirits and vinegar
Nigeria	9	0.00	Coffee, tea, mate, and spices	Trinidad and Tobago	73	0.00	Articles of iron or steel
Russia	27	48.13	Mineral fuels, mineral oils, and products of their distillation, etc.	Paraguay	12	52.91	Oil seeds and oleaginous fruits, miscellaneous grains, seeds, and fruit, etc.
Russia	31	41.11	Fertilizers	Paraguay	25	32.49	Salt, sulfur, earths and stone, plastering materials, lime and cement
Russia	72	5.00	Iron and steel	Paraguay	69	2.58	Ceramic products
Russia	28	1.53	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.	Paraguay	8	02.05	Edible fruit and nuts; peel of citrus fruit or melons
Russia	25	1.46	Salt; sulfur; earths and stone; plastering materials, lime and cement	Paraguay	70	1.93	Glass and glassware
Russia	48	0.86	Paper and paperboard; articles of paper pulp, of paper, or of paperboard	Paraguay	15	1.92	Animal or vegetable fats and oils and their cleavage products, etc.
Russia	29	0.54	Organic chemicals	Paraguay	48	1.46	Paper and paperboard; articles of paper pulp, of paper, or of paperboard
Russia	40	0.47	Rubber and articles thereof	Paraguay	72	1.10	Iron and steel
Russia	39	0.31	Plastics and articles thereof	Paraguay	44	0.93	Wood and articles of wood; wood charcoal
Russia	34	0.10	Soap, organic surface-active agents, washing prep, etc.	Paraguay	22	0.48	Beverages, spirits and vinegar
Spain	27	23.78	Mineral fuels, mineral oils, and products of their distillation, etc.	Germany	87	12.15	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
Spain	28	19.27	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.	Germany	72	10.27	Iron and steel

Partner	HS96 2D	%	Product description	Partner	HS96 2D	%	Product description
Spain	25	16.60	Salt; sulfur; earths and stone; plastering materials, lime and cement	Germany	48	10.09	Paper and paperboard; articles of paper pulp, of paper, or of paperboard
Spain	72	7.34	Iron and steel	Germany	84	9.63	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof
Spain	48	4.23	Paper and paperboard; articles of paper pulp, of paper, or of paperboard	Germany	38	7.96	Miscellaneous chemical products
Spain	31	3.46	Fertilizers	Germany	29	07.02	Organic chemicals
Spain	87	2.90	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	Germany	39	6.34	Plastics and articles thereof
Spain	39	2.68	Plastics and articles thereof	Germany	28	4.24	Inorganic chemicals; organic or inorganic compounds of precious metals or rare-earth metals, of radioactive elements, etc.
Spain	84	2.37	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof	Germany	31	3.76	Fertilizers
Spain	73	2.28	Articles of iron or steel	Germany	27	3.50	Mineral fuels, mineral oils, and products of their distillation, etc.

Source: Authors based on ALADI.