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INDIA'S TRADE IN DIRTY PRODUCTS

Malini L Tantri* and Varadurga Bhat**

Abstract

This paper, focusing on dirty industries, attempts to explain how pollution-intensive are India's exports and does India really have a comparative advantage in dirty products along with discussing the emerging issues. The analysis, based on UN Comtrade dataset, helps us to argue that much of India's exports happen under this category, which does cause a high environmental concern. Meanwhile, a majority of the products are noticed having better RCA values, indicating a comparative advantage for their future expansion. While aiming for the same, there is a need to attend to the sector-specific problems encountered by them, along with having a well-knit environmental policy in place.

Keywords: Dirty Industries, Trade, Comparative Advantage, India

Introduction

The impact of trade liberalization on a country's welfare depends on whether there are appropriate environmental policies in place within the country (OECD n.d). In India, the environment has not been given a specific mention in the country's foreign trade policy over the years, compared to the EU, which in 2014, along with 13 WTO members, started the Green Goods initiative, aiming primarily at tariff removal on a broad list of green goods (European Commission, 2015). The EU also provides additional trade preferences to countries under their Generalised Scheme of Preferences (GSP) if they ratify and implement conventions relating to the environment. Thus, the concept of environment in India's foreign trade policy has received attention in bits-and-pieces than a holistic approach. Moreover, the government was not meticulous in allowing and restricting specific types of industries in the broader interest of the environment which has resulted in the expansion of polluting industries and their corresponding exports in the country.

Though dirty industries and their possible impact on delocalization and environmental impacts have received due attention across the globe (Albrecht, 1998; Azar and Elliott, 2007; Broner and Bustos, 2012; Busse, 2004; Cole *et al*, 2005; Gallagher and Ackerman, 2000; Grether and de Melo, 2004; Hettige *et al*, 1995; Mani, 1996; Mani and Jha, 2006; Mani and Wheeler, 1998; Van Beers and Van den Bergh, 1997; Walter, 1979), a little is researched in the Indian context (see Gamper-Rabindran and Jha, 2004; Sawhney and Rastogi, 2015), and mainly based on quantitative models incorporating the pollution abatement costs or environmental stringency as a policy variable. However, a comprehensive study on the recent trends in exports and imports from dirty industries, especially after the new economic policy of 1991, which also could throw light into the policy scenario taking trade-environment interface, is lacking in the Indian context. Our study fills this gap. By taking the example of dirty industries, it attempts to explain how dirty are our exports and do we really have a comparative advantage in these products along with addressing the emerging issues. It also flags the policy arena that has resulted in such a pattern.

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The study contributes to the existing literature in three ways. First, the list of industries used for this study is the first of its kind expressed in Standard International Trade Classification (SITC) codes encompassing almost all the dirty industrial sectors. Since most of the studies on dirty industries have used International Standard Industrial Classification (ISIC) codes, a comprehensive list of pollution intensive sectors as per SITC codes in line with ISIC was needed. Second, the study throws light on the policy issues along with analysis of trends and pattern as against the econometric approach of the existing literature. Third, the time period selected for this study covers the most recent year (2018), thus able to reveal the emerging and up-to-date trends in the Indian dirty industrial sector. The rest of the paper is organized as follows: the section following this outlines the approach and methodology followed in the paper. The third section provides empirical evidence. The fourth section highlights the policy discourse and the last section summarizes the paper.

Concept, Approach and Methodology

Dirty industries are pollution intensive industries. The concept originally emerged in the late 1980s in association with pollution haven hypothesis and industrial flight hypothesis (Tobey 1990; Walter, 1979). Two approaches are used in literature to classify industries into relatively dirty and clean industries. The conventional approach considers the sectors with high pollution abatement costs per unit of output or as percentage of total costs in the US, and OECD countries as dirty industries (Tobey, 1990; Low and Yeats, 1992; Low, 1992; Mani, 1996). These studies used SITC codes to list the dirty industries. The second approach, computed by the World bank (Hettige, *et al*, 1995) is the direct approach which considers the industries with high emission intensities (emissions per unit of output). This approach used ISIC codes to identify pollution intensive industries. Both approaches resulted in almost similar list of pollution-intensive industries. Mani and Wheeler (1998)[1] prepared a list of pollution-intensive industries using the second approach and computed average sectoral rankings for conventional air and water pollutants, and heavy metals. Among these, iron and steel, nonferrous metals, industrial chemicals, pulp and paper, and non-metallic mineral products were identified as the dirtiest manufacturing industries. Broner and Bustos (2012)[2] computed pollution emission intensity per dollar of sales in a given industry for 112 industries. They ranked the pollution intensive manufacturing industries for Nitrogen Oxides, Sulphur Dioxide and Carbon Oxides separately. The study listed pulp/paper and paperboard mills, non-metallic minerals, chemicals, petroleum and coal products, iron and steel as the top polluting industries. In India.

The Central Pollution Control Board has classified industries into four categories: Red, orange, green and white, based on the pollution index which is a function of the emissions (air pollutants), effluents (water pollutants), hazardous wastes generated and consumption of resources (CPCB, 2016). Out of these, 60 industries listed under the red category[3] are the highest polluting industries with a pollution index score of 60 and above.

[1] See Appendix 1

[2] See Appendix 1

[3] See Appendix 1

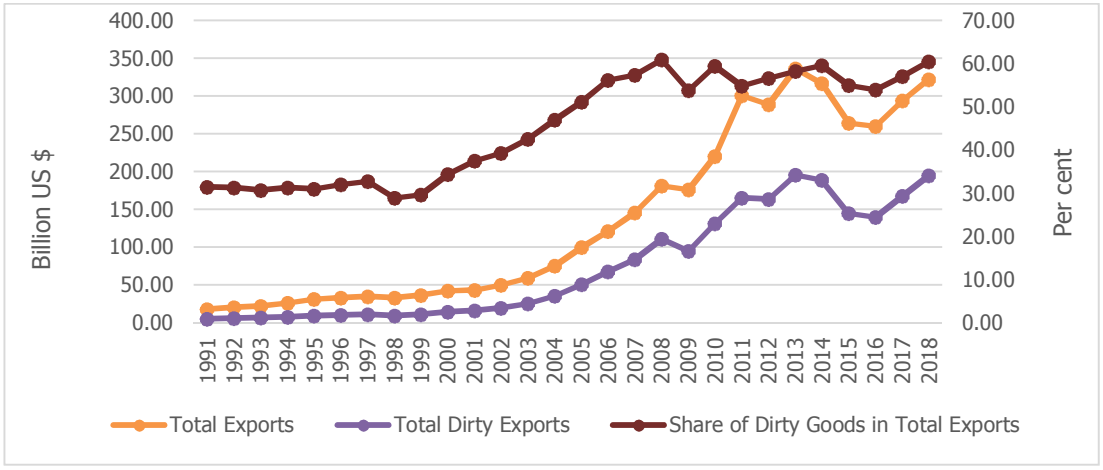
The selection of dirty industries for the present study has been done based on the lists provided by Mani and Wheeler (1998), Broner and Bustos (2012) and CPCB (2016). A detailed list of all sixteen categories selected for our study with all the product codes and descriptions under each category is given in Appendix 2. Enough care has been taken to make the list comprehensive, covering all the sectors mentioned in the lists provided by the above studies. We have matched the dirty industrial sectors to the SITC codes using SITC Revision 3 classification. The analysis is carried out at 3-digit level, classifying them into sixteen categories. For a few industries 4-digit and even 5-digit levels are used to be more precise, especially when all the industry subcategories in a particular 3-digit category are not classified as pollution-intensive industries. We collected data on exports and imports from UN Comtrade, for the period 1991-2018. Trend, pattern and direction have been analyzed for exports and imports of dirty industries followed by the calculation of revealed comparative advantage indices (RCAI). The data of FDI has been collected by Department for Promotion of Industry and Internal Trade, Government of India. We have used various reports by government and non-government agencies to analyze the policy with respect to the pollution intensive sectors.

Empirical Evidence

Trend, Pattern and Direction of Dirty Industries Trade in India

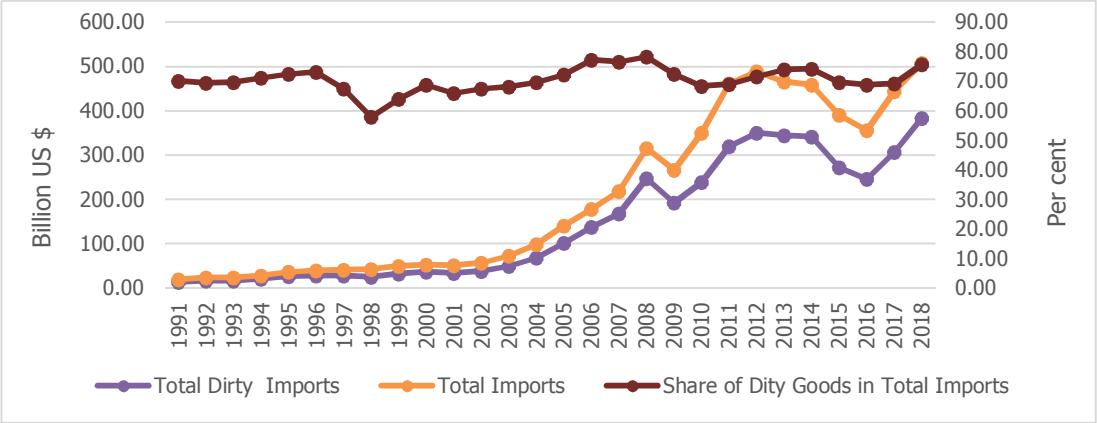
India's exports and imports of dirty goods during the reference period have increased substantially (Figures 1 and 2) and it has followed the same trends as the total exports and imports of the country. Their share in total exports has almost doubled (from 31.42 per cent to 60.56 per cent) during the study period. Within that a continuous upward trend is noticed between 1999-2008, 2011-2014, and 2016-2018. During the same period, the share of imports of dirty goods in total imports of the country has increased marginally from 70.22 per cent to 75.71 per cent. There are not many variations except for the years 1997 and 1998, where the share of dirty imports has dropped considerably, which among others could be due to East Asian phenomena. The share of dirty imports also declined in the years following the global financial crisis and between 2014-2017.

Figure 1: Trends in India's Exports of Dirty Goods during 1991-2018



Source: Authors' calculations based on UN Comtrade Database, accessed on 08 April, 2020

Figure 2: Trends in India's Imports of Dirty Goods during 1991-2018



Source: Authors' calculations based on UN Comtrade Database, accessed on 08 April, 2020

Among the sixteen categories of dirty industries, five contribute 70 per cent of total trade (Table 1). Textile and leather constituted the largest category of Indian dirty exports with a share of 17.76% in 1991. The category has witnessed a persistent fall in its share in dirty exports and eventually lost its place in the top five. Mining and ore beneficiation sector also experienced a gradual decline it its share. The share of petroleum and coal products has continuously increased and since 2004 it is enjoying the top position in India's dirty exports. Iron and steel was a major category between 2002 and 2011. Other sectors have a marginal share in Indian dirty exports during the entire study period. Among these sectors, non-ferrous metals, food and beverages, and pulp and paper witnessed a remarkable growth over time (Table 2). A look at the top five leading categories of imports reveals a somewhat similar picture (Table 1). There is not much change over time in the top categories of imports. There are only three major categories of imports in India, among the dirty sectors, namely, petroleum and coal, machinery and electricals, and chemicals. These sectors together accounted for 76.48 per cent of India's total dirty imports in 1991. Their share has increased to 79.13 per cent in 2018. All other sectors except iron and steel had a very negligible share in total dirty imports throughout the study period, though some sectors have witnessed a tremendous growth (Table 2).

Table 1: Top Five Leading Categories of Dirty Products Trade in India

Rank	Exports		Imports	
	1991	2018	1991	2018
1	Textile and Leather (17.76)	Petroleum and Coal Products (24.76)	Petroleum and Coal Products (42.61)	Petroleum and Coal Products (43.91)
2	Machinery and Electrical Products (15.18)	Machinery and Electrical Products (17.19)	Chemicals (17.30)	Machinery and Electrical Products (24.93)
3	Mining and Ore Beneficiation (12.57)	Automobiles (11.99)	Machinery and Electrical Products (16.57)	Chemicals (10.29)
4	Automobiles (8.76)	Chemicals (11.53)	Iron and Steel (5.69)	Mining and Ore Beneficiation (3.67)
5	Pharmaceuticals (8.60)	Pharmaceuticals (8.07)	Mining and Ore Beneficiation (3.63)	Automobiles (3.59)

Note: Figures in brackets are the percentage shares of the category in total dirty exports/imports

Source: Authors' Calculations based on UN Comtrade Database, accessed on 08 April, 2020

The growth pattern of dirty industries trade across selected sectors and over three years, reveal that during 1991-2018, the dirty exports have grown at a faster rate (15.26%) than the total exports (13.11%) (Table 2). Among the subcategories of the dirty sectors, petroleum and coal, stands at the top with a growth rate of 23.63 percent, followed by non-ferrous metals (17.75%), automobiles (17.26%), food and beverages (16.37%), and pulp and paper (15.28%). Except photographic films, exports from all subcategories have significantly grown over the study period. Imports of dirty products also exhibit a similar trend with a higher growth rate of 13.78 per cent than the growth of overall imports (13.54%). The top five sectors with the highest growth rates are wood products (19.25%), food and beverages (15.58%), manufactures of metals (15.36%), mining and ore beneficiation (14.84%), and machinery and electrical products (14.47%). Over the reference period, the highest growth rate is noticed between 2001-2010, across all categories. A comparison of growth of exports and imports reveals that, during the study period, India's total imports have grown faster than its exports. But the exports of dirty goods have increased at a higher rate than their imports. Apart from this, the gap between the growth of total exports and dirty exports are much higher than the gap between the dirty imports and total imports. These findings necessitate the need for a detailed analysis of the trends in the subcategories of dirty sectors.

Among the subcategories of dirty sectors, imports of non-metallic minerals, manufactures of metals, wood products, rubber, textile and leather products, mining and ore beneficiation, and photographic films have registered a higher growth than their exports during the reference period. All other categories have seen a surge in exports faster than imports. The largest difference between growth rates of exports and imports was observed for petroleum and coal products, followed by non-ferrous metals, pulp and paper, pharmaceuticals, and chemicals. In the last five years (2014-2018) based on the highest average growth rate, we have computed the emerging sectors within dirty industries, which seems to be having the potential to be the major players in the coming years (Table 3). Among the five emerging sectors of exports, chemicals, machinery, and electricals and pharmaceuticals are among the top five categories with respect to their share in total exports of dirty industries in 2018. Pulp and paper has retained its position as both leading and emerging sector. Among imports, machinery and electrical products is one of the top five categories with regard to the share in dirty imports. Wood products, machinery and electricals and manufactures of metals are both leading and emerging sectors in imports.

Table 2: Decadal Growth Rates of Exports and Imports of Dirty Products during 1991-2018

Year	Exports (%)				Imports (%)			
	1991-2000	2001-2010	2011-2018	1991-2018	1991-2000	2001-2010	2011-2018	1991-2018
Food and Beverages	10.47	21.83	3.61	16.37	8.25	29.45	2.09	15.58
Pulp and Paper	20.47	14.42	8.27	15.28	9.91	16.22	5.99	10.74
Non-metallic Minerals	13.61	13.62	8.12	12.26	6.25	22.5	4.89	13.67
Iron and Steel	11.86	23.68	0.75	14.04	2.11	31.38	-2.36	11.93
Non-Ferrous Metals	7.23	31.62	5.59	17.75	13.88	21.9	3.82	12.96
Chemicals	17.38	19.56	3.89	14.75	6.58	23.97	1.24	11.81
Petroleum and Coal Products	-5.52	35.03	-7.90	23.63	11.05	23.91	-5.08	14.42
Rubber	7.07	15.72	1.50	11.66	12.32	24.02	2.3	14.44
Wood Products	3.09	18.82	8.52	11.86	25.99	26.91	6.47	19.25
Textile and Leather	7.05	11.49	0.28	9.07	12.12	14.77	4.61	11.66
Manufactures of Metals, n.e.s	11.54	14.14	1.49	12.21	13.14	26.01	3.65	15.36
Pharmaceuticals	11.50	19.36	6.24	14.99	4.96	20.56	4.05	11.87
Machinery and Electrical Products	10.83	22.80	3.73	15.16	11.59	23.82	4.9	14.47
Photographic Films	16.87	2.27	-15.63	0.24	7.64	3.85	-6.02	2.99
Automobiles	5.70	30.90	3.04	17.26	7.92	30.54	2.69	14.34
Mining and Ore Beneficiation	-3.76	29.23	-10.17	8.76	4.69	28.45	-2.05	14.84
Total Dirty Exports	9.09	24.21	0.02	15.26	9.88	24.21	-0.71	13.78
Total Exports	8.88	18.85	-0.48	13.11	10.98	23.09	-0.94	13.54

Source: Authors' Calculations based on UN Comtrade Database, accessed on 08 April, 2020

Table 3: Top Five Emerging Categories of Dirty Products Trade in India

Exports		Imports	
Categories	Average growth rate between 2014-18 (%)	Categories	Average growth rate between 2014-18 (%)
Pulp and Paper	13.07	Pulp and Paper	6.17
Non-metallic Minerals	6.54	Non-metallic Minerals	7.32
Chemicals	9.42	Wood Products	7.28
Machinery and Electrical Products	8.39	Manufactures of Metals, nes	7.08
Pharmaceuticals	4.36	Machinery and Electrical Products	10.58

Source: Authors' Calculations based on UN Comtrade Database, accessed on 08 April, 2020

The direction of trade (Appendix 3) over the years has shown significant changes. For the latest available year except petroleum products, USA and China are the most preferred nations. At the same time, dirty products are also majorly sourced from China (except for petroleum and mining and iron ore products) and USA (except for petroleum products). For petroleum products, India is highly dependent on OPEC countries.

Revealed Comparative Advantage and Dirty Industries Trade

Traditional trade theory given by David Ricardo focuses on the aspect of comparative advantage to decide the pattern of trade. Difference in pre-trade relative prices was seen as the basis for comparative

advantage, which is practically not possible to measure. Even the modern Heckscher-Ohlin-Samuelson theory is considered as an improved version of Ricardo's theory, where comparative advantage was explained in terms of factor intensity and factor abundance. Balassa (1965, 1977, 1979, 1986) came with a new measure of Revealed Comparative Advantage (RCA) in order to measure specialization. He used the relative export performance of a country in individual product categories as an indicator of comparative advantage. Assuming that 'the commodity pattern of trade reflects the inter-country differences in relative costs as well as in non-price factors, this is assumed to "reveal" the comparative advantage of the trading countries' (Balassa, 1977). Along with measuring comparative advantage 'RCA indices also incorporate the effects of changes in the policy environment' (Grether and de Melo, 2003). The RCA Index (RCAI) for country i and commodity j is calculated as follows.

$$RCAI_{ij} = \frac{X_{ij}/X_i}{X_{wj}/X_w},$$

Where X_{ij} stands for country i's export of commodity j, X_{wj} is the world export of commodity j, X_i is the total export of country i and X_w represents total world exports. RCAI can also be calculated for different sectors using the same formula. The value of RCAI ranges between 0 and $+\infty$. RCAI value higher (lower) than one for any commodity/sector indicates comparative advantage (or specialization)/disadvantage (or under specialization) in that commodity/sector. Low and Yeats (1992), Grether and de Melo (2003), and Cole *et al* (2005) used the RCAI developed by Balassa (1965) to measure specializations in pollution-intensive industries.

In this background, to understand whether India experiences any comparative advantage in the exports of dirty products we computed RCAI at two levels: First, RCAI for all sixteen major categories of products and second, RCAI for all the subsectors of the sixteen categories. The results presented in Table 4 indicate that in 1991, India specialized in only 3 sectors namely, textile and leather, pharmaceuticals, and mining and ore beneficiation. But over time, there were large variations in the values of RCAI across different sectors. In 2018, India had a comparative advantage in eleven sectors out of sixteen. India's RCAI value for dirty industries has continuously increased during 1991-2018, and India started to enjoy RCAI>1 since 2010. A more detailed analysis of sector-wise and direction-wise RCAIs is needed to examine the effects of policies on comparative advantage.

The direction of shift in the RCAI value has been positive for many sectors. The highest comparative advantage was observed in textiles and leather sector throughout the study period, and the values have increased during the study period. Except pharmaceuticals, photographic films and mining and ore beneficiation, all the sectors witnessed a positive growth in RCAI values. The RCAI values computed at disaggregated levels indicate that (Table 5) compared to 1991, there was a sea change in RCA enjoyed by India in 2018. Many products had RCAI>1 and many products have experienced considerable growth in RCAI values over the reference period. During 1991-2018 the number of products with RCA>1 increased from 28 to 87. Machinery and electrical products sector show an overall comparative disadvantage, but at disaggregated level 24 out of 41 products in this sector have RCAI>1. In 2018, the top five categories of dirty exports also enjoyed comparative advantage and except pharmaceuticals, others have registered a positive growth in RCAI values.

Table 4: RCA for Different Categories of Dirty Industries during 1991-2018

Categories	RCAI Value				RCA Classification				Direction of Shift			
	1991	2001	2011	2018	1991	2001	2011	2018	1991-2001	2001-2011	2011-2018	1991-2018
Food and Beverages	0.25	0.44	0.56	0.73	Disadvantage	Disadvantage	Disadvantage	Disadvantage	+	+	+	+
Pulp and Paper	0.04	0.22	0.20	0.43	Disadvantage	Disadvantage	Disadvantage	Disadvantage	+	-	+	+
Non-metallic Minerals	0.44	1.12	0.75	1.27	Disadvantage	Advantage	Disadvantage	Advantage	+	-	+	+
Iron and Steel	0.57	1.18	1.21	1.57	Disadvantage	Advantage	Advantage	Advantage	+	+	+	+
Non-Ferrous Metals	0.40	0.50	0.64	1.06	Disadvantage	Disadvantage	Disadvantage	Advantage	+	+	+	+
Chemicals	0.60	1.20	1.00	1.71	Disadvantage	Advantage	Advantage	Advantage	+	-	+	+
Petroleum and Coal Products	0.34	0.52	1.64	1.66	Disadvantage	Disadvantage	Advantage	Advantage	+	+	+	+
Rubber	0.76	1.14	0.81	1.04	Disadvantage	Advantage	Disadvantage	Advantage	+	-	+	+
Wood Products	0.14	0.11	0.15	0.24	Disadvantage	Disadvantage	Disadvantage	Disadvantage	-	+	+	+
Textile and Leather	2.15	2.49	3.26	4.36	Advantage	Advantage	Advantage	Advantage	+	+	+	+
Manufactures of Metals, n.e.s	0.88	1.43	1.62	2.18	Disadvantage	Advantage	Advantage	Advantage	+	+	+	+
Pharmaceuticals	2.12	1.38	0.93	1.11	Advantage	Advantage	Disadvantage	Advantage	-	-	+	-
Machinery and Electrical Products	0.18	0.22	0.53	0.81	Disadvantage	Disadvantage	Disadvantage	Disadvantage	+	+	+	+
Photographic Films	0.17	0.24	0.11	0.05	Disadvantage	Disadvantage	Disadvantage	Disadvantage	+	-	-	-
Automobiles	0.20	0.19	1.13	1.53	Disadvantage	Disadvantage	Advantage	Advantage	-	+	-	+
Mining and Ore Beneficiation	4.05	1.59	1.44	1.03	Advantage	Advantage	Advantage	Advantage	-	-	-	-
Total Dirty Exports	0.44	0.53	1.02	1.27	Disadvantage	Disadvantage	Advantage	Advantage	+	+	+	+

Source: Authors' calculations based on UN Comtrade database, accessed on 8April, 2020

Table 5: A Comparison of Products at Disaggregate Level with RCAI>1

Categories	1991	2018
Food and Beverages	011	011
Pulp and Paper	0	0
Non-metallic Minerals	661	661, 662, 665, 2732, 2782, 2784
Iron and Steel	671, 678	671, 672, 673, 674, 678, 679
Non-Ferrous Metals	0	684, 685, 686
Chemicals	514, 516, 591	511, 512, 513, 514, 515, 516, 523, 591, 593
Petroleum and Coal Products	334, 345	334, 335, 344
Rubber	0	625
Wood Products	0	0
Textile and Leather	531, 532, 611, 612, 653, 6514, 6517, 6518, 6519	266, 531, 532, 533, 611, 612, 653, 657, 6514, 6515, 6516, 6517, 6518, 6519 (all except one)
Manufactures of Metals, n.e.s	697, 699	691, 692, 693, 694, 695, 696, 697, 699 (all categories)
Pharmaceuticals	542	542
Machinery and Electrical Products	711	711, 712, 713, 714, 716, 718, 722, 723, 724, 725, 727, 735, 737, 741, 742, 743, 746, 747, 748, 749, 751, 771, 774, 778
Photographic Films	883	0
Automobiles	785	781, 782, 784, 785, 791, 792, 793
Mining and Ore Beneficiation	281, 285, 287	281, 285, 289

Source: Authors' Calculations based on UN Comtrade Database, accessed on 08 April, 2020

Policy Discourse and Dirty Industries

On the one hand, the pollution intensive products have made a significant contribution to Indian economy and they have their due place in the global map. For instance, India is the second largest producer of cement in the world, accounting for more than 7% of the global installed capacity (IBEF, 2021). The cement industry provides employment to about 20000 people per million tonne of cement production (Cement Manufacturers Association, 2021). The Indian pharma sector contributes approximately 20% to global generic market in terms of value (Sahay, 2020 May 7). It has provided employment to over 5.5 million people (Mehta and Rani, 2018). India is the world's second largest producer of crude steel and the largest producer of sponge iron. The iron and steel industry contributes about 2 per cent to Indian GDP and provides direct/indirect employment to about 25 lakh people (Ministry of Steel, 2019). The quality of Indian steel has received global attention. Indian The steel industry has an 'output multiplier effect of nearly 1.4X on GDP and employment multiplier factor of 6.8X' (ibid). The Indian chemical industry is the sixth largest in the world and the third largest in Asia. With an employment of above 5 million people (above 5% share in employment), it contributes about 2.11% to Indian GDP and about 15% to India's manufacturing GDP (CII, n.d). India is also one of the largest producers of automobiles in the world, contributing more than 6% of India's GDP, approximately 35% to manufacturing GDP, and a major generator of employment opportunities directly and indirectly by proving jobs to about 38 million people (Goenka, 16 April). The oil and gas sector has provided employment to over one lakh people, of which exploration and production vertical accounted for the highest manpower deployment (30%) followed by marketing (28%) and refinery (23%) as in March, 2016 (GOI, 2016). The contribution of mining to GDP

stood at 1.6% in 2018-19 (GOI, 2020). During the pandemic, when country's GDP is at stake, the pharma sector could help the economy to withstand the global pandemic induced economic shocks.

On the other hand, the products listed under this category have high environmental implications. Total greenhouse gas emissions from energy and industrial processes increased from 682.39 million tonnes of carbon equivalents to 2573.12 million tonnes of carbon equivalents between 1991 and 2018.Their share in total GHG emissions has increased from 64% to 77% in this period. The manufacturing/construction sector contributed about 23% of the total energy related emissions. Chemical industries are the major sources of industrial accidents and they produce approximately 7.7 million tonnes of hazardous waste every year (Mishra, 2020, January 9). For instance, globally, pollution driven by pharmaceutical sector is widely recognised as a threat to ecosystems and human health as waste can enter the environment at all three stages of their life cycle i.e., production, use, and disposal (see for detail: Nash *et al* 2004; BIO Intelligence Service, 2013; Larsson, 2014; Deloitte, 2016; Changing Markets, 2016). The argument holds true even with respect to emerging dirty products from India. In this context, any policy measures in these products have to be doubly checked as export earnings and the corresponding growth number will be at the cost of environment sustainability. In this backdrop this section highlights the major policy facts and issues surrounding the dirty industries.

Environment in the Making of Trade Policy

The concept of protection of environment entered into Indian constitution in the form of directive principles of state policy (Article 48A) in 1976 as 42nd amendment. Article 51A (g) of the constitution makes it the fundamental duty of Indian citizen to protect and improve environment. Though Acts specific to different sectors such as The Wildlife (Protection) Act, 1972, Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act, 1981, The Forest (Conservation) Act, 1980 were introduced, they were not very effective in protecting the environment due to poor implementation triggered by federal issues such as the division of power between Centre and states (Gamper-Rabindran and Jha, 2004). Environment (Protection) Act, 1986 (EPA) was the first general legislation for environmental protection in India. The National Environmental policy came in 2006 with an emphasis on conservation of resources and sustainable development. But this has not helped much in articulating the need for environmental consciousness while drafting the country's foreign trade policy. It clearly reflects how the Ministry of Commerce and Industry, which is the nodal agency for trade being not integrated with the Ministry of Environment, thereby depicting the larger governance issues. India currently has a bits-and-pieces approach in accommodating the growing global trend to address domestic crisis. For instance, The EXIM Policy (1997-2002) included a clause saying that scrap/waste/remnants arising out of production process or in connection therewith may be sold or disposed of in the domestic tariff area on the payment of applicable duties or exported. However, there shall be no duties/taxes on such scrap/waste/remnants in case the same are destroyed with the permission of customs authority.

From EXIM Policy (2004-2009), a clause was included saying that the Directorate General of Foreign Trade may, through a notification, adopt and enforce any measure necessary for conservation of exhaustible natural resources. The EXIM Policy 2006 also states that all imported goods should be subject to environmental and safety norms. In 2007, the Ministry of Environment allowed the import of genetically

modified soybean oil (Economic Times, 2007). The Karnataka State government banned the export of iron ore from 2010 due to environmental concerns over illegal mining (Times of India, 2010). However, the government in 2019 set plans to re-open the industry to exports, subject to certain conditions including permitting the exports of only low-grade ore (Deccan Herald, 2019). The EXIM Policy (2015-2020) included a clause saying that exporters of minor forest produce and their value-added products shall obtain Registration-cum-Membership Certificate (RCMC) from the Shellac Export Promotion Council. Resultantly, though we are exporting these products, we are in far below the global value chains (Ray and Miglani, 2016). The recent Draft Environment Impact Assessment (EIA) Notification, 2020 issued in March, 2020, by the Ministry of Environment, Forest and Climate Change allows post-facto approval for the projects, and reduces the time for the public to submit responses, which may help the industries to evade environmental clearances, and thus can be detrimental to the environment. The new draft also empowers the central government to categorize some projects as strategic, which will keep such projects away from public domain (Aggarwal, 2020; GoI, 2020; Mohanty, 2020).

Foreign Direct Investment

Not surprisingly, this sector has attracted a huge sum of FDI over the years. Leading dirty industries together contributes 17.11 per cent of total FDI inflow into the country (April 2000-March 2020). Within that, Automobiles (5.15%) followed by Chemicals (3.75%), Drugs and Pharmaceuticals (3.51%) have the highest share. Except Pharmaceuticals (74% under automatic route is permitted for brownfield pharma) and Petroleum and Natural gas (49% FDI allowed in petroleum refining by Public Sector Undertakings (PSUs) without any dilution of domestic equity in existing PSUs under automatic route) 100 per cent FDI is allowed under the automatic route. Japan, UK and, Mauritius are invariably major investors across the top five dirty industries in India. Surprisingly, these countries do not figure in the top five destination for India's dirty exports and imports. Also, their share over the years has declined except imports from Mauritius.

Location

With respect to the location of these industries historical factors, resource availability, proximity to ports and ease of doing business (RBI, 2019) and favorable state policies play a significant role. For instance, coal deposits are primarily found in the states of eastern and south-central India such as Jharkhand, Odisha, Chhattisgarh, West Bengal, Madhya Pradesh, Telangana and Maharashtra which accounted for 98.26% of the total known coal reserves in India (GoI, 2015). Accordingly, these states are the largest coal producers. Similarly, petroleum and natural gas industries are concentrated in Maharashtra, Gujarat, Assam, Andhra Pradesh, Kerala, Tamil Nadu, Karnataka, Rajasthan, West Bengal and Tripura based on proximity to reserves (GoI, 2016). Chemical and petrochemical industries are mainly located in Gujarat, Maharashtra and Uttar Pradesh, which together account for 50% of Indian Chemical and petrochemical Industry (FICCI, 2014). Machinery and Automobiles industries are concentrated in Tamil Nadu, NCR region, Gujarat, Karnataka, Jharkhand, Madhya Pradesh, Maharashtra, and West Bengal, whereas pharmaceutical industries are mainly located on the west coast of India, Andhra Pradesh, Tamil Nadu and Karnataka (SESEI, 2018).

Sector Specific Issues

Though dirty industries are contributing significantly towards India's total exports, a few unattended sector specific problems reported, which need policy attention. For instance, in the case of mining sector, India is expected to become the world's second highest producer of coal (IBEF, 2020). However, the contribution of the mining sector to the country's GVA declined over ten years from 3.9 per cent in 2009 to 2.7 per cent in 2019. (KPMG, 2020). Yes Bank (2014) identified how the mining industry in India is yet to reach its full potential due to deposits being located in dense forest areas and those with tribal population, on account of which extra conservation and rehabilitation efforts are required. Though the National Mineral Policy, 1993 aimed at increasing private investments and encourage FDI, there was still heavy regulation and legal requirements from the government which did not lead to significant private investment, as licenses were mostly offered to public sector companies; during 2011-12, close to 68 per cent of mineral production was from the public sector alone (FICCI, 2013), and it has resulted in large potential areas being blocked without any exploration. Moreover, tax concessions were not provided to explore mines, and clearing leases required approvals from multiple agencies.

India has also spent a minimal amount on mine exploration (as low as 0.5% of global spending in 2010). There have also been issues of illegal mining and tribal conflicts (ibid). A study by ISID (2012) argues that though India is producing and exploring a large amount of surface minerals including iron ore, manganese and bauxite, the sector has not significantly diversified into exploring base and noble minerals including lead, zinc, copper, nickel, gold and diamond, which require sophisticated technology and significant expertise. Major issues affecting the chemical industries include the high cost of raw materials in India for the chemical industry, the high cost involved in researching and developing new products, lack of education amongst farmers on the proper usage of various agrochemicals, the lack of an efficient distribution channel to supply to end consumers, and high entry barriers particularly with regard to the petrochemicals industry were particularly highlighted (FICCI, 2013).

India's pharmaceuticals, which is the third largest in the world in terms of volume, is also the largest exporter of generic medicines, making up 20 per cent of global exports (Invest India, 2020). The cost of producing drugs and pharmaceuticals in India also happens to be close to 60 per cent lower than the costs in the USA, and the country's policy on intellectual property rights is entirely compliant with the WTO agreement (ibid.) Despite the low costs, PwC (2010) estimated that close to 45-55 per cent of costs came from logistical costs alone in supplying from the factory to the shelf, where improvements need to be made in terms of providing good cold-chain facilities to avoid distribution shocks, and reducing the time between order cycles so that drugs can be provided at affordable prices to a country where most of the population is below middle income. The situation did not change much even when pharma units were working within SEZs set up in the country (Tantri, 2016).There were also prior issues of domestic companies creating copycat versions of patented drugs due to the lack of a patented system in India that aligned with international standards, where companies could manufacture patented drugs provided their processes were different. However, since 2005, such production is no longer permitted. The pharma industry at a point was highly fragmented, and though Indian companies have been moving towards more mergers and acquisitions, some of them find it difficult to align their foreign acquisitions to the Indian market on account of pricing pressures, since India prides itself on its low cost of production.

There is also the need to penetrate rural markets which lack the required infrastructure and distribution channels. (PwC, 2010). Feinberg and Majumdar (2001) studied FDI inflows in the Indian pharma sector over 14 years, and concluded that only the MNCs benefitted from these investments, with not much technology and knowledge being passed onto the Indian companies. Joseph and Ranganathan (2016) noted how most foreign direct investment in the healthcare sector was directed towards the manufacturing of generic drugs, and how most of the inflow was focused on acquiring Indian firms versus making new investments in research and development. They concluded that FDI investments did not lead to huge benefits in terms of promoting pharma exports and developing new technologies.

In terms of oil refining capacity, India has the potential to be the second largest refiner in Asia, with private companies owning more than one-third of the total refining capacity. (IBEF, 2019). India is also the third largest consumer of oil in the world. Consumption of petroleum products in India grew more than 5 per cent from 2017-18 (ibid.) The government is planning to double the refining capacity to 500 million tonnes by 2030 (IBEF, 2021). India's strategic reserves of petroleum of nearly 40 million barrels can cover just over 10 days of net imports, and given the rising consumption in India, could cover only four days of net imports by 2040. As a result, the government has been recommended to pursue the next phase of increasing strategic reserves by nearly 50 million barrels through encouraging more investors and collaborating with countries that hold the necessary expertise (IEA, 2020). Clarke and Graczyk (2010) suggested that the government should move towards a market-price oriented regime and reduce the burden of providing subsidies.

The government in its report on the petroleum sector for 2007-2012 mentioned how investments need to be attracted through creating an investor-friendly environment, increasing production, increasing the spread of pipelines, and promoting research and development as measures that need to be taken. With respect to machinery and electrical equipment,, India was the 10th largest producer of machinery equipment in 2014, slipping from 8th position in 2010. In terms of electrical equipment, though India's position improved from 6th to 5th position during the same period, overall contribution to global production had declined marginally. India has also seen a rise in importing machinery from developed countries that have new, innovative machines, and countries like China that provide them at lower costs (EXIM Bank, 2017). A reason for the rise in imports has been the failure of domestic manufacturers to keep up with the rising demand of capital goods in the country. Another reason is the high cost of producing steel, a critical component in machinery production, which is nearly 50-70 per cent higher among certain Indian firms compared to average costs globally. Also, there are a large number of MSMEs involved in the machinery sector, due to which the scale of operations and technologies used are low, and there are significant delays in delivery times of equipment to end users on account of them being custom made versus being produced and stored in advance due to capacity constraints and poor transport and high power costs. (ibid).

Summary

The present study, besides filling the major gaps in research, has attempted to provide a holistic understanding of India's trade pattern in dirty industries. The analysis reveals that much of our exports happen under this category, which do have high environmental concern. But a majority of products have

better RCAI values, indicating a comparative advantage in their future expansion. While aiming for the same, there is a need to attend to the sector specific problems encountered by them along with having a well-knit environmental policy in place so that trade and industrial expansion does not have major environmental concerns. This has become more relevant after the outbreak of the Covid-19 pandemic, as India has announced a huge package with emphasis on 'self-reliance', relaxing the regulations related to labour and environment in an aggressive attempt to attract foreign investment to boost the economy.

If the policy approach fails to protect the environment and labour, there is a risk of getting into the trap of growth with a race to the bottom, which may push the engine of growth into reverse gear in future. Compromising with sustainable development goals in an attempt to achieve speedy recovery may result in further exploitation of the environment and natural resources, with huge implications to ecology, economy and livelihoods. Hence adopting a greener and cleaner growth path is most advisable in order to achieve growth with sustainability. Encouraging manufacturing activities in clean and environment-friendly industrial sectors, adopting more efficient and cleaner methods in the dirty sectors, and developing alternatives to the most polluting sectors may help India in the long run in ensuring growth without compromising key development aspects.

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Appendix 1: Classifications of Pollution Intensive Industries by Mani and Wheeler, Broner and Bustos and Central Pollution Control Board

Mani and Wheeler (1998)			
Iron and Steel	Petroleum Refineries	Beverages	Metal Products
Non-Ferrous Metals	Industrial Chemicals	Food Products	Machinery
Pottery	Other Chemicals	Rubber Products	Glass Products
Electrical Products	Wood Products	Leather Products	Miscellaneous-Petroleum, Coal Products
Pulp and Paper	Miscellaneous- Manufacturing	Non-Metallic Mineral Products	
Broner and Bustos (2012)			
Lime and gypsum	Pesticide & fertilizer	Iron/Steel Mills and Ferroalloy	Other Nonmetallic Mineral
Cement and concrete	Basic Chemicals	Nonferrous Metal (not Aluminum)	Steel Products
Glass and glass products	Petroleum and Coal Products	Alumina and Aluminum	Clay Product and Refractory
Pulp/paper/paperboard mills	Veneer/Plywood/Eng. Wood	Other Chemical Products	
CPCB (2016)			
Integrated Iron & Steel	Nuclear power plant	Photographic film /chemicals	*Petroleum and Coal Products*-Coke making, liquefaction, coal tar distillation, Oil Refinery
Petrochemicals	Ports /harbor/jetties	Thermal Power Plants	Food and beverages-Milk and dairy products, slaughter houses, fermentation
Lead acid battery-recyclers	Pharmaceuticals	Hotels (Big)	*Textile and leather processing*-yarn, dyes, tanneries, synthetic fibres
Oil and gas extraction	E-Waste Recyclers	Health-care Establishment	Airports and Commercial Air Strips
Metal surface treatment	Power generation plant	Railway locomotive workshop/ service centers	Machinery and Electrical Products-DG Set (> 5 MVA), Lead acid battery
Mining and ore beneficiation	Ship Breaking	Hazardous waste recycling (Spent cleared metal catalyst)	Hazardous Waste Recyclers (Spent catalyst)
Automobile Manufacturing	Paints varnishes, pigments	Nonmetallic Minerals-Cement, Asbestos, fibreglass,	Sugar (excludingKhandsari)
Pulp & Paper	Waste electrical and electronic recyclers	Non-Ferrous Metals-Aluminium, copper, zinc smelters	*Chemicals*-Basic and organic chemicals, Fertilisers, pesticides, glue and gelatin, firecrackers, explosives, phosphorous and its compounds, Chlorates, per-chlorates & peroxides, Chlorine, fluorine, bromine, iodine, Chlor Alkali, Chlorinated hydrocarbons, Lubricating oils and grease mfg., Carbon black & allied, Isolated storage of hazardous chemicals, Phosphate rock processing

Appendix 2: Description of Dirty Industries as Per SITC Rev. 3 Selected for the Present Study

Industry	SITC No.	
Food and Beverages	011	Meat of bovine animals, fresh, chilled or frozen
	012	Other meat and edible meat offal, fresh, chilled or frozen (except meat and meat offal unfit or unsuitable for human consumption)
	016	Meat and edible meat offal, salted, in brine, dried or smoked; edible flours and meals of meat or meat offal
	017	Meat and edible meat offal, prepared or preserved, n.e.s.
	09811	Homogenized preparations from meat & edible meat offal
	0986	Yeasts (active/inactive); other single-cell micro-organisms, dead (but not including vaccines of heading 541.63); prepared baking-powders
	022	Milk and cream and milk products other than butter or cheese
	023	Butter and other fats and oils derived from milk
	024	Cheese and curd
	112	Alcoholic Beverages
Pulp and Paper	251	Pulp and waste paper
	641	Paper and paperboard
	642	Paper and paperboard, cut to size or shape, and articles of paper or paperboard
Non-Metallic Minerals (lime, gypsum, asbestos, cement, glass, clay and refractory, pottery, etc)	2732	Gypsum, plasters, limestone flux, limestone and other calcareous stone of a kind used for the manufacture of lime or cement
	2782	Clays and other refractory minerals, n.e.s.
	2784	Asbestos
	661	Lime, cement, and fabricated construction materials (except glass and clay materials)
	662	Clay construction materials and refractory construction materials
	663	Mineral manufactures, n.e.s.
	664	Glass
	665	Glassware
	666	Pottery
Iron and Steel	671	Pig-iron, spiegeleisen, sponge iron, iron or steel granules and powders and ferro-alloys
	672	Ingots and other primary forms, of iron or steel; semi-finished products of iron or steel
	673	Flat-rolled products of iron or non-alloy steel, not clad, plated or coated
	674	Flat-rolled products of iron or non-alloy steel, clad, plated or coated
	675	Flat-rolled products of alloy steel
	676	Iron and steel bars, rods, angles, shapes and sections (including sheet piling)

	677	Rails or railway track construction material, of iron or steel
	678	Wire of iron or steel
	679	Tubes, pipes and hollow profiles, and tube or pipe fittings, of iron or steel
Non-Ferrous Metals (including aluminium)	681	Silver, platinum and other metals of the platinum group
	682	Copper
	683	Nickel
	684	Aluminium
	685	Lead
	686	Zinc
	687	Tin
	689	Miscellaneous non-ferrous base metals employed in metallurgy, and cermets
Chemicals (including radioactive materials, explosives, fertilisers and pesticides	511	Hydrocarbons, n.e.s., and their halogenated, sulphonated, nitrated or nitrosated derivatives
	512	Alcohols, phenols, phenol-alcohols, and their halogenated, sulphonated, nitrated or nitrosated derivatives
	513	Carboxylic acids and their anhydrides, halides, peroxides and peroxyacids; their halogenated, sulphonated, nitrated or nitrosated derivatives
	514	Nitrogen-function compounds
	515	Organo-inorganic compounds, heterocyclic compounds, nucleic acids and their salts, and sulphonamides
	516	Other organic chemicals
	522	Inorganic chemical elements, oxides and halogen salts
	523	Salts and peroxysalts, of inorganic acids and metals
	524	Other inorganic chemicals; organic and inorganic compounds of precious metals
	525	Radioactive and associated materials
	592	Starches, inulin and wheat gluten; albuminoidal substances; glues
	593	Explosives and pyrotechnic products
	597	Prepared additives for mineral oils and the like; prepared liquids for hydraulic transmission; anti-freezing preparations and prepared de-icing fluids; lubricating preparations
	598	Miscellaneous chemical products, n.e.s.
	272	Fertilizers, crude, other than those of division 56
	562	Fertilizers (other than those of group 272)
	591	Insecticides, rodenticides, fungicides, herbicides, anti-sprouting products and plant-growth regulators, disinfectants and similar products, put up in forms or packings for retail sale or as preparations or articles (e.g., sulphur-treated bands, wicks and

Petroleum and Coal Products	321	Coal, whether or not pulverized, but not agglomerated
	322	Briquettes, lignite and peat
	325	Coke and semi-coke (including char) of coal, of lignite or of peat, whether or not agglomerated; retort carbon
	333	Petroleum oils and oils obtained from bituminous minerals, crude
	334	Petroleum oils and oils obtained from bituminous minerals (other than crude); preparations, n.e.s., containing by weight 70% or more of petroleum oils or of oils obtained from bituminous minerals, these oils being the basic constituents of the preparation
	335	Residual petroleum products, n.e.s., and related materials
	342	Liquefied propane and butane
	343	Natural gas, whether or not liquefied
	344	Petroleum gases and other gaseous hydrocarbons, n.e.s.
	345	Coal gas, water gas, producer gas and similar gases, other than petroleum gases and other gaseous hydrocarbons
Rubber	621	Materials of rubber (e.g., pastes, plates, sheets, rods, thread, tubes, of rubber)
	625	Rubber tyres, interchangeable tyre treads, tyre flaps and inner tubes for wheels of all kinds
	629	Articles of rubber, n.e.s.
Wood Products	246	Wood in chips or particles and wood waste
	633	Cork manufactures
	634	Veneers, plywood, particle board, and other wood, worked, n.e.s.
	635	Wood manufactures, n.e.s.
Textile and leather (including yarn, synthetic fibres, dyeing, tanneries, colouring materials)	266	Synthetic fibres suitable for spinning
	531	Synthetic organic colouring matter and colour lakes, and preparations based thereon
	532	Dyeing and tanning extracts, and synthetic tanning materials
	533	Pigments, paints, varnishes and related materials
	6514	Sewing thread of man-made fibres, whether or not put up for retail sale
	6515	Synthetic filament yarn (other than sewing thread), textured, not put up for retail sale, including monofilament of less than 67 decitex
	6516	Other synthetic filament yarn (other than sewing thread), including monofilament of less than 67 decitex
	6517	Artificial and man-made filament yarn (other than sewing thread); artificial monofilament, n.e.s.; strip and the like of artificial textile materials, n.e.s.
	6518	Yarn (other than sewing thread) of staple fibres; synthetic monofilament, n.e.s.; strip and the like of synthetic textile materials of an apparent width not exceeding 5 mm
	6519	Yarn of textile fibres, n.e.s. (including paper yarn and yarn, slivers and rovings of glass fibre)
	653	Fabrics, woven, of man-made textile materials (not including narrow or special fabrics)
	657	Special yarns, special textile fabrics and related products

	611	Leather
	612	Manufactures of leather or of composition leather, n.e.s.; saddlery and harness
	613	Furskins, tanned or dressed (including heads, tails, paws and other pieces or cuttings), unassembled, or assembled (without the addition of other materials), other than those of heading 848.31
Manufactures of metals, n.e.s.	691	Structures and parts of structures, n.e.s., of iron, steel or aluminium
	692	Metal containers for storage or transport
	693	Wire products (excluding insulated electrical wiring) and fencing grills
	694	Nails, screws, nuts, bolts, rivets and the like, of iron, steel, copper or aluminium
	695	Tools for use in the hand or in machines
	696	Cutlery
	697	Household equipment of base metal, n.e.s.
	699	Manufactures of base metal, n.e.s.
Pharmaceuticals	541	Medicinal and pharmaceutical products, other than medicaments of group 542
	542	Medicaments (including veterinary medicaments)
Machinery and Electrical Products	711	Steam or other vapour-generating boilers, superheated water boilers, and auxiliary plant for use therewith; parts thereof
	712	Steam turbines and other vapour turbines and parts thereof, n.e.s.
	713	Internal combustion piston engines and parts thereof, n.e.s.
	714	Engines and motors, non-electric (other than those of groups 712, 713 and 718); parts, n.e.s., of these engines and motors
	716	Rotating electric plant and parts thereof, n.e.s.
	718	Power-generating machinery and parts thereof, n.e.s.
	721	Agricultural machinery (excluding tractors) and parts thereof
	722	Tractors (other than those of headings 744.14 and 744.15)
	723	Civil engineering and contractors' plant and equipment; parts thereof
	724	Textile and leather machinery and parts thereof, n.e.s.
	725	Paper mill and pulp mill machinery, paper-cutting machines and other machinery for the manufacture of paper articles; parts thereof
	726	Printing and bookbinding machinery and parts thereof
	727	Food-processing machines (excluding domestic); parts thereof
	728	Other machinery and equipment specialized for particular industries; parts thereof, n.e.s.
	731	Machine tools working by removing metal or other material
	733	Machine tools for working metal, sintered metal carbides or cermets, without removing material

	735	Parts, n.e.s., and accessories suitable for use solely or principally with the machines falling within groups 731 and 733 (including work or tool holders, self-opening die-heads, dividing heads and other special attachments for machine tools); tool holder
	737	Metalworking machinery (other than machine tools) and parts thereof, n.e.s.
	741	Heating and cooling equipment and parts thereof, n.e.s.
	742	Pumps for liquids, whether or not fitted with a measuring device; liquid elevators; parts for such pumps and liquid elevators
	743	Pumps (other than pumps for liquids), air or other gas compressors and fans; ventilating or recycling hoods incorporating a fan, whether or not fitted with filters; centrifuges; filtering or purifying apparatus; parts thereof
	744	Mechanical handling equipment and parts thereof, n.e.s.
	745	Non-electrical machinery, tools and mechanical apparatus and parts thereof, n.e.s.
	746	Ball- or roller bearings
	747	Taps, cocks, valves and similar appliances for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves
	748	Transmission shafts (including camshafts and crankshafts) and cranks; bearing housings and plain shaft bearings; gears and gearing; ball or roller screws; gearboxes and other speed changers (including torque converters); flywheels and pulleys (including
	749	Non-electric parts and accessories of machinery, n.e.s.
	751	Office machines
	752	Automatic data-processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, n.e.s.
	759	Parts and accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines falling withing groups 751 and 752
	761	Monitors and projectors, not incorporating television reception apparatus; reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus
	762	Reception apparatus for radio-broadcasting, whether or not combined, in the same housing, with sound recording or reproducing apparatus or a clock
	763	Sound recording or reproducing apparatus; video recording or reproducing apparatus; whether or not incorporating a video tuner
	764	Telecommunications equipment, n.e.s., and parts, n.e.s., and accessories of apparatus falling within division 76
	771	Electric power machinery (other than rotating electric plant of group 716) and parts thereof
	772	Electrical apparatus for switching or protecting electrical circuits or for making connections to or in electrical circuits (e.g., switches, relays, fuses, lightning arresters, voltage limiters, surge suppressors, plugs and sockets, lamp-holders and junct
	773	Equipment for distributing electricity, n.e.s.
	774	Electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes, and radiological apparatus
	775	Household-type electrical and non-electrical equipment, n.e.s.
	776	Thermionic, cold cathode or photo-cathode valves and tubes (e.g., vacuum or vapour or gas-filled valves and tubes, mercury arc rectifying valves and tubes, cathode-ray tubes, television camera tubes); diodes, transistors and similar semiconductor devices;
	778	Electrical machinery and apparatus, n.e.s.

Photographic films	882	Photographic and cinematographic supplies
	883	Cinematographic film, exposed and developed, whether or not incorporating soundtrack or consisting only of soundtrack
Automobiles	781	Motor cars and other motor vehicles principally designed for the transport of persons (other than motor vehicles for the transport of ten or more persons, including the driver), including station-wagons and racing cars
	782	Motor vehicles for the transport of goods and special-purpose motor vehicles
	783	Road motor vehicles, n.e.s.
	784	Parts and accessories of the motor vehicles of groups 722, 781, 782 and 783
	785	Motor cycles (including mopeds) and cycles, motorized and non-motorized; invalid carriages
	786	Trailers and semi-trailers; other vehicles, not mechanically-propelled; specially designed and equipped transport containers
	791	Railway vehicles (including hovertrains) and associated equipment
	792	Aircraft and associated equipment; spacecraft (including satellites) and spacecraft launch vehicles; parts thereof
	793	Ships, boats (including hovercraft) and floating structures
Mining and ore beneficiation	281	Iron ore and concentrates
	282	Ferrous waste and scrap; remelting scrap ingots of iron or steel
	283	Copper ores and concentrates; copper mattes; cement copper
	284	Nickel ores and concentrates; nickel mattes, nickel oxide sinters and other intermediate products of nickel metallurgy
	285	Aluminium ores and concentrates (including alumina)
	286	Uranium or thorium ores and concentrates
	287	Ores and concentrates of base metals, n.e.s.
	288	Non-ferrous base metal waste and scrap, n.e.s.
	289	Ores and concentrates of precious metals; waste, scrap and sweepings of precious metals (other than of gold)

Appendix 3: Direction of India's Dirty Exports and Imports

Exports					**Imports**				
Categories	**1991**		**2018**		**Categories**	**1991**		**2018**	
Machinery	Fmr USSR	34.40	USA	17.27	Petroleum and Coal Products	Areas, nes	36.02	Saudi Arabia	14.44
	USA	7.37	Germany	6.42		UAE	15.65	Iraq	13.61
	United Kingdom	4.48	UAE	5.89		Saudi Arabia	15.24	Iran	7.88
	Nigeria	4.14	China	4.22		Iran	9.51	UAE	7.62
	Bangladesh	3.97	United Kingdom	4.22		Australia	7.16	Nigeria	6.46
Automobiles	Italy	9.93	USA	13.79	Machinery	Germany	20.22	China	38.54
	Fmr USSR	9.06	UAE	7.29		USA	18.41	China, Hong Kong SAR	8.55
	Sri Lanka	8.50	Mexico	7.15		Japan	17.36	Germany	6.59
	USA	5.15	Sri Lanka	5.04		France	6.85	USA	6.01
	United Kingdom	3.69	Bangladesh	4.82		United Kingdom	6.26	Rep. of Korea	5.39
Chemicals	Fmr USSR	15.18	China	14.21	Chemicals	USA	22.17	China	28.19
	USA	12.16	USA	11.41		Morocco	15.19	USA	8.71
	Germany	8.58	Brazil	4.95		Germany	9.05	Saudi Arabia	6.13
	Japan	5.64	Indonesia	3.69		Fmr USSR	6.98	Singapore	5.57
	United Kingdom	5.39	Germany	3.55		Jordan	5.99	Rep. of Korea	3.96
Pharmaceuticals	Fmr USSR	31.90	USA	32.74	Mining and Ore Beneficiation	USA	30.79	Australia	13.16
	Germany	11.98	United Kingdom	3.73		United Kingdom	11.41	Chile	9.54
	USA	5.61	South Africa	3.44		Germany	7.95	USA	7.72
	Switzerland	5.19	Nigeria	2.74		Netherlands	7.11	UAE	6.99
	Nigeria	3.65	Russian Federation	2.73		Singapore	7.00	South Africa	6.92
Petroleum and Coal	Areas, nes	98.23	UAE	13.87	Automobiles	Japan	45.73	China	17.38
	Bangladesh	0.96	Singapore	13.22		USA	11.83	Germany	9.25
	Nepal	0.53	Netherlands	8.86		Netherlands	7.57	Rep. of Korea	8.08
	Italy	0.09	China	6.46		Italy	5.31	USA	7.47
	Singapore	0.07	USA	6.27		Germany	4.94	Singapore	7.26

Source: Authors' Calculations based on UN Comtrade Database, accessed on 08 April, 2020

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