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Pollution and International Trade in Services

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Abstract

Two major topics in recent rounds of international trade negotiations have been environmental concerns, and services trade. While each is undoubtedly important, they are unrelated. The service sector emits only a small part of overall pollution, and those service industries that do pollute do not trade internationally. This paper uses data on trade in services from the U.S. Bureau of Economic Analysis, and data on the pollution intensity of various industries from the U.S. Environmental Protection Agency, to demonstrate that the correlation between services trade and pollution intensity is negative.

Pollution and International Trade in Services

Recent rounds of international trade negotiations have increasingly addressed services, a sector that has been growing as a share of output in industrialized countries, and the negotiations have also increasingly focused on how trade might affect the environment. It is natural, therefore, to link these two subjects and ask whether increased trade in services might affect the environment. In this paper I show that the services-environment link is small, for two reasons. First, services account for only a small fraction of overall pollution; and second, those service industries that do emit pollution (including through the use of intermediate inputs that themselves pollute) tend to be the ones that are least likely to be traded across international borders.

Trade in services only became a formal topic of discussion in 1986, with the Uruguay round of world trade negotiations. These talks led to the General Agreement on Trade in Services (GATS), which became law in January 1995. Meanwhile, the combined value of imports and exports of services to the U.S. grew from $296 billion in 1987 to $1.6 trillion in 2007 (see Table 1). Adjusted for price inflation, this amounts to a 243 percent increase in international services trade. During the same period, U.S. international goods trade grew by 183 percent. So while the service sector only makes up 35 percent of U.S. international trade, its share has been growing. It is thus easy to see why services have become increasing important to international trade negotiations.

It is also clear that the environment has become increasingly important to trade negotiations. Environmental groups have long protested trade agreements, partly out of concern that producers will relocate to countries with weak pollution regulations, avoiding strict regulations in developed countries and damaging the environments of

developing countries. The North American Agreement on Environmental Cooperation (NAAEC) was a direct response to those concerns regarding the North American Free Trade Agreement (NAFTA). NAAEC requires participant countries enforce their own environmental regulations. The link between trade negotiations and environmental concerns was formalized in the U.S. by Executive Order 13141, "Environmental Review of Trade Agreements." The order stipulates that "the United States will factor environmental considerations into the development of its trade negotiating objectives." The current U.S. administration continues to conduct environmental reviews of trade agreements, as required by the order.

So both services and environmental concerns are attracting increasing attention during international trade negotiations. Are they linked? The evidence in this paper suggests they are not, for two reasons. Services contribute only a tiny fraction of overall pollution, even taking into account the inputs necessary to produce those services. And those services that are most heavily traded across borders are least likely to pollute. The first of these two points is simplest, so I start with that.

Services account for a small fraction of pollution

To find out how important services are to overall pollution, I examine the U.S. Environmental Protection Agency's (EPA) National Emissions Inventory (NEI). The NEI houses the EPA's repository for pollution data compiled by states and industries. It includes pollution from point, mobile, and area sources. The NEI reports emissions of common air pollutants: sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM10), and volatile organic compounds (VOCs), a precursor to

ozone, or "smog". I have obtained from the EPA the NEI for the year 2002,

disaggregated by four-digit standard industrial classification (SIC) codes.[1] Using those

data, I separated out services from other large sources of pollution, and tabulated the data

in Table 2.

Table 2 reports the share of overall pollution emitted by each sector. For none of

the five air pollutants does the service sector account for even five percent of the total.

For the largest, VOCs, the service sector accounts for only 3.7 percent of total emissions.

In fact, the top row of Table 2 probably exaggerates the pollution from services

that could potentially be traded internationally. One particularly large polluting sector,

transportation, does not necessarily belong. While transportation services are traded

internationally, that trade does not alter the location of the activity, or of the pollution

generated. An American can purchase airline travel from Montreal to Washington D.C.

from either a Canadian or an American carrier. Goods can be shipped across the United

States by American trucking companies or, under the NAFTA rules, Mexican or

Canadian companies. In no case, however, does the international trade change the

location of the economic activity. Importing the transportation does not change the route

the plane or truck travels, only who gets paid. In cases such as transportation, where

international trade merely involves a flow of payments, and does not affect the location

of the polluting activity, no trade-environment link exists.

There are, however, several counter-arguments to eliminating transport from the

analysis – and even some reasons why the transport component may be understated. If

increased international trade lowers the cost of transportation services, through

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[1] Correspondence with Roy Huntley, U.S. EPA.

economies of scale, there may be even more transport as a consequence, and hence more pollution from transportation. More importantly, transport is an input into many goods and services. In the analyses that follow, I take into account the pollution caused by intermediate imports, including transport, to the extent those inputs are used in current production methods. If international trade increases, transport will increase as a fraction of all goods and services, increasing their emissions total per dollar of output. Accounting for these second-order effects is beyond the scope of this discussion, which simply notes that services do not contribute much to overall pollution, and traded services contribute even less.

If we do eliminate transportation from the list of services, the pollution from the remainder of the service sector accounts for less than one percent of total pollution in the U.S. (See the second row of Table 2.) For the largest, still VOCs, services now account for only 0.7 percent of total U.S. emissions.

There is, however, one caveat to the calculations in Table 2. Some service industries may not pollute very much directly, but may use inputs whose production generates pollution. Or, they may use inputs whose production uses other inputs that pollute, and so on. Some of the manufactured goods that emit 70 percent of the CO in the United States may be used as inputs to service industries. If we import those services, the location of that manufacturing activity may change as well, which means the environmental consequences of services trade may be larger than suggested by Table 2.

To account fully for the complications arising from intermediate inputs, I use an industry-by-industry accounting for pollution emitted in the U.S., developed by the EPA, that includes both direct pollution and pollution generated indirectly by inputs. With

4

those data I can both account for the concern about intermediate inputs, and demonstrate that the services share of total pollution is still small, and that those industries that pollute are the least likely to be traded.

Polluting services are less traded internationally

To demonstrate a link between pollution intensity and trade intensity, we first need definitions and data for both concepts.

Calculating trade intensity

The U.S. Bureau of Economic Analysis (BEA) publishes annual statistics about international trade in services (Koncz and Flatness, 2007). The BEA documents two types of services trade, sales through foreign affiliates and cross-border trade. The first, sales through foreign affiliates, does not involve changing the location of the service activities. U.S. imports of services via foreign affiliates occur whenever a U.S. resident purchases a service in the U.S. from a company that is majority-owned by a foreign country. U.S. exports of services via foreign affiliates occur whenever a resident of a foreign country purchases a service from a company that is majority owned by the U.S. In neither case is the location of the service, or the pollution generated by the service, shifted as a result of trade. All that changes is the ownership of the company providing the service. According to the BEA, sales through affiliates

> "are not considered U.S. international transactions, because under the residency principle of balance-of-payments accounting, affiliates of multinational companies are regarded as residents of the countries where they are located rather than of the countries of their owners."

Accordingly, and because sales through affiliates do not change the location of pollution, I ignore this first type of international services trade in the rest of this analysis.[2]

The second channel of international services trade, cross-border trade, will be the focus here. This includes trades between unrelated parties and intra-firm exchanges within multinational companies. These are recorded as exports and imports in the seller and buyer countries' international accounts. To calculate the trade intensity of these types of services, I add the values of exports and imports, and divide by total output.

Turning again to Table 1, we can see that much of the growth in services has come from these majority-owned foreign affiliates. In fact, if we limit the analysis to cross-border trade, total services trade in the U.S. has grown more slowly than total goods trade -- 162 percent compared with 183 percent in real terms. So the growth of services trade has come mostly via channels that do not relocate pollution, and for which there is therefore no direct trade-environment link.

Calculating pollution intensity

To calculate the pollution intensity of service industries, I rely on the U.S. EPA's Trade and Environmental Assessment Model (TEAM), which reports a list of emissions intensities for each six-digit North American Industry Classification System (NAICS) code. These industry-by-industry emissions intensities were calculated by the U.S. EPA and Abt Associates (2004) specifically to assess the environmental effects that might arise from international trade agreements. TEAM is based on the 1997 NEI and can be

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[2] One could argue that opportunities for sales through affiliates, via foreign direct investment, increase economic activity and therefore pollution. That is a secondary effect that I ignore by necessity for sales through affiliates as well as for cross-border trade.

used to generate emissions factors (environmental consequences per dollar of output) for 1,099 six-digit NAICS industry codes, and for more than 1,000 different environmental outcomes, including air pollutants, individual toxic chemicals, hazardous waste, and land use. Here I focus on the NAICS codes that comprise the services sector, and common air pollutants for which there are sufficient data on emissions by traded service industries.

Note that by construction these TEAM emissions coefficients only contain information about pollution in the U.S. We cannot use the coefficients to say anything about pollution changes overseas that result from changing imports or exports to the U.S. If we seen increased U.S. exports of a service, we can use the coefficients to tell us how much pollution those exports are causing where they are produced, in the U.S. If we see increased U.S. imports of a service, we can use the coefficients to estimate how much pollution would have been emitted in the U.S. had those imports instead been produced domestically. In general, I think of this concept as the U.S. pollution "displaced" by trade. We can use the TEAM coefficients to estimate the amount of pollution that would have been caused in the U.S. had imports been produced locally, or the amount of pollution emitted in the U.S. as a consequence of producing goods for export. This pollution is displaced from one country to another as a consequence of trade.

Table 3a displays these direct TEAM emissions coefficients for each broad category of services, as defined by the U.S. Census Bureau. They are calculated by taking a weighted average of the emissions coefficients (z_i) for each 6-digit NAICS code, where the weights are industry's sales in 1997. Not surprisingly, transportation and waste remediation are the two most polluting services.

There is, however, one complication mentioned above – the role of pollution generated by intermediate inputs. If we simply rely on direct TEAM emissions factors, we only measure the pollution emitted by each industry in production of its final output. This would understate the pollution associated with a given change in service trade, because pollution from intermediate inputs would be ignored.

A simple example may help to explain the problem. One internationally traded service is industrial machinery repair and maintenance (NAICS code 8113). U.S. airlines, for example, increasingly outsource their maintenance to other countries, including Mexico, China, and the Philippines.[3] The process of repairing an airplane does emit pollution, including volatile organic compounds used in solvents. But the manufacture of those solvents also involves pollution. Suppose that initially airplanes are maintained in the United States, that maintaining planes requires solvent as an input, and that solvent is entirely produced domestically. If the U.S. decides to outsource airplane maintenance, pollution will decline in the U.S. for two reasons: a reduction in airplane maintenance, and a reduction in solvent production.

How much of the decline in U.S. pollution can be attributed to the increase in imported maintenance services? In this example, we can account for 100 percent, by construction. The reduction in airplane maintenance will be reflected in the increased imports of maintenance services. But the reduction in solvent production will not, because there are no solvent imports. If we simply multiply the change in imported maintenance services by the respective direct emissions coefficient for maintenance services, from TEAM, we will understate the pollution displaced by imports. The change

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[3] Reuters. February 11, 2008. "Airline Outsourcing Endangering Passengers, National Security, Say Aviation Mechanics."

8

in solvent production occurs abroad and is embodied in the airplane maintenance. The direct emissions coefficients understate the amount of U.S. pollution reduction that would be the consequence of increased service imports.

To account for intermediate inputs properly, we need to account for not only the pollution embodied in the intermediate inputs to imported services, but also the pollution embodied in the intermediate inputs to those intermediate inputs, and so on ad infinitum. (The solvent used in maintaining the plane itself requires chemical inputs that may produce pollution, and so on.) For this calculation, the EPA and Abt used a basic Leontief input-output framework to estimate the pollution caused by production of final output, including intermediate inputs.[4]

Suppose that an $n \times n$ matrix $\mathbf{C}$ has elements c_{ij} representing the dollar value of input industry i needed to produce one dollar's worth of output industry j. Then we can write the total output, $\mathbf{x}$, a vector of n outputs – one from each industry – as the sum of output used as intermediate goods and final output, $\mathbf{y}$.

$$
\begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} c_{11} & \cdots & c_{1n} \\ \vdots & \ddots & \vdots \\ c_{n1} & \cdots & c_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_n \end{bmatrix} + \begin{bmatrix} y_1 \\ \vdots \\ y_n \end{bmatrix}
\tag{1}
$$

Or, in vector notation:

$$
\mathbf{x} = \mathbf{Cx} + \mathbf{y}
\tag{2}
$$

If we were examining changes in U.S. production, we would observe $\mathbf{x}$, the value of all output, including both intermediate inputs and final products. Pollution could be approximated by multiplying $\mathbf{x}$ by a vector of direct emissions coefficients, $\mathbf{z}$, such as

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[4] See, for example, Miller and Blair (1985).

those from TEAM. But when we examine trade flows, we see only the final product **y**, without the production of intermediate inputs. In this case, we need a set of *total* pollution coefficients. These coefficients must embody all the pollution generated by all of the inputs to **y**, all the inputs to those inputs, and so on. To calculate this, solve equation (2) for **x** to get

$$\mathbf{x} = [\mathbf{I} \cdot \mathbf{C}]^{-1} \mathbf{y} = \mathbf{T}\mathbf{y} \qquad (3)$$

where **I** is the identity matrix.

The matrix $\mathbf{T} = [\mathbf{I} - \mathbf{C}]^{-1}$ is a standard Leontief total requirements matrix. Each element t_{ij} contains the dollar amount of industry i necessary to produce one dollar of output industry j, including the amount of i used in all other industries that are used in j, as well as the amount of i used in the inputs to those industries, and so forth. The vector **x** represents the total amount of manufactured goods necessary to produce output **y**. To generate the total pollution coefficients, premultiply the Leontief total requirements matrix by the **z** vector from TEAM as follows:

$$\tilde{\mathbf{z}} = \mathbf{z}'\mathbf{T} = \mathbf{z}'\left[\mathbf{I} \cdot \mathbf{C}\right]^{-1} \qquad (4)$$

The only new information needed to construct $\tilde{\mathbf{z}}$ is **C.** That information can be found in the input-output tables for the United States published periodically by the BEA. The EPA used the 1997 input-output tables create an estimate of **C** and to translate direct emissions coefficients, **z**, into total emissions coefficients, $\tilde{\mathbf{z}}$, using equation (4).

Using the total emissions coefficients, $\tilde{\mathbf{z}}$, in place of the direct emissions coefficients, **z**, captures all of the pollution generated by intermediate goods, and does not understate pollution displaced by traded services. Unfortunately $\tilde{\mathbf{z}}$ instead overstates pollution displaced by traded services. If the solvents used to maintain airplanes in the

10

United States are entirely imported, importing maintenance from abroad displaces no

U.S. solvent production, and the appropriate emissions coefficient is the direct one ($\mathbf{z}$).

The two emissions coefficients, direct ($\mathbf{z}$) and total ($\tilde{\mathbf{z}}$), thus constitute lower and

upper bounds on the amount of U.S. pollution displaced whenever a service is imported.

The direct coefficient assumes there are no polluting intermediate goods, or that all

polluting intermediates were themselves imported. The total coefficient assumes all

intermediate inputs, as well as the inputs to those inputs, were entirely produced within

the U.S. In the analyses below I will present both calculations, but then use the total

coefficient, which overstates pollution from services, in order to be conservative in my

argument that internationally traded services account for little pollution.

Table 3b displays the total emissions coefficients ($\tilde{z}_i$), including pollution

generated by intermediate inputs. These are typically three times as large as the direct

coefficients in Table 3a.

Only some services have data on cross-border trade

The U.S. BEA collects data on international services trade for only a few

industries (Koncz & Flatness, 2007; Wichard and Borga, 2002). One natural

presumption is that there simply is no international trade in the other service industries.

The dollar values of international trade in haircuts, taxi rides, window-washing, etc. are

so small as to be not worth tracking or reporting. If this is true, then the main point of

this paper can be made quite simply. Those services that are traded internationally, and

for which the BEA reports trade data, are the least polluting service sectors of the

economy.

Table 4 makes this point. The top row reports the average pollution (per $million of output) for the entire service sector. This is the same as the bottom row of Table 3a. The second row of Table 4 reports that same weighted average for the industries for which BEA publishes cross-border trade data. The average pollution emitted by these traded industries is much smaller. The top panel uses the TEAM pollution coefficients that understate total pollution because they only count the pollution emitted directly from producing final output. These coefficients understate the pollution from both the "all services" and "cross-border trade" categories, and including pollution from intermediate inputs is unlikely to change the result that traded services are the least polluting.

To check this, in the bottom panel of Table 4 I report the same calculation using the total emissions coefficients ($\tilde{z}$), including pollution from intermediate goods. This overstates pollution from the services sector (line (3)) because it double-counts services used as inputs to other services, and it overstates pollution relocated by trade because traded final product need not change the production location of intermediate inputs. The basic point remains. Those services for which the U.S. BEA collects international trade data – presumably those services that *are* traded internationally – are the least polluting. This is clear whether we use the direct emissions coefficients for final product only, or the total emissions coefficients counting intermediate inputs.

Among traded services, those traded more pollute less

Finally, among those services for which the U.S. BEA collects international trade data, the industries most intensively traded are the ones that pollute the least. Table supports this claim. It presents data for each of the 11 industries where the BEA collects

12

international trade information, and where the BEA category corresponds closely to the NAICS classifications.

Column (1) of Table 5 reports the trade intensity for each of the industries. This is simply total imports plus exports over domestic production. The two services with the most international trade are reinsurance (NAICS 52413), driven by $12 billion worth of imports in 2002, and education (NAICS 611), driven by $13 billion worth of exports. Given the nature of these two industries, it is immediately obvious that more heavily traded industries pollute less.

Columns (2) through (7) report the pollution intensities, including intermediate inputs, for each of the industries and for each of the six pollutants. Below the industry-specific data, I report the raw correlations between trade intensity (column (1)), and the relevant pollution intensities. All of the correlations are negative except for VOCs. The positive VOC correlation is driven by the last industry, commercial and industrial machinery repair and maintenance (NAIC 8113), which has both high pollution and high international trade. If I drop industry 8113 from the correlation, they all become even more negative, including the VOC correlation.

The negative relationship between trade intensity and pollution intensity is not driven by the two outliers, education and reinsurance. At the bottom of Table 5, I report the correlations excluding those two industries. Again, all of the correlations, except for VOCs, are negative, even omitting those two heavily traded, non-polluting industries.

Are these results different for trade within NAFTA?

A final concern one might have involves the degree to which trade agreements or geographic proximity affect the conclusion that traded services do not pollute. Services trade with neighboring countries might be different than services trade with far distant countries. Or, trade agreements such as the NAFTA may alter the pollution-intensity of services trade.

At the very bottom of Table 5, I report the correlations between the pollution intensities and the trade intensity of each industry with Canada and Mexico, respectively. If anything, this makes the case stronger. The correlations between pollution intensity and services trade with Canada is, for every pollutant, more negative that for trade with all countries. The correlations for trade with Mexico are more negative for four of the six pollutants. Limiting the analysis to the NAFTA countries dos not alter the conclusion that traded services are the least polluting.

Conclusions

The analysis abstracts from several complications. Increased international trade may increase the amount of transportation used as an input to many goods and services, increasing their emissions. Some of the traded services may be aimed directly at reducing pollution – environmental consulting, technology transfer, etc. And international trade and investment may increase the scale of economic activity – for both services and goods – and increase pollution accordingly. But these concerns are at best secondary, and some of them work in opposite directions, and they are unlikely to reverse the fundamental point.

The point here is simple. International trade has important links to the environment, and service industries are important to international trade, but international trade in services bear little relation to the environment. Why? Services contribute relatively little to overall pollution, and those industries that are traded internationally are among the least polluting.

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Table 1. Services trade is growing faster than goods trade, due to sales through affiliates.

| Year | U.S. Services Trade ($billions) | | | | | | | U.S. Goods Trade ($billions) | | |
| | X-border | | | Sales through affiliates | | | Total Services | Exports | Imports | Total Goods |
	Exports (1)	Imports (2)	Total (3)	Exports (4)	Imports (5)	Total (6)	(7)	(8)	(9)	(10)
1987	87.0	73.9	160.9	72.3	62.6	134.9	295.8	250.2	409.8	660.0
2005	367.8	281.6	649.4	528.5	389.0	917.5	1566.9	1023.1	1861.4	2884.5
% change (nominal)	323	281	304	631	521	580	430	309	354	337
% change (real)	173	147	162	374	303	341	243	165	194	183

Source: Koncz and Flatness (2007).

Table 2. Services percent of total pollution is small.

Sector	Share of total emissions: 2002 (percent)				
	CO (1)	NOx (2)	PM10-FIL (3)	SO2 (4)	VOC (5)
Services	2.30	0.93	0.77	0.46	3.69
- without transport	*0.65*	*0.56*	*0.47*	*0.44*	*0.72*
Manufacturing	69.60	19.98	51.56	15.75	74.42
Utilities	21.37	74.06	36.04	82.69	6.86
Extractive industries	4.89	4.73	8.42	1.01	10.59

Source: US EPA National Emissions Inventory 2002.
Pollutants:
 - CO: carbon monoxide.
 - NOx: nitrogen dioxide
 - PM10-FIL particulate matter, smaller than 10 microns, filterable.
 - SO2: sulfur dioxide.
 - VOC: volatile organic compounds.
Omitted categories: construction, wholesale and retail trade, administration and government.

Table 3a. Pollution directly from each service sector, 2002.

NAICS	Description	Sales ($millions) (1)	Tons per $million					
			CO (2)	SO2 (3)	NO2 (4)	VOC (5)	PM10 (6)	Air toxics (7)
48-49	Transportation & warehousing	382,152	25,689	2,310	24,517	3,362	1,147	383
51	Information	891,846	705	16	116	72	7	29
52	Finance & insurance	2,803,855	772	71	72	96	25	124
53	Real estate & rental & leasing	335,588	8,339	490	4,739	917	268	212
54	Professional, scientific, & technical services	886,801	1,235	67	207	139	782	86
55	Management of companies & enterprises	107,064	477	49	42	56	12	97
56	Administrative & support & waste management & remediation service	432,578	56,165	248	2,314	5,801	688	403
61	Educational services	30,691	651	57	54	52	9	87
62	Health care & social assistance	1,207,300	1,171	43	184	166	16	90
71	Arts, entertainment, & recreation	141,904	1,206	619	2,145	256	171	138
72	Accommodation & food services	449,499	1,226	72	204	140	32	176
81	Other services (except public administration)	307,049	1,684	539	973	5,301	81	964
TOTAL		7,976,326	6,258	265	2,117	864	243	178

Source: calculations from TEAM. This understates total pollution because it ignores pollution from intermediate goods.

Table 3b. Pollution from each service sector, including indirectly from intermediate inputs, 2002.

NAICS	Description	Tons per $million					
		CO	SO2	NO2	VOC	PM10	Air toxics
		(2)	(3)	(4)	(5)	(6)	(7)
48-49	Transportation & warehousing	76,661	6,892	73,154	10,029	3,425	1,144
51	Information	2,383	54	392	242	23	97
52	Finance & insurance	2,746	251	256	341	88	442
53	Real estate & rental & leasing	30,691	1,805	17,419	3,378	989	781
54	Professional, scientific, & technical services	4,550	246	763	511	2,865	317
55	Management of companies & enterprises	8,983	921	786	1,048	225	1,831
56	Administrative & support & waste management & remediation service	146,048	646	6,007	15,097	1,791	1,049
61	Educational services	668	59	55	53	9	89
62	Health care & social assistance	1,230	45	193	175	17	95
71	Arts, entertainment, & recreation	1,549	797	2,746	329	220	178
72	Accommodation & food services	3,525	207	587	404	92	505
81	Other services (except public administration)	3,192	1,022	1,845	10,047	154	1,828
TOTAL		19,263	816	6,517	2,661	748	547

Source: calculations from TEAM. This overstates total pollution because it double-counts pollution from intermediate goods.

Table 4. Services traded internationally are the least polluting.

	Air Pollutants (tons/$million)					
	CO (1)	SO2 (2)	NO2 (3)	VOC (4)	PM10 (5)	Toxics to air (6)
Direct pollution, ignoring intermediates						
(1) All service industries	6,258	265	2,117	864	243	178
(2) Service industries for which BEA publishes x-border trade data	1,262	80	115	107	15	148
Total pollution, including via intermediate inputs						
(3) All Service Industries	19,263	816	6,517	2,661	748	547
(4) Service industries for which BEA publishes x-border trade data	3,965	221	530	420	72	291

Source: calculations from TEAM and BEA.

Table 5. Among traded services, those traded more pollute less
– Indirect pollution including intermediate inputs.

NAICS	Description	Imp. + exp. as a percent of domestic sales (1)	CO (2)	SO2 (3)	NO2 (4)	VOC (5)	PM10 (6)	Air toxics (7)
5133	Telecommunications	2.02	5,018	39	980	528	46	113
5142	Data processing, hosting, & related services	5.01	3,832	288	342	350	75	388
52413	Reinsurance Carriers	41.01	945	70	84	116	9	123
5411	Legal services	2.22	6,616	638	594	600	169	684
541330	Engineering services	0.80	5,700	488	539	575	189	656
54151	Computer systems design & related services	2.21	1,802	133	163	178	31	189
54161	Management consulting services	3.17	2,356	211	205	196	41	251
541710	Research & development in the phys, engineering & life sciences	4.82	4,668	480	450	524	96	593
611	Educational services	49.61	668	59	55	53	9	89
711	Performing arts, spectator sports, & related industries	0.49	1,262	80	115	107	15	148
8113	Com & industrial mach & equip (except auto/elect) repair & maintenance	29.79	5,950	538	558	2,413	145	711

Correlation between services trade and pollution

			CO	SO2	NO2	VOC	PM10	Air toxics
- correlation with column (1)			-0.42	-0.26	-0.41	+0.13	-0.32	-0.25
- correlation without sector 8113			-0.60	-0.43	-0.51	-0.57	-0.48	-0.47
- correlation without sectors 52413 and 611			-0.27	-0.12	-0.29	+0.27	-0.18	-0.11
- correlation with trade intensity with Canada			-0.59	-0.39	-0.53	-0.58.	-0.49	-0.44
- correlation with trade intensity with Mexico			-0.41	-0.38	-0.27	-0.41	-0.37	-0.41

Notes: Trade data for 2002.
Source: calculations from TEAM and BEA.