OECD Trade and Environment Working Papers 2017/02

Trade in services related to the environment

Jehan Sauvage,

Christina Timiliotis

https://dx.doi.org/10.1787/dc99bf2b-en

OECD

OECD TRADE AND ENVIRONMENT WORKING PAPERS

This paper is published under the responsibility of the Secretary-General of the OECD. The opinions expressed and the arguments employed herein do not necessarily reflect the official views of OECD countries.

The publication of this document has been authorised by Ken Ash, Director of the Trade and Agriculture Directorate

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

This document has been declassified on the responsibility of the Joint Working Party on Trade and the Environment under the OECD reference number COM/TAD/ENV/JWPTE(2015)61/FINAL.

Comments on the series are welcome and should be sent to tad.contact@oecd.org.

OECD TRADE AND ENVIRONMENT WORKING PAPERS

are published on www.oecd.org/trade.

© OECD (2017)

You can copy, download or print OECD content for your own use, and you can include excerpts from OECD publications, databases and multimedia products in your own documents, presentations, blogs, websites and teaching materials, provided that suitable acknowledgment of OECD as source and copyright owner is given. All requests for commercial use and translation rights should be submitted to *rights@oecd.org*.

TRADE IN SERVICES RELATED TO THE ENVIRONMENT

Jehan Sauvage and Christina Timiliotis, OECD

This paper discusses the nature and scope of international trade in environmentally related services, and analyses the implications that services trade restrictions have on the provisions of these services domestically and abroad. Numerous services appear crucial to the delivery and proper functioning of environmental goods and equipment be they a wastewater-treatment facility or a renewable power plant. By helping lower the costs of these services and improving access to world-class suppliers, trade policy can contribute alongside energy and environmental policy to the prevention and abatement of greenhouse-gas emissions and pollution in all its forms. Besides clarifying the role and scope of services related to the environment, the analysis undertaken in this paper suggests that the restrictions that countries impose on services trade may have a detrimental effect on the provision of environmental activities through the establishment by specialised firms of a commercial presence abroad, i.e. through mode 3 trade in services.

Keywords: Environmental services; trade in services; climate change; services trade restrictions; trade policy

JEL classification: F14; F18; F64; L84; L97; Q56

Acknowledgements

This paper was written by Jehan Sauvage and Christina Timiliotis of the Natural Resources Policy Division of the OECD Trade and Agriculture Directorate under the supervision of Franck Jésus. The authors wish to thank Stéphanie Lincourt for her help in formatting the document, Robert Akam for his help editing it, and Mark Mateo for providing excellent statistical assistance. The authors' gratitude also goes to the following OECD staff members who provided helpful comments and suggestions at various stages of the project: Shardul Agrawala, Rachel Bae, Massimo Geloso Grosso, Dorothée Rouzet, Ronald Steenblik, and Shunta Yamaguchi. In addition, the analysis greatly benefitted from the insights and data that Grant Ferrier (principal, Environmental Business International Inc.) provided.

Table of Contents

Executive summary 4

Trade in environmentally related services and the costs of preventing and abating pollution 7

Toward a broader understanding of trade in environmental services 13

A case study of mode 3 trade in environmental consulting and engineering services....20

Conclusion: Three policy priorities for the trade and environment agenda....28

References 30

Technical appendix....33

Restrictions to trade in environmentally related services and the supply of core environmental services 33

The determinants of firms' exports of environmental consulting and engineering services 45

Annex 1. A short guide to the product and sector classifications used in this report 52

Annex 2. Mapping environmentally related services in existing classifications, with examples 54

Tables

Table 1. Many restrictions affecting services trade concern primarily Mode 3 and 4....11
Table 2. Countries have made few commitments in environmental services under the GATS....14
Table 3. Trade in core environmental services seems most affected by restrictions to trade in engineering, architecture, and computer and related services....20
Table 4. Larger firms are more productive, pay higher salaries, and export more 23
Table 5. Most firms in the sample concentrate their activities in their home region 27
Table 6. Summary statistics 36
Table 7. Model 1: Two-way STRI and inward FATS, PPML estimator 39
Table 8. Model 2: Bilateral STRI and inward FATS, PPML estimator....40
Table 9. Model 3: Home-country STRI and inward FATS, PPML estimator 41
Table 10. Model 4: Host-country STRI and inward FATS, PPML estimator 42
Table 11. Bilateral STRI and inward FATS, PPML estimator, with full sets of fixed effects....43
Table 12. Two-way STRI and inward FATS, Logit estimator 44
Table 13. Summary statistics 47
Table 14. Exports, firm characteristics, and the STRI: Panel regressions 49
Table 15. Exports, firm characteristics, and the STRI: Cross-section regressions (2014-15) 51

Figures

Figure 1. China now accounts for almost half of world exports in solar PVs and light-emitting diodes ladder 8
Figure 2. Environmental products often lie around the top of the complexity ladder....9
Figure 3. The stringency of environmental policies has increased over the past two decades....15
Figure 4. The degree to which services relate to the environment 18
Figure 5. Providers of environmental C&E services conduct more and more of their business abroad 26
Figure 6. Western Europe and North America together account for most of the environmental C&E market 26
Figure 7. Restrictions placed on trade in engineering services are associated with a lower propensity of firms to export environmental C&E services....27

EXECUTIVE SUMMARY

The scale of the environmental challenges confronting policy makers today is tremendous, requiring that several different policy domains be mobilised. Trade policy is one such domain, as lower trade barriers could give polluters access to cheaper or more advanced equipment and technologies for preventing or mitigating environmental harm. Keeping the costs of environmental goods and services low is not only a way of preserving efficiency and competitiveness, but also a way of making cleaner practices more accessible and widespread.

It is essential that trade negotiations not only address barriers to trade in environmental goods, but also those affecting the international supply of services related to the environment. From the construction of a geothermal power plant to the repair and maintenance of a wastewater-treatment facility, numerous services appear crucial to the delivery and proper functioning of environmental equipment. In the same way that computer users need both the software and the hardware, users of environmental equipment will most likely place significant value upon the provision of associated services for installing and operating the equipment.

The scope of what constitutes an environmentally related service is, however, unclear. Trade negotiators have long taken environmental services to refer to the few sectors described under division 94 of the UN's Central Product Classification (CPC), namely activities in relation to wastewater treatment, waste collection and management, remediation, sanitation and similar services, and a few other environmental-protection-related services. Although these are undoubtedly core environmental activities, the environmental industry has considerably evolved in recent decades, to the point where it now spans a number of services not classified as "environmental" but having nonetheless an environmental use or purpose. There is, for example, mounting evidence that services like consulting, design, engineering, construction, and repair and maintenance can play critical roles in the installation and operation of environmental facilities, be they renewable-energy plants or wastewater-treatment facilities.

The environmental purpose of a service remains, nevertheless, a matter of degree. Where services serve a clear environmental purpose, they could be deemed "environmentally related", though for statistical purposes they might often be classified as "business services" or "construction services". This recognises that not all activities matter the same for the prevention and abatement of pollution, so that defining the precise scope of environmentally related services generally amounts to an empirical exercise. There would, nonetheless, be benefits in making the relationship between core environmental activities and other related services more apparent. Regardless of whether environmental and related services are liberalised in the context of a sector-specific agreement (e.g. an extension of the EGA to services) or of a horizontal services negotiation (e.g. a plurilateral agreement on trade in services), this relationship implies in particular that the value of commitments countries make under environmental services is often a function of the commitments they make under other related services.

Analysis in this report indicates that the trade restrictions that countries impose on certain environmentally related services are negatively associated with the international supply of core environmental services. The findings are most robust in the case of restrictions imposed on engineering, architecture, computer and related services, and, to a lesser extent, construction services. While this may seem counterintuitive, the results are generally suggestive of a significant and negative correlation between countries' exports of core environmental services and the restrictions to services trade that they have put in place, reflecting the anti-competitive nature of restrictions hindering the entry of new competitors. Further liberalisation of trade in environmentally related services could thus benefit both

domestic importers and exporters, enabling environmental companies to procure the services inputs they need at competitive prices, and to operate on a larger scale.

Results from a case study looking at 61 companies providing environmental consulting and engineering (C&E) services — a type of environmentally related service — seem to corroborate the above finding that services trade restrictions are associated with a lower export performance by firms. Because environmental C&E services feed into numerous projects spanning all sorts of environmental domains, restricting the supply of these services makes the diffusion of cleaner technologies and practices unnecessarily costly. The case study also finds exporting firms to be larger, more productive, and to pay higher salaries than their domestically focused counterparts. Efforts to remove remaining obstacles to trade in environmentally related services could therefore have important implications for sector-wide productivity, skills, and earnings.

Overall, the report identifies three policy priorities that should stand high on the trade and environment agenda. First is the need to accelerate efforts to liberalise trade in environmentally related services given the environmental and economic gains that this would entail. Second — and where the intention of countries is indeed to accelerate the uptake of cleaner technologies — is the necessity for trade negotiations to consider the complementary relationship that exists between environmental services, strictly speaking, and those other services that are not necessarily classified as “environmental” but that serve, nonetheless, a clear environmental purpose. Finally, countries should consider investing more resources into the systematic collection of information on firms that provide environmentally related services at home and abroad. Only through better data can more analysis be conducted and more informed decisions be taken.

TRADE IN SERVICES RELATED TO THE ENVIRONMENT

This report contributes to work foreseen in the 2015-16 Programme of Work and Budget (PWB) of the OECD Trade Committee under "Trade in Services Related to the Environment" (3.1.3.1.1). It seeks to provide trade negotiators and environmental policy makers with a better understanding of how international trade in services can contribute to addressing today's environmental challenges, be they the mitigation of greenhouse-gas (GHG) emissions or the cleaning of waste water.

To do this, Section 1 of the report first lays the case for liberalising trade in environmental goods and services (EGS) by explaining how freer trade could contribute to reducing the costs of preventing and abating pollution. It is argued there that policy makers increasingly need to turn their attention to services since most liberalisation efforts to date have sought to address barriers to trade in environmental goods only, or at least initially, leaving out a number of services that constitute essential inputs for many environmental projects.

Section 2 then shows that the range of services feeding into environmental projects is often considerably broader than "core" environmental services such as those listed under division 94 of the UN's Central Product Classification (CPC)1. The analysis in that section thus demonstrates the importance for negotiations to widen the scope of services related to the environment to include other environmentally related activities such as environmental consulting and engineering or the construction and maintenance of renewable-energy plants.

Section 3 adds supporting evidence by looking at the particular case of multinational firms supplying environmental consulting and engineering services abroad. Using a new firm-level data sample and OECD indicators of services trade restrictiveness, the case study finds that restrictions to services trade have had a detrimental effect on the commercial presence abroad of companies supplying environmental consulting and engineering services.

Last, Section 4 uses the analysis conducted in the preceding sections to derive a set of policy priorities, namely: (i) accelerate efforts to liberalise trade in services related to the environment; (ii) in doing so, consider how trade in environmental and in other related services complement each other; and (iii) invest in the collection by governments of better data on trade in environmental and related services in order to obtain evidence that helps uncover the benefits of trade.

1 Annex 1 provides a brief guide to the product and sector classifications used in this report.

Trade in environmentally related services and the costs of preventing and abating pollution

Environmental targets and objectives often come at a cost

Keeping low the costs of pollution prevention and control not only helps preserve efficiency and competitiveness, but it also makes cleaner practices more accessible and widespread. As early as 1972, the OECD Council was recommending that polluters bear the costs of carrying out measures for preventing and abating pollution. What came to be known as the "Polluter-Pays Principle" (OECD, 1972) thus recognises that environmental policies often come at a cost, and that this cost ought to be borne by those directly responsible for environmental degradation[2]. A chief concern for policy makers has therefore been to ensure that the costs of carrying out pollution prevention and control stay within acceptable limits that would be compatible with both economic and environmental objectives.

Several goods and services feed into the costs that polluting firms incur for meeting the requirements prescribed by environmental laws and policies. The last time the US Census Bureau and the US Environmental Protection Agency (EPA) conducted a survey of pollution abatement costs and expenditures — known as the "PACE" survey — the two agencies found that total pollution abatement capital expenditures by US manufacturers in 2005 amounted to USD 5.9 billion, of which USD 3.9 billion (66%) were dedicated to the abatement of air emissions, USD 1.4 billion (23%) to the treatment of water discharges, and the remaining USD 0.7 billion (11%) to the management of solid waste (US Census Bureau, 2008). Total pollution-abatement operational expenditures were even higher, at USD 20.7 billion. What the PACE survey also reveals is that there are many components to the costs of preventing and abating pollution, namely capital investment in pollution-control equipment, purchases of materials and supplies, energy costs, and the salaries and wages of specialised personnel.

There are several different ways in which governments can help polluters achieve reductions in their abatement costs, including by designing environmental policies so that firms abate their emissions more efficiently. Recent OECD work has shown, for instance, that environmental policies can be designed to be stringent, while at the same time minimising unnecessary burdens and barriers to competition, and reconciling economic and environmental objectives more generally (Kozluk, 2014). Another way to keep pollution-abatement costs low is for governments to ensure that domestic polluters gain access to competitively priced environmental equipment and services[3].

Trade in environmental goods and services can help make cleaner technologies cheaper

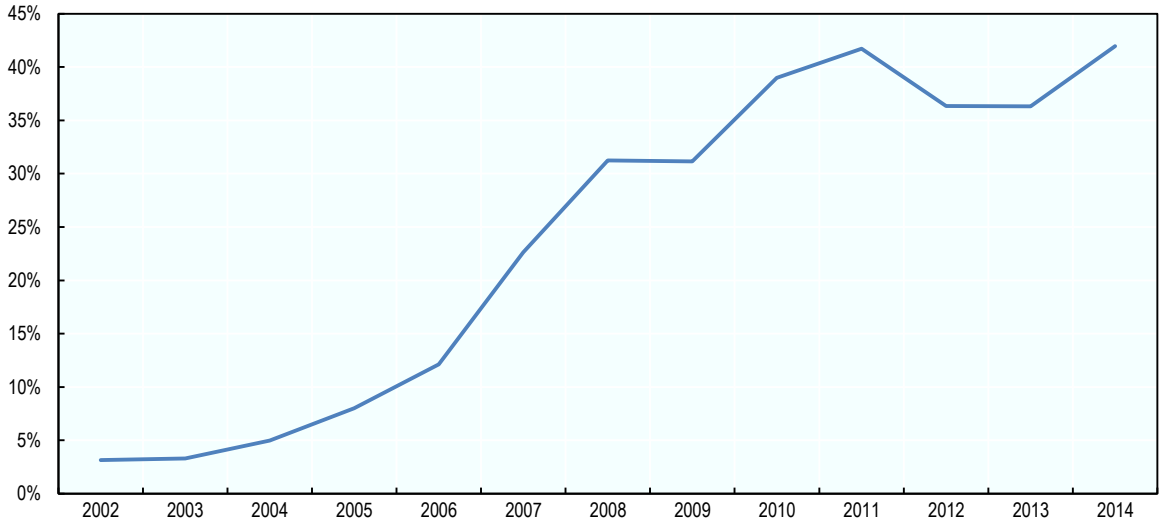
The removal of barriers to international trade in environmental goods and services (EGS) offers an appealing avenue for helping contain the costs of meeting particular environmental goals or targets. By giving firms access to cheaper or more advanced technologies for preventing or mitigating environmental harm, trade can contribute to lowering the costs of environmental policies while keeping intact their degree of ambition. This has been most evident in the case of renewable-energy equipment such as solar photovoltaic panels (PVs), the price of which has declined sharply in recent years, driven in large part by growing imports from the People's Republic of China (hereafter "China) (Figure 1).

2 The so-called Porter hypothesis, on the other hand, posits that "an increase in [environmental] regulatory stringency can trigger innovation and improve competitiveness" (Pasurka, 2012), which would therefore reduce abatement costs to the point where they might become negative. A report by McKinsey & Company (2010) argues that this is not a mere theoretical curiosity, with the study estimating negative marginal abatement costs for greenhouse-gas emissions for a range of investments in energy efficiency. Negative abatement costs are generally only possible in the presence of large market failures and barriers (e.g. credit constraints, information asymmetries, or agency problems).

3 Subsidising polluters' purchases of environmental equipment would only serve to shift pollution-abatement costs from the private sector to taxpayers and violate the polluter-pays principle.

Figure 1. China now accounts for almost half of world exports in solar PVs and light-emitting diodes ladder

China's share of world exports under HS 8541.40



Note: The data used for generating this graph concern exports recorded under the HS 2012 heading "8541.40 – Photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes."

Source: OECD calculations based on data from the UN Comtrade database.

Just as trade in environmental goods has helped lower the price of cleaner equipment and technologies, trade in environmentally related services could make the prevention and control of pollution cheaper by allowing firms to source the services they need from foreign suppliers. This point takes on particular importance once it is recognised that there exist strong complementarities between environmental goods and the provision of services. From the construction of a geothermal power plant to the repair and maintenance of a wastewater-treatment facility, numerous services appear essential to the proper delivery and functioning of environmental equipment. In the same way that computer users need both the software and the hardware, users of environmental equipment will most likely place significant value upon the provision of associated services for installing and operating the equipment. This makes the costs of environmental goods and services inextricably linked. It also implies that efforts to liberalise trade in environmentally related services and the current negotiations to address obstacles to trade in environmental goods should not be considered independently.

Anecdotal evidence exists in support of the view that environmental goods and services are complementary. On the basis of interviews conducted with companies selling or purchasing environmental products, a recent study by Sweden's National Board of Trade concluded that a number of services[4] were "indispensable for the trade in environmental goods", and went on to argue for the joint liberalisation of trade in environmental goods and associated services given their "synergetic relationship" (National Board of Trade, 2014). The US International Trade Commission (USITC, 2013a) arrived at similar findings in the case of the US solar, wind, small hydropower, and geothermal sectors, stressing that "a broad group of services are indispensable to the development and functioning of renewable energy projects."[5] The same argument was made by De Melo and Vijil (2014) in the context of their study analysing the impacts of policy barriers on trade in EGS, and in which much

4 Examples of the services mentioned in the study include assembly and installation, technical testing and analysis services, and computer services. See Table 1 in National Board of Trade (2014).

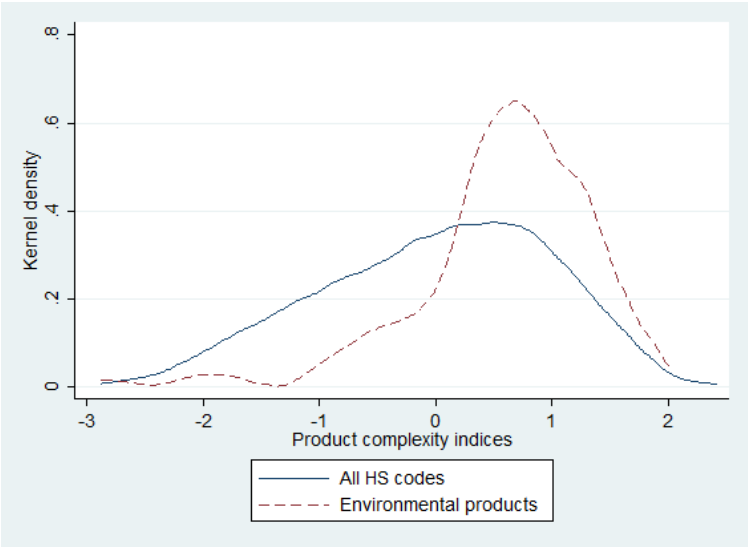
5 As in the case of the study undertaken by Sweden's National Board of Trade (2014), the USITC (2013a) found those broader services to include scientific and technical consulting services, professional services, and construction and engineering services.

emphasis is placed on the concept of "jointness" in the provision of environmental goods and environmental services.[6]

Although complementarities between goods and services can be observed outside the environmental sector[7], there are good reasons to believe this phenomenon to be particularly prominent in the case of EGS. Similar to what happens for a number of capital goods, the installation and operation of machines and pieces of equipment used in preventing or abating pollution can be complex, requiring that users possess specific knowledge and skills that can be costly to acquire. Demand for such knowledge and skills is likely strong in the environmental sector, where products often lie around the top of the complexity ladder (Figure 2). One consequence of this complexity is that consumers do not value wind turbines, solar PVs or gas chromatographs per se. Rather, they seek to acquire these goods in combination with ancillary services such as installation, technical support, training, and maintenance (National Board of Trade, 2014). It follows that any policy restriction placed upon the provision of those ancillary services therefore has the potential to deter or slow the uptake of cleaner technologies.

Figure 2. Environmental products often lie around the top of the complexity ladder

(Kernel density function of product complexity indices)



Note: Environmental products are here taken to refer to the OECD's Combined List of Environmental Goods (CLEG), which contains about 250 six-digit HS lines. See Annex 1 in Sauvage (2014) for more information on the CLEG. Kernel density is a non-parametric method for estimating and smoothing probability density functions.

Source: OECD calculations based on data obtained from The Atlas of Economic Complexity (online version), Center for International Development, Harvard Kennedy School.

Policy restrictions affecting trade in environmentally related services take on many forms

Trade in EGS can be thought of as being determined by intertwined sets of tailwinds and headwinds. Tailwinds are forces that serve to increase the amount of EGS traded worldwide. They include economic growth, demography, environmental awareness, and the degree of ambition of environmental policies. Recent OECD work has shown in particular that stringent environmental policies go hand-in-hand with increased specialisation and exports in environmental goods, and there is no reason to think that services are any different (Sauvage, 2014). Headwinds, on the other hand, refer

6 Table A1 3 in De Melo and Vijil (2014) illustrates the "jointness" in the provision of environmental goods and environmental services using the example of 26 core environmental products.

7 See for example Nordås (2010) and Nordås and Kim (2013).

to the many forces that act to hinder trade in EGS. For goods, those include traditional border measures such as import tariffs, quotas, licenses, and numerous other non-tariff measures ranging from discriminatory subsidies to burdensome customs procedures and local-content requirements (World Energy Council, 2016).

There are several reasons that may prevent foreign services suppliers from competing on a level-playing field with domestic suppliers, many of which involve restrictions on foreign investment and the cross-border movement of personnel. A number of non-tariff measures may apply to goods and services alike, such as where government procurement favours local suppliers, or where subsidies or the tax regime give local companies an undue advantage. In many cases, however, measures restricting trade in services will display distinct characteristics that warrant separate discussion, in particular since much services trade occurs through the establishment of a commercial presence abroad (Box 1).[8] Environmentally related services seem no different, with commercial presence abroad (mode 3) accounting for the lion's share of all trade in environmental and related services (USITC, 2013b; National Board of Trade, 2014).

Box 1. Trade in services by mode of supply with examples drawn from the environmental industry

Article 1 of the General Agreement on Trade in Services (GATS) defines four modes of supply through which services are generally traded. Those four modes are:

- **Mode 1 — cross-border trade**: from the territory of one Member into the territory of any other Member.

Example: A company monitors and diagnoses its wind turbines from one, foreign-based remote operations centre.

- **Mode 2 — consumption abroad**: in the territory of one Member to the service consumer of any other Member.

Example: An engineer travels abroad to further his or her knowledge of energy efficiency through a course organised by foreign experts.

- **Mode 3 — commercial presence abroad**: by a service supplier of one Member, through commercial presence in the territory of any other Member.

Example: A firm establishes several subsidiaries abroad to provide environmental consulting and engineering services locally.

- **Mode 4 — temporary presence of natural persons abroad**: by a service supplier of one Member, through the temporary presence of natural persons of a Member in the territory of any other Member.[9]

Example: Experts in a particular environmental domain travel abroad to train local staff or conduct repairs.

Whether a company establishes, maintains, or expands its activities abroad hinges upon, among other factors, its ability to invest and operate in a given country as a foreign entity. The range of possible restrictions is accordingly wide (Table 1). Examples include foreign-equity limits, investment-screening procedures, or restrictions on the legal form that affiliates can take, all of which discriminate against foreign investors. In practice, few restrictions on commercial presence seem to directly target core environmental services in sectors such as wastewater treatment or solid-waste management (USITC, 2013b). One particular example would be EU Directive 2004/17/EC (the "Utilities Directive"), in which Article 58 establishes a 50% local-content obligation for procurement procedures in the energy and water sectors of EU Member States. The Philippine Constitution also restricts foreign entry into the

8 Estimates by the WTO Secretariat suggest that mode 3 (i.e. commercial presence abroad) accounted for roughly 55% of the value of all services trade in 2011. See Lanz and Maurer (2015).

9 As indicated by the WTO, "mode 4 refers to the presence of persons of one WTO member in the territory of another for the purpose of providing a service. It does not concern persons seeking access to the employment market in the host member, nor does it affect measures regarding citizenship, residence or employment on a permanent basis."

country's public-utility sector — including into water- and sewage-treatment services — by limiting foreign participation to 40% (USTR, 2016). Meanwhile, Singapore reaffirmed in the Trans-Pacific Partnership (TPP) its right to maintain or adopt any measure affecting wastewater management, which makes the sector effectively "unbound" (i.e. not subject to any commitment with regards to market access and national treatment).

Restrictions on commercial presence seem more prevalent when one considers the broader set of services that form important inputs to environmental projects, be they engineering or construction services. In Indonesia, for example, Presidential Regulation No. 39 places a 55% limit on the share of equity that can be detained by foreigners in the case of companies providing certain services in relation to consulting, engineering, and construction. Several countries in the OECD and beyond[10] also require that managers in engineering firms be locally-licensed professionals, a provision that may hamper the hiring of foreigners.

Table 1. Many restrictions affecting services trade concern primarily Mode 3 and 4

Examples of restrictions affecting services trade
Restrictions on the legal form of companies
Economic-needs test for the establishment of a commercial presence
Foreign equity limits
Nationality or residency requirements for accreditation of certain types of services
Restrictions on the acquisition of land and real estate
Limited eligibility for subsidies, including tax benefits
Limited recognition of third-country diplomas required to practice regulated professional services
Public monopolies restricting entry of private services providers
Government procurement favouring local suppliers
Costly and time-consuming visa applications
Labour-market tests
Limitations on the duration of stay of foreign providers
Investment screening procedures
Professional qualification exams
Local content requirements

While generally not specific to the environmental sector, complex visa procedures or limitations on the duration of stay of foreign suppliers can delay, or even fully deter the entry of natural persons, including those seeking to provide environmentally related services by way of mode 4 (National Board of Trade, 2014). Under mode 3 trade in services, subsidiaries of multinational services firms frequently draw on the labour market of the host country for sourcing the staff they need. Mode 4 trade in services requires, on the other hand, the temporary presence in the country of natural persons from abroad, whether in the form of contractual services suppliers, intra-corporate transferees[11], or business visitors. Adding in the fact that services are labour-intensive activities, this makes obstacles to the movement of people a likely strong impediment to trade in services across countries.

10 Examples include Austria, Brazil, Canada, China, Germany, Italy, and Spain. These particular examples were drawn from the OECD's STRI database: http://sim.oecd.org/default.ashx.

11 There are a number of cases in which mode 3 and mode 4 happen to be complementary. The movement of intra-corporate transferees is one of them.

Besides direct restrictions, market structure can also prove an important obstacle to services trade. Many environmental services are still provided by municipal departments or local public utilities, which makes barriers to competition unusually high in the sector. Sanitation services in Germany, which include sewage-treatment services, are, for example, considered "core" responsibilities (hoheitliche Kernaufgabe) of the municipalities. This causes the services to be exempt from value-added tax and corporate tax, and further bars private companies from directly supplying sanitation services in the country, leaving their provision in the hands of municipal sanitation departments (Regiebetrieb). Municipalities are, however, permitted to sign joint operating contracts with private companies (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 2001). In Viet Nam, the provision of sewage services often remains in the hands of public monopolies or may be delegated to private operators with exclusive rights.

Trade negotiations should address restrictions to the supply of environmentally related services

Although the past two decades have witnessed a number of initiatives aiming to liberalise trade in environmental goods and services, progress has been uneven to date. At the multilateral level, WTO members agreed in 2001 to launch negotiations for the reduction or elimination of tariffs and non-tariff barriers to trade in EGS pursuant to Paragraph 31 (iii) of the Doha Declaration. Negotiators proved unable to conclude negotiations under the Doha round, however, shedding doubt on the feasibility of liberalising EGS trade on a multilateral basis under a single-undertaking approach. Disagreement over which goods and services ought to be considered "environmental" also plagued the negotiations, with WTO members submitting more than 400 individual products to the Committee on Trade and Environment meeting in Special Session (CTE-SS).

Efforts to liberalise trade in EGS have proved more successful at the regional level, particularly among members of APEC who agreed in 2011 to "to reduce by the end of 2015 [APEC countries'] applied tariff rates to 5% or less" for a set of 54 environmental goods (APEC, 2012). The environmental chapters of a number of regional trade agreements (RTAs) concluded in recent years also comprise provisions calling specifically for the liberalisation of trade in EGS, in addition to the tariff reductions and commitments that these agreements normally accomplish through other chapters (e.g. on market access). This is, for instance, the case of the EU-Korea agreement that entered into force in 2011, and in which Article 13.6 calls for Parties to "strive to facilitate and promote trade and foreign direct investment in environmental goods and services, […] including through addressing related non-tariff barriers." Article 20.18 of the recently signed Trans-Pacific Partnership (TPP) similarly mentions that "the Parties shall endeavour to address any potential barriers to trade in environmental goods and services [including potential non-tariff barriers] that may be identified by a Party."

Current negotiations to forge a plurilateral agreement eliminating bound tariffs on a selection of environmental goods — known as the Environmental Goods Agreement (EGA) — are perhaps the most far-reaching initiative yet.[12] As of mid-2016, there were 17 Parties to the negotiations, namely: Australia, Canada, China, Costa Rica, the European Union, Hong-Kong (China), Iceland, Israel, Japan, Korea, New Zealand, Norway, Singapore, Switzerland, Chinese Taipei, Turkey, and the United States. Although the EGA is a plurilateral agreement, the tariff cuts that will be made by the signatories are to benefit all WTO members (on a most-favoured-nation basis).

While laudable, most negotiations to date have essentially concerned environmental goods, leaving the issue of environmental services by and large unaddressed. Where environmentally related services have been liberalised, this was more the incidental result of broader trade negotiations that did not proceed from a concerted effort to remove impediments to the diffusion of cleaner technologies. A similar picture emerges on the analytical front as the majority of existing studies have concentrated on environmental goods rather than services.[13] This is due in large part to the paucity of data for

12 Technically speaking, the EGA does not aim to eliminate bound tariffs but rather reduce them to 0%.

13 Recent examples of studies analysing trade in environmental goods empirically include Sauvage (2014), De Melo and Vijil (2014), and Jha (2008).

empirically analysing trade in environmentally related services, and arguably trade in services more generally. Information on barriers to services trade was also scarce until the release in 2014 of the OECD's Services Trade Restrictiveness Index (STRI), which looks at more than 10 000 individual regulations to identify policy measures that inhibit services trade in sectors such as accounting, engineering, and telecommunications.[14] Numerous challenges remain, however, that make it difficult to quantitatively assess the impacts that policies have had on trade in environmentally related services, including in particular the question of how to define the scope of those services.

Toward a broader understanding of trade in environmental services

The previous section has argued that many services form crucial inputs into the prevention and abatement of pollution, so that sourcing them internationally could potentially contribute to lowering the costs of cleaner technologies and practices. Identifying what those particular services are thus constitutes a necessary first step in removing the numerous policy restrictions that continue to hamper trade in environmentally related services. Only then can policy reform be designed to facilitate such trade, be it in the form of cross-border supply, the movement of relevant professionals, or the establishment of a commercial presence abroad. The second section of this report therefore concentrates on the question of the scope of environmental and related services. The discussion emphasises in particular that the range of services serving a clear environmental purpose often extends beyond the narrow confines of "environmental services" in existing services classifications.

Few changes have been made to the definition of environmental services used by trade negotiators

Trade negotiators have usually taken environmental services to mean the sectors described under division 94 of the UN's Central Product Classification (CPC) (see Annex 1). Version 2.1 of the CPC (United Nations, 2015) includes under this division activities such as wastewater treatment (CPC 941), the collection and management of hazardous and non-hazardous waste (CPC 942-943), remediation services (CPC 944), sanitation and similar services (CPC 945)[15], and other environmental protection services not elsewhere specified (CPC 949). This arguably narrow focus on services traditionally provided by municipal utilities owes much to the WTO's Services Sectoral Classification List (MTN.GNS/W/120) — otherwise known as the W/120 list — that was designed in 1991 for the purpose of negotiating the General Agreement on Trade in Services (GATS), and which uses the older provisional version of the CPC (CPC Prov). Because it reflects an earlier conception of the environmental industry, the W/120 list is restricted to the collection and treatment of wastewater and refuse (i.e. solid waste), sanitation services, and some other services grouped under CPC Prov 94, such as noise abatement (see Annex 1 and Annex 2).

Although WTO members remain free to adapt their own classification systems in any way they choose, the CPC and the W/120 list have had a major influence on services trade negotiations, having been used by countries to organise their schedules of commitments under the GATS and under the services chapters of a great many RTAs. Commitments relating to environmental services strictly speaking have tended to be relatively few under the GATS, with many countries having made no commitment under mode 1 — so that mode 1 is "unbound" — in terms of both market access and national treatment (Table 2).[16] That trend is less pronounced for the other three modes of supply but remains significant nonetheless.

14 More information on the OECD's STRI database can be found at: www.oecd.org/tad/services-trade/services-trade-restrictiveness-index.htm. The STRI does not yet cover core environmental services such as wastewater treatment or solid-waste management, unfortunately.

15 "Sanitation" is here taken to include activities in relation to street sweeping, the removal of snow, and the cleaning of beaches.

16 A notable counter-example is the schedule of commitments that the United States submitted under the GATS, where no limitations on market access and national treatment seem to apply to environmental

Much liberalisation seems, nevertheless, to have taken place in the context of RTAs. The OECD conducted in 2009 a survey of the preferential content of services RTAs[17], in which it found that roughly 40% of all market-access commitments for environmental services in the RTAs surveyed had been GATS-plus, meaning that they improved on prior GATS commitments (Miroudot et al., 2010). A similar analysis was later undertaken by De Melo and Vijil (2014) who found that RTAs had tended to improve on GATS commitments made under environmental services, particularly in the case of "North-South RTAs". This reflects partly the larger number of commitments developed countries have made in the GATS, and which leave little "binding overhang" or "GATS water"[18] to be addressed through RTAs between high-income countries.

Table 2. Countries have made few commitments in environmental services under the GATS

(GATS commitments for environmental services, by mode of supply)

Mode of supply	Market Access		National Treatment	
	Unbound	Full commitment	Unbound	Full commitment
Mode 1 = cross-border	84%	10%	80%	20%
Mode 2 = consumption abroad	57%	32%	55%	45%
Mode 3 = commercial presence	55%	20%	55%	45%
Mode 4 = movement of natural persons	54%	0%	54%	14%

Note: The data shown above refer to the sample of WTO members covered by Miroudot et al. (2010), which includes all OECD members and a large number of non-member economies, including Albania, China, Costa Rica, Croatia, El Salvador, Honduras, India, Indonesia, Jamaica, Jordan, Malaysia, Morocco, Oman, Peru, the Philippines, Singapore, Thailand, and Viet Nam. The European Union, being a customs union, is here treated as one single WTO member. Environmental services here refer to activities 6A, 6B, 6C, and 6D in the W/120.

Source: OECD calculations on the basis of data collected by Miroudot et al. (2010).

Despite its central role in trade negotiations, there have not been any updates to the W/120 list by the Special Session of the Council on Trade in Services (CTS SS), even though the environmental industry and other sectors (e.g. telecommunications and information technologies) have considerably evolved and matured since the 1990s. While version 2.1 of the CPC does single out more environmental services than the W/120 list, these are generally not reported under division 94 and some still lack specificity from an environmental standpoint. A recent study by the International Centre for Trade and Sustainable Development (ICTSD) stressed, for example, that "the only explicit reference made to renewable energy [in version 2 of the CPC] is found in 'engineering services for power projects' (CPC 2 83324)" (Monkelbaan, 2013), and the same holds for version 2.1 of the CPC. This clearly raises a number of questions in light of the growing economic and environmental importance of the renewable-energy sector.

Environmental services as presently classified cover too narrow a range of activities

From a niche activity focussed on municipal utilities and the end-of-pipe abatement of industrial emissions, the environmental industry has now grown to become a large contributor to economic

services under modes 1 to 3. The document also clarifies the scope of activities it covers under "environmental services", which include services such as environmentally related training, consulting, and maintenance and repair.

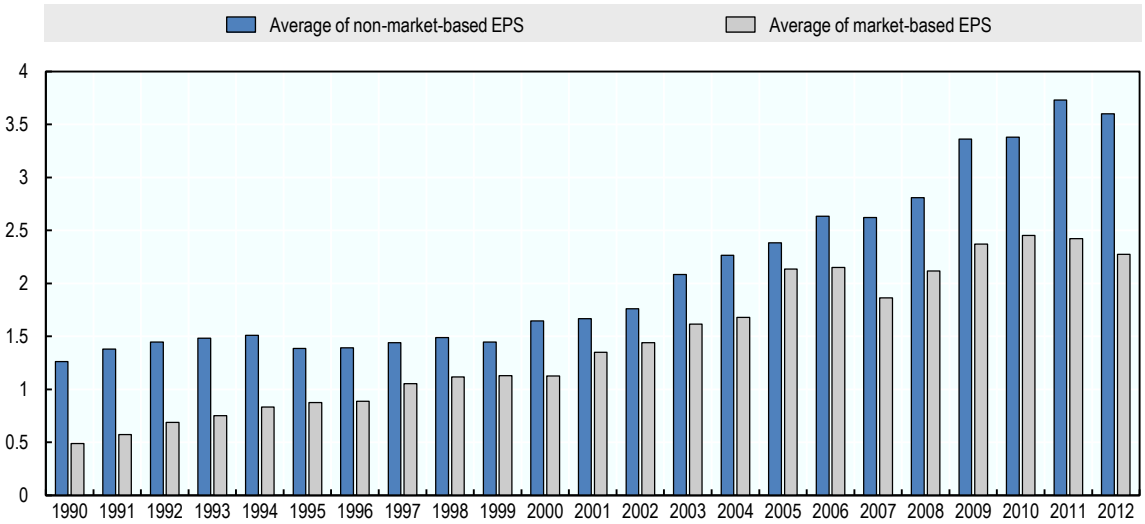
17 The agreements surveyed correspond to all services RTAs in force at the end of 2009 where an OECD member country, China, or India is a Party.

18 As defined by Miroudot and Pertel (2015), "the water in the General Agreement on Trade in Services (GATS) refers to the difference between the bound level of trade restrictiveness permitted by the GATS and the actual trade regime."

growth and job creation, spanning several sectors and activities. This evolution has been paralleled and largely driven by a comparable increase in the ambition and stringency of environmental regulations (Figure 3), which served to increase demand for cleaner goods and technologies. A significant portion of that demand has been directed toward equipment for the generation of electricity from renewable energy sources, with the latter's share in total OECD-wide power generation having increased from about 16% in 2000 to approximately 22% in 2014 (OECD, n.d.). There has also been a trend toward more reliance on pollution prevention through changes in integrated processes to replace or complement the abatement of emissions using end-of-pipe technologies (Pasurka, 2012).

Figure 3. The stringency of environmental policies has increased over the past two decades

OECD-wide average by component of the Environmental Policy Stringency index



Note: This graph uses the economy-wide version of the OECD's index of Environmental Policy Stringency (EPS), which ranges from 0 (not stringent) to 6 (highest degree of stringency). Underlying calculations are made using a fixed sample of OECD countries to prevent any composition bias.

Source: Botta and Kozluk (2014).

Changing commercial realities in the environmental industry are evident in the increasing array of services that firms now offer in relation to pollution prevention and abatement. The several short case studies described in Steenblik and Geloso Grosso (2011) show that the mitigation of GHG emissions involves a wide range of activities going well beyond division 94 of the CPC and the W/120's coverage of environmental services. One such activity is the remote monitoring of the performance of wind turbines by the General Electric Company (GE), an example of mode 1 cross-border trade that could be classified as computer-related services under CPC 84. Another would be the services provided in relation to the design, construction, and installation of landfill-gas recovery units (usually classified under CPC 83, 54, and 87 respectively) and those in connection with the sale of ensuing carbon credits (usually classified under CPC 71), all of which are predominantly supplied under mode 3 (i.e. commercial presence abroad).

As the example above of GE's remote monitoring of wind turbines suggests, it is not just the scope of environmental activities that has changed, but also their mode of delivery. Wind turbines usually require some form of monitoring, but technological progress now allows this to be performed from a distance, including from abroad. Services that could only be supplied through the establishment of a commercial presence abroad (mode 3) can now increasingly be supplied remotely, e.g. through mode 1. The relatively few multilateral commitments that WTO members have made under mode 1 trade in environmental services (Table 2) may, in that regard, turn out to be problematic as new modes of delivery become operational. The schedule of commitments that Australia submitted under the GATS indicates, for example, that the country has kept mode 1 trade in environmental services unbound "due to lack of technical feasibility". While RTAs and plurilateral agreements may subsequently allow

commitments to be made for such services and modes, this also means more water in the GATS in the absence of any progress at the multilateral level.

Several other studies have been conducted over recent years, which all show that the range of integrated services feeding into environmental projects extends far beyond existing official classifications of "environmental services". Most studies are qualitative in nature and focussed on the renewable-energy sector[19], like Monkelbaan (2013), who identified a number of services linked to "the diffusion of sustainable energy technologies" and showed these to encompass activities as diverse as site analysis, project financing, licensing and legal services, environmental impact assessments, construction, installation, repair and maintenance. In a similar vein, Sweden's National Board of Trade (2014) looked at two specific environmental goods, namely filters for purifying water (HS 8421.21) and wind-powered rotary converters (HS 8502.31), to conclude that a number of services beyond CPC 94 were "indispensable" for conducting trade in those two products. Again, the services listed as examples in the study comprise wide-ranging activities like design, financial consulting, installation, construction, R&D, advisory and consultative services, computer services, and educational services for training. The structure of the environmental industry itself often displays a similar pattern, with multinational environmental-services firms like Arcadis, CH2M, or Tetra Tech offering packages of services spanning site evaluation, due diligence, permitting, environmental auditing, construction, and remediation.

Approaches to liberalising trade in environmental services should consider synergies between services

Given the scope of the services feeding into key environmental projects and technologies, it is essential that liberalisation efforts extend beyond core CPC 94 services to include other activities in connection to pollution prevention and abatement. Failure to do so would likely impair the diffusion of cleaner equipment and practices since it has been shown that there exist strong complementarities between environmental goods and services, but also between certain services themselves along the value chain. The WTO already noted in 1998 that "liberalizing initiatives based on a narrow definition focusing on pollution control alone would compare unfavourably with those based on broader definitions […] in terms of creating incentives for firms to adopt cleaner technologies and manage resources in order to prevent the creation of pollution in the first place" (WTO, 1998). In that respect, it may be helpful to establish a distinction between "core" environmental services strictly speaking (i.e. those defined under CPC 94 and in the W/120) and the broader environmentally related services that comprise ancillary activities not listed in CPC 94, but which are nonetheless essential inputs to environmental projects.

The necessity to broaden the scope of negotiations on liberalising trade in environmental services has long been recognised by a number of WTO members, as evidenced by some of the submissions countries made to the Council on Trade in Services meeting in Special Session (CTS SS). The submission the EU made back in 2000 under the title *GATS 2000: Environmental Services* called, for example, for using a "cluster" approach to the liberalisation of environmental services (WTO, 2000).[20] While preserving the vertical, exclusive nature of the W/120 in terms of sectors, this proposed approach offers a more granular description of "core" environmental services under CPC 94, together with a broader "cluster" or "checklist" of ancillary services. Ancillary services here comprise activities not specifically classified as environmental but serving an environmental purpose: e.g., environmental design, engineering, R&D, and consulting services.

19 One notable exception is USITC (2013b).

20 Another example can be found in WTO document JOB(07)/208, which uses a cluster approach to look at the wider range of services linked to the generation and supply of energy (WTO, 2007). Importantly enough, this document stresses that "[because] energy services constitute a closely interrelated set of activities, the absence of commitments in some of these services from a country's offer undermines the value of its other energy services commitments."

Regardless of whether trade negotiators seek to address environmental services specifically (e.g. an extension of the EGA to services) or through broader services negotiations (e.g. through a plurilateral Trade in Services Agreement, or TiSA), there is value in ensuring that liberalisation efforts reflect commercial realities in the environmental-services industry. Using a cluster approach for liberalising services trade would make particular sense where: (i) companies supply integrated solutions that involve different services along a value chain, as in the case of Build-operate-transfer (BOT) projects (Nielson et al., 2001); and (ii) existing classifications are inadequate and unlikely to change in the short- to medium-term.[21] The discussion above has already shown this to be the case for the environmental industry and the W/120 list, though other activities could potentially also benefit from a cluster approach (e.g. the tourism industry, which spans services such as construction, finance, transport, and recreational, cultural, and sporting services).

Should countries see value in adopting a cluster approach for liberalising trade in environmentally related services, next comes the question of how to define such a cluster? Perhaps the most obvious way would involve consideration of the "end-use" of the services, i.e. to what end or for what project the services are supplied. A distinction could, for example, be made between the construction of a soccer stadium (a component of subclass CPC 54270: General construction services of outdoor sport and recreation facilities) and the construction of a waste-recycling facility (a component of subclass CPC 54290: General construction services of other civil engineering works), even though both projects require construction services generally speaking.

Yet consideration of the end-use of a service may not suffice for inclusion in an environmental cluster. Drawing a distinction between services on the basis of their end-use is consistent with the general principles set out in the OECD-Eurostat Manual for Data Collection and Analysis of the EGS industry, which notes that goods and services ought to be classified according to whether they have a "clear environmental purpose" (OECD-Eurostat, 1999). What a clear environmental purpose is remains, however, subject to interpretation. At one extreme, one could argue for the inclusion of every single service that is used in a given environmental project, say a wastewater treatment plant. Others could retort that the internet and phone services that the treatment plant is using are, for example, hardly specific, accounting only for a negligible fraction of the total sales of the telecommunications provider, or of the total costs of the wastewater treatment facility.

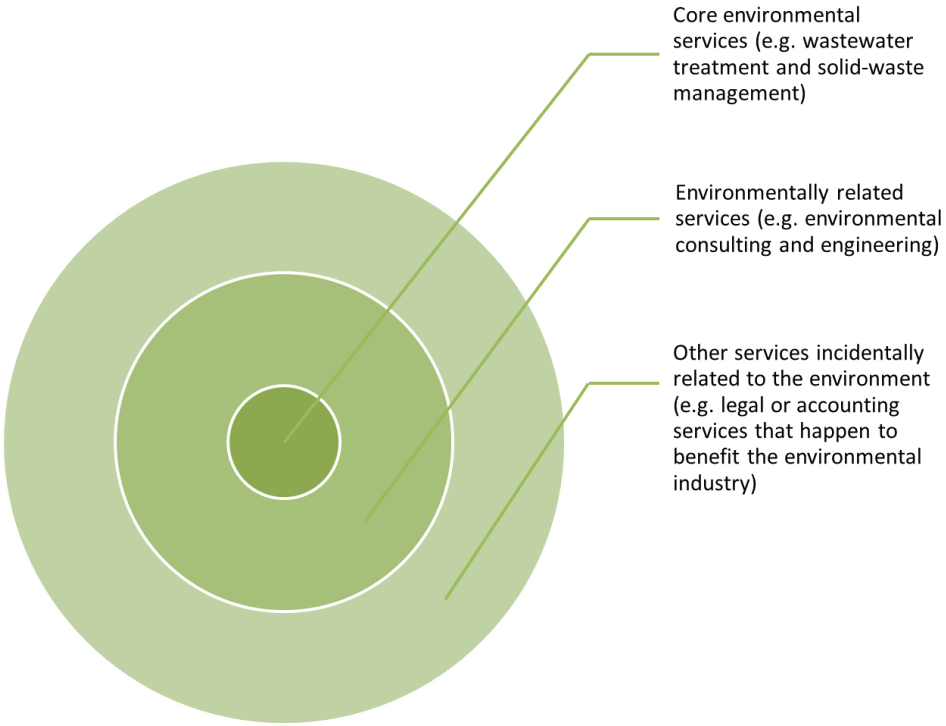
What the above discussion suggests is that the environmental purpose of a service is eventually a matter of degree. Earlier OECD work noted that whether or not to include particular services in a cluster hinged, among other factors, on the notions of market operation and relativity (Nielson et al., 2001). Market operation refers to how critical a related service is to the provision of the core service. In the case of the environmental industry, this could be extended to services that are essential to the provision of cleaner equipment and technologies, and not just core environmental services. Relativity, on the other hand, concerns how important relative to other services a particular activity is to the provision of the core service or environmental technology at hand. Using again the example of the wastewater treatment plant (see previous paragraph), it could be argued that the phone and internet services that the facility uses are probably essential to its operations — that is, they meet the market-operation criterion — but that their economic importance is relatively minor compared with that of other services, such as the maintenance of the plant. In that case, being unable to import those phone and internet services from abroad may not necessarily impose a binding constraint on the provision of wastewater-treatment services.

Being essentially an empirical question, the scope of environmentally related services ought to be kept open to allow for technological progress and changes in preferences. Just like GE now monitors the

21 Another example can be found in WTO document JOB(07)/208, which uses a cluster approach to look at the wider range of services linked to the generation and supply of energy (WTO, 2007). Importantly enough, this document stresses that "[because] energy services constitute a closely interrelated set of activities, the absence of commitments in some of these services from a country's offer undermines the value of its other energy services commitments."

performance of wind turbines from abroad, wastewater treatment plants could conceivably be operated from a distance, thereby making internet-based data transmission a relatively important ancillary service for wastewater treatment.[22] Bearing these various considerations in mind, Figure 4 offers a visual depiction of the degree to which different services relate to the environment. The inner, darker circle shows so-called core environmental services, such as those found under CPC 94 or in the W/120. The middle circle represents environmentally related services — that is, services that are not necessarily classified as "environmental" (e.g. under CPC 94) but that nonetheless serve a clear environmental purpose and that could constitute a cluster. Annex 2 lists many examples of such services and their corresponding classification in the W/120, the CPC, and the ISIC. Last, the outer, lighter circle stands for those other less-specific services that might contribute incidentally to an environmental project but whose primary purpose lies essentially elsewhere. An example of the latter would be the provision of legal or accounting services to the environmental industry.

Figure 4. The degree to which services relate to the environment



22 In fact, companies such as Germany-based Klaro GmbH already offer services for the intelligent, remote control of small wastewater treatment plants. This highlights again that mode 1 may increasingly be used in the future for supplying a range of environmentally related services.

Using preliminary evidence to help define the scope of environmentally related services

Although limited, available evidence on the scope of environmentally related services leans toward activities such as architecture, design, engineering, consulting, construction, and computer and related services. The discussion earlier in this section has already reviewed some of the existing literature, which predominantly used case studies to identify design, architecture, construction, consulting, engineering, and computer services — among others — as constituting essential inputs to many environmental projects. Empirical analysis conducted for the present report arrives at similar findings, this time from a quantitative angle. On the basis of data from Eurostat on foreign affiliates' trade in services, econometric results show restrictions to trade in engineering services, computer and related services, architecture services, and, to a lesser extent, construction services to be significantly and negatively correlated with the supply of core environmental services by foreign firms established in Europe (Table 3).

Not all activities seem to matter the same for the provision of core environmental services by foreign affiliates. Restrictions to other activities like accounting or legal services do not, for instance, display a significant correlation with mode 3 trade in core environmental services. While not always significant, estimated coefficients for restrictions to trade in construction services do not necessarily imply that construction services matter less for core environmental projects. Rather, the results may reflect the different role that construction services play in the environmental industry, often intervening sporadically in environmental projects and in a less centralised fashion than other services inputs like engineering or computer services. This could also explain why exports of core environmental services seem particularly affected by restrictions on construction services applied in the importing (host) country.

Except for restrictions on construction services, results in Table 3 reveal a stronger correlation between trade in core environmental services and services restrictions applied in the exporting country, as opposed to restrictions applying in the importing country. Although these findings might seem surprising, earlier estimates of the correlation between the STRI and services trade have also identified at times stronger negative values for exporters than importers (Nordås and Rouzet, 2015). A plausible explanation for this result could be that restrictions on services trade at home make domestic firms less competitive than their foreign counterparts, in particular where those restrictions take the form of anti-competitive regulations hindering the entry of new competitors, or where regulatory burdens raise the operating costs of firms operating in the exporting country (Rouzet and Spinelli, 2016). In the present context, services restrictions at home may increase the cost of services used as inputs in the environmental industry, thereby causing domestic providers of environmental services to be at a disadvantage relative to foreign competitors.[23] Back-office functions like computer services are, for example, sometimes provided by the headquarters to the entire corporate group, so that restricting the provision of computer services at home may end up increasing costs company-wide.

Although necessary, broadening the scope of environmental services in trade negotiations also entails additional complications, particularly as regards the so-called "dual-use" problem. The dual-use problem has traditionally been associated with negotiations for liberalising trade in environmental goods (Steenblik, 2005), though it may also concern trade in certain environmentally related services. It refers to the fact that many goods or services used in the prevention and abatement of pollution can also have several other possible uses that are not environmental. This is, for example, the case of certain chemicals used in water treatment, and which may also be used in non-environmental activities (or worse, in environmentally harmful activities). One could similarly imagine a case wherein the provision of consulting and engineering services by subsidiaries of a multinational firm benefits both the oil and gas industry and the water-treatment sector in the host country. Whether the dual-use issue is more of a problem for services than it is for goods is an open question. Services have, however, a much higher

23 This would, for example, be the case where environmental services exporters are unable to fully pass on the extra costs onto customers in their home country, thereby rendering those firms less cost-competitive internationally.

degree of user specificity and customisation than goods, which could make them less prone to the dual-use problem. Similar to discussions of environmental goods under the Harmonized System (HS), adopting a broader understanding of environmentally related services may also lead to complications where the CPC lacks specificity.

Table 3. Trade in core environmental services seems most affected by restrictions to trade in engineering, architecture, and computer and related services

Estimated coefficients on restrictions to services trade, by model specification and sector

	Model 1		Model 2	Model 3	Model 4
	Importer STRI	**Exporter STRI**	**Bilateral STRI**	**Exporter STRI**	**Importer STRI**
Engineering services	0.230	**-0.830****	**-1.115****	**-0.874****	0.294
	(0.88)	(-2.05)	(-1.99)	(-2.01)	(1.14)
Computer and related services	-0.0344	**-1.409****	**-1.882****	**-1.422****	-0.0328
	(-0.07)	(-2.15)	(-2.14)	(-2.33)	(-0.08)
Construction services	-0.397	-0.589	-0.878	-0.698	**-0.726***
	(-0.80)	(-1.07)	(-1.12)	(-1.01)	(-1.79)
Architecture services	0.315	**-0.866****	**-1.398****	**-1.039****	0.197
	(0.94)	(-2.33)	(-2.14)	(-1.98)	(0.65)
Accounting services	0.0420	0.466	0.738	0.523	-0.0499
	(0.12)	(0.76)	(1.06)	(0.96)	(-0.22)
Legal services	0.0812	0.130	0.357	0.300	0.227
	(0.31)	(0.27)	(0.51)	(0.51)	(1.10)
Observations	3283	3283	3283	2345	1236

Note: See the technical appendix for more information about the estimation method, the data, and the different model specifications used for obtaining the above coefficients. Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively. Coefficients highlighted in bold are those that are statistically significant at conventional levels (i.e. 10% maximum).

A case study of mode 3 trade in environmental consulting and engineering services

The previous section has shown that many services beyond those that are classified as "environmental" end up feeding into environmental projects, generally as part of integrated business solutions. This makes it essential for trade negotiators and environmental policy makers alike to ensure that their efforts to aid in the diffusion of cleaner technologies do address restrictions affecting the broader set of environmentally related services, and not just core environmental services such as those listed under CPC 94. To better underscore the economic and environmental merits of addressing barriers to trade in environmentally related services, this section takes a closer look at firms providing environmental consulting and engineering services at home and abroad. Not only does this case study help illustrate the importance for governments of facilitating international trade in environmentally related services, but it also provides a foretaste of what better data on trade in such services could achieve.

Mode 3 trade in environmental consulting and engineering services offers promising ground for case studies

Environmental consulting and engineering (C&E) services serve at the crux of the provision of environmental solutions globally. Due to the central role they play in co-ordinating and overseeing the completion of environmental projects, environmental C&E services have grown in importance and

scope, spanning today all sorts of environmental themes and media from air to water pollution, the management of hazardous and other waste, natural-resource protection, or cleaner energy infrastructure. As a result, few environmental C&E providers happen to be uniquely specialised in, say, renewable energy or water treatment. To the contrary, most multinational firms operating in the sector have extended their reach to cover the whole spectrum of environmentally related civil engineering, usually as the offshoot of an even broader portfolio of services that are not necessarily tied to the environment. As an illustration, Ramboll Environ, a Denmark-based provider of environmental C&E, offers services in relation to air-quality management, environmental impact assessments, health sciences, resource and waste management, and water, among others. Yet the company belongs to the larger Ramboll Group, a civil-engineering multinational that operates in business segments as varied as buildings, transport, urban planning and design, and energy (including fossil fuels) through its nearly 300 offices around the world.

Not only do environmental C&E firms span all environmental themes and media, but they also take part in most phases of the environmental project cycle. A typical project goes through a number of phases, from ex ante evaluations and impact assessments, to approval and permitting, design, construction, operation, maintenance, decommissioning, and remediation. Clients will therefore place extra value on the provision of integrated solutions by one company (or consortium of companies) offering to act as project manager, and co-ordinating the whole range of actors (e.g. contractors) that are involved at the various stages. UK-based Amec Foster Wheeler has, for example, overseen the delivery of facilities from the concept stage through to commissioning in domains like water treatment or radioactive waste storage. In the case of renewable energy, the company provided engineering, procurement, and construction services for the completion in 2009 of a 2 MW solar-power facility at Colorado State University, using more than 8 000 solar photovoltaic panels purchased from China's Trina Solar.[24]

Given the range of activities that environmental C&E cover, these services are often more trade-exposed than other environmentally related services. Data provider Environmental Business International Inc. (EBI) reports, for instance, that environmental C&E represented only 14% of total turnover in the US environmental services industry in 2012, but accounted for a staggering 74% of all US exports of environmental services in that same year. As with many other services, the international provision of environmental C&E often takes the form of mode 3 trade in services — that is, the establishment of a commercial presence abroad through a local subsidiary — though numerous projects may at times necessitate the temporary movement of specialised personnel (mode 4) or the supply of services through purely electronic channels (mode 1).

To better understand the nature and drivers of trade in environmentally related services, the present case study has involved the collection of firm-level data for a sample of 61 companies providing environmental C&E services at home and abroad.[25] Although the number of firms covered by this sample may seem small, their combined revenue makes up roughly 40% of the global market for environmental C&E services, which approached USD 57 billion in 2012 according to estimates from EBI. This reflects the high degree of concentration observed for the environmental services industry more broadly, as small- and medium-sized enterprises (e.g. small-scale consultancies) hardly ever operate abroad by way of a commercial presence on the ground.[26] Some industry rankings estimate, for instance, that the top 20 firms in hazardous waste management and wastewater treatment together had global market shares of 70% and 67% respectively in 2015; that share even reached 69% for the top 10 multinationals providing air-quality services (ENR, 2016).

24 See www.amecfw.com/aboutus/projects/providing-epc-services-for-2mw-solar-facility-at-colorado-state-university (accessed 2 September 2016).

25 Section 2 of the technical appendix provides a detailed description of the data collected.

26 Small local companies can, nevertheless, act as sub-contractors for multinationals undertaking large-scale projects abroad.

The data collected for this case study offer a unique look at firms supplying environmental C&E services internationally by way of mode 3 (i.e. commercial presence abroad). This makes the sample a valuable new source of quantitative information, particularly as: (i) most empirical analyses of services trade have to date looked only at mode 1 and mode 2 trade in services; (ii) mode 3 remains the dominant mode of supply in international services trade; and (iii) remaining barriers to trade in professional and business services concern predominantly mode 3 and mode 4.[27] Taken together, these considerations underline the value of conducting empirical analysis of mode 3 trade in services.[28]

A portrait of environmental consulting and engineering firms

The 61 firms covered by this case study are based in 12 different countries, though the vast majority of them operate from North America. Unlike their European or Asian counterparts that are generally publicly listed, North American firms often are private firms that are either employee-owned or remain largely in the hands of their founding families. Of the sample's 27 firms that are private, as many as 21 (78%) are thus based in the United States alone. Mergers and acquisitions seem frequent in the industry, generally as a way to grow in size or expand into new markets. US-based Tetra Tech, for example, took over Australia-based Coffey International in 2016 to gain a stronger presence in the Asia-Pacific region and offer a broader range of services to its clients. In a similar fashion, Canada-based Stantec Consulting recently acquired both Canadian engineering firm Dessau in 2015 and US-based MWH Global in 2016 to increase its operations in Quebec and overseas, and extend its offer of water-related services.

Firm size often dictates how international the operations of a company are, and particularly so in the case of mode 3 trade in services. While evidence suggests firm size to be also important for other modes of supply (Breinlich and Criscuolo, 2011), the reliance of the environmental C&E industry on high-value mergers and acquisitions for accessing new markets and business segments shows size to matter especially under mode 3. The ten firms in the sample that had less than 1 000 employees over the period 2011-15 do not appear to generate much revenue through offices or subsidiaries abroad, though some occasionally engage in mode 4 by sending specialised staff on short assignments abroad (e.g. for local capacity building in the area of irrigation systems). By contrast, the three largest firms in the sample — each numbering more than 35 000 employees in 2015 — generated half (or more) of their revenue through their foreign operations in that same year. One tentative explanation for this finding could be that exporting environmental C&E services through mode 3 entails higher fixed costs than through other modes of supply. This implies the existence of economies of scale favouring large firms, which are best positioned for incurring the higher fixed costs associated with mode 3.

27 Many of the restrictions identified in the OECD's STRI database under professional and business services pertain to foreign entry (mode 3) or the movement of people (mode 4).

28 This does not mean that there would be no value in undertaking further analysis for the other three modes, especially where technology allows new services to be traded remotely, and where modes of supply complement each other in the provision of environmentally related services.

Table 4. Larger firms are more productive, pay higher salaries, and export more

Descriptive statistics for the period 2011-15

Variable	Unit	Obs.	Mean	Std. Dev.	Min	Max
First revenue quintile						
Total revenue	USDmn	54	67.9	56.5	6.1	158.2
Employees		41	358	410	53	1998
Average salary	USD	40	55856.6	24693.2	13187.6	92218.7
Profit rate	%	34	5.0	8.2	-11.5	25.4
Export intensity	%	50	6.9	18.5	0.0	74.0
Labour productivity	USDmn	41	0.15	0.07	0.06	0.37
Age of the firm	Years	54	38	21	5	82
Second revenue quintile						
Total revenue	USDmn	53	308.8	117.3	160.1	498.3
Employees		23	2236	1176	742	4250
Average salary	USD	22	74464.3	25451.2	20420.3	109560
Profit rate	%	12	7.6	8.0	-3.3	17.1
Export intensity	%	41	22.4	30.0	0.0	84.8
Labour productivity	USDmn	23	0.22	0.18	0.07	0.62
Age of the firm	Years	53	48	15	19	81
Third revenue quintile						
Total revenue	USDmn	54	875.8	200.9	512.0	1200.0
Employees		42	5549	1499	3400	8500
Average salary	USD	33	80044.7	10444	58746.1	100819
Profit rate	%	22	4.4	7.0	-11.2	13.1
Export intensity	%	52	41.7	23.9	0.0	73.8
Labour productivity	USDmn	42	0.17	0.03	0.11	0.23
Age of the firm	Years	54	66	27	34	134
Fourth revenue quintile						
Total revenue	USDmn	53	1926.3	560.3	1201.0	2992.0
Employees		41	12640	4386	5010	31700
Average salary	USD	32	86987.4	17263.9	50338.7	127928
Profit rate	%	24	5.5	3.3	-4.8	11.6
Export intensity	%	53	41.5	23.9	4.0	83.4
Labour productivity	USDmn	41	0.16	0.04	0.08	0.24
Age of the firm	Years	53	67	26	20	123
Fifth revenue quintile						
Total revenue	USDmn	53	10760.1	10059.7	3001.0	39400.0
Employees		46	33191	13767	11404	92000
Average salary	USD	32	104277.0	22989.8	66038.8	166000.0
Profit rate	%	17	4.7	3.1	-4.4	8.9
Export intensity	%	53	48.4	25.7	2.0	89.5
Labour productivity	USDmn	46	0.26	0.14	0.14	0.72
Age of the firm	Years	53	74	35	21	127

Note: The average salary is calculated by dividing a firm's total labour costs by its number of employees, and therefore includes a number of employer and employee payroll contributions. Export intensity is the percentage of a firm's revenue that is generated by its foreign affiliates. Labour productivity is simply calculated by dividing total turnover by the number of employees. See the technical appendix for more information about the data.

As a result, many of the companies supplying environmental C&E abroad by way of mode 3 are large multinationals that generate annual turnover well in excess of USD 500 million and employ thousands of staff members across the globe. In 2015, the average firm in the sample thus reported total revenue in the vicinity of USD 3 700 million[29] and employed more than 12 000 staff members. The data reveal, however, considerable dispersion around those mean values. Firms in the top revenue quintile (i.e. the 20% largest firms by revenue) appear, for example, to employ 100 times more people than firms in the bottom revenue quintile while earning 160 times more revenue. These differences in size are also suggestive of large differences in labour productivity since revenue appears to be growing more than proportionately with the number of employees.

Consistent with the literature connecting firm performance and trade in services[30], larger companies in the sample tend to be more productive, to pay higher salaries, and to export relatively more (Table 4). This finding echoes those of theoretical models of international trade with firm heterogeneity, in which only the most productive firms in an industry are able to export (e.g. Melitz, 2003). That is, the most productive firms "self-select" into entering export markets. Unsurprisingly, larger firms in the sample also tend to be older: environmental C&E companies usually start small before they either grow through mergers and acquisitions or end up taken over by other larger firms. The largest firm in the sample thus finds its origins in civil-engineering projects that were undertaken in the United States in the 1920s. On the other hand, whether or not firms are publicly listed does not seem to matter for export behaviour or size, nor does profitability, which shows no clear pattern across the sample.[31]

One recurring trait of firms in the sample seems to be their reliance on highly skilled and specialised personnel. The 2015 annual report of US-based Tetra Tech mentions, for instance, that the company's professional staff includes "archaeologists, architects, biologists, chemical engineers, chemists, civil engineers, computer scientists, economists, electrical engineers, environmental engineers, environmental scientists, geologists, hydrogeologists, mechanical engineers, oceanographers, project managers and toxicologists" (Tetra Tech, 2016). Firms supplying environmental C&E services abroad are essentially exporting the intellectual and technical skills that their employees possess. A premium is therefore placed by companies on the hiring of specialised individuals with high levels of qualification. This implies in turn that salaries be high enough to attract talent. Using data for 2015 on the total employee expenses reported by firms and their staff numbers, this study arrives at an average sample-wide salary of USD 72 212 in super-gross terms.[32] By contrast, OECD earnings statistics for 2015 indicate that average annual salaries stood at USD 58 714 for the United States and at USD 40 516 for the whole of the OECD. The environmental C&E industry appears in that regard to be characterised by relatively high salaries. Moreover, those salaries seem to be increasing with revenue and export intensity, in direct reflection of the positive relationship that exists between productivity and firm size.

29 This refers to total firm revenue, including, but not limited to, revenue generated through environmental C&E activities.

30 Examples of recent empirical studies linking firm characteristics and services trade include Breinlich and Criscuolo (2011), Temouri et al. (2013), and Wagner (2014). See also Wagner (2012) for a brief survey of the literature covering both goods and services trade.

31 Other studies of services trade have also obtained ambiguous results for firm profitability, notably Temouri et al. (2013). Results seem equally ambiguous for goods trade according to Wagner (2012).

32 The data only allow us to estimate the average salary per annum inclusive of a number of employer and employee payroll contributions.

The patterns and determinants of trade in environmental C&E services

On average, firms in the sample generate about half of their turnover abroad and that share has been increasing in recent years (Figure 5). This suggests that providers of environmental C&E services engage in mode 3 trade[33] on a considerable scale. As already in Table 4, export intensity appears to increase with firm size, with firms in the bottom revenue quintile generating on average only7% of their revenue through their foreign subsidiaries. This contrasts with firms in the top revenue quintile, for which international revenue represented on average 48% of total revenue over the period 2011-15.

Firm size is not, however, the sole determinant of export intensity as country characteristics do seem to influence the degree to which companies internationalise their operations. One such characteristic is the size of the domestic market, with smaller home markets prodding firms to seek business opportunities abroad. Many of the firms generating relatively little of their revenue abroad thus seem to be based in the United States, whereas firms based in Denmark or the Netherlands display comparatively high levels of export intensity.

Although a full breakdown by destination country could not be obtained[34], the data collected for this case study indicate that two broad geographical areas — namely North America and Western Europe — concentrate most of the market for environmental C&E services (Figure 6). Even if smaller in revenue terms, the Asia-Pacific region ranks third, thanks in large part to the sizable Australian market. Adding in information on where firms in the sample are based, the estimates also reveal that most providers of environmental C&E services concentrate their activities in their home region or continent (Table 5). There are variations at the country level though, as companies based in Australia, Denmark, and the United Kingdom appear to be serving the North-American market to a larger extent than their own home region. As indicated before, this may partly reflect the larger size of the North-American market relative to the size of the market in those other countries. But it may also reflect other firm- and country-level characteristics that need to be accounted for using statistical and econometric analysis.

On average, the restrictions that countries impose on trade in engineering services are associated with lower export intensity for firms providing environmental C&E services (Figure 7). Although the small sample size places restrictions on what can be achieved by way of econometric analysis, results in the technical appendix seem to confirm that firm size and labour productivity are strongly and positively correlated with mode 3 exports of environmental C&E services at the firm-level; at the country-level, the size of the domestic market and restrictions placed on services trade appear, on the other hand, to be negatively correlated with exports. Lack of information on the particular countries where firms export (i.e. operate through commercial presence) makes it impossible to assess the statistical relationship between services trade restrictions applied by the destination country and that country's imports of environmental C&E services. Analysis in the previous section has, nevertheless, shown services trade restrictions to matter greatly for exports as well (Table 3). The observed statistical relationship between services trade restrictions and mode 3 exports is thus consistent with earlier results.

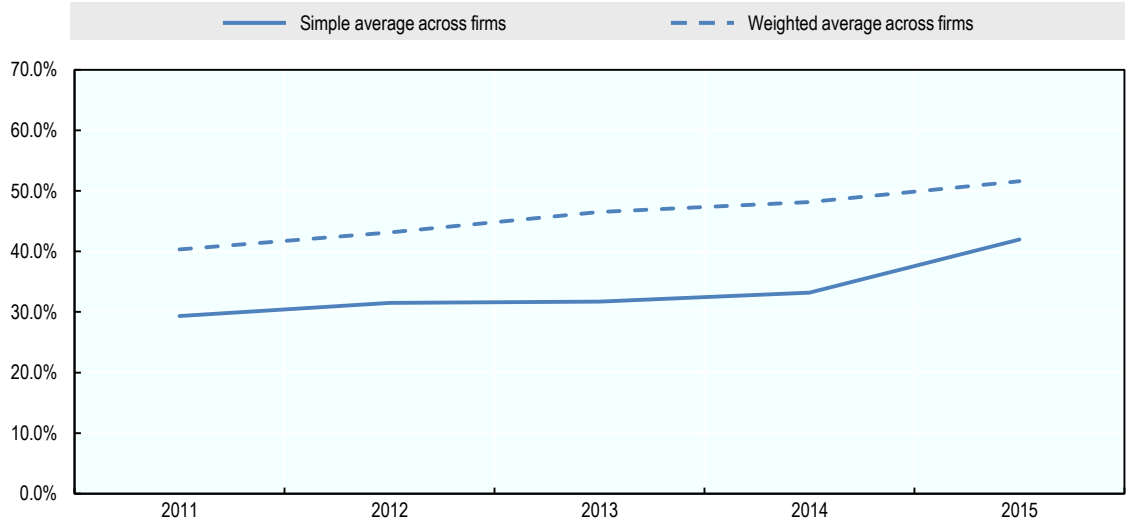
While by definition case studies only provide context- or sector-specific insights, the present analysis of trade in environmental C&E services still has a number of implications for policy makers. One is the detrimental effect that services trade restrictions have on the international activities of firms providing environmental C&E services. Environmental C&E services feed into numerous projects spanning all sorts of environmental domains, from renewable energy to water treatment and noise abatement. Restricting the supply of these services therefore makes the diffusion of cleaner technologies and practices unnecessarily costly.

33 The latest revision of the *Manual on Statistics of International Trade in Services* "chooses to view domestic sales [or] output of foreign affiliates as the primary statistical indicator of Mode 3" (United Nations et al., 2012).

34 Company websites and financial reports generally provide a breakdown of revenue by broad geographical area only.

Figure 5. Providers of environmental C&E services conduct more and more of their business abroad

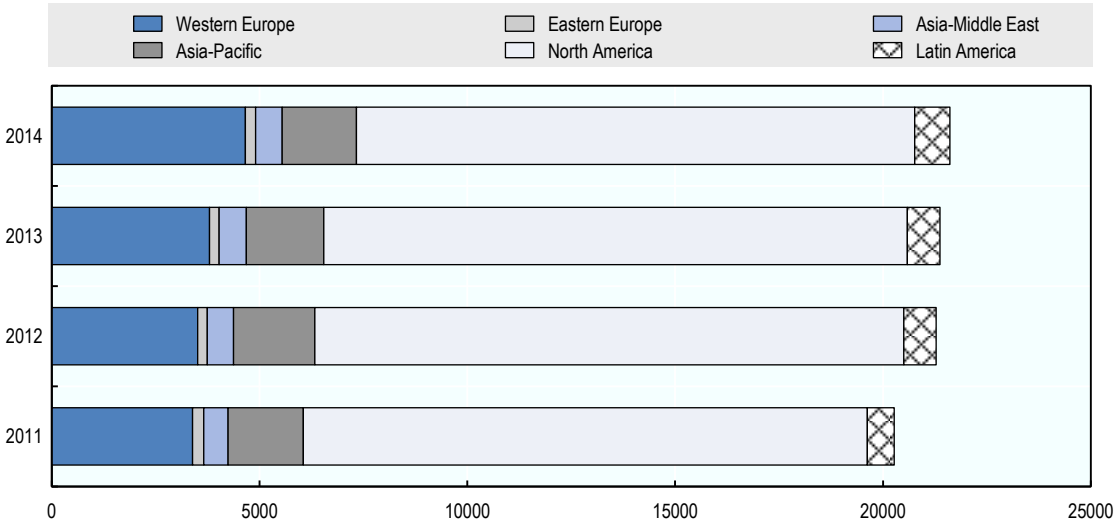
(International turnover, as a % of total turnover)



Note: The weighted average uses total revenue by year (a proxy for firm size) to weigh the export intensity of the different firms in the sample. See the technical appendix for more information about the data.

Figure 6. Western Europe and North America together account for most of the environmental C&E market

Total sample-wide environmental C&E revenue, by market and year; USD million, current)



Note: Numbers in bold are the percentages of revenue that companies in the sample generate in their home region or continent.

Table 5. Most firms in the sample concentrate their activities in their home region

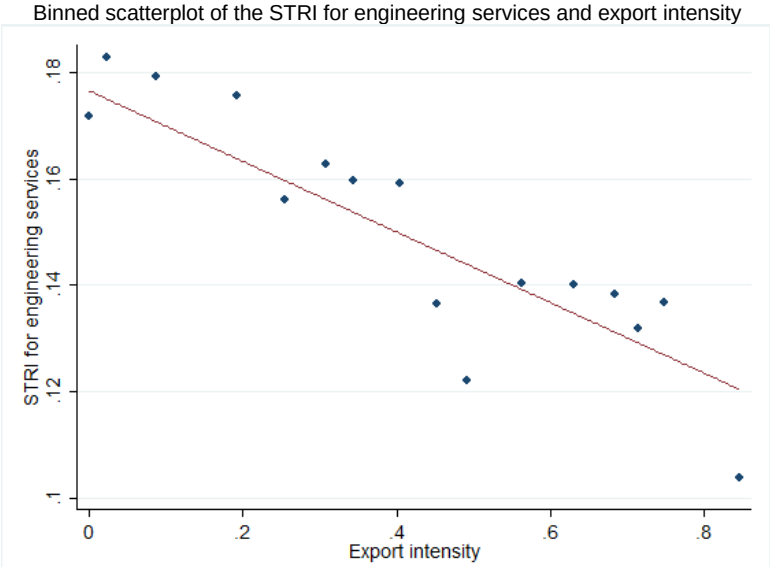
Environmental C&E revenue by home region and destination market, %

	Markets served through commercial presence					
Home region	**Western Europe**	**Eastern Europe**	**Asia-Middle East**	**Asia-Pacific**	**North America**	**Latin America**
Asia-Pacific	6.4%	0.2%	2.8%	**43.2%**	44.2%	3.2%
North America	7.0%	0.7%	2.6%	6.6%	**80.5%**	2.6%
Western Europe	**52.8%**	2.6%	4.3%	5.9%	27.8%	6.7%

Another implication is that the case study has shown the provision of environmental C&E services to rely intensively on skilled labour earning relatively high salaries. Not only does this imply that many OECD countries potentially have a comparative advantage in environmental C&E services, but it also means that developing and emerging economies can gain through transfers of skills and the building of a domestic capacity for addressing environmental challenges. With most trade in environmental C&E services taking place through the establishment of a commercial presence locally (i.e. mode 3), opportunities abound for local partnerships, skill transfers, and job creations (USAID-APEC, 2011). Finally, the relatively high productivity and skill-intensity of most providers of environmental C&E services has implications for trade liberalisation. By favouring larger, more productive firms, trade liberalisation in environmentally related services — and business services more generally — could further increase the demand for skills and generate aggregate productivity gains in liberalising economies (Breinlich and Criscuolo, 2011).

Figure 7. Restrictions placed on trade in engineering services are associated with a lower propensity of firms to export environmental C&E services

Binned scatterplot of the STRI for engineering services and export intensity



Note: Export intensity is the share of a firm's revenue that is generated by its foreign affiliates. Values for both variables were averaged over 16 bins.

Conclusion: Three policy priorities for the trade and environment agenda

Accelerating efforts to liberalise trade in services related to the environment

By giving firms access to cheaper equipment and technologies for preventing or mitigating environmental damage, international trade can contribute to lowering the costs of environmental policies while keeping intact their degree of ambition. Numerous services are essential to the uptake and diffusion of cleaner technologies, adding to the purchase of environmental equipment other costs for customising, installing, and keeping that equipment functioning in a predictable and optimal manner. Wind turbines require, for example, that they be frequently monitored and their performance tailored to changing weather conditions. It is in that sense important that further efforts be made to liberalise trade in those services that feed into environmental projects, complementing ongoing efforts to liberalise trade in environmental goods, but also current initiatives for mitigating pollution in all its forms.

Policy obstacles to trade in environmental goods and services not only impede imports of cleaner technologies: they also harm exports. There is mounting evidence that trade barriers undermine the competitiveness of firms participating in global value chains, and the environmental industry is no exception (OECD, 2016). Further liberalisation of trade in environmentally related services could thus benefit both importers and exporters, enabling companies to procure the services inputs they need at competitive prices and to operate on a larger scale. The analysis in this report has shown firms exporting environmental consulting and engineering services to be larger, more productive, and to pay higher salaries than their domestically focussed counterparts. Efforts to remove remaining obstacles to trade in environmentally related services could therefore have important implications for sector-wide productivity, skills, and earnings.

Although most of this report emphasises mode 3 trade in environmentally related services (trade in services through the establishment of a commercial presence abroad), liberalisation efforts should also address services traded through other modes of supply. Mode 4 (the temporary movement of personnel abroad) holds in particular great potential for allowing small- and medium-sized companies to fully participate in the global environmental industry. This is notably important for those developing and emerging economies that concentrate a relatively large number of small-scale services providers. More generally, firms often provide services to their clients using more than one mode of supply, which underscores the value of addressing cross-border trade, investment, and the movement of people in a co-ordinated fashion. Technological advances are also making it possible to supply remotely services that used to require proximity between the supplier and the consumer. This could at times necessitate that countries reconsider earlier commitments that are "unbound" under mode 1 and 2.

Considering the decisive role played by environmentally related services

As commercial realities evolve, a need arises for trade negotiators to reconsider the scope of what ought to be liberalised under "environmental services" if the intention of countries is indeed to accelerate the uptake of cleaner technologies. The analysis in this report has shown that many services that are not necessarily classified as "environmental" end up playing decisive roles in environmental projects. This is, for example, the case of those services that are associated with the permitting, design, construction, maintenance, and decommissioning of environmental facilities, be they renewable-energy projects or wastewater-treatment plants. It is essential that negotiations consider how these services interrelate in order to make the most of trade liberalisation.

The complementary relationship between trade in environmental and in other related services implies that the value of commitments made by countries under environmental services is function of the commitments they made under other related services. One way to approach this problem — without there being a need to modify existing classifications — is to define a cluster of environmentally related services organised around a "core" of environmental services strictly speaking. Regardless of whether environmental services are liberalised in the context of a sector-specific agreement (e.g. an extension of the EGA to services) or of a horizontal services agreement (e.g. a plurilateral agreement on trade in services), there would be benefits in making the relationship between environmental and other related

services more apparent, for example when assessing the value of the requests and offers countries table during negotiations. Viewing environmental and related services as a cluster does not mean, however, that other, not environmentally related services should not be liberalised.

Not only do good data allow for good analysis, but they also enable more informed decisions

Lack of knowledge on the scope, magnitude, and direction of trade in environmental and related services should remain a cause for concern. Policy makers need more than ever supporting evidence that helps uncover the benefits of trade. Although substantial improvements have been made to quantify restrictions to trade in services (in large part owing to the STRI), the data remain very poor for measuring services trade itself. This issue is particularly acute for the environmental industry, constraining the ability of the OECD and others to conduct empirical analysis of the sector and informing trade negotiations. There is in particular a need for more information at the firm-level so as to better account for the broader set of services that feed into environmental projects.

By enabling more quantitative analysis, better data would help shed light on the significance of the environmental industry for economic growth, productivity, and jobs. The analysis undertaken in this report provides in that regard a foretaste of what could be achieved with better data. The case study in section 3 sketches a portrait of firms providing environmental consulting and engineering services at home and abroad, which identifies a number of characteristics that these companies share. It is, for instance, noteworthy that those firms rely intensively on skilled employees that earn relatively high salaries.

More data would, nevertheless, be needed to obtain a comprehensive picture of trade in environmental and related services, and governments therefore need to invest in the collection of information on firms that provide these services. A number of national and international institutions are already engaged in the collection of data relating to environmental goods and services. At the European level, Eurostat has, for example, spearheaded efforts to collect information on the EGS sector, and steps were recently taken to go further (Eurostat, 2015).[35] This EU-wide initiative may in the future provide a ready source of data covering a large number of OECD member countries. Steps would still need to be taken, however, to obtain information covering non-European countries and ensure geographical and economic representativeness.

35 In an attempt to further enhance the availability of data on the EGS sector, the European Parliament and the Council recently took steps to improve reporting by Member States in the context of Regulation 538/2014 (dated 16 April 2014) on “European environmental economic accounts”.

References

Anderson, J. and E. van Wincoop (2003), "Gravity with gravitas: A solution to the border puzzle", *American Economic Review*, Vol. 93, No. 1, pp. 170-92.

APEC (2012), ANNEX C – APEC List of Environmental Goods, 2012 Leaders' Declaration, Asia-Pacific Economic Cooperation, 8-9 September 2012, Vladivostok.

Botta, E. and T. Koźluk (2014), "Measuring environmental policy stringency in OECD Countries: A composite index approach", *OECD Economics Department Working Papers*, No. 1177, OECD Publishing, Paris. http://dx.doi.org/10.1787/5jxrjnc45gvg-en

Breinlich, H. and C. Criscuolo (2011), "International trade in services: A portrait of importers and exporters", *Journal of International Economics*, Vol. 84, No. 2, pp. 188–206.

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2001), Der Wasssersektor in Deutschland – Methoden und Erfahrungen (The water sector in Germany – Methods and experiences), Umweltbundesamt, Selm.

Chen, N. and D. Novy (2011), "Gravity, trade integration, and heterogeneity across industries", *Journal of International Economics*, Vol. 85, No. 2, pp. 206-221.

De Melo, J. and M. Vijil (2014), "Barriers to trade in environmental goods and environmental services: How important are they? How much progress at reducing them?", *Centre for Economic Policy Research Discussion Papers*, No. 9869, March 2014, London.

ENR (2016), *The Top 200 Environmental Firms*, Engineering News-Record, August 2016.

Eurostat (2008), NACE Rev.2: Statistical Classification of Economic Activities in the European Community, *Eurostat Methodologies and Working paper*, European Commission, Luxembourg.

Eurostat (2015), A Practical Guide towards Compiling EGSS Statistics, Working Group Environmental Expenditure Statistics, European Commission, Brussels.

Jha, V. (2008), "Environmental priorities and trade policy for environmental goods: A reality check", ICTSD Trade and Environment Series, *Issue Paper* No. 7, International Centre for Trade and Sustainable Development, Geneva.

Koźluk, T. (2014), "The indicators of the economic burdens of environmental policy design: Results from the OECD Questionnaire", *OECD Economics Department Working Papers*, No. 1178, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5jxrjnbnbm8v-en

Lanz, R. and A. Maurer (2015), "Services and Global Value Chains — Some evidence on Servicification of Manufacturing and Services Networks", WTO Working Papers, No. ERSD-2015-03, Economic Research and Statistics Division, World Trade Organization, Geneva.

McKinsey & Company (2010), Impact of the financial crisis on carbon economics: Version 2.1 of the Global Greenhouse Gas Abatement Cost Curve.

Melitz, M. (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", *Econometrica*, Vol. 71, No. 6, pp. 1695-1725.

Miroudot, S. and K. Pertel (2015), "Water in the GATS: Methodology and Results", *OECD Trade Policy Papers*, No. 185, OECD Publishing, Paris. http://dx.doi.org/10.1787/5jrs6k35nnf1-en.

Miroudot, S., J. Sauvage and B. Shepherd (2013), "Measuring the cost of international trade in services", *World Trade Review*, Vol. 12, No. 4, pp. 719-735.

Miroudot, S., J. Sauvage and M. Sudreau (2010), "Multilateralising regionalism: How preferential are services commitments in regional trade agreements?", *OECD Trade Policy Papers*, No. 106, OECD Publishing, Paris. DOI: http://dx.doi.org/10.1787/5km362n24t8n-en

Monkelbaan, Joachim (2013), Trade in Sustainable Energy Services, International Centre for Trade and Sustainable Development (ICTSD), Geneva.

National Board of Trade (2014), *Making Green Trade Happen – Environmental Goods and Indispensable Services*, September 2014, Stockholm.

Nielson, J., C. Pellegrino, R. Morris and R. Thompson (2001), "Using 'Cluster' Approaches to Specific Commitments for Interdependent Services", in OECD (2001), *Trade in Services: Negotiating Issues and Approaches*, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264194960-en

Nordås, H. K. (2010), "Trade in goods and services: Two sides of the same coin?", *Economic Modelling*, Vol. 27, No. 2, pp. 496-506.

Nordås, H. K. and Y. Kim (2013), "The Role of Services for Competitiveness in Manufacturing", *OECD Trade Policy Papers*, No. 148, OECD Publishing, Paris. http://dx.doi.org/10.1787/5k484xb7cx6b-en

Nordås, H. K. and D. Rouzet (2015), "The impact of services trade restrictiveness on trade flows: First estimates", *OECD Trade Policy Papers*, No. 178, OECD Publishing, Paris.: http://dx.doi.org/10.1787/5js6ds9b6kjb-en

OECD (2016), Global Value Chains for Environmental Goods and Services: An Interim Report, 20 May 2016, [COM/TAD/ENV/JWPTE(2016)5].

OECD (1972), Guiding Principles Concerning International Economic Aspects of Environmental Policies, Recommendation adopted on 26 May 1972, C(72)128.

OECD (n.d.), *Green Growth Indicators*, OECD.Stat Web Browser, accessed 7 December 2015.

OECD-Eurostat (1999), *The Environmental Goods and Services Industry: Manual for Data Collection and Analysis*, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264173651-en

Pasurka, C. (2012), "Perspectives on Pollution Abatement and Competitiveness: Theory, Data, and Analyses", chapter 4 in R. N. Stavins (ed.), *Economics of the Environment: Selected Readings*, Sixth edition, W.W. Norton & Company, New York.

Rouzet, D. and F. Spinelli (2016), "Services Trade Restrictiveness, Mark-Ups and Competition", *OECD Trade Policy Papers*, No. 194, OECD Publishing, Paris. http://dx.doi.org/10.1787/5jln7dlm3931-en

Santos Silva, J.M.C. and S. Tenreyro (2006), "The Log of Gravity", *The Review of Economics and Statistics*, Vol. 88, No. 4, pp. 641-658.

Sauvage, J. (2014), "The stringency of environmental regulations and trade in environmental goods", OECD *Trade and Environment Working Papers*, No. 2014/03, OECD Publishing, Paris. http://dx.doi.org/10.1787/5jxrjn7xsnmq-en

Steenblik, R. (2005), "Liberalising trade in 'environmental goods': Some practical considerations", *OECD Trade and Environment Working Papers*, No. 2005/05, OECD Publishing, Paris. http://dx.doi.org/10.1787/888676434604

Steenblik, R. and M. Geloso Grosso (2011), "Trade in services related to climate change: An exploratory analysis", *OECD Trade and Environment Working Papers*, No. 2011/03, OECD Publishing, Paris. http://dx.doi.org/10.1787/5kgc5wtd9rzw-en

Swedish Federation of Consulting Engineers and Architects (2013), *The Consulting Engineering and Architectural Groups: A Swedish and International survey*, Sector Review, December 2013, Stockholm.

Temouri, Y., A. Vogel and J. Wagner (2013), "Self-selection into export markets by business services firms – Evidence from France, Germany and the United Kingdom", *Structural Change and Economic Dynamics*, Vol. 25, pp. 146-158.

Tetra Tech (2016), *Annual Report 2015*, Pasadena, California.

United Nations (2008), International Standard Industrial Classification of All Economic Activities – Revision 4, *Statistical Papers Series M*, No. 4, Rev. 4, United Nations Publication, New York.

United Nations, International Monetary Fund, Organisation for Economic Co-operation and Development, Statistical Office of the European Union, United Nations Conference on Trade and Development, World Tourism Organization and World Trade Organization (2012), Manual on Statistics of International Trade in Services 2010 (MSITS 2010), United Nations Publications, New York.

United Nations (2015a), *Global Inventory of Statistical Standards*, http://unstats.un.org/unsd/iiss/Central-Product-Classification-CPC.ashx.

United Nations (2015b), International Trade Statistics Knowledgebase, http://unstats.un.org/unsd/tradekb/Knowledgebase/Sectoral-Classification-List-W120.

US Census Bureau (2008), *Pollution Abatement Costs and Expenditures: 2005*, MA200(05), US Government Printing Office, Washington D.C.

USITC (2013a), *Renewable Energy and Related Services: Recent Developments*, *Investigation* No. 332-534, USITC Publication 4421, August 2013, United States International Trade Commission, Washington D.C.

USITC (2013b), *Environmental and Related Services*, *Investigation* No. 332-533, USITC Publication 4389, March 2013, United States International Trade Commission, Washington D.C.

USTR (2016), *2016 National Trade Estimate Report on Foreign Trade Barriers*, Office of the United States Trade Representative, Washington D.C.

Wagner, J. (2012), "International trade and firm performance: A survey of empirical studies since 2006", *Review of World Economics*, Vol. 148, No. 2, pp. 235-267.

Wagner, J. (2014), "Exports, foreign direct investments and productivity: Are services firms different?", *The Services Industries Journal*, Vol. 34, No. 1, pp. 24-37.

World Energy Council (2016), *World Energy Perspective* – Non-tariff measures: next steps for catalysing the low-carbon economy, Rules of trade and investment 2016, London.

WTO (1998), "Environmental Services: Background Note by the Secretariat", S/C/W/46, 6 July 1998, World Trade Organization, Geneva.

WTO (2000), "GATS 2000: Environmental Services", Communication from the European Communities and their Member States, S/CSS/W/38, 22 December 2000, World Trade Organization, Geneva.

WTO (2007), "Review of Progress in Energy Services", Communication from the European Communities, JOB(07)/208, December 2007, World Trade Organization, Geneva.

Technical appendix

This technical appendix provides background and additional detail on the empirical analyses that were conducted to inform and support the main report. Section 1 discusses the first such analysis, which investigates the correlation between the OECD's STRI and the sales of core environmental services by foreign affiliates operating in Europe. Section 2 describes the data that were collected for the case study of mode 3 trade in environmental consulting and engineering (C&E) services (Section 3 of the main report), and then looks at the various factors that affect the export performance of the firms covered by the sample.

Restrictions to trade in environmentally related services and the supply of core environmental services

Background: Measuring barriers to trade in environmental services

Quantifying barriers to services trade, and even more so barriers to trade in environmental services, has generally proven a difficult task for at least two reasons. First is the need to consistently identify for several countries specific, trade-inhibiting restrictions that apply in particular sectors—something which requires a thorough understanding of countries' own laws and regulations. Second is the necessity to then translate the information thus collected into some quantitative indicator that can later be used in statistical analysis.

To circumvent these difficulties, some studies have sought to infer trade costs by comparing actual trade flows to a hypothetical zero-cost benchmark. One common approach has been to solve a gravity-type model of trade so that trade costs between two countries are expressed as a function of observable variables like countries' gross output and bilateral exports (Chen and Novy, 2011). Although it was initially developed for goods trade, the approach was successfully applied to cross-border services trade as measured through the balance of payments—that is, to mode 1 and mode 2 trade in services for the most part (Miroudot et al., 2013). Applying this approach to trade in environmental services requires, however, that sufficiently disaggregated data be available on gross output and bilateral exports in the environmental-services industry. As explained in the main body of the report, data on the environmental-services industry are, where existing, generally poor. Even if such data were widely available, the approach would not be suitable for estimating costs to mode 3 trade in services, which the report has shown to be essential to trade in environmental services.

Given the lack of ready-made options, other studies have attempted to proxy restrictions to services trade using other related indicators. A recent investigation by the USITC (2013b) did so using the OECD's indicators of non-manufacturing sectoral regulations (NMR) as a proxy for restrictions affecting services trade. While not available specifically for the environmental industry, the NMR indicator provides a measure of openness to competition in a number of sectors, including environmentally relevant ones like architecture, engineering, and electricity supply. Using a composite value of the NMR index for different sectors, together with a standard gravity model of trade, the USITC concluded in its study that restrictions to ancillary services had had a statistically negative impact on mode 3 trade in environmental services, as measured using the sales of foreign affiliates operating in the core environmental sector. While the NMR index only provides a rough approximation of actual restrictions to services trade, the USITC study represents, nonetheless, a rare contribution as it assesses empirically the extent to which certain regulations impede trade in environmental services.

The release in 2014 of the OECD's Services Trade Restrictiveness Index (STRI) has since improved the measurement of restrictions to services trade, which should allow for more robust empirical analyses of trade in services.[36] Underlying the STRI is a comprehensive database of more than 10 000 laws and regulations affecting trade in 22 services sectors and 44 countries over the period 2013-16. The index covers the five relevant forms of trade barriers described in the main body of the report, namely restrictions on foreign entry, restrictions to the movement of people, other discriminatory measures, barriers to competition, and regulatory transparency. None of these measures apply specifically to core environmental services though, as data collection has yet to cover the sector. The index is, nevertheless, available for a number of services potentially relevant to environmental projects, such as engineering, construction, and architecture.

Approach and limitations

In what follows, the analysis seeks to estimate correlations between restrictions to trade in various services and the sales of foreign affiliates operating in Europe's core environmental-services sector—corresponding to NACE Rev. 2 Section E, "Water supply, sewerage, waste management and remediation activities". By comparing the coefficients thus obtained for a range of different services, the results should help identify which of those services (and corresponding restrictions) seem most relevant for the provision of core environmental activities. In doing so, the analysis aims to provide empirical support to the question of the scope of environmentally related services, thereby allowing policy makers to focus their efforts on those restrictions that are most binding on environmental projects. Absent an STRI indicator for the core environmental industry, this report focusses on restrictions to other sectors that are thought to potentially have some impact on trade in environmental services, namely: architecture, engineering, construction, computer and related services, accounting, and legal services.

As in USITC (2013b) and Nordås and Rouzet (2015), the econometric analysis in this report uses a standard gravity model of trade, which relates trade flows between pairs of countries to each country's economic mass (typically measured using GDP or total population) and bilateral trade costs. In the absence of a true measure of bilateral trade costs, this report relies on a set of proxy variables that are thought to adequately reflect trade costs and that the trade literature has generally found to be helpful in explaining trade patterns. Those proxy variables are: the geographical distance separating two trade partners; whether or not they share a common language; whether or not they share a border (contiguity); and whether or not both countries are members of the European Single Market (Switzerland and EEA member countries, which include EU Member States). The model also includes a variable for the STRI indicator, which takes on different values depending on the sector considered in the regression.

The trade literature (e.g. Anderson and van Wincoop, 2003) has stressed the importance for gravity models to include so-called "multilateral resistance terms" (MRTs). MRTs are meant to reflect the fact that trade costs between two trading partners depend not only on bilateral frictions, but also on each partner's "resistance" or frictions against the rest of the world. There are different ways in which one can account for MRTs in gravity models, the most common one being the use of country fixed-effects (i.e. country dummy variables). Because the STRI is a time-invariant[37] and country-specific indicator, country fixed-effects cannot, however, be employed here since they would absorb all potential correlation that might otherwise exist between the STRI and trade flows. The omission of MRTs imposes severe limitations on the econometric analysis carried out in the present study, and alternative specifications are therefore tried to verify the robustness of the results. As in Nordås and Rouzet (2015), one such specification involves using importer-year (exporter-year) fixed-effects while including only the STRI indicator for the exporting country (importing country).

36 See Nordås and Rouzet (2015) for early examples of empirical analysis of services trade using the STRI and a gravity model of trade. More recently, OECD (2016) analyses the correlation between the STRI and price-cost margins in a number of services sectors.

37 As of September 2016, the STRI was only available for 2014 and 2015, with very little changes observed over these two years.

The data collected on the sales of foreign affiliates operating in Europe's core environmental-services sector display an unusually high number of zero trade flows. Of the 6 948 observations the dataset contains, 1 893 are missing, in part due to concerns over commercial confidentiality. Of those 5 055 observations that are non-missing, only 409 (8%) are above zero. This suggests that many pairs of countries do not trade core environmental services at all in any given year, at least as far as mode 3 is concerned. It is, however, impossible to assert whether the zeroes in the dataset are genuine — reflecting an actual lack of trade — or whether they reflect poor reporting by countries, e.g. because countries lack the administrative capacity to collect and report the data accurately. In the absence of more information, the analysis in this report assumes the zeroes to be genuine while excluding missing data points.

The high propensity of zero trade flows in the dataset has a number of consequences for the analysis. One is the necessity to reject standard approaches that use ordinary least squares to estimate a log-linear form of the gravity equation, as this would require dropping all zero observations from the dataset. One common remedy in such cases is for the estimation to rely instead on a Poisson-Pseudo-Maximum Likelihood (PPML) estimator. Not only do PPML estimators allow the analysis to retain zero trade flows, but they also have the added benefit of being consistent even in the presence of heteroskedasticity (Santos Silva and Tenreyro, 2006). The baseline model used in the present analysis therefore takes the form:

$$exports_{ijt} = exp\big(\beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln dist_{ij} + \beta_4 lang_{ij} + \beta_5 contig_{ij} + \beta_6 SM_{ijt} + \beta_7 \ln STRI_i + \beta_8 \ln STRI_j + \gamma\delta_t\big) + \varepsilon_{ijt}$$

where subscript i denotes the exporting country, subscript j denotes the importing country, and subscript t denotes years. In addition to the GDP terms for each of the two trading partners, the right-hand side of the equation comprises a set of proxy variables reflecting bilateral trade costs. As explained above, these variables concern geographical distance ($dist_{ij}$), common languages ($lang_{ij}$), geographical contiguity ($contig_{ij}$), and membership in the Single European Market (SM_{ijt}). The STRI indicator then enters the equation either once for each trading partner ($STRIi$ and $STRIj$) or as a bilateral average of the STRI values for the two trading partners ($STRI_{ij}$). The model also controls for unobserved time-varying factors (e.g. the global recession or yearly changes in commodity prices) through a set of T-1 year fixed-effects (δt).

Data sources and variable description

Exports of core environmental services

To assess the statistical relationship between mode 3 exports of core environmental services and restrictions to trade in other services, the model uses as a dependent variable data obtained from Eurostat on the inward activities of foreign affiliates[38], i.e. inward foreign affiliates' trade statistics (inward FATS in short). The inward FATS considered here correspond to the annual turnover of foreign-controlled enterprises that are resident in the country compiling the statistics and that operate in Section E of the NACE Rev. 2 classification, i.e. "Water supply, sewerage, waste management and remediation activities". The data thus obtained cover 30 host (destination) countries and 43 home (origin) countries over the period 2008-13. While the former group only comprises EEA, EFTA, or EU-accession countries, the latter group includes a broader set of countries, such as: Australia, Canada, China, Japan, New Zealand, the Russian Federation, Turkey, and the United States. The sample remains, nevertheless, heavily biased toward European countries.

38 According to the Eurostat website (accessed 27 October 2016): "Inward FATS describe the overall activity of foreign affiliates resident in the compiling economy. A foreign affiliate within the terms of inward FATS is an enterprise resident in the compiling country over which an institutional unit not resident in the compiling country has control. In simpler terms, inward FATS describe how many jobs, how much turnover, etc. are generated by foreign investors in a given European host economy."

Control variables

Data on GDP are expressed in current USD billion and were obtained from the OECD's statistics portal (OECD.Stat) or from the World Bank's World Development Indicators (WDI) database. Geographical indicators (distance, language, and contiguity) were obtained from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

Restrictions on services trade

Values for the STRI indicators were obtained from the OECD's statistics portal for the following sectors: architecture, engineering, construction, computer and related services, accounting, and legal services. The STRI is, however, only available for OECD member countries and the following economies: Brazil, China, Colombia, Costa Rica, India, Indonesia, Lithuania, the Russian Federation, and South Africa.

Table 6. Summary statistics

Variable	Unit	Obs.	Mean	Std. Dev.	Min	Max
International revenue	current USD million	249	1359.802	3148.368	0.000	20555.700
Employment	number of employees	207	11602	14032	53	92000
Labour productivity	current USD million	193	0.191	0.109	0.060	0.717
Tangible fixed assets per employee	current USD million	165	0.070	0.300	0.001	2.139
Working capital over total turnover	current USD million	122	0.157	0.112	-0.067	0.554
GDP	constant 2010 USD million	305	8735196	7090451	246885	16600000
Economic growth	percentage points	305	1.939	1.018	-2.620	5.990
STRI (engineering)	0-1 scale	300	0.158	0.040	0.083	0.288
STRI (computer and related services)	0-1 scale	300	0.154	0.024	0.109	0.228
STRI (construction)	0-1 scale	300	0.207	0.064	0.071	0.258
STRI (architecture)	0-1 scale	300	0.155	0.034	0.087	0.262

Detailed results and caveats

Detailed results are shown in Table 7 to 12 below and confirm the presumption that restrictions to services trade tend to be negatively correlated with the sales of foreign affiliates operating in Europe's core environmental-services sector. The estimates reveal, however, a stark contrast between the different sectors, with estimated coefficients being only statistically significant for restrictions concerning engineering services, computer and related services, architecture services, and, to a lesser extent, construction services. Although the estimated coefficients for restrictions on accounting and legal services have a positive sign, standard errors indicate that they are not statistically different from zero. In the case of construction services, the estimated coefficients have the expected sign — that is, a negative one — but are not always statistically different from zero[39] either.

Caution should nevertheless be exercised when interpreting the results across different sectors since corresponding values for the STRI indicators can be strongly correlated with one another. That is particularly the case for engineering services and architecture services, but also for construction services and computer and related services, for which pairwise Pearson correlations exhibit values above 0.7. Such a high degree of correlation places limits on how far one can go in attributing the variation in estimated coefficients to sector-specific factors. That being said, companies offering environmentally related services (e.g. environmental consulting and engineering services) to the core environmental industry generally offer these services in conjunction as an integrated package[40], which can make the distinction between services like engineering and architecture less important.

Another interesting finding is the stronger correlation often observed between inward FATS and restrictions to services trade applied in the origin (i.e. home) country, as opposed to restrictions applied in the destination (i.e. host) country. Although these findings might seem surprising, earlier estimates of the effects that the STRI has on services trade have also identified at times stronger negative impacts on exporters than on importers (Nordås and Rouzet, 2015). A plausible explanation for this result could be that restrictions to services trade at home make domestic firms less competitive than their foreign counterparts, in particular where those restrictions take the form of anti-competitive regulations hindering the entry of new competitors, or where regulatory burdens raise the operating costs of firms operating in the exporting country (Rouzet and Spinelli, 2016). In the present context, services restrictions at home may increase the cost of services used as inputs in the environmental industry, thereby causing domestic providers of environmental services to be at a disadvantage relative to foreign competitors.

The results seem to hold irrespective of the model specification used, confirming in general the more pronounced correlation observed for restrictions applied in the home (origin) country. Model 1 (Table 7) includes restrictions applied in the home country and in the host country as two distinct variables. The model is then run once for every service sector to which the restrictions apply. Model 2 (Table 8) deviates from Model 1 in that the STRI enters the equation as a bilateral variable. This is done by calculating the geometric average of the values that the indicator takes for the home country and the host country.[41] Meanwhile, Model 3 (Table 9) combines restrictions to services trade applied in the home (origin) country with a set of importer-year fixed effects. Together with a symmetrical model (Model 4 in Table 10) that combines restrictions to services trade applied in the host (destination) country with a set of exporter-year fixed effects, the results support once again earlier findings concerning both the differential effects by sector, and those by home- or host-country status. In particular, the regressions including only restrictions to services trade applied in the host (destination)

39 The *z* statistics fail to reject the null hypothesis (H0) that the coefficients are equal to zero at conventional confidence levels.

40 See, for example, the case study in Section 3 of the present report, where most firms in the sample happen to offer services spanning architecture, consulting, design, and engineering.

41 As in Nordås and Rouzet (2015), this average is weighted by each partner's share in the joint GDP of the two countries.

country show no significant correlation with inward FATS, except for restrictions on construction services.[42]

Although the results would suggest a strong and economically meaningful relationship between restrictions to trade in certain services and the turnover of foreign affiliates in the core environmental-services sector, lack of time variation in the STRI indicator and the relatively narrow coverage of the data sample warrant particular caution when interpreting the estimated coefficients. In particular, data-availability concerns make it difficult for the analysis to fully control for multilateral resistance as explained above. As a robustness check, the analysis therefore uses an alternative version of Model 2 that drops the GDP variables but includes both importer-year and exporter-year fixed effects (Table 11). Taken together, these two sets of fixed effects should allow controlling for any effect that multilateral resistance may have on the results. This addition necessitates, however, that several observations be dropped to allow the PPML estimator to converge, which reduces the precision of the estimated coefficients and generates its own set of problems. These caveats notwithstanding, the estimation indicates a negative and statistically significant correlation between restrictions to trade in engineering, construction, and computer and related services on the hand, and inward FATS on the other hand.

The STRI adds together many individual trade restrictions, some of which only impede the volume of services trade at the (intensive) margin while others deter foreign entry into the destination country (the extensive margin). In cases where many restrictions in a sector fall into the latter category, the probability of foreign affiliates entering the market therefore decreases or approaches zero. One way to account for this possibility is to use discrete-choice models, such as probit and logit estimation techniques. These models are applicable when trying to explain a discrete choice, i.e. whether entry into a market occurs or not. As an additional robustness check, the analysis thus uses a binary dependent variable in lieu of inward FATS; this variable takes the value of one if inward FATS are strictly positive and zero otherwise. A logit-equivalent of Model 1 is then estimated using the same independent variables as before (Table 12). The results are once again similar from a qualitative standpoint.

42 The inclusion of importer-year or exporter-year fixed effects comes at the cost of dropping observations to allow the PPML estimator to converge.

Table 7. Model 1: Two-way STRI and inward FATS, PPML estimator

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variables	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**
Host-country GDP (log)	0.583***	0.604***	0.549***	0.619***	0.578***	0.599***
	(3.52)	(3.63)	(3.37)	(3.84)	(3.23)	(3.82)
Home-country GDP (log)	1.040***	0.967***	0.946***	1.010***	1.062***	1.040***
	(5.88)	(6.20)	(5.92)	(5.85)	(5.40)	(5.11)
Geographical distance	-0.606***	-0.582**	-0.465**	-0.590***	-0.599**	-0.581**
	(-2.66)	(-2.51)	(-1.99)	(-2.68)	(-2.50)	(-2.33)
Common language	0.408	0.551	0.619	0.419	0.447	0.491
	(0.85)	(1.07)	(1.18)	(0.84)	(0.89)	(1.04)
Contiguity	0.913*	0.778	0.883*	0.871*	0.909*	0.850
	(1.91)	(1.42)	(1.69)	(1.81)	(1.92)	(1.50)
Single European Market	1.431**	1.351**	1.354**	1.569**	1.477**	1.525**
	(2.25)	(2.00)	(2.23)	(2.35)	(2.54)	(2.38)
Home-country STRI engineering (log)	-0.830**					
	(-2.05)					
Host-country STRI engineering (log)	0.230					
	(0.88)					
Home-country STRI computer (log)		-1.409**				
		(-2.15)				
Host-country STRI computer (log)		-0.0344				
		(-0.07)				
Home-country STRI construction (log)			-0.589			
			(-1.07)			
Host-country STRI construction (log)			-0.397			
			(-0.80)			
Home-country STRI architecture (log)				-0.866**		
				(-2.33)		
Host-country STRI architecture (log)				0.315		
				(0.94)		
Home-country STRI accounting (log)					0.466	
					(0.76)	
Host-country STRI accounting (log)					0.0420	
					(0.12)	
Home-country STRI legal (log)						0.130
						(0.27)
Host-country STRI legal (log)						0.0812
						(0.31)
Constant	-5.848**	-7.071**	-6.734**	-5.970**	-4.391	-4.935*
	(-1.99)	(-2.15)	(-2.08)	(-2.02)	(-1.28)	(-1.75)
Observations	3283	3283	3283	3283	3283	3283
R-squared	0.275	0.274	0.227	0.253	0.231	0.215
Fixed effects	Year	Year	Year	Year	Year	Year
Standard errors	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

Table 8. Model 2: Bilateral STRI and inward FATS, PPML estimator

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variables	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**
Host-country GDP (log)	0.528***	0.505***	0.539***	0.562***	0.566***	0.599***
	(2.89)	(2.79)	(2.87)	(3.27)	(3.13)	(3.93)
Home-country GDP (log)	1.023***	0.978***	0.971***	1.008***	1.064***	1.043***
	(5.66)	(5.87)	(5.64)	(5.68)	(5.73)	(5.51)
Geographical distance	-0.450**	-0.498**	-0.506**	-0.476**	-0.585**	-0.565**
	(-2.02)	(-2.16)	(-2.25)	(-2.11)	(-2.54)	(-2.46)
Common language	0.408	0.443	0.485	0.472	0.505	0.504
	(0.82)	(0.89)	(0.95)	(0.98)	(1.03)	(1.05)
Contiguity	1.090**	0.923*	0.871*	1.006**	0.906*	0.839
	(2.26)	(1.79)	(1.66)	(2.04)	(1.85)	(1.50)
Single European Market	1.623**	1.450**	1.259**	1.790**	1.449**	1.558**
	(2.31)	(2.03)	(2.11)	(2.25)	(2.47)	(2.32)
Bilateral STRI engineering (log)	-1.115**					
	(-1.99)					
Bilateral STRI computer (log)		-1.882**				
		(-2.14)				
Bilateral STRI construction (log)			-0.878			
			(-1.12)			
Bilateral STRI architecture (log)				-1.398**		
				(-2.14)		
Bilateral STRI accounting (log)					0.738	
					(1.06)	
Bilateral STRI legal (log)						0.357
						(0.51)
Constant	-7.645**	-8.121**	-6.312**	-8.095**	-4.112	-4.894*
	(-2.35)	(-2.41)	(-2.15)	(-2.31)	(-1.32)	(-1.75)
Observations	3283	3283	3283	3283	3283	3283
R-squared	0.288	0.285	0.225	0.261	0.244	0.218
Fixed effects	Year	Year	Year	Year	Year	Year
Standard errors	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

Table 9. Model 3: Home-country STRI and inward FATS, PPML estimator

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variables	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**
Home-country GDP (log)	1.107***	1.045***	1.041***	1.084***	1.179***	1.174***
	(5.53)	(5.85)	(5.28)	(5.51)	(5.03)	(5.58)
Geographical distance	-0.514*	-0.667**	-0.659***	-0.599**	-0.704***	-0.769***
	(-1.82)	(-2.51)	(-2.60)	(-2.15)	(-3.07)	(-2.73)
Common language	0.741*	0.971**	1.028*	0.942*	0.871**	0.968**
	(1.66)	(1.96)	(1.84)	(1.69)	(1.99)	(1.98)
Contiguity	1.008***	0.783**	0.646	0.806**	0.808**	0.590
	(2.62)	(2.30)	(1.58)	(2.11)	(2.26)	(1.38)
Single European Market	1.754**	1.386	1.250	1.835*	1.611**	1.620**
	(1.97)	(1.60)	(1.45)	(1.92)	(2.11)	(2.00)
Home STRI engineering (log)	-0.874**					
	(-2.01)					
Home STRI computer (log)		-1.422**				
		(-2.33)				
Home STRI construction (log)			-0.698			
			(-1.01)			
Home STRI architecture (log)				-1.039**		
				(-1.98)		
Home STRI accounting (log)					0.523	
					(0.96)	
Home STRI legal (log)						0.300
						(0.51)
Constant	-5.615	-4.855	-3.593	-5.207	-2.531	-2.349
	(-1.43)	(-1.37)	(-1.14)	(-1.32)	(-0.95)	(-0.79)
Observations	2345	2345	2345	2345	2345	2345
R-squared	0.489	0.506	0.432	0.449	0.462	0.428
Fixed effects	Importer-year	Importer-year	Importer-year	Importer-year	Importer-year	Importer-year
Standard errors	Cluster by exporting country	Cluster by exporting country	Cluster by exporting country	Cluster by exporting country	Cluster by exporting country	Cluster by exporting country

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

Table 10. Model 4: Host-country STRI and inward FATS, PPML estimator

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variables	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**
Host-country GDP (log)	0.587***	0.566***	0.491***	0.580***	0.569***	0.596***
	(3.58)	(3.26)	(2.86)	(3.44)	(3.19)	(3.16)
Geographical distance	-1.231***	-1.128**	-1.004**	-1.171***	-1.130***	-1.158***
	(-2.98)	(-2.56)	(-2.49)	(-2.85)	(-2.65)	(-2.96)
Common language	0.203	0.230	0.342	0.177	0.232	0.260
	(0.52)	(0.53)	(0.90)	(0.42)	(0.57)	(0.62)
Contiguity	0.151	0.200	0.291	0.181	0.205	0.173
	(0.28)	(0.36)	(0.56)	(0.33)	(0.37)	(0.32)
Single European Market	-1.488	-1.272	-1.181	-1.353	-1.296	-1.329
	(-1.62)	(-1.24)	(-1.04)	(-1.39)	(-1.26)	(-0.79)
Host STRI engineering (log)	0.294					
	(1.14)					
Host STRI computer (log)		-0.0328				
		(-0.08)				
Host STRI construction (log)			-0.726*			
			(-1.79)			
Host STRI architecture (log)				0.197		
				(0.65)		
Host STRI accounting (log)					-0.0499	
					(-0.22)	
Host STRI legal (log)						0.227
						(1.10)
Constant	9.392**	8.042*	6.091	8.716*	8.033*	8.475**
	(2.06)	(1.65)	(1.51)	(1.94)	(1.67)	(2.03)
Observations	1236	1236	1236	1236	1236	1230
R-squared	0.383	0.388	0.410	0.386	0.386	0.393
Fixed effects	Exporter-year	Exporter-year	Exporter-year	Exporter-year	Exporter-year	Exporter-year
Standard errors	Cluster by importing country	Cluster by importing country	Cluster by importing country	Cluster by importing country	Cluster by importing country	Cluster by importing country

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

Table 11. Bilateral STRI and inward FATS, PPML estimator, with full sets of fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variables	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**	**Inward FATS (turnover)**
Geographical distance	-1.169***	-1.215***	-1.151***	-1.042***	-0.844***	-0.882***
	(-8.22)	(-7.93)	(-6.88)	(-7.18)	(-5.29)	(-5.45)
Common language	0.723***	0.478	0.636**	0.800***	0.937***	0.815***
	(2.72)	(1.52)	(2.10)	(2.70)	(3.99)	(2.88)
Contiguity	0.685***	0.734***	0.662***	0.663***	0.912***	0.805***
	(3.86)	(3.82)	(3.65)	(3.84)	(5.09)	(4.27)
Single European Market	4.026**	-0.898	-0.901	4.616**	5.194***	5.296***
	(2.13)	(-0.44)	(-0.43)	(2.48)	(2.81)	(2.82)
Bilateral STRI engineering (log)	-1.191**					
	(-2.08)					
Bilateral STRI computer (log)		-2.247***				
		(-2.85)				
Bilateral STRI construction (log)			-1.525**			
			(-2.14)			
Bilateral STRI architecture (log)				-0.397		
				(-0.54)		
Bilateral STRI accounting (log)					3.222***	
					(4.51)	
Bilateral STRI legal (log)						0.946**
						(2.12)
Constant	5.901***	9.411***	10.04***	6.216***	9.643***	6.788***
	(2.79)	(3.65)	(3.94)	(2.74)	(4.00)	(3.06)
Observations	677	675	675	677	677	680
R-squared	0.776	0.768	0.760	0.761	0.797	0.756
Fixed effects	Importer-year & Exporter-year	Importer-year & Exporter-year	Importer-year & Exporter-year	Importer-year & Exporter-year	Importer-year & Exporter-year	Importer-year & Exporter-year
Standard errors	Robust	Robust	Robust	Robust	Robust	Robust

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

Table 12. Two-way STRI and inward FATS, Logit estimator

	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variables	**Entry**	**Entry**	**Entry**	**Entry**	**Entry**	**Entry**
Host-country GDP (log)	0.849***	0.810***	0.756***	0.848***	0.787***	0.953***
	(5.47)	(5.51)	(5.30)	(5.52)	(5.20)	(5.96)
Home-country GDP (log)	1.893***	1.867***	1.839***	1.895***	1.848***	1.838***
	(8.15)	(8.30)	(8.33)	(8.05)	(8.19)	(7.91)
Geographical distance	-1.603***	-1.556***	-1.467***	-1.629***	-1.549***	-1.433***
	(-4.33)	(-4.03)	(-3.94)	(-4.52)	(-4.09)	(-3.85)
Common language	0.377	0.542	0.526	0.358	0.472	0.555
	(0.63)	(0.95)	(0.93)	(0.60)	(0.84)	(0.99)
Contiguity	1.970***	2.075***	2.010***	2.031***	1.813***	1.937***
	(3.27)	(3.26)	(3.19)	(3.49)	(3.29)	(3.39)
Single European Market	2.210***	2.155***	2.152***	2.312***	2.344***	2.503***
	(3.68)	(3.35)	(3.43)	(3.81)	(4.02)	(3.65)
Home-country STRI engineering (log)	-0.897**					
	(-2.46)					
Host-country STRI engineering (log)	0.559					
	(1.50)					
Home-country STRI computer (log)		-1.106**				
		(-2.25)				
Host-country STRI computer (log)		-0.794				
		(-1.32)				
Home-country STRI construction (log)			-0.468			
			(-1.18)			
Host-country STRI construction (log)			-0.908			
			(-1.60)			
Home-country STRI architecture (log)				-1.168***		
				(-2.95)		
Host-country STRI architecture (log)				0.454		
				(1.09)		
Home-country STRI accounting (log)					-0.323	
					(-0.72)	
Host-country STRI accounting (log)					0.215	
					(0.41)	
Home-country STRI legal (log)						-0.223
						(-0.65)
Host-country STRI legal (log)						0.892***
						(2.96)
Constant	-11.74***	-14.38***	-13.62***	-12.25***	-11.06***	-12.12***
	(-4.05)	(-4.26)	(-4.14)	(-4.36)	(-3.56)	(-4.15)
Observations	3283	3283	3283	3283	3283	3283
Pseudo R-squared	0.548	0.542	0.537	0.548	0.532	0.547
Fixed effects	Year	Year	Year	Year	Year	Year
Standard errors	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair	Clustered by country pair

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively. The dependent variable ("entry") is a binary indicator that takes the value of one if inward FATS are strictly positive and zero otherwise.

The determinants of firms' exports of environmental consulting and engineering services

Construction of the data sample

No consistent set of data currently exists for mode 3 trade in environmental consulting and engineering (C&E) services, nor is the sector well identified in existing services or industry classifications. The case study in this report has therefore necessitated the collection of information for individual firms that are known to provide such services internationally on a significant scale. The identification of individual firms for inclusion in the sample was based on industry rankings, and specifically those provided directly by California-based Environmental Business International Inc. (EBI), but also the listings of the top 200 environmental firms that ENR (2016) produces every year. To complement those rankings and achieve wider geographical coverage, firm identification also relied on: a ranking produced in 2013 by the Swedish Federation of Consulting Engineers and Architects (The European top 300 consulting engineering and architectural groups, which has a sub-category for environmentally related consulting and engineering); on Industry Canada's Canadian Company Capabilities online directory (for companies under NAICS code 54162, "Environmental Consulting Services"); and on the FactSet database (again, for companies under NAICS code 54162). Firms generating less than USD 10 million in annual turnover or employing less than 100 employees were generally excluded, except where the inclusion of such firms helped improve geographical coverage, and where detailed financial information on these firms was accessible through public records or through the Orbis database.

For each of the 61 firms identified, data were then collected through an online search of company websites, annual reports, and published financial statements (e.g. the form 10-K that companies listed in the United States submit to the Securities and Exchange Commission pursuant to the Securities Exchange Act of 1934). In a few cases, the data were also collected or complemented using the Orbis database. The financial information thus obtained was then merged with information provided by EBI on the breakdown of firm revenue by broad geographical region, which EBI itself collected through a firm survey.

The latest revision of the Manual on Statistics of International Trade in Services "chooses to view domestic sales [or] output of foreign affiliates as the primary statistical indicator of Mode 3" (United Nations et al., 2012). Data collection therefore centred on the revenues that firms generate at home and through their affiliates abroad. Where possible, information was also collected for a number of other firm-level characteristics and financial variables, including: the number of employees; total employee expenses (i.e. labour costs); the profit rate; earnings before interest, tax, depreciation, and amortisation (EBITDA); working capital; tangible assets (i.e. property, plant, and equipment); and the age of the firm. Data on intangible assets were, unfortunately, not consistently available across firms and countries, in particular since definitions may differ regarding the inclusion of goodwill.

The resulting dataset covers 61 firms from 12 countries over the period 2011-15, yielding a total of 305 data points or observations. In the interest of preserving commercial confidentiality, the list of firms included in the sample and corresponding data are not made public.

Approach and limitations

The analysis in this section seeks to assess the respective influence that firm- and country-level characteristics have on the exports of firms providing environmental C&E services through mode 3 — that is, through the establishment of a commercial presence abroad. Particular attention is paid at the country-level to the role that services trade restrictions may have on the propensity of firms to export. The small sample size (generally less than 200 observations depending on the set of variables considered) imposes severe constraints on what can be achieved by way of econometric analysis, however. This implies, for example, that only a small set of explanatory variables be considered, limiting the use of fixed effects to account for unobserved differences across countries and years. The short time period considered (2011-15) leaves also little room for exploiting yearly variations at the firm level. This particular problem is compounded by the fact that the STRI indices — which measure the

degree to which countries restrict trade in services — were only available for the years 2014 and 2015 at the time the analysis was undertaken.

Taken together, the above considerations orient the analysis toward the use of two different models. One uses panel regressions in combination with country and year fixed effects to try controlling for unobserved country or time characteristics that might affect exports independently of the variables measured here. This requires that the STRI indices be interacted with a variable varying across firms and years to prevent the country fixed effects from capturing the information contained in the STRI indices. The other model relies on simple cross-section regressions for the years 2014 and 2015, which allow for the direct inclusion of the STRI indices but do not permit the use of fixed effects. Both models thus provide different kinds of information and should together allow some conclusions to be made on the respective importance that the different variables considered have on firm-level exports.

The literature on firm characteristics and export performance has identified the size of firms and their productivity to be among the most important determinants of export status (see, for example, Wagner, 2012). Recent contributions looking at services firms specifically have since confirmed this finding (e.g. Breinlich and Criscuolo, 2011; Temouri et al., 2013; and Wagner, 2014). As in Breinlich and Criscuolo (2011), the basic specification in this section therefore includes employment as an indicator of firm size together with labour productivity. Apart from the STRI indices (country-level), other control variables of interest include: tangible fixed assets per employee (firm-level); working capital as a share of total turnover (firm-level); countries' real GDP (country-level); and countries' rate of economic growth (country-level).

Although they are less prevalent in this analysis than in the previous one using FATS data, zero trade flows still account for about 27% of all observations. Zero values of exports do convey useful information in the present context, particularly since they tend to concern smaller firms that are not (yet) able to supply their services abroad through mode 3. It is therefore important that they be retained in the analysis. All the regressions that follow therefore use a Poisson estimator as in the earlier gravity equations using FATS data. Standard errors in the panel regressions are clustered at the firm-level while cross-sections use robust standard errors. The basic model for panel regressions therefore takes the form:

$$exports_{ikt} = exp(\beta_0 + \beta_1 \ln employment_{ikt} + \beta_2 \ln lab\ prod_{ikt} + \beta_3(\ln employment_{ikt} + \ln STRI_k) + \Phi X_{ikt} + \Lambda Y_{kt} + \rho\theta_k + \gamma\delta_t) + \varepsilon_{ikt}$$

where subscript i denotes the exporting firm, subscript k denotes that firm's home country, and subscript t denotes years. In addition to the employment and labour-productivity variables, the right-hand side of the equation comprises a set of control variables at the firm- (X_{ikt}) and country-level (Y_{kt}), as well as an interaction term for the STRI and employment. The model also controls for unobserved time-varying factors (e.g. the global recession or yearly changes in commodity prices) through a set of T-1 year fixed-effects (δ_t), and for unobserved, time-invariant country characteristics (e.g. geographical factors such as remoteness) through a set of K-1 country fixed effects (θ_k). The model used for cross-section regressions is then a simplified version the above model:

$$exports_{ik} = exp(\beta_0 + \beta_1 \ln employment_{ik} + \beta_2 \ln lab\ prod_{ik} + \beta_3 STRI_k + \Phi X_{ik} + \Lambda Y_k) + \varepsilon_{ik}$$

Data sources and variable description

Dependent variable

The model uses as a dependent variable data on the turnover that firms in the sample generate through their subsidiaries abroad. Although the sample covers 61 firms based in 12 countries over the period 2011-15, it remains heavily biased toward North-American firms.

Firm size and productivity

Because the international revenue of companies is an important component of their total revenue, the analysis uses their total number of employees as a measure of firm size. The correlation is predictably very strong (0.82) between total revenue and total employment. Although total factor productivity (TFP) would provide a more accurate measure of productivity, the calculations to obtain it are data-intensive and beyond the possibilities that the limited sample offers. The analysis relies instead on labour productivity, measured as total revenue divided by the total number of employees.

Control variables

At the firm-level, two alternative control variables are used successively, namely the value of fixed tangible assets per employee — a measure of a firm's capital-labour ratio — and the ratio of working capital (i.e. current assets minus current liabilities) over total revenue — a measure of a firm's short-term financial health and liquidity. At the country-level, data on GDP are expressed in constant 2010 USD million and were obtained from the OECD's statistics portal (OECD.Stat) or from the World Bank's World Development Indicators (WDI) database. Annual rates of economic growth were also obtained from those same sources.

Restrictions on services trade

Because the sample covers firms that provide environmental consulting and engineering (C&E) services, the analysis concentrates first and foremost on restrictions to trade in engineering services, though other related services are also considered. Those services are computer and related services, construction, and architecture. For each of those services, values for the STRI indicators were obtained directly from the OECD's statistics portal.

Table 13. Summary statistics

Variable	Unit	Obs.	Mean	Std. Dev.	Min	Max
International revenue	Current USD million	249	1359.802	3148.368	0.000	20555.700
Employment	Number of employees	207	11602	14032	53	92000
Labour productivity	Current USD million	193	0.191	0.109	0.060	0.717
Tangible fixed assets per employee	Current USD million	165	0.070	0.300	0.001	2.139
Working capital over total turnover	Current USD million	122	0.157	0.112	-0.067	0.554
GDP	Constant 2010 USD million	305	8735196	7090451	246885	16600000
Economic growth	Percentage points	305	1.939	1.018	-2.620	5.990
STRI (engineering)	0-1 scale	300	0.158	0.040	0.083	0.288
STRI (computer and related services)	0-1 scale	300	0.154	0.024	0.109	0.228
STRI (construction)	0-1 scale	300	0.207	0.064	0.071	0.258
STRI (architecture)	0-1 scale	300	0.155	0.034	0.087	0.262

Detailed results and caveats

Tables 14 and 15 show detailed results concerning the statistical relationship between exports, firm characteristics, and restrictions to services trade. Consistent with the literature on export performance and firm characteristics, firm size and labour productivity both appear to be significantly and positively correlated with exports across all the specifications considered here. While the analysis does not rule out the possibility of reverse causality (i.e. exports also affecting productivity in return), the small sample size and the lack of an adequate instrument do not permit the use of a two-stage least-squares estimator. The relevant empirical literature generally fails to identify "learning-by-exporting" effects though, and so any potential bias would presumably be small.

Tangible fixed assets per employee do not seem to correlate with exports in the panel regressions while they do in the cross-sections. This could indicate a lesser (higher) reliance on physical (intangible) assets in exporting firms but additional analysis would be needed to ascertain that presumption. Working capital seems, on the other hand, to be positively correlated with exports. At the country-level, real GDP and economic growth — two alternative indicators of domestic market size — appear negatively correlated with exports, confirming that firms based in larger or fast-growing countries will tend to focus on their domestic activities more.

Similar to the previous analysis that used FATS data to measure trade in core environmental services, results again indicate that restrictions to services trade are negatively and significantly correlated with exports of environmental C&E services at the firm-level. This is particularly so for engineering and construction services, for which estimated coefficients are significant in both panel and cross-section regressions. Variables in the panel regressions suffer, however, from multicollinearity by construction since the STRI variables are interacted with total employment. While this complicates the interpretation of the coefficients and of their significance, it also suggests that smaller firms are more affected by services restrictions than larger ones, possibly due to the existence of fixed costs for exporting. As a robustness check, the analysis also uses cross sections, allowing the STRI variables to be included directly, without there being a need for interaction terms. The resulting estimates are qualitatively close to those obtained using panel regressions, and point to the statistical importance for exports of restrictions applied to trade in engineering and construction services.

Table 14. Exports, firm characteristics, and the STRI: Panel regressions

Explanatory variables	(1) Int. revenue	(2) Int. revenue	(3) Int. revenue	(4) Int. revenue	(5) Int. revenue	(6) Int. revenue	(7) Int. revenue	(8) Int. revenue	(9) Int. revenue
Employment (log)	1.139***	1.153***	1.241***	1.137***	1.132***	2.767***	4.938***	2.626***	8.574***
	(15.20)	(15.59)	(15.35)	(15.13)	(14.90)	(9.57)	(7.52)	(9.88)	(6.70)
Labour productivity (log)	1.635***	1.805***	1.737***	1.637***	1.653***	1.635***	1.635***	1.635***	1.635***
	(9.98)	(7.26)	(17.65)	(10.00)	(10.18)	(9.98)	(9.98)	(9.98)	(9.98)
Tangible fixed assets per employee (log)		-0.0922							
		(-0.59)							
Working capital over total turnover			3.138***						
			(4.85)						
Real GDP (log)				-2.380					
				(-1.20)					
Economic growth					-0.114***				
					(-2.96)				
STRI (engineering) x Employment (log)						-1.628***			
						(-5.82)			
STRI (computer and related services) x Employment (log)							-3.799***		
							(-5.82)		
STRI (construction) x Employment (log)								-1.488***	
								(-5.82)	
STRI (architecture) x Employment (log)									-7.436***
									(-5.82)
Constant	-0.755	-1.129	-1.972**	32.86	-0.356	-4.462***	-8.760***	-3.711***	-15.67***
	(-0.89)	(-1.46)	(-2.35)	(1.17)	(-0.41)	(-4.75)	(-6.07)	(-4.19)	(-6.24)
Observations	192	165	122	192	192	187	187	187	187
Fixed effects	Country and year	Country and year	Country and year	Country and year	Country and year	Country and year	Country and year	Country and year	Country and year
Standard errors	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

Table 14. Exports, firm characteristics, and the STRI: Panel regressions (*continued*)

Explanatory variables	(10) Int. revenue	(11) Int. revenue	(12) Int. revenue	(13) Int. revenue	(14) Int. revenue	(15) Int. revenue	(16) Int. revenue	(17) Int. revenue
Employment (log)	2.884***	5.220***	2.733***	9.132***	2.886***	5.077***	2.744***	8.746***
	(10.08)	(8.01)	(10.39)	(7.18)	(9.77)	(8.09)	(10.00)	(7.35)
Labour productivity (log)	1.653***	1.653***	1.653***	1.653***	1.741***	1.741***	1.741***	1.741***
	(10.17)	(10.17)	(10.17)	(10.17)	(17.42)	(17.42)	(17.42)	(17.42)
Tangible fixed assets per employee (log)								
Working capital over total turnover					3.109***	3.109***	3.109***	3.109***
					(4.80)	(4.80)	(4.80)	(4.80)
Real GDP (log)								
Economic growth	-0.114***	-0.114***	-0.114***	-0.114***	-0.0701***	-0.0701***	-0.0701***	-0.0701***
	(-2.96)	(-2.96)	(-2.96)	(-2.96)	(-2.69)	(-2.69)	(-2.69)	(-2.69)
STRI (engineering) x Employment (log)	-1.752***				-1.643***			
	(-6.29)				(-6.50)			
STRI (computer and related services) x Employment (log)		-4.087***				-3.834***		
		(-6.29)				(-6.50)		
STRI (construction) x Employment (log)			-1.600***				-1.501***	
			(-6.29)				(-6.50)	
STRI (architecture) x Employment (log)				-7.999***				-7.503***
				(-6.29)				(-6.50)
Constant	-4.345***	-8.968***	-3.537***	-16.41***	-5.516***	-9.852***	-4.758***	-16.83***
	(-4.62)	(-6.28)	(-3.96)	(-6.61)	(-4.90)	(-5.93)	(-4.54)	(-6.35)
Observations	187	187	187	187	117	117	117	117
Fixed effects	Country and year	Country and year	Country and year	Country and year	Country and year	Country and year	Country and year	Country and year
Standard errors	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm	Clustered by firm

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

Table 15. Exports, firm characteristics, and the STRI: Cross-section regressions (2014-15)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Explanatory variables	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**	**Int. revenue**
Employment (log)	1.030***	0.966***	0.956***	1.114***	1.049***	1.119***	1.040***	1.156***	1.031***	1.118***	1.057***	1.182***	1.048***
	(9.26)	(7.97)	(8.71)	(18.13)	(10.76)	(16.40)	(9.20)	(13.92)	(9.13)	(16.33)	(10.38)	(15.43)	(10.61)
Labour productivity (log)	0.957***	1.673***	1.231***	1.442***	1.008***	1.307***	0.964***	1.165***	0.956***	1.307***	1.008***	1.207***	1.010***
	(6.56)	(4.55)	(10.40)	(10.71)	(7.21)	(8.94)	(6.76)	(7.44)	(6.56)	(8.87)	(7.24)	(8.28)	(7.00)
Tangible fixed assets per employee (log)		-0.490**											
		(-2.55)											
Working capital over total turnover			0.606										
			(0.59)										
Real GDP (log)				-0.357***									
				(-6.84)									
Economic growth					-0.202*					0.0197	-0.185*	-0.186**	-0.207*
					(-1.94)					(0.19)	(-1.73)	(-2.18)	(-1.94)
STRI (engineering)						-10.54***				-10.67***			
						(-7.25)				(-6.54)			
STRI (computer and related services)							-3.379				-2.496		
							(-1.05)				(-0.76)		
STRI (construction)								-5.150***				-5.129***	
								(-5.88)				(-6.32)	
STRI (architecture)									-0.567				0.442
									(-0.23)				(0.17)
Constant	-1.013	-1.637	0.0368	4.325***	-0.673	0.198	-0.581	-0.928	-0.935	0.186	-0.405	-0.712	-0.712
	(-0.80)	(-1.49)	(0.03)	(4.52)	(-0.57)	(0.22)	(-0.45)	(-0.90)	(-0.74)	(0.21)	(-0.34)	(-0.72)	(-0.62)
Observations	72	61	42	72	72	70	70	70	70	70	70	70	70
Standard errors	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust	Robust

Note: Numbers in parentheses are z statistics, where ***, **, and * denote statistical significance at the 1%, 5%, and 10% level respectively.

Annex 1

A short guide to the product and sector classifications used in this report

ISIC

- The *International Standard Industrial Classification of All Economic Activities* (ISIC) is the most widely used classification of economic activities, its purpose being to "provide a tool for comparing statistical data on economic activities at the international level" (United Nations, 2008). The ISIC was initially developed in 1948 and is periodically reviewed by the United Nations Statistics Division. The fourth revision of ISIC (ISIC Rev.4) is the latest instalment to date. Most countries have adopted the ISIC or have created their own national activity classifications, drawing inspiration from the ISIC (Figure 8).

NACE

- The *Statistical Classification of Economic Activities in the European Community* (NACE) is the European equivalent of ISIC in that it classifies economic activities rather than products (goods or services). This classification was first introduced in 1970, with its latest revision dating back to January 2008 (NACE Rev.2).

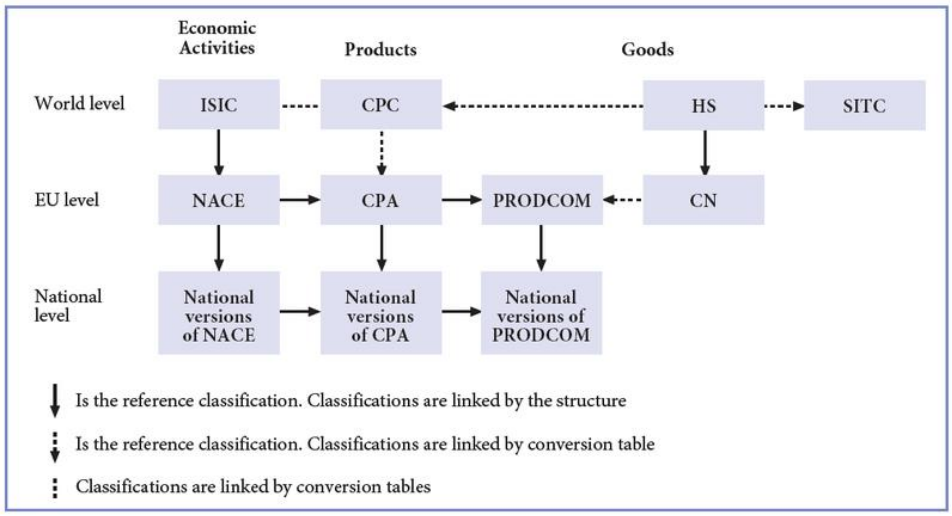
CPC

- The *Central Product Classification* (CPC) is a standard categorisation of products, including both goods and services that can be traded nationally or internationally. The CPC's first provisional version was established in 1991 (CPC prov.) and has since gone through several periodic reviews to account for technological and economic changes, the most recent version corresponding to CPC 2.1. The list is maintained by the United Nations Statistics Division and has played an important part in negotiations under the GATS and in many regional trade agreements.
- The CPC was initially developed to "enhance harmonization among various fields of economic and related statistics and to strengthen the role of national accounts as an instrument for the coordination of economic statistics" (United Nations, 2015a). Sections 0 to 4 use sub-headings from the Harmonized System (HS) but also allow for more detailed sub-categories. Sections 6 to 9 are designated for services only. The European *Statistical Classification of Products by Activity in the European Economic Community* (CPA) proceeds from the CPC itself (Figure 8).

W/120

- The W/120 list refers to the services sectoral classification list described in the WTO document known as "MTN.GNS/W/120" and dated 10 July 1991. The list was initially designed for the purpose of negotiating the GATS and uses the older provisional version of the CPC (CPC Prov).

Figure 8. The international system of economic classifications from a European perspective



Source: Eurostat (2008).

Annex 2

Mapping environmentally related services in existing classifications, with examples

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
Core services							
Water supply	18000 (Water)		69210 (Water, except steam and hot water, distribution services through mains)	69210 (Water distribution through mains, except steam and hot water (on own account)	69210 (Water distribution through mains, except steam and hot water (on own account)	3600(Water collection, treatment and supply)	36.00 (Water collection, treatment and supply)
				69230 (Water distribution, except through mains (on own account)	69230 (Water distribution, except through mains (on own account)	3600 (Water collection, treatment and supply)	36.00 (Water collection, treatment and supply)
			18000 (Natural water)	18000 (Natural water)	18000 (Natural water)	3600 (Water collection, treatment and supply)	36.00 (Water collection, treatment and supply)
				17400 (Ice and Snow)	17400 (Ice and Snow)	3530 (Steam and air conditioning supply)	35.30 (Steam and air conditioning supply)
			85990 (Other support services n.e.c., including reading of water meters)	85970 (Landscape care and maintenance services)	85970 (Landscape care and maintenance services)	8130 (Landscape care and maintenance service activities)	81.30 (Landscape service activities)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
				85999 (Other support services n.e.c.)	85999 (Other support services n.e.c.)	7490 (Other professional, scientific and technical activities n.e.c.)	74.9 (Other professional, scientific and technical activities n.e.c.)
						8299 (Other business support service activities n.e.c.)	82.99 (Other business support service activities n.e.c.)
Wastewater treatment	94010 (Sewage services)	6 A (Sewage services)	94110 (Sewage treatment services)	94110 (Sewerage and sewage treatment services)	94110 (Sewerage and sewage treatment services)	3700 (Sewerage)	37.00 (Sewerage)
			94120 (Tank emptying and cleaning services)	94120 (Septic tank emptying and cleaning services)	94120 (Septic tank emptying and cleaning services)	3700 (Sewerage)	37.00 (Sewerage)
Solid and hazardous waste collection and disposal	94020 (Refuse collection and disposal services)	6 B (Refuse disposal services)	94211 (Non-hazardous waste collection services)	94221 (Collection services of non-hazardous recyclable materials, residential)	94221 (Collection services of non-hazardous recyclable materials, residential)	3811(Collection of non-hazardous waste)	38.11 (Collection of non-hazardous waste)
				94229 (Collection services of non-hazardous recyclable materials, other)	94229 (Collection services of non-hazardous recyclable materials, other)	3811 (Collection of non-hazardous waste)	38.11 (Collection of non-hazardous waste)
				94231 (General waste collection services, residential)	94231 (General waste collection services, residential)	3811 (Collection of non-hazardous waste)	38.11 (Collection of non-hazardous waste)
				94239 (General waste collection services, other)	94239 (General waste collection services, other)	3811 (Collection of non-hazardous waste)	38.11 (Collection of non-hazardous waste)
			94212 (Non-hazardous waste treatment and disposal services)	94312 (Ship-breaking and other dismantling of wrecks services)	94312 (Ship-breaking and other dismantling of wrecks services)	3830 (Materials recovery)	38.3 (Materials recovery)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
				94313 (Non-hazardous recyclable materials preparation, consolidation and storage services)	94313 (Non-hazardous recyclable materials preparation, consolidation and storage services)	3811 (Collection of non-hazardous waste)	38.11 (Collection of non-hazardous waste)
				94319 (Other non-hazardous waste preparation, consolidation and storage services)	94319 (Other non-hazardous waste preparation, consolidation and storage services)	3811 (Collection of non-hazardous waste)	38.11 (Collection of non-hazardous waste)
				94331 (Sanitary landfill services, non-hazardous waste)	94331 (Sanitary landfill services, non-hazardous waste)	3821 (Treatment and disposal of non-hazardous waste)	38.21 (Treatment and disposal of non-hazardous waste)
				94332 (Other landfill services, non-hazardous waste)	94332 (Other landfill services, non-hazardous waste)	3821 (Treatment and disposal of non-hazardous waste)	38.21 (Treatment and disposal of non-hazardous waste)
				94333 (Incineration of non-hazardous waste)	94333 (Incineration of non-hazardous waste)	3821(Treatment and disposal of non-hazardous waste)	38.21 (Treatment and disposal of non-hazardous waste)
				94339 (Other non-hazardous waste treatment and disposal services)	94339 (Other non-hazardous waste treatment and disposal services)	3821(Treatment and disposal of non-hazardous waste)	38.21(Treatment and disposal of non-hazardous waste)
			94221 (Hazardous waste collection services)	94211 (Collection services of hazardous medical and other biohazardous waste)	94211 (Collection services of hazardous medical and other biohazardous waste)	3812 (Collection of hazardous waste)	38.12 (Collection of hazardous waste)
				94212 (Collection services of industrial hazardous waste (except medical and other biohazardous waste))	94212 (Collection services of industrial hazardous waste (except medical and other biohazardous waste))	3812 (Collection of hazardous waste)	38.12(Collection of hazardous waste)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
				94219 (Collection services of other hazardous waste)	94219 (Collection services of other hazardous waste)	3812 (Collection of hazardous waste)	38.12 (Collection of hazardous waste)
			94222 (Hazardous waste treatment and disposal services)	94311 (Hazardous waste preparation, consolidation and storage services)	94311 (Hazardous waste preparation, consolidation and storage services)	3812 (Collection of hazardous waste)	38.12 (Collection of hazardous waste)
				94312 (Ship-breaking and other dismantling of wrecks services)	94312 (Ship-breaking and other dismantling of wrecks services)	3830 (Materials recovery)	38.31 (Dismantling of wrecks)
							38.32 (Recovery of sorted materials)
				94321 (Hazardous waste treatment services)	94321 (Hazardous waste treatment services)	3822 (Treatment and disposal of hazardous waste)	38.22 (Treatment and disposal of hazardous waste)
				94322 (Hazardous waste disposal services)	94322 (Hazardous waste disposal services)	3822 (Treatment and disposal of hazardous waste)	38.22 (Treatment and disposal of hazardous waste)
Sanitation and similar services	94030 (Sanitation and similar services)	6 C (Sanitation and similar services)	94310 (Sweeping and snow removal services)	94510 (Sweeping and snow removal services)	94510 (Sweeping and snow removal services)	8129 (Other building and industrial cleaning activities)	81.22 (Other building and industrial cleaning activities)
							81.29 (Other cleaning activities)
			94390 (Other sanitation services)	94590 (Other sanitation services)	94590 (Other sanitation services)	8129 (Other building and industrial cleaning activities)	81.22 (Other building and industrial cleaning activities)
							81.29 (Other cleaning activities)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
Cleaning services of exhaust gases	94040 (Cleaning services of exhaust gases)		94900 (Other environmental protection services n.e.c.)	94411 (Site remediation and clean-up services, air)	94411 (Site remediation and clean-up services, air)	3900 (Remediation activities and other waste management services)	39.00 (Remediation activities and other waste management services)
				94412 (Site remediation and clean-up services, surface water)	94412 (Site remediation and clean-up services, surface water)	3900 (Remediation activities and other waste management services)	39.00 (Remediation activities and other waste management services)
				94413 (Site remediation and clean-up services, soil and groundwater)	94413 (Site remediation and clean-up services, soil and groundwater)	3900 (Remediation activities and other waste management services)	39.00 (Remediation activities and other waste management services)
				94420 (Containment, control and monitoring services and other site remediation services n.e.c.)	94420 (Containment, control and monitoring services and other site remediation services n.e.c.)	3900 (Remediation activities and other waste management services)	39.00 (Remediation activities and other waste management services)
				94430 (Building remediation services)	94430 (Building remediation services)	3900 (Remediation activities and other waste management services)	39.00 (Remediation activities and other waste management services)
				94490 (Other remediation services n.e.c.)	94490 (Other remediation services n.e.c.)	3900 (Remediation activities and other waste management services)	39.00 (Remediation activities and other waste management services)
				94900 (Other environmental protection services n.e.c.)	94900 (Other environmental protection services n.e.c.)	3900 (Remediation activities and other waste management services)	39.00 (Remediation activities and other waste management services)
Noise abatement services	94050 (Noise abatement services)	6 D (Other)	94900 (Other environmental protection services n.e.c.)	(see CPCprov 94040)	(see CPCprov 94040)	(see CPCprov 94040)	(see CPCprov 94040)
Nature and landscape protection services	94060 (Nature and landscape protection services)	6 D (Other)	94900 (Other environmental protection services n.e.c.)	(see CPCprov 94040)	(see CPCprov 94040)	(see CPCprov 94040)	(see CPCprov 94040)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
Other environmental protection services	94090 (Other environmental protection services)	6 D (Other)	94900 (Other environmental protection services n.e.c.)	(see CPCprov 94040)	(see CPCprov 94040)	(see CPCprov 94040)	(see CPCprov 94040)
Related services (examples)							
Environmental consulting	86721 (Advisory and consultative engineering services)		83331 (Engineering advisory and pre-design services for residential and non-residential buildings)	83310 (Engineering advisory services)	83310 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
			83332 (Engineering advisory and pre-design services for civil engineering works)	83310 (Engineering advisory services)	83310 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
			83333 (Engineering advisory and pre-design services for industrial plant and processes)	83310 (Engineering advisory services)	83310 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
			83339 (Engineering advisory and pre-design services for other projects)	83310 (Engineering advisory services)	83310 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
Scientific testing	8676 (Technical testing and analysis services)		8356 (Technical testing and analysis services)	8344 (Technical testing and analysis services)	8344 (Technical testing and analysis services)	7120 (Technical testing and analysis)	71.20 (Technical testing and analysis)
Urban planning	86741 (Urban planning services)		83221 (Urban planning services)	83221 (Urban planning services)	83221 (Urban planning services)	7110 (Architectural and engineering activities and related technical consul-tancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
				83222 (Rural land planning services)	83222 (Rural land planning services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
				83223 (Project site master planning services)	83223 (Project site master planning services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
							71.12 (Engineering activities and related technical consultancy)
Landscape architecture	86742 (Landscape architectural services)		83222 (Landscape architectural services)	83231 (Landscape architectural advisory services)	83231 (Landscape architectural advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
				83232 (Landscape architectural services)	83232 (Landscape architectural services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
Engineering	8672 (Engineering services) includes 86721-86729		8333 (Engineering advisory and pre-design services) inlcudes	8331 (Engineering advisory services)	8331 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
			8334 (Engineering design services)	8332 (Engineering services for specific projects)	8332 (Engineering services for specific projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
							71.12(Engineering activities and related technical consultancy)
			8335 (Engineering services during the construction and installation phase)	8332 (Engineering services for specific projects)	8332 (Engineering services for specific projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
			8313 (Scientific and technical consulting services n.e.c.)	8393 (Scientific and technical consulting services n.e.c.)	8393 (Scientific and technical consulting services n.e.c.)	7490 (Other professional, scientific and technical activities n.e.c.)	74.3 (Translation and interpretation activities)
							74.9 (Other professional, scientific and technical activities n.e.c.)
			8332 (Project management services concerning construction)	83330 (Project management services for construction projects)	83330 (Project management services for construction projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
			8339 (Other engineering services)	8332 (Engineering services for specific projects)	8332 (Engineering services for specific projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
							71.12 (Engineering activities and related technical consultancy)
Architecture	8671 (Architectural service)		8321 (Architectural services and advisory services)	8321 (Architectural services and advisory services)	8321 (Architectural services and advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
Design	86724 (Engineering design services for the construction of civil engineering work)		83342 (Engineering design services for civil engineering works)	83323 (Engineering services for transportation projects)	83323 (Engineering services for transportation projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
				83325 (Engineering services for telecommunications and broadcasting projects)	83325 (Engineering services for telecommunications and broadcasting projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
				83326 (Engineering services for waste management projects (hazardous and non-hazardous))	83326 (Engineering services for waste management projects (hazardous and non-hazardous))	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
							71.12 (Engineering activities and related technical consultancy)
				83327 (Engineering services for water, sewerage and drainage projects)	83327 (Engineering services for water, sewerage and drainage projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
				83329 (Engineering services for other projects)	83329 (Engineering services for other projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.11 (Architectural activities)
							71.12 (Engineering activities and related technical consultancy)
General management	86601 (Project management services other than for construction)		8319 (Other management services, except construction project management services)	8319 (Other management services, except construction project management services)	8319 (Other management services, except construction project management services)	7020 (Management consultancy activities)	70.21 (Public relations and communication activities)
							70.22 (Business and other management consultancy activities)
	86501 (General management consulting services)		83111 (Management consulting services)	83111 (Strategic management consulting services)	83111 (Strategic management consulting services)	7020 (Management consultancy activities)	70.21 (Public relations and communication activities)

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
							70.22(Business and other management consultancy activities)
Construction	51 (Construction work)		54 (Construction services)	54 (Construction services)	54 (Construction services)	41 (Construction of buildings)	41 (Construction of buildings)
						42 (Civil engineering)	42(Civil engineering)
						43 (Specialized construction activities)	43 (Specialised construction activities)
						3320 (Installation of industrial machinery and equipment)	33.20 (Installation of industrial machinery and equipment)
			83211 (Architectural advisory and pre-design services)	83211 (Architectural advisory services)	83211 (Architectural advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.1 (Architectural and engineering activities and related technical consultancy)
				83212 (Architectural services for residential building projects)	83212 (Architectural services for residential building projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.1 (Architectural and engineering activities and related technical consultancy)
				83213 (Architectural services for non-residential building projects)	83213 (Architectural services for non-residential building projects)	7110 (Architectural and engineering activities and related technical consultancy)	71.1 (Architectural and engineering activities and related technical consultancy)
				83214 (Historical restoration architectural services)	83214 (Historical restoration architectural services)	7110 (Architectural and engineering activities and related technical consultancy)	71.1 (Architectural and engineering activities and related technical consultancy)
			83331 (Engineering advisory and pre-design services for buildings)	83310 (Engineering advisory services)	83310 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical	71.1 (Architectural and engineering activities and related technical

Service	CPC prov.	W/120	CPC 1.1	CPC 2.0	CPC 2.1	ISIC Rev. 4	NACE Rev 2
						consultancy)	consultancy)
			83332 (Engineering advisory and pre-design services for civil engineering works)	83310 (Engineering advisory services)	83310 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.1 (Architectural and engineering activities and related technical consultancy)
			83333 (Engineering advisory and pre-design services for industrial plant and processes)	83310 (Engineering advisory services)	83310 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.1 (Architectural and engineering activities and related technical consultancy)
			83339 (Engineering advisory and pre-design services for other projects)	83310 (Engineering advisory services)	83310 (Engineering advisory services)	7110 (Architectural and engineering activities and related technical consultancy)	71.1 (Architectural and engineering activities and related technical consultancy)