6 Global value chains, environmental policies, and the Pollution Haven hypothesis

Global value chains are the focus of this chapter.[1] The increased fragmentation of production chains around the globe over the last decades, paired with varying efforts of environmental protection across countries, have reinforced fears of policy makers that industrial activity may shift towards jurisdictions with laxer environmental policies – an argument known as the Pollution Haven hypothesis. The empirical evidence on this hypothesis has focused on aggregate trade patterns so far. Using data on gross exports and domestic value added of exports in the manufacturing sector across 23 OECD and 6 BRIICS countries over the period 1990-2009, this study assesses how trade patterns are related to differences in national environmental policies of trading partners based on a gravity model of bilateral trade flows. The results of the study show that an increasing difference between the domestic and the trading partners' environmental policy stringency does not alter overall trade but it does affect the specialisation of countries: tighter environmental policies in one country are linked to a comparative disadvantage in dirty industries and a comparative advantage in cleaner industries. These effects are, however, small in magnitude, when compared with other policies such as trade liberalisation measures.

Background

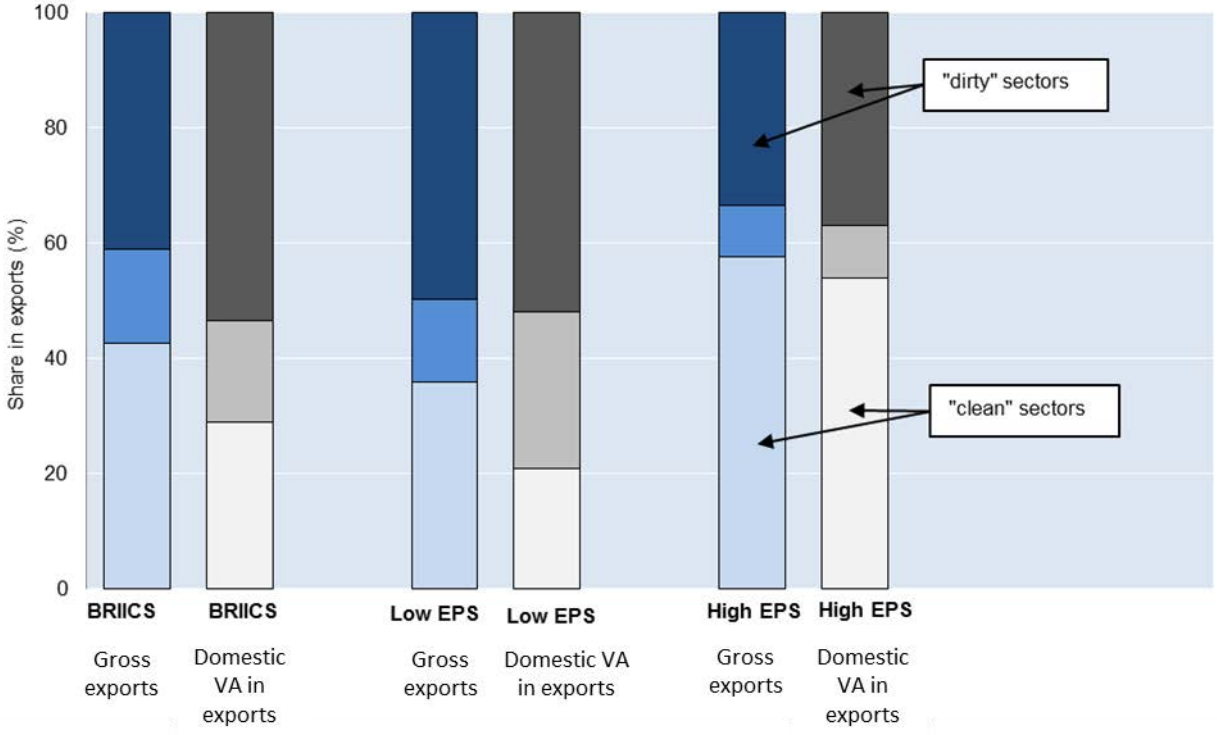
The increased fragmentation of production chains gives rise to global value chains

While traditional trade theory identified countries' factor endowments, i.e. labour, capital, institutions and natural capital, as a main driver of trade patterns, the past two decades have shown an increasing importance of specialised stages of the production process. Therefore, in recent trade models, the focus has shifted towards the fragmented production process along global value chains (GVCs), which exploit differences in factor endowments and efficiencies across jurisdictions and thereby lead to different stages of specialisation (Baldwin and Yan, 2014[1]). A comparative advantage of one country over another is thus not always associated with the sale of finished goods and services but rather with specialised intermediate goods and services.

The comparative advantage of economies might be shifted by tighter environmental policies

Increasing environmental protection efforts might lead to a change of comparative production advantages across economies. Environmental policies might implicitly or explicitly increase the cost of using the environment as a production factor and require firms to invest some of their production inputs into pollution mitigation and abatement. Given that the stringency of environmental policies differ heavily across countries, the relative costs of environmental inputs differ across countries as well, potentially affecting the comparative advantage of economies in the production of certain goods and services. Tighter environmental policies may increase the relative cost advantage of economies towards cleaner production, thereby potentially putting polluting domestic firms at a competitive disadvantage. Separating effects for BRIICS and OECD countries, Figure 6.1 shows that dirty sectors indeed have a higher export share in countries with less stringent environmental policies. Whether this is a simple coincidence or whether environmental policies triggered these patterns, is the subject of this analysis.

Figure 6.1. Export shares by sector-specific environmental dependence across country groups and different levels of EPS



Notes: The figure shows the share of exports (domestic VA in exports and gross exports) of three industry groups, by pollution intensity: "dirty" (4 sectors with highest pollution intensity), "medium" (2 sectors with average pollution intensity) and "clean" (4 sectors with lowest pollution intensity). Averages over the sample 1995-2008 are reported. Countries are grouped into BRIICS (generally lowest EPS), low EPS (OECD countries with lowest average EPS across the sample: Australia, Ireland and the Slovak Republic) and high EPS (OECD countries with highest EPS across the sample: Denmark, Germany and Switzerland).
Source: Koźluk and Timiliotis (2016[2]).

Offshoring versus efficiency gains – what the theory says

A priori, it is unclear whether and how firms will adjust their production chains in response to more stringent environmental policies. On the one hand, environmental policies which increase input costs might provide incentives for offshoring certain production stages to countries with laxer environmental policies along the lines of the Pollution Haven Hypothesis (PHH) (McGuire, 1982[3]). Additionally, these policies might incentivise sourcing carbon-intensive inputs from other countries and thereby affect trade patterns. On the other hand, tighter environmental policies might lead to a re-design of production processes whereby efficiency potentials might be discovered, an argument known as the Porter Hypothesis (Porter, 1991[4]; Porter and van der Linde, 1995[5]). Reaping efficiency and productivity gains in response to environmental policies might increase the competitiveness of firms and provide them with a comparative advantage in cleaner production processes.

Empirical studies so far ignored changes in the domestic part of value added in exports

The link between GVCs and environmental policies has not been studied in depth until now. While there is an extensive literature on the link between environmental policies and trade (see Koźluk and Timiliotis (2016[2]) for a detailed review), the empirical evidence around GVCs has been limited so far. The majority of studies investigating the PHH have used gross or net trade flows, thereby ignoring effects on the

domestic value added part of exports. One notable exception is a study by Kellenberg (2009[6]) which finds support for the PHH for value added in affiliates of US-owned multinationals. Studies focusing on gross or net trade flows mostly use gravity models of trade behaviour, often augmented with factor endowments and policy-related drivers of trade. While some papers look at overall competitiveness, the majority focuses on effects in highly polluting sectors, which are expected to be most affected (e.g. Van Beers and van den Bergh (1997[7]); Ederington, Levinson and Minier (2005[8]); Kellenberg (2009[6]). The choice of a proxy for environmental policies ranges from pollution abatement costs over expert surveys to indicators directly measuring the stringency of policy instruments. However, conducting robustness checks with several proxies is uncommon in the literature so far.

Contribution of this study - new evidence on domestic part of GVCs

This study offers two main contributions to the literature. First, by using a newly developed cross-country measure of environmental policy stringency (EPS), it provides one of the first large-scale empirical studies on the link between GVCs and environmental policies across two decades. Second, new data on domestic value added in exports is used to shed light on the domestic changes in value added to exported goods, in addition to analysing global trade patterns in net exports.

Empirical set-up

An augmented gravity model is deployed

The empirical analysis is based on a gravity model of bilateral trade, augmented with variables explaining competitive differences across countries. Gravity models have been extensively used in the trade literature (e.g. McCallum, (1995[9]); Frankel (1997[10]); Frankel and Rose (2002[11])) and have recently been augmented with variables explaining competitiveness differences in the vein of the Heckscher-Ohlin model (e.g. legal institutions in Nuun (2007[12]); financial development in Manova (2013[13]); Nicoletti et al. (2003[14])). One of these “policy-related endowments” added in this study is the stringency of environmental policies.

Data on the domestic share of value added provide a detailed look at GVCs

The empirical analysis examines the impact of environmental policy stringency on the traditional measure of trade between countries, net exports, as well as on the domestic share of value added in exports. While trade in intermediate goods was proportional to trade in final goods for a long time, the increasing appearance of global value chains altered this relationship (Yi, 2003[15]). Domestic environmental policies are expected to have a stronger effect on the domestic value added in production and exports than simply on gross exports which, to a large share, include imported intermediate components. It is therefore important to differentiate how much domestic value added lies in the exported goods in order to identify a more accurate relationship between environmental policies and trade patterns.

Heterogeneous sector effects

The analysis allows for heterogeneous sector- and production-stage effects. The environmental policy variable is only observed at the country-level. However, sectors might be more or less sensitive to changes in these policies. Therefore, the effects of environmental policy stringency are allowed to vary with the pollution intensity of sectors – assuming that pollution-intensive sectors may be subject to stronger effects of environmental policies (similar approaches are used by Rajan and Zingales (1998[16]); Johansson et al. (2014[17]); and Albrizio, Koźluk and Zipperer (2017[18]), summarised in Chapter 2). Furthermore, effects of tariffs are allowed to vary across intermediate and final goods. Following Johansson et al., (2014[17]), an

input and output tariff variable is constructed, capturing the fact that intermediate goods tend to be more vulnerable to trade barriers than final goods because they are more easily substituted (Miroudot, Lanz and Ragoussis, 2009[19]).

Empirical model

Given the significant share of zero trade flows between countries in the dataset, a Poisson Pseudo Maximum Likelihood estimator is used to estimate the following equation:

$$\begin{aligned} Exp_{ijst} = \exp(&\alpha + \gamma_1 Gravity_{ijt} + \beta_1 Endowment_{it} * Intensity_s + \beta_2 Endowment_{jt} * Intensity_s \\ &+ \beta_3 Policy_{it} * Sensitivity_s + \beta_4 Policy_{jt} * Sensitivity_s + \delta_1 Endowment_{it} \\ &+ \delta_2 Policy_{it} + \delta_3 Endowment_{jt} + \delta_4 Policy_{jt} + \gamma_2 InputTariff_{sit} \\ &+ \gamma_3 OutputTariff_{sijt} + \lambda_1 EPSgap_{ijt} + \lambda_2 EPSgap_{ijt} * ED_s + \theta_i + \theta_j + \theta_s + \theta_t) \\ &+ \varepsilon_{ijst} \end{aligned}$$

where i is the exporting country, j is the importing country, s is the sector and t is the year. In the first analysis, Exp_{ijst} is the USD value of total gross manufacturing exports from country *i* to country *j* in year *t* in sector *s*; in the second analysis, Exp_{ijst} is the domestic value added in *i*'s exports to j. $Gravity_{ijt}$ is a set of gravity variables commonly used in such models such as geographical distance between capitals, GDP of each of the partner countries, dummies for the existence of a common border, common language, participation of both countries in a regional trade agreement, or a common currency. $Endowment$ is a set of country-level variables reflecting the endowments of the country with production factors such as the stock of physical capital per worker, human capital per worker and energy supply per capita. These variables are included for both trading partners and interacted with the variable $Intensity_s$ which measures the intensity with which the production factors are used in industry *s*. $Policy$ reflects policy and institutional variables, such as financial development and institutional quality. The policy variable is included for both trading partners and interacted with $Sensitivity_s$ which measures the dependence of a given sector on the respective policy variable. $InputTariff_{sit}$ is a weighted average of tariffs on intermediate goods imported into country *i* and used in sector *s*. $OutputTariff_{sijt}$ is a measure of average tariffs that importer *j* imposes on products of industry *s*. $EPSgap_{ijt}$ reflects the difference in the environmental policy stringency between country *i* and country *j*. This is interacted with ED_s, the environmental dependence of sector *s* on environmental policies, a sensitivity proxy which measures the industry pollution-intensity of sector *s*. $\theta_i, \theta_j, \theta_s, \theta_t$ are fixed effects for the importing country, the exporting country, the sector and the year. ε_{ijst} is the error term.

Data

The dataset is an unbalanced panel, which covers 23 OECD economies and 6 BRIICS countries, 10 manufacturing sectors, and spans the time period from 1990 to 2009. The data on gross imports are taken from the OECD STAN database, the EPS estimates are also taken from the OECD. The gravity variables are sourced from the CEPII database, CIA World Factbook, the WTO, De Sousa (2012[20]). The endowment and sensitivity variables are from Kowalski (2011[21]), Barro and Lee (2010[22]), World Bank, GTAP database, tariff data from Most Favourite Nation database and GTAP (see Koźluk and Timiliotis (2016[2]) for a detailed description of the variables and the respective sources).

Results

Only dirty sectors move part of gross exports to pollution havens

The results for gross exports show no support for the PHH at the country-level, but significant heterogeneous effects across sectors. When using gross manufacturing exports as the dependent

variable, no significant effect of the EPS indicator is found, as shown in Table 6.1. However, when interacting the EPS variable with environmental dependence to allow for heterogeneous effects across sectors, a statistically significant negative effect is found for the difference in environmental policy stringency on trade patterns. The estimates for the other coefficients are in line with previous findings, but not shown here for the sake of brevity and can be found in Koźluk and Timiliotis (2016[2]). Calculating marginal effects for dirty and clean sectors reveals that for sectors where environmental policies are more stringent in the exporting country, exports of dirty sectors are significantly lower than in the case when environmental policies are equally stringent in both countries (Figure 6.2). For a difference of 0.42 in the EPS variable (which equals moving from the median to the 75th percentile of the EPS distribution), exports are 4% lower than in the case where both trading partners have equal levels of EPS. Similarly, when the exporting country has laxer environmental policies, exports of dirty sectors tend to be higher compared to the case, when environmental policy stringency is similar. Effects for clean sectors are not significant. These results suggest that countries face a comparative disadvantage in gross exports in dirty sectors when their domestic environmental efforts are stronger than the ones of their trading partners.

Table 6.1. Global value chain effects - main estimation results

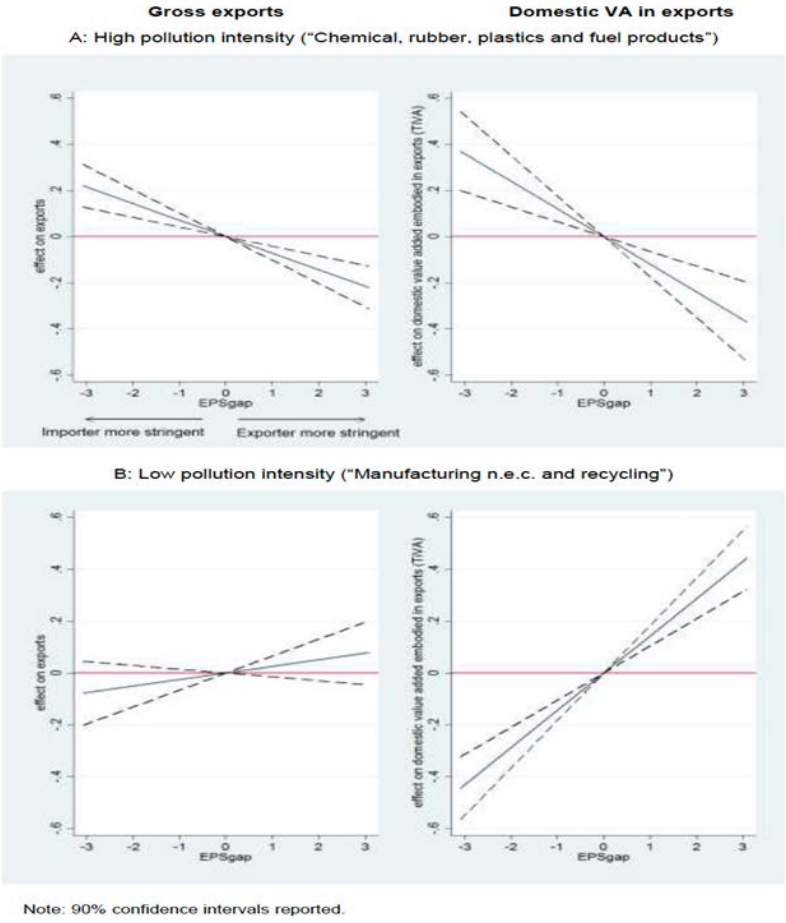
Dependent variable:	Gross exports (in logs)		Domestic VA in exports (TiVA)	
	(1)	(2)	(3)	(4)
EPSgap	-0.0183	-0.0230	0.00364	0.00188
	(0.0166)	(0.0163)	(0.0284)	(0.0282)
EPSgap*ED		-0.142***		-0.362***
		(0.0366)		(0.0616)
Fixed effects (Exporter, importer, industry, year)	Yes	Yes	Yes	Yes
Pseudo R-squared	0.850	0.850	0.841	0.842
Observations	121 240	121 240	32 480	32 480

Notes: Robust standard errors in parentheses. ***, ** and * represent p<0.01, p<0.05, p<0.1 respectively.

The domestic share of value added is affected for both dirty and clean sectors

The results of the estimation based on domestic value added in exports additionally show a positive significant effect for clean sectors. The results shown in column 3 and 4 in Table 6.1. confirm the results found previously. However, as Figure 6.2 shows, next to the negative effect for dirty sectors, clean sectors see a positive impact on their domestic value added in exports when environmental policy stringency is high in the exporting country. If the environmental policy stringency is lower in the exporting country, then the value added in clean domestic sectors declines.

Figure 6.2. Marginal effects of environmental dependence on exports



Note: 90% confidence intervals reported.

Economic significance for the domestic share of exports is larger than for net exports but the overall effect is small compared to other trade determinants

The economic significance of the results is higher for the domestic value added in exports than for gross exports, but small compared to other trade determinants. The initial hypothesis that environmental policies have a stronger impact on the domestic part of global value chains is confirmed in the analysis that compares the magnitude of the effects from the two estimations. When comparing the economic significance of the effects of environmental policy stringency to other trade determinants, the effect appears limited: The effects of a change in the EPS variable from the median to the 75th percentile would be equivalent to an 8% increase in output tariffs for dirty sector.

Robustness checks

The results are robust to several robustness checks. First, using energy prices taken from Sato et al. (2019[23]) as an alternative measure of environmental policies does not change the results significantly, neither does using the in-sample energy intensity of industries rather than pre-sample pollution intensity as sensitivity proxy. Using the sector's stage in the GVC in terms of being up- or downstream as an alternative proxy of environmental dependency does not alter the results significantly either. Second, using a lag of the EPS variable confirms the results of the contemporaneous estimation, showing an even stronger effect. Third, the results are robust to different specifications of the fixed effects structure, estimation based on different country and year sub-samples, and on alternative specifications of the gravity model.

Conclusion

Dirty industries face a competitive disadvantage, clean industries a competitive advantage

The findings of this study show no support for the PHH for aggregate trade, but they show evidence that environmental policies induce changes in specialisation across countries, in line with the PHH. The baseline results show no significant effect of tighter environmental policy on overall trade patterns in manufacturing goods. However, the country-specific stringency of environmental policies has a significant effect on the specialisation of firms, confirming the PHH. When the gap in environmental policy stringency between two trade partners increases, relative input prices change and the country with tighter environmental policies seems to suffer from a comparative disadvantage in "dirty" industries, while laxer environmental policies are associated with a new comparative advantage in "clean" industries. These effects are stronger for the domestic value added in exports than for total gross exports. While these specialisation effects are present, the analysis shows that these changes in trade patterns are small when compared to changes induced by, for example, trade liberalisation measures.

The detailed design of environmental policies is not captured

The role of the design of environmental policies has to be kept in mind when interpreting the results. The measure used in this study for environmental policy stringency can only be seen as a general proxy. It fails to capture details of the design of policy instruments, especially exemption rules for high-polluting sectors. These exemptions can sometimes hamper innovations and investments, delaying a shift towards cleaner production.

A good policy setting could help clean sectors gain competitiveness

An adequate policy setting may help economies foster growth in "clean" sectors. The extent to which environmental policies influence bilateral trade patterns and the comparative advantage of economies depends on the ability of the economies to shift resources from losing sectors to cleaner and innovative sectors. This ability is often influenced by general economic policy settings in the countries. Implementing suitable policy settings, which support the switch from dirty to clean sectors can thus help achieving environmental objectives and potentially create a first-mover advantage in the production of "cleaner" goods and services.

Delaying environmental efforts risks masking competitiveness losses of dirty sectors

Halting environmental efforts risks artificially preserving the competitiveness of "dirty" sectors. Tightening environmental policies often faces resistance from sectors which fear losing their competitiveness, namely the "dirty" industries. Shying away from implementing more stringent environmental policies in the first place, however, only preserves the seemingly competitive "dirty" sectors, reducing incentives for investment in cleaner technologies and decreases any potential first-mover advantages.

Joint global climate commitments should be supplemented with agreements for clean technology transfers

A global climate agreement, which implies a tightening of environmental policies around the world would leave less room for offshoring of carbon-intensive sectors. If the gap in environmental policies across countries decreases due to a global effort of strengthening environmental policies, domestic "dirty" sectors are less likely to move to another country with laxer environmental policy standards. Additional agreements for clean technology transfers across countries might further help to ensure a global level-playing field of environmental policies.

Notes

[1] This chapter is a summary of the paper "Do Environmental Policies affect Global Value Chains? A New Perspective on the Pollution Haven Hypothesis" by T. Koźluk and C. Timiliotis (2016), published as OECD Economics Department Working Paper, No. 1282.

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