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Global manufacturing SO_2 emissions: does trade matter?

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Abstract A growth-decomposition (scale, technique and composition effect) covering 62 countries and seven manufacturing sectors over the 1990–2000 period shows that trade, through reallocations of activities across countries, has contributed to a 2–3% decrease in world SO_2

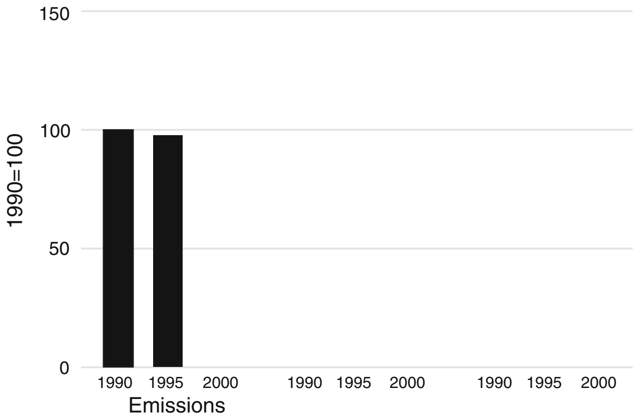
1 Introduction

The last 30 years have witnessed a dramatic increase in manufacturing exports by developing countries, which lead to a deep structural change of trade patterns at the worldwide level. These shifts fuelled fears in environmentalist circles that world pollution would grow since it is generally admitted that lower income countries are characterized by lower environmental regulations (see for example Dasgupta et al. (1999)). In the trade and environment literature, this argument is usually known as the "pollution haven" (PH) hypothesis. It has been theoretically challenged, because even though less stringent (and poor) countries may specialize in polluting industries (according to the PH argument), capital abundant (and rich) countries tend to specialize in capital-intensive industries that also happen to be polluting, so that the net effect of trade expansion on pollution is generally unclear (see Copeland and Taylor (2004)). This theoretical ambiguity is paralleled by a large and growing empirical literature (see e.g. Cole and Elliott (2003b) for recent evidence based on both old and new trade models), and it is fair to say that the debate is still largely unsettled, because results are sensitive to data availability, empirical methodology and the type of pollutant considered.

Sulphur dioxide (SO_2) is a pollutant frequently analyzed because of its suitable characteristics: it is a by-product of goods production[1] with strong regional effects, available abatement technologies, and different regulations across countries. Moreover, a deeper understanding of SO_2 emissions contributes to a better understanding of three environmental problems: air pollution and smog, acid rain, and global climate change.[2] The SO_2 case is also a representative example of the methodological difficulties faced when analyzing the trade and environment nexus. One might say that the debate has been principally informed by studies following a rigorous (and useful) methodology, but applied to indirect and potentially relatively unrepresentative data [e.g. SO_2 concentrations rather than production-related emissions by Antweiler et al. (2001) or Frankel and Rose (2005), or economy-wide emissions rather than industry-specific ones as in Cole and Elliott (2003a)]. With the exception of the recent work by Levinson (2007), which is limited to the US case, a common feature of these studies is that their estimates of the link between emissions and trade is indirect, due to the lack of disaggregated data linking pollution directly to production and to the resulting trading activities.

This paper is an answer to the need for more direct and detailed evidence on the link between trade and SO_2 emissions at the worldwide level. Using new data which 20(is8560.1384(e9773(/FT1)[(),0-3.4257(07)]TJ-4)0196(2/F8.7(0taile297.-8.7(as)-how8.7(e)7d)-

a growth-decomposition analysis based on observed worldwide changes in



kilograms of SO_2 per employee or per dollar) which vary across time, sector and country are from our companion paper.[4]

Figure 1 presents the evolution of SO_2 emissions, output and employment in the manufacturing sector at the world level. The contrast is striking between the decline in manufacturing emissions by 10%, while employment and output are concurrently rising by 10 and 20% respectively. Overall, manufacturing became a lot cleaner at the worldwide level.

Three reasons for this decline in emission are reviewed in the different panels of Fig. 2. Figure 2a shows an increase in the output share of clean products.[5] However, employment shares follow an opposite trend, suggesting that the explanation is more complex and linked to differences in productivity gains between "clean" and "dirty" sectors.

A second possibility would be that, contrarily to what is feared by environmentalists, production could have shifted towards cleaner countries. Splitting the sample into a "North" and "South" group in Fig. 2b gives ammunitions to the environmentalists: the share of the South is rising, particularly for employment, which increases from 50 to almost 60% across the sample period. Thus, although it remains to be confirmed that Southern countries are indeed dirtier (see below), the global shift towards cleaner countries seems an even more inadequate explanation than the previous one.

declining for both North and South. Note also that the difference in levels

Using a “^” to denote percentage changes and neglecting interaction terms (which are uniformly allocated to main effects in the application), total logarithmic differentiation of (2) yields (3) which shows that global growth of SO_2 emissions can be decomposed into a scale effect, L_t, a

Table 2 Scale, composition and technique effects (percent)

	Shares in 1990		Total effect	Decomposition of total effect			
	Labor share	Emission share		Scale	Between country	Between sector	Technique
Total effect[a]	100	100	9.85	9.55	2.44	–3.03	–13.94
Decomposition by end use							
Domestic use	79.40	77.38	–19.17	–12.61	–1.86	11.88	–16.57
Exports	20.60	22.62	22.00	80.80	–19.66	–32.57	–6.57

[a] Slight differences in results with those in Table 1 come from the inclusion of one additional interaction term. The total effect is a weighted average of the different end use effects where emission shares are used as weights

strong, the between-sector effect would be negative for domestic use and positive for exports, the opposite of the observed pattern.

These aggregate results are based on summing the elements of (4) over 62 countries and seven sectors (434 combinations). Hence it is natural to identify influential countries and sectors by grouping together the relevant combinations. Figure 3 ranks the countries (Fig. 3a) and activities (Fig. 3b) that account for the bulk of the change in emissions. We concentrate here on absolute effects to isolate the combinations of sectors and countries that have experienced the largest (be it positive or negative) structural change in SO_2 emissions. Figure 3a lists 12 countries that account for three quarters of the cumulative effects. Except for Chile, Peru and India, all countries contribute to a decline in emissions. The right-hand panel carries out the same decomposition as in Table 2. We find negative technique effects for all countries but for the three mentioned above and also large technique effects for China (10%) and Germany (3.3%).[11] Figure 3b reports the ranking for the six dirty industries and the residual “clean” sector. Looking at the net contribution to the decline in emissions, the leading sectors are petroleum and coal products, followed by chemicals and iron and steel, with most of the contribution to the decline coming from the adoption of cleaner technologies. Non-ferrous metal stands out as the only sector with a strong net growth in emissions.

These findings are broadly confirmed when the results are reported at the most disaggregated level (see Table A6 in Grether et al. (2007)). Among the most influential commodity-country combinations, Chile and Peru stand out with a positive rather than negative technique effects for their copper smelting activities.[12] Non-ferrous metal is also the most influential sector in China.

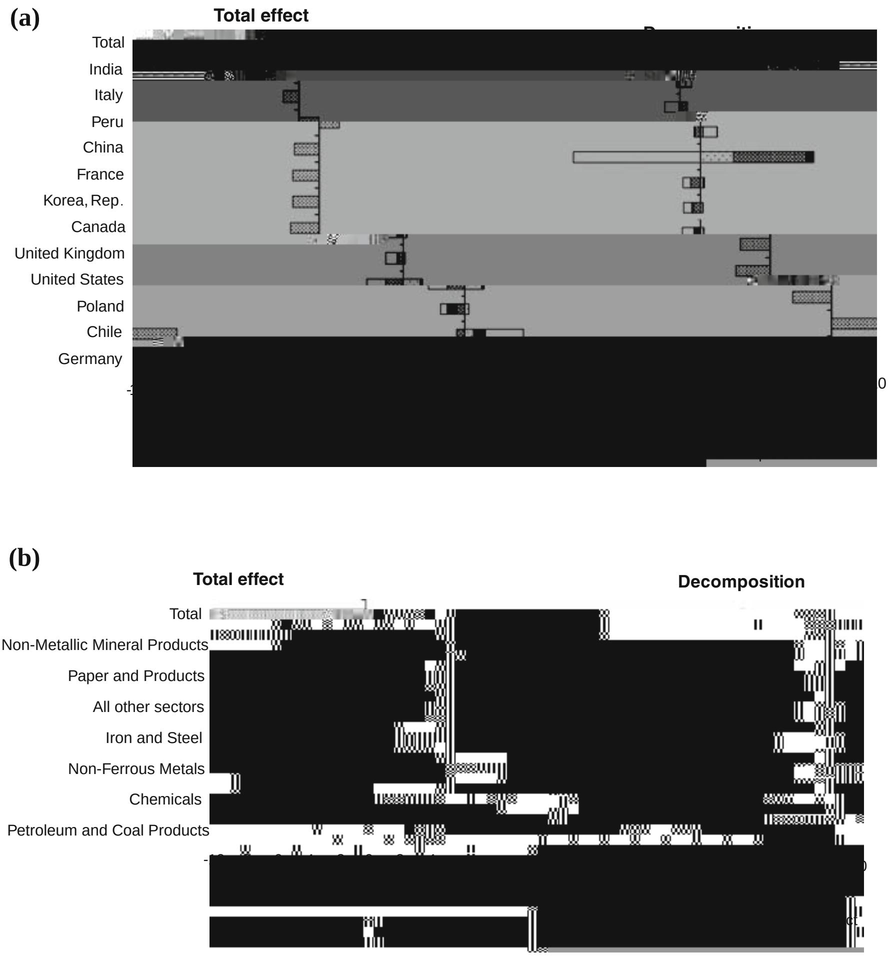


Fig. 3 Growth decomposition by country and sector. a Contribution of each country to total effect (ranked by decreasing absolute total effect) b Contribution of each sector to total effect (ranked by decreasing absolute total effect)

Summing up, the decompositions suggest that the (temporal) reallocation of production brought by trade (or between-country effect in our framework) has led to a small reduction (around 2–3%) rather than to an increase in SO_2 emissions at the world level. This result is quite robust across databases and should mitigate the fears raised by environmentalists. However, to get a fuller sense of trade-related effects, one must move beyond a temporal analysis and carry out a counterfactual analysis based on a no-trade benchmark.

3 Would autarky be any cleaner?

By allowing production to be decoupled from consumption, trade leads to a different level of world emissions than in a no-trade situation. To this effect, we

$$E_{kt} \quad M_{kt} n r_{kt}; \qquad (7)$$

where M_{kt} is world imports (or exports) of good k ($M_{kt} = \sum_i M_{kit}$), n is the number of countries in the world, and r_{kt} is the covariance between pollution intensity and

diversity of available sources of average SO_2 emissions per tonne-km (tkm) shipped.[14]

International shipment estimates are reported in the middle part of Table 4.[15] Results show an increase in tonnage, value and in tkm tonnage. The increase in tkm translates into a similar increase in transport-related emissions. As a result, the share of transport-related emissions in total production-related emissions increases over the period (see bottom part of Table 4). Taking the average estimates, international from trade-related composition effects and trade related transport activities, we obtain that global worldwide manufacturing emissions are increased through trade by 16% in 1990 and 13% in 2000, i.e. the strong decline in the PH pattern identified in the previous section is almost eaten away by the increase in transport-related emissions.

environmental policies, all of which are likely to be of practical importance. These effects could be taken into account relatively easily in a multi-country general equilibrium simulation model which would also be an appropriate setting to study the effects of Pigovian taxation. Both extensions should be the focus of forthcoming efforts.

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