# Do Offshoring and Foreign Investment Influence Industrial Pollution Intensities in China?

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Industrial pollution is a major source of both air and water pollution in China. The unique trajectory of China's growth, heavily reliant on export production and foreign investment, suggests a link between its entry into global supply chains and current high pollution levels. Views on the environmental consequences of the international fragmentation of production are widely divergent. Some argue that global supply chain trade allow industrial countries to offshore the dirtier parts of their production process to poorer countries. Cole, Elliott, and Okubo (2012), for example, argue that firms that self-report higher levels of abatement expenditures are likely to be relatively pollution-intensive and are more likely to offshore part of their production process.

In contrast, Dean and Lovely (2010) propose several new channels by which supply chain trade may generate beneficial environmental effects. First, if highly fragmented industries are relatively clean, supply chain trade could shift the composition of developing countries' output and trade away from more conventional "dirtier" products, toward cleaner goods. Second, participation in global supply chains may increase the range of fragments that can be produced in a developing country. Using the Feenstra-Hanson (1997) model of fragmentation, Dean and Lovely show that inflows of FDI into fragmented production could cause the average pollution intensity of fragments produced in both the host and the source country to fall. Third, integration into global

supply chains is often accompanied by foreign capital inflows. This foreign investment is likely to promote access to greener technologies than those used locally. Thus, supply chain trade has the potential to (1) shift production toward cleaner industries, (2) generate a favorable composition effect within fragmented industries, and (3) strengthen the technique effect as greener technology is used.

Dean and Lovely (2010) find direct evidence of the first effect, and additional evidence suggestive of the second and third effects. The pollution intensity of China's aggregate exports has fallen dramatically. We show this is partly due to a major shift in the composition of trade toward highly fragmented industries, which are cleaner than China's traditional export industries. But the primary cause is a shift in production techniques across Chinese industries toward cleaner processes. Our econometric evidence suggests that the increased role of processing trade and foreign investment has contributed to reducing the pollution intensity of China's exports at the aggregate level.

Levinson (2009, 2010) investigates whether the falling pollution intensity of US production is due to the US simply replacing pollution-intensive goods production with imports. While he finds that changes in the composition of US output can partly explain falling US pollution intensity, the main explanation is cleaner US production techniques. US imports are, in fact, shifting towards cleaner products over time. Since supply chain trade is a dominant part of US-China trade, these results are consistent with the second channel above. As multinationals engage in production of fragments abroad, supply chain trade could reduce both the pollution intensity of the bundle of fragments produced in the host and the source country.

This paper builds on the work of Dean and Lovely (2010), but turns the analysis to the industry level. We measure the pollution intensity of individual industries from 1995-2006, using one measure of water pollution and three forms of air pollution ($SO_2$, smoke and dust). We then test econometrically how the involvement of each in the global supply chain affects the pollution intensity of production. To test for evidence of these favorable effects of supply chain trade, we investigate two hypotheses drawn from the model of trade and investment described above:

(1) a larger share of processing trade in total trade reduces an industry's pollution intensity;

(2) an industry's pollution intensity rises as the *state* share of investment rises and falls as the *foreign* share of investment rises.

We also examine the role of average firm size, productivity dispersion, pollution tax rates, the Two Control Zone policy for $SO_2$, WTO membership, and domestic and foreign trade barriers.

To test these hypotheses, we use industry fixed-effect regressions and instrumental variable techniques. We build a rich data set covering the period 1995-2006 by linking information from the Annual Survey of Industrial Production to pollution, output, and pollution fee statistics from China Environmental Yearbooks, and to detailed trade data from China Customs. We identify instruments for production fragmentation by modeling the determinants of processing trade. Potential instruments include export rebate rates, China's relative labor costs, and the real exchange rate. Similarly, we model the determinants of foreign investment to create an instrument using historic industry shares of FDI.

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