International outsourcing and innovation in clean technologies

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With the pressing challenges posed by climate change and other environmental issues, understanding the incentives for firms to develop and adopt new and cleaner technologies has become a lively research area, both on the theoretical (e.g. Acemoglu et al., 2012) and on the empirical side (Aghion et al., 2014). In this paper, we examine for the first time[1] the relationship between trade with low-cost countries and innovation in "clean" technologies that aim to reduce material or energy use. Based on a theoretical North-South product cycle model with international outsourcing and innovation, we argue that, as materials become cheaper through importing, they represent a lower fraction of production costs, so that innovating to reduce the use of material becomes less interesting. Hence, when the share of materials sourced from low-cost countries increases, innovation efforts to reduce material use is predicted to decrease. In other words, our model predicts a trade-off between international outsourcing and innovation in environment-friendly technologies.

To investigate this question, we combine three sources of data for an unbalanced panel of over 5,000 French companies observed during six periods of times from 1994 to 2010. Detailed data on innovation activities is available from the Community Innovation Survey (CIS), which asks firms about their innovation activities. The six waves of survey include a set of questions on environmentally-friendly innovation. In particular, firms were asked to score from 0 to 3 the importance in their decision to innovate of making innovations that reduce either use of energy or material per unit of output. The CIS data is complemented with firm-level data on imported inputs. Annual country-of-origin and product-level import transaction records at the firm level are obtained from the French customs. We use product classification information to identify imported goods that enter into production processes, distinguishing materials and energy-intensive products from other products in order to precisely match the CIS innovation questions. Information on the country of origin of imports allows us to proxy the relative cost of inputs faced by companies. Finally, financial data from a third database allows us to control for firm heterogeneity, through characteristics such as the number of employees, whether the firm is owned by a multinational company, etc. We use industry fixed effects to take unobserved differences

[1] Most of the recent literature on the determinants of environmental innovation has focused on the role of environmental policy (see e.g. Popp, 2002; Johnstone et al., 2010; Aghion et al., 2014). Only one paper analyzes trade and innovation behavior jointly at the firm-level, but outside of the environmental area. Böler, Moxnes, and Ulltveit-Moe (2012) examine the interdependence of R&D and intermediate inputs and their joint impact on firm's productivity. They find that importing increases productivity, which frees up resources that can then be used to increase innovation activity.

between industries into account.[2] We also include time period fixed effects to control for any period specific shocks that impact every firm.

Our empirical analysis offers strong support for our theoretical predictions. We find robust evidence that a higher proportion of materials and energy imported from low-cost countries is negatively associated with firms' propensity to introduce a new technology that reduces material or energy use. This finding is stable across the set of countries that we define as 'low-cost': our baseline results follow the definition in Bernard et al. (2006) and use countries with a GDP per capita which is lower than 5% of that of the US, but our results are robust to considering instead all non-OECD countries, BRICS countries or only China and India. Similarly, our results are robust to a number of placebo and falsification tests. For example, we find that the share of materials imported from EU countries does not have a statistically significant effect on the propensity to introduce an environmental innovation.

To explore the direction of the observed correlation between innovation in 'clean' technologies and low-cost imports, we adopt an instrumental variable approach. We instrument our main explanatory variable (the share of materials imported by firm *i* from low-cost countries) with the share of materials imported from low-cost countries by the US and the European Union weighted by the distribution of products imported by firm *i*. This instrument has the required properties: first, imports by the US and other European countries depend partly on prices of inputs in low-cost countries and are thus strongly correlated with imports by French companies; second, it is unlikely that imports by third-party countries directly influence innovation by French companies. Our instrumental variable estimations confirm our main results. The coefficients are still negative and highly statistically significant, and the point estimates increase in absolute terms, suggesting the presence of some reverse causality. We conclude from the IV estimation strategy that a higher proportion of materials and energy imported from low-cost countries has a negative impact on firms' propensity to introduce a new technology that reduces material or energy use.

The magnitude of the effects uncovered in this paper is large: at the sample mean, an increase in the share of materials imported from low-cost countries by one standard deviation (a move from 3% to 15%) is predicted to decrease firms' propensity to introduce a material or energy saving innovation by 14 percentage points. The same increase reduces the probability of material or energy saving innovations being highly important by 5 percentage points and increases the probability of these innovations being unimportant by 7 percentage points. To put these figures into perspective, on should consider that the share in US imports of intermediate goods coming from China and India alone has increased from 2.0% in 1990 to 9.5% in 2010. Thus, our results suggest that, ceteris paribus, trade with low-cost countries might have significantly reduced environmental innovation during the past 20 years.

[2] We favor industry fixed effect over firm fixed effects as it has no impact on the size of the coefficient. This suggests that our control variables successfully control for firm heterogeneity.

This paper has important policy implications for the current debates on carbon 'leakage'. In a free-trade world, increased carbon prices following adoption of unilateral climate policies may generate a pollution-haven effect in other countries or regions, whereby foreign countries specialize in the production of carbon-intensive products in which they have a newly acquired competitive advantage and which they can subsequently export back to 'virtuous' countries. Environmental policies may thus fail to achieve their desired objective while destroying jobs in environmentally-friendly countries. Our paper suggests that leakage may not only affect jobs and emissions in the short run. It also affects long-run emissions and competitiveness by reducing incentives for firms to conduct innovation in 'clean' technologies. This may provide further justification for policies to prevent leakage.

References

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