T000230

pollution haven hypothesis

The pollution haven hypothesis, or pollution haven effect, is the idea that polluting industries will relocate to jurisdictions with less stringent environmental regulations. Empirical studies of the phenomenon have been hampered by the difficulty of measuring regulatory stringency and by the fact that stringency and pollution are determined simultaneously. Early studies based on cross sections of data found no significant effect of regulations on industry locations. Newer studies that use panels of data to control for unobserved heterogeneity or instrumental variables to account for simultaneity have found statistically significant, reasonably sized effects.

The pollution haven hypothesis (or pollution haven effect) posits that jurisdictions with weak environmental regulations – 'pollution havens' – will attract polluting industries relocating from more stringent locales. The premise is intuitive: environmental regulations raise the cost of key inputs to goods with pollution-intensive production, and reduce jurisdictions' comparative advantage in those goods. The Heckscher–Ohlin model provides the theoretical foundations by showing that regions will export goods that use locally abundant factors as inputs. Empirically, however, robust evidence that industries shift production to less stringent jurisdictions has proven elusive.

Econometric studies of the pollution haven effect have typically focused on reduced-form regressions of a measure of economic activity on some measure of regulatory stringency and other covariates:

$$Y_i = \alpha R_i + X_i'\beta_i + \varepsilon_i \tag{1}$$

where Y is economic activity, R is regulatory stringency, X is other characteristics that will affect Y, and ε is an error term. The pollution haven hypothesis is that estimates of $\partial Y/\partial R$ will be negative ($\hat{\alpha}<0$). The empirical literature contains a wide variety of implementations of (1). Some studies focus on international trade, where Y_i represents, say, net exports from country i, and the right-hand side contains country characteristics. Others focus on employment, foreign direct investment, or new manufacturing plant births. Equation (1) has also been used to examine the pollution haven hypothesis at the level of sub-national jurisdictions, such as US states or counties. Some studies have further disaggregated Y by industry, in the expectation that environmental regulations have a larger effect on polluting industries than on clean ones.

On the right-hand side of (1), finding an appropriate measure of regulatory stringency (R) is not simple. The problem is not merely one of collecting the appropriate data; merely conceiving of data that would represent R is difficult. What we want to know is how much more costly production is in a given jurisdiction relative to others, due to the jurisdiction's environmental regulations. These environmental compliance costs could take many forms: environmental fees or taxes, permitting costs, regulatory delays, emissions limits that require installation of costly technology, the threat of lawsuits, product or process redesign, forgone output, and so forth. Some attempts to measure these costs involve creating indices by weighting various country or state characteristics such as environmental agencies' budgets, public awareness of environmental problems, the international environmental agreements the country has joined, states' congressional delegations' voting on environmental issues, or other general indicators. Other studies have used measurements of pollution directly, arguing that, for example, high sulphur emissions

are evidence of lax regulations. Studies based on US data have used measures of manufacturers' pollution abatement expenditures by state or industry, using the US Census Bureau's *Pollution Abatement Costs and Expenditures* (PACE) survey, which ran from 1973 to 1994 and resumed in 2005.

None of these measures of R is ideal for testing the pollution haven hypothesis. The compiled indices of stringency are inherently ad hoc, and typically not available in more than one cross section. Using pollution directly as a proxy for stringency is also problematic. High levels of pollution could be symptomatic of lax of regulations, or could mean that the jurisdiction, finding itself with a poor environment, must enact stringent regulations to reduce pollution. This is true in the United States, where counties that are out of compliance with national air-quality standards are required by the federal Clean Air Act to enforce stricter emissions laws. Even direct measures of abatement costs from the PACE are troublesome. States with the highest average abatement costs are those with the most polluting industrial compositions. Estimates of (1) in which average abatement costs proxy for R find that more polluting industries locate in places with higher abatement costs – the opposite of the pollution haven effect.

Even if we had available an ideal measure of regulatory stringency, R, two further econometric issues complicate estimates of eq. (1): unobserved heterogeneity and simultaneity. The first problem is that some unobserved characteristics of the jurisdictions or industries being studied are likely to be correlated with both economic activity and regulatory stringency. A country with an unobserved comparative advantage in a polluting good (abundant high-sulphur coal or proximity to markets) is likely to both export that good and enact strict environmental regulations. This means that R and ε are correlated in (1), and estimates of $\hat{\alpha}$ will be biased. In fact, cross-section comparisons sometimes find that countries with higher stringency have more polluting activity, which is in turn easily mistaken for evidence of the Porter hypothesis that environmental regulations promote competitiveness (Porter and van der Linde, 1995).

The simplest solution to the problem of unobserved heterogeneity is to estimate a panel-data version of (1) and include fixed effects by jurisdiction or industry, whatever the relevant unit of observation:

$$Y_{it} = v_i + \alpha R_{it} + X'\beta_{it} + \varepsilon_{it} \tag{2}$$

These fixed effects (v_i) capture the unobserved characteristics of jurisdictions or industries that make them likely to have both strict environmental regulations and high levels of activity. However, including fixed effects requires panel data on regulatory stringency, which makes measuring stringency in the first place even more difficult.

The second econometric issue confronting estimates of (1) and (2) is that economic activity and pollution regulations may be determined simultaneously. The pollution haven hypothesis suggests that environmental regulations affect exports, but the reverse may also be true: exports may affect regulations. If trade increases incomes, and environmental quality is a normal good, trade could increase voters' demand for strict environmental regulations. Or, increased pollution caused by trade could increase local demand for strict environmental regulations. In theory the straightforward solution to this problem is to use instrumental variables. In practice this means finding instruments for a variable, R, that is difficult to measure in the first place. In the panel context (2), it means finding something that changes over time, is correlated with R_{it}, and is uncorrelated with ε_{it}.

The empirical studies that employ these techniques span more than 30 years, and are growing in number. While enumerating them here would be

impractical, their broad lessons are becoming clear. The first generation of empirical work on the pollution haven hypothesis used cross sections of data and made no attempt to control for unobserved heterogeneity or simultaneity. Most of them found small insignificant effects of environmental regulations, a few found counter-intuitive positive effects, and none found robust significant support for the pollution haven hypothesis. This early literature is summarized in Jaffe et al. (1995, p. 157): 'Overall, there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness.'

In recent years, economists have begun to use panels of data and fixed-effects models to control for unobserved heterogeneity, and instrumental variables to control for simultaneity. In contrast to the earlier cross-section studies, this newer work has tended to find statistically significant, reasonably sized evidence of pollution havens. It is catalogued in detail by Brunnermeier and Levinson (2004), and summarized in Copeland and Taylor (2004, p. 48), who write that 'after controlling for other factors affecting trade and investment flows, more stringent environmental policy acts as a deterrent to dirty-good production'.

One example of this recent literature exploits the US Clean Air Act, which mandates that every county in the United States achieve the same minimum level of ambient air quality. Federal law requires counties that fail to attain this standard to implement more stringent regulations. A convenient aspect of this law for pollution haven research is that from the perspective of any single county the law is exogenous. Neither the law's first enactment in 1970 nor any subsequent tightening of the air quality standards has been a function of any one county's characteristics. This suggests that an indicator for whether a particular county is in compliance with the national standards makes a good instrument for the stringency of that county's environmental regulations. Non-compliance changes over time, is correlated (positively) with stricter regulations, and is unlikely to be correlated with ε_{it}. Using this strategy, Becker and Henderson (2000) find that a county's failure to meet the national air quality standards reduces the number of new plants being built by four heavily polluting industries by between 26 and 45 per cent. Greenstone (2002) shows that these non-attainment counties had about 590,000 fewer jobs, $37 billion less capital stock, and $75 billion less output (in 1987 US dollars) between 1972 and 1987 than counties that met the national standards.

An important caveat should accompany findings of this type: they are positive, or descriptive, rather than normative. These tests of the pollution haven hypothesis merely measure whether industry relocates to less stringent jurisdictions; they have no welfare implications. Nevertheless, advocacy groups with widely varying agendas have seized on the issue. Some environmental groups express concern about pollution increases, resulting either from the trade-induced change in the pollution havens' industrial compositions or from the increase in overall economic activity due to trade. Manufacturing interests and labour unions in developed countries worry that the pollution haven effect means a loss of domestic profits and jobs. Free trade advocates fear that protectionist interests will use environmental regulations as a justification for trade barriers, or as a direct protectionist mechanism by lobbying for lower environmental standards as a form of subsidy to manufacturers. Anti-globalization protestors claim that trade liberalization will exacerbate all of these outcomes: degrading environmental quality in developing countries, weakening manufacturing in developed countries, and deterring all countries from setting sufficiently strict environmental standards.

In some cases these diverse parties have different or related interpretations of the pollution haven hypothesis. The most straightforward interpretation, represented by $\alpha<0$ in eqs. (1) and (2), is that environmental regulations cause polluting activity to shift to less stringent jurisdictions. Although virtually all of the empirical literature tests this descriptive hypothesis, much of the policy debate revolves around tangential issues with more normative implications.

One such related issue is whether trade liberalization exacerbates the pollution haven effect. Note the subtle difference. The straightforward pollution haven hypothesis is that environmental regulations affect trade. This extension claims that trade barriers disproportionately affect trade in polluting goods, and hence the environment. It seems that would be true only if the trade barriers had a larger effect on polluting industries than on clean industries. An empirical test of this extension would rewrite eq. (2) to include trade barriers and an interaction between trade barriers and regulations:

$$Y_{it} = v_i + \alpha R_{it} + \gamma T_{it} + \theta R_{it} T_{it} + X'\beta_{it} + \varepsilon_{it} \tag{3}$$

where T_{it} represents trade barriers such as tariffs (Ederington, Levinson and Minier, 2004). The straightforward pollution haven effect is now $\partial Y/\partial R = \alpha + \theta T$. The indirect effect of trade barriers on the pollution haven effect is $\partial\partial Y/[\partial T \partial R] = \theta$. Given the difficulties in measuring both regulatory stringency and trade barriers, and the likely endogeneity of both, few studies have attempted to estimate this indirect effect of trade liberalization on pollution havens. Nevertheless, it is important to be clear that the basic empirical estimates of the pollution haven effect do not address this more complex extension.

A second concern related indirectly to the pollution haven hypothesis is that governments will engage in inefficient competition to attract polluting industries by weakening their environmental standards. A welfare-maximizing government should set standards so that the benefits justify the costs at the margin. This does not mean that environmental standards will be equal everywhere. Jurisdictions have different assimilative capacities, costs of abatement, and values regarding the environment. So heterogeneity in pollution standards is to be expected, and by extension industry migration to less stringent jurisdictions does not necessarily raise efficiency concerns.

There might be cause for concern, however, if jurisdictions compete for investment from polluting industries by setting environmental regulations below Pareto-efficient levels. They might do so, for example, if there were cross-border spillovers, and the benefits of hosting a polluting manufacturer outweighed the *local* costs. Alternatively, if the industry is concentrated and pays rents to outside shareholders, jurisdictions may compete away their ability to capture some of the industry's rents. In these types of case, countries may lower their regulations below the Pareto-optimal levels in a 'race to the bottom' in environmental standards. Depending on the costs and benefits of hosting a polluting industry, they may also raise their standards above the Pareto-optimal levels in what has been called the 'not-in-my-backyard' (NIMBY) phenomenon. Levinson (2003) summarizes the theoretical and empirical literature on inter-jurisdictional environmental competition.

These questions of trade liberalization and inter-jurisdictional competition, however, extend the central issue of the pollution haven hypothesis. Most empirical studies of the pollution haven hypothesis ask the straightforward, descriptive question: have pollution-intensive industries become concentrated in jurisdictions with less stringent regulations? Early analyses based on cross sections of data typically found that environmental regulations had small or statistically insignificant effects on industry location.

However, recent studies using panel data to control for unobserved heterogeneity or instrumental variables to control for the simultaneity of regulations have found statistically significant, reasonably sized pollution haven effects.

Arik Levinson

See also

<xref = E000096> environmental economics;
<xref = xyyyyyy> international trade (theory);
<xref = S000300> strategic trade policy;
<xref = xyyyyyy> trade policy, political economy of.

Bibliography

Becker, R. and Henderson, J. 2000. Effects of air quality regulations on polluting industries. *Journal of Political Economy* 108, 379–421.
Brunnermeier, S. and Levinson, A. 2004. Examining the evidence on environmental regulations and industry location. *Journal of Environment & Development* 13, 6–41.
Copeland, B. and Taylor, M. 2004. Trade, growth, and the environment. *Journal of Economic Literature* 42, 7–71.
Ederington, J., Levinson, A. and Minier, J. 2004. Trade liberalization and pollution havens. *Advances in Economic Analysis & Policy* 4(2) Article 6. Berkeley Electronic Press.
Greenstone, M. 2002. The impacts of environmental regulations on industrial activity: evidence from the 1970 and 1977 Clean Air Act amendments and Census of Manufactures. *Journal of Political Economy* 110, 1175–219.
Jaffe, A., Peterson, S., Portney, P. and Stavins, R. 1995. Environmental regulations and the competitiveness of US manufacturing: what does the evidence tell us? *Journal of Economic Literature* 33, 132–63.
Levinson, A. 2003. Environmental regulatory competition: a status report and some new evidence. *National Tax Journal* 56, 91–106.
Porter, M. and van der Linde, C. 1995. Toward a new conception of the environment–competitiveness relationship. *Journal of Economic Perspectives* 9(4), 97–118.
U.S. Census Bureau.Various years. *Pollution Abatement Costs and Expenditures, MA200*. Washington, DC: U.S. Government Printing Office.

Index terms

environmental regulations
fixed-effects models
free trade
Heckscher–Ohlin trade theory
inter-jurisdictional competition
not in my backyard (NIMBY)
pollution abatement costs and expenditures
pollution haven hypothesis
Porter hypothesis
protectionism
race to the bottom
regulatory stringency
tariffs
unobserved heterogeneity

Index terms not found:

Heckscher–Ohlin trade theory
protectionism