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METHODS

Free trade and the environment-development system☆

Brantley Liddle *

Technology and Development Program, Massachusetts Institute of Technology, Cambridge, USA

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Abstract

We develop a simulation model to analyze the trade-environment-development system that contains a number of important advances over the earlier and current theoretical models. Our model, like other models, has an income-induced pollution policy, allows country factor endowments to influence trade patterns, and allows production factors to be mobile intersectorally. Unlike other theoretical models, our model treats pollution stemming from both production and consumption in a way that does justice to empirical observations. We model pollution policy *explicitly* as an abatement investment, thus effectively allowing for differences in pollution-intensive technology across countries. In addition, we allow for an internationally traded intermediate good (a natural resource). As a result of this novel approach, we find that (1) the benefits of trade (i) can be either positive or negative, and (ii) depend on country endowments; and (2) the pollution effects of trade are closely tied to the benefits of trade. Our model generally shows higher pollution levels under free trade than autarky; however, our results do not support the pollution haven hypothesis (i.e. trade causes less pollution in developed countries and more pollution in developing ones). Some developing countries produce more of the pollution-intensive good, but ultimately consume less pollution under autarky because they have higher per capita income and, thus, invest more heavily in environmental upgrading under autarky.

Keywords: Environment and trade; Pollution haven hypothesis; Pollution displacement hypothesis; Simulation models

1. Introduction

Free trade is believed to have conflicting impacts on the environment, both increasing pollution and motivating reductions in it. Trade can lead to a cleaning of the environment through a *technique effect*, i.e. as a response to the increased income that trade promotes, pollution policy is tightened, which spurs pollution reducing innovation/investment. On the other hand, environmental quality could decline through the *scale effect*, i.e. trade leads to an increase in the size of the economy, which tends to increase pollution. There is also a *composition effect*, where the pollution

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* Correspondence address: 5604 York Lane, Bethesda, MD 20814, USA. Fax: +1-603-908-6573.

E-mail address: btliddle@alum.mit.edu (B. Liddle).

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from the production of a pollution-intensive good declines in one country as it increases in another via the trade of that good. The occurrence of the composition effect has been attributed to two related hypotheses. The pollution haven hypothesis argues that low environmental standards will become a source of comparative advantage, and thus drive shifts in trade patterns. The pollution displacement hypothesis expects trade liberalization to lead to more rapid growth of pollution-intensive industries in developing countries as developed countries enforce stricter environmental regulations.

In our analysis of the trade-environment-development system, we developed and used a multidisciplinary simulation model consisting of economic, environmental, and demographic subsystems. A simulation model allows a more complete treatment of the complex environment-development nexus than earlier theoretical models. In addition, we recognize two empirically based stylized facts, (1) even in the presence of environmental policy (e.g. a pollution tax) factor endowments (e.g. labor, physical capital, materials, and technology) are still important drivers of industry location; and (2) much pollution results from consumption activity or sectors not subject to trade (e.g. transport).

Although there has been much work on the interaction between trade and the environment, many questions remain. The empirical literature is ambiguous, in part because of difficulty in articulating a difference between the very similar results of the migration of and specialization in pollution-intensive industries. Leonard (1988), Tobey (1990), Grossman and Krueger (1993), Jaffe et al. (1995) reject the pollution haven hypothesis, finding that factor endowments are more important than toleration of pollution in determining trade patterns and plant location decisions. Ugelow (1982), Robison (1988) find the impact of environmental regulations to be small, but potentially affecting trade. Meanwhile, Birdsall and Wheeler (1992), Low and Yeats (1992), Lucas et al. (1992), Lee and Ronland-Holst (1997), Dessus and Bussolo (1998) find that openness to trade in developing countries leads to specialization or an increase in pollution-intensive production there (i.e. confirming the displacement hypothesis).

Much of the theoretical literature, however, supports the migration of polluting industries (either through trade or capital flight) from a country introducing pollution policy. Many of the theoretical models contain assumptions that greatly restrict the ability to generalize their results. For example, Pethig (1976), Siebert et al. (1980), McGuire (1982), Chichilnisky (1994), Rauscher (1997) essentially treat pollution policy as exogenous, i.e. they do not emphasize the role of income in influencing pollution policy. Copeland and Taylor (1994, 1995) improve on these models by allowing for income-induced differences in pollution policy. However, in those models the income-induced policy differences are the *sole* motive for trade. Copeland and Taylor (1997) allow factor endowments also to influence the patterns of trade and find trade's impact on the environment ambiguous. In their latest model primary factors are not mobile across industries — one industry has only labor as an input, the other only capital. The costs to produce the polluting good now depend on environmental taxes and the cost of capital, and the country with the higher taxes is assumed to have the lower cost of capital. Not surprisingly, they find that whether trade is good or bad for the environment depends on whether differences in income or differences in capital endowment dominate, i.e. whether the differences in environmental taxes is greater than the differences in the cost of capital.

In addition, most theoretical models consider pollution resulting only from production. This can be a serious omission since the lighting and space conditioning of buildings (both residential and commercial) plus personal transport comprise 60–80% of total energy consumption in OECD countries (data from IEA, 1993), and since transport also is responsible directly for much urban (particulates, ozone, and NO_x) and global air pollution (CO_2). Two models, Copeland and Taylor (1995), Rauscher (1997), do consider pollution from the consumption of goods; however, the two goods (one polluting in consumption, one not) are easily substituted without loss in utility and are traded internationally. This assumption runs contrary to the empirical examples above, which are goods not easily replaced and not at all subject to trade.