International Review of Economics and Finance 43 (2016) 482–498

Contents lists available at ScienceDirect

International Review of Economics and Finance

journal homepage: www.elsevier.com/locate/iref

Global environmental standards with heterogeneous polluters

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ARTICLE INFO

Article history:
Received 17 June 2014
Received in revised form 8 January 2016
Accepted 11 January 2016
Available online 29 January 2016

JEL classification:
Q48
Q53
L91

Keywords:
Intra-industry trade
Firm heterogeneity
Environmental standards
Environmental R&D

ABSTRACT

We introduce environmental quality standards into a model of intra-industry trade with heterogeneous polluters. Pollution stems from consumption and pollution intensity declines with product-specific environmental quality. We formally analyze the effects of global environmental standards and three trade-liberalization policies. When consumer preferences for environmental quality are weak (strong) relative to the environmental quality elasticity of production costs, firms discovering dirtier (cleaner) products are more profitable and engage in exporting. More stringent environmental standards or trade liberalization policies enhance per-capita real consumption. The effects of these policies on global pollution and welfare are ambiguous.

1. Introduction

The nexus between trade and the environment has generated an intense academic and policy debate.[2] Despite the large body of theoretical and empirical literature, the channels through which international trade influences environmental quality are not well understood. Consider, for instance, the effects of tougher environmental standards on international competitiveness and global pollution. On the one hand, Porter (1991) and Porter and Van der Linde (1995) argue that tough environmental standards trigger environmentally friendly technological innovations that may reduce global pollution and enhance international competitiveness. On the other hand, Palmer, Oates, and Portney (1995), citing survey evidence argue that the costs of environmental regulations exceed their benefits implying that environmental regulations harm international competitiveness.

Similar considerations apply to several other controversial hypotheses concerning the effects of globalization on the environment. According to the "race to the bottom" hypothesis, import competition from countries with low environmental standards puts pressure for less stringent environmental regulations in countries with high environmental standards; the "pollution heaven hypothesis" asserts that countries with low environmental standards become destinations of multinationals using pollution-intensive technologies leading to higher global pollution; and the "gains from trade" hypothesis states that openness encourages growth and innovation both of which could improve environmental quality.

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[2] Frankel (2009) offers an excellent overview of the literature addressing the environmental effects of trade.

http://dx.doi.org/10.1016/j.iref.2016.01.009

The aforementioned arguments have been developed using traditional static and dynamic trade models generating inter-industry trade based on comparative advantage (Bovenberg & Smulders, 1995; Brock & Taylor, 2005). A few studies have addressed environmental issues in open economies engaging in intra-industry trade generated by symmetric monopolistically competitive firms (Gurtzgen & Rauscher, 2000; Fung & Maechler, 2005; Haupt, 2006).

The present paper studies formally the impact of environmental standards and globalization in an economic environment characterized by environmental-quality heterogeneity. It is partially motivated by the global automobile industry which constitutes a major source of air pollution.[3] The global automobile industry features substantial intra-industry trade and product-specific heterogeneity in environmental quality.[4] Environmental standards on vehicle emissions constitute an important national and global policy tool used to improve air quality. These environmental quality standards are expressed as minimum fuel efficiency requirements in the United States or maximum CO_2 emissions in Europe.[5] Finally, the global character of the automobile industry has generated international cooperation leading to a global harmonized emission standard.

Investment in environmental R&D is common in U.S. manufacturing industries and accounts for a sizable share of R&D. Scott (2003) surveys a group of manufacturing companies and reports that, on average, 23.9% of firm R&D expenditures are channeled towards environmental projects. Moreover, over one-half of the firms participating in the survey indicate that environmental R&D projects are undertaken because of specific environmental legislation. Goldberg (1998) confirms this finding by arguing that Corporate Average Fuel Economy Standards (CAFE) regulation offers incentives to develop environmentally friendlier technologies and vehicles.

In this paper we propose a model of intra-industry trade with heterogeneous polluters and structurally symmetric countries to address the following questions. What determines environmental-quality heterogeneity within each industry and the environmental content of intra-industry trade? Do more stringent global environmental standards lower industry productivity and competitiveness? What are the effects of higher environmental standards and trade liberalization on global consumption-based pollution, and welfare?

Following the theory of trade with heterogeneous firms, we envision a global economy consisting of many structurally identical countries with labor as the sole factor of production.[6] We are the first to recognize that the assumption of structurally identical countries is restrictive and excludes the analysis of North–South environmental issues including national differences in emission standards. However, this assumption carries several advantages. First, it offers considerable analytical mileage and sharpens the intuition of main results. Second, the assumption of symmetric countries excludes links between trade and the environment that have been analyzed extensively by other studies: there are no gains from trade based on terms-of-trade changes; there are no cross-country income differences; and there are no incentives for international factor movements. In other words, the assumption of structurally identical countries highlights the environmental effects of firm heterogeneity which is missing from the existing literature on trade and the environment.

In our model, new varieties are discovered through resource-based environmental R&D investment. Firms engage in environmental R&D in response to government regulations with the purpose of meeting the minimum environmental quality standard.[7] We view environmental R&D as a compulsory investment before any production materializes. We assume that firms pay a fixed entry cost to invest in environmental R&D enabling them to draw an environmental quality parameter from a common and known distribution. Each successful firm learns the environmental quality level and faces an exogenous, government-imposed, minimum environmental-quality standard, such as CO_2 emissions. If the discovered variety does not meet this standard, the firm exits the market immediately. Firms producing products with environmental quality equal or greater than the government imposed standard serve the market. Additionally, we assume that the marginal cost of production increases with the level of environmental quality. For instance, in the case of cars installing lighter materials, high-quality batteries, better electronic components, and using more high-skilled workers raise both fuel efficiency and per-unit production costs.

As in Melitz (2003), successful firms can engage in exporting by paying a fixed foreign-market entry cost and incurring a per-unit trade cost. These assumptions provide an endogenous export cutoff environmental quality level that partitions firms by export status. The government-imposed standard serves the same purpose in the present model as the domestic fixed cost of production in the literature on heterogeneous firms and trade.

As in the case of vehicles and household appliances, consumption generates pollution. The amount of pollution per variety is proportional to the quantity consumed adjusted by the pollution intensity. The latter decreases with variety's environmental quality. In other words, firms that discover products with higher environmental quality exhibit lower pollution intensities. This assumption is consistent with evidence on cars: the 2015 Mitsubishi Mirage with fuel efficiency of 37 MPG emits 238 g of CO_2 per mile, whereas the 2015 Chevrolet Spark EV (electric) with fuel efficiency of 119 MPG emits close to zero grams of CO_2.[8]

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[3] Emissions, such as air toxics and urban smog, contribute substantially to health and environmental degradation. Additionally, a typical consumer's most polluting daily activity is car driving. On average, each car generates 20 lb of CO_2 per gallon burned leading to 6 to 9 tons of CO_2 emissions each year. For a typical household in the United States, vehicle emissions contribute to 51% of CO_2, followed by household appliances (26%), and heating and cooling (18%).

[4] Cars with different level of fuel efficiency deliver different amounts of emissions. For instance, among 2014 models, Chevrolet Spark EV delivers 119 miles per gallon whereas Mercedes-Benz SLS delivers 14 miles per gallon. Many countries including the United States, Japan and Germany export and import cars and trucks from each other. Feenstra and Taylor (2014, Table 6-4) report that in 2012 the value of intra-industry index for small cars was 40%.

[5] In 2009, President Barack Obama announced higher emission standards requiring each manufacturer to reach an average of 35.5 miles per gallon (MPG) by 2016. The European Union has adopted the grams per kilometer car emissions standard (EU NEDC). An, Early, and Green-Weiskel (2011) provide more details on policies associated with vehicle emissions.

[6] The literature developing the theory of trade with heterogeneous firms includes Melitz (2003), Melitz and Ottaviano (2008), Baldwin and Harrigan (2011), and Johnson (2012) among many others. Redding (2011) provides an excellent literature review of theories of trade with heterogeneous firms.

[7] Environmental R&D may reduce the cost of abatement or reduce the amount of polluting inputs used in the production process, as in Bovenberg and Smulders (1995) and Xepapadeas and de Zeeuw (1999).

[8] See www.fueleconomy.gov, the official U.S. government source for fuel economy information.