International Review of Economics and Finance 34 (2014) 52–71

Contents lists available at ScienceDirect

International Review of Economics and Finance

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

Bilateral trade and the environment: A general equilibrium model based on new trade theory

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ARTICLE INFO

Article history:
Received 21 January 2013
Received in revised form 7 July 2014
Accepted 8 July 2014
Available online 22 July 2014

JEL classification:
F18
L60
Q53
Q56

Keywords:
Bilateral trade
Trade barriers
Comparative advantage
Environmental regulations
Harmonization

ABSTRACT

This study develops a trade–environment model based on new trade theory and emphasizes the role of international productivity differences in quantifying environmental consequences of trade. I introduce environmental policy and factor endowment differentials into a multi-country general equilibrium model of bilateral trade with random productivities and trade barriers. I calibrate the model for the OECD countries by estimating trade barriers and productivity parameters so as to match bilateral manufacturing trade shares. The calibrated model is used to analyze impacts of free trade and two types of environmental harmonization policies. I find that full trade liberalizations help to lower OECD pollution emissions by 32%, and about half of the decline in pollution is due to international productivity differences. I also show that harmonization of environmental taxes across the OECD countries is predicted to be more effective than the harmonization of pollution quotas in reducing aggregate pollution while under both policies trade impacts are relatively small.

1. Introduction

The relationship between trade and environment has received a great deal of attention since the early 1990s, among both academics and policy makers. Simultaneously, a substantial body of literature on the environmental consequences of trade liberalization has developed (e.g., Copeland and Taylor (1994, 1995), Antweiler, Copeland, and Taylor (2001), Cole and Elliot (2003), Frankel and Rose (2005), Managi, Hibiki, and Tsurumi (2009)). Economic models employed in this strand of the literature are typically based on traditional theory of trade, and more specifically, two-country Heckscher–Ohlin–Samuelson trade models.

In this paper, I extend the literature by developing a multi-country general equilibrium model of trade and environment based on new trade theory. As it is well-established over the past decade, world trade patterns are captured more accurately by new trade models that account for international differences in productivity and trade barriers (see for example, Eaton and Kortum (2002), Alvarez and Lucas (2007), Wu, Liu, and Pan (2013)). The model studied in this paper shows that these findings of new trade theory play a crucial role for an accurate estimation of the impact of trade on environmental quality. It demonstrates that international differences in productivity may generate about one half of the total change in pollution following free trade.

The model assumes a multi-country framework where countries differ in capital abundance, environmental regulation levels, productivity, and trade barriers. In other words, trade is driven by both Ricardian and Heckscher–Ohlin–Samuelson type incentives. Trade barriers are assumed to be potentially different across industries. A gravity equation is then used for the estimation of trade barriers

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http://dx.doi.org/10.1016/j.iref.2014.07.003
1059-0560/

faced by different countries. Hence, comparative advantages are determined by an interaction of both country and industry characteristics. Pollution, which is regulated by the individual governments, is modeled as a by-product of production. Model parameters are calibrated to match bilateral manufacturing trade shares in the OECD countries and as a result, the model produces export–import ratios and home trade shares that are in reasonable agreement with the OECD data.

Main findings from the calibrated model can be summarized as follows: (1) Free trade increases net-exports of pollution-intensive goods by the developed countries in the OECD. In other words, pollution haven effects are not predicted to be dominant. This qualitative finding supports some of the earlier results obtained in the literature. Quantitatively, free trade is predicted to facilitate a 32% reduction in air pollution emissions within the OECD. (2) About one half of the decline in pollution emissions is due to productivity differentials. Omission of this channel causes a significant underestimation of the impact of trade openness on environmental quality. (3) Depending on the type of the environmental harmonization policy chosen, trade implications and achieved levels of pollution reductions will differ. The model predicts that a greater reduction in pollution emissions can be achieved through harmonization of environmental taxes than under harmonization of pollution quotas while both policies aim to reach highest standards prevailing in the OECD.

The framework adopted in this paper is mainly built on the seminal work by Eaton and Kortum (2002), but it further incorporates the role of environmental regulations, capital abundance and sectoral differences in factor shares. As another divergence from Eaton and Kortum (2002), trade barriers are assumed to differ across industries in this paper. This model is also closely related to some of the influential studies that explore the relationship between trade liberalizations and environmental quality. Two of these studies are Copeland and Taylor (1994, 1995). While the pollution aspect has been added to the model following Copeland and Taylor (1994), the approach in this study is different in some aspects. In their papers, the authors present general equilibrium models with local and global pollution, respectively, where there are two regions or countries (high income North and low income South). In this paper, I adopt a multi-country framework with local pollution. These models predict that trade liberalization could increase world pollution since trade shifts the location of most pollution intensive industries to the South where the environmental regulations are weakest. A critical assumption driving this result is that comparative advantages in the world are determined solely by income-induced differences in the strength of environmental policy. An alternative approach in the literature is to include factor endowment differences as an additional factor determining comparative advantage since such effects could easily dominate the environmental policy induced differences. This possibility is considered in Antweiler et al. (2001), Copeland and Taylor (2003, 2004) and used as a dominant framework in several recent empirical studies that examine the impact of trade on the environmental quality. However, although a pure Heckscher–Ohlin–Samuelson trade model is particularly useful when the countries in question are sufficiently different, it cannot replicate patterns of trade between similar countries. In this model, I assume that comparative advantages are driven by a combination of factor endowments, productivities, trade barriers, and environmental regulations. This study is also related to an important recent paper, Beladi and Oladi (2011), in which the authors analyze the effects of trade liberalization on the environment under imperfect competitive market assumption in a two-country framework. They show that trade liberalization by the home country reduces global pollution if and only if the foreign technology is sufficiently cleaner than the home technology. Multi-country approach adopted in this paper forces us to assume competitive markets to keep the model tractable. At a different level, there are a number of studies that utilize reduced form equations from a theoretical general equilibrium model for estimation purposes (see for example, Managi et al. (2009), Antweiler et al. (2001)). However, the main structural parameters of these models remain hidden under this approach. In this paper, model parameters can be calibrated to match bilateral trade shares and the general equilibrium setting addresses potential endogeneity problems.

The remainder of this paper is organized as follows. Section 2 is devoted to the discussion of some data for the OECD countries regarding the relationship between trade patterns and other indicators to motivate the model choice. In Section 3, I introduce the model and then define and characterize a trade equilibrium. Section 4 describes the calibration procedure and presents main results from the baseline calibration while Section 5 discusses findings from the counterfactual experiments. Finally, Section 6 concludes.

2. Data and motivation

In Table 8 presented in Appendix C, I list several indicators for the OECD countries corresponding to year 2000, namely, export–import ratios in pollution-intensive (i.e., “dirty”) manufacturing goods, percentage share of a country's GDP in the total GDP of the OECD countries and capital–labor ratios.

The first column of Table 8 is formed as follows. First, the dirty manufacturing industries are determined by using the data by Hettige, Martin, Singh, and Wheeler (1987) prepared for the World Bank Industrial Pollution Projections Project (IPPP). The data show several measures of pollution emissions in pounds per number of employees in the US manufacturing sector on an ISIC 3-digit level. I particularly focus on air pollution data due to data availability concerns and rank the US manufacturing sectors according to total amount of air pollution emitted and identify the eight most polluting industries as petroleum refineries, miscellaneous petroleum and coal products, non-ferrous metals, iron and steel, industrial chemicals, other non-metallic mineral products, paper and products and other chemicals. Assuming that these pollution intensities are common to all countries, I proceed to calculating the export–import ratios in these polluting sectors using the NBER-UN World Trade Data 1962–2000 by Feenstra, Lipsey, Deng, Ma, and Mo (2005). The export and import values for the above-mentioned pollution-intensive goods are aggregated for the year 2000 after the concordance between ISIC and SITC was obtained. An export–import ratio that is greater (less) than one shows that the country is a net exporter (net importer) of the dirty goods.

The second column of Table 8 shows the percentage share of a country's GDP in total GDP of all OECD countries for the year 2000. The data used is GDP in current US dollars by WDI (World Development Indicators).