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Effects of environmental regulations on South Asian food and agricultural exports: A gravity analysis

W. P. A. S. Wijesinghe

ASIA-PACIFIC RESEARCH AND TRAINING NETWORK ON TRADE

Working Paper

NO.139 | JANUARY 2014

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Effects of environmental regulations on South Asian food and agricultural exports: A gravity analysis

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Please cite this paper as: W. P. A. S. Wijesinghe, 2014, Effects of environmental regulations on South Asian food and agricultural exports: A gravity analysis

ARTNeT Working Paper No. 139, January 2014, Bangkok, ESCAP.

Available at www.artnetontrade.org.

* Department of Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniya, Sri Lanka. This study received a grant from International Development Research Centre, Canada, through ARTNeT capacity building programme for trade research. The author gratefully acknowledges the excellent contribution provided by P. Thadchaigeni for the completion of the study, Prof. J. Weerahewa for her guidance and the reviewers for their valuable comments and suggestions. The technical support of the United Nations Economic and Social Commission for Asia and the Pacific and ARTNeT Secretariat in preparation of the study for online dissemination is much appreciated. Any remaining errors are the responsibility of the author who can be contacted at asanka197@gmail.com

Abstract: Regardless of the occasional dissenting voices, free trade is now being embraced by many of the nations of the world. South Asian countries joined the global consensus for frictionless trade by forming regional trade blocs under the banner of the South Asian Association for Regional Cooperation (SAARC). However, intra- and interregional trade in SAARC has not yet reached the desired stage, and a range of empirical studies have therefore been carried out with the objective of determining the causes. This current study is also motivated by the poor performance of the South Asian countries in world trade and it investigates the effects of environmental regulation on the food and agricultural trade of four South Asian nations, i.e., Bangladesh, India, Pakistan and Sri Lanka. For this study, the Gravity Model for international trade analysis was used with country- and time-specific fixed effects followed by Heckman sample selection model to avoid possible biases that are widely cited in the gravity literature. Trade data were retrieved from Trade Map while data for other gravity variables were retrieved from relevant recognized data sources. The Environmental Performance Index (EPI) was utilized as a proxy measure for the environmental regulation of the four SAARC nations and their trade partners to denote environmental regulation of reporting and partner countries. The results of the coefficient estimates revealed that even though there appears to be a relationship between stringent regulations and foreign trade without these specific effects, its significance fades as soon as both the importing and exporting country-specific effects are taken into consideration.

JEL classification: F14, F15, F18

Keywords: Food and agricultural exports, fixed effects, Heckman Selection Model, Environmental Performance Index, South Asia

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1. Background

During the present era of human civilization, international trade has become widely accepted as a vehicle for welfare gains to nations around the world, a fact that is being proved continuously by empirical research despite occasional dissenting voices. Apart from the integration of nations in world trade through global consensus, such as the General Agreement on Trade and Tariff (GATT) and its successor the World Trade Organization (WTO), a growing trend in regional cooperation to achieve perceived benefits from free regional trade has been witnessed since the 1990s. As of early 2013, some 546 notifications of Regional Trade Agreements (RTAs) (counting goods, services and accessions separately) had been received by GATT/WTO; of these, 354 were in force (WTO, 2013). The best-known regional trade agreements, i.e., the European Union, the European Free Trade Association (EFTA), North American Free Trade Agreement (NAFTA) and the Association of Southeast Asian Nations (ASEAN) Free Trade Area (AFTA), were catalytic in the emergence of more regional cooperation in free trade.

Under the banner of the South Asian Association of Regional Cooperation (SAARC), the South Asian countries also attempted to catch up with this trend as the welfare gains from open trade were being realized by the pioneer East Asian nations. The phenomenal urge of the SAARC nations to harvest from free trade is evident from the number of free trade agreements (FTAs) that have been reached in the region – currently 23, of which 21 are bilateral trade agreements. However, the actual benefits realized have not been particularly encouraging for the member countries (Dissanayake and Weerahewa, 2009). As a result a range of empirical studies, including the present study, have been carried out with the objective of determining the causes.

Despite significant trade liberalization attempts, progress in both intraregional and interregional trade has not been achieved at the desired rate and SAARC's recent share of exports and imports of goods as a percentage of world exports and imports amounted to 2.4 per cent and 3.9 per cent, respectively (IMF, 2010). More recent studies have indicated that smaller trade gains in South Asia are mainly due to insufficient attention being given to trade facilitation measures, such as efficiency in customs and other border procedures, the quality of transport, and costs of international and domestic transportation (Dissanayake and Weerahewa, 2009; Weerahewa, 2009). In addition, while tariff levels have declined as a result of trade liberalization in the region, environmentally-related, non-tariff measures (NTMs) and other technical standards have emerged as significant factors in determining world trade.

The impact of environmental regulation on trade has received steadily increasing attention since the early 1970s, following the introduction of stringent environmental regulations in developed countries (Xu, 2000). Van Beers and van den Bergh (2003) argued that relatively strict environmental policies could have a strong impact on foreign trade. One side of the argument is that countries that face relatively strict environmental regulations domestically tend to experience deterioration in international competitiveness and a decline in foreign trade, at least in the pollution-intensive industries (Harris and others, 2000*).* On the contrary, it is believed that by applying more strict environmental regulations, countries tend to become technologically innovative, thereby reducing production costs and improving their

ability to export in a long term (Costantini and Crespi, 2008). This view opens a novel avenue to understanding trade-impeding factors in the South Asian region.

However, although substantial empirical evidence exists of the trade flow determinants in the SAARC region, the effect of environmental regulation by SAARC member States and their trading partners on bilateral trade flows has not been considered in contemporary trade analyses. Existing empirical studies on the effects of environmental regulation on trade flows, which have been carried out mainly in Organisation for Economic Co-operation and Development (OECD) countries, have provided mixed results. Therefore, it is important to address the subject in the South Asian context. Since food and agricultural exports play a vital role in South Asian trade, this study attempts to quantify the effects of environmental regulation on the flow of agricultural exports by South Asian countries. Specifically, the study uses gravity model, incorporating the stringency of environmental regulation as an explanatory variable, under different model specifications.. The study focuses on trade flows of Bangladesh, India, Pakistan and Sri Lanka with their trading partners from 2003 to 2007..

This study is organized as follows. Section 2 reviews the current state of the integration of South Asian countries in the world markets in general and the state of agricultural trade in particular. Section 3 contains a brief review of the gravity model, focusing on the theoretical and econometrical issues that influence the selection of the models and techniques used in standard gravity estimates. Section 4 explains the methodology. Section 5 presents the results and discussion, followed by the conclusion in section 6.

2. Trade in South Asia

2.1 South Asia in the global trading system

The world trading system has become increasingly open and competitive in the past few decades. The elimination of the quantitative restrictions and reduction of tariffs in developed and developing countries through global consensus have paved the way for most countries to (a) adopt outward-looking economic policies, (b) seek ways of promoting growth and employment through expanding export production and (c) attract inward investment. The empirical studies on the relationships between trade and growth show supports to free trade (Kraay and Dollar, 2001).More than half of the developing countries, i.e., China, India and several other large countries, are now globalizing economies that have more or less embraced free trade. South Asia is no exception to this global trend in free trade as it has moved from import substitution to more liberal trade policies and export promotion. During the late 1970s in Sri Lanka and in the late 1990s in other South Asian countries, the tariff structures were simplified and the number of tariff bands was reduced. The changes in the tariff structures and exchange rate regimes as well as relaxation of payment restrictions during the 1990s are indicative of the move by South Asian countries towards greater openness in their trade (Samaratunga and others, 2007).

Following their significant trade liberalization attempts, South Asian countries have recorded rapid growth in international trade. India, which is the largest economy in South Asia and accounts for nearly 75 per cent of regional GDP, more than doubled its trade-to-GDP ratio from about 15 per cent to 35 per cent between 1990 and 2005. Similarly, other countries in the region, including Bangladesh and Sri Lanka, have also experienced impressive increases in their international trade. However, despite the gains from international trade, the region continues to have a smaller share of global trade and its exports still play a limited role in GDP. The region's share in the total world trade was less than 2 percent from 2003 to 2012 (table 1), which puts South Asia far behind the trade blocs of ASEAN and NAFTA.

Another significant phenomenon in the South Asian export pattern is the dominance of India, a fact that challenges the claim that South Asia has gained welfare improvements due to free trade. Accounting for the largest land area and population in South Asia, India claims the largest share in total and agricultural exports of South Asia exceeding 70 per cent in recent years (figures 1 and 2). Conversely, the contributions by smaller nations such as Bhutan, Nepal and Maldives are substantially less. This skewed distribution of trade within the region raises grave concerns over the viability of regional cooperation in enhanced regional trade, as inequality of this magnitude will discourage the smaller players.

2.2 Agricultural trade: A way towards the elimination of rural poverty in South Asia

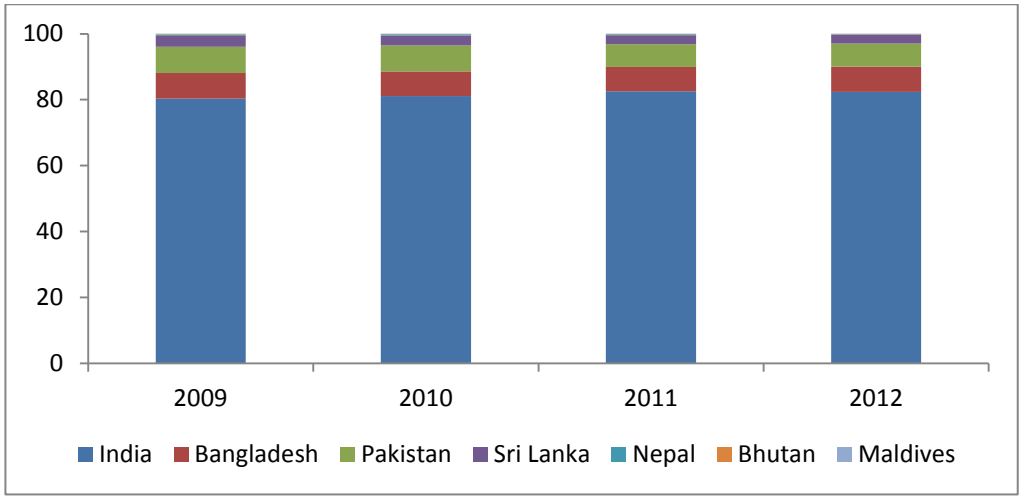
South Asia, which comprises three developing countries and five least developed countries, is densely populated with 1.5 billion people. The region has experienced robust economic growth, averaging 6 per cent a year, during the past 20 years. This strong growth has translated into declining poverty and impressive improvements in human development. The percentage of people in South Asia living on less than US$ 1.25 per day fell from 61 per cent to 36 per cent between 1981 and 2008. However, the South Asian region is remains home to many of the developing world's poor. According to the World Bank's most recent poverty estimates, about 571 million people in the region survive on less than US$ 1.25 dollars per day, accounting for more than 44 per cent of the developing world's poor. About 70 per cent of the population and about 75 per cent of the poor live in rural areas. Most of the rural poor depend on rain-fed agriculture, livestock raising, fragile forests, and/or casual and often migratory employment (World Development Report, 2008b). Rural poverty, fuelled by the free trade policies and with the agricultural sector left in the backseat in the drive for development, has become a burning issue in the region. Thus, elimination of rural poverty with the focus on agricultural growth requires more attention by the policymakers of the region.

Table 1. Shares of agricultural and total exports by SAARC, NAFTA and ASEAN in world trade

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
South Asian total exports as percentage of total world exports	1.12	1.13	1.27	1.30	1.34	1.41	1.77	1.79	2.01	1.94
South Asian agricultural exports as percentage of total world agricultural exports	1.76	1.78	1.96	2.01	2.07	2.24	1.98	2.25	2.76	3.25
ASEAN total exports as percentage of total world exports	6.28	6.24	6.20	6.34	6.17	6.07	6.48	6.94	6.85	6.99
ASEAN agricultural exports as percentage of total world agricultural exports	6.62	6.64	6.50	6.75	7.27	8.00	7.75	8.62	9.20	8.82
NAFTA total exports as percentage of total world exports	15.54	14.54	14.24	13.91	13.39	12.70	12.90	12.95	12.55	13.10
NAFTA agricultural exports as percentage of total world agricultural exports	16.00	14.87	14.30	14.53	14.68	14.87	14.44	14.69	14.44	15.11

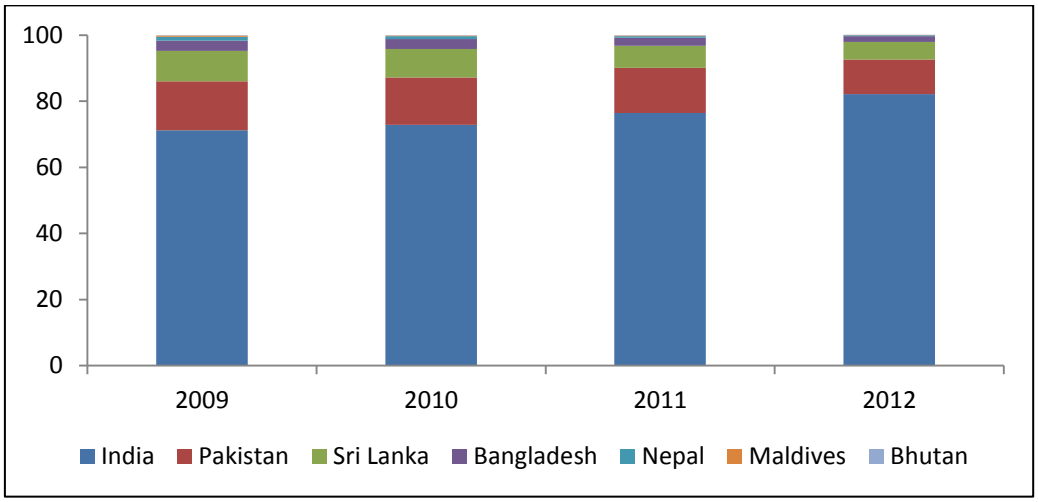
Source: Author's calculations, based on ITC exports data.

Figure 1. Percentage share of South Asian countries in total trade of the region, 2009-2012



Source: Author's calculations, based on ITC exports data.

Figure 2. Percentage share of South Asian countries in total agricultural exports of the region, 2009-2012



Source: Author's calculations, based on ITC exports data.

The structural changes that South Asian economies underwent in the 1980s and 1990s diverted the attention of policymakers from the agriculture sector towards more competent sectors such as manufacturing and services. According to the World Development Report (World Bank, 2008b), agricultural growth in the region is less than 3 per cent, which is far below the growth rates of other economic sectors. However, the agriculture sector is still an important component of the region's economy as it provides employment for about 60 per cent of the labour force and contributes 22 per cent of the total regional GDP. In addition, 25 percent of the active rural males, usually the poorest, are primarily employed as labourers in the agricultural sector. A notable importance of the growth of the agriculture sector in South Asia is that it is especially effective in reducing poverty. World Bank estimates show that,

overall, GDP growth originating in agriculture is, on average, at least twice as effective in benefiting the poorest half of a country's population than the growth generated in non-agricultural sectors.

Agriculture was a key to India's substantial long-term decline of poverty. Agricultural growth can reduce poverty directly by raising farm incomes, and indirectly through labour markets and by reducing food prices. Studies on India show that, in the long term, the food price effect has the largest influence on poverty reduction (World Bank, 2008a). However, in South Asia, the number of rural poor has continued to rise and will likely exceed the number of urban poor until 2040. Thus export-oriented agricultural growth is an urgent requirement for the region.

Table 2. Contribution of agricultural exports to total exports by South Asian countries

Exporters	2009	2010	2011	2012
India	8.32	8.71	9.89	13.03
Pakistan	18.44	19.15	20.54	18.29
Sri Lanka	10.89	10.58	10.32	10.03
Bangladesh	8.73	9.68	9.48	8.55
Nepal	27.77	23.65	21.50	19.05
Maldives	97.67	96.15	96.82	8.94
Bhutan	6.11	7.18	8.47	0.42

Source: Author's calculations based on ITC exports data.

2.3 Trade integration of South Asia: Successes and failures

The South Asian Preferential Trading Agreement (SAPTA), which was launched by SAARC in April 1995, is considered to bea major stepping-stone towards a higher level of intraregional trade liberalization and economic cooperation among the member countries. With this magnitude of trade liberalization, South Asian countries have the potential to emerge as another significant trading bloc following in the footsteps of the European Union, NAFTA and ASEAN. However, this trade liberalization move has, so far, achieved fewer benefits than anticipated.

The trade performance of South Asian countries during the past two decades has been poor relative to that of other regions. Exports from South Asia have only doubled during that period to approximately US$ 100 billion. In contrast, exports by East Asia grew tenfold (Newfarmer and Pierola, 2006). Despite the policy shift from inward-looking trade policies to more outward-oriented trade policies, the performance of the export sector in South Asia has proved far less satisfactory than expected due to several reasons.

First, international trade as a proportion of GDP is still well below the world average, and lower than any other region except NAFTA. Exports by South Asia accounted for only 13 percent of GDP in 2005 compared with the global average of 23 percent. The importance of international trade for South Asia has increased but from a very low base. During the 30 years from 1975 to 2005, exports by South Asia more than doubled, from 5 per cent to 13 percent of GDP; however, East Asia recorded an increase of almost fourfold, from 10 to 39

percent of GDP. In absolute terms, South Asia is a very small player in global trade, accounting for only about 1.2 percent of total world exports and 1.7 percent of imports (World Bank, 2008a).

Second, intraregional trade in South Asia is the smallest compared with other regions. Pierola and Newfarmer (2006) noted that South Asia's intraregional trade as a share of its total trade volume had remained at around 2 percent since 1980. This is very low compared with approximately 15 percent for East Asia. In fact, even when geographic proximity, levels of GDP, population and trade arrangements are taken into account, intraregional trade in South Asia is still lower than that of East Asia (Wilson and Otsuki, 2007).

The poor performance of South Asia has been attributed to several reasons including:

(a) Constraints in supply chains and trade logistics, which include a number of increasingly important barriers to exports by South Asian countries;

(b) The lack of harmonized transport systems, frequent reloading of goods, port congestion affecting turnaround times of ships, complicated customs clearance and non-transparent administrative procedures at customs.

Apart from these reasons, behind-the-border barriers, environmental regulations and standards imposed by importers also hinder export growth. Most countries in the South Asian region are of the view that the potential gains from tariff reductions have not been fully realized because of problems involved in meeting higher environmental and health-related standards. The primary exports of the region, which include textiles and garments, carpets, leather products and agricultural commodities such as tea, face setbacks from time to time due to the impact of environmental regulations set by importers (Kumar and Chaturvedi, 2003). The share of agricultural exports in total exports from South Asia has declined due to the higher quality standards imposed by the importing countries. Most industrial units in least developed countries such as Bangladesh and Nepal are small and medium-sized enterprises (SMEs), which lack financial and technological capability to comply with the requirements set by developed country importers (Khutan, 2009).

The linkage between trade and environment has become quite a controversial issue in the global trade policy debate. Despite the attempts byWTO to harmonize standards, the barriers in the form of environmental regulations enter the trade arena, mostly through unilateral actions (*Trade Insight*, 2012). The WTO Agreements on Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT) are intended to ensure that these standards and regulations are not used for protectionist purposes and do not cause adverse impacts on trade. However, provided there is scientific basis, importing countries try to impose their own standards and other regulations such as inspections of imported products, specific treatment or processing of products, fixing minimum allowable levels of pesticide residue, labelling and packaging requirements, good manufacturing practices etc.

According to UNCTAD statistics, in 2012 some 87 per cent of non-tariff measures imposed in trade are related to SPS, TBT and quality control measures. South Asian countries are bound by the TBT and SPS agreements. Major import sources and export destinations for South Asia include countries such as European Union members and North America, where more attention is given to environmental regulations of trade. A study by Mohanty and

Manoharan (2002) found that the NTMs imposed by European countries contained much higher environmental and health measures for the agricultural sector than for the industrial sector. The European Union has imposed various health and sanitary measures on imported products. For example, imports of fresh, chilled, frozen meat/fisheries products must meet certain health and hygiene standards and the imported products must come from European Union-approved sources.

A considerable amount of literature exists that quantifies the effects of various types of environmental regulations on bilateral trade, and the gravity model of trade is the key *expost* econometric technique used in such studies. The standard gravity equation of trade assumes that the volume of bilateral trade is positively related to the product of the countries' GDP and negatively related to geographical distance between trade partners. After the original gravity model evolved into a sophisticated tool used to measure not only border measures but also behind-the-border measures, environmental regulations were incorporated into several studies by considering the relative strictness of environmental regulations of trading partners.

Van Beers and Van den Bergh (1997) used a gravity equation to test the impact of environmental stringency on bilateral exports by OECD countries. They constructed indicators of environmental stringency based mainly on energy intensities and recycling rates, and ranked OECD countries according to their stringency in a 0-1 index. Their main finding was that OECD exports were negatively and significantly affected by regulations that were more stringent, in the case of both the exporters and the importers. They also showed that imports were negatively correlated with the importing country’s stringency. In another work on a gravity model, Grether and De Melo (2003) represented stringency by a regulatory gap between countries, measured by the difference in GDP per capita. However, after controlling for different factors such as endogeneity of some variables in their trade equation, they found that the relationship between the regulatory gap and trade flows was not robust.

In a study on the effects of environmental regulations on the export dynamics of energy technologies using gravity model, Costantini and Crespi (2008) represented environmental regulation with a mixture of direct and proxy measures. The measures included CO_2 emissions, current environmental protection expenditures of both the public and the private sectors (CURE), the percentage of revenue from environmental taxes on total revenues (ENVTAX) and public investments in environmental protection (ENVINV). The empirical results showed that a more stringent environmental regulation provided a positive impulse for increasing investments in advanced technological equipment, thus providing an indirect source of comparative advantage at international level.

Kee and others (2010) examined the effects of domestic climate change measures such as carbon tax and energy efficiency standards on international competitiveness of industries by incorporating dummy variables for the presence of carbon tax and energy efficiency standard in a gravity setting. Through a panel of industry data on OECD countries from 1988 to 2005, they showed that h carbon taxes and energy efficiency standards had a statistically significant negative effect on competitiveness through impacts on bilateral trade flows (depending on the model specification).

3. Universal 'force of gravity' – workhorse in international trade analysis

Tinbergen (1962), who was the founding father of the Gravity Model of International Trade, proposed an econometric exercise to a team of fellow colleagues at the Netherlands Economic Institute, "to determine the normal or standard pattern of international trade that would prevail in the absence of trade impediments". This particular econometric model was formulated along the lines of Newtonian universal gravitation, where trade flow is directly related to the economic size of the countries involved, and inversely related to the distance between them (De Benedictis and Taglioni, 2001). The inception of the gravity model) has given rise to a vast amount of publications and working papers. Leamer and Levinsohn (1995) argued that the gravity model has generated "some of the clearest and most robust findings in empirical economics" while Anderson (1979) claimed that the gravity model probably could be the most successful empirical trade device at that time. The gravity model evolved into a theoretically-grounded sophisticated tool for the analysis of bilateral trade flows with enrichments made by various researchers.

The application of gravity equations to empirical analyses of international trade was pioneered by Tinbergen (1962), Pölyhonnen (1963), Pullianinen (1963) and Linneman (1966). Subsequently Leamer and Stern (1970) attempted to provide a theoretical backup to the gravity model, based on a probability model. This interpretation had the advantage of explaining the multiplicative functional form and had a useful flexibility. Although the potential or probability of the Leamer and Stern (1970) gravity interpretation or the subsequent Leamer hybrid was plausible, it lacked a compelling economic justification (Anderson, 1979). Contributing to the theoretical debate of the gravity model, Anderson (1979) used the properties of expenditure systems with a maintained hypothesis of identical homothetic preferences across regions in order to give a theoretical explanation to the gravity model. He used Cobb-Douglas and CES utility functions to derive a more sophisticated gravity model and the micro foundation provided was based on the Armington assumption of specialization of each nation in the production of only one good for this equation.

Another crucial contribution to the theoretical development of the gravity model came from Bergstrand (1985, 1989 and 1990). Bergstrand (1985) presented a general equilibrium world trade model from which a gravity equation was derived by making certain assumptions including perfect international product substitutability. This was followed by the application of Dixit and Stiglitz's (1977)monopolistic competition model and the incorporation of the Linder Hypothesis by Bergstrand (1989) and Bergstrand (1990), respectively. Further, Helpman and Krugman (1985) derived the gravity model under the assumption of increasing returns to scale in production while Evenett and Keller (1998) derived the gravity model from both the Heckscher-Ohlin model and increasing returns to scale hypothesis, under perfect and imperfect product specialization. The gravity with gravitas model by Anderson and Van Wincoop (2003) fixed effects estimation models as well as the approximation techniques of Baier and Bergstrand (2009) are more recent contributions to the development of the gravity model.

The thrust for a more precise gravity model for the analysis of bilateral trade flows ended up with variety of theoretical gravity models. These improvements are largely due to the

detailed scrutiny paid to the basic gravity model from a theoretical point of view. Similarly, the estimation techniques were subjected to the scrutiny of the researchers, resulting in econometrically advanced alternative estimators other than the conventional Ordinary Least Square estimation methodology. The most prominent problems addressed were the heteroskedasticity and the presence of zero observations, as the conventional estimators were not efficient enough. The log linear model was challenged, based on the fact that the model could not be expected to provide unbiased estimates of mean effects when the errors are heteroskedastic.

Silva and Tenreyro (2006) provided strong empirical evidence that the resulting biases were significant and they suggested the Poisson estimator as an alternative approach. The omission of zero bilateral flows was found to have a substantial impact on the dependent variable and very important implications for parameter values that are estimated using conventional estimation techniques. The sample selection correction introduced by Heckman (1979) was widely used in the gravity literature as a remedy for the above problem. Helpman and others (2008) provided empirical evidence for the usage of this remedy. However, the gravity literature is full of alternative gravity estimators, all of which are claimed to have advantages over the others. Prasada (2009) noted that the numerous empirical contributions to international trade using the gravity framework apply different techniques mainly based on the discretion of the authors.

4. Methodology

4.1 Model specification

Although the gravity model has been criticized for its deficient theoretical underpinnings, its empirical success in predicting bilateral trade flows has shifted the attention to empirical issues. Thus, the gravity model has a distinct feature of availability of alternative specifications due to the concerns of lapse in a given model. The previous works done on gravity also suggest adopting several functional forms in order to give attention to the differences in estimates, due to differences in model specifications. Gravity models are estimated either by using either a cross-section of country data or a single time series of data in a country-by-country approach. However, since these models do not account sufficiently for heterogeneity, models studying a group of countries throughout a specific period are favoured. To increase the degrees of freedom and to identify business-cycle effects, the inclusion of time and country effects is advocated in the empirical literature.

In considering the above issues, this study uses the theoretical gravity model with fixed effects of countries and business-cycle effects captured by time fixed effects as a baseline. However, given the advantages and disadvantages of the different methods, this study includes several methods starting from the gravity model in an attempt to show the effects of the estimation biases. The different estimation methods used are shown below. The augmented gravity model that includes the policy variable is:

$$\ln EXPORT_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln DIST_{ij} + \beta_8 comlang\_off_{ij} + \beta_8 colony_{ij} + \beta_8 comcol_{ij} + \beta_4 \ln POP_{it} + \beta_5 \ln POP_{jt} + \beta_6 EPI_{it} + \beta_7 EPI_{jt} + \beta_8 BTA_{ijt} + \beta_8 WTO_{ijt} + \beta_9 D_t + U_{ij}$$

Equation 1

The baseline theoretical gravity model based on Anderson and van Wincoop (2003) is shown by the following equation:

$$\ln EXPORT_{ijt} = \beta_0 + \beta_1 \ln DIST_{ij} + \beta_2 contig_{ij} + \beta_3 comlang_{off_{ij}} + \beta_4 colony_{ij} + \beta_5 comcol_{ij} + \beta_6 EPI_{it} + \beta_7 EPI_{jt} + \beta_8 BTA_{ijt} + \beta_9 WTO_i$$

Equation 2

From this baseline model, three further models are considered. Model 3 allows for exporter country effects and time effects by including $D_i$and D_t. Model 4 allows for both exporter and importer country effects by including both exporter (D_i) and importer (D_j) fixed effects with time (D_t) fixed effects. Finally, model 5 is estimated with country-pair (D_{ij}) and time (D_t) fixed effects.

This study uses the information available over time, and the EPI, which is the variable of interest here is time-variant. Depending on the type of fixed effects included in each model, the models were estimated with the elimination of variables that were perfectly collinear with fixed effects.

In the above specified models, *ln* denotes the natural logarithm, subscript *i* denotes the South Asian exporting country and *j* denotes the importing country, and *t* denotes the time period (year). $EXPORT_{ijt}$ is the value of food and agricultural exports from South Asian country *i* to its trading partner *j* in the year *t*. GDP_{it} and GDP_{jt} is the gross domestic product of the two countries in year *t*. GDP_{it} and GDP_{jt} are incorporated to capture the potential supply of the exporting country and potential demand of the importing country, respectively, in year *t*. $DIST_{ij}$,$contig_{ij,}$ $comlang\_off_{ij,}$ $colony_{ij}$ and $comcol_{ij}$ are the trade cost variables indicating geographical distance, contiguity, the common official language dummy, the dummy for colonial relationship in the past, and dummy for country pairs that were colonized by the same power, respectively. EPI_{it} and EPI_{it} denote the strictness of environmental regulation of exporters and importers in year *t*. The BTA_{ijt} dummy indicates the presence of bilateral trade agreements in general between the exporting and importing countries in year *t*. WTO_{ij} is the dummy equal to unity for country pairs that are WTO members at time *t*. β_0 is a constant term that accounts for the effects of unmeasured trade distortions on exports and the error term U_{ijt} takes care of all the possible measurement errors; the error term is assumed to be independently and identically distributed.

Data for environmental stringency is lacking and the constraint remains on adopting a suitable proxy variable. The EPI data used here rank the countries on change in their environmental performance over the past decade. This includes 22 performance indicators in the 10 policy categories, i.e., environmental health, water (effects on human health), air pollution (effects on human health), Air Pollution (ecosystem effects), Water Resources

(ecosystem effects), biodiversity and habitat, forests, fisheries, agriculture and climate change. As the data on which the index is built capture the policy categories mentioned above and the indicators capture the levels of regulation, level of protection and the level of achievement of relevant targets under each policy category, this study exercised the respective EPI of the countries included in the analysis as a proxy measure of stringency of environmental regulation. The higher the index, the higher is the performance and thus the higher is the stringency of environmental regulation. Similar approaches are found in the literature where one such study by Xu (1999) made use of a set of environmental stringency indices developed by the World Bank. This set of indices considers the state of policy and performance in four environmental dimensions, i.e., air, water, land and living resources. The resulting composite index was taken as a proxy for environmental, and a large number was taken as an indication of high stringency of environmental policy.

The basic log linear version of the gravity model suffers from the presence of zero trade values. The prevalence of zero trade values as dependent variables are undefined when converted into logarithms and dropped from the sample. Since dropping zero trade values from the sample can cause a loss of potentially useful information and produce biased estimates of the coefficients, treatment of zero trade values needs caution. Recent gravity literature considers the zero problem and some predominant approaches are available. The first approach is to add a small positive number to all trade flows; although this method is commonly used, it does not have any theoretical basis. The next approach is to adopt the Poisson Pseudo-Maximum Likelihood Estimation technique, as emphasized by Silva and Tenreyo (2006).

Another alternative approach proposed in the literature is to apply a Heckman Sample Selection Model. Helpman and others (2008) developed a gravity equation model with a Heckman correction. In terms of sample selection, the problem of zero trade values can be considered as an omitted variables problem and the explanation is that dropping zero values indicates the dependant variable is not just bilateral trade, but bilateral trade contingent on the existence of a trading relationship. Thus, a latent variable is left out – the probability of being included in the estimation sample.

The Heckman sample selection model holds the answer to this problem. The model first estimates a Probit model in which the dependent variable indicates the trade propensity, which is an indicator of the probability of a particular data been included in the estimation sample; this is known as the selection equation. This equation associates the unobserved variable with a group of observed variables. Thus, the selection equation should consist of all the variables in the outcome equation. However, it is also preferable to incorporate one additional variable that affects the selection equation but not the outcome equation. This variable must only affect the probability of the two countries involved in trade, but not the amount of trade when it occurs. Then the outcome equation is estimated by OLS including a measure of probability of being included in the sample, which is derived from the Probit estimates.

There are two ways of estimating the Heckman model. Abstractly, the Heckman model is a two-step estimator. However, it can be estimated either simultaneously using the maximum likelihood (ML) procedure or as two separate equations. However, since the ML procedure is homoskedastic, and due to technical drawbacks, most studies adopt the maximum likelihood procedure (Greene, 2003). So far, the gravity literature is also inconclusive about which

model should be preferred in empirical studies. As a result of the issue of zero trade values and the alternative approaches advocated so far in the literature, this study employs the Heckman sample selection model following OLS estimates. Thus, the estimation results are comparable across different functional forms in terms of the value and significance of the coefficients and the model significance.

4.2 Data and data sources

The values of food and agricultural commodity exports by South Asian countries from 2003 to 2007 were obtained from the TradeMap database. According to the Harmonized System (HS) classification of 1996, food and agricultural commodities are defined as belonging to HS codes 1 to 24. Due to the limitation of trade data on South Asian countries, only Bangladesh, India, Pakistan and Sri Lanka were taken as South Asian exporting countries while the importing countries included all other countries engaged in trade with South Asia from 2003 to 2007. Using the TradeMap database, and depending on the availability of data for other explanatory variables, it was possible to obtain the stringency of environmental regulation in 127 partner countries for 2003-2007. Data on GDP were taken from the World Economic Outlook Database of the International Monetary Fund. Trade cost variables were obtained from CEPII database. The data on bilateral trade agreements between trading partners were obtained from bilateral.org and other relevant databases.

This study utilized the Environmental Performance Index (EPI), developed by the Yale Centre for Environmental Law and Policy of Yale University, and the Centre for International Earth Science Information Network of Columbia University in collaboration with the World Economic Forum and Joint Research Centre of the European Commission. The latest work on this was done in 2012. The trend in the EPI was developed in order to rank the countries according to the changes in their environmental performance during the past decade.

5. Results and discussion

5.1 Trading partners and environmental regulations

Major trading partners of South Asian countries include regional and national partners as well as other countries. Table 3lists the major trading partners of South Asian countries.

Table 3. Major import and export partners of South Asian countries

Country	Major importers	Major exporters
Bangladesh	China; India; Japan; Singapore; Republic of Korea	United States; Germany; United Kingdom; France; Italy
Bhutan	India; Japan; Thailand; United States; Germany	India; Hong Kong, China; Thailand; United States; Israel
India	China; Saudi Arabia; United States; Switzerland; United Arab	United States; United Arab Emirates; China; Singapore;

	Emirates.	United Kingdom
Nepal	India; China; Singapore; Malaysia; Thailand	India; United States; China; Germany; United Kingdom
Maldives	Singapore; United Arab Emirates; India; Malaysia; Sri Lanka	Thailand; Japan; Sri Lanka; United Kingdom; Taiwan Province of China
Pakistan	United Arab Emirates; Saudi Arabia; China; United States; Kuwait	United States; United Arab Emirates; Afghanistan; United Kingdom; Germany
Sri Lanka	India; China; Singapore; Hong Kong, China; Islamic Republic of Iran	United States; United Kingdom; India; Germany; Belgium

Source: TradeMap database, 2008.

Environmental regulation, which is the key element of this study, is measured using the EPI. Since the EPI index is taken as a proxy for the stringency of environmental regulations, the higher the value the greater is the stringent environmental regulation. Table 4lists the top five countries in the sample according to their respective EPI values.

Table 4. Top five countries in the sample according to EPI rankings, 2007

Country	EPI
Switzerland	78.0
Italy	69.4
France	68.6
United Kingdom	68.4
Germany	66.6

Source: Yale UniversityEPI rankings, 2007.

Although the rankings in table 4arebased on the 2007 EPI values of the countries considered in the sample, even based on the latest values for 2012, Switzerland is still ranked first with an EPI of 76.69. The other countries are also included in the strongest performers list of 2012. It is evident from the above description that the trading partners of South Asian countries consist of strong environmental performers whose concern can affect trading with partner countries mostly with regard to environmentally sensitive industries. Table 5 shows the EPI of the South Asian countries included in the sample.

Table 5. EPI ranking of South Asian countries

Country	EPI
Sri Lanka	54.8
Bangladesh	42.0
Pakistan	39.2
India	36.3

Source: Yale UniversityEPI rankings, 2007.

According to 2012 statistics, Sri Lanka is still a modest environment performer with an EPI value of 55.72 whereas India is listed last with a value of 36.23. Bangladesh and Pakistan are also among the weaker performers with values of 42.55 and 39.56 respectively.

5.2 Results of empirical estimates

The OLS estimates of the models are presented in table 6. The coefficient estimates of the gravity models specified indicate the elasticity estimates with regard to different continuous variables in log form. In the augmented gravity model (model 1), GDP variables have positive and significant effects on the value of agricultural exports. The results indicate that an increase in GDP of an exporting country by 1 per cent will increase the value of exports by a value more than 1 per cent, whereas in the case of the importing country's GDP the increase in value of trade is less than 1 per cent. The trade cost variables with the exception of the contiguity dummy, which is insignificant, have expected signs and significant coefficients. Most importantly, the stringency of environmental regulation variable – which is the variable of interest in this study – has a negative coefficient for importer EPI and positive for exporter EPI. The coefficient values of the stringency variable are relatively larger, e.g., when there is a one-unit increase in the EPI of an exporting country the increase in export value is 22 per cent. Similarly, a one-unit increase in the EPI of an importing country results in a 4 per cent decrease in exports by the exporting country.

In model 2, significant differences in the coefficients can be observed when compared with model 1 where no fixed effects are included. The coefficients of EPI become insignificant with negative coefficients. The coefficients of the trade cost variables are significant with expected signs except that of the common colonizer dummy. Unlike in model 1, the WTO and bilateral trade agreement (BTA) dummies become significant.

In model 3, which includes exporter, importer and time, the fixed effects yield very different results from the previous two estimates, where the distant coefficient is positive and significant. The coefficients of EPI also become insignificant. These results strongly imply that environmental regulation becomes unimportant, which means that they do not have a real impact when the model addresses the unobserved heterogeneity of exporter, importer and time effects.

Although model 3 assumes that the unobserved heterogeneous component of countries is constant over time, some aspects affecting trade are not fixed overtime. Thus, in model 4, exporter-year and importer-year fixed effects are included with year dummies. These variables absorb all country-specific factors, including those that vary over time. To avoid the perfect multi-collinearity, the EPI variable was transformed in another direction where it varies bilaterally as well as with time. However, the transformed EPI is insignificant.

Finally, model 5 removes all the variables that are collinear with country-pair dummies and estimates only with the variables of interest, country-pair and year dummies. It is probable that specific bilateral characteristics of partners, such as remoteness, influence trade. The inclusion of country-pair fixed effects controls this effect. Here, the coefficients of EPI are again insignificant. All these estimates, based on theoretical gravity models, imply the insignificance of EPI on the trade flow of South Asian countries when they are controlled for country-specific as well as partner-specific and time-specific fixed effects.

Table 6. Results of the econometric estimation with the specified models

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
ln_GDP_exporter	1.457**	na	na	na	na
	(0.058)				
ln_GDP_importer	0.879**	na	na	na	na
	(0.030)				
ln_Distance	-0.908**	-1.186**	1.666**	1.679**	na
	(0.095)	(0.118)	(0.203)	(0.224)	
Contiguity	-0.325	0.936	1.893**	1.846**	na
	(0.474)	(6.688)	(0.377)	(0.433)	
Common official language	0.727**	0.659**	0.578**	0.538*	na
	(0.134)	(0.176)	(0.174)	(0.191)	
Colony	1.760**	4.362**	1.542	3.310	na
	(0.279)	(0.294)	(1.096)	(2.629)	
Common colonizer	0.554**	-0.160	-0.818	1.978	na
	(0.127)	(0.155)	(1.679)	(1.384)	
Both partners in WTO	0.216	1.126**	2.926*	1.693	na
	(0.133)	(0.174)	(0.972)	(1.419)	
Both partners in a BTA	0.133	2.021**	0.087	0.239	na
	(0.151)	(0.168)	(0.258)	(0.307)	
EPI_exporter	0.202**	-0.020	0.196	na	0.031
	(0.012)	(0.083)	(0.055)		(0.359)
EPI_importer	-0.041**	-0.001	0.010	na	-0.005
	(0.005)	(0.006)	(0.051)		(0.354)
EPI_both_exporter and importer	na	na	na	0.001	na
				(0.001)	
Constant	4.865**	24.250**	-3.130	-5.832*	10.198**
	(0.992)	(4.427)	(4.883)	(-2.07)	(2.677)
No. of observations	2078	2078	2078	2078	2078
R squared	0.500	0.265	0.748	0.683	0.928
Exporter fixed effects	No	Yes	Yes	No	No
Importer fixed effects	No	No	Yes	No	No
Exporter-year fixed effects	No	No	No	Yes	No
Importer-year fixed effects	No	No	No	Yes	No
Time-fixed effects	No	Yes	Yes	Yes	Yes
Country-pair fixed effects	No	No	No	No	Yes

*Note:*Robust standard errors in brackets. **significant at 1 per cent level; *significant at 5 per cent level.

The estimates of the Heckman model (see annex), which is an alternative method of handling zero trade values raise some valuable consensus. Model 1, 2 and 5 were reestimated using Heckman specification. Since this study employed an MLE procedure in estimating the Heckman model, a likelihood ratio test was used to check whether the selection and outcome equations were independent of each other. Failure to reject the

hypothesis that the rho[1] is equal to zero indicates that the OLS estimates are unbiased. Here, in the theoretical gravity models, the null hypothesis is not rejected, suggesting that the OLS estimates are not biased. In addition, the zero trade flows are lower when the number of observations is considered. Heckman estimates also yield the insignificant EPI coefficients, and they are more or less similar to that of the corresponding models without being treated for zero trade flows.

6. Conclusion

This study attempts to find the effects of the environmental regulations on the food and agricultural trade flows of the four major South Asian economies under gravity settings. The results of the theoretical gravity models reveal that the environmental stringencies of the importers and exporters do not have a significant impact on the food and agricultural trade of the South Asian countries considered in this study when controlled for the heterogeneity of importing and exporting countries and heterogeneity of partners. Although the application of the different methods leads to somewhat different estimation results, it is clear from this study that the impact of environmental regulation on export flows of South Asian countries cannot be assessed properly without consideration of the importing and exporting country effects. Even though there appears to be a relationship between stringent regulations and foreign trade, without taking into account these specific effects its significance fades as soon as both the importing and exporting country-specific effects are taken into consideration. However the trade flows are explained more by conventional determinants of trade such as WTO membership and bilateral trade relations. Hence South Asian countries should focus more on bolstering the bilateral and multilateral trade partnerships for a higher welfare gains from trade in food and agricultural products.

[1] Rho is the correlation between the error terms of the outcome and selection equations; the null hypothesis tested is $cor(ui,\xi i) = 0$.

Annex

Results of the econometric estimation with Heckman models

Variable	Model 1		Model 2		Model 5	
	OLS	Heckman	OLS	Heckman	OLS	Heckman
ln_GDP_exporter	1.457**	1.520	na		na	na
	(0.058)	(0.057)				
ln_GDP_importer	0.879**	0.899	na		na	na
	(0.030)	(0.296)				
ln_Distance	-0.908**	-0.955	-1.186**	-1.179**	na	na
	(0.095)	(0.959)	(0.118)	(0.142)		
Contiguity	-0.325	-0.342	0.936	-0.022	na	na
	(0.474)	(0.472)	(6.688)	(0.085)		
Common official language	0.727**	0.762	0.659**	0.658**	na	na
	(0.134)	(0.135)	(0.176)	(0.176)		
Colony	1.760**	1.751	4.362**	4.350**	na	na
	(0.279)	(0.290)	(0.294)	(0.301)		
Common colonizer	0.554**	0.557	-0.160	-0.160	na	na
	(0.127)	(0.127)	(0.155)	(0.155)		
Both partners in WTO	0.216	0.223	1.126**	0.122**	na	na
	(0.133)	(0.154)	(0.174)	(0.178)		
Both partners in a BTA	0.133	0.164	2.021**	2.010**	na	na
	(0.151)	(0.136)	(0.168)	(0.183)		
EPI_exporter	0.202**	0.213	-0.020	-0.022	0.031	0.031
	(0.012)	(0.116)	(0.083)	(0.085)	(0.359)	(0.031)
EPI_importer	-0.041**	-0.040	-0.001	-0.001	-0.005	-0.005
	(0.005)	(0.005)	(0.006)	(0.06)	(0.354)	(0.031)
EPI_both_exporter and importer	na	na	na	na	na	
Constant	4.865**	4.359**	24.250**	25.135**	10.198**	-3.680
	(0.992)	(0.980)	(4.427)	(4.59)	(2.677)	(6.890)
Censored observations		462		462		462
Arc hyperbolic Tangent		0.140**		-0.020		-0.025
of Rho		(0.040)		(0.191)		(0.026)
Ln(sigma)		0.678**		0.868**		-0.306
		(0.018)		(0.015)		(0.031)
Rho		0.139**		-0.020		-0.025
Sigma		1.971		2.383		0.736
Lambda		0.274		-0.048		-0.018
No. of observations	2078	2540	2078	2540	2078	2540
R squared	0.500		0.265		0.928	
Exporter-fixed effects	No	No	Yes	Yes	Yes	Yes
Importer-fixed effects	No	No	No	No	Yes	Yes
Time-fixed effects	No	No	Yes	Yes	Yes	Yes
Country-pair fixed effects	No	No	No	No	Yes	Yes

*Note:*Robust standard errors in brackets. **significant at 1 per cent level; *significant at 5 per cent level.

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Fax: +66(0)2-288-1027
Email: artnetontrade@un.org