Global Trade Analysis Project
https://www.gtap.agecon.purdue.edu/

This paper is from the
GTAP Annual Conference on Global Economic Analysis
https://www.gtap.agecon.purdue.edu/events/conferences/default.asp

Abstract # 2506

Impact of trade liberalisation on the environment---Illustrations from East Asia

Kakali Mukhopadhyay & Paul J. Thomassin

Kakali Mukhopadhyay
Department of Agricultural Economics,
McGill University, Québec, Canada
Tel :(514) 398-8651
Fax :(514)398-7990
kakali_mukhopadhyay@mcgill.ca

and

Paul J. Thomassin
Department of Agricultural Economics,
McGill University, Québec, Canada
Tel :(514) 398-7956
Fax :(514)398-7990
paul.thomassin@mcgill.ca

1. Introduction

East Asian countries have experienced remarkable economic development, being led and sustained by their liberalised policies and manufactured exports. Although not yet having formed a legal economic integration as a whole, as seen in North America and in Western Europe, the growth in intraregional trade has been higher than in these two counterparts. Over the last 15-20 years have heralded one of the most dramatic periods of economic growth and development the world has experienced. East and south East Asia's increasing trade and investment linkages are due in part to unilateral reforms, which started earlier than in other regions, and the fragmentation and relocation of production processes that has arisen since the mid-1980s. East and south East Asia's regional libearlisation strategy led to lower average tariff rates than most of the other regions throughout the period. In addition, the periods of relocation of production processes coincided with periods of increased foreign direct investment into the countries of relocation. East and south East Asian net inflows of FDI as a percent of GDP are higher than any region from the mid 1980s until the late 1990s. Even without the support of the formal regional trade agreements, countries in east and south East Asia achieved lowered barriers to intra regional trade, increased trade both within the region and with world markets, diversification of production and trade, increased foreign direct investment and growth.

The move in the region is now toward concluding free trade agreements (FTAs) and economic partnership agreements (EPAs). Each country in East Asia, including China and Japan, is accelerating its move towards concluding such agreements with other

countries in the region. The potential of an “East Asian Free Business Zone” is becoming a reality by 2010.

Japan accounts for 60% of East Asia’s total GDP, while China accounted for 20% of the total figure in 2004 (Watanabe, 2005**).** Since its accession to the WTO in 2001, China has undertaken various reforms and a large volume of legislative work to steadily develop its economy to carry out its WTO commitments by the year of 2007. As a result the move toward further liberalization of cross-border economic activities will have gathered momentum across the region. This would start as early as 2008 when Japan, China and Korea push forward FTA-based integration, with the ASEAN Free Trade Area (AFTA) acting as a hub.

Thailand has gradually increased its international trade relationship with the ASEAN countries through the expansion of both exports and imports with a rising trade surplus since 1993. Thailand is one of the main countries that have played an important role in the Free Trade Area development in ASEAN. The tariff reduction program has been implemented in Thailand since January 1993. The ASEAN Free Trade Area (AFTA) was endorsed by the ASEAN Heads of Government at the Fourth ASEAN Summit in Singapore in 1992. Regarding the Common Effective Preferential Tariff (CEPT), Thailand has been able to reduce its average tariff rate from 10.6 percent in 1998 to 4.64 percent in 2003 (Ministry of Commerce Thailand, 2002). This also reduced its product tariff rates to 0 percent on 5,337 product items at the end of 2003.

AFTA is expected to influence the necessary reforms of Vietnam’s trade policies. Full participation in AFTA will certainly create opportunities for Vietnam. Possibilities of expanding labor intensive exports to ASEAN markets on a preferential basis will be of

some assistance to Vietnamese producers (Thanh, 2001). In July 2003, the government of Vietnam announced a revised CEPT schedule resulting in industrial adjustments as regional free trade begins to improve.

Indonesia is a founding member of the ASEAN and participates in the ASEAN Free Trade Area (AFTA). With few exceptions, AFTA tariffs on intraregional trade were reduced to between 0 and 5 percent in 2002. Initially, 20 percent of Indonesia's tariff lines were excluded from AFTA reductions. Now, only 1 percent is excluded. Tariff reductions for certain sensitive items, such as rice and sugar, were also finalised after 2002. Reductions in Indonesia's AFTA tariff rates have closely followed reductions in MFN rates. As a result, the margin of preference for Indonesia's ASEAN trading partners has remained fairly small at about 2.5 percent. The margin is probably even smaller for agricultural commodities because of the sharp reduction in tariffs required by Indonesia's Letter of Intent (LOI) with the IMF.

It is expected that an East-Asian multi-lateral regional trading community will be established by 2020. This multi-lateral regional trading community is expected to decrease the current barriers to trade between individual countries, expand the movement of goods and services between countries, and continue the economic growth within individual countries.

Economic growth has often also been accompanied by environmental degradation of both the national and international environment. Climate change, ozone depletion, and deforestation are often sited as examples of environmental problems that have resulted from economic growth. This region has also been plagued with various environmental problems as a result of rapid industrialization and trade openness.

One of the on-going debates in trade discussions is how to protect the environment when multi-lateral regional trade agreements are being negotiated. The regional economic integration within ASEAN+3 and their possible impact on environment in 2020 using GTAP model are the subject of this article.

Towards this direction the objective of the present study is to estimate the detailed economic and environmental impacts of trade liberalization in six East Asian countries (*Japan, Korea, China, Indonesia, Thailand, and Vietnam)* by the year 2020.

The structure of the paper is as follows: A brief survey of the literature is presented in section 2. Section 3 explains the method of analysis. Details of data bases, aggregation scheme and scenario development are described in section 4. Section 5 deals with the analysis of results. Section 6 concludes the paper with policy options.

2. A BRIEF REVIEW OF LITERATURE

There are numerous studies on the impact of trade liberalization including WTO impact, sectoral and regional implications, environmental as well as poverty implications. This paper adds to the literature by focusing on trade and environmental issues in the region.

There are numerous studies on the impact of trade liberalization including WTO impact, sectoral and regional implications (Leojour, 2000; Eickout et al.2004; Kawasaki, 2005; Ezaki and Nguyen, 2007; Dimaran et al. 2007; Theirfelder et al, 2007; Strutt and Rae, 2007; Hertel, 2007; Thomassin and Mukhopadhyay, 2007).

There are several studies on WTO implications especially on South East Asian countries. Lejour (2000) focuses on the impact of China's accession to the WTO on the sectoral production within China and its main trading partners. They concluded that China benefits much more from trade liberalization if other countries also dismantle their trade

barriers. A Chinese unilateral action would mainly benefit other countries in South-East Asia. Kawasaki (2005) looked at the sectoral and regional implications of trade liberalization on the Japanese economy. In model simulations, the dynamic impacts of trade liberalization through capital formation mechanisms and productivity improvements are taken into account in addition to standard static efficiency gains. Trade liberalization will more or less benefit all of Japan's trade partners. However, the ratio of agricultural production, which is estimated to shrink according to trade liberalization, is higher in lower- income prefectures. In contrast, the ratio of transport equipment production, which is estimated to expand according to trade liberalization, is higher in higher-income prefectures. Regional differences in income levels would increase given current structures of industries by regions. Structural reforms of the economy would be required in implementing trade liberalization measures. Recently Ozaki and Nguyen (2007) have studied the impact of regional economic integration on growth, income distribution and poverty in East Asia (Vietnam, Thailand and China) using GTAP. The results indicate that East Asian FTA's generally have positive effect on growth improved income distribution, and resulting in poverty reduction. Though, impacts on China are found to be little bit exception. Dimaranan, Ianchovichina and Martin (2007) using GTAP framework analyses the impact of rapid growth of China and India on the world economy. They argue that both China and India are labor abundant and dependant on manufactures, their export mixes are very different. The findings reveal that accelerated growth through efficiency improvements in China and India, especially in their high-tech industries, will intensify competition in global markets resulting in contraction of the manufacturing sectors in many countries. McDonald, Robinson and Thierfelder(2007)using a global

general equilibrium trade model, study the impact of the dramatic expansion of trade by India, China, and an integrated East and Southeast Asia trade bloc on the global economy, especially developing countries,. The result indicates that the integration of east and south East Asia with the creation of free trade area would increase welfare in the region and generate small losses for countries outside the block. This would also lead to significant changes in the structure of production and trade. Strutt and Rae (2007) argue that multilateral trade negotiations have faced many hurdles and frustrations in recent years, giving increased impetus for some countries to negotiate regional and bilateral trade agreements. In this paper, they focus on some of the agreements that China is currently negotiating. They explore how such preferential trade agreements might impact on one another. They use the dynamic GTAP model to assess the anticipated impact of possible liberalization scenarios. Hertel et al. (2007) forecasted the global food supply and demand to the year 2025 with a particular emphasis on Asia and China. The paper explores the possible implications of divergent future productivity growth in agriculture on Asian countries and their impacts on trade pattern and their resource use. The result shows that the increase in import demands in Asian countries are export opportunities for industrial countries and Latin America.

Literature on energy-economy-environment-trade linkage, an important objective in applied economic policy analysis, is growing. Burniaux and Truong (2002) implemented an extended version of the GTAP model called GTAP-E, which includes the standard GTAP model as a special case. Implications for policy analysis are demonstrated via a simple simulation experiment in which global carbon emissions are reduced via a carbon tax. Results show that incorporating energy substitution into GTAP is essential for

conducting analysis of this problem. The policy relevance of GTAP-E in the context of the existing debate about climate change is illustrated by some simulations of the implementation of the Kyoto Protocol. Similarly, Tsigas, Gray and Hertel(2004) investigated the impact of trade policy on the environment using GTAP modeling. It involves trade liberalization in the Western Hemisphere – a topic which has received considerable discussion in the past decade, and one that raises many environmental concerns. They found that trade liberalization in the Western Hemisphere is likely to benefit all participating countries. However, it guarantees neither improved environment nor more degradation. Burniaux (2001) analyses the influence of international investment reallocation in the context of unilateral reductions of GHGs emissions undertaken by industrialized countries. The analysis is based on the simulation results obtained by using a recursively dynamic AGE model developed at the Center for Global Trade Analysis (GDYN-E) to simulate the economic consequences of the Kyoto Protocol. These results show that, for most parameter values, the amount of leakage associated with the implementation of the Protocol remains modest. In particular, the existence of investment reallocation may become much more influential under certain circumstances related to different types of investor's expectations, different levels of inter-fuel substitution, a longer time horizon and the existence or not of alternative carbon-free energy sources (called "backstops" energies).

Similar literature on international capital mobility related to the reallocation of investment and the resulting effects on growth and emissions was attempted by McKibbin et al., (1999) and Babiker (2001). With a fairly elaborated description of the international capital markets, the G-Cubed model reports that capital reallocation in the

context of the Kyoto Protocol has little impact on leakage as most of this reallocation takes place among Annex 1 countries rather than towards non-Annex 1 countries (McKibbin et al., 1999). The results suggest that regions that do not participate in permit trading systems, or that can reduce carbon emissions at relatively low cost, will benefit from significant inflows of international financial capital under any Annex I policy, with or without trading. It appears that the United States is likely to experience capital inflows, exchange rate appreciation and decreased exports. In contrast, the Rest of OECD region, as the highest cost region, will see capital outflows, exchange rate depreciation, increased exports of durables and greater GDP losses. Similarly, Babiker (2001) shows that assuming perfect capital mobility does not affect the carbon leakage significantly.

Very little GTAP literature is focusing on trade liberalization and its impact on environment. Kang and Kim (2004) analyzed the air pollution impact in Korea induced by trade liberalization between Korea and Japan using a standard multi-region CGE model based on GTAP database Ver. 5.0. The simulation results show that the aggregated environmental effect depends on the change of specialization structure between pre and post trade liberalization. The inter-industrial difference of emission coefficients and of disposal cost by air pollutants plays a major role in determining the scale of the aggregated environmental effect. Free trade agreement between Korea and Japan reduces the overall air pollution emission by 0.36% but increases the pollution disposal cost slightly by 0.06%. This analysis provides useful environmental policy guidelines for pursuing a "win-win strategy" in trade. Strutt and Anderson (2000) illustrated with a case study of Indonesia, a large newly industrializing country that is rich in natural resources and committed to taking part in major multilateral and regional trade liberalizations over

the next two decades. They used GTAP to project the world economy to 2010 and 2020 without and with those reforms. An environmental module is attached to the Indonesian part of the GTAP model so as to measure the effects of changes in economic activity on air and water pollution. A base case projection without trade reform is compared with alternative scenarios involving full global implementation of Uruguay Round commitments by 2010, and the additional move to MFN free trade by APEC countries by 2020. The study concluded that, at least with respect to air and water, trade policy reforms slated for the next two decades would in many cases improve the environment and reduce the depletion of natural resources and in the worst cases would add only slightly to environmental degradation – even without toughening the enforcement of existing environmental regulations or adding new ones, and even if the reforms stimulate a faster rate of economic growth. Eickhout et al. (2004) quantify the impact of trade liberalization on developing countries and the environment. They found that liberalization leads to economic benefits. The benefits are modest in terms of GDP and unequally distributed among countries. Developing countries gain relatively the most. However, between 70 and 85 per cent of the benefits for developing countries is the result of their own reform policies in agriculture. Trade liberalization will have environmental consequences, which might be positive or negative for a region. They suggested that environmental and trade agreements and policies must be sufficiently integrated or coordinated, to improve the environment and attain the benefits of free trade.

3. GTAP MODEL

The most widely recognized method to undertake such an analysis is with a Computable General Equilibrium (CGE) model for global trade. The CGE modeling framework that

has been chosen to undertake the analysis is produced by the Center for Global Trade Analysis at Purdue University. The database and model is called the Global Trade Analysis Project (GTAP) (Hertel, 1997).

The basic structure of the Global Trade Analysis Project (GTAP) model includes: industrial sectors, households, governments, and global sectors across countries. Countries and regions in the world economy are linked together through trade. Prices and quantities are simultaneously determined in both factor markets and commodity markets. Three main factors of production are included in the model: labour, capital, and land. Each industrial sector requires labour and capital, while the agricultural and forestry sectors require all three factors. Labour and land cannot be traded while capital and intermediated inputs can be traded. It is assumed that the total amount of labour and capital available is fixed.

In the model, firms minimize costs of inputs given their level of output and fixed technology. The production functions used in the model are of a Leontief structure. This means that the relationship between fixed and intermediate inputs is fixed. Similarly, the relationship between the amount of intermediate inputs and outputs is also fixed. Firms can purchase intermediate inputs locally or import them from other countries.

Household behaviour in the model is determined with an aggregate utility function. This utility function includes private consumption, government consumption and savings. Current government expenditures go into the regional household utility function as a proxy for government provision of public goods and services.

Domestic support and trade policy (tariff and non-tariff barriers) are modeled as ad valorem equivalents. These policies have a direct impact on the production and

consumption sectors in the model. Changes in these policies will have an impact on the production and consumption decisions of sectors in the model.

There are two global sectors in the model: transportation and banking. The transportation sector takes into account the difference in the price of a commodity as a result of the transportation of the good between countries. The global banking sector brings into equilibrium the savings and investment in the model.

In equilibrium, all firms have zero real profit, all households are on their budget constraint, and global investment is equal to global savings. Changing the model's parameters allows one to estimate the impact from a countries/region original equilibrium position to a new equilibrium position.

Closure plays a very important role in GTAP modeling. Closure is the classification of the variables in the model as either endogenous or exogenous variables. Endogenous variables are determined (solved for) by the model and exogenous variables are predetermined outside the model. Therefore, these variables may be shocked. Closure can be used to capture policy regimes and structural rigidities. The closure elements of GTAP can include: population growth, capital accumulation including FDI, industrial capacity, technical change, and policy variables (tax, subsidies).

The number of endogenous variables has to equal the number of equations. This is a necessary but not a sufficient condition for a solution. It may be GE or PE depending on the choice of the exogenous variables. The standard GTAP closure is characterized by: all markets are in equilibrium, all firms earn zero profits and the regional household is on its budget constraint.

4. Model aggregation, Scenario development and macro variable assumptions

The GTAP model and database that is used to undertake the analysis is version 6. This version of the model includes 57 commodities (sectors) and 87 countries (regions). The 57 industrial sectors in the model provide a broad disaggregation of the industrial sectors in each country and region.

The 87 countries were aggregated into 14 regions with an emphasis on the countries in the East Asian region. Annex 1 provides the details of the aggregation scheme used in the study. Given the regional emphasis of the study, the greatest level of disaggregation occurs with the countries in East Asia, while other countries not part of the economic integration were aggregated into larger regional areas. This aggregation includes 9 individual countries in East Asia and 5 other regions. The 9 individual countries are: Japan, Korea, China, Indonesia, Thailand, Vietnam, Malaysia, Philippine, and Singapore, while the other regions that have been aggregated are: rest of south East Asia as 'other ASEAN', NAFTA, rest of OECD, ROW1 (which includes South Asian countries and Hong Kong), ROW2 (combines the rest of the countries in the world). All 14 regions by 57 industrial sectors are included in the model that will be used to address the study objective.

Environmental indicators and coefficients

The environmental indicators that have been considered for the present study are CO2 (Gg), CH4 (Gg) and N2O (Gg) collected from GTAP environmental databases (V6.2, Lee, 2006) for the six Asian countries (Thailand, Vietnam, Indonesia, China, Japan and Korea). These databases are for CO2 emissions and non-CO2 GHG emissions (CH4,

N2O) by 57 sectors and 87 regions. BOD data collected from individual country data sources (except China).

To estimate the environmental coefficients used in the model we considered total industrial output for the sectors as reported in the GTAP model. This allows for consistency in the denominator.

Updated coefficients for GHG emission and BOD release across the countries -

To update the coefficients we considered the past behaviour of the emission. We prepared 1995 and 2000 emission coefficient to calculate the growth of the emission coefficients. The change in growth of these emission coefficients over these five years was used to estimate 2010, 2015 and 2020. Data on both industrial output and GHG emissions has obtained to estimate the GHG emission coefficients for the year 1995. Coefficients have been estimated for the 57 sectors. We were able to obtain GTAP data to estimate industrial output and emission output. The CO2 emission data for the year1997 was used as a proxy for the 1995 data. The data was prepared by Lee (GTAP V5.4, 1997). This emission data covers 57 sectors and 78 regions.

GTAP sector-specific CH4 and N2O emissions (Gg) were available for 1995. The CH4 and N2O emissions were prepared by Lee (2002). This data covered 57 sectors and 66 regions.

The industrial output data was taken from GTAP V4 (1995). The industrial sector output data represented 50 industrial sectors and 45 regions. The 50 industrial sectors were converted to 57 industrial sectors on the basis of the 2000 industrial sector output ratios for the disaggregated sectors. Disaggregation of these sectors was based on the definition of the industrial sectors for the GTAP V4 and GTAP V6 data sets.

Preparation of the growth of the GHG coefficient-- When the percentage change in the GHG coefficient from 1995 to 2000 fell within a “reasonable” range, then these percentage changes were kept. When the percentage change in the coefficient was “extreme”, a number of different options were used to modify these estimates. The modification used depended on the country, the 1995 and 2000 emission levels, and other information.

For BOD updating we consider BOD release data from World Bank and output data from the GTAP data base for the year 1995 and 2000, to estimate the coefficient of BOD release across the countries for future projection of these coefficients. Since there is no sectoral BOD release data, we applied the average coefficient changes for all of the sectors. Due to the paucity of the BOD data (World Bank) we applied the Indonesia coefficient changes for Vietnam and Japan coefficients for Thailand.

Apart from this estimate change in total emissions, we have also suggested that future periods should have decreases in the emission coefficients for BOD. The suggested adjustment is a 25 percent for developed countries (Japan and Korea) and a 15 percent reduction for developing countries (China, Indonesia, Thailand, and Vietnam). This suggestion is based on the assumption of technological improvement due to the pollution reduction strategies taken world wide.

Scenario Development

Business as Usual:

We are taking the 2000 model and using our macroeconomic shocks to generate a new economy for 2010, 2015, and 2020. In this analysis the tariff structure for all regions and

countries remains as they are in 2000. This Business As Usual (BAU) remains the same throughout the analysis and is the base from which the other scenarios will be compared. Medium Economic Integration (MEI) describes a situation where the timing of the tariffs reductions, both import tariffs and export subsidies, is delayed. This has been done for within Asean (W-ASEAN) and Asean with a bilateral agreement with China, Japan, and Korea (ASEAN-CJK) together.

Deep Economic Integration (DEI) expresses a situation where economic integration, reductions in both import tariffs and export subsidies, occurs in a rapid timeframe. This has also been done for both within Asean (W-ASEAN) and Asean with a bilateral agreement with China, Japan, and Korea (ASEAN-CJK) together. The last simulation was part of the DEI scenario. In this simulation, tariff barriers were reduced by 80 percent and 100 percent for agricultural and non-agricultural commodities, respectively, for the ASEAN plus Japan, China, and Korea. This simulation differed from all of the other simulations because in this case the tariff barriers between Japan, China, and Korea were reduced to defined levels. This is the simulation that treats ASEAN plus, Japan, China, and Korea and a fully integrated trading block where tariffs are reduced for all countries and between all countries. The economic integrated region in this case includes: Japan, Korea, China, Indonesia, Thailand, Vietnam, Malaysia, Philippines, Singapore, and other ASEAN. So the ASEAN+3 agreement will be under DEI scenario

The above scenario description required a change in the development of the GTAP model to undertake the analysis. In this case, the up-dating of the model to 2020 would require a number of discrete steps.

Modifications of the GTAP Model to 2020

For the current study we have considered the recursive updating process. The recursive process uses projections of macroeconomic variables into the future to simulate what the various economies would look like in the future. The recursive up-dating process is based on forecasting the countries and regions economies by exogenously shocking the baseline model with projections of selected macroeconomic variables. These projections of the macroeconomic variables are taken from reliable sources who try to predict the future direction and strength of an economy. The literature suggests that the number of macroeconomic variables to be used for the forecasting should be keep to a reasonable number. In addition, most previous attempts of the recursive up-dating process have been for small models; i.e. with fewer industrial sectors and fewer regions. As a model increases in size; in either industrial sectors or regions or both; it increases the data requirements but also the complexities in the modeling and computing tasks.

Macroeconomic Variable Estimates and Underlying Assumptions

Five primary factors of production are used in the production system: land; used only by the primary sector that require natural resources; unskilled labour and skilled labour, and physical capital. The first step in the process was to develop a BAU projection to 2010 from the benchmark 2000 GTAP6 data base. The projection of the global economy to 2010 was made with assumptions concerning economic and factor growth rates. Exogenous projections of each region's GDP growth (World Bank, World Development Indicators) were estimated in addition to estimates of factor endowments such as population, skilled and unskilled labour and capital stock (Walmlessly, 2007 personal communication and Dimaranan, et al., 2007, UN2006, World Bank). Total factor

productivity was endogenously determined to accommodate the combination of these exogenous shocks. This approach allows one to predict the level and growth of GDP as well as trade flows, input use, welfare and the wide range of other variables. Instead of considering capital accumulation, we have added the extra change in **It** resulting from trade liberalisation shocks along with the baseline capital forecast for t+1. The resulting forecast provided a projection of the global economy in 2010 that was in equilibrium. This forecasted economy to 2010 provides the starting point for subsequent simulation exercise. Projections for the fundamental drivers of global economic change over the period 2010, 2015 and 2020 are presented in Table 1.

Table 1 here

This BAU scenario projection is developed to provide a picture of how the global economy and world trade might look with the current tariff barriers. It provides a baseline to compare the implementation of the trade agreements. It also facilitates comparison of how the trade agreements may impact economies overtime, relative to what would have been the case without implementation of these agreements. The structure of the world economy is projected to change in a number of significant ways.

The GTAP model simulates the impact of the tariff reductions under several scenarios. It estimates how trade flows will change while reducing import tariff restrictions. As the trade flow between countries changes, as a result of the import tariff reductions, the growth of the economies will be impacted, so also will industrial sectoral output, trade, and the environment.

5. Analysis of the results

When a country participates in a free trade area, it may experience gains due to trade creation and either a gain or a loss due to trade diversion. The former has a positive effect

on welfare, since the removal of tariffs within the region allows the country to allocate its resources more efficiently in production (Caves and Jones 1981). The model was run to address trade liberalization by simulating a regional trade agreement that decreased import tariff restrictions and export subsidy between the six individual countries and other ASEAN countries. The experiments were undertaken in the current study is already briefed in previous section.

It is expected that the trade agreement will affect the country's output growth along with the share of export and import. The present study is primarily focusing on those results. The welfare implications followed by the status of poverty is also accounted for each phase of agreement.

Results show that the output growth rate is highest for China followed by Vietnam, Thailand and Indonesia and lowest for Japan in all phases. The output growth of ROW1 is also higher compared to rest of OECD and NAFTA. The real output trend is maintained almost in all trade scenario case.

Table 2 here

Table 2 presents the percentage changes in output growth of each trade agreement phase compared to the following BAU period (2020). The table focuses how far the agreement countries growth increased after each set of trade agreement.

Before proceeding to explain the East Asian countries development in each phase of trade agreement, let's have a look at the world economy situation due to the ASEAN agreements. The percentage change in output growth of the world economy in all trade agreement phases is negative. The performance of the total output growth of the ten agreement countries is highest in ASEAN +3 agreements at 2020. The agreement countries output growth fluctuates in each phase of trade agreement. The highest output growth is achieved by

Vietnam followed by Thailand, Singapore, Malaysia and Indonesia in all trade agreement cases. The performance is not too rosy for Japan and Korea, though ASEAN +3 agreement is good for them. Besides that, Japan will be losers under DEI 2020 and Korea losers in case of MEI 2020(table 3). Though China's output growth is not significant but shows a positive growth.

Table 3 here

The result of output growth in different agreements during the period 2000-20 can be further analyzed by investigating the export and import share of each country among the study region and outside the region. China's export and import shares within the region under study declines during the course of the period (Figure 1 and 2). As far as the shares are concerned, it has the lowest share compared to the other nine regions. While Japan and Korea shares have increased gradually throughout the period (2000-10, 2000-15, and 2000-2020). Other countries also increase their trade share.

Like output growth, the responses of export and import share have increased for Vietnam, Malaysia, Thailand, Singapore, Philippine, and Indonesia in W-ASEAN and ASEAN-CJK agreements. While for China, Japan, and Korea the increase share is noted only in ASEAN+3 agreements. For China, the share of export and import within the region varies between 23-25% in DEI and MEI. But in case of ASEAN +3, share increased to 28% approx for both the export and import. Japan and Korea's share is also at par with BAU in all agreement phase except at ASEAN+3, where the share has increased almost 10-12% more than the BAU 2020. Overall, these shares show that the trade agreement in ASEAN countries with China, Japan and Korea will accentuate the growth of the

individual economy under agreement. This confirms the predictions of the output estimates.

The sectoral rankings of output, export and import in each agreement case across the countries can add more insight in the study.

The output ranking of the top six sectors remain almost constant in each business as usual period (2000, 2010, 2015 and 2020), while fluctuations in ranking are observed within the sectors across the countries. In case of china, vegetable, fruits and nuts and animal products are in top ten in 2000 and 2010, but 2015 onwards electronic equipment is the new entry instead of other two. For Indonesia and Thailand, food products sector is major till 2015 taken over by manufacturing equipment and paper and paper products respectively in 2020. In case of medium integration and deep, the same sectors are playing as top ten across the countries. The fluctuations in rankings within the sectors are observed for Indonesia, Thailand and Vietnam only.

Table 4 here

The exports ranking share for top six sectors are almost similar like the output rank shares (table 4) across the countries except for one or two changes during the period(from 2000 to 2020). For China, wearing apparel is entered in place of mineral products. For Japan, metals nec is entered in place of paper publishing, while for Indonesia coal and leather are in place of chemical rubber and plastic, and motor vehicle. Similarly for Korea, leather is in place of chemical rubber and plastic. Leather is replaced by motor vehicle in Thailand and Crops nec, instead of mineral products in Vietnam.

The export share rank for top six sectors are remain constant in medium and deep integration case. But few sectors share has increased in each trade agreement. For

example, electronics equipment for China and Thailand always ranked first in their export share. And this share has gone up from 17% (BAU2000) to 26% (ASEAN+3, 2020) in China and 24% to 37% in Thailand.

Most interesting result has been observed for Japan, the export share of manufacturing equipment(26% to 23%), electronic equipment(20% to 11%) and motor vehicles(17% to 15%) have gone down during 2000 to ASEAN+3 agreement at 2020. on the other hand Ferro alloys has gone up from 3.03% to 9% in the same period. A minor increase of textile and motor vehicle sectors share of export is observed for Korea for the period 2000 to 2020 ASEAN+3 agreement. Manufacturing equipment is increased from 11% to 16% during the same period. For Vietnam, chemical rubber and plastic sector is a new addition in the export list especially in the trade agreement phase with a large share of 25.90 % (ASEAN+3). Further, two new additional sectors are on the list, which cover almost 32% of the export share. Thailand, electronic equipment and manufacturing equipment share have increased by 1.5 fold. From the above export share scenario, it is clear that the exportable sectors are not too sensitive for Japan, but it is sensitive for other countries like Thailand, Vietnam and Indonesia. Here the question arises whether at all these exportable sectors are dominating in the ten regions for these countries. To explain further on that here we present the top six exportable sectors performance in different trade scenarios. Table 5 captures the top six sectors export share in BAU2000 and ASEAN+3 2020.

Table 5 here

It is interesting to note that ferrous metal is always in the top six lists for Japan in the entire DEI scenario, but again for higher tariff reduction case metal nec added in the list.

Similarly for Thailand sugar is added in the top six lists as it is moving to higher tariff reduction. These sectoral classifications will help us to identify the sectors for reviewing the environmental pollution.

In case of import, the share of the top six sectors differing in the trade agreement phase across the countries. Some new sectors have entered in the list due to trade agreement compared to BAU. But one interesting point is to be noted that top six sectors are common in exports and imports in most cases. This has happened due to intra industry trade. Intra-industry trade occurs when a country exports and imports goods in the same industry. Such trade is more beneficial than inter-industry trade because it stimulates innovation and exploits economies of scale. Further, international trade is largely trade within broad industrial classifications. Here we considered 2000 BAU as a representative of all other BAU period (2010, 2015, and 2020). Though the percentage shares fluctuate within the BAU period but the sectors remain constant.

For Japan, most of the sectors share has gone down (except Ferro alloys) while for China Korea and Indonesia (wood products share declined), top six sectors share has gone up compared to BAU 2000. In case of Thailand, electronic equipment and manufacturing equipment share have increased by 2.5 fold. For Vietnam, three new additional sectors are in the import list which covered almost 44% share.

The sectors specific regional export share and the import share for six countries show that top six sectors are more or less constant except few cases, but the shares are responding high for higher tariff reduction case (Indonesia, Thailand and Vietnam). While for China (electrical equipment), Japan and Korea (ferrous), the sectoral performance of export and import is insignificant except few sectors.

Overall, Japan will be losers in DEI2020, but gainer in ASEAN+3 and MEI 2020. It experiences negative output growth, followed by the reduction of both export and import share in DEI 2020 compared to BAU. Korea will be a loser in most of the trade agreement phases except DEI 2020 and ASEAN+3. Though it has a negative output growth, the export increased marginally but import reduced compared to the BAU. While real output growth is insignificant in different trade scenarios, China will be a gainer in all trade agreement phases. Its export and import share has also increased marginally compared to BAU. Other agreement countries will be benefited with increased industrial output growth due to trade liberalisation, while non-agreement countries have decreased industrial output growth

For the rest of the agreement countries it is observed that if the economy moves to higher tariff reduction scenario, greater will be the output growth so also export and import. The non agreement countries are the losers in all scenario cases.

The share of the top six sectors differs depending upon the trade agreement phase across the countries. Some new sectors have entered the top six sectors due to the trade agreement scenarios when compared to BAU. The percentage shares of the top sectors fluctuate but the sectors themselves remain constant from BAU to ASEAN+3. The top six sectors in both exports and imports are common in most cases. This is due to intra industry trade. Shares are sensitive to high tariff reduction in Thailand and Vietnam. In China, Japan, and Korea, the changes in the sectoral performance of exports and imports are insignificant except for a few cases (Electrical equipment for China, Ferrous for Japan and Korea). These sectoral performances from different trade scenarios will help us to think of the environmental implications.

Environmental Impact

Trade patterns influenced the composition and scale of exports that ultimately change the industrial output growth, which leads to impacts on the environment. It provides estimates for the environmental indicators e.g. BOD, CO2, N2O, and CH4. It should be noted that the environmental coefficients have been changed over time. We have updated the environmental coefficients for the year 2010, 2015 and 2020. These updated coefficients are applied to estimate the volume of pollution in each scenario cases across the year. For example, we have used the 2015 environmental coefficient to prepare the volume of pollution in different trade scenarios under 2015. The estimation procedure of the updated environmental coefficients is already briefed in the data section.

Tables 6 through 7 provide estimates the volume of CO2 (Gg), and N2O (Gg) and figure 3 and 4 shows the growth of CH4 (Gg) and BOD (tons) in BAU and trade scenarios.

In case of CO2 growth, Indonesia is leading followed by China and Vietnam in BAU phases. In almost all trade scenarios Vietnam's growth has decreased compared to BAU. But other countries have shown a positive growth in the trade scenario case compared to BAU. Overall Vietnam's CO2 growth is still high during all the trade agreement cases compared to other countries. Japan's CO2 growth is modest compared to other countries and the changes compared to BAU and trade scenarios are insignificant. A minor fall of CO2 growth has been observed for china compared to BAU.

The highest N2O growth has been observed for Vietnam followed by Korea Thailand, and Japan while China secures the lowest. In trade agreement phases, Vietnam shows the highest growth followed by Korea, and transport nec is the major player in this case for Vietnam. But for Japan, CRP is important for N2O growth.

Table 6 here

Table 7 here

China's BOD growth is highest followed by Vietnam and Indonesia. Korea's growth is reasonable, while the negative growth observed for Japan always. The interesting point here is to note that across the countries BOD growth is reduced to some extent in all trade scenarios compared to BAU 2020. Here the positive technological effect is highlighted. The drastic fall of the BOD growth (68% in BAU to 33.63% in ASEAN+3) in Thailand has been made possible by the output fall of the sectors like paddy rice and textile in ASEAN +3 agreement.

Figure 3

Figure 4

In CH4 growth, Japan is leading followed by Indonesia and Korea during the BAU period. But in the ASEAN+3 phase, Japan and Vietnam's growth is significant compared to other countries and also other trade phases. Paddy rice is responsible for this high growth. Thailand reduced its growth in all trade agreement phases compared to BAU. Vietnam's CH4 emission growth is significant in trade phases compared to BAU.

The total CO2 and CH4 emission assessment from six countries shows that ASEAN +3 agreements is growth inducing and pollution reducing (except ch4). It implies that overall GHG emission within the region will be declining by 28027 Gg of CO2, if ASEAN+3 agreements materialize. Overall growth of the four environmental indicators across the countries in BAU and different trade phases shows that Vietnam is leading.

The growth rate of each pollutant indicator is not similar in trade phases and BAU. Among all indicators CH4 responded significantly in different trade scenarios compared

to BAU. But other indicators responses in trade agreement cases are relatively insignificant compared to BAU. The overall change actually depends on the sectoral performances. Some sectors are sensitive for some pollutant in one country, but the same will not hold for the other country. So here we show the intensive sectors across the countries for each pollutant.

Table 8 here

CO2 intensive sectors are always differing across the countries. Here we have identified six prominent CO2 intensive sectors for each country. These identified sectors are remains prominent during the BAU as well as trade agreement phase. The only changes observed is the volume of CO2 emission for some sectors that has increased during the trade agreement phase. Some cases it has declined. Sectors like Chemical, rubber, plastic products and Mineral products nec are mostly common across the countries for CO2. On the other hand paddy rice and animal products are common for CH4 across the countries, while transport nec and vegetables, fruits and nuts are common for N2O.

Table 9

Table 10

Table 11

The sectors are differing across the countries in case of BOD. The mostly common sectors observed are chemical, rubber, plastic products and Bovine cattle, sheep and goats, horses.

The sectors are remaining constant in almost all the trade scenario cases compared to BAU across the countries. The identified sectors for each pollutant indicators across the countries are mostly responsible for high growth of CO_2, CH_4 and N_2O emission along

with BOD release. The welfare decomposition result provides further insight into the analysis. The next section we present the welfare decomposition in different trade scenarios along with poverty implications.

Welfare implication

Welfare gains from such multilateral liberalization are fundamentally determined by two factors: the change in the efficiency with which any given economy utilizes its resources, and changes in a country's terms of trade- which permits us to calculate the regional equivalent variation-or the amount of money that could be taken away from consumers, at initial prices, while leaving them at the same level of post simulation utility. If the region in question experiences a terms of trade improvement, i.e., export prices rise relative to the import prices, then the equivalent variation gain will be larger than the efficiency gain. If the terms of trade deteriorate, then the opposite will happen. How welfare impacts of the different trade liberalization do varies across the fourteen regions is presented below. From table 12, we can observe that trade liberalization under the MEI scenario and the DEI ASEAN + 3 scenario leads to increase global welfare. However, further analysis shows that the gain in welfare are mainly attributed to the ten regions involved in the trade liberalization while the rest of the regions faces a loss in welfare with the exception of ROW2 under the MEI scenario. Yet, not all the gain in welfare is distributed evenly among the ten regions involved. In the MEI scenario, China, Malaysia and Thailand are the regions that experience the greatest welfare increase while Korea actually faces a decline in total welfare. When we extend this trade liberalization to include tariff reductions between China, Japan and Korea under the DEI ASEAN+3 scenario, China, Korea and Thailand are now the 3 regions with the most welfare increase

while Japan actually experienced a welfare decline. From these two scenarios, China and Thailand appears to gain most welfare from trade liberalization in the region.

Table12 here

If we further decomposes these two results as shown in table 13, most region involved in the trade liberalization improved in their allocative efficiency resulting an increase in the global allocative efficiency. However, the exceptions are of Singapore in the MEI scenario and Japan in the ASEAN+3 scenarios which experience a deterioration in allocative efficiency (–8249.6 million USD). On the other hand, under the trade agreements appear to have brought a huge deterioration of term of trades for China in both scenarios. Already we described that the tot effect is negative for China, Japan and Korea in MEI 2020 while positive tot effect observed Japan and Korea in DEI ASEAN+3.

Table 13 here

An attempt has also been made to capture the poverty implication from the study. U and y defines the per capita utility of aggregate household expenditure and regional household income respectively. Both are positive for China and all other countries under two agreements. This implies that overall countries household expenditure and income has increased. While for Japan and Korea, it is reduced in MEI 2020. But to look into the poverty aspect exactly, we have to consider the unskilled labour situation whether at all improved. For that, we consider the wages of unskilled labour which is compared with the GDP (both are at the current price). Results for MEI are showing that the unskilled labour return is higher than GDP growth for all six countries. But for ASEAN+3, it shows exactly opposite (Table 13). Though, the overall countries household expenditure and income improved but this improvement not affecting the unskilled labour as such. So

we can conclude that if ASEAN+3 at all materialize it will not improve the poverty situation of the country, even though the countries are expecting to be benefited overall.

Decomposition analysis

The output growth and trade share for all the countries provide an idea for all the countries under agreement. How far the progress will be in all respect for each countries are participating in the ASEAN agreement. The pollution measures are primarily influenced by the output performance as well as the technology effect (updated pollution coefficient) during the three periods (2010, 2015, and 2020). Apart from the overall measures, the sectoral contribution in case of output, trade and environment study helps us to identify the sensitive sectors. But the factors responsible for the total environmental effect across the pollutants as well as by sectors can be explained by the Scale, composition and technology effect (Strutt and Anderson, 2002). We can identify three environmental effects of policy changes-- the change in the level of aggregate economic activity, the change in the contribution of each sector to output, and the change in production technology. This decomposition is useful for finding the causes of changes in environmental damage.

One important point is to note that the developing countries including Korea's composition effect is negative across the scenarios, in case of CO2. But surprisingly, Japan is positive throughout. This implies that the CO2 intensive industries are expanding in trade agreement phase. The scale effect is positive for all the countries. It defined that overall output has increased. But the positive sign of technology effect over the period implies that technological improvement would not possible in case of CO2.

For BOD, all the countries have negative technology effect. This is due to the fact that the technology will be improved and coefficient will be reduced during 2010-15 and 20 as

considered. But composition and activity effect are positive for Japan and Indonesia in all trade scenario case. The rest of the countries are having negative composition effect again like CO2. The pollution intensive industries are expanding in Japan and Indonesia in case of CO2 and BOD.

Table 14 here

Table 15 here

But for CH4 and N20 cases, though the technology effect is positive, but composition effect is negative for Japan and Indonesia along with other countries.

On the whole, the activity effect is primarily responsible for the increase in pollution across the countries. For developing countries, negative composition effect helps to minimize the total pollution effect, but technology effect increased it. While for Japan, the three factors act positively to increase pollution (except BOD).

6. Conclusion

East Asian free trade agreement will increase the output growth of the countries under agreement. Other countries in the world will have a marginal negative growth. Among the countries, Vietnam will be achieving highest growth followed by Thailand. Lowest positive growth is attained by Japan and Korea. Japan will be losers in DEI 2020, but gainer in ASEAN+3 and MEI 2020. ASEAN+3 is favourable for all the agreement countries. Though real output growth is insignificant in different trade scenario, China will be a gainer in all trade agreement phases.

The total export and import share increased marginally from 2000-2020, but its share has increased among ten region case compared to BAU, especially for Vietnam, Indonesia,

Thailand, Malaysia. It responded relatively low for china, (electronic equipment), Japan (ferrous metal) and Korea (ferrous metal) except one or two sectors.

For the rest of the agreement countries it is observed that if the economy moves to higher tariff reduction scenario, greater will be the output growth so also export and import. The non agreement countries are the losers in all scenario cases.

The free trade impact on the environment is not too severe. The CO2 growth in MEI 2020 and DEI 2020 across the countries is marginal compared to BAU 2020, except Vietnam. Other GHGs performance is relatively at par. The only difference is observed for CH4 and N2O, a high growth from 2000BAU to 2020 BAU. BOD growth is also reasonable in different trade scenarios. Due to high macro growth, it is expected that the pollution growth also be high. But overall trade agreement is not unfavorable for the environment except few specific sectors across the countries. Here we can mention the limitation of not incorporating the industrial waste in the study. Though the environmental indicators performance (CO2, BOD, CH4 and N2O) is not too severe in different trade scenarios but it might be severe for industrial waste.

The decomposition of total pollution shows that activity effect plays a significant role across the pollutants and among the countries. Technology and composition effect is fluctuating. In conclusion, these Composition Effect values for the different environmental indicators seem to give evidence against the pollution haven hypothesis. What can be observed is that on general, the industries composition in the developing countries becomes cleaner with trade liberalization while the opposite happens in the industrialized countries. Also given the MEI and DEI scenarios, Thailand benefits the most in term of negative composition effect. On the other hand, the composition effect

becomes positive for Japan in case of CO2 and BOD. However, with the adoption of trade liberalization among all countries under the ASEAN +3 scenarios, we can see that all the countries tend to benefit from the effect of negative for most of the pollutants categories. This may provide a further incentive to pursue greater trade liberalization among the countries in the study.

Acknowledgement
Authors gratefully acknowledge Ministry of Environment Japan (MOEJ) and IGES, Japan for funding the study. This study would not have been completed without assistance and immense support from various government organisations and research institutes in different countries in Asia. In this respect thanks are due to SEPA (CHINA), TEI (Thailand), LIPI (Indonesia), KEI (KOREA) and INSET (Hanoi University of technology, Vietnam). Our special thanks to the GTAP experts at Purdue University for their continuous support. We are indebted to Prof. Debesh Chakraborty, Department of Economics, Jadavpur University, Calcutta, India for his valuable comments and suggestion. We also acknowledge the research assistance provided by Howard Gumilong (Master student, Department of Agricultural economics, McGill University).

References

Babiker M. (2001), "Subglobal climate-change actions and carbon leakage: the implication of international capital flows", Energy Economics 23(2001) 121-139.

Burniaux, J-M (2001) International Trade and Investment Leakage Associated with Climate Change Mitigation, GTAP Technical Paper, Centre for Global Trade Analysis, Purdue University

Burniaux, J-M and Truong P. T. (2002) GTAP-E: An Energy-Environmental Version of the GTAP Model, GTAP Technical Paper No 16, Centre for Global Trade Analysis, Purdue University

Caves, R., and R. Jones (1981) World Trade and Payments. Boston: Little, Brown.

Dimaranan, B, Elena Ianchovichina and Will Martin (2007) China, India and the Future of the World Economy: Fierce Competition or Shared Growth? Presented at the 10th Annual Conference on Global Economic Analysis, June 7-9, 2007, Purdue University, USA

Eickhout, B., H. van Meijl, A. Tabeau and H. van Zeijts(2004) Between Liberalization and Protection: Four Long-term Scenarios for Trade, Poverty and the Environment, Paper prepared for the 7th Annual Conference on Global Economic Analysis: Trade, Poverty, and the Environment, June 17-19, 2004 Washington D.C., United States

Ezaki, M and Tien, N (2007) Regional Economic Integration and its impacts on Growth, income distribution and poverty in East Asia: A CGE analysis, Paper presented at the 16th International Input-output Conference, July 2-6.

Hertel, T. (1997) Global Trade analysis: Modeling and Application (edited), Cambridge University press, UK.

Hertel, T, M. Verma, A. Bouët, J.Cranfield and P. Preckel (2007), Global Nutrition Impacts of Rapid Economic Growth in China and India, GTAP Resource #2484, Presented at the 10th Annual Conference on Global Economic Analysis, June 7-9, 2007, Purdue University, USA

Kang, S., et al. (2004) A Comparative Study on the Environmental Impact of Korea-Japan Free Trade. Korea Environment Institute, Seoul: Korea.

Kawasaki, K. (2005) The Sectoral and Regional Implications of Trade Liberalization. Working Paper. Centre for Global Trade Analysis, Purdue University.

Lee, Huey-Lin (2006) An Emissions Data Base for Integrated Assessment of Climate Change Policy Using GTAP, GTAP Resource #1143

Lee, H-L (2006), The GTAP Non-CO2 Emissions Data Base, GTAP Resource #1186

Lejour A (2000), China and the WTO: the impact on China and the world economy Paper presented at the annual conference of the Development Economics Study Group, Nottingham, United Kingdom, March 27- 29, 2000, and the third annual conference of Global Economic Analysis, Melbourne, Australia, June 20-30, 2000.

McKibbin W., M.T. Ross, R.Shackleton and P.J. Wilcoxen (1999), "Emissions trading, capital flows and the Kyoto Protocol", paper presented at the IPCC Working Group III Expert Meeting, May 27-28, The Hague

Ministry of Commerce (2002), ASEAN Free Trade Area (AFTA), 17/03/2003

Mukhopadhyay, K (2006) Impact on the Environment of Thailand's trade with OECD countries, Asia Pacific Trade and Investment Review, 2(1): 25-46

Nielsen, C.P (2003) Vietnam's Rice Policy: Recent reforms and Future Opportunities, Asian Economic Journal, 17(1):1-26

Strutt, A and A. Rae (2007) Interacting Preferential Trade Agreements: Illustrations from Asia-Pacific, Presented at the 10th Annual Conference on Global Economic Analysis, June 7-9, 2007, Purdue University, USA

McDonald, S, S. Robinson and K. Thierfelder (2007) Asian Growth Poles: Implications of Trade Liberalisation and Economic Integration by China and India for Other Developing Countries, Presented at the 10th Annual Conference on Global Economic Analysis, June 7-9, 2007, Purdue University, USA

Tsigas, M, D. Gray and T. Hertel (2004) How to Assess the Environment Impacts of Trade Liberalization, GTAP Working Paper 1076. Centre for Global Trade Analysis, Purdue University.

Thanh Loc, V. T (2001) The AFTA impact on Vietnam's economy, Centre for International Management and Development Antwerp and Centre for ASEAN Studies, CAS Discussion paper # 35, October.

Thomassin, P and Mukhopadhyay, K (2007) Modeling the Impact of East Asian Free Trade on the Environment—A GTAP Analysis, Paper presented at the 16th International Input-output Conference, July 2-6, Istanbul Turkey.

Watanabe, O (2005) East Asian Economic Integration and Issues in Enhancing Japan-China Business Alliance, Keynote Address at the Symposium on Japan-China Business Alliance in Beijing, China, June 16th, 2005

Table 1: Factor inputs, GDP, Population projections (2000-2010): Cumulative Percentage Changes.

2000-10	POPULATION	GDP	Unskilled	Skilled	Capital
China	6.42	113.11	8.04	32.30	93.89
Japan	0.57	18.48	1.84	-4.94	25.55
Korea	4.05	53.79	-2.71	39.51	45.60
Indonesia	13.18	57.98	28.48	74.00	51.63
Malaysia	19.96	55.78	18.69	54.16	58.92
Philippines	22.03	46.70	18.66	50.43	42.16
Singapore	14.31	46.21	6.07	11.24	67.65
Thailand	7.35	56.70	1.00	32.98	65.13
Viet Nam	14.86	85.98	14.40	19.74	37.54
Other ASEAN	12.44	48.36	12.67	24.60	43.21
Rest of OECD	5.62	21.50	7.02	5.10	31.97
NAFTA	10.46	30.77	14.55	21.49	33.21
ROW1	17.35	61.64	19.01	38.10	50.33
ROW2	17.22	50.49	22.48	32.40	36.01
2010-15	POPULATION	GDP	Unskilled	Skilled	Capital
China	2.74	46.93	3.67	22.82	41.20
Japan	-0.90	10.41	1.63	-4.81	12.27
Korea	0.91	26.42	10.30	32.88	24.62
Indonesia	4.99	31.94	14.24	37.00	25.82
Malaysia	7.62	29.46	8.96	26.21	29.46
Philippines	8.70	23.43	9.33	25.22	21.08
Singapore	4.73	20.93	3.04	5.62	33.82
Thailand	2.52	28.24	0.50	16.49	32.56
Viet Nam	6.19	39.68	7.20	9.87	18.77
Other ASEAN	5.69	25.14	6.54	13.52	22.12
Rest of OECD	1.08	11.83	4.45	0.28	16.74
NAFTA	4.63	15.94	9.52	11.41	17.36
ROW1	7.10	31.78	8.81	19.04	26.69
ROW2	8.04	25.04	11.54	16.67	18.01
2015-20	POPULATION	GDP	Unskilled	Skilled	Capital
China	2.35	46.93	3.74	16.44	37.39
Japan	-1.67	10.41	-0.44	-2.59	11.07
Korea	0.21	26.42	12.88	26.18	24.13
Indonesia	4.09	31.94	14.24	37.00	25.82
Malaysia	6.57	29.46	10.13	19.51	29.46
Philippines	7.58	23.43	9.33	25.22	21.08
Singapore	3.24	20.04	3.04	5.62	33.82
Thailand	1.84	28.24	0.50	16.49	32.56

Viet Nam	5.38	37.54	7.20	9.87	18.77
Other ASEAN	5.24	24.47	6.96	10.42	21.73
Rest of OECD	1.24	13.16	4.72	-0.42	16.22
NAFTA	4.11	14.61	10.41	7.98	16.99
ROW1	6.26	27.64	9.10	14.91	25.78
ROW2	7.51	24.36	11.92	13.80	18.01

Table 2 Percentage Change in the real Value of Output during 2000-2020

	2000-10	2010-15	2015-20
China	137.68	53.22	54.39
Japan	21.39	11.15	11.05
Korea	60.08	28.41	29.38
Indonesia	68.88	36.27	37.78
Malaysia	66.04	33.41	34.07
Philippines	54.50	26.23	27.15
Singapore	58.88	26.19	25.77
Thailand	69.58	33.20	34.62
Vietnam	97.43	41.74	40.06
Other ASEAN	53.31	26.30	26.28
Rest of OECD	24.40	12.91	14.47
NAFTA	34.36	16.83	15.60
ROW1	71.33	35.20	31.75
ROW2	53.63	25.05	24.72
Total	40.59	21.20	22.27

Table 3 Percentage Change in the Real Value of Output during BAU and trade scenario

	MEI2020	DEI2020	Asean+3
China	0.226826	0.220441	0.245326
Japan	0.038563	-0.0535	0.008018
Korea	-0.20541	0.1536	0.307858
Indonesia	1.301892	1.967802	2.30368
Malaysia	2.062391	2.335077	3.30249
Philippines	2.004186	2.70509	2.309773
Singapore	3.056455	3.298833	2.07006
Thailand	5.309981	7.807834	6.883408
Vietnam	6.521725	8.413023	13.58655
Other ASEAN	0.042887	0.252729	0.138058
Rest of OECD	-0.27257	-0.1471	-0.60634
NAFTA	-0.26016	-0.26577	-0.68681
ROW1	-0.71389	-0.75411	-0.76548
ROW2	-0.16274	-0.22716	-0.6082

Total	-0.07764	-0.03634	-0.29772

Table 4 Top six sectors rank in output growth BAU 2020

China	Japan	Korea	Indonesia	Thailand	Vietnam
Machinery and equipment nec	Motor vehicles and parts	Machinery and equipment nec	Electronic equipment	Electronic equipment	Mineral products nec
Chemical, rubber, plastic products	Chemical, rubber, plastic products	Electronic equipment	Textiles	Machinery and equipment nec	Leather products
Electronic equipment	Electronic equipment	Chemical, rubber, plastic products	Chemical, rubber, plastic products	Motor vehicles and parts	Paddy rice
Textiles	Machinery and equipment nec	Ferrous metals	Paper products, publishing	Textiles	Oil
Mineral products nec	Ferrous metals	Motor vehicles and parts	Machinery and equipment nec	Chemical, rubber, plastic products	Food products nec
Manufactures nec	Paper products, publishing	Petroleum, coal products	Motor vehicles and parts	Wearing apparel	Machinery and equipment nec

Table 5 Top six sectors export share in different trade scenarios within region

BAU2000	**China**		**Japan**		**Korea**
Electronic equipment	17.64	Machinery & equip.	26.06	Electronic equip.	28.26
Machinery & equip.	15.05	Electronic equip.	20.86	Machinery & equip.	11.59
Manufactures nec	11.07	Motor vehicles & parts	17.84	Chemical, rubber, plastic	10.24
Wearing apparel	9.69	Chemical, rubber, plastic	9.22	Motor vehicles & parts	8.83
Leather Products	8.33	Transport equip. nec	3.73	Textile	7.69
Chemical, rubber, plastic products	6.31	Ferrous metals	3.30	Transport equip. nec	5.48
	Indon.		**Thail.**		**Viet.**
Electronic equipment	12.41	Electronic equip.	24.08	Leather Products	17.58

Wood products	8.72	Machinery & equip.	12.30	Oil	13.91
Chemical, rubber, plastic products	7.51	Chemical, rubber, plastic products	8.91	Wearing apparel	10.29
Wearing apparel	6.81	Food products nec	6.81	Food products nec	8.83
Textile	6.48	Manufactures nec	4.28	Machinery & equip.	5.14
Machinery & equip.	5.51	Textile	4.07	Crops nec	5.10

ASEAN+3	**China**		**Japan**		**Korea**
Electronic equip.	27.95	Machinery & equip.	23.73	Electronic equip.	25.55
Machinery & equip.	19.26	Motor Vehicle	15.82	Machinery & equip.	15.46
Manufactures nec	12.06	Chemical, rubber, plastic products	12.64	Chemical, rubber, plastic products	9.05
Wearing apparel	6.85	Electronic equip.	11.12	Textile	8.91
Chemical, rubber, plastic products	6.82	Ferrous metals	8.46	Motor vehicles and parts	8.58
Textile	5.51	Metals nec	4.63	Ferrous metals	6.89
	Indon		**Thail.**		**Viet.**
Electronic equipment	19.49	Electronic equipment	36.18	Chemical, rubber, plastic products	25.90
Textile	10.48	Machinery & equip.	19.11	Leather products	18.87
Chemical, rubber, plastic products	10.07	Chemical, rubber, plastic products	13.20	Oil	14.97
Machinery & equip.	7.65	Sugar	5.07	Wearing apparel	8.82
Paper and paper products	6.55	Motor vehicles and parts	3.52	Textile	6.71
Coal	5.37	Textile	3.33	Machinery & equip.	6.56

Table 6 CO2 growth (%) in BAU and trade agreement

CO2(Gg)	China	Japan	Korea	Indonesia	Thailand	Vietnam
BAU2000	2603782.6	859206.9	315667.1	222079.3	155830.4	43986.8
BAU2020	23532966.6	2903492.9	2067617	2923395.6	875579.8	370814.9
%	803.8	237.9	554.99	1216.4	461.9	743.0
MEI2020 (80100)	23441548.2	2907898.4	2082256	2915116.0	880352.3	324178.2
%	800.3	238.4	559.63	1212.6	464.9	637.0
DEI2020	23559371.6	2907786.3	2087504	2916631.0	881945.2	327660.0
%	804.8	238.4	561.29	1213.3	466.0	644.9

ASEAN+3	23347893.4	2935857.2	2119832	2934006.6	907309.3	278228.3
%	796.7	241.7	571.54	1221.2	482.2	532.5

Table 7 N2O emission in BAU and trade scenarios

N2O(Gg)	China	Japan	Korea	Indonesia	Thailand	Vietnam
BAU2000	2032.0	62.3	35.0	110.5	25.7	23.0
BAU2020	8513.3	1013.7	1036.9	1306.2	386.7	2317.4
MEI2020(80100)	8527.8	1013.7	1042.2	1299.8	367.3	2789.0
DEI2020Asean+3	8468.6	1012.8	1052.0	1278.6	363.5	2875.0

Table 8 CO2 intensive sectors for six countries (BAU)

China	**Japan**	**Korea**	**Indonesia**	**Thailand**	**Vietnam**
Coal	Mineral products nec	Mineral products nec	Oil	Petroleum, coal products	Metals nec
Oil	Machinery and equipment nec	Textiles	Petroleum, coal products	Mineral products nec	Manufactures nec
Gas	Paper products, publishing	Motor vehicles and parts	Machinery and equipment nec	Machinery and equipment nec	Petroleum, coal products
Ferrous metals	Chemical, rubber, plastic products	Transport equipment nec	Manufactures nec	Forestry	Mineral products nec
Mineral products nec	Textiles	Chemical, rubber, plastic products	Ferrous metals	Chemical, rubber, plastic products	Electronic equipment
Chemical, rubber, plastic products	Fishing	Paper products, publishing	Electronic equipment	Minerals nec	Paper products, publishing

Table 9 CH4 intensive sectors for six countries (BAU)

China	**Japan**	**Korea**	**Indonesia**	**Thailand**	**Vietnam**
Coal	paddy rice	paddy rice	Animal products nec	Bovine cattle, sheep and goats, horses	Paddy rice
Paddy rice	animal products	animal products	Bovine cattle, sheep and goats, horses	Paddy rice	Gas

animal products	Coal	raw milk	Paddy rice	Sugar cane, sugar beet	Animal products nec
cereal grains	raw milk	coal	cereal grains	Gas	Sugar cane, sugar beet
gas	Gas	Bovine cattle, sheep and goats, horses	Gas	Animal products nec	Raw milk

Table 10 N2O intensive sectors for six countries (BAU)

China	**Japan**	**Korea**	**Indonesia**	**Thailand**	**Vietnam**
Crops nec	transport nec	transport nec	paddy rice	Sugar cane, sugar beet	Transport nec
paddy rice	chemical rubber and plastic	chemical rubber and plastic	cereal grains	Bovine cattle, sheep and goats, horses	Sugar cane, sugar beet
transport nec	animal products	animal products	vegetable fruits and nuts	Plant-based fibers	Animal products nec
vegetable fruits and nuts	raw milk	raw milk	transport nec	Transport nec	Crops nec
Cereal grains nec	vegetable fruits and nuts	paddy rice	plant based fibre	Paddy rice	Vegetables, fruit, nuts
Plant-based fibers	paddy rice	vegetable fruits and nuts	animal products	Vegetables, fruit, nuts	Paddy rice

Table 11 BOD intensive sectors for six countries (BAU)

China	**Japan**	**Korea**	**Indonesia**	**Thailand**	**Vietnam**
Textiles	Chemical, rubber, plastic products	Animal products nec	Leather products	Animal products nec	Fishing
Food products nec	Ferrous metals	Bovine cattle, sheep and goats, horses	Wood products	Food products nec	Sugar
Vegetable oils and fats	Petroleum and coal tar products	Paper products, publishing	Bovine cattle, sheep and goats, horses	Gas	Chemical, rubber, plastic products
Chemical, rubber,	Wearing apparel	Textiles	Vegetable oils and fats	Bovine cattle, sheep	Textile

plastic products				and goats, horses	
Animal products nec	Paper products, publishing	Chemical, rubber, plastic products	Textiles	Crops nec	Leather products
Electronic equipment	Bovine cattle, sheep and goats, horses	Ferrous metals	Beverages and tobacco products	Wool, silk-worm cocoons	Manufacturing nec

Table 12 Welfare decomposition in different trade scenarios

MEI2020	Allocative Efficiency	tot	Total	Asean+3 2020	Allocative Efficiency	tot	ASEAN+3
China	10072.4	-5991.6	4373.1	China	27833.1	-13692.5	15894.8
Japan	2253.5	-707.1	1627.9	Japan	-8249.6	7686.1	-1624.8
Korea	477.8	-726.1	-225.2	Korea	1849	4416.3	5939.1
Indonesia	1059.4	1793	2753.2	Indonesia	634.9	130.8	894.1
Malaysia	2909.8	3183.7	6688.9	Malaysia	2092.5	-272.4	2070.3
Philippines	996.6	374.3	1379.3	Philippines	477.9	-108.6	375.1
Singapore	-222.1	3108.6	3035.3	Singapore	81	993.4	1115.4
Thailand	3628.4	3088	6842.3	Thailand	2217.3	6504.2	8833.7
Vietnam	2812.1	360	3578.3	Vietnam	1692.4	1292.3	4698
Other ASEAN	401.5	-139.3	238.4	Other ASEAN	541.1	-78.6	455.3
Rest of OECD	-847.8	-3613.7	-3976.6	Rest of OECD	-213.5	-3266.6	-3028
NAFTA	-652	-1771.1	-3888.6	NAFTA	-580.8	-1512.4	-4158.4
ROW1	-1431.7	-2200.6	-3743.3	ROW1	-1700.3	-4094	-6033.8
ROW2	-1248.1	3241.8	1526.9	ROW2	-1750.1	2002.1	-505.9
Total	20209.7	0	20209.7	Total	24924.9	0	24924.9

Table 13 Poverty Scenario in different trade scenarios

	ASEAN+3 2020				**MEI2020**			
	Un Skilled Wages (%)	VGDP	U	Y	Un Skilled Wages (%)	VGDP	U	Y
China	1.04	-0.032	0.37	0.02	0.519	0.069	0.1	0.08
Japan	0.259	1.034	-0.04	1.04	0.004	-0.071	0.04	-0.1
Korea	0.765	2.948	0.8	3.16	0.199	-0.227	-0.03	-0.24
Indonesia	-0.277	0.716	0.25	0.8	1.737	1.678	0.8	1.78
Thailand	0.271	5.998	4.4	7.4	4.079	4.979	3.5	6
Vietnam	10.067	11.542	4.76	11.9	11.883	7.803	3.85	8.19

Table 14 Decomposition effect of CO2 in different trade scenario

CO2(Gg)						
DEI2020	China	Japan	Korea	Indonesia	Thailand	Vietnam
Scale	12067729	427562.9	525112.7	495991.5	354994.5	142915.7
Composition	-292740.5	16587.75	-58083.2	-90937.7	-121671	-551.653
Technique	9180600.7	1604429	1304807	2289498	492791.8	141309.1
MEI2020	China	Japan	Korea	Indonesia	Thailand	Vietnam
Scale	12068664	428748.1	522098.9	491302.1	343158.9	139655.2
Composition	-307061.5	15121.78	-60850	-89829.7	-108609	1905.421
Technique	9076163.4	1604822	1305340	2291564	489972	138630.8
ASEAN+3 2020	China	Japan	Korea	Indonesia	Thailand	Vietnam
Scale	12071372	428354.9	526407.7	498356.8	350614.3	151834.8
Composition	-482642.1	22358.07	-53653.8	-91144.3	-114458	19329.3
Technique	9155381	1625937	1331411	2304715	515322.7	63077.34

Table 15 Decomposition effect of BOD in different trade scenario

BOD(tons)						
DEI2020	China	Japan	Korea	Indonesia	Thailand	Vietnam
Scale	68235524	1005884	3586407	2626736	6194565	480672.5
Composition	-18554988	32095.63	-1502855	55650.41	-3473249	-123206
Technique	-15665099	-1177132	-1631210	-938521	-1323321	-122933
MEI2020	China	Japan	Korea	Indonesia	Thailand	Vietnam
Scale	68240810	1008672	3565823	2601901	5988038	469706.2
Composition	-18487293	25959.01	-1453133	62773.77	-3262156	-114146
Technique	-15682851	-1175844	-1642422	-934212	-1324431	-122469
ASEAN+3	China	Japan	Korea	Indonesia	Thailand	Vietnam
Scale	68256123	1007747	3595251	2639263	6118132	510670.4
Composition	-19217600	44577.45	-1566926	-28454.4	-4035451	-154059
Technique	-15508940	-1182652	-1609961	-921110	-1167983	-122725

Figure 1

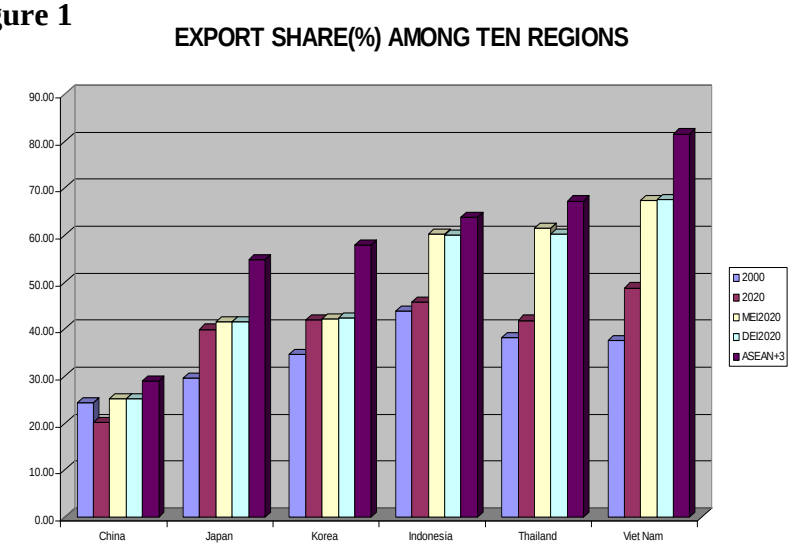


Figure 2

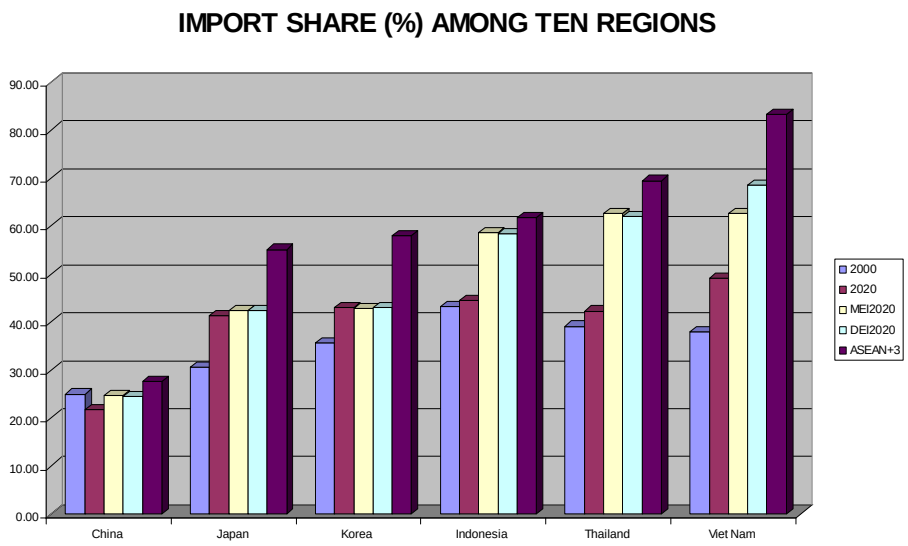


Figure 3

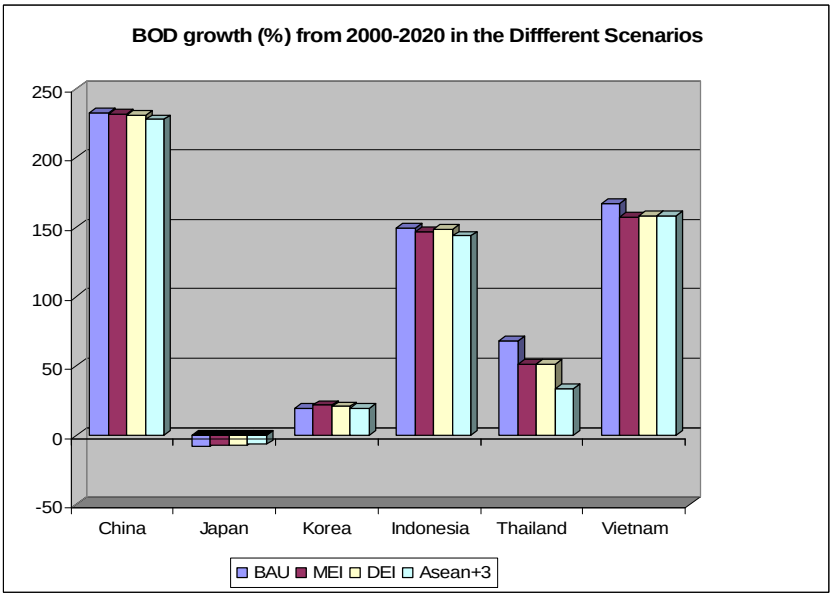
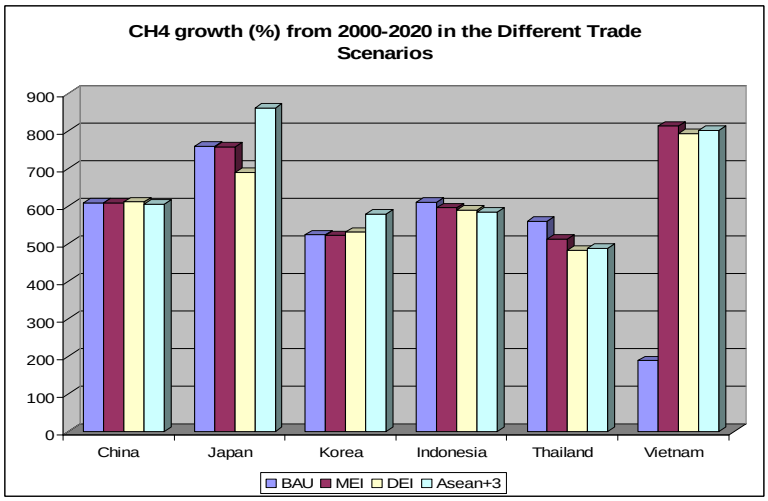


Figure 4



Annex 1: Regional aggregation.

	Country	Region
aus	Australia	Rest of OECD
nzl	New Zealand	Rest of OECD
xoc	Rest of Oceania	ROW1
chn	China	China
hkg	Hong Kong	ROW1
jpn	Japan	Japan
kor	Korea	Korea
twn	Taiwan	ROW1
xea	Rest of East Asia	ROW1
idn	Indonesia	Indonesia
mys	Malaysia	Malaysia
phl	Philippines	Philippines
sgp	Singapore	Singapore
tha	Thailand	Thailand
vnm	Vietnam	Vietnam
xse	Rest of Southeast Asia	Other ASEAN
bgd	Bangladesh	ROW1
ind	India	ROW1
lka	Sri Lanka	ROW1
xsa	Rest of South Asia	ROW1
can	Canada	NAFTA
usa	United States	NAFTA
mex	Mexico	NAFTA
xna	Rest of North America	ROW2
col	Colombia	ROW2
per	Peru	ROW2
ven	Venezuela	ROW2
xap	Rest of Andean Pact	ROW2
arg	Argentina	ROW2
bra	Brazil	ROW2
chl	Chile	ROW2
ury	Uruguay	ROW2
xsm	Rest of South America	ROW2
xca	Central America	ROW2
xfa	Rest of FTAA	ROW2
xcb	Rest of the Caribbean	ROW2
aut	Austria	REST OF OECD
bel	Belgium	REST OF OECD
dnk	Denmark	REST OF OECD
fin	Finland	REST OF OECD
fra	France	REST OF OECD
deu	Germany	REST OF OECD
gbr	United Kingdom	REST OF OECD
grc	Greece	REST OF OECD

irl	Ireland	REST OF OECD
ita	Italy	REST OF OECD
lux	Luxembourg	REST OF OECD
nld	Netherlands	REST OF OECD
prt	Portugal	REST OF OECD
esp	Spain	REST OF OECD
swe	Sweden	REST OF OECD
che	Switzerland	REST OF OECD
xef	Rest of EFTA	ROW2
xer	Rest of Europe	ROW2
alb	Albania	ROW2
bgr	Bulgaria	ROW2
hrv	Croatia	ROW2
cyp	Cyprus	ROW2
cze	Czech Republic	ROW2
hun	Hungary	ROW2
mlt	Malta	ROW2
pol	Poland	ROW2
rom	Romania	ROW2
svk	Slovakia	ROW2
svn	Slovenia	ROW2
est	Estonia	ROW2
lva	Latvia	ROW2
ltu	Lithuania	ROW2
rus	Russian Federation	ROW2
xsu	Rest of Former Soviet Union	ROW2
tur	Turkey	ROW2
xme	Rest of Middle East	ROW2
mar	Morocco	ROW2
tun	Tunisia	ROW2
xnf	Rest of North Africa	ROW2
bwa	Botswana	ROW2
zaf	South Africa	ROW2
xsc	Rest of South African CU	ROW2
mwi	Malawi	ROW2
moz	Mozambique	ROW2
tza	Tanzania	ROW2
zmb	Zambia	ROW2
zwe	Zimbabwe	ROW2
xsd	Rest of SADC	ROW2
mdg	Madagascar	ROW2
uga	Uganda	ROW2
xss	Rest of Sub-Saharan Africa	ROW2