Economic and Environmental Impacts of Trade Liberalization: The Case of Indonesia

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Abstract

In recent years, there has been a growing interest in the environmental impacts of trade liberalization given the rising environmental awareness of the general public. Unfortunately, existing studies have yet to arrive at a consensus in this area. This thesis provides further discourse in this area with a case study of Indonesia and its participation in free trade agreement with Japan (IJEPA) and ASEAN (AFTA). A static global CGE model, known as Global Trade Analysis Project (GTAP) was used to assess the economic and environmental impacts of growth and trade liberalization. Projection of the Indonesian economy to the year 2022 suggested that it will grow rapidly over this period. Comparison of trade liberalization scenarios with a counterfactual base, however, indicates that Indonesia's participation in these trade agreements will only have a marginal positive impact on Indonesia's industrial output. Nevertheless, it did result in a noticeable increase in trade flows and there were signs of trade diversion occurring. In 2022, it was projected that Indonesia will see a large deterioration in its environment due to the growth in output. Counterfactual analysis of trade liberalizations indicated that it has only a marginal environmental impact. Generally, air pollution emissions increased while water pollution decreased following tariff reforms. In conclusion, the study suggests that Indonesia's participation in the AFTA and IJEPA agreements are not likely to bring drastic changes to her economic and environmental performance.

Résumé

Au cours des dernières années, la pression publique a attisé l'intérêt concernant l'impact environnemental découlant de la libéralisation des marchés. Malheureusement, les études se penchant sur ce sujet ne sont pas encore arrivé à un consensus. Cette recherche a pour objectif d'augmenter la compréhension dans ce domaine de recherche par l'utilisation d'une étude de cas basée sur l'Indonésie et de sa participation dans le traité de libre échange avec le Japon (IJEPA) et celui de l'Association des Nations du Sud-Est Asiatique (AFTA). L'étude de cas utilise un modèle monétaire d'équilibre général, multisectoriel et intertemporel, connu sous le nom anglais de Global Trade Analysis Project (GTAP), pour évaluer l'impact environnemental de la croissance et de la libéralisation des marchés. Les prévisions pour l'économie Indonésienne jusqu'en 2022 indique une croissance importante pendant cette période. Cependant, en comparant le scénario d'ouverture des marchés avec celui sans ouverture des marchés, la participation de l'Indonésie dans cet accord de libre échange indique un faible impact sur la production industrielle de l'Indonésie. Malgré peu d'effet sur la production, une augmentation significative des échanges et une modification du type d'échanges se produit. En 2022, le modèle prédit une détérioration de l'environnement du pays causée par une croissance de la production. Une comparaison avec le statu quo indique que la libéralisation des marchés n'a qu'un effet négligeable sur l'environnement. En général, la pollution atmosphérique augmente alors que la pollution de l'eau diminue suite à la réforme des tarifs douaniers. En conclusion, l'étude suggère que la participation de l'Indonésie dans les accords de l'AFTA et l'IJEPA ne génère pas de changements drastiques dans les performances économiques et environnementales du pays.

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Chapter 1: Introduction

1.1 Overview

In 1994, after many years of negotiations and set backs, the Uruguay Round (UR) of the General Agreement on Trade and Tariffs (GATT) was finally concluded and signed by more than a hundred countries. It represents the first major worldwide effort in trade liberalization where the signatories agreed to reduce tariffs over time to allow for improved access to their markets. The replacement of GATT with the World Trade Organization (WTO) provides a formal institution to deal with trade disputes and a negotiation forum for its members, both aimed to further facilitate trade liberalization efforts. It seemed that the world has entered a new era of trade liberalization.

Yet, the 1990s also saw a rise in regionalism with the emergence of two major regional trading blocs, the European Union (EU) and the North American Free Trade Agreement (NAFTA). Not only did they adopt deeper and broader tariff reductions, they tried to reduce non-tariff barriers to further boost trade among member nations. While at a glance, these arrangements seem to push trade liberalization further, they may actually act as regional protectionism if they are trade diverting. These regional agreements can make it more difficult for countries outside the region to compete with imports because they are more likely to face a higher tariff barrier. More importantly, the formation of such a powerful regional trading blocs may trigger the spread of regionalism around the world as other countries try to compete and counter balance their influence.

1.2 Economic Regionalism in East Asia

The conclusion of the UR of GATT and the formation of two powerful trading blocs, the E.U and NAFTA, provide an interesting situation for countries in East Asia. On one hand, they are encouraged to trade in a newly liberalized world and yet are facing the risk of being sidelined from the E.U. and/or NAFTA economic concentration. This is a significant concern for East Asian countries since many of their exports are destined to developed economies in these blocs. It took time for the East Asian economies to confront these changes because none of them felt the urgency to strengthened intra-regional trade relationships through bilateral or regional FTAs. In fact, there was a lack of impetus in the region until the late 1990s to pursue FTAs with only 4 being concluded in East Asia by the end of 2002 (JETRO 2003). Similarly, there was no great interest in forming a regional trade agreement (RTAs) exclusive to the region. The only RTA signed in the region was the ASEAN Free Trade Agreement (AFTA) in 1992, initially involving six countries in South East Asia but none of the major economies in East Asia. Therefore, the absence of a strong economic center in the region to compete with the E.U. or NAFTA may leave the East Asian countries as fringe players with these two regional markets.

There are several factors why countries in East Asia were initially hesitant in embracing economic regionalism as outlined in JETRO (2003). In the early 1990s the main economic powers in East Asia: China, Japan and Korea were more interested in pursuing multilateral trade liberalization agreements through the GATT framework because of the greater prominence of interregional trade rather than intraregional trade. Moreover, there was resistance from the United States (U.S.) over the formation of an exclusively East Asian economic block since the U.S. is a major trading partner with most of these economies. This was a significant political hurdle. The lack of leadership from Japan, as the most advanced economy in the region, and wariness in the region over her colonial legacy did not help the situation. Lastly, the diversity in the cultural, economic and social characteristics among the region only further dampened the likelihood of a RTA. It was only towards the late 1990s that East Asian nations became more serious in pursuing a regional trading block and FTAs.

One of the events that help changed the East Asian perspective on FTA/RTAs was the establishment of the EU and NAFTA in the mid 1990s. It provided the incentive for the East Asian countries to form a counter balance in the region, especially with the lack lustre performance of the Asia-Pacific Economic Cooperation (APEC) in facilitating trade liberalization. The late 1990s also saw a decrease in political resistance from the US towards East Asian regionalism coupled with a changing geo-politic and economic power in the region that created a different dynamic in the region. The rapid rise of China as an economic power has prodded other Asian countries to try to benefit from its growth, while at the same time contain its growing influence. On the other hand, the stagnation of the Japanese economy in the 1990s has taken some of the edge off her colonial history. The final push came with the Asian economic crisis of 1998 as countries realized that the creation a regional trading block would increase economic stability in the region given the interdependence of their economies (JETRO 2003). As a result, towards the end of the 1990s East Asian countries started to seriously negotiate free trade agreements, both regional and bilateral, in an effort to avoid similar economic crisis. Since then numerous FTAs agreements have been signed by countries in the region. The following table provides a brief overview of some of the FTAs negotiations undertaken by a few major countries in the region.

Table 1.1: FTA negotiations involving countries in East Asia.

Country	FTA Implemented	FTA Signed	FTA Under Negotiations
China	Thailand (2003), ASEAN (2005), Chile (2006)	Pakistan (2006), New Zealand (2008)	Australia, Iceland
Japan	Singapore (2002), Mexico (2005) Malaysia (2006), Thailand (2007)	Philippines (2006), Chile (2007), Brunei (2007), Indonesia (2007)	ASEAN, Republic of Korea, Gulf cooperation council, Vietnam, India, Australia and Switzerland
Korea	ASEAN (2007), Singapore (2006), EFTA (2006), Chile (2004)	US (2007)	Canada, India, Mexico, Japan, EU
Indonesia	AFTA(1992)	Japan (2007)	
Malaysia	AFTA (1992), Japan (2006)		Australia , Chile, Korea, New Zealand, Pakistan, US
Philippines	AFTA (1992)	Japan (2006)	
Thailand	AFTA (1992), China (2003), India (2004), Australia (2005), New Zealand (2005), Japan (2007)	Peru (2005)	EFTA
Singapore	AFTA (1992), Japan (2002), Australia (2003), EFTA* (2003), United states (2004), Jordan (2005), Panama (2006), Republic of Korea (2006)	New Zealand (2000), India (2005)	Canada, China, Gulf Cooperation Council, Mexico, Pakistan, Peru, Ukraine
ASEAN	China (2005), Korea (2007)		Australia and New Zealand, India, Japan

Source: Compiled by the author.

Despite the fact that there has been great progress in the development of FTAs in the East Asian region, there is a clear divergence in free trade policies adopted by each country (JETRO 2003). As the leading economy in the region, Japan has been quite aggressive in pursuing free trade agreements with two main goals, to ensure a secured supply of resources for her economy and to counter the rising geopolitical influence of China. On the other hand, China's objective of signing a FTA with her South East Asian neighbours is to reduce the anxiety over her growing power. Korea and Thailand has also been actively involved in establishing bilateral FTA in an effort to gain better market access to both existing and promising markets. As the nation with the most FTAs, the city-state of Singapore believes that their economic future and strength will lie in being a free trade hub in the region. Yet, other countries such as Indonesia, Malaysia and The Philippines are more reluctant to pursue FTAs as they worry that the FTAs may diminish their influence in the region. They prefer to work through the ASEAN framework where they may have stronger negotiating leverage and will not undermine the regional grouping. As a result, they are not engaged in many bilateral trade agreements. For example, Indonesia has only one other bilateral trade agreement outside the ASEAN framework. In conclusion, all of these factors contribute to the interesting dynamics of trade liberalization in the East Asian region and highlight the hurdles in achieving a comprehensive regional trade agreement in East Asia.

1.3 Trade and the Environment

As countries in East Asia moved forward in signing FTAs, much of the discussion has been focused on traditional issues such as their impact on growth and welfare. However, the increased coverage and awareness of environmental issues around the world in recent years has injected a new dimension into this discussion. In the past, environmental problems were seen as domestic challenges that should be addressed by individual governments. Recently, issues such as climatic change have brought environmental issues to the international stage and have resulted in international institutions; for example the Kyoto Protocol. In East Asia, reports of continued environmental degradation and deterioration in pollution indicators in some countries have only heightened this concern. As a result, in recent years, questions have arisen regarding the possible impact of trade liberalization on pollution in the region.

There has always been a concern that trade liberalization accelerated environmental degradation in developing countries due to both faster growth and their often lax environmental laws and standards. Conceptually, this is illustrated through the pollution haven hypothesis (PHP), which proposes that increased trade will result in 'dirty' industries moving from developed to developing nations due to differences in their environmental standards where the former have a more stringent standard. The differences in standards provide a comparative advantage in dirty industries to developing nations. While this argument is appealing, empirical experiments carried out have yet to provide conclusive results. Yet, given that countries in East Asia differ widely in their development stages, this is an interesting area to consider since the environment is an asset that should be accounted for in any economic deliberations. Therefore, more research is needed to bridge trade liberalization goals with environmental concerns to ensure that environmental benefits or costs are taken into account.

Given this background, an interesting country to study in the region is Indonesia, the largest economy in South East Asia, since it has recently gained prominence as a major greenhouse gas emitter in the world. Recently, Indonesia has signed a trade agreement with Japan, under the Indonesia-Japan Economic Partnership Agreement (IJEPA) in addition to of her ongoing engagement in AFTA. It will be of interest to study how her involvement in these two agreements could impact her pollution emissions in the future.

1.4 Problem Statement

As with other East Asia countries that are changing their stance on FTAs, Indonesia is in the process of considering several bilateral/multilateral FTAs with other countries in the region. She has recently signed a major economic agreement with Japan in addition to her existing commitment under AFTA. However, as a country that is a major contributor of GHGs in the world, one of the main challenges facing Indonesia today is to contain this growth in pollution. Yet, a major environmental concern of trade liberalization is that it may accelerate environmental degradation in developing countries. Unfortunately, few studies have been done in this area, especially employing actual tariff cuts proposed in the FTAs. Leaving out costs associated with environmental degradation may lead to an overstatement of the benefits of free trade. Therefore, it is important to consider the possible environmental impacts of trade liberalization to allow for a more comprehensive assessment of FTAs.

1.5 Objectives

The goal of this study is to determine the impact trade liberalization will have on Indonesia using the AFTA and IJEPA as a case study. It will analyze both the economic and environmental impacts that these economic agreements may have on Indonesia. Thus, the specific objectives of the study will be to:

- Measure the economic and environmental impact of growth in Indonesia.
- Analyze the economic impact of AFTA and IJEPA on Indonesia.
- Assess whether tariff reductions under the in the AFTA and IJEPA will result in a deterioration of the selected pollution indicators in Indonesia.
- Study whether the inclusion of broad agriculture tariff reduction in both AFTA and IJEPA will have a significant impact on both Indonesia's economic and environmental performance.

1.6 Thesis Structure

The second chapter outlines the context to the study by providing a brief description of the economic structure and conditions in Indonesia. It will also discuss Indonesia's trade pattern, especially between two of her most important partner, Japan and ASEAN. It ends by looking briefly at Indonesia's environmental situation and policy.

The third chapter reviews studies that have investigated the area of trade and growth with a focus on research that has been done on analyzing the impact of

FTAs/RTAs on growth. It also identifies the two most common touch methods that are used to conduct this type of analysis: econometric and general equilibrium model. The chapter ends by looking at studies relating to trade and the environment.

The fourth chapter outlines the method of analysis employed in this study. The Global Trade Analysis Project (GTAP) framework, which is the model used, is described. This chapter also provides a description of the different scenarios and the environmental indicators used in the analysis.

In chapter five, the results of the study are presented. The first part of the chapter analyzes the economic changes brought by growth and the economic impact of trade liberalization. The second part of the chapter estimates the environmental impact that occurred due to these changes.

The last chapter will end the report by highlighting the conclusions that can be taken from this study. It will also provide a review of the limitations faced in this research and suggestions that can be undertaken or done in future studies.

Chapter 2: The Indonesian Economy

As the fourth populous country in the world, Indonesia is among the largest economy in East Asia, only behind Japan, China and South Korea. She has the largest economy among the members of the Association of South East Asian Nations (ASEAN). In 2007, the population of Indonesia was 224.9 million with a constant value GDP of Rp 1,963.09 trillion (base year 2000), which was equivalent to US$ 432.06 billion in current value (IMF 2009). Unfortunately, despite its economic size, the GDP per capita in Indonesia in 2007 was only US$ 1,921 in current value and categorized her as a lower middle-income country under the World Development Indicator (WDI). Yet, these figures only provide a snap shot of the current economic condition in Indonesia and do not sufficiently capture the progress that she has made in the past 20 years especially considering the economic turbulence that she faced in the late 1990s. This chapter will examine some of the important economic indicators and their recent evolution in order to provide a better understanding of the Indonesian economy.

2.1 Growth in the Indonesian Economy

Indonesia has been considered one of the most promising developing economies in the region, especially in the early 1990s. According to the IMF (2009), during these periods, Indonesia enjoyed high economic growth with GDP increasing at a rapid average rate of around 7% between 1990 and 1996. As a result, real GDP grew from Rp 942.93 trillion to Rp 1,438.97 trillion while constant GDP per capita increased over the period from Rp 5.24 million to Rp 7.25 million. Unfortunately, this period of high growth rate came to a halt with the arrival of the Asian economic crisis that battered many of the Asian countries during the latter half of 1997. In 1998, when the crisis was at its worst, Indonesia's GDP actually contracted by 13.13% to Rp 1308.84 trillion in 1998 causing GDP per capita to drop to Rp 6.40 million. Taking into account the depreciation of the Indonesian Rupiah in the world market, in current dollars, GDP per capita dropped from US$ 1,184 in 1997 to US$ 516 in 1998. Since then, she has not been able to recapture her pre-crisis economic performance, with economic growth rates ranging from 4-5% post crisis although there has been a steady increase over the years. Figure 2.1 shows the trend in GDP since the year 1990. In addition, Table 2.1 provides a detail breakdown of GDP growth from the year 1990. Furthermore, it also shows the growth rates of the agricultural, industrial and service sectors in Indonesia. The growth rate changes among these three sectors indicate that the industrial sector was an important influence in GDP during the early 1990s, prior to the crisis in 1998. Since then, the service sector appears to be enjoying a higher growth rate, which helped compensate for the reduced performance of the industrial sector. The agricultural sector growth rate remained low throughout the period.

Figure 2.1: Indonesia's GDP in Constant Prices (base year 2000)

Source: IMF 2009.

Table 2.1: Growth rate of Indonesia's GDP, agriculture, industry and service sectors.

	1990	1991	1992	1993	1994	1995
GDP at constant 2000 price (trillion Rp)[1]	942.93	1008.47	1073.61	1146.79	1233.25	1334.63
GDP Growth Rate (%)[1]	7.24	6.95	6.46	6.82	7.54	8.22
Agricultural Sector Growth Rate (%)[2]	3.07	2.88	6.26	1.66	0.56	4.38
Industry Sector Growth Rate (%)[2]	11.53	11.71	8.18	9.84	11.17	10.42
Services Sector Growth Rate (%)[2]	9.81	9.35	6.78	7.37	7.09	7.61
	1996	**1997**	**1998**	**1999**	**2000**	**2001**
GDP at constant 2000 price (trillion Rp)[1]	1438.97	1506.60	1308.84	1319.19	1389.77	1440.41
GDP Growth Rate (%)[1]	7.82	4.70	-13.13	0.79	5.35	3.64
Agricultural Sector Growth Rate (%)[2]	3.14	1.00	-1.33	2.16	1.88	4.08
Industry Sector Growth Rate (%)[2]	10.69	5.17	-13.95	1.97	5.89	2.73
Services Sector Growth Rate (%)[2]	6.75	5.58	-16.46	-1.03	5.17	5.03
	2002	**2003**	**2004**	**2005**	**2006**	**2007**
GDP at constant 2000 price (trillion Rp)[1]	1505.22	1577.17	1656.52	1750.82	1847.13	1963.09
GDP Growth Rate (%)[1]	4.50	4.78	5.03	5.69	5.50	6.28
Agricultural Sector Growth Rate (%)[2]	2.63	3.79	2.82	2.72	3.36	3.43
Industry Sector Growth Rate (%)[2]	4.26	3.76	3.94	4.70	4.49	4.75
Services Sector Growth Rate (%)[2]	5.05	6.36	7.11	7.87	7.33	8.82

Source: (1) IMF 2009.
(2) ADB 2008.

Agriculture Sector

Similar to other developing countries, the agricultural sector in Indonesia makes a significant contribution to the economy. However, a declining share over the years means that its importance has diminished. In 2007, the sector output as a percentage of GDP was 12.97%, a considerable decline from the 19.4% in the year 1990 (ADB 2008). Yet this is not surprising given that the growth in the sector is lower than the industrial and services sectors for most of the years since 1990. The only period that the sector saw an increase in its share of GDP is during the Asian economic crisis when there were large contractions in the industrial and service sectors. Despite this fact, the agriculture sector remains an integral part of the economy as it provides employment to a disproportionate amount of the Indonesian labor force through both large farms/plantations and smallholdings (U.S. Department of Agriculture 2009). In 2005, it made up 44% of total employment in Indonesia (ADB 2008). During this period, the main focus of Indonesian agriculture production was on rice crops production; although in recent years there has been a significant growth in palm oil plantations.

The main reason why growth in agriculture has been slow but steady is because Indonesia, as with other developing countries, is very concerned with the issue of food security. In a local context, this meant a focus at achieving self-sufficiency in rice production given that it is the staple food consumed by most Indonesians. However, with increased food consumption this has been extended to include several other food crops and animal proteins (U.S. Department of Agriculture 2009). To achieve this objective, the Indonesian government provides price incentives, input subsidies and investment in irrigation together with the promotion of high-yield crop varieties and better cultivation methods. In addition, the government also employs a protectionist position in agricultural trade in an attempt to shield local food prices from world price fluctuations through the use of quotas, steep tariffs and bans. In recent years, however, the government has relaxed some of these protectionist measures because of pressure from international organization such as the IMF and its commitment to various trade agreements (Thomas and Orden, 2004). As a result of these policies, agriculture growth is driven mainly by domestic demand and the transmission of shocks from the world market is dampened.

Industry Sector

The recent economic development that occurred in Indonesia has resulted in a steady movement towards industrialization. This was further accelerated by the rapid growth of the industry sector in the late 1980s and the early 1990s. As seen in table 2.1, the industry sector grew by an impressive rate of approximately 10% annually during the period 1990 to 1996 (ADB 2008). Unfortunately, the industrial sector was hit hard during the Asian economic crisis, contracting by as much as 13.95% in 1998. While positive growth returned soon after the height of the crisis, the sector has yet to regain the growth rate it had experience prior to the crisis, with an average growth rate hovering around 4% annually through the early 2000s. More importantly, the trend in growth rate after the crisis appears to be stagnant. Despite this fact, the sector is the dominant sector in the Indonesian economy. In 2007, industry sector output as a percentage of GDP was 46.83%, a significant increase from 39.12% in 1990 (ADB 2008). As a result, changes in the sector can be felt on the growth of the Indonesian economy, helping to explain the growth rate pattern of GDP in Indonesia.

Industrial policy in Indonesia during the early 1990s can be traced back to the direction taken after the oil boom period in the early 1980s. Faced with a decline in earnings, the Indonesian government was forced to follow a broad adjustment plan throughout the 1980s whose aim was macroeconomic stability and economic diversity. Steps taken include currency devaluation, government expenditure cuts and simplifying of both investment procedures and export/import licensing. In addition broad tariff cuts were adopted across many sectors. At the same time, external factors were moving in her favor. Rising wages and currency appreciation in Japan and East Asia's newly industrialized economies helped to encourage relocation of factories into the country. These factors helped to ensure that industries in Indonesia grew at an impressive rate. When foreign direct investment (FDI) started to decrease in 1993, the government further simplified investment procedures and reduced tariff barriers helping to stimulate FDI. This allowed the impressive growth to continue until the mid 1990s. (Resosudarmo and Irhamni 2008)

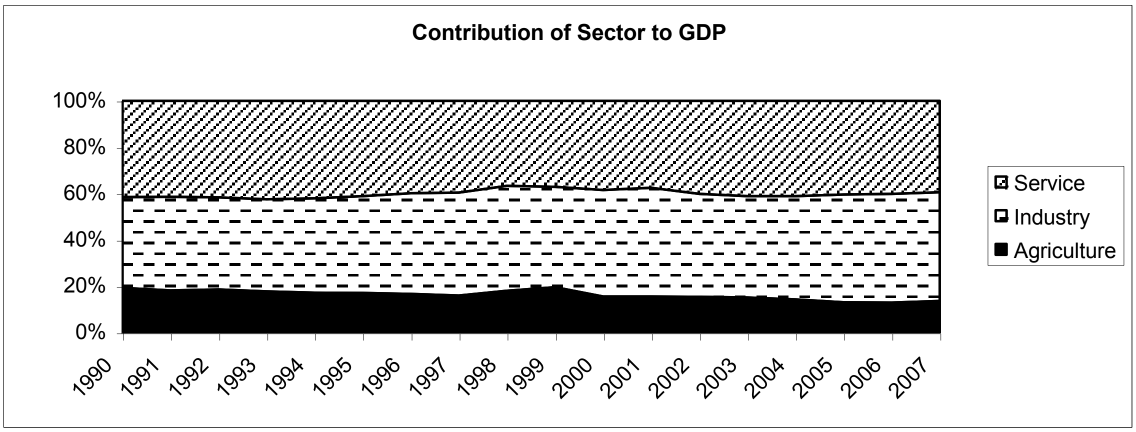
Unfortunately, the impressive growth in the Indonesian industry sector came to a halt during the Asian economic crisis. Questions concerning in the stability of the Indonesian economy resulted in the reversal of capital inflows that grew worse as the crisis peaked. The drying up of FDI coupled with the collapse of the Indonesian currency led to a de-industrialization of the economy and a decline in the relative importance of the industry sector. In coping with the crisis, Indonesia was forced to take a loan from the International Monetary Fund (IMF) and set up the post crisis policy direction. Indonesia continued to liberalize her economy in order to comply with the IMF recovery program and her commitments under the ASEAN Free Trade Agreements (AFTA) and WTO. This was followed by an attempt to divest and privatized state companies while at the same time decentralizing some policy decisions to the regional authorities. Unfortunately, this plan only helped to create further complexities in conducting business. Recently the government has begun to pursue a more sectoral approach in trying to assist in the development of competitiveness in some important industries for the future. Despite this, the industry sector has yet to recover its pre-crisis performance. (Resosudarmo and Irhamni 2008)

Service Sector

The service sector has always been an integral part of the Indonesian economy. Despite the changes that have occurred to the share of agriculture and industrial sector in the economy since the 1990s, the share of the service sector of the Indonesian GDP has remained relatively steady and constant. Annual growth in the service sector however, actually declined slightly towards the mid 1990s and was highly negative during the Asian crisis. In fact, in 1998, the service sector contracted by as much as 16.46% (ADB 2008). Fortunately recovery from the economic crisis proceeded well for the sector and by 2007, its annual growth rate was actually higher than its pre-crisis level at 8.82%. In fact between 2003 and 2007 its growth rate was just slightly less than double of the industrial sector. This meant that it has been an important contributor to Indonesian economic growth in the last few years. In addition, this has also allowed the service sector to regain some of its share of the GDP. As a result, in 2007, its output as a percentage of GDP was 39.43% compared to 41.47% in 1990 (ADB 2008).

The service sector can be divided into 5 broad sub-sectors: i) trade ii) transport and communications iii) finance iv) public administration and v) other services. Among these sub-sectors, trade services captured the largest share, making up about 37.82% of the service sector in 2007 (ADB 2008). However, there is a declining trend of its share, for example, prior to 2003 it consistently made up more than 40% of the service sector. For the next two sub-sectors, their shares of the service sector appear to be steady over the period. The transport and communications sub-sector made up about 16.96% of the service sector while finance captures 19.59% respectively in 2007 (ADB 2008). Interestingly, for the transport and communications sector, the recent liberalization in communications services did not appear to boost its growth and share. On the other hand, the financial reforms that have been taken by the Indonesian government since the Asian economic crisis have been focused on strengthening the financial industry rather than its expansion. The share of the public administration sub-sector has declined since 2000 compared to the 1990s. In 2007, the public administration sub-sector's share was 13.18% compared to 16.37% in 1990 (ADB 2008). This decline is surprising given the increase in government expenditures during this period, especially in personnel and material expenditures. Compared to the 1990s, there is an increase in the share of the 'other services' sub-sector. Its share has increased from about 8% in the 1990s to approximately 12% in the 2000s (ADB 2008).

Figure 2.2: Agriculture, Industry and Service Sector share of GDP (%)

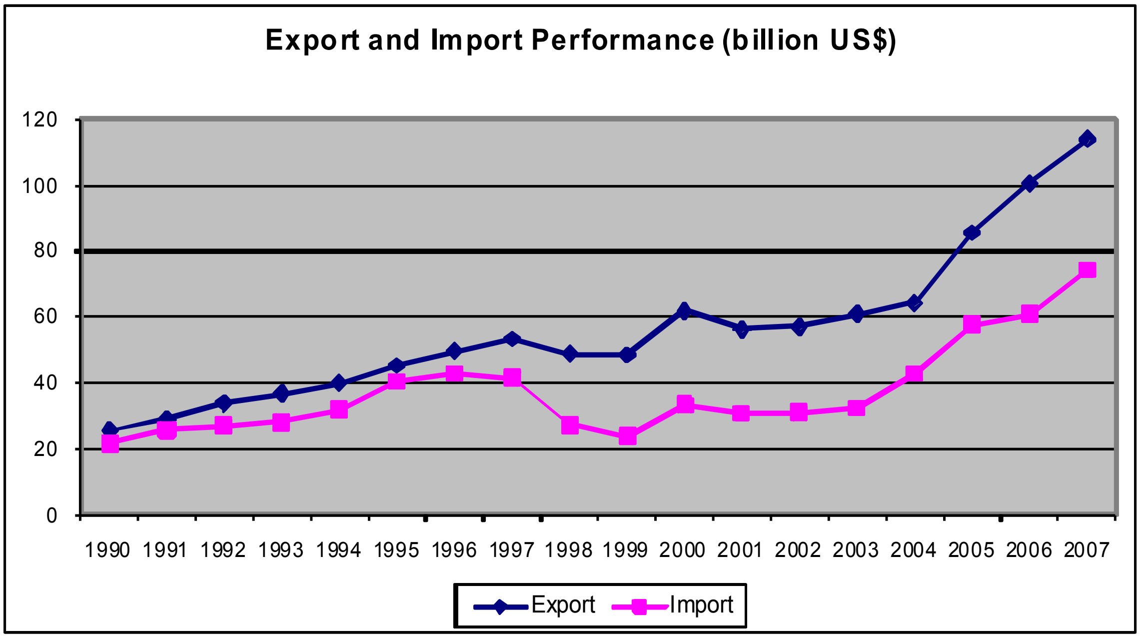


Source: ADB 2008

2.2 Indonesia and Trade

From 1990 to 2007 Indonesia's export and import values have been about 20-30% of her GDP. Over this period, her exports have risen steadily from US$ 25.7 billion in 1990 to US$ 114.1 billion in 2007 and a similar trend can be seen in her import, rising from US$ 21.8 billion in 1990 to US$ 74.5 billion by 2007 (UN Comtrade). The crisis saw a slight decline in exports and a much bigger drop in imports. Comparing 1997 and 1998, Indonesia's exports decreased from US$ 53.4 to US$ 48.8 billion while imports declined from US$ 41.7 billion to US$ 27.3 billion. Clearly, the depreciation of Indonesian's Rupiah had a greater adverse impact on her imports. Figure 2.3 shows the trend of export and import growth in Indonesia, from 1990 to 2007. Overall, the Indonesia economy has become more open. The increase in openness has been mainly driven by the increase in exports. However, fluctuations in the trend of the degree of openness do not provide a clear indication of the direction that it will take in the future. Table 2.2 shows the degree of openness in Indonesia from 1990 to 2007 calculated based on data obtained from UN Comtrade.

Figure 2.3: Trend in export and import in billions of US$.



Source: UN Comtrade.

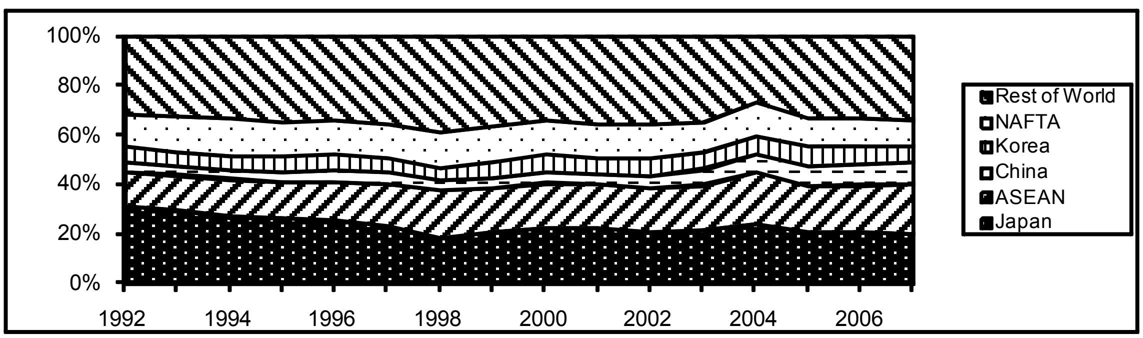
Table 2.2: Degree of openness of Indonesia.

Year	Export/GDP	Import/GDP	Degree of Openness
1990	25.27	23.73	49.01
1991	25.55	24.10	49.65
1992	27.88	24.96	52.84
1993	26.75	23.77	50.52
1994	26.51	25.37	51.88
1995	26.31	27.65	53.96
1996	25.82	26.44	52.26
1997	27.86	28.13	55.99
1998	52.97	43.22	96.19
1999	35.51	27.43	62.94
2000	40.98	30.46	71.44
2001	38.15	30.07	68.22
2002	32.69	26.39	59.08
2003	30.48	23.14	53.62
2004	32.22	27.54	59.76
2005	34.07	29.92	63.99
2006	31.03	25.62	56.65
2007	29.36	25.33	54.69

Source: Calculated from data obtained from UN Comtrade.

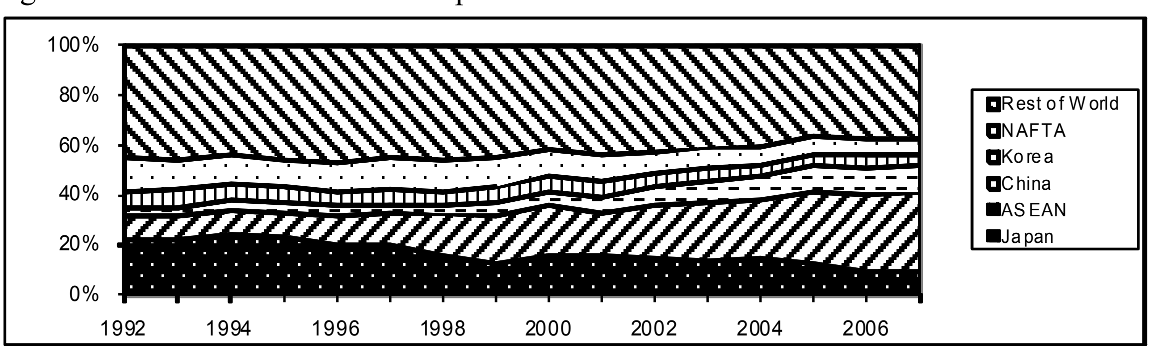
A large proportion of Indonesian trade is concentrated in a few important trading partners such as China, Japan, Singapore, Korea and the United States. In 2007, these five countries contributed 55.2% and 44.2 % of Indonesia's exports and imports respectively. Among them, however, Japan has always been Indonesia's top export partner and only recently lost her position as the top import partner. Similarly, as a region the ASEAN has been a prominent trading partner with Indonesia. In 2007, ASEAN export to and imports from Indonesia was valued at US$ 22.3 billion and US$ 23.8 billion respectively, accounting for 19.5% and 31.9% of total exports and imports. Since both of Japan and ASEAN play an integral role in Indonesia's trade, this highlights the importance of IJEPA and AFTA to Indonesia and the impact they may have on her economy. Figures 2.4 and 2.5 illustrate the exports from and imports to Indonesia from various countries and regions.

Figure 2.4: Destinations for Indonesian exports.



Source: UN Comtrade.

Figure 2.5: Source of Indonesian imports.



Source: UN Comtrade.

In 1992, Indonesia signed her first major trade agreement, the AFTA. Under AFTA, the ASEAN members agreed to reduce intra-regional tariffs on goods placed under a 'Common Effective Preferential Tariff' (CEPT) scheme to between 0-5% by 2002, with the intention of eliminating them. These commitments were expanded upon at the end of the 1990s with an agreement to phase in sensitive products to the list by the end of 2010. By 2003, the average tariff on CEPT products the initial six signatory countries to the agreement dropped from 12.76% to 1.51%[1]. Over the same period, Indonesia saw an increase amount of trade with other ASEAN countries. In 1992, Indonesia's exports to the region amounts to 13.43% of its total exports and this share increased to 19.54% in 2007. Similarly, the share of its import from the region increased from 9.66% in 1992 to 31.95% in 2007. This trend reinforces the importance of this intra-regional ASEAN trade and AFTA to Indonesia. Trade within this region is playing a larger role in Indonesia's economic and environmental performance.

Table 2.3: ASEAN's shares of Indonesia's trade.

Year	Indonesia's Export (billion $)			Indonesia's Import (billion $)		
	World	ASEAN	%	World	ASEAN	%
1992	33.97	4.56	13.43	27.28	2.64	9.66
1993	36.82	5.00	13.57	28.33	2.66	9.38
1994	40.05	5.98	14.93	31.98	3.04	9.52
1995	45.42	6.48	14.26	40.63	4.22	10.38
1996	49.81	7.69	15.43	42.93	5.12	11.94
1997	53.44	9.12	17.06	41.68	5.41	12.99
1998	48.85	9.35	19.13	27.34	4.51	16.48
1999	48.67	8.28	17.01	24.00	4.78	19.93
2000	62.12	10.88	17.52	33.51	6.48	19.35
2001	56.32	9.51	16.88	30.96	5.46	17.64
2002	57.16	9.93	17.38	31.29	6.77	21.63
2003	61.06	10.73	17.57	32.55	7.73	23.75
2004	64.48	13.00	20.15	42.95	10.21	23.78
2005	85.66	15.82	18.47	57.70	17.04	29.53
2006	100.80	18.48	18.34	61.07	18.97	31.07
2007	114.10	22.29	19.54	74.47	23.79	31.95

Source: UN Comtrade.

[1] Based on figure provided by the ASEAN secretariat overview of AFTA on its website at http://www.asean.org

Further analysis of the composition of trade between ASEAN and Indonesia revealed that the top 5 commodities exports (based on HS1996 classification at the 2 digit level) by dollar value from Indonesia to ASEAN consisted of both primary resources and intermediate goods. This trend can be observed from 1996 and 2006 with three commodities continuing to remain in the top 5 exporting sector across the period. They are the 'mineral fuels, oils distillation products', 'electrical and electronic equipment' and 'nuclear reactors, boilers, machinery, etc'. The top 5 imported commodities from ASEAN to Indonesia were intermediate or final goods with 'mineral fuels, oils distillation products' being the top imported commodities for the ten year period. The prominence of 'mineral fuels, oils distillation products' in both Indonesian exports and imports can be explained by the fact that while Indonesia is an oil producing nation, she has limited refining capacity to transform them into other products. As a result, Indonesia exports much of its unrefined oil while importing refined petroleum products. Together, the export and import trends reflect the position Indonesia has among the ASEAN nations. As a resource rich country that is neither the most nor least developed in the region, Indonesia exports both primary and intermediate goods to her neighbours while mainly importing intermediate and finished goods, especially from her relatively more developed ASEAN trading partners like Singapore, Thailand and Malaysia. The overlap of some export and import commodities also indicates that the industrial sectors in the countries may be at the different stages of productions. In conclusion, there appears to be a well-established trading relationship between ASEAN and Indonesia that highlights the region as one of Indonesia's most important trading partners.

Table 2.4: The value of the five largest exports from Indonesia to ASEAN (million US$).

Commodities	1996	Commodities	2001	Commodities	2006
Mineral fuels, oils distillation products	1164.02	Electrical, electronic equipment	1864.25	Mineral fuels, oils distillation products	3024.97
Electrical, electronic equipment	1116.83	Nuclear reactors, boilers, machinery, etc	1363.60	Electrical, electronic equipment	2797.64
Pearls, precious stones, metals, coins, etc	525.29	Mineral fuels, oils distillation products	1202.95	Nuclear reactors, boilers, machinery, etc	1963.82
Nuclear reactors, boilers, machinery, etc	522.71	Paper & paperboard, articles of pulp, paper and board	389.71	Copper and articles thereof	941.36
Rubber and articles thereof	226.85	Pearls, precious stones, metals, coins, etc	317.56	Animal, vegetable fats and oils, cleavage products, etc	838.82

Source: UN Comtrade.

Table 2.5: The value of the five largest commodity imports to Indonesia from ASEAN (million US$).

Commodities	1996	Commodities	2001	Commodities	2006
Mineral fuels, oils distillation products	1508.44	Mineral fuels, oils distillation products	1619.70	Mineral fuels, oils distillation products	10180.74
Nuclear reactors, boilers, machinery, etc	531.70	Organic chemicals	643.78	Nuclear reactors, boilers, machinery, etc	1401.55
Electrical, electronic equipment	435.87	Nuclear reactors, boilers, machinery, etc	615.48	Organic chemicals	1334.29
Cereals	432.82	Ships, boats and other floating structures	348.44	Vehicles other than railway, tramway	898.72
Organic chemicals	309.12	Plastics and articles thereof	241.85	Ships, boats and other floating structures	874.38

Source: UN Comtrade.

The IJEPA is an economic partnership between Indonesia and Japan that includes both tariff reductions and economic co-operation. It is the second major trade agreement that Indonesia signed. Under the agreement, Indonesia plans to remove 93% (58% of which will be removed upon implementation) of the tariff lines imposed on Japanese goods while Japan agrees to reduce 90% (80% of which will be removed upon implementation) of the tariff lines on Indonesian goods. For Indonesia, it provides an opportunity to further penetrate the large Japanese market while it allows Japan to secure a continual supply of raw resources for her economy. It is also hoped that the agreement will strengthen trade activities between the two countries that have been declining gradually in recent years. In 2007, Japan's share of Indonesian exports and imports were 20.71% and 8.76% respectively, down from 31.68% and 22.04% in 1992.

Table 2.6: Japan’s share of Indonesian trade.

Year	Indonesia’s Export (million $)			Indonesia’s Import (million $)		
	World	Japan	%	World	Japan	%
1992	33.97	10.76	31.68	27.28	6.01	22.04
1993	36.82	11.17	30.34	28.33	6.25	22.06
1994	40.05	10.93	27.29	31.98	7.74	24.20
1995	45.42	12.29	27.06	40.63	9.22	22.69
1996	49.81	12.89	25.87	42.93	8.50	19.81
1997	53.44	12.48	23.36	41.68	8.25	19.80
1998	48.85	9.12	18.66	27.34	4.29	15.70
1999	48.67	10.40	21.36	24.00	2.91	12.14
2000	62.12	14.42	23.20	33.51	5.40	16.10
2001	56.32	13.01	23.10	30.96	4.69	15.15
2002	57.16	12.05	21.07	31.29	4.41	14.09
2003	61.06	13.60	22.28	32.55	4.23	12.99
2004	64.48	10.27	15.93	42.95	6.08	14.16
2005	85.66	18.05	21.07	57.70	6.91	11.97
2006	100.80	21.73	21.56	61.07	5.52	9.03
2007	114.10	23.63	20.71	74.47	6.53	8.76

Source: UN Comtrade.

Further decomposition of trade between Indonesia and Japan revealed that primary input goods form the bulks of Indonesia exports to Japan and this pattern has remained for the last ten years as shown in Table 2.7. In 2006, 4 out of the top 5 commodity exports by dollar value are primary goods and only one can be considered an intermediate good. Mineral fuels, oils, distillations products continued to top Indonesian exports to Japan for the period, although the rising price of crude oil may have partly contributed to this. The import side on the other hand is completely to the contrary, with intermediate and final goods dominating the top five commodity imports from Japan. For the period 1996-2006, nuclear reactors, boilers, machinery, etc were the most important imports to Indonesia based on trade value. Again, similar to the export trend, there was relatively little shift in the type of commodities that formed the bulk of imports into Indonesia. Table 2.8 provides the top five commodity imports, based on trade values, for selected years from Japan. The composition of both the exports and imports clearly reinforces the development status of each country. As the less developed country, Indonesia exports more primary and labour-intensive goods while importing more capital-intensive goods and vice-versa. A similar pattern was also observed with Indonesia’s world trade, considering that most of her major trading partners were more developed countries. These trends have not changed over the years despite Indonesia's growth and can be partially explained by the allocation of FDI during the period.

Table 2.7: Top five commodity exports from Indonesia to Japan (million US$).

Commodities	1996	Commodities	2001	Commodities	2006
Mineral fuels, oils distillation products	6265.46	Mineral fuels, oils distillation products	6718.35	Mineral fuels, oils distillation products	10893.75
Wood , articles of wood, wood charcoal	2034.92	Wood , articles of wood, wood charcoal	1073.22	Ores, slag and ash	2022.77
Fish, crustaceans, molluscs, aquatic inverterbrates nes	975.52	Electrical, electronic equipment	1016.30	Nickel and articles thereof	1225.00
Ores, slag and ash	624.27	Fish, crustaceans, molluscs, aquatic inverterbrates nes	728.90	Electrical, electronic equipment	1009.83
Electrical, electronic equipment	288.84	Ores, slag and ash	519.41	Wood , articles of wood, wood charcoal	1009.34

Source: UN Comtrade.

Table 2.8: Top five commodity import from Japan to Indonesia (million US$)

Commodities	1996	Commodities	2001	Commodities	2006
Nuclear reactors, boilers, machinery, etc	2921.72	Nuclear reactors, boilers, machinery, etc	1378.90	Nuclear reactors, boilers, machinery, etc	1794.66
Vehicles other than railway, tramway	1892.48	Vehicles other than railway, tramway	1169.19	Vehicles other than railway, tramway	874.62
Electrical, electronic equipment	618.29	Iron and steel	293.31	Iron and steel	535.60
Organic chemicals	592.63	Organic chemicals	274.17	Electrical, electronic equipment	368.86
Iron and steel	523.79	Electrical, electronic equipment	233.07	Organic chemicals	280.69

Source: UN Comtrade.

2.3 FDI in Indonesia

The Asian economic crisis that occurred in 1998 has been particularly difficult for Indonesia in terms of FDI. Directly prior to 1998, Indonesia was enjoying an economic boom and where government approved FDI was upwards of US$ 20 billion for the year 1996 and 1997 (Bank Indonesia). This FDI contributed to Indonesia's fast growing economy. When the crisis hit, this decreased to US$ 9.32 billion in 1998 before rising slowly to US$ 15.6 billion in 2006. Approved FDI has not reached its pre-crisis height. A major source of FDI into Indonesia was from developed Asian countries such as Japan, South Korea and Singapore. These countries were also hit hard by the crisis, leading to a drastic decrease in FDI from these sources. Unfortunately, Indonesia did not seem to have a coordinated policy to promote a particular sector as a FDI destination. The focus of FDI has shifted from the chemical and pharmacy sectors (24.5%) in 1996, to the hotels sector (45.8%) in 2001, and eventually to the metal goods sector (18.7%) and construction sector (16.4%) in 2006. There was a lack of FDI into other capital intensive industries besides the chemical and pharmacy sector. In conclusion, this declining and unfocused FDI is unlikely to have led to major changes in Indonesian's output production, which could affect her trade patterns. As a result, over the past ten years, the focus of Indonesia's exports remains on primary goods.

2.4 A Brief Environmental Picture of Indonesia

2.4.1 Greenhouse Gas (GHG) Emissions in Indonesia

Despite not being a major economic power, Indonesia has managed to become one of the leading GHG emitters in the world. In a report released in 2007 by PT. Pelangi Energy Citra Abadi Enviro and sponsored by the World Bank and the United Kingdom Department of International Development, Indonesia ranked third in the world for GHG emissions behind the United States and China. It emitted approximately 3,014 million tons of CO_2 equivalent ($MtCO_{2e}$), much of which could be attributed to land use change and deforestation with forestry as an emission source contributing 2,563 $MtCO_{2e}$ or about 85% of total emissions. A further breakdown of CO_2 emissions from the report are found in table 2.9.

Table 2.9: Yearly CO_2 emission in $MtCO_{2e}$ for 2006, selected countries

Emissions Sources	United States	China	Indonesia	Brazil	Russia
Energy	5,752.00	3,720.00	275.00	303.00	1,527.00
Agriculture	442.00	1,171.00	141.00	598.00	118.00
Forestry	(403.00)	(47.00)	2,563.00	1,372.00	54.00
Waste	213.00	174.00	35.00	43.00	46.00
Total	6,005.00	5,017.00	3,014.00	2,316.00	1,745.00

Source: PT. Pelangi Energy Citra Abadi Enviro. *Executive Summary: Indonesia and Climate Change*, Jakarta, March 2007.

A report on Indonesia's CO_2 emissions from fuel combustion was also published by the International Energy Agency (IEA) and showed emission increases over the year, rising from 192.22 million tons of CO_2 ($MtCO_2$) in 1995 to 330.95 $MtCO_2$ in 2005, a 72.17% increase. Over the period, CO_2 emissions per capita rose from 1.00 ton CO_2 (tCO_2) in 1995 to 1.50 tCO_2 in 2005, a 50.00% increase (refer to Table 2.10). It is important to note that these reports are based on emissions arising from fuel combustion only and thus do not provide the full extent of CO_2 emitted by Indonesia. This trend illustrates that Indonesia's economic growth during the period came with environmental consequences. The largest contributor of this growth in CO_2 emission from fuel combustion came from electricity and heat production sectors, which saw an increase in emissions of 55.64 $MtCO_2$ or a significant 171.25% increase from its 1995 level. A summary of other important sectors that helped to contribute to this increase are listed in table 2.11. Therefore, given the prominence of Indonesia in contributing to the world's GHG emissions, it is critical to ensure that her involvement in a FTA will not further deteriorate the situation.

Table 2.10: Indonesia's CO_2 emissions from fuel combustion.

Country	Measure	1995	2000	2005	% change (1995-2005)
Indonesia	CO_2 Sectoral Approach (Mt of CO_2)	192.22	264.62	330.95	72.17
	CO_2 / GDP (kg CO_2 per 2000 US$ PPP)	0.33	0.44	0.44	33.33
	CO_2 / Population (t CO_2 per capita)	1.00	1.28	1.50	50.00

Source: IEA 2008.

Table 2.11: CO_2 emissions from fuel combustion in selected sectors in Indonesia.

Sectors	1995	2000	2005	% change (1995-2000)
Main Activity Electricity and Heat Production	32.49	55.14	88.13	171.25
Manufacturing Industries and Construction	41.84	71.23	93.09	122.49
Iron and Steel	4.80	4.93	3.19	-33.54
Chemical and Petrochemical	2.49	3.29	2.98	19.68
Non-Metallic Minerals	8.00	9.86	16.57	107.13
Mining and Quarrying	3.25	3.32	4.23	30.15
Textile and Leather	3.70	3.86	4.80	29.73
Transport	48.75	63.30	73.87	51.53
Road	42.03	56.01	66.76	58.84
Residential	20.90	29.36	27.48	31.48
Agriculture/Forestry	4.78	6.33	7.18	50.21

Source: IEA 2008.

2.4.2 Environmental Policy of Indonesia

Over the years, Indonesia has made some attempts to deal with environmental problems. The paper by Resosudarmo and Irhamni (2008) provides a good summary of environmental policies undertaken by Indonesia. In the 1970s, concerns regarding the impact of industrial and economic development in Indonesia resulted in the creation of the Ministry of Environment by then President Soeharto. However, it was only in 1989 that there was a serious attempt to curb pollution emitted by the industrial sectors as the government introduced regulations that required firms to provide an environmental assessment report (AMDAL) on new economic activities for approval by the relevant ministry. Unfortunately, as with many regulations in a developing country, control and enforcement of this regulation was weak. At the same time, the Indonesian government also introduced a clean river program called PROKASIH due to the declining water quality in the rivers of Jakarta based on biological oxygen demand (BOD) and total suspended solids (TSS). The goal was to reduce industrial waste pollution by 50% before moving to commercial and private discharges. While the government considered the program a success, reviews from external parties have been mixed. In 1995, the government embarked on an environmental rating program called PROPER with the aim to promote environmental regulation compliance, clean technologies and firms' in-house environmental capabilities to prepare them for International Standards Organization (ISO) 14001 certification. By 1998, 324 plants participated in the program but unfortunately the economic crisis brought it to a halt. The program was only restarted in 2002 with more comprehensive goals that were backed with new regulations regarding AMDAL, toxic waste management and air-water pollution. In 2004, the program had 85 firms participating. These programs formed the bulk of Indonesia's environmental policies and it highlights the lack of continuity and weak enforcement that have plagued Indonesia's environmental policy initiatives. Therefore, it is not surprising that environmental problems are likely to continue to be an issue in Indonesia for the foreseeable future.

In conclusion, this chapter has outlined the different trends of the Indonesian economy and environmental policy. Indonesia's GDP grew at a rapid rate in the 1990s until the Asian economic crisis in 1998 when the GDP growth rate was negative. Since then and through the 2000s the GDP growth rate was moderate. At the same time, her exports and imports grew as she gradually moved to a more open economy. Japan and ASEAN continue to be two of her most important trading partners. Unfortunately, the growth in Indonesia has also been accompanied with a deteriorating environment; Indonesia has become one of the leading GHG emitters in the world. As with many developing nation, environmental policy in Indonesia has also been ineffective in tackling this issue. This information provides a useful context to analyze the possible impact of AFTA and IJEPA on Indonesia.

Chapter 3: Literature Review

The aim of this chapter is to trace the relationship between free trade and the environment. The discussion will start by briefly reviewing the literature on trade and growth focusing on the impact of trade liberalization. It will then touch briefly the two types of modelling often used in economic analysis of free trade, before moving on to review free trade agreement (FTA) and regional trade agreement (RTA) studies that have been done on the East Asian Region. The following section will then review the relationship between trade and the environment, covering different aspects in this topic such as: the impact of regulation on comparative advantage, the 'pollution haven hypothesis', the environmental Kuznets curve and the impact of trade liberalization on pollution emissions.

3.1 Trade and growth

The relationship between trade and growth is a subject that has been studied extensively and much of the prevailing view is that trade helps induce growth. Countries with fewer barriers to international trade are expected to grow faster economically. This view has been reinforced by the publication of influential papers such as Dollar (1992) and Sachs and Warner (1995). Dollar (1992) developed an index of real exchange rate distortions using the data compiled by Summer and Heston (1988) as a measure of trade openness. A higher value for the index means that a country is less outward oriented. This index was shown to be negatively correlated with growth in an analysis involving 95 countries over the period 1976-1985, indicating that countries are likely to gain from being more outwardly oriented. Similarly, in Sachs and Warner (1995), the authors created a zero-one dummy as an indicator of openness by considering factors such as tariff rate, tariff barriers, social economic system, state monopoly of major exports and black market premium, all of these means are ways in which policymakers are able to restrict international trade. Placed in an econometric equation, this dummy showed a robust and positive impact on growth where countries that passed all the requirements for openness grew 2.44% faster. Other studies by Edwards (1993), Dollar and Kraay (2004), Irwin and Tervio (2002) have also reached similar conclusions. Therefore, it appears that there are positive economic benefits that can be reaped by countries that engage in trade and adopt more open trade policies.

As with all studies, there is a need to interpret these results carefully. An important issue brought out by Rodriguez and Rodrik (1999) is that there is no clear theoretical background indicating such a relationship and that endogenous growth theory does not provide a clear link between openness to trade and growth. Similarly, Grossman and Helpman (1991) concluded that the effect of trade on growth depends on how it impacts the allocation of resources in a country, whether it is towards activities that create long term growth or otherwise. Moreover, many of these studies seem to be plagued by methodological shortcoming especially in the generation of indices used to indicate trade openness. Therefore, while there seems to be a general consensus in the literature that trade liberalization/openness may have a beneficial impact on economic growth, there are still many caveats to this conclusion.

3.2 Economic effects of FTAs and RTAs

The slow progress of the multilateral trade agreement as proposed under the WTO framework has encouraged many countries to pursue their own bilateral/regional FTAs. By December 2008, 194 RTAs have come into force according to the WTO (2009). As a result, there has been an increase in empirical work studying the impact of FTAs on the economy as the number of FTAs/RTAs increased. These studies can be categorized according to the two different methodologies they used. The first group employs econometric methods based on historical data to assess impacts on trade flows while the second uses general equilibrium models.

3.2.1 Studies Employing Econometric Approach

Econometric assessment of RTAs usually utilizes gravity models to estimate the relationship between policy changes and trade. This usually involves the regression of a trade variable against several variables that represents important factors such as distance, population, GDP and a binary variable that indicates involvement in the FTA/RTA. Studies employing gravity models to assess the impact of RTAs on trade have reached various conclusions. Braga, Safadi and Yeats (1994) estimated that if the Americas were to employ EU levels of trade integration, shares of intra-member trade were expected to increase from 41.1% to 62.5%. In Zahniser et al (2002), the authors attempted to analyze the impact of NAFTA and MERCOSEUR on U.S. agricultural exports to the region. They concluded that NAFTA did not have a significant impact on U.S trade with Canada and Mexico as existing conditions were relatively liberalized already while MERCOSEUR did appear to have a trade diversion impact on US agricultural export to Brazil, especially on wheat. Yet, Dee and Gali (2003) analyzed 18 RTAs and found that 12 appeared to have a negative net trade effect where trade diversion from non-members was greater than trade creation amongst member nations. In addition, significantly more liberal RTAs such as the EU and NAFTA did not seem to have a significantly greater positive impact on members' trade when compared to other less liberal agreements. While the use of gravity models is appealing, Burfisher, Robinson and Thierfelder (2004) point out two problems with these models. The first is that they lack a sound theoretical base for the analysis and the second is the estimation problem that the estimated coefficients of trade-agreement variables also capture the effects of unidentified variables.

3.2.2 Studies Employing CGE Approach

The alternative approach that is used in RTAs studies is the computable general equilibrium (CGE) model. This framework employs a detailed specification of both economic structure and agents' behavioural parameters to simulate the impact of existing or planned RTAs. The main attraction of using a CGE model is that they allow endogenous prices and terms of trade analysis that helps in determining possible welfare impacts of RTAs. Using a CGE model, Llyod and MacLaren (2004) suggest that RTAs have a positive welfare and net trade creating impact on members while the effects on non-members are negative and worsen with increasing RTA size. More recently, Siriwardana (2007) attempted to evaluate the impact of Australia-United States Free Trade Agreement (AUSFTA) using Global Trade Analysis Project (GTAP) model. Her results indicate that AUSFTA increases output, trade and welfare of member nations at the expense of non-members nations where Australia's and U.S. GDP increased by 0.1% and 0.08% respectively while welfare increased by US$ 308 million and US$ 1,261 million. Other studies by Scollay and Gilbert (2001) and Urata and Kiyota (2003) have also estimated positive impacts on member countries of RTAs and FTAs. Indeed, a review of CGE-based literature on RTAs by Robinson and Thielfelder (2002) reached the same conclusion. Several authors, Panaragiya and Dutta-Gupta (2001) and Schiff and Winters (2003), have criticized CGE models because they employ random and questionable parameters values. However, Burfisher, Robinson and Thierfelder (2004) have argued that sensitivity analysis indicates that the general conclusions derived from CGE studies are robust to a reasonable variation in parameter estimates. In conclusion, while carefully considering these caveats, CGE models can provide a very useful tool in analysing the economic impacts of FTAs and RTAs.

3.2.3 FTAs and RTAs in East Asia

As mentioned previously there has been a growing interest in FTAs/RTAs negotiations and implementations among countries in East Asia. Several recent studies have been carried out to try and analyze their impacts in the region. Ballard and Cheong (1997) carried out simulations of different RTA scenarios involving different countries in the Pacific Rim region (including East Asian countries) using a CGE model. Their main conclusions were that these countries would stand to gain welfare benefits by participating in the RTA and that these gains increased with an increase in the RTA size. In addition, their comparison of perfectly-competitive and imperfectly-competitive models indicated that the former results in smaller welfare gain.

As part of a broader study on the impact of free trade agreements between South-South countries using the GTAP framework, Fugazza and Vanzetti (2008) also studied the possible impact of a regional trade agreement within developing countries in the

Asian region. Their results have shown that such agreement will result in a net welfare increase of US$ 14,489 million for these countries. However, this welfare increase is not evenly distributed with countries such as the Republic of Korea, Taiwan and ASEAN seeing a large welfare gain while China and India experiencing welfare decline. Surprisingly, the Asian regional trade agreement resulted in a marginal decline in trade value. While the authors did not provide any explanation to this observation, one possible reason is that trade diversion of exports from non-member countries may have exceeded the trade creation among member countries in the region. A general conclusion from this study was that it would be more beneficial for these countries to engage in a broader trade agreements that include countries outside the region.

Focusing on the East Asian region, Urata and Kiyota (2003) tried to examine the effect of an East Asian FTA on trade in the region. Their analysis of trade patterns in East Asia indicated that many East Asian economies have a comparative advantage in the electronic equipment sector that arises from labour-intensive assembling operations that are part of the production process. Their results indicated that an East Asian FTA would have a positive impact on members' GDP and welfare. Moreover, the positive impacts on ASEAN countries are sizeable with Thailand's GDP increasing by 16% as a result of the FTA. Further sectoral analysis revealed that sectors with comparative advantage did gain from trade liberalization. The FTA led to a decline in non-member countries' GDP and welfare, indicating the presence of trade diversion. However, their result showed that an East Asian FTA did not have a great impact on export and import composition with less than a 5% change for most of the sectors and economies studied.

Taking a different approach to regionalism in East Asia, Lee and Park (2005) focused their analysis on a select few FTAs/RTAs scenarios that were under considerations. These included: China-Korea, Japan-Korea, China-Japan-Korea and ASEAN-China-Japan-Korea (ASEAN+3) FTAs. Using a gravity model, they first determined the coefficient of the RTA variable and used it to estimate the impact of the different FTAs scenarios under consideration. Their estimates indicated that a China-

Japan-Korea FTA led to a 54% increase in intra-block trading. Unlike many other studies, they did not find a significant trade diversion effects.

An analysis of the impact of free trade agreements involving the ASEAN region has also been done by Ariyasajjakorn et al (2009). Their study uses the GTAP framework to analyze the impact of free trade within ASEAN and between ASEAN, China, Japan, Korea and India. It showed that free trade within ASEAN resulted in an increase in GDP for all member countries except for Thailand and Vietnam while non-member countries' GDP contracted. Similarly, when this is extended to include China, Japan, Korea and India (ASEAN+4), all member countries saw an increase in their GDP. In fact, Vietnam's real GDP, which contracted by –0.32% in the ASEAN only scenario saw an increase of 1.03% in the ASEAN+4 scenario. The FTA also resulted in a net welfare increase for the ASEAN countries. This increase, however, was not evenly distributed and that the more industrialized economies in the region, i.e. Malaysia, Singapore and Thailand, saw a greater increase in welfare compared to those less developed ones. These observations are similar to that of Mukhopadhyay and Thomassin (2008). In this earlier study, the authors uses the GTAP framework with a recursive process to estimate the impact of ASEAN free trade without and with the addition of Japan, China and Korea (ASEAN+3) added to the arrangement up to the year 2020. Their results indicated that this regional free trade agreement resulted in an increase in output growth for the countries involved with Vietnam seeing the largest increase (13.58%) in an ASEAN+3 deep trade integration scenario. The agreement also resulted in a trade diversion with member nations experiencing significant increases in export and import from other member countries. The increase in output and trade among member nations meant that welfare increases for these countries. Unfortunately, the agreement also resulted in a welfare decline among non-member countries.

In addition to the above, a paper by Qui et al (2007) studied the impact of China-ASEAN Free Trade Agreement (CAFTA) on China's agricultural trade using the GTAP version 6 framework. Their analysis indicated that by 2010, CAFTA would help improve both economic growth and welfare for both ASEAN and China. CAFTA was estimated to increase GDP growth by approximately 0.2%, 0.6% and 0.5% for China, older ASEAN members and newer ASEAN members respectively. Similarly, older ASEAN member stood to gain the most welfare of US$ 1,507 million followed by China with US$ 517 million. The agreement also boosted trade among the member nations as total exports and imports increased. For China this translated to an increase for both agricultural export and import. In the export side, the tea/horticulture, vegetable and fruits, and sugar sectors saw significant increases while for import the increase is driven by the vegetable oil sector. A later study done by Park, Park and Estrada (2009) using a GTAP framework modified for General Algebraic Modelling Systems (GAMS) further reinforced these observations. In their report, CAFTA resulted in a net increase in total GDP, welfare and trade among member nations. However, the author noted that these benefits were not equally distributed among the nations with the more developed countries like Thailand, Singapore and Malaysia benefiting more while some members actually seeing a marginal decline.

The consensus among these studies suggests that FTAs in East Asia are likely to have a positive impact on countries in the region. A study focusing on Indonesia by Hartono et al (2007) arrived at the same conclusion. The authors analyzed how different FTAs scenarios might affect Indonesia's GDP, welfare, investment, trade and even income distribution. Overall, they found that most of the FTAs had positive impacts on these factors. For example an Indonesia-China FTA would lead to a 0.20% and 0.65% increase in GDP and welfare respectively while it would cause real investment, exports and imports to increase by 2.28%, 0.85% and 2.66% respectively. Their analysis of an Indonesia-Japan FTA (IJFTA) also yielded similar results, with GDP, real investment and welfare increasing by 0.04%, 1.81% and 0.38% respectively. In addition, they found that income equity increased. Hence, this indicates that it may be beneficial for Indonesia to pursue a FTA with Japan.

The analysis of the different free trade scenarios in the East Asia studies discussed so far have clearly concluded that East Asian countries would benefit from adopting FTAs/RTAs. However, many of them employ a 100% tariff reduction to capture policy shocks in their FTA analysis, which is both unrealistic and unlikely to be adopted by countries in their free trade negotiations. The relatively recent FTAs negotiations in East Asia may have prevented them from using actual tariff shocks that would be eventually adopted and thus these studies provide a good indication of the greatest gains that can be achieved. However, with the conclusions of several FTAs in the region in the past few years has now provided a new opportunity to analyze the impacts of these trade agreements using the actual tariff reduction schedules.

3.3 Trade and Environment

In recent years, the increased concern about global climate change has pushed environmental issues to the forefront of public discourse. As a result, environmental considerations have become an important factor in policy making decisions today, including trade policies. While the increased focus and public awareness of this issue appears to be a recent phenomenon, work in this area has actually been going on for a significant period of time. In the 1960s, initial public concern regarding the environment focused mainly on the impact of industrial pollution in developed economies. It was in 1970s that environmental issues began to appear in trade studies. The survey by Dean (1992) highlights the various areas of concerns in the trade and environment literature: (i) environmental regulation and comparative advantage (ii) trans-boundary pollution and trade (iii) non-tariff barriers in term of standards (iv) trade of hazardous substances, and (v) the impact of trade liberalization on environmental degradation. Among these, (i) and (v) are among the most important and often discussed issues.

3.3.1 Environmental Regulation and Comparative Advantage

The effect of environmental regulation on comparative advantage has been the focus of many studies relating trade and environment. Siebert (1985) surveyed simple trade models that have been used to examine the impacts of environmental policies on comparative advantage. The conclusion drawn from this survey was that countries with a greater absorption capacity are more likely to have a comparative advantage in producing pollution intensive goods. The adoption of environmental regulation however, will impose an environmental control cost (ECC) on producers in a country, thus reducing their price advantage compared to competing producers in other countries. As a result, the imposition of environmental regulation is likely to result in a decline in comparative advantage of an environmentally rich country in producing dirty goods. Empirical evidence, however, indicates that ECC's impacts on trade did not appear to be significant. This can be explained by the fact that total ECC are a small fraction of total production costs in most industries and thus do not significantly impact output level and trade pattern.

An early study by Walter (1973) tried to determine whether ECC in the US was trade neutral. To measure the ECC, the author compared actual prices of 83 goods and services with an estimated price if they were to conform to the desired environmental standard. The costs considered include research and development costs together with depreciation, operating and capital cost of the pollution control equipment used. His calculation indicated that overall, the share ECC of US exports was 1.75% compared to 1.52% for US imports in 1971. This figure only varied slightly among individual trading partners. Given this results, the author concluded that ECC would only marginally impact US trade.

A similar study was undertaken by Robinson (1988) using a general equilibrium model to investigate the effect of changes in pollution abatement cost on US trade. From the results, the author concluded that environmental abatement costs appeared to have changed US comparative advantage. The results indicated that the US imported more high-abatement (high polluting) goods and exported more low-abatement (low polluting) goods. The ratio of import to export abatement content rose from 1.17 to 1.39 during 1977 to 1982, an indication that import composition was getting more pollution intensive. In addition, it was estimated that a 1% increase in US sectoral price due to environmental abatement costs resulted in a 0.67% decrease in US trade in 1977. This result indicates that marginal changes in abatement cost would only lead to marginal changes to trade flow. Furthermore, considering the ECC ranged from 1.92%-2.89% of total cost in pollution intensive industries, as calculated in Tobey (1990), it seemed that its impact would be limited. In conclusion, these studies appear to back support the conclusion that environmental regulations may influence a country's comparative advantage but its actual impact may be limited because the ECC is a small fraction of the total cost of production.

3.3.2 The Pollution Haven Hypothesis

Given the relationship between ECC and comparative advantage, the focus in trade-environment literature shifted to the movement of dirty industries to 'pollution havens'. 'Pollution havens' are countries that are considered to have lower environmental standards, more 'environmental' resources, and thus have a comparative advantage on dirty industries. Taylor (2004) used the pollution haven hypothesis (PHH) to predict whether a reduction in trade barriers would result in a migration of pollution-intensive industries from countries with stringent environmental regulation to those with lax regulations. It is different from the concept of a 'pollution haven effect' (PHE) that focuses on the effect of environmental policy changes on trade flows. Given that less developed countries are more likely to have lenient or less well enforced environmental regulations in place, the PHH is a major concern among developing economies as they engage in trade liberalization.

The theoretical model of the PHH was first developed in the paper by Copeland and Taylor (1994). The authors developed a static general equilibrium model with two countries (North and South) and one factor of production (human capital) that determines income, demand for environmental goods, and the level of environmental regulation of a country. Given that pollution is a joint product of production and that abatement efforts consume resources, the model considers pollution as an input to production. Their model shows that with differences in human capital and thus income and environmental regulation, trade results in a migration of dirty industrial production from the rich country, with stringent environmental regulation, to the poor country, with the lax regulations, as proposed by the PHH. The higher pollution abatement costs in rich countries that are a result of more stringent environmental regulation are expected to give a comparative advantage to dirty industries located in poor countries. Therefore, production of dirtier goods is expected to move to low-income countries and vice-versa in a free trade scenario. Dietzenbacher and Mukhopadhyay (2007) explored this conclusion further through the Heckscher-Ohlin theory. A low-income developing country with lax environmental regulations means that it is well endowed with 'pollution permits' compared to high-income developed country that have stringent environmental regulations. Thus, the former have a comparative advantage in producing pollution intensive good and will specialized in them in a trade.

Bommer (1999) supported this conclusion by constructing a simple model where signalling between policy-maker and polluting industry was used to test whether dirty industries relocate to countries with more lenient environmental standards because of diminishing competitiveness arising from trade liberalization. He concluded that for an import-competitive polluting industry (one that mainly sells its good in the domestic market), trade liberalization not only causes producers to relocate their resources to less environmentally stringent countries, thus creating a 'pollution haven', but also used the relocation as a strategic rent-seeking move to deter policymakers from imposing more stringent environmental controls. Trade liberalization in this situation seems to result in a loss-loss situation for the environment.

A survey of empirical studies on the PHH does not seem to indicate a conclusive outcome. Using a gravity model, Grether and Melo (2003) studied 5 polluting industries in 52 countries over the period 1981-1998. Their analysis revealed that four of the industries moved in a North-South direction. While this is an indication that there has been a relocation of dirty industries to lower income countries, the authors concluded that there is not much evidence that they were driven there by regulatory gaps. Dessus and Bussolo (1998) used a recursive CGE model to assess the impact of economic activity on Costa Rica's environment to 2010. The model employed a high level of disaggregation for pollutants, products, sectors and household types, while allowing substitution between polluting and non-polluting factors. The results indicated that trade liberalization appears to increase the share of pollution-intensive production in Costa Rica as both the highly polluting sectors and the export agriculture growth rates increased to 6.4% and 6.2% compared to 4.8% and 2.5% in the benchmark scenario respectively. Similarly, Lee and Roland-Holst (2000) and Kuik and Verbruggen (2002) found that trade seems to increase pollution in less developed countries.

Beghin, Roland-Holst and van der Mensbrugghe (1995) arrived at different conclusions. Utilizing the Trade and Environment Equilibrium Analysis (TEQUILA) CGE model on Mexico and NAFTA, they ran a twenty-year simulation where ad valorem tariffs were reduced gradually over the period. One of their main conclusions was that although increased trade liberalization resulted in a 3.2% rise in real GDP and a corresponding 2.5%-4.8% increase in pollution, there was no evidence of PHH. Despite the expansion of a few dirty activities in certain sectors, overall industrial composition in Mexico had actually become cleaner. However, it must be noted that Mexico did increase its imports of 'dirty' products to replace domestic production and this may constitute in itself a pollution export to other nations but just not to its free trade partners. Similarly, Ederington, Levinson and Minier (2004) concluded that there was no significant relationship between tariff reductions and dirty industries migration across borders. They found that tariff reduction in the US, from 1974 to 1994, did not have a significant impact on imports from clean and polluting industries.

There are several reasons why dirty industries have not migrated to less developed countries. Cole and Elliott (2005) suggest that the high capital cost of relocation may act as a hindrance to relocation and the tariff reductions are not large enough to have any major impact. In addition, if tariff reductions are similar for both dirty and clean industry, there is no reason for industrial composition to change. Taylor (2004) also highlights that limited factor mobility for certain inputs may hinder movement of dirty industry into other countries. In sectors such as agriculture and mining, availability of suitable land plays a huge role in relocation decisions. Moreover, the measurement of preferences for pollution abatement also takes into account the level of per capita income of the country that creates a feedback effect. As poor countries benefit from trade and economic growth, the demand for environmental goods are expected to rise, leading to more stringent environmental regulation and making it less attractive to dirty industries. The possibility of innovation and technology spill-over may also reduce the comparative advantage of developing countries in producing pollution intensive goods especially over a long timeframe. These considerations illustrate that differences in environmental standards are only one of numerous factors that influence relocating decisions of a firm and therefore it is important to interpret any empirical results in this context.

3.3.3 The Environmental Kuznets Curve

While much emphasis has been placed on the possible migration effects of dirty industries across borders with trade liberalization, there is also a concern that trade liberalization will impact the environment through growth. Much of this has been based on the environmental Kuznets curve (EKC), which is an inverted U-shape relationship between income level and environmental damages. The curve suggests that pollution increases until a maximum before decreasing as income increases from low to high level. Using the global environmental monitoring system (GEMS), Grossman and Krueger (1995) examined the relationship between per capita income and the level of several environmental indicators. Their results supported the EKC hypothesis; for example SO2 and smoke pollution peak at an income level of $4000 per capita. Similarly, using data from 48 countries over 20 years, Hilton and Levinson (1998) found an EKC relationship in lead emissions from automotives where it peaked at $7000 per capita. However, Shafik (1994) showed that not all pollutions follow this pattern. Utilizing data from 149 countries covering the period 1960 to1990, he showed that water and sanitation improved with income, while other indicators such as: CO_2, municipal wastes, and dissolved oxygen worsened. Unfortunately, given the complexity of the relationship between trade and growth, it is difficult to pinpoint the paths that underlie the linkages between trade, growth, and pollution. Torras and Boyce (1998) attempted to identify some of these and their results have showed that literacy, political rights and civil liberties strongly influence the level of air and water quality in certain low income nations. In this respect, de Bruyn, van den Bergh and Opschoor (1998) suggested that it may be inappropriate to generalize EKC patterns for all countries since the process of development are likely to differ among them. Despite this fact however, the EKC provides a good link on how trade may influence pollution through growth.

3.3.4 The Impact of Trade liberalization on the Environment

Other studies have provided a general analysis of the relationship between trade liberalization and the environment. Beghin, Roland-Holst and van der Mensbrugghe (1995) found that trade liberalization under NAFTA led to a 2.5%-4.8% increase in pollution level in Mexico while Dessus and Bussolo (1998) estimated that trade liberalization would increase emissions levels by 15% to 20% in Costa Rica when compared to the benchmark scenario for the year 2010. A study by Lee and Roland-Holst (1997) on the impact of trade liberalization between Indonesia and Japan came to the same conclusion. The analysis involved creating a two-country, 19-sector CGE framework based on the 1985 SAM of both nations and standard CGE model specifications. Data for pollution emissions were obtained from the Industrial Pollution Projection system of the World Bank. Effluent intensities of industries in Indonesia and Japan were derived from estimates of U.S. industries. This however, meant that the Indonesian effluent level is likely to be understated while it is the reverse for Japan. Their results indicated that in the absence of technological improvements, a unilateral tariff reduction adopted by Indonesia would lead to an increase in emissions of all pollutants in Indonesia, ranging from 0.51% for BOD to 3.73% for lead. For Japan, emission levels decreased for these pollutants but only by a marginal amount, ranging from -0.02% to -0.09%. Between the two countries, emission levels increased for the majority of pollutants. These studies suggest that trade liberalization leads to an increase in pollution level. A more recent study by Mukhopadhyay and Thomassin (2009) that focuses on the impact of a free trade agreement among ASEAN, Japan, China and Korea using the GTAP framework also showed that while trade liberalization is expected to increase output, trade and welfare among member nations it is resulted in a deterioration of the environment.

On the contrary, however, the study by Strutt and Anderson (2000) indicates that trade may lead to an improvement in the environment and at worst only results in a small environmental degradation while bringing great economic benefit to the country involved. Employing the Global Trade Analysis Project (GTAP) CGE modelling framework and database with a 23 sectors and 5 regions aggregation, the authors tried to determine the impact of the Uruguay Round tariff reductions and MFN tariff reductions by APEC on Indonesia by the year 2010 and 2020 respectively. The study estimated that complete implementation of the Uruguay Round by 2010 with China as a WTO member would boost Indonesia's GDP by 1.4% while actually reducing CO_2 and SO_x emissions by 0.6% and NOx emission by 1%. They found that changes in the sectoral composition of industries and technical gains might offset the increase in pollution coming from the increased growth. MFN tariff reductions however resulted in a small increase in pollution in 2020, 2.1%, 3.4% and 3.8% for CO_2, SO_x and NO_x respectively. Kang and Kim (2004) also provided some empirical support that trade liberalization may have a beneficial environmental impact based on their study of a Korea-Japan FTA. Using the GTAP framework, their results showed that the complete removal of both tariff and non-tariff barriers between Korea and Japan resulted in a reduction of 3.92 kt of SOx and 6.13 kt of NOx. Overall air pollution emissions will decrease by 0.36%. A more recent study by Mukhopadhyay and Thomassin (2009) that focuses on the impact of a free trade agreement among ASEAN, Japan, China and Korea using the GTAP framework also showed that while trade liberalization is expected to increase output, trade and welfare among member nations it did not appear to have a negative impact on most member nations.

One possible reason why there are differences in these results may be due to the fact that trade liberalization may not have the same general environmental impact on different countries. This variation in environmental impacts is highlighted by Ferrantino and Linkins (1999). In their study, the authors analyzed the potential impact of two trade liberalization scenarios on toxic industrial emissions. Using the GTAP CGE modelling framework and database, they considered 25 sectors and 10 regions with a focus on sectors that had very high toxic emissions such as textiles, apparel, leather, pulp and paper, chemicals, iron-steel and non-ferrous metals. Emissions data for the study were obtained from the Toxic Release Inventory of the U.S. Environment protection Agency. Changes in the emissions levels in the study were calculated by assuming that the U.S. coefficients were applicable across regions and adjustments were made to them according to the GDP level based on a relationship between environmental quality and per capita income as outlined in Grossman and Krueger (1995). Under the Uruguay Round of tariff reductions, the results indicated that changes in toxic emissions varied across regions with emission declining by 3.43% in China-Hong Kong and increasing by 1.84% in South East Asia. Similarly, in the second zero-for-zero trade liberalization scenarios where all tariffs in manufactures were eliminated, toxic emissions declined by 7.73% in China-Hong Kong and increased by 1.4% in Korea-Singapore-Taiwan. Overall, however, world toxic pollution declined marginally by 0.003% and 0.18% for the Uruguay Round and for the zero-for-zero tariff reductions respectively. In conclusion, non-uniform environmental impacts may partially explain the divergence in the results among studies in this area. Yet, a consistent finding among these studies is that the environmental impacts of trade liberalization do not appear to be large in magnitude.

3.3.5 Decomposing Pollution Changes

Recent studies have also begun to decompose trade impacts on the environment into three parts. These are through the scale, composition and technique effect. The scale effect accounts for the changes in pollution due to changes in the level of economic activity arising from trade liberalization where the types of activities remain the same. However, trade liberalization also brings changes to the structure of sectors and the composition of industries in an economy as countries specialized in activities that they have comparative advantage in. The impact of these changes on pollution is captured by the composition effect. Lastly, changing factor prices and possible technological spill-over which means that production methods and pollution emission rates may not remain the same and this changes is accounted through the technique effect. The sum of these three effects determines the total impact of trade liberalization on the environment. Examples of studies that disaggregate the environmental impact of trade liberalization include Kuik and Verbruggen (2002) and Strutt and Anderson (2000). Kuik and Verbruggen (2002) analyzed a scenario where Northern countries unilaterally adopted the Kyoto Protocol. Implementation of the Uruguay Round resulted in a positive scale (+11.7 Mt) and technique (+90.6 Mt) effects but a negative composition (-22.17Mt) effect in the emission of carbons in the South. This led to an overall increase in total CO_2 emission in the South driven by the technique effect. In Strutt and Anderson (2000), the authors also utilized this decomposition but using a different methodology. However, their results suggested that Uruguay Round implementation by 2010 with China in the WTO would reduce CO_2 output in Indonesia by 0.733 Mt driven mainly by a negative composition effect (-2.318 Mt). Clearly, these different results suggest that there are still opportunities for further analysis.

In summary, the literature review surveyed studies analyzing the economic and environmental impact of trade. On the economic side, trade has always been seen as a tool to promote growth and that many empirical studies have indicated that countries that are more open to trade grow faster. With the increasing number of FTAs being negotiated, more studies have analyzed their impacts. These studies have used either an econometric or CGE approach. While each has their advantages and disadvantages, one of the main advantages of the latter is that the model is able to differentiate industries and capture a range of indirect effects such as inter-industry changes. Studies of FTAs in the East Asian region suggest that the countries involved are likely to benefit from them. However, as stated before, most of these studies employed a 100% tariff reduction in their analysis. With the new FTAs that are being concluded in the region, it will be interesting to analyze the impact of FTAs using actual tariff reduction rather than hypothetical ones.

Early studies on trade and the environment focused on the effect of environmental regulation on comparative advantage. They concluded that while the cost of complying with environmental regulation does not significantly impact trade it could have a negative effect. A natural follow up to this discussion was the concern that ‘dirty industries’ would migrate to less developed nations that are perceived to have a comparative advantage in dirty industries following the PHH. The evidence in the literature on this issue is mixed at best. Cole and Elliot (2005) and Taylor (2004) provide several reasons why these differences arise. Similarly, empirical studies evaluating the impact of trade liberalization on pollution emissions have arrived at various conclusions, although they found that environmental impacts do not appear to be significant. Recent studies have started to decompose the impact of trade liberalization on pollution into three effects: scale, composition and technique effects. This decomposition is useful in identifying the different sources that contribute to changes in environmental indicators. Unfortunately, despite the continuously growing literature in this area, studies on the impact of trade liberalization on the environment in East Asian remain sparse. Yet, this provides an opportunity to further explore the impact of recent FTAs agreement in the region.

In conclusion, this study complements existing studies by focusing on Indonesia, a country that despite being a major GHGs emitters has not been covered much, through an analysis of the impact of the AFTA and the IJEPA on Indonesian economy and environment. It is distinct from some of the previous works that had been done on Indonesia. Unlike Hartono et al (2007) this study uses a computed general framework and not gravity model. It also differs from the studies by Lee and Roland-Holst (1997) and Strutt and Anderson (2000) as they focus on different trade liberalization scenarios: a complete nominal tariff removal in the former and Uruguay Round tariff reductions for the latter.

Chapter 4: Method of Analysis

The Global Trade Analysis Project (GTAP) framework and database was used to undertake this analysis. GTAP is a CGE model that was developed by Hertel (1997). This chapter outlines the specification of the model and provide a brief description of the framework and assumptions. This is followed by a description of the experimental design that is used to analyze the impact of AFTA and IJEPA on Indonesia's economy and environment. Included in the latter section is a description of the macroeconomic variables, the scenario development, the environmental coefficients and the decomposition analysis.

4.1 Model Specification

This section outlines the structure of the GTAP model as specified in the Hertel (1997) and described by Mukhopadhyay and Thomassin (2008). The GTAP model is a general equilibrium framework where countries and regions in the world economy are linked together through trade. The model incorporates both demand and supply in its specifications. On the demand side, the model uses a Cobb-Douglas aggregate utility function to allocate regional household expenditures among private expenditures, government expenditures and savings along a constant budget share to provide an indicator of welfare for the regional household. In this framework, a representative household in each region maximizes the constant difference of elasticity expenditure (CDE) functions that are calibrated to an income level and elasticity of demand that vary according to the level of development and the consumption pattern of the region. The use of a CDE functions allows the model to capture preferences that lie in between the nonhomothetic constant elasticity of substitution (CES) and fully flexible functions. It also allows the model to be calibrated easily to existing data on income and own-price elasticities of demand. However, one main limitation of this approach is its limitation on substitution effect (Hanoch 1975).

On the supply side, firms combine primary factors and intermediate goods using the Leontief production structure and a constant return to scale technology to produce final goods in a perfectly competitive environment. The final goods produced are then sold to both private households and the government. There are five primary factors of production in the model: capital, land, natural resources, skilled and unskilled labours. Among these factors, land and natural resources are sector-specific. Labour is considered to be mobile across industries but not countries while capital is both mobile across industries and countries. The GTAP model uses nested CES functions to determine firms' demand for primary and intermediate inputs. In addition, GTAP utilizes the Armington's approach to determine firms' demand for imported and domestic goods. Under this approach, all goods are differentiated and firms first decide on the sourcing of imports before deriving a composite price. This price is then used to calculate the optimal combination of imported and domestic goods to be used. All sectors in the model produce a single output and firms face a zero profit assumption.

The GTAP model also incorporates 2 global sectors apart from the regional sectors. They are the global banking sector, which facilitates global savings and investments, and global transportation, which accounts for the difference between free on board (f.o.b) and cost, insurance and freight (c.i.f) values. In addition, domestic support and trade barriers (tariff and non-tariff) are measured in ad-valorem equivalents. The equilibrium nature of the model is derived from the accounting relationships that make up the model. The GTAP model does not take into consideration macroeconomic policies or monetary phenomena. It is static in nature and the impact of investment on production and trade is felt through its effects on final demand.

There are two ways to achieve macroeconomic closure in the model based on the accounting identity $S - I \equiv X - R - M$ where $R = 0$ in the model due to the absence of observation in the database. The first is to fix the trade balance to zero while national savings or investment is allowed to adjust. The second is through the use of the global bank that adjusts its purchases of shares in regional investment goods to account for changes in global savings. The latter allows modellers to endogenize both sides of the identity above. Both methods are neoclassical in nature. Closure is an important part of the model because it is used to capture policy changes and structural rigidity. It classifies different variables in the model into either endogenous or exogenous variables. Some examples of closure elements in the GTAP model are: population growth, capital accumulation, industrial capacity, technological change and policy instruments such as taxes and subsidies. For the model to solve, the number of endogenous variable must be equal to the number of equations used. This is a necessary but not sufficient condition. The choice of exogenous variables will determine whether the model is a general or partial equilibrium model. Finally, in a standard GTAP closure, all markets are in equilibrium with all firms earning zero profits and regional households are on their budget constraint. A further detailed description of the GTAP modelling framework can be found in Hertel (1997).

4.2 Data and Aggregation Strategy

For the simulation, the study uses the GTAP 6 database that covers 57 sectors and 87 regions. The trade data in the database was obtained from the UN Comtrade while the sectoral/regional data are based input-output (I-O) data for each country. Due to the large size of the trade database, common problems such as quality, availability and consistency exist. These problems are compensated by the extensive data available that allows for an in-depth analysis. To deal with missing data, the authors of the database estimate them using a time-series method developed by the USDA. A partner country approach is also used to check for the consistencies of the trade data as there are 3 source of systematic bias: exports, imports and commodity specific margins. The GTAP database only accounts for nonfactor service (i.e. business, insurance) trade and not factor service trade (i.e. interest, dividend) due to the availability of data. As for tariff data, the GTAP database uses an aggregated tariff derived from applied tariff rates.

The main focus of this study is to analyze the possible impact of Indonesia's participation in AFTA and IJEPA. The 87 regions in the original database were aggregated to nine regions with an emphasis on countries in East Asia to facilitate and focus the scope of the analysis. The 9 regions are ASEAN, China, Indonesia, Japan, Korea, NAFTA, Rest of Asia (ROA), Rest of OECD (ROO) and Rest of the World (ROW). ASEAN is grouped as a region because the region collectively is a major trading partner of Indonesia and has a liberalized trade relationship with Indonesia through AFTA. Similarly, China and Korea are listed as individual countries because they play an important role in the region and are major trading partners of both Indonesia and Japan. In regards to the aggregated regions, ROO is separated from ROW because of their distinct development stages that may influence their trade relationships and composition with Indonesia. An overview of the regional aggregation can be found on Appendix 1, while Appendix 2 gives a description of the sectors in the model. Since there was no aggregation of the sectors, the model used in the study of the objectives included 9 regions and 57 sectors.

4.3 Experimental Design

Five scenarios were simulated using the GTAP model to analyze the impact of the economic integration on Indonesia's economy and environment through the AFTA and IJEPA. The initial benchmark equilibrium was based on data from the year 2001. From here, the economies were projected to the year 2007, 2012, 2017 and 2022 through a recursive process using estimated macroeconomic variables to create counterfactual equilibrium benchmarks. These points in time were selected based on the assumption that the IJEPA would be implemented in 2007 and a 15 year time-frame was broken down into 5 year intervals to investigate the long term impacts of the agreement and to capture the gradual nature of tariff reductions.

In order to undertake the analysis, the first step was to create a counterfactual equilibrium benchmark by projecting the economies to the year 2022 through a recursive process using estimated macroeconomic variables. This was done by taking the existing economies in the base model and projecting them from 2001 to 2007. The estimated 2007 equilibrium was then made the starting point for the projection to the year 2012. This process was repeated until 2022. To carry out the 4 trade liberalization scenarios, this process was repeated with the tariff reductions included. The results from these runs were then compared to the counterfactual benchmark results to analyze the impact of trade liberalization on the Indonesian economy. The impact of the different tariff reductions on the environment were examined using a set of environmental coefficient that had been prepared separately. Lastly, the environmental impacts were further disaggregated to determine the scale, composition and technique effects.

4.3.1 Macroeconomic Variable Estimates

Macroeconomic variable estimates used to project the economies were adopted from various sources. Exogenous projections of GDP growth in each region was done using data from the World Bank (2007). Estimates of capital stock, skilled and unskilled labour growth were based on Dimaranan, Ianchovichina and Martin (2007), and Mukhopadhyay and Thomassin (2008). Population growth estimates were based on United Nations (2006). Aggregation of the data to correspond to the regional classification used in this study was undertaken using a simple average. The data was also calibrated to fit the time line used in this study. In the model, total factor productivity was determined endogenously to permit the application of these exogenous shocks. In this way, a diverse range of variables such as level and growth of GDP, trade flows and welfare can be measured. The complete list of the macroeconomic variable estimates can be found in Appendix 3. These variables were chosen as part of the standard shocks used to project economies in the GTAP framework.

4.3.2 Scenario Development

Five scenarios that were considered in this study: 1) Business as Usual (BAU), 2) IJEPA, 3) AFTA, 4) AFTA and IJEPA and 5) AFTA and IJEPA with simulated agriculture liberalization. Table 4.1 provides a brief outline of the five scenarios and the tariff reductions involved.

Table 4.1: Outline of five scenarios considered.

Scenarios	Regional scope	Commodity Scope	Tariff Reductions
Business as Usual (BAU)	All regions	All commodities	None
IJEPA	Indonesia-Japan	5 export and 8 import commodities	Various rates*
AFTA	Indonesia-ASEAN	13 export and 7 import commodities	Various rates*
AFTA+IJEPA	Indonesia-Japan	5 export and 8 import commodities	Various rates*
	Indonesia-ASEAN	13 export and 7 import commodities	Various rates*
AGRI AFTA+IJEPA	Indonesia-Japan	5 export and 8 import commodities	Various rates*
		All remaining agriculture sector	25% in 2007, 50% in 2012, 100% in 2017
	Indonesia-ASEAN	13 export and 7 import commodities	Various rates*
		All remaining agriculture sector	25% in 2007, 50% in 2012, 100% in 2017

Source: Prepared by the author.

* Detailed descriptions of the rates used are presented in Table 4.2 and Table 4.3 for Indonesia-Japan tariff reductions and Table 4.4 and Table 4.5 for Indonesia-ASEAN tariff reductions

1) *Business as Usual (BAU)*

The 2001 base model was projected to 2007, 2012, 2015 and 2022 by shocking it with the estimated macroeconomic variables. In this scenario, no tariff shocks, i.e. reductions, were employed and tariff rates for all regions remained constant at their 2000. The main purpose of this scenario is to provide a counterfactual base of comparison for the other scenarios. In addition, this scenario provides an insight into the expected economic growth and changes that Indonesia would experience to the year 2022 together with their environmental impacts.

2) *IJEPA*

In this scenario, tariffs shocks based on the IJEPA were applied to the model beginning with the year 2007. Subsequent tariffs shocks were identified for the year 2012, 2017 and 2022. This corresponds to the trade liberalization timeline that has been agreed to under the agreement. This scenario estimates the analysis of the impact of the IJEPA on the Indonesian economy.

The tariff data used in this scenario was compiled from tariff reduction schedules obtained from the Japan, Ministry of Trade, Economy and Industry (2007). To make the analysis more manageable, only sectors that play an important role in trade between the two countries were considered. These were identified as sectors that fall within the top 10 sectors by trade volume according to the UN Comtrade database in 2006 and their existing tariff rates. IJEPA employs a detailed Harmonized Commodity Description and Coding System (HS) classification to the six digit level and this allows for the aggregation of tariff rates up to the sectoral level used in the GTAP model. This involved matching the HS classification system to the Central Product Classification (CPC) and International Standard Industry Classification (ISIC) used in the GTAP database. A weighted average method was then used to aggregate these tariffs using the 2006 trade volume as a base for the weights. A drawback of using trade volume to estimate the aggregation weights is that it is biased towards goods that face lower tariffs since they are likely to have higher trade volumes. Shocks were applied to existing import tariffs from five sectors in Japan and 8 sectors in Indonesia to reach the projected tariff rates in the respective periods as shown in Table 4.2 and 4.3. There were only five sectors under consideration in Japan because many of the existing imports from Indonesia to Japan are already exempt from tariffs.

Table 4.2: Tariff shocks applied to Indonesian export to Japan.

Sector	GTAP tax rate in 2000 (%)	Tariff shocks (%)		
		2007	2012	2017
frs	0.1	-99.26	-71.49	-100.00
fsh	2.9	-40.66	-38.71	-5.15
ofd	3.2	-16.27	-9.05	-3.85
wap	9.2	-98.38	-52.43	-44.08
crp	0.2	-22.14	-99.89	-100.00

Note: Sectoral abbreviations are defined in Appendix 2

Table 4.3: Tariff shocks applied to Indonesian import from Japan.

Sector	GTAP tax rate in 2000 (%)	Tariff shocks (%)		
		2007	2012	2017
tex	5.6	-99.81	-87.87	-100.00
crp	5.1	-11.86	-80.22	-76.31
i_s	7.9	0.00	-0.32	-7.52
fmp	10.2	-6.25	-12.91	-10.52
mvh	14	-27.68	-81.89	-82.87
otn	5.1	-15.96	-92.67	-100.00
ele	0.7	0.00	-75.69	-100.00
ome	3.2	-29.07	-63.90	-75.58

Note: Sectoral abbreviations are defined in Appendix 2

3) *AFTA*

For this scenario, tariffs shocks were based on the AFTA that was signed by Indonesia in 1992. The main aim of this scenario is to study the impact of AFTA on Indonesia. In addition, together with the IJEPA scenario, it provides for a comparative analysis with other scenarios to determine whether Indonesia's participation in both agreements gives rise to additional benefits than each agreement individually. Here, tariff shocks were applied in the year 2007 and 2012 to capture the trade liberalization objectives under AFTA. No shocks were applied in 2017 and 2022 because under AFTA the ASEAN countries were expected to eliminate tariffs on most commodities by 2010.

The tariff data used in this scenario was compiled from the Consolidated Common Effective Preferential Tariff (CEPT) scheme (ASEAN Secretariat 2006) that agreed by the ASEAN countries under AFTA. Tariff reductions were employed starting from 2007. To simply the tariff aggregation, tariff from three countries: Malaysia, Singapore and Thailand were used to represent ASEAN, considering they make up approximately 85% of Indonesia's exports to and imports from her ASEAN trading partners[2]. Similar to the IJEPA scenario, important trade sectors were first identified based on the UN Comtrade data. Tariff rates on these sectors were then aggregated from the six digit HS system to the classification used in GTAP using a trade weighted average. For ASEAN, the tariffs were aggregated individually within each country to the GTAP classification before being combined using a trade weighted average to produce a

[2] Calculated beased on trade values obtained from the UN Comtrade.

single tariff rate. The projected tariff rate reductions in 13 export and 7 import sectors in Indonesia for the year 2007 are listed below in Table 4.4 and Table 4.5. The 13 export sectors accounted for 71.0% of Indonesia export to ASEAN and the 7 imports sectors accounted for 68.2% of Indonesian imports from ASEAN. For the year 2012, tariff on these sectors were completely eliminated.

Table 4.4: Tariff shocks applied to Indonesian export to ASEAN.

Sector	GTAP tax rate in 2001 (%)	Tariff shocks (%)	
		2007	2012
frs	0.5	-99.09	100.00
coa	2.4	-100.00	0.00
oil	0.3	-100.00	0.00
vol	1.3	-97.25	100.00
ppp	4.6	-51.95	100.00
p_c	0.3	-62.41	100.00
crp	4.5	-78.25	100.00
nfm	1.6	-23.69	100.00
fmp	3.3	-45.50	100.00
mvh	20.8	-87.65	100.00
otn	6.1	-93.35	100.00
ele	0.7	-92.73	100.00
ome	2.3	-83.21	100.00

Note: Sectoral abbreviations are defined in Appendix 2

Table 4.5: Tariff shocks applied to Indonesian import from ASEAN.

Sector	GTAP tax rate in 2001 (%)	Tariff shocks (%)	
		2007	2012
p_c	2.9	-99.51	100.00
crp	3.8	-59.70	100.00
i_s	4.8	-56.16	100.00
fmp	6.2	-67.21	100.00
mvh	7.5	-45.70	100.00
ele	1.2	-52.43	100.00
ome	2.5	-51.82	100.00

Note: Sectoral abbreviations are defined in Appendix 2

4) *AFTA and IJEPA*

In this scenario, both AFTA and IJEPA shocks were applied at the same time. The results from this scenario were then compared with those of 'AFTA' and 'IJEPA' scenarios to determine whether there were any significant interactions between the two policy shocks. In addition, it also provides a comparison to study the potential effect of simulated agriculture tariff reductions that are carried out in the next scenario.

5) *AFTA and IJEPA Agriculture Tariff Elimination*

Tariff shocks in this scenario were similar to those in the fourth scenario but with the addition of liberalization in the agricultural sector. As with most free trade negotiations, there are some sensitive sectors that are exempted from liberalization. In IJEPA, much of the existing agricultural protection is left untouched as it is deemed sensitive by both countries. Similarly, while the situation is much more liberalized between ASEAN and Indonesia, there is still a significant amount of trade protection for the agricultural sector. This is because the agricultural sector often plays an important role in the economy of developing nations and food independence issues often make countries wary about opening up their agriculture sector to foreign competition. For example, in Indonesia the agricultural sector contributes 12.97% of the GDP in 2006 (ADB 2008). The agricultural sector also plays an important role in pollution emissions, e.g. CH_4 and BOD emissions. This scenario will estimate the impacts of including the agricultural sector in the free trade agreement. The simulation of agriculture liberalization in this scenario involved a 25% tariff reduction in 2007, 50% tariff reduction in 2012 and complete elimination of agriculture tariffs by 2017.

4.3.3 Environmental Coefficients and Analysis

Six environmental indicators were used to analyze the environmental impact of trade liberalization on Indonesia in this study. They are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), biological oxygen demand (BOD), chemical oxygen demand (COD) and suspended solids (SS). These indicators were chosen because of the limited availability of data, a focus on global warming and the challenges facing Indonesia in curbing her GHG emissions (CO_2, CH_4 and N_2O), and their use in other studies. To measure these emissions, the study used the environmental coefficients and their associated growth rates that were employed in Thomassin and Mukhopadhyay (2008). These were calibrated to fit the timeline used in this study. The GHG emission data from the GTAP environmental databases (Lee 2003, 2006) was used to estimate the environmental coefficients for the 57 sectors and 9 regions in the model. For BOD, COD and SS emissions, the data is collected from Thomassin and Mukhopadhyay (2008).

Each environmental coefficient measures the pollution emission per dollar value of output for each sector. The coefficients are multiplied by the total output of each sector in a particular region to calculate the sectoral and total emissions in that region. In addition, the environmental coefficients were updated for each time period to reflect technological change and to capture existing trends in emissions. Beginning with coefficients for the year 2001, these were projected using estimated growth rate for the year 2007, 2012, 2017 and 2022. For GHGs, the coefficient growth rates were reduced by half in each 5-year period starting from 2007. For BOD, COD, and SS, the coefficient growth rates were reduced by half in each 5-year period starting from 2012. This is based on the assumption that significant technological progress will occur during this period. The impact of tariff shocks were measured by calculating the differences of total emissions pre and post shocks.

4.3.4 Decomposition Analysis

The total change in the pollution emissions due to the tariff shocks was further decomposed into the scale, composition, and technique effects using the method outlined by Kuik and Verbruggen (2002). This disaggregation is useful for separating out the factors contributing to the change in pollution emissions. This allows for a more focused policy response. The following is a brief outline of the equations used to measure these effects as outlined in the appendix of Kuik and Verbruggen (2002).

Composition Effect

The composition effect is estimated by keeping the size of the economy and the technology of production constant. Based on this, the following equation was used to determine the composition effect. The ratio in the first small bracket functions to rescale the economy and thus pollution to that prior to the shocks.

$$\{(\Sigma q_{i,0}/\Sigma q_{i,1}) x (\Sigma q_{i,1} x c_{i,0})\} - (\Sigma q_{i,0} x c_{i,0}) \qquad (1)$$

where q = industry output

c = CO_2 emission coefficient (replaced by other pollution coefficients as required)

i = industry index; $i \in n$ industries

0,1 = scenario without and with macro/policy changes respectively

Scale Effect

To measure the scale effect, the technological coefficients are held constant. In this case, a rescaled pollution output was subtracted from the new pollution output. Both outputs were measured using the old pollution coefficients. The former term was obtained by multiplying old to new output ratios with the new pollution output.

$$(\Sigma q_{i,1} x c_{i,0}) - \{(\Sigma q_{i,0}/\Sigma q_{i,1}) x (\Sigma q_{i,1} x c_{i,0})\} \qquad (2)$$

Technique Effect

The technique effect was measured using the following equation, which calculates the difference in pollution if the new and old pollution coefficients were used.

$$(\Sigma q_{i,1} x c_{i,1}) - (\Sigma q_{i,1} x c_{i,0}) \qquad (3)$$

These equations provide a simple tool to disaggregate changes in total pollution into its three components. This provides a more in depth analysis of the changes that are occurring.

Chapter 5: Results and Analysis

This chapter outlines the results of Indonesian trade liberalization policies on both the economy and the environment based on the scenarios described in chapter 4. In particular, the implications of these policies on trade flows, industrial patterns, welfare changes and the environment are analyzed.

5.1 Projected Economic Impacts in Indonesia in the BAU Scenario

5.1.1 Output Changes

In the BAU run, the world economy was projected into the future without implementing any policy shocks in the form of tariff reductions. Tables 5.1 and 5.2 show the projected and percentage changes in the output levels of the different economies to the year 2022.

Table 5.1: Projected changes in output levels in the BAU scenario (million US$).

	2001	2007	2012	2017	2022
1 Indonesia	289798	411478	541106	745350	1053269
2 Japan	7331684	8348149	9179794	10048907	11009442
3 China	3135854	5301556	7700643	11375095	17568149
4 Korea	969487	1316179	1692952	2182691	2868804
5 ASEAN	1059859	1436599	1847776	2393307	3141670
6 NAFTA	20245256	24604406	29113057	34305470	40340721
7 Rest of Asia	2191311	3077328	4045139	5342660	7208671
8 Rest of OECD	17034236	19299815	21837073	24689607	27953425
9 ROW	6316351	7763719	9199544	10831665	12651642
Total	58573835	71559229	85157083	101914750	123795793

Table 5.2: Total percentage changes in output levels in the BAU scenario.

	Percentage Changes 2001-2007	Percentage Changes 2007-2012	Percentage Changes 2012-2017	Percentage Changes 2017-2022
1 Indonesia	41.99	31.50	37.75	41.31
2 Japan	13.86	9.96	9.47	9.56
3 China	69.06	45.25	47.72	54.44
4 Korea	35.76	28.63	28.93	31.43
5 ASEAN	35.55	28.62	29.52	31.27
6 NAFTA	21.53	18.32	17.84	17.59
7 Rest of Asia	40.43	31.45	32.08	34.93
8 Rest of OECD	13.30	13.15	13.06	13.22
9 ROW	22.91	18.49	17.74	16.80
Total	22.17	19.00	19.68	21.47

Table 5.2 shows that China has the highest rate of output growth throughout the period, growing by 457% over the 22 years period. Among the three regions of interest, Indonesia has the highest output growth (263%) followed by ASEAN (196%) and Japan (50%) respectively. Overall, world output was expected to grow by 111% over the period. These results were not surprising given the high growth rates of East Asian countries in general. In Indonesia, the leather sector experienced the fastest growth followed by the paper and paper products (PPP) sector growing by 572% and 530% respectively. However, given their limited share of the total Indonesian output, it is unlikely that they are the main source of Indonesia's growth. Other important sectors that grew significantly included: other government services, electronic equipment and trade sectors that grew by 524%, 501% and 371% respectively. In fact, by 2022, these sectors are the top three sectors in terms of the value of output, making up 21.6% of Indonesia's output in 2022. Despite the differential growth rates among the different sectors, there did not seem to be a significant change in the composition of sectoral output in the country. Table 5.3 provides the top 6 sectors by output in Indonesia from 2000 to 2022. While there have been some fluctuations in the ranking of the sectors, it showed no major change and is a reflection of the general trend in sectoral output in the country. The trade sector continues to contribute the largest share to Indonesia value output.

Table 5.3: Top six sectors by value of output in Indonesia.

2001		2007		2012		2017		2022	
Sector	Share (%)	Sector	Share (%)	Sector	Share (%)	Sector	Share (%)	Sector	Share (%)
trd	6.00	trd	6.30	trd	6.58	trd	7.03	trd	7.78
cns	5.99	cns	6.25	cns	6.28	ele	6.21	osg	6.97
crp	5.45	crp	5.50	crp	5.49	cns	6.13	ele	6.81
tex	4.22	ele	4.84	ele	5.42	osg	5.64	cns	5.48
ele	4.12	osg	4.46	osg	4.93	crp	5.42	crp	5.24
osg	4.06	tex	4.43	tex	4.63	tex	4.78	tex	4.72

Note: Sectoral abbreviations are defined in Appendix 2

5.1.2 Export-Import Changes

As Indonesia output increases over the period, so does her exports and imports. Indonesia's exports increased to US$ 244.92 billion and imports to US$ 166.86 billion in 2022 from US$ 68.5 billion and US$ 47.0 billion respectively in 2001. The share of exports and imports as a percentage of output stayed relatively stable over the period, approximately 23% for exports and 16% for imports as shown in Table 5.4. However, Indonesia saw a shift in the direction of her export and import flow that is in line with the existing trends seen in recent years i.e. Japan's share of Indonesian trade continued to decline. In 2022, Japan's share of Indonesia's exports has declined from 17.9% to 11.9% and from 15.5% to 10.9% for imports. At the same time, China continues her emergence as an important trading partner for Indonesia as her share of Indonesia's exports increases from 6.3% to 10.0% and from 6.8% to 15.8% for imports. More importantly, ASEAN as a trading block emerged as Indonesia's most important trading partner over the period, accounting for 16.6% and 17.3% of Indonesia's exports and imports respectively. Figures 5.1 and 5.2 show the development of Indonesia's trade flows over the period.

Table 5.4: Indonesia's total exports and imports value and ratios for the period 2001 to 2022.

	2001	2007	2012	2017	2022
Export (US$ million)	68549.72	95691.88	124768.06	171404.21	244925.18
Import (US$ million)	47047.12	66915.70	87602.36	119665.02	166862.65
Output (US$ million)	289798.00	411478.00	541106.00	745350.00	1053269.00
Export-Output Ratio (%)	23.65	23.26	23.06	23.00	23.25
Import-Output Ratio (%)	16.23	16.26	16.19	16.05	15.84

Figure 5.1: Development of Indonesia's export flow by region from 2001 to 2022.

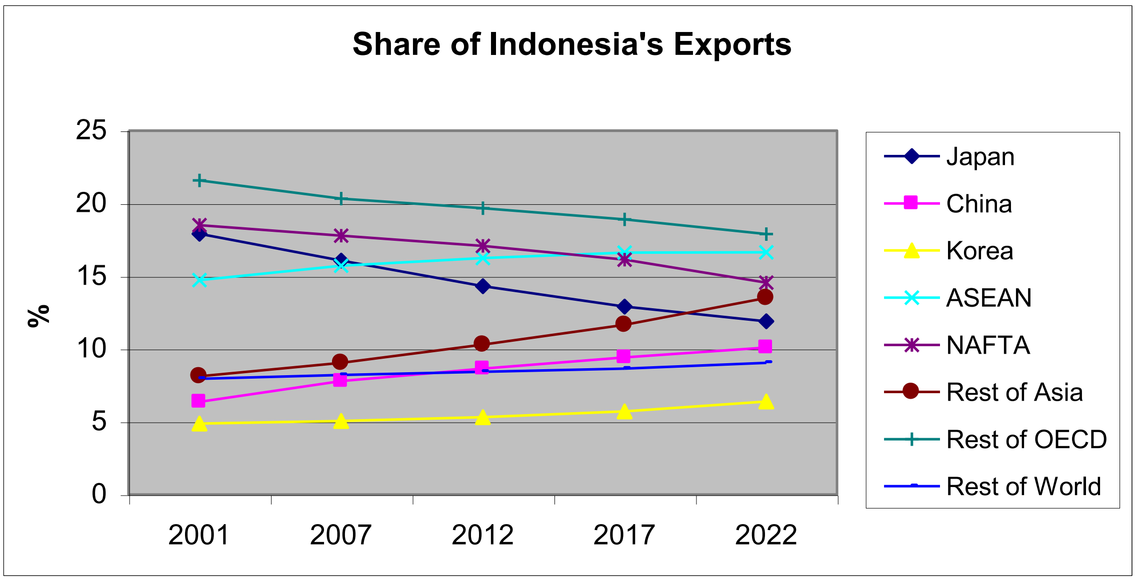
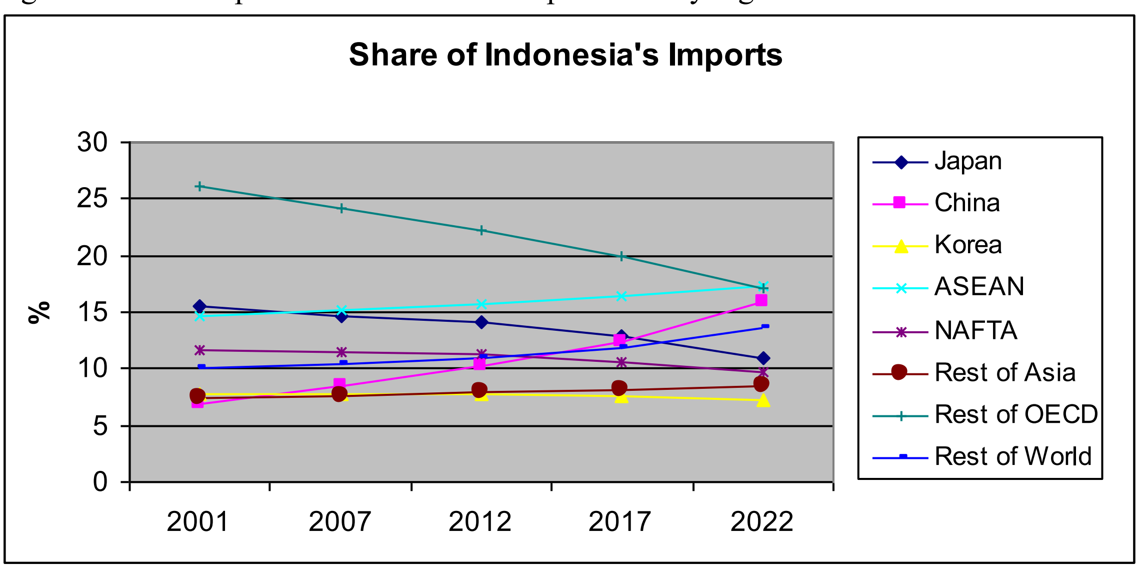


Figure 5.2: Development of Indonesia's import flow by region from 2001 to 2022.



The changes in exports and imports are also accompanied by a noticeable shift in their composition. There is a significant rise in the share of fossil fuels and natural gas, rising from 12.6% to 24.5% of exports. This increase is driven by the increase in the export of coal sector whose export share jump from 3.15% to 11.0%. The top exporting sector in Indonesia, the electronic equipment sector, saw a small increase in its export share. On the other hand, the lumber, chemical rubber products, wearing apparel and textiles sectors saw a decline in their export shares. The decline in the lumber sector's export reflected the decreasing supply of timber as a result of large scale deforestation and government policies that attempted to restrict lumber export. While the government has removed outright export bans on certain lumber products in 2001, there is still a significant tariff imposed (Economic Intelligent Unit 2007). In the case of wearing apparel and textiles, the decline is likely due to the increase in production cost such as wages in Indonesia and lower productivity of its aging machinery that will adversely impact its international competitiveness (Economic Intelligent Unit 2004).

Similarly, Indonesian imports saw a rise in the share of imports from the petroleum and coke (P_C), and oil sectors where both rose by 4.9%. Given the slower than average growth of output in the P_C and oil sectors, 131% and 90% respectively, this meant that there was a need to increase imports to satisfy increasing domestic demand. This reflects the decreasing oil output in Indonesia as reserves declined and investment in new exploration fell (Economic Intelligent Unit 2007). Despite this, other machinery and equipment (OME), chemical rubber products and other business services sectors continue to dominate the share of Indonesian imports. Tables 5.5 and 5.6 provide a breakdown of the top five Indonesian exports and imports sectors and their shares in 2001 and 2022. In conclusion, the results of the BAU scenario indicated that as Indonesia grew economically over the period and moved along the development curve, she appeared to be exporting more capital intensive goods but was still reliant on importing capital intensive goods from more developed nations to support this growth.

Table 5.5: The top five export sectors for Indonesia in the BAU scenario in the year 2001 and 2022.

2001		2022	
Sectors	Share (%)	Sectors	Share (%)
Electronic Equipment (ele)	12.41	Electronic Equipment (ele)	14.05
Lumber (lum)	8.72	Coal (coa)	10.98
Chemical Rubber Products (crp)	7.51	Oil (oil)	8.04
Wearing Apparel (wap)	6.81	Other Machinery and Equipment (ome)	6.31
Textiles (tex)	6.48	Chemical Rubber Products (crp)	5.93

Table 5.6: The top five importing sectors for Indonesia in the BAU scenario in the year 2001 and 2022.

2001		2022	
Sectors	Share (%)	Sectors	Share (%)
Other Machinery and Equipment (ome)	14.21	Other Machinery and Equipment (ome)	13.02
Chemical Rubber Products (crp)	13.77	Chemical Rubber Products (crp)	12.96
Other Business Services (obs)	11.68	Other Business Services (obs)	9.00
Electronic Equipment (ele)	6.27	Petroleum and Coke Products (p_c)	8.88
Trade (trd)	5.02	Oil (oil)	7.64

5.2 Projected Economic Effects of Trade Liberalization

5.2.1 Output Changes

Overall Changes

Indonesia experienced considerable economic growth under the BAU scenario. This section reports the economic impact on the value of output of the various trade liberalization scenarios. Tables 5.7 and 5.8 show the changes in the value of total output that arises from the different trade liberalization scenarios in 2022 compared to the BAU case.

Table 5.7: Projected changes in the value of total output in different trade liberalization scenarios compared to the BAU scenario in 2022 (million $).

	IJEPA	AFTA	AFTA+IJEPA	AGRI AFTA+IJEPA
Indonesia	1136.35	4969.33	5363.91	5461.25
Japan	613.16	-2223.77	4074.51	4205.50
China	-1133.48	-476.24	-1470.89	-1500.25
Korea	-394.07	-412.38	-786.68	-765.90
ASEAN	-568.46	3304.60	2239.91	3060.36
NAFTA	-2168.12	-2968.54	-4788.04	-4565.46
Rest of Asia	-760.98	-582.86	-1311.32	-1424.63
Rest of OECD	-1968.63	-1401.50	-3143.31	-3237.83
ROW	-5648.68	-4630.58	-5233.50	-5074.76

Table 5.8: Percentage changes in the value of total output in different trade liberalization scenarios compared to the BAU scenario in 2022.

	IJEPA	AFTA	AFTA+IJEPA	AGRI AFTA+IJEPA
Indonesia	0.11	0.47	0.51	0.52
Japan	0.01	-0.02	0.04	0.04
China	-0.01	0.00	-0.01	-0.01
Korea	-0.01	-0.01	-0.03	-0.03
ASEAN	-0.02	0.11	0.07	0.10
NAFTA	-0.01	-0.01	-0.01	-0.01
Rest of Asia	-0.01	-0.01	-0.02	-0.02
Rest of OECD	-0.01	-0.01	-0.01	-0.01
ROW	-0.04	-0.04	-0.04	-0.04

Trade liberalization impacts output growth in two ways, by affecting the demand for outputs and the supply of inputs. The results in Tables 5.7 and 5.8 indicate that Indonesia stands to benefit from participating in both AFTA and IJEPA. However, the magnitude of the changes appears to be small when compared to the value of total output under the BAU scenario. This can be explained by the fact that Indonesia already has a relatively liberalized trading relationship with both Japan and ASEAN as indicated in Table 5.9. The impact of the IJEPA was smaller than that of the AFTA. The results also indicate that the agreements only benefited member countries while non-member countries have negative output changes in all scenarios. In the case of the IJEPA scenario, Indonesia and Japan output is 0.11% and 0.01% higher over the BAU output value respectively while other countries saw a decline. Similarly, in the AFTA scenario, Indonesia and ASEAN output increased by 0.47% and 0.11 % respectively while other countries faced negative output changes. Similarly output increased for member nations in the 'AFTA+IJEPA' and 'AGRI AFTA+IJEPA' scenarios and decreased for non-member countries. In these two scenarios however, simultaneous trade liberalization brought an increased gain to Japan as her output is higher when compared to the sum of the 'IJEPA' and 'ASEAN' case. Unfortunately, Indonesia and ASEAN saw a decline in their output gain. The inclusion of the additional reduction in agriculture products in the 'AGRI AFTA+IJEPA' scenarios appears to have had only a marginal impact on Indonesia, Japan and ASEAN output as agriculture trade between the countries is relatively small. In the BAU scenario, agriculture exports from Indonesia to Japan and ASEAN are only 0.41% and 1.93% of total exports respectively in the year 2022.

Table 5.9: Aggregate tariff rate for Indonesia based on GTAP6 Database.

Import	Japan	ASEAN	Export	Japan	ASEAN
Agriculture	2.1	3.0	Agriculture	1.6	7.9
Industry	5.7	4.0	Industry	1.2	4.5

<u>Sectoral Output Changes</u>

Given the changes in the overall value of output, the tariff reductions under the various agreements appeared to have varying impacts on the associated sectors. Table 5.10 shows some selected sectors that experienced tariff changes under the IJEPA. The results indicate that the sector most affected by the tariff reductions is the motor vehicles sector that saw its output decreased by US$ 834.81 million compared to the BAU scenario. Similarly, the chemical rubber products sector is also adversely affected by IJEPA as its output declined by US$ 142.44 million. However, several other sectors benefited from the agreement such as the OME sector that saw the value of its output increased by US$ 454.62 million. Overall, the impacts on the sectors involved were mixed in the IJEPA case and that the relative changes were minor.

Table 5.10: Changes in the value of output in selected sectors in the IJEPA scenario (US$ million).

Sector	tex	wap	crp	mvh	ele	ome
Output Change	333.93	159.64	-142.44	-834.81	179.03	454.62
%	0.67	0.76	-0.26	-2.71	0.25	1.37

Note: Sectoral abbreviations are defined in Appendix 2

Tariff reductions under AFTA had a more significant impact on the output of the sectors involved when compared to the IJEPA scenario. Contrary to the IJEPA case, the motor vehicles sector's output increased by US$ 1,778.23 million over the BAU scenario. The OME sector also saw a similar increase in value. Yet, the sector that saw the largest relative change was the other transport equipment sector whose value of output increased by US$ 460.05 million or 11.50%. The only sector that saw a large decline in output is the electronic equipment sector. Its output declined by US$ 626.61 million but this was relatively small compared to its existing output, accounting for only a 0.87% decrease. Table 5.11 shows the output changes of selected sectors that saw tariff reductions under AFTA. Overall, the tariff reductions in AFTA appeared to have benefited the associated sectors in Indonesia.

Table 5.11: Changes in the value of output in selected sectors in the AFTA scenario (US$ million).

Sector	ppp	crp	mvh	otn	ele	ome
Output Change	296.67	673.83	1778.23	460.05	-626.61	1747.12
%	0.67	1.22	5.76	11.50	-0.87	5.26

Note: Sectoral abbreviations are defined in Appendix 2

When both sets of tariff cuts were combined under the 'AFTA+IJEPA' scenario, the effects of the two agreements appeared to be compounded. In addition, given that the impact of tariff cuts under the AFTA was relatively larger than with the IJEPA, the effects of AFTA dominate. As a result, the value of output increased in the OME sector and was further enhanced by US$ 2,198.84 million while the positive impact of AFTA liberalization on the value of the motor vehicles sector's output was dampened by the IJEPA tariff cuts as it increased by only US$ 1,003.16 million. Similarly, the positive impact of the IJEPA tariff reductions on the textiles and wearing apparel sectors disappeared as these sectors experience output declined under the AFTA. The value of output of the textiles and wearing apparel sectors declined by US$ 298.62 million and US$ 211.34 million respectively in the 'AFTA+IJEPA' scenario.

Table 5.12: Changes in the value of output in selected sectors in the AFTA+IJEPA scenario (US$ million).

Sector	tex	wap	ppp	crp	mvh	otn	ele	ome
Output Change	-298.62	-211.34	177.34	517.94	1003.16	475.21	-496.95	2198.84
%	-0.60	-1.01	0.40	0.94	3.25	11.88	-0.69	6.62

Note: Sectoral abbreviations are defined in Appendix 2

Table 5.13 shows that agricultural tariff reductions under the 'AGRI AFTA+IJEPA' scenario brought various changes to the agriculture related sectors. The other crops sector saw a significant increase in output of US$ 174.86 million while the sugar sector output declined by US$ 172.43 million. For the paddy rice sector, an important agricultural sector in Indonesia, the value of output declined by 1.10% or US$ 96.76 million. The tariff reductions had mixed impacts, with negative outcomes for some sectors and positive impacts on others.

Table 5.13: Changes in the value of output in selected sectors in the 'AGRI AFTA+IJEPA' scenario (US$ million).

Sector	pdr	c_b	ocr	mil	pcr	sgr
Output Change	-96.76	-41.28	174.86	59.04	-78.83	-172.43
%	-1.10	-2.37	3.06	3.77	-0.71	-3.41

Note: Sectoral abbreviations are defined in Appendix 2

Despite the output changes in the sectors facing tariff reductions, there were no changes in the sectoral ranking of output by values across the different scenarios. The top five sectors in the BAU maintained their positions with little change in their shares of total output. However, some of the sectors that experienced tariff reductions also appeared to be among those that experienced the greatest change. Under the IJEPA agreement, the OME sector experienced the greatest increase in the value of its output while motor vehicles sector saw the greatest decline in the values of its output, increasing by 1.37% and contracting by 2.71% respectively compared to the BAU scenario. Similarly, the textiles sector was among the top gainers in the value of output while the chemical rubber products sector was only second to the motor vehicles sector in the decline in the value of output. In the case of AFTA, both the motor vehicles and OME sectors saw the largest increases in the value of output over the BAU scenario, while the electronic equipment sector had the second largest decline in the value of output. In both

'AFTA+IJEPA' and 'AGRI AFTA+IJEPA', the OME sector led value of output gain while the electronic equipment sector saw one of the largest declines in the value of output. Sectors that experienced the direct impact of the tariff reductions were among those with the largest change in output value. Tables 5.14 and 5.15 list the sectors that experience the greatest increase and decrease in their output.

Table 5.14: Top 5 sectors with the greatest increase in value of output (US$ million).

IJEPA	Output increase	AFTA	Output increase	AFTA + IJEPA	Output increase	AGRI AFTA + IJEPA	Output increase
ome	454.62 (1.37)	mvh	1778.23 (5.76)	ome	2198.84 (6.62)	ome	2187.05 (6.58)
ppp	411.43 (0.93)	ome	1747.12 (5.26)	cns	1197.29 (2.07)	cns	1238.44 (2.15)
cns	374.69 (0.65)	cns	861.96 (1.49)	mvh	1003.16 (3.25)	mvh	1010.57 (3.28)
tex	333.93 (0.67)	trd	728.65 (0.89)	trd	871.24 (1.06)	trd	904.80 (1.10)
trd	181.63 (0.22)	crp	673.83 (1.22)	crp	517.94 (0.94)	crp	545.33 (0.99)

Note: Sectoral abbreviations are defined in Appendix 2

Table 5.15: Top 5 sectors with greatest decrease in value of output (US$ million).

IJEPA	Output decrease	AFTA	Output decrease	AFTA + IJEPA	Output decrease	AGRI AFTA + IJEPA	Output decrease
mvh	-834.81 (-2.71)	lea	-675.84 (-2.86)	lea	-756.69 (-3.20)	lea	-734.47 (-3.11)
crp	-142.44 (-0.26)	ele	-626.61 (-0.87)	ele	-496.95 (-0.69)	ele	-561.01 (-0.78)
lea	-67.55 (-0.29)	tex	-596.93 (-1.20)	tex	-298.62 (-0.60)	tex	-314.96 (-0.63)
osg	-39.59 (-0.05)	wap	-355.77 (-1.70)	wap	-211.34 (-1.01)	wap	-220.80 (-1.06)
nfm	-34.67 (-0.25)	dwe	-226.61 (-0.48)	dwe	-196.83 (-0.42)	dwe	-174.30 (-0.37)

Note: Sectoral abbreviations are defined in Appendix 2

5.2.2 Export-Import Changes

Overall Changes

Changes occurred in the pattern of exports and imports with trade liberalization and the associated increase in output. It was observed that increased trade liberalization resulted in increased exports and imports for Indonesia (Table 5.16). Under the IJEPA, exports and imports increased by 0.44% and 0.40% respectively when compared to the BAU scenario. Similarly, AFTA resulted in an increase in exports and imports by 1.01% and 1.25% respectively. The greatest increase was seen in the 'AGRI AFTA+IJEPA' scenario where exports and imports increased by 1.67% and 1.91% respectively. While the increases may not be large, they clearly indicate that tariff reductions had a positive impact on Indonesian trade. In addition, the changes in the export/import to output ratio also indicates a small increase in openness. Under the IJEPA scenario, which had the smallest tariff reductions, export-output ratio and import-output ratio increased by approximately 0.08% and 0.05% respectively when compared to the BAU scenario. Similarly, under the most intensive tariff reduction scheme, i.e. the 'AGRI AFTA+IJEPA' scenario, export-output and import-output ratios increased by approximately 0.27% and 0.22% respectively. Thus, greater tariff reductions resulted in a larger increase in the export/import to output ratio, indicating greater openness.

Table 5.16: Changes in the values of exports and imports in 2022 under different trade liberalization scenarios compared to the BAU scenario.

	IJEPA	AFTA	AFTA+IJEPA	AGRI AFTA+IJEPA
Export (million US$)	1078.21	2467.89	3381.53	4085.85
Changes (%)	0.44	1.01	1.38	1.67
Import (million US$)	665.47	2087.62	2632.73	3190.93
Changes (%)	0.40	1.25	1.58	1.91

Figure 5.3: Changes in the export-output ratio in 2022 under different tariff reduction schemes compared to the BAU scenario (%).

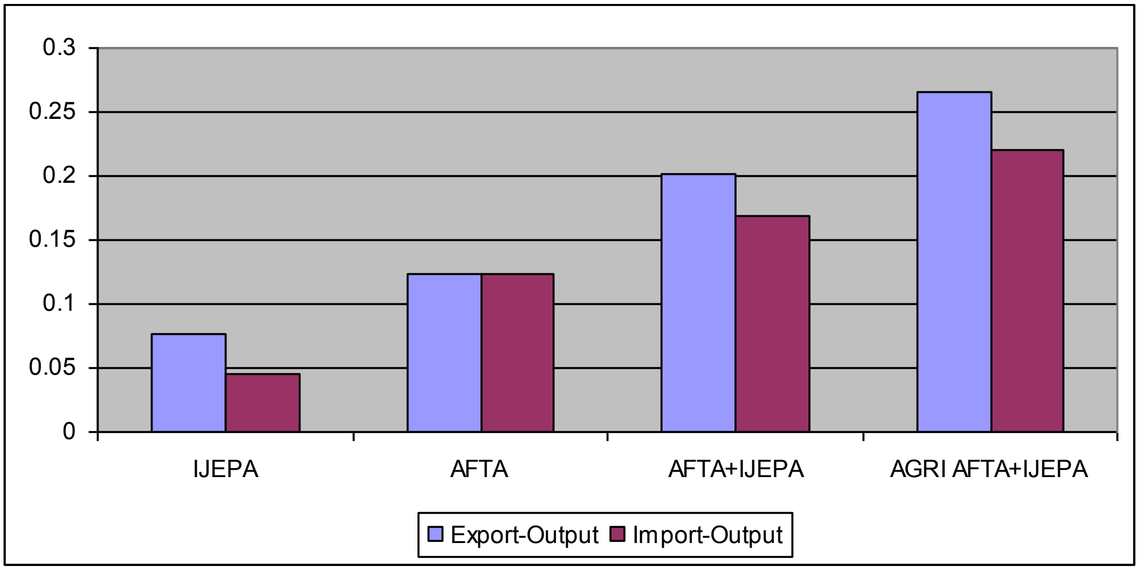


Table 5.17: Changes in regional share of Indonesian exports and imports in the trade liberalization scenarios compared to the BAU scenario in 2022 (%).

	IJEPA		AFTA		AFTA+IJEPA		AGRI AFTA+IJEPA	
	Export	Import	Export	Import	Export	Import	Export	Import
Japan	0.09	1.71	-0.24	-0.24	-0.15	1.46	-0.16	1.46
China	-0.02	-0.48	-0.21	-0.33	-0.23	-0.79	-0.25	-0.85
Korea	-0.02	-0.21	-0.10	-0.19	-0.12	-0.4	-0.13	-0.41
ASEAN	0.03	-0.46	1.90	1.55	1.94	1.05	2.04	1.47
NAFTA	-0.01	-0.11	-0.41	-0.15	-0.42	-0.25	-0.44	-0.31
Rest of Asia	-0.04	-0.17	-0.25	-0.13	-0.29	-0.30	-0.30	-0.44
Rest of OECD	-0.03	-0.23	-0.47	-0.21	-0.50	-0.43	-0.52	-0.54
ROW	0.00	-0.05	-0.23	-0.29	-0.23	-0.34	-0.24	-0.39

Analysis of trade flows further indicates that trade liberalization had a positive impact on export-import flows between agreement countries and a negative impact on non-agreement countries indicating the presence of trade diversion. In the IJEPA scenario, Japan's share of Indonesian exports increased only marginally by 0.09% while her share of imports increased by 1.71% compared to the BAU scenario. This large increase in import share happened at the expense of China and ASEAN, who saw the largest decline. This may be an indication that trade liberalization may have had some impact on the sourcing of imported inputs to Indonesia. This is further supported by the fact that the US$ 665.47 million net increase of imports to Indonesia was much smaller than the US$ 2,945.41 million dollars increase of imports from Japan, indicating that other regions were experiencing a decline in their exports to Indonesia. Therefore, some trade diversion of import products occurred due to the IJEPA.

With AFTA, ASEAN's share of Indonesian exports and imports increased by 1.90% and 1.55% respectively to the detriment of other regions' shares. Unlike with the IJEPA, there appears to be a more equitable impact on both exports and imports. On the export side, NAFTA and the Rest of OECD lost the most from the agreement, while China is the region that saw the greatest decline in Indonesian import share. While there may have been some trade diversion effects causing these changes, they appeared to be driven more by additional exports and imports that originate from the ASEAN region. Compared to the BAU scenario, Indonesian exports and imports to and from ASEAN increased by US$ 5,115.98 million and US$ 2,985.20 million respectively under AFTA. Accounting for trade diversions from other region this led to a net increase in exports and imports by US$ 2,468.01 million and US$ 2,087.51 million respectively from ASEAN. This showed that the AFTA created additional trade between Indonesia and ASEAN, which helped increase ASEAN's share of Indonesia's trade. Thus, changes in Indonesia's trade flows under AFTA were influenced by both trade diversion and trade creation.

In both the 'AFTA+IJEPA' and the 'AGRI AFTA+IJEPA' scenarios, there appears to be an interaction between the impacts of the two agreements. The negative impact of AFTA on Indonesia's exports to Japan resulted in a declining Japan's share, while the IJEPA dampened the increase in Indonesian imports originating from the ASEAN region. This also meant that the decline in trade shares from the other regions is compounded. As a result, for example, in the 'AFTA+IJEPA' case China's share of Indonesian imports declined by 0.79%, which was more than if only each individual agreement was considered. Again, these changes in the trade flows indicated that a significant trade diversion effect occurred as trade increase between agreement regions resulted in a declining share among non-agreement regions. Trade diversion was also the highest in the 'AGRI AFTA+IJEPA' scenario where there was the greatest level of integration. Lastly, the agriculture tariff reductions had a positive impact on trade flow between Indonesia and ASEAN, especially on ASEAN's share of Indonesian imports. This is an indication that the tariff reductions may have had an impact on agriculture commodity flows between the two regions. The analysis of changes in overall export and import trends provides a broad overview of the impact of the different trade liberalization scenarios. However, further sectoral level analysis will provide a deeper insight to the factors influencing these changes.

Sectoral Export-Import Performance

Sectoral analysis of export and import impacts of tariff reductions showed that in general, they benefit the affected sectors in Indonesia. Under the IJEPA scenario, tariff liberalization resulted in an increase in both export and import of the sectors affected by tariff cuts. The largest increase was seen in the OME sector where its exports and imports increased by US$ 373.80 million and US$ 151.90 million respectively. On the other hand the motor vehicles sector saw a significant relative increase of 6.14% in export volume and 3.16% in import volume.

Table 5.18: Export-Import changes in selected sectors in Indonesia under the IJEPA scenario (US$ million).

Sector	tex	wap	crp	mvh	Ele	ome
Export	191.71	116.92	140.61	118.89	137.16	373.80
%	1.41	1.04	0.97	6.14	0.40	2.42
Import	55.41	2.16	69.33	146.67	22.32	151.90
%	1.01	0.53	0.32	3.16	0.26	0.70

Note: Sectoral abbreviations are defined in Appendix 2

Similar to the IJEPA results, under AFTA scenario, most of the sectors that experienced tariff reductions saw an increase in their export-import volume over the BAU scenario. Again, the OME sector experiences the largest increase in both exports and imports at US$ 1,206.64 million and US$ 617.08 million respectively. The chemical rubber products sector also saw a large increase in exports of US$ 1,005.61 million, while the motor vehicles sector exports increased by US$ 984.08 million. In fact, the relative increase of exports from the motor vehicles and other transport equipment sectors were very large. For the motor vehicles sector, export volume rose by 50% compared to the BAU scenario, while for other transport equipment sector the increase was 27.27%. Unlike the IJEPA case, however, the electronic equipment sector experienced a decline in export volume by US$ 281.38 million. Interestingly, the changes in the import side were less pronounced.

Table 5.19: Export-Import changes in selected sectors in Indonesia under the AFTA scenario (US$ million)

Sector	ppp	crp	mvh	otn	Ele	ome
Export	158.14	1005.61	984.08	328.38	-281.38	1206.64
%	1.12	6.92	50.79	27.27	-0.82	7.81
Import	41.39	220.19	242.34	135.99	78.47	617.08
%	1.44	1.02	5.22	2.99	0.92	2.84

Note: Sectoral abbreviations are defined in Appendix 2

The effect of both sets of tariff reductions under the 'AFTA+IJEPA' scenario saw the OME sector continues to have a significant increase in its exports and imports. Compared to the BAU scenario, exports and imports of the OME sector are US$ 1,576.93 million and US$ 751.15 million higher in the 'AFTA+IJEPA' scenario. In addition, the motor vehicles and the other transport equipment sectors continued to see a significant increase in their exports. Interestingly, the wearing apparel sector exports declined by US$ 147.76 million despite an increase in the IJEPA scenario. This indicates that there was a significant negative impact of the AFTA on the wearing apparel exports.

Table 5.20: Export-Import changes in selected sectors in Indonesia under the AFTA+IJEPA scenario (US$ million).

Sector	tex	wap	ppp	crp	mvh	otn	ele	ome
Export	28.89	-147.76	115.98	1134.57	1122.53	348.14	-180.72	1576.93
%	0.21	-1.32	0.82	7.81	57.93	28.91	-0.53	10.20
Import	35.59	0.38	39.42	271.65	386.26	150.03	94.10	751.15
%	0.65	0.09	1.37	1.26	8.32	3.30	1.10	3.46

Note: Sectoral abbreviations are defined in Appendix 2

Lastly, the agricultural tariff cuts undertaken in the 'AGRI AFTA+IJEPA' scenario appeared to have a positive impact on trade volumes of the sectors affected. On the export side, the other crops sector saw its exports increase significantly by US$ 194.48 million or 19.50% compared to the BAU scenario. Similarly, milk exports increased by US$63.45 million. On the contrary, the reductions appeared to have very little impact in the export of paddy rice and processed rice sectors. For imports however, the processed rice sector saw the largest increase followed by the sugar sector as imports increased by US$ 171.08 million and US$103.5 million respectively. The paddy rice sector also saw a relatively significant increase in import of 28.52%, which was valued at US$32.01 million. These changes indicate that the agriculture tariff cuts had a greater impact on the imports of agriculture goods into Indonesia than on exports.

Table 5.21: Export-Import changes in selected sectors in Indonesia under the AGRI AFTA+IJEPA scenario (US$ million).

Sector	pdr	c_b	ocr	mil	pcr	sgr
Export	0.11	0.00	194.48	63.45	0.46	14.42
%	-100.00	0.25	19.50	17.82	36.71	123.86
Import	32.01	-0.22	29.95	9.16	171.08	103.51
%	28.52	-9.77	1.94	0.73	11.62	11.25

Note: Sectoral abbreviations are defined in Appendix 2

Analysis of sectoral import and export changes under the different scenarios have indicated that tariff cuts had a very diverse impact on the sectors involved. However, similar to the sectoral output changes, there were no major shift in the export and import ranking at the sectoral level arising from tariff reductions adopted in the different scenarios. The top five sectors in exports and imports remained in their respective positions across the different scenarios. Yet, the ranking of sectors that gained the greatest export and import shares in Tables 5.22 and 5.23 below clearly indicate that the sectors that were directly impacted by tariff reductions were also the one that experienced the greatest change in trade volumes. In the IJEPA scenario, the top 5 and the top 3 sectors that saw the largest increase in export and import shares respectively were directly affected by the tariff cuts. Similarly, in the AFTA scenario, the OME and motor vehicles sectors dominated the increase in export and import shares. Both sectors were affected directly by tariff cuts. A similar pattern was seen in the remaining two scenarios. Therefore, this is an indication that there is a close association between sectors that experience the direct effect of tariff reductions and the largest increases in trade volumes. Lastly, the results also showed that the AFTA had a greater impact on trade flow than IJEPA and thus when both agreements were in place, the effect of AFTA was the dominant one.

Table 5.22: List of sectors with the largest increase in export shares in Indonesia (%).

IJEPA	Changes in Shares	AFTA	Changes in Shares	AFTA + IJEPA	Changes in Shares	AGRI AFTA + IJEPA	Changes in Shares
ome	0.12	ome	0.42	ome	0.55	ome	0.54
tex	0.05	mvh	0.39	mvh	0.44	mvh	0.44
mvh	0.04	crp	0.35	crp	0.38	crp	0.37
crp	0.03	otn	0.13	otn	0.13	otn	0.13
wap	0.03	fmp	0.04	fmp	0.04	ocr	0.07

Note: Sectoral abbreviations are defined in Appendix 2

Table 5.23: List of sectors with the largest increase in import shares in Indonesia (%).

IJEPA	Changes in Shares	AFTA	Changes in Shares	AFTA + IJEPA	Changes in Shares	AGRI AFTA + IJEPA	Changes in Shares
mvh	0.08	ome	0.20	ome	0.24	ome	0.22
ome	0.04	mvh	0.11	mvh	0.18	mvh	0.18
tex	0.02	i_s	0.05	trd	0.05	pcr	0.08
pfb	0.01	otn	0.05	otn	0.05	sgr	0.05
trd	0.01	trd	0.05	i_s	0.04	trd	0.05

Note: Sectoral abbreviations are defined in Appendix 2

Analysis of trade flows across the scenarios did show changes in the export and import flows of the sectors involved in the tariff cuts. In the case of IJEPA, Japan's share of Indonesian wearing apparel sector exports increased by 0.94%. It appeared that export tariff reductions under IJEPA only resulted in marginal changes in trade flows. A similar situation was seen with other sectors that saw export tariff reductions, such as the fish and oil seeds sectors. However, there was a larger impact on the import side. For example, the import tariff reduction on the motor vehicles sector resulted in a 15.9% increase in Japan's share of Indonesian import of motor vehicles. Other sectors, such as OME and chemical rubber products sectors that saw reductions in import tariffs by Indonesia also experienced similar results.

Tariff reductions under the AFTA appeared to have a similar impact on trade flows. The motor vehicles and other transport equipment sectors, which saw the greatest tariff reductions, experienced the greatest change in export flows. ASEAN's share of Indonesian exports of the two sectors increased by 24.2% and 13.4% respectively. These changes indicated that AFTA had brought significant changes in the direction of exports of the motor vehicles and other transport equipment sectors. It has made ASEAN a destination for more of the motor vehicles and other transport equipments produced in Indonesia. Similarly, ASEAN's share of Indonesian imports of fabricated metal products and motor vehicles rose by 6.10% and 5.00% respectively.

For the 'AFTA+IJEPA' scenario, the effects of the agreements seem to be cumulative. As a result, similar sectors experienced the greatest changes in trade flows. However, considering that each agreement often had a trade diversion effect on non-agreement countries (this include ASEAN for the IJEPA and Japan for the AFTA), the magnitude of the changes was dampened. For example, the Japan share of Indonesian motor vehicles sector imports decreased from 15.9% in the IJEPA scenarios to 12.7% in the 'AFTA+IJEPA' scenario. While ASEAN share of motor vehicles sector import to Indonesia decreased from 5.0% under the AFTA scenario to –1.0% due to the effect of IJEPA. The agriculture tariff cuts in the 'AGRI AFTA+IJEPA' scenario did not appear to have a great impact on increasing agriculture shares of Indonesian imports and exports from and to Japan or ASEAN. Tables 5.24 and 5.25 below summarize the changes in trade flows experienced in certain selected sectors that experienced tariff reductions.

Table 5.24: Changes in Japan's share of Indonesian trade flows in selected sectors (%).

Sector	IJEPA	AFTA	AFTA+IJEPA	AGRI AFTA+IJEPA
Export				
14 fsh	0.676	-0.022	0.631	0.609
25 ofd	0.603	-0.026	0.574	0.596
28 wap	0.941	-0.003	0.943	0.943
33 crp	0.096	-0.415	-0.325	-0.324
Import				
27 tex	2.517	0.010	2.532	2.532
33 crp	3.464	-0.892	2.428	2.436
38 mvh	15.887	-3.027	12.676	12.672
39 otn	2.801	-0.044	2.733	2.734
40 ele	0.526	-0.140	0.379	0.377
41 ome	4.020	-0.642	3.294	3.291

Note: Sectoral abbreviations are defined in Appendix 2

Table 5.25: Changes in ASEAN's share of Indonesian trade flow in selected sectors (%).

Sector	IJEPA	AFTA	AFTA+IJEPA	AGRI AFTA+IJEPA
Export	Changes in ASEAN sectoral export share			
31 ppp	0.006	2.764	2.777	2.780
33 crp	-0.028	5.152	5.111	5.123
37 fmp	0.004	5.168	5.172	5.171
38 mvh	-0.091	24.179	23.600	23.604
39 otn	-0.058	13.357	13.247	13.253
40 ele	0.007	1.298	1.306	1.308
41 ome	-0.031	4.592	4.518	4.519
Import	Changes in ASEAN sectoral import share			
32 p_c	0.000	2.294	2.294	2.293
33 crp	-1.195	4.736	3.480	3.443
35 i_s	-0.099	2.333	2.216	2.218
37 fmp	-0.610	6.101	5.369	5.368
38 mvh	-5.320	5.006	-0.986	-0.985
40 ele	-0.075	1.192	1.116	1.116
41 ome	-0.817	2.434	1.574	1.576

Note: Sectoral abbreviations are defined in Appendix 2

In conclusion, there seems to be a correlation between the changes in output and the changes in export and import shares of some sectors. Under the IJEPA scenario, the OME and textiles sectors are both among the top 5 sectors with the greatest increase in both output value and export shares. Results from the AFTA scenario show that the OME and motor vehicles sectors saw the greatest increase in output and export-import shares compared to the BAU scenario. This supports the idea that increases in output is closely linked with increases in export and import shares. When both sets of tariff reduction were applied under the 'AFTA+IJEPA' scenario, a similar relationship was observed where OME and motor vehicles sectors continued to dominate the gain in output and export-import shares as the impact of the two agreements were compounded. This resulted in greater gains in some sector but greater loss in others. In the 'Agri AFTA+IJEPA' scenario, the additional tariffs applied to the agricultural sectors did not appear to have significant additional impact to the overall economy when compared to the 'AFTA+IJEPA' scenario. While the magnitude of the agriculture tariff reduction was large, the value of existing agricultural output and trade was relatively small compared to the whole economy. As a result, any gain in output or export/import shares may not be large enough to have a significant impact to the whole economy.

Furthermore, from the above observations, it could be seen that the OME, motor vehicles and the textile sectors are 3 important manufacturing sectors most affected by the trade liberalization policies that Indonesia plans to pursue. Historically, in Indonesia, these sectors were initially developed through an import substitution policy that lasted through the 1980s and were heavily dependent on both non-tariff barriers and high imports tariff (Resosudarmo and Irhamni 2008). Starting from the 1980s, the Indonesian government has also started to pursue export industrialization strategy but this was not accompanied by measures that would diversify products and markets or improve competitiveness. Coupled with other structural and organizational weaknesses, these made Indonesia’s manufacturing sector vulnerable to increasing competition from other developing nations (Dhanani 2000). For example, the labor intensive textile industry in Indonesia are losing its competitiveness with rising wages especially from lower cost producers such as China, Vietnam and Cambodia (EIU 2004, 2007). This partially explained the changes in export and import that occurred with the reduction of tariffs under AFTA and IJEPA. Under IJEPA, the textiles industry benefited from lower tariff as Indonesia has a lower labor cost in competing against Japanese textile firms, resulting in a net increase in output and export. However, under AFTA, tariff reductions meant that it is less protected against other low cost producing nations in ASEAN, resulting in a decrease in Indonesian textile output that resulted in a net decrease in the IJEPA+AFTA scenario. Similarly, for the motor vehicle sector, it is a low technology and low wage industry. While its low wage costs provided the with come competitive advantage despite its relatively low technology (EIU 2004), the sector did not appear to be able to compete with Japanese producers as motor vehicle production decline in Indonesia under the IJEPA. This was coupled with an increased in motor vehicles imports from Japan. However, in the case AFTA, the low wages might still give Indonesia’s producers the edge against regional competitors as both output and export increased. To conclude, the changes in these important sectors upon trade liberalization reflected the industrial policy that Indonesia has taken in the past.

5.2.3 Welfare Changes due to Trade Liberalization

Thus far, the discussion of the results has focused on changes in output and trade arising from the trade policy adopted in the different scenarios. These impacts of trade liberalization have welfare implications for the different regions. In the GTAP framework, representative agents in each region aim to maximize their welfare level based on a unique welfare function by ensuring equal marginal utility of consumption across the different commodities. The adoption of trade policy changes will cause a change to agents' income and together with new price variables this will help to determine the new welfare of the regions. Table 5.26 outlines the welfare changes measured in equivalent variation that occurred across the four scenarios together with the decomposition of total welfare into three components: allocative efficiency (AE), terms of trade (ToT) and investment goods and saving (I-S) effects. A brief survey of the results indicated that trade liberalization lead to welfare level improvements in agreement countries at the expense of non-agreement countries resulting in a net loss in global welfare. The distribution of welfare increases among agreement countries, however, was not equal. In the case of IJEPA, Japan's welfare gain is three times that of Indonesia. Under AFTA, Indonesia gained approximately three times as much welfare as ASEAN. The interaction of the trade policy also appeared to favor Indonesia while balancing out the welfare gain from Japan and ASEAN. Unfortunately, this resulted in a marginal welfare loss of US$ 0.8 million for ASEAN in the 'AFTA+IJEPA' scenario and only a small welfare gain of US$ 5.6 million in the 'AGRI AFTA+IJEPA' scenario. Welfare gains for Indonesia appeared to rise with increasing trade liberalization. These gains increased from US$ 114.9 million in the IJEPA scenario to US$ 403.2 million in the 'AGRI AFTA+IJEPA' scenario. Clearly, in term of welfare, it is beneficial for Indonesia to pursue the agreements.

Table 5.26: Welfare gains arising from trade liberalization (US$ million).

IJEPA	Allocative Efficiency	Term of Trade	I-S Effect	Total
Indonesia	8.9	-21.4	127.4	114.9
Japan	48.9	341.3	-90	300.2
China	-14.1	-79.2	8.7	-84.6
Korea	-8.6	-41.8	1.1	-49.3
ASEAN	-15.2	-61.6	3.7	-73.4
NAFTA	-6.3	-47.8	-22.5	-76.7
Rest of Asia	-6.8	-40.2	-3.1	-50.1
Rest of OECD	-27.1	-54.3	-17.3	-98.5
ROW	-6.3	5	-7.9	-9.1
Total	-26.6	0	0	-26.6
AFTA	Allocative Efficiency	Term of Trade	I-S Effect	Total
Indonesia	29.5	268.1	-64	233.7
Japan	-17.3	-137.4	29.5	-125
China	-1.4	-34.1	22.4	-13
Korea	-4.6	-34	5.2	-33.3
ASEAN	-8.4	86.4	7.3	85.1
NAFTA	-18	-55.7	-16.6	-90.5
Rest of Asia	-25	-36.5	3	-58.5
Rest of OECD	-36.5	-93.4	10.3	-119.7
ROW	-20.5	36.5	3.1	19
Total	-102.2	0	0	-102.2
AFTA+IJEPA	Allocative Efficiency	Term of Trade	I-S Effect	Total
Indonesia	50.9	246.9	58.7	356.4
Japan	30.8	203	-60	173.7
China	-15.3	-111.8	30.9	-96.2
Korea	-13.1	-75	6.3	-81.8
ASEAN	-32.8	19.6	12.5	-0.8
NAFTA	-24.6	-103.3	-37.9	-165.6
Rest of Asia	-31.5	-76	0.1	-107.4
Rest of OECD	-63.2	-145.8	-6.3	-215.2
ROW	-26.9	42.3	-4.4	11
Total	-125.6	0	0	-125.6
Agri AFTA+IJEPA	Allocative Efficiency	Term of Trade	I-S Effect	Total
Indonesia	84.9	260.3	58	403.2
Japan	24.9	196.9	-58.6	163
China	-15.4	-121.7	34.2	-102.9
Korea	-13.6	-77	6.7	-84.1
ASEAN	-57.9	53.1	10.3	5.6
NAFTA	-24.9	-111.7	-40.5	-177.2
Rest of Asia	-33.2	-85.8	0.4	-118.5
Rest of OECD	-59.3	-159.7	-5.9	-224.8
ROW	-30.6	45.6	-4.6	10.5
Total	-125.2	0	0	-125.2

Further analysis into the components of welfare changes showed that the source of welfare gain for the agreement countries differed. For example, in the IJEPA scenario, the main source of welfare gain for Indonesia was the I-S effect that saw a gain of US$ 127.4 million while there was only a small increase in allocative efficiency and actually a deterioration in the ToT of US$ -21.4 million. On the other hand, the IJEPA scenario brought a large ToT welfare gain of US$ 341.3 million for Japan in addition to a gain of US$ 48.9 million in allocative efficiency, despite a welfare loss of US$90.0 million due to the I-S effect. Decomposition of total effects also indicated that a positive ToT effect was the main driver behind welfare gain among agreement countries. In fact, across the different scenarios, only in the IJEPA scenario did a member country experience negative ToT effect. Last but not least, allocative efficiency for Indonesia also increased with greater trade integration. Unfortunately, these welfare measures do not take into account the value of the environment and ignore the impact of resource depletion and pollution in their assessment.

5.3 Projected Environmental Impacts in Indonesia due to Growth and Structural Changes in the BAU Scenario

5.3.1 Overall Pollution changes

Thus far, the discussion has focused on the economic impact of growth in Indonesia. Yet, this growth in output in the Indonesian economy is expected to have a direct impact on the environment. Table 5.6 shows a summary of the changes in the level of pollution indicators for Indonesia under the BAU scenario. While it was expected that the pollution level in Indonesia would increase, the rate of growth in air pollution appeared to greatly exceed the rate of output growth. By 2022, the emissions of CO_2 and N_2O increased by 731% and 664% respectively, which was more than double the rate of output growth (263%) while CH_4 emissions grew by 497%. In general water pollution growth appears to be slower than those of air pollutions. The COD indicator grew by 374% while BOD and SS grew by 228% and 96.9% respectively. BOD and SS growth were slower than output growth. Further analysis of these emissions revealed several interesting trends at the sectoral level.

Table 5.27: Changes in pollution indicators under the BAU scenario.

	2001	2007	2012	2017	2022
CO_2 (Gg)	222079	450779.	792970	1273543	1845504
CH_4 (Gg)	7163	14096	21118	30041	42785
N_2O (Gg)	110	264	430	626	844
BOD (tons)	1176116	1542913	1984898	2715441	3861099
COD (tons)	1152592	1599655	2227525	3390385	5470303
SS (tons)	13726	15595	18048	21835	27028

CO_2

The other transport sector emerged as playing a leading role in driving the increase in CO_2 emissions. In 2001, it emitted 39,048 Gg of CO_2 accounting for only 17.6% of the total CO_2 emissions but by 2022, it emitted 822,506 Gg of CO_2 to account for 44.6% of the total CO_2 emissions. This large increase in emissions appeared to be driven primarily by the higher CO_2 coefficient of the sector (more CO_2 emitted per $ value of output), which increased by 522% by 2022. This magnified the impact of the 238% growth in its output. Other sectors that contributed significantly to CO_2 emission in 2022 include the oil, P_C and electricity sectors. They emitted 172,281 Gg (9.3%), 140,484 Gg (7.6%) and 103,371 Gg (5.6%) of CO_2 respectively. As the main source of CO_2 emissions, the share of the electricity sector declines over the years, from 29.7% in 2001 to 5.6 % in 2022. This can be attributed to the projected improvement in the CO_2 coefficient of the sector that decreased by 52%, helping to slow down emission growth to 57% over the period despite output growth of 228%. However, there is a clear picture that fuel production, processing and consumption will form the large part of CO_2 emissions in Indonesia in the future.

Table 5.28: The five sectors with the largest CO_2 emissions and their shares.

2001	Share (%)	2007	Share (%)	2012	Share (%)	2017	Share (%)	2022	Share (%)
ely	29.8	otp	33.0	otp	39.2	otp	42.5	otp	44.6
otp	17.6	ely	13.2	oil	9.7	oil	9.9	oil	9.3
p_c	8.1	p_c	10.4	p_c	9.7	p_c	8.6	p_c	7.6
nmm	6.2	oil	8.1	ely	8.5	ely	6.6	ely	5.6
gas	5.8	atp	3.6	gdt	4.6	gdt	5.3	gdt	5.6

Note: Sectoral abbreviations are defined in Appendix 2

CH_4

In the case of CH_4, the three most important contributors in Indonesia are: other government services[3], paddy rice and other animal products sectors. Each emitted 16,738.33 Gg (38.9%), 13,254.12 Gg (30.8%) and 6,729.69 Gg (15.7%) of CH_4 respectively in 2022. Among them, emissions from the other animal products sector grew the fastest as it increased by 749%. This was followed by other government services sector at 628% and paddy rice sector at 314%. For the other animal products and paddy rice sectors, the increase in value of their emission coefficients may have contributed to this rapid growth as CH_4 emission per unit value of output increased by 273% and 140% respectively over the period. This helped to negate the effect of declining output shares of both sectors. As for the other government services sector, the increased output appears to be the main factor driving the growth considering that its CH_4 coefficient was projected to only increase slightly by 17%. Finally, the cattle sector experienced the highest growth rate in CH_4 emissions as its emissions increased from 243.10 Gg to 4,059.89 Gg. As a result, its share of CH_4 emissions increased to 9.4% from 3.4%. Similar to the other agricultural sectors, the rapid increase in its CH_4 emission coefficient (671%) appeared to be the driver of the emissions increase. In conclusion, these results highlight the role agricultural sectors played in CH_4 emissions.

Table 5.29: The five sectors with the largest CH_4 emissions and their shares.

2001	Share (%)	2007	Share (%)	2012	Share (%)	2017	Share (%)	2022	Share (%)
pdr	44.7	pdr	44.2	pdr	41.0	pdr	36.6	osg	38.9
osg	32.1	osg	27.9	osg	28.0	osg	31.5	pdr	30.8
oap	11.1	oap	14.8	oap	16.3	oap	16.6	oap	15.7
gas	4.0	ctl	6.3	ctl	8.4	ctl	9.5	ctl	9.4
ctl	3.4	gro	2.5	gro	3.1	gro	3.2	gro	3.0

Note: Sectoral abbreviations are defined in Appendix 2

N_2O

Sectoral analysis of N_2O pollution indicates that there were slight changes in the sectoral composition of emissions. There was a steady decline in the N_2O pollution shares of the paddy rice and vegetable and fruit (V_F) sectors while the other grains and other transport sectors saw an increase in their shares. The decrease in the paddy rice and V_F

[3] Other government services sector includes services sewage and refuse disposal, and sanitation and similar activities.

sectors N_2O emissions shares occurred despite a significant projected increase in N_2O coefficients for both sectors. In fact the N_2O coefficients for the paddy rice and V_F sectors are expected to increase by 228% and 204% respectively. Instead, the decrease in share was caused by the decline in output share of both sectors that halved over the period. On the other hand, the rapid rise in the N_2O emission share of the other grains sectors was driven by the increase in its pollution coefficient that increases by 756%. Despite these changes, the sectoral rankings of N_2O emissions remained relatively constant throughout the 22 years period, with the paddy rice, V_F and other grains sectors being the top three emitters of N_2O in 2022, emitting 190.4 Gg (22.5%), 136.22 Gg (16.1%) and 132.2 Gg (15.7%) respectively.

Table 5.30: The five sectors with the largest N_2O emissions and their shares.

2001	Share (%)	2007	Share (%)	2012	Share (%)	2017	Share (%)	2022	Share (%)
pdr	30.5	pdr	29.2	pdr	27.0	pdr	24.7	pdr	22.5
v_f	23.4	v_f	21.4	v_f	19.5	v_f	17.6	v_f	16.1
oap	8.3	gro	12.1	gro	14.5	gro	15.6	gro	15.6
gro	8.0	pfb	9.9	pfb	10.9	pfb	11.0	pfb	10.6
pfb	7.4	oap	8.7	oap	8.6	oap	8.5	otp	10.3

Note: Sectoral abbreviations are defined in Appendix 2

BOD

BOD emissions in Indonesia throughout the BAU scenario were dominated by 3 sectors: lumber, leather and chemical rubber products. They accounted for 92.3% of total BOD emissions in 2022. This was a trend that was observed throughout the period. However, among these sectors there was a slight change in rank as there was a steady decline in BOD emissions share from the lumber sector accompanied by an increase in share of the leather sector. The chemical rubber products sector's share remained relatively constant. By 2022, the leather sector accounted for 39.6% of BOD emissions in Indonesia moving above the lumber sector that accounted for 33.5%. These shares translated to 1,527,174 tons and 1,294,399 tons of BOD emissions respectively. Given that the growth rates of the BOD coefficients among the different sectors were equal, this means that the shifts in the BOD shares can be directly attributed to the changes in output shares of the sectors. Therefore, this reflects the decline in importance of the lumber sector in the Indonesian economy and the rapid growth of the leather sector. Indeed as seen earlier, the leather sector has the highest output growth, far exceeding the average output growth rate of the whole economy.

Table 5.31: The five sectors with the largest BOD emissions and their shares.

2001	Share (%)	2007	Share (%)	2012	Share (%)	2017	Share (%)	2022	Share (%)
lum	44.6	lum	43.9	lum	41.7	lum	38.1	lea	39.6
lea	23.1	lea	25.2	lea	28.5	lea	33.2	lum	33.5
crp	21.5	crp	21.0	crp	20.6	crp	20.2	crp	19.2
tex	4.2	tex	4.3	tex	4.4	tex	4.5	tex	4.4
ctl	3.4	ctl	2.9	ctl	2.6	ctl	2.2	ctl	1.9

Note: Sectoral abbreviations are defined in Appendix 2

COD

Similar to the BOD emissions, the top three sectors that dominated COD emissions in Indonesia are the leather, chemical rubber products and lumber sectors. They contributed most of the COD pollution calculated. However, unlike BOD, the share of COD emissions was highly concentrated in the leather sector, accounting for 80.9% of COD emissions by 2022. The chemical rubber products and lumber sectors only accounted for 15.9% and 3.1% respectively. The large share of COD pollution by the leather sector was due to its high COD coefficient. Even in the year 2001, its COD coefficient was 223.8 tons per unit value of output compared to 18.8 tons and 8.0 tons for chemical rubber products and lumber sector respectively. Therefore, it was not surprising that the leather sector is the dominant contributor of COD emissions. Similar to the BOD case, emission coefficients over the period were projected to decrease at a steady rate for all sectors involved and thus the only factor that influenced the changes in emission shares was the relative growth rates of output value in each sector. As a result, the rapid growth in the leather sector leads to a very significant share of total COD emissions.

Table 5.32: The five sectors with the largest COD emissions and their shares.

2001	Share (%)	2007	Share (%)	2012	Share (%)	2017	Share (%)	2022	Share (%)
lea	68.2	lea	70.6	lea	73.5	lea	77.0	lea	81.0
crp	25.8	crp	23.8	crp	21.6	crp	19.0	crp	15.9
lum	5.9	lum	5.5	lum	4.8	lum	3.9	lum	3.1
ely	0.1	ely	0.1	ely	0.1	ely	0.1	ely	0.1
vol	0.0	vol	0.0	vol	0.0	vol	0.0	vol	0.0

Note: Sectoral abbreviations are defined in Appendix 2

SS

Unlike the other two water pollutants, the three sectors that played an important part in BOD and COD did not contribute significantly to SS pollution. While leather and chemical rubber products sectors ranked second and third in term of SS emission shares in 2022, they only accounted for 9.2% and 3.0% of SS emissions respectively. It was the cattle sector that contributed to most of the SS emissions in Indonesia. At the peak in 2001, the cattle sector accounted for 93.7% of the SS emissions at 12,867 tons. However, this declined steadily over the period and by 2022, the sector only accounted for 86.3% of total SS emission at 23,320 tons. Again, given that the decrease in emission coefficients were set to be uniform across all sectors, these results reflect the changing importance of output shares among the different sectors. Based on the output data, the cattle share of Indonesian output decreased by 0.08% in 2022 from 2001 and this directly contributed to the decline in its pollution share. Similarly, since the share of leather sector output saw an increase, this resulted in an increased share of the SS emissions.

Table 5.33: The five sectors with the largest SS emissions and their shares.

2001	Share (%)	2007	Share (%)	2012	Share (%)	2017	Share (%)	2022	Share (%)
ctl	93.7	ctl	92.5	ctl	91.2	ctl	89.2	ctl	86.3
lea	3.2	lea	4.0	lea	5.1	lea	6.7	lea	9.2
crp	2.0	crp	2.3	crp	2.5	crp	2.8	crp	3.0
tex	0.5	tex	0.6	tex	0.7	tex	0.8	tex	0.9
rmk	0.2	ely	0.2	ely	0.2	ely	0.2	ely	0.2

Note: Sectoral abbreviations are defined in Appendix 2

5.4 Projected Environmental Impact of Trade Liberalization

This section analyzes the impact of trade liberalization on the environment. Table 5.34 provides the changes in pollution indicators for each scenario compared to the BAU scenario in the year 2022.

Table 5.34: Total changes in the pollution emissions compared to the BAU scenario in the year 2022.

	IJEPA	AFTA	AFTA + IJEPA	AGRI AFTA + IJEPA
CO_2 (Gg)	1604.44	7647.45	8447.51	8787.70
%	0.09	0.41	0.46	0.47
CH_4 (Gg)	-25.75	128.71	94.66	-53.37
%	-0.06	0.30	0.22	-0.12
N_2O (Gg)	0.04	-0.05	-0.21	-0.89
%	0.00	-0.01	-0.02	-0.11
BOD (tons	-4805.67	-40679.57	-47172.94	-45106.34
%	-0.12	-1.06	-1.24	-1.18
COD (tons)	-14851.41	-116541.43	-134164.55	-129604.88
%	-0.27	-2.14	-2.51	-2.43
SS (tons)	-23.92	-55.87	-88.36	43.65
%	-0.09	-0.21	-0.33	0.16

The results indicate that the tariff reductions had varying impacts on the different pollution indicators under the different scenarios. However, the impacts were small in magnitude, ranging from –2.51% to 0.47%. While CO_2 pollution increased in all the scenarios when compared to BAU, BOD and COD experienced a decline. CH_4, N_2O, and SS pollution had mixed results with increases and decreases depending on the trade agreement adopted. The trend in these changes appears to be closely related to that of welfare changes across the different scenarios. Greater trade liberalization had resulted in increasing welfare but also increasing GHGs emissions, with the exception of CH_4, N_2O in the AGRI AFTA+IJEPA scenario. On the other hand, the water pollutions levels declined with greater trade liberalization with the exceptions of the AGRI AFTA+IJEPA scenario. Since the pollution levels are not measured in dollar value, however, it is difficult to conclude whether the changes in the GHGs and water pollution will result in a net increase or decrease in welfare in Indonesia. Given these various trends, however, it is useful to analyze the changes to each pollution indicator individually and to explore them further at the sectoral level.

CO_2

Indonesia's participation in both the AFTA and the IJEPA whether separately, combined or with the addition of agriculture tariff reductions increased CO_2 emissions in the country. More importantly, the greater the trade liberalization adopted, the greater the increase in CO_2 emission. Under the IJEPA, which was the least extensive and deep of the trade liberalization scenarios, CO_2 emissions in Indonesia increased only marginally by 0.09% compared to under the 'AGRI AFTA+IJEPA' scenario that saw CO_2 emissions increased by 0.47%. In all the scenarios, the OME sector saw the largest increase in CO_2 emissions followed by the other transport sector. However, it is important to note that the main cause of the increase in pollution in the two sectors was different. For the OME sector, the increase in CO_2 emission was driven mainly by the increase in output as a result of trade liberalization. As seen earlier, OME sector output value increased by 1.37% in the IJEPA scenario to a high of 6.62% in the 'AFTA+IJEPA' scenario. On the other hand, for the other transport sector, a large CO_2 coefficient magnified the effect of the small change in output value. In fact, the other transport sector's CO_2 emission coefficient was the highest among all the sectors. Table 5.35 provides the five sectors that saw the largest increase in CO_2 emissions. The ranking of the top five sectors in CO_2 emissions across the different scenarios did not changed compared to the BAU scenario.

Table 5.35: The five sectors with the largest increase in CO_2 emissions compared to the BAU scenario (Gg).

IJEPA		AFTA		AFTA + IJEPA		AGRI AFTA + IJEPA	
ome	764.40 (1.37)	ome	2937.61 (5.26)	ome	3697.12 (6.62)	ome	3677.30 (6.58)
otp	376.41 (0.05)	otp	2925.24 (0.36)	otp	2987.08 (0.36)	otp	3266.70 (0.40)
cns	182.84 (0.65)	ely	587.06 (0.57)	cns	584.25 (2.07)	cns	604.33 (2.15)
ppp	103.93 (0.93)	gdt	560.89 (0.54)	ely	551.07 (0.53)	ely	587.06 (0.57)
nmm	78.28 (0.52)	cns	420.62 (1.49)	gdt	526.55 (0.51)	gdt	576.15 (0.56)

Note: Sectoral abbreviations are defined in Appendix 2

CH_4

Unlike CO_2 emission, the AFTA and the IJEPA had different impacts on CH_4 emissions for Indonesia. Under the IJEPA, Indonesia saw only a marginal change in CH_4 pollution, decreasing by 0.06% only. This was driven by the decrease in the other government services and the paddy rice sectors that saw their CH_4 emissions decline by 9.02 Gg and 8.32 Gg respectively. Under the AFTA however, these two sectors contributed the largest increases in CH_4 pollution, as emissions increased by 70.4 Gg (0.42%) and 39.6 Gg (0.30%) respectively. As a result, total CH_4 emissions increased by

0.40% under the AFTA. When both the AFTA and the IJEPA were adopted, the effect of the IJEPA helped to dampen the increase in CH_4 emissions arising from the AFTA. Thus, there was a slight decline in the increase of total CH_4 emissions as shown in Table 5.34. Surprisingly, CH_4 emissions actually declined by 0.12% with the adoption of the agriculture tariff reductions. This was because it resulted in a decrease in paddy rice output in Indonesia and thus decreasing CH_4 emission from the sector by 1.09% or 145.27 Gg. These results indicate that the other government services and paddy rice sectors were the two most important sectors determining in the changes in CH_4 emission across the different scenarios. For the paddy rice sector, its high CH_4 emissions were largely due to its relatively high CH4 coefficient, while for the other government services sector it was mainly caused by output increases.

N_2O

The impact of the AFTA and the IJEPA on the emissions of N_2O were minimal. In both the AFTA and the IJEPA the tariff cuts were mainly targeted to non-agricultural industries. Therefore, the agricultural sectors were likely to experience only marginal changes in output due to inter sectoral linkages. Since the data used in this study for N_2O emission was largely limited to the agricultural sector, this meant that the changes in N_2O pollution observed under the 'AFTA', 'IJEPA' and 'AFTA+IJEPA' scenarios would be limited. Despite this fact, there were several interesting observations. In the IJEPA, the plant fibers sector saw a small increase in N_2O pollution of 0.41 Gg (0.45%). However, this increase was countered by a decline in N_2O pollution from other agricultural sectors resulting in almost no change in total emissions as compared to the BAU scenario. On the other hand, in the 'AFTA' scenario, the plant fibres sector experienced a decline in N_2O emissions of 0.95 Gg (1.06%), but the increase in emission by the paddy rice, other transport and other government services sectors balanced it out. Given that these effects were compounded in the 'AFTA+IJEPA' scenario, the results were similar in that these sectors cancelled each other effects out. The adoption of agriculture tariff cuts, however, had a small impact on N_2O emissions. They decreased by 0.11% in the 'AGRI AFTA+IJEPA' scenario compared to the BAU scenario. This decrease in emissions was driven by the paddy rice sector that saw a 2.09 Gg (1.09%) decline in N_2O emissions.

Thus, considering that the bulk of the N_2O emissions originated from the agricultural sector, it is not surprising that it was the agricultural tariff cuts that had the most impact.

BOD

The results in Table 5.34 indicate that BOD emissions declined in all trade liberalization scenarios. The decrease in BOD pollution however was much more significant under the scenario 'AFTA' as compared to the 'IJEPA' scenario. In the 'IJEPA' scenario, BOD pollution decreased by 0.12%. This small decrease was driven by the leather sector. The decrease in the leather sector output coupled with its high pollution coefficient meant that BOD emissions from the sector declined by 4,367.62 tons (-0.28%) compared to the BAU case. Together with the 1,909.65 tons (0.26%) decline in emissions from the chemical rubber products sector, it more than compensated for the increase in emission of 1,137.84 tons from the textiles sector, resulting in a small decline in total BOD emissions under IJEPA. Under AFTA, the leather sector contributed significantly to the decline in BOD emissions as emissions from this sector declined by 43,698.8 tons (2.86%). The only sector with a significant increase in BOD emissions under AFTA was the chemical rubber products sector. This sector emissions increased by 9,034.1 tons (1.22%) and this meant that emissions decreased overall. Combining the two sets of tariff cuts, the 'AFTA + IJEPA' scenario, saw the largest decline in emissions as leather sector BOD emissions decreased further. As a result, in this scenario net BOD emissions decreased by 1.24% compared to the BAU case. The adoption of the agriculture tariff cuts however, resulted in a slight increase in BOD emissions. Emissions declined under the 'AGRI AFTA+IJEPA' scenario by 0.06 percent below the 'AFTA+IJEPA' results. This was caused by the increase in emissions from the chemical rubber products sector. Given that chemical products are an important input in many agricultural activities, it was expected that the increase in agricultural output, due to the tariff reductions, would lead to an increase in demand for chemical rubber products output and thus resulting in increased emissions. The changes in BOD across the scenarios clearly indicated that the leather sector played a significant role in the decline of BOD emissions.

COD

Similar to BOD, COD pollution declined under all scenarios with the greatest decrease seen in the 'AFTA+IJEPA' scenario. Since COD emissions are closely associated with BOD pollution, similar patterns between these two indicators were observed. The decrease in COD emissions was driven by the decline in emissions from the leather sector. Under the IJEPA scenario COD emissions from the leather sector declined by 12,661.2 tons (0.28%). This sector was the major contributor to the total emission decline of 14,851.4 tons. The decrease in emissions from this sector was even larger in the AFTA scenario as it declined by 126,678 tons. This greatly exceeded the 10,616.78 ton increase in COD emissions from the chemical rubber products sector. A similar situation was observed under the remaining two scenarios and the emission from the leather sector declined further by 141,832 in the AFTA+IJEPA scenario. Since the leather sector contributed 81.0% of the COD emissions in the BAU scenario in 2022, due to its high pollution coefficient, any changes in the sector arising from trade liberalization was expected to be magnified and thus would have a large impact on COD emission levels. Thus, the leather sector continued to play an important role in the decline of COD pollution emissions.

SS

For SS pollution, trade liberalization led to a decrease in emissions for all scenarios, except the 'AGRI AFTA+IJEPA' scenario, when compared to the BAU case. Similar to the other two water pollution indicators, SS pollution had its largest decline in the 'AFTA+IJEPA' scenario and that much of this decline can be attributed to the leather sector. This was despite the fact that the cattle sector was the dominant contributor to SS pollution in the BAU scenario in 2022. In the IJEPA scenario, further sectoral analysis revealed that two sectors, the cattle and leather sectors, contributed the most to the decline in SS emissions. Emissions from the cattle and leather sectors decreased by 16.3 tons and 7.07 tons respectively. Given there were only marginal changes among the remaining sectors, these accounted for most of the 23.9 ton decline in SS emission under the IJEPA scenario. Under the AFTA scenario, emissions from the chemical rubber products and cattle sectors actually saw an increase of 10.0 tons and 7.8 tons respectively. However, given that the leather sector emissions declined by 70.8 tons, net emissions change was negative. Similarly, in the 'AFTA+IJEPA' scenario, SS emissions from the leather sector declined by 79.3 tons when compared to the BAU case and this accounted for most of the decline in SS pollution in the scenario. In the 'AGRI AFTA+IJEPA' scenario, however, the implementation of the agricultural tariff reduction resulted in a slight increase in the output of the cattle sector, causing its emissions to increase by 112.87 tons. This increase exceeded the decline in SS emissions from the leather sector resulting in a net increase in SS pollution. In conclusion, these results indicate that these two sectors play an important role in the changes of SS emissions arising from trade liberalization. However, unlike the other two water pollution scenarios, the prominence of the leather sector in these changes was due to output changes. On the other hand, it was the cattle sector with its large SS coefficient that amplified the effect of any output changes that arose from trade liberalization.

5.5 Decomposition Analysis

To further understand the different factors that contributed to the environmental impacts of growth and structural change in Indonesia, it is useful to decompose these changes into the scale, composition, and technique effects. Table 5.36 provides a summary of the decomposition results. It appeared that in the case of the GHGs emissions, the main driver behind the increase was the technique effect followed by the scale effect. The large value of the technique effect indicated that there might be a significant deterioration of technological efficiency in production in term of GHGs emissions, especially in sectors that were major contributors of GHGs. On the other hand, the negative composition effect indicated that the composition of industries in Indonesia over the period actually became cleaner in term of GHGs emissions. However, the magnitude of the effect was relatively small and indicated that only marginal changes might have occurred. Indeed, the ratio of the magnitude of the composition to the technique effect among the three GHGs ranged from 3.25% in the case of CO_2 to 7.67% in the case of N_2O. On the contrary, for the water pollution indicators, it was the composition (with the exception of SS) and scale effect that contributed to the increase in pollution. More importantly, it was observed that the scale effect was the main contributor to the increase in water pollutions. The technique effect, as expected, is negative since negative growth rates were used in projecting the water pollution coefficients based on the assumption that there will be technological progress that will help reduce the impact of industrial production on the environment. In addition, the scale effect was expected to be positive for all the indicators given that output was expected to increase over the period. To better understand these decomposition results, it is useful to examine changes at the sectoral level.

Table 5.36: Decomposition of pollution increase in the BAU scenario in year 2022.

	Composition	Scale	Technique	Total Change
CO_2 (Gg)	-38275.2	484230.8	1176884.5	1622840.1
CH_4 (Gg)	-728.5	16951.7	19589.7	35812.9
N_2O (Gg)	-47.2	166.6	615.0	734.4
BOD (tons)	92107.2	3341127.9	-749660.3	2683574.8
COD (tons)	644236.0	4733734.9	-1062124.3	4315846.6
SS (tons)	-4848.4	23389.1	-5247.9	13292.8

In the case of CO_2, the negative composition effect was mainly driven by three sectors that were major contributors of CO_2 emissions in 2001 but experienced a slower growth rate than the economy as a whole. They were the non-metallic minerals, P_C and gas sectors. The positive scale effect on the other hand was driven by two sectors, the electricity and other transport sectors that accounted for 32.6% and 19.8% of the total scale effect respectively. Their importance in the scale effect can be attributed to their large share of total CO_2 emissions. Over the period, two sectors stood out in contributing to the positive technique effect. The other transport and the oil sectors saw their CO_2 coefficient increased by 522% and 903% respectively from 2001 to 2022 and this contributed to a large positive technique effect from both sectors. Given the importance of the technique effects on changes in CO_2 pollution, it appears that the rapid deterioration of the CO_2 coefficient in these two sectors was an important driver in CO_2 emissions increase in Indonesia.

An analysis at the sectoral level for the decomposition of CH_4 pollution changes suggested that the paddy rice and other government services sectors were the two sectors that had the greatest influence on the changes in CH_4 pollution. The paddy rice sector contributed the most in terms of the negative composition and positive technique effects in CH_4 pollution. A steady decline in the share of output in the sector contributed to its negative composition effect of –1,682.03 Gg. Unfortunately, this reduction in pollution was countered by a significant positive composition effect from the other government services sector of 1,651.80 Gg. The other sectors that were included in the CH_4 emissions calculation experienced a slight decline in their shares, this resulted in a net negative composition effect. Growth in output in both the sectors, however, is the main driver behind the positive scale effect. In fact, the other government services and the paddy rice sectors accounted for 61.1% and 23.8% of the scale effect respectively. A deterioration of emission coefficient in the paddy rice sector resulted in a large positive technique effect of 7,735.57 Gg. Other significant sectors that had a similar trend included the other animal products, cattle and other government services sectors. In fact most sectors experienced a decline in CH_4 emission coefficient. In conclusion, the increase in CH_4 pollution was driven strongly by the growth in output of the paddy rice and other government services sectors coupled with the deterioration of CH_4 coefficients in a few other sectors.

Similar to CH_4, the paddy rice sector played an important part in the N_2O pollution change since it contributed the most to the changes in the three effects. In the composition effect, the paddy rice sector contributed -17.72 Gg to the decline in pollution, followed by the V_F sector with -13.59 Gg. In terms of the scale effect, the paddy rice sector contributed 42.13 Gg (25.3%) of emissions followed by the other government services and V_F sectors with 36.00 Gg (21.6%) and 32.45 Gg (5%) respectively. Increases in the emission coefficients among the agricultural sectors lead to a positive technique effect, with the paddy rice sector contributing a significant 132.28 Gg of emission followed by the other grains and V_F sectors with 116.75 Gg and 91.45 Gg respectively. In fact, almost all the agricultural related sectors experienced a worsening N_2O coefficient. Given that Table 5.33 indicates that the bulk of the increase in N_2O pollution arises from the technique effect, this suggests that it was the main factor in the increase of N_2O pollution over the 22 years period.

Among the water pollution indicators, it was observed that there was a positive composition effect in BOD emissions. This indicates that there was an apparent shift of production toward BOD intensive industries in Indonesia. The increase in the share of output from the leather sector appeared to be the main reason behind this positive composition effect. The increase in leather sector output resulted in a 230,570.30 tons of composition effect in BOD emission from the sector. Fortunately the decline in output share from another dirty sector, the lumber sector, helped to reduce the magnitude of this effect. It contributed to a decline of 99,171.50 tons of BOD emissions in the composition effect. However, both sectors contributed significantly to the scale effect, 1,321,993 tons from the leather sector and 1,020,492 tons from lumber sector, accounting for 73.1% of the scale effect. Given that the two sectors were the top contributors to BOD emissions, this meant that the reduction in their coefficient had a significant impact on the technical effect. For the leather sector this translated to –296,620 tons in technical effect while it is –251,409 tons for the lumber sector. These decompositions further highlight the important role the two sectors played in BOD emissions.

Analyzing the different effects on changes in the COD emissions at the sectoral level, the leather sector stood out as the most important sector in influencing these effects. Similar to BOD emission, it was the sector that helped drive the positive composition effect while accounting for 81.0% of the total COD scale effect. In fact, it was the only sector that made a significant contribution to the composition effect. This contribution was 668,394.7 tons, which accounted for most of the COD emissions composition effect. Considering that it had the highest COD emission coefficient and that all sectors were assumed to undergo uniform reductions in their COD coefficient, this meant that the sector also contributed the most to the negative technique effect at –859,865.0 tons.

Unlike the other two water pollutions that had positive composition effect, the decomposition of SS emissions indicated that Indonesia seemed to be moving towards less SS pollution intensive industries. The cattle sector, an important contributor to SS pollution, saw a decline in their share of output value leading to –5,204.59 tons in composition effect. Since no other sector in the SS calculation experienced rapid growth, this resulted in a net negative composition effect. Despite this, the cattle sector contributed significantly to the increase in SS pollution through the scale effect where it accounted for 86.3% of the SS emissions scale effect with 20,186.94 tons of emissions. Conversely, its high SS emission coefficient also meant that it contributed the most to the negative technique effect at –4,529.41 tons. Unfortunately, the decline in pollution through the composition and technique effect was insufficient to overcome the large increase in pollution arising from the scale effect, resulting in a net increase in SS pollution.

Table 5.37: Differences in the composition, scale and technique effects in the IJEPA and AFTA scenarios compared to the BAU scenario in 2022.

	Composition	Scale	Technique	Total Change
IJEPA				
CO_2 (Gg)	-73.62	526.50	1151.56	1604.44
CH_4 (Gg)	-10.51	-2.51	-12.73	-25.75
N_2O (Gg)	-0.08	0.03	0.10	0.04
BOD (tons)	-2944.14	-2794.93	933.40	-4805.67
COD (tons)	-6811.11	-10924.86	2884.56	-14851.41
SS (tons)	-17.42	-11.15	4.65	-23.92
AFTA				
CO_2 (Gg)	-169.35	2702.74	5114.06	7647.45
CH_4 (Gg)	-7.71	89.88	46.54	128.71
N_2O (Gg)	-0.24	0.44	-0.25	-0.05
BOD (tons)	-19259.18	-29321.50	7901.11	-40679.57
COD (tons)	-46551.19	-92625.86	22635.62	-116541.43
SS (tons)	-59.96	-6.76	10.85	-55.87

The comparison of decomposition analysis of pollution changes in the IJEPA and AFTA scenarios and the BAU scenario in 2022 revealed a few interesting observations as shown in Table 5.37. Since this study utilizes the GTAP framework and not GTAP-E framework used in Kuik and Verbruggen (2002), environmental coefficients that were used to measure pollution emission were fed exogenously. Given that the same set of coefficients was used across all scenarios for each time period, it would be expected that the technique effect should be zero. However, given the method of calculation that was used, the technique effect was obtained as a residue of pollution change after taking into account the scale and composition effect. This is done by decomposing total pollution changes up to 2022 in each scenario separately before comparing the effects across the scenarios and calculating their differences.The results showed that the magnitude of the differences between AFTA-BAU were larger than that between IJEPA-BAU. This was because the impact of AFTA on the Indonesian economy was more pronounced than that of the IJEPA.

In the case of CO_2, tariff reductions in both the IJEPA and the AFTA resulted in a smaller composition effect and larger scale and technique effects. Under IJEPA and AFTA, composition effects were 73.62 Gg and 169.35 Gg less than the BAU case respectively. This indicated that the composition of industries in Indonesia had become less CO_2 intensive as a result of tariff reductions. The increased in output in the Indonesian economy in the two trade liberalization scenarios, however, meant that there was a larger scale effect of CO_2. Compared to the BAU scenario, scale effect is 526.50 Gg larger in the IJEPA scenario and 2,702.74 Gg larger in the AFTA scenario. The increased growth also meant that the contribution of increasing pollution coefficients were larger. This was captured by the larger technique effect experienced under the IJEPA (+1,151.6 Gg) and the AFTA (+5,114.60 Gg). Given the increase in scale and technique effects, total CO_2 emissions were larger in the IJEPA and the AFTA scenarios compared to the BAU scenario in 2022.

For CH_4 emissions, composition effect under the IJEPA and the AFTA scenarios were 10.51 Gg and 7.71 Gg smaller than in the BAU scenario respectively. Tariff reductions in the IJEPA scenario also resulted in a smaller scale (-2.51 Gg) and technique (-12.73 Gg) effects compared to the BAU scenario. The smaller scale and technique effects in the IJEPA scenario arose because tariff reductions resulted in a slower growth of CH_4 emitting sectors compared to the BAU case. Tariff reductions in the AFTA scenario, however, had the opposite effect as it resulted in a larger scale (+89.88 Gg) and technique effects (+46.54 Gg). Therefore, total CH_4 pollution in the AFTA scenario was larger than that in the BAU scenario.

Similarly, tariff reductions in the IJEPA and the AFTA scenarios resulted in a decline in the composition effect of N_2O emissions compared to the BAU scenario. Composition effects of N_2O in the two scenarios are 0.08 Gg and 0.24 Gg less than that of the BAU scenario respectively. The scale effects under the two trade liberalization scenarios were also larger than that in the BAU case. The IJEPA and the AFTA, however, had an opposite impact on the technique effect. Under the IJEPA, technique effect of N_2O emission was larger (+0.10 Gg) than the BAU scenario while it was smaller under the AFTA (-0.25 Gg). As a result of these changes, total N_2O pollution was higher in the IJEPA scenario but lower in the AFTA scenario compared to the BAU case.

In the case of BOD emissions, tariff reductions in both the IJEPA and the AFTA had similar impacts on composition, scale and technique effects changes, albeit the magnitude of the changes under the AFTA was larger than that of the IJEPA. Despite being significant and positive, composition effects in the IJEPA and the AFTA scenarios were 2,944.14 tons and 19,259.18 tons less than in the BAU case. This shows that trade liberalizations helped slowed down the movement of industries toward more BOD intensive industries. The smaller scale effects of the IJEPA (-2,794.93 tons) and the AFTA (-29,321.50 tons) compared to the BAU case also indicated that growth in BOD emitting sectors were relatively slower in the IJEPA and the AFTA scenarios compared to the BAU. However, this slower growth meant that the contribution of decreasing BOD coefficient in reducing BOD emissions through a negative technique effect was reduced. This was reflected by a less negative technique effects in the IJEPA and AFTA scenario. Technique effects were 933.40 tons and 7,901.11 tons larger in the IJEPA and the AFTA scenarios respectively compared to the BAU case.

Similar to the BOD observations, tariff reductions under the IJEPA and the AFTA resulted in a decrease in COD composition and scale effects, and an increase in COD technique effect. Under the IJEPA and the AFTA, composition effects were 6,811.11 tons and 46,551.19 tons less than the BAU case respectively. Scale effects declined by 10,924.86 tons and 92,625.86 tons while technique effects increased by 2,884.56 tons and

22,635.62 tons respectively. Since COD emissions are closely linked to that of the BOD, a similar conclusion could be made from these changes. The smaller composition effects meant that tariff reductions helped reduced the movement of industries towards more COD intensive industries. The differences in the scale effects also indicated a slower growth among COD emitting industries but this also meant that it reduced the impact of emission reduction through the technique effect.

Changes in the composition, scale and technique effects of SS emissions due to the IJEPA and the AFTA were similar to that of BOD and COD. Composition and scale effects were smaller in the IJEPA and the AFTA scenarios compared to the BAU case. The difference amounted to –17.42 tons and –59.96 tons respectively for the composition effect and –11.15 tons and –6.76 tons respectively for the scale effect. The technique effect, however, was less negative as a result of tariff reductions under these two scenarios. Therefore, technique effects in the IJEPA and the AFTA scenarios were 4.65 tons and 10.85 tons larger than in the BAU scenario.

In summary, there was a significant increase in all of the pollution indicators in the BAU scenario. The deterioration in the environmental coefficients seemed to be the driving factor for the increase in emissions among the GHGs in the BAU scenario as reflected by the large technique effect. On the other hand, the scale effect was the largest contributor to the increase in water pollution. The changes in these pollutions also appeared to be driven mainly by a few sectors rather than economy wide increases. The main challenge arising from this picture is that while it is easy to target certain sectors to alleviate emissions in each separate indicator, it will be difficult to arrive at a single policy change that will affect all the pollution indicators equally.

Further analysis of the differences in composition, scale effects between two trade liberalization scenarios, the IJEPA and the AFTA, and the BAU scenario revealed a few notable observations. In the case of GHGs, tariff reductions resulted in a more negative composition effect, which meant that it encouraged movement of industries to less GHGs polluting industries. However, in the case of CO_2 emissions, it resulted in a positive scale and technique effects that outweigh the negative composition effect, leading to an increase of total CO_2 emissions. Similarly, for the water pollutants, trade liberalizations under the IJEPA and the AFTA resulted in a smaller composition effect. This meant that it helped slowed down movement of industries towards more water polluting industries. Thus, it appeared that trade liberalizations in Indonesia helped to encourage less polluting industries.

Chapter 6: Summary and Conclusion

6.1 Summary

The relationship between trade reforms and the environment is a subject that is still much debated today. The recent drive towards trade liberalization among developing nations has increased the concern that it will have a negative impact on the environment, especially given the lax environmental standards in most of these countries. Indonesia is one example of a developing nation that has recently tried to further liberalize her economy by pursuing free trade agreements (FTAs). However, she is also a country that is plagued by an increasing pollution emission problem, having emerged as one of the major polluter in the world. Thus, there is a concern that its participation may further deteriorate this situation.

In this study, the Global Trade Analysis Project (GTAP) framework and database was used to construct a multiregional CGE model to estimate the impact of trade liberalization in Indonesia, more specifically her participation in AFTA and IJEPA. The model contained 57 sectors and 9 regions. A recursive process was used to project the model to the year 2022. A number of scenarios were also used to estimate the economic and environmental impact of trade liberalization in Indonesia. The five scenarios attempted were: (1) Business as Usual (BAU), (2) IJEPA, (3) AFTA, (4) AFTA+IJEPA, and (5) agricultural sector tariff reductions with AFTA+IJEPA. In the BAU scenario, the current level of tariff reductions was maintained while tariff reduction changes were applied to the other scenarios. This allow for a counterfactual analysis of the economic impacts of trade liberalization. Using a set of environmental coefficients that had been collected separately, the effect of these changes on the environment were then measured based on six indicators: CO_2, CH_4, N_2O, biological oxygen demand (BOD), chemical oxygen demand (COD) and suspended solids (SS).

Initial projections of the Indonesian economy suggested that it was expected to grow rapidly and this would have a major impact on pollution emissions. Indonesia's output was estimated to grow by 263% by 2022 in the BAU scenario. The public administration and the electricity sectors play a prominent role in this growth in output with increases of 524% and 501% respectively. As a result of this growth, pollution emissions grew significantly with CO_2 growing the fastest. In 2022, CO_2 emissions increased by 731% to 1.84 million Gg with the transportation sector contributing the bulk of this increase due to an increase in its emission coefficient. While water pollutions grew slower than air pollution, they still grew considerably with BOD pollution increasing by 228%. This increase in BOD emission is dominated by the lumber, leather and chemical rubber products sector accounted for 92.3% of total emissions. A decomposition analysis of the increase in pollution in BAU 2022 suggested that the increase in GHGs emissions arose due to a large technique effect while it was a large scale effect that resulted in an increased in water pollution. It appeared that the difference between the growth in air and water pollution emissions was due to the increase in air pollution coefficients. There did not appear to be a significant change in either sectoral output and export/import patterns in Indonesia during this period of growth.

Table 6.1: Overview of the economic and environmental changes for Indonesia under different scenarios when compared to the BAU scenario in 2022.

	IJEPA	AFTA	AFTA+IJEPA	AGRI AFTA+IJEPA
Economic Indicators				
Output	+	+	+	+
Export	+	+	+	+
Import	+	+	+	+
Welfare	+	+	+	+
Environmental Indicator				
CO_2	↑	↑	↑	↑
CH_4	↓	↑	↑	↓
N_2O	↑	↓	↓	↓
BOD	↓	↓	↓	↓
COD	↓	↓	↓	↓
SS	↓	↓	↓	↓

Note: + indicates an increase; ↑ indicates a rise in pollution; ↓ indicates a decline in pollution

Table 6.1 provides an overview of the impact of trade liberalization in Indonesia in under the various scenarios when compared to the BAU in 2022. In all the scenarios, tariff reductions lead to an increase in output, export/import and welfare. The impacts of trade liberalization on the environment are however mixed. CO_2 pollution increased in all scenarios when compared to the BAU scenario while the level of water pollutions (BOD, COD and SS) decreased. For CH_4 and N_2O however, trade liberalization a mixed effect depending on the tariff reduction schedules employed.

Further analysis of the various trade liberalization scenarios results indicated that the agreements had only a marginal impact on both Indonesia's economic output. The AFTA had a much greater impact on Indonesia when compared to IJEPA, while their combined impact was smaller. The IJEPA resulted in 0.11% increase in Indonesia's output compared to a 0.47% under the AFTA. Under IJEPA, the sector that saw the largest output increase was the 'other machinery sector' and for AFTA, it was the 'motor vehicle' sector. Combining the two agreements resulted in a 0.54% increase in output. Additional agriculture tariff reductions had little impact on economic output given that the trade in the agriculture sector is not significant. Indonesia was the country that benefited the most from participating in these trade agreements. Similar to other studies, member countries benefited from the agreements while non-member countries experienced a decrease in their economic output. The value of the economic change that resulted from the agreements was not very significant; however, it provided an indication that further trade liberalization would likely have a positive impact on the Indonesia economy. The agreements, nevertheless, did influence the export and import flows among the countries involved. Trade shares among member countries increased as trade shares of non-member countries decreased indicating that trade diversion had occurred. These changes occurred due to both the decrease in exports/imports from non-agreement regions to Indonesia and new exports/imports between agreement regions. The agreements brought welfare gains to Indonesia and increased integration resulted in higher welfare gains.

While there is a clear trend in the economic impact of the trade agreements on Indonesia, their impact on the environment was mixed at most. Among the air pollution indicators, the trade agreements had a negative impact (increase in emissions) on CO_2 and CH_4 emissions in general, while its effect on N_2O emissions was negligible. CO_2

emissions saw the greatest increase when Indonesia adopted both agreements, increasing by 0.46% compared to the BAU case. Separately, the IJEPA and AFTA resulted in a 0.09% and 0.41% increased in CO_2 pollution respectively. The results also indicated that adopting agricultural tariff liberalization resulted in a reduction in CH_4 pollution due to the decrease in output from the paddy sector. On the other hand, the agreements had a positive impact (decrease in emissions) on all water pollution indicators especially COD emissions. COD emission declined by 2.51% when both AFTA and IJEPA is adopted by Indonesia. Including the agricultural sector in trade liberalization reduced the decrease in water pollution as it encourages agriculture production that was the main source of this pollution. Further sectoral analysis of these changes indicated that the bulk of the impact was caused by a few select sectors. In the case of CO_2 emissions, the 'other machinery and equipment' sector saw the largest increase in emission under all trade liberalization scenarios followed by 'other transportation' sector. For the former, emission increased by 3697.12 Gg (6.62%) when both AFTA and IJEPA were adopted and it saw a significant output increase. On the other hand, for the later, a small positive impact of trade liberalization was magnified by a high pollution coefficient. Similarly, the decline in water pollution is dominated by the leather sector that saw its output decrease with trade liberalization. In the case of COD, emission from the leather sector declined by 141,832 tons (3.20%) when Indonesia adopts both AFTA and IJEPA, contributing significantly to the decline in total emission.

In conclusion, it appears that Indonesia's current participation in the two free trade agreements as part of its trade liberalization policy is unlikely to have a large impact economically or environmentally. The reason for this is because the countries involved already have relatively liberal trading relationships. Apart from certain sectors, most of the goods traded between the countries already face low tariffs. As a result, the tariff reductions that are to be adopted do not appear to be significant enough to cause major changes in either output and therefore pollution in Indonesia. However, it is still beneficial for Indonesia to pursue these agreements since their net impacts on output, trade and welfare are positive. Moreover, Indonesia appears to benefit the most by participating in both agreements simultaneously. Last but not least, the assessment of environmental changes due to growth and trade liberalization indicates that they are driven by a few select sectors. Thus, a sector oriented environmental policy aimed at these sectors may help slow down pollution growth in Indonesia in the future, especially given the lack of focus currently in Indonesia's environmental policy. The results of this study are also inline with previous studies on the subject where trade liberalization was only expected to have a small or marginal impact on pollution emissions (Lee and Roland-Holst, 1997; Strutt and Anderson, 2000).

6.2 Limitations and Further Consideration

Based on these results, there are a few areas of further research that could be pursued. In this study, a static CGE was recursively simulated and this approach comes with its limitations, especially in terms of incorporating changes in total factor productivity. A comparative study using a dynamic CGE model could be undertaken to estimate the impacts and to see whether the results differ. This would allow a comparison of both the results and method used to simulate the model. Secondly, the calculation of pollution emissions in this study was done externally after the simulations of the different scenarios and was not internally integrated into the GTAP Framework. This meant that there was no interaction between the increase in pollution and its feedback effect on changes to the economy. This is an interesting area that can be studied in the future. The use of the GTAP-Energy model could address this issue for CO_2 emissions. However, this approach would have to be expanded to the other environment indicators. The study faced problems in obtaining complete and reliable environmental data sets for the different indicators, especially those of the developing countries. Unfortunately, this is an issue that plagues many economic studies in environmental assessment that deal with multi-regional analysis. Research into estimating these coefficients using alternative methodologies would be of interest. Other areas of research for the environmental data would include a procedure to predict the size of the environmental coefficient in the future.

Finally, this study limited itself in analyzing the pollution impact of the agreements without looking into policies that can be adopted to negate them. While the trade liberalization impacts on the environment may only be marginal, projection of the Indonesian economy in the BAU scenario indicated a substantial deterioration in the environmental indicators. Thus, another area of research would be to study the different possible policies that could be used to minimize this environmental impact. This is particularly important for Indonesia since it already is a major contributor of GHGs and does not really have a substantial environmental policy to address this issue. Policies such as pollution taxes, subsidies, tradable permits and regulations could be potentially used to address this issue.

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Appendix 1: Aggregation of 87 the regions into 9 regions

	Old	region		New
No.	Code	Description	No.	Code
1	aus	Australia	8	RestofOECD
2	nzl	New Zealand	8	RestofOECD
3	xoc	Rest of Oceania	7	RestofAsia
4	chn	China	3	China
5	hkg	Hong Kong	7	RestofAsia
6	jpn	Japan	2	Japan
7	kor	Korea	4	Korea
8	twn	Taiwan	7	RestofAsia
9	xea	Rest of East Asia	7	RestofAsia
10	idn	Indonesia	1	Indonesia
11	mys	Malaysia	5	ASEAN
12	phl	Philippines	5	ASEAN
13	sgp	Singapore	5	ASEAN
14	tha	Thailand	5	ASEAN
15	vnm	Vietnam	5	ASEAN
16	xse	Rest of Southeast Asia	5	ASEAN
17	bgd	Bangladesh	7	RestofAsia
18	ind	India	7	RestofAsia
19	lka	Sri Lanka	7	RestofAsia
20	xsa	Rest of South Asia	7	RestofAsia
21	can	Canada	6	NAFTA
22	usa	United States	6	NAFTA
23	mex	Mexico	6	NAFTA
24	xna	Rest of North America	9	ROW
25	col	Colombia	9	ROW
26	per	Peru	9	ROW
27	ven	Venezuela	9	ROW
28	xap	Rest of Andean Pact	9	ROW
29	arg	Argentina	9	ROW

Source: Prepared by the author.

Appendix 1 (continued)

No.	Old Code	region Description	No.	New Code
30	bra	Brazil	9	ROW
31	chl	Chile	9	ROW
32	ury	Uruguay	9	ROW
33	xsm	Rest of South America	9	ROW
34	xca	Central America	9	ROW
35	xfa	Rest of FTAA	9	ROW
36	xcb	Rest of the Caribbean	9	ROW
37	aut	Austria	8	RestofOECD
38	bel	Belgium	8	RestofOECD
39	dnk	Denmark	8	RestofOECD
40	fin	Finland	8	RestofOECD
41	fra	France	8	RestofOECD
42	deu	Germany	8	RestofOECD
43	gbr	United Kingdom	8	RestofOECD
44	grc	Greece	8	RestofOECD
45	irl	Ireland	8	RestofOECD
46	ita	Italy	8	RestofOECD
47	lux	Luxembourg	8	RestofOECD
48	nld	Netherlands	8	RestofOECD
49	prt	Portugal	8	RestofOECD
50	esp	Spain	8	RestofOECD
51	swe	Sweden	8	RestofOECD
52	che	Switzerland	8	RestofOECD
53	xef	Rest of EFTA	9	ROW
54	xer	Rest of Europe	9	ROW
55	alb	Albania	9	ROW
56	bgr	Bulgaria	9	ROW
57	hrv	Croatia	9	ROW
58	cyp	Cyprus	9	ROW

Source: Prepared by the author.

Appendix 1 (continued)

No.	Old Code	region Description	No.	New Code
59	cze	Czech Republic	8	RestofOECD
60	hun	Hungary	8	RestofOECD
61	mlt	Malta	9	ROW
62	pol	Poland	8	RestofOECD
63	rom	Romania	9	ROW
64	svk	Slovakia	8	RestofOECD
65	svn	Slovenia	9	ROW
66	est	Estonia	9	ROW
67	lva	Latvia	9	ROW
68	ltu	Lithuania	9	ROW
69	rus	Russian Federation	9	ROW
70	xsu	Rest of Former Soviet Union	9	ROW
71	tur	Turkey	8	RestofOECD
72	xme	Rest of Middle East	9	ROW
73	mar	Morocco	9	ROW
74	tun	Tunisia	9	ROW
75	xnf	Rest of North Africa	9	ROW
76	bwa	Botswana	9	ROW
77	zaf	South Africa	9	ROW
78	xsc	Rest of South African CU	9	ROW
79	mwi	Malawi	9	ROW
80	moz	Mozambique	9	ROW
81	tza	Tanzania	9	ROW
82	zmb	Zambia	9	ROW
83	zwe	Zimbabwe	9	ROW
84	xsd	Rest of SADC	9	ROW
85	mdg	Madagascar	9	ROW
86	uga	Uganda	9	ROW
87	xss	Rest of Sub-Saharan Africa	9	ROW

Source: Prepared by the author.

Appendix 2: Detailed Sector Description

Number	Code	Description
1	pdr	Paddy Rice: rice, husked and unhusked
2	wht	Wheat: wheat and meslin
3	gro	Other Grains: maize (corn), barley, rye, oats, other cereals
4	v_f	Veg & Fruit: vegetables, fruitvegetables, fruit and nuts, potatoes, cassava, truffles,
5	osd	Oil Seeds: oil seeds and oleaginous fruit; soy beans, copra
6	c_b	Cane & Beet: sugar cane and sugar beet
7	pfb	Plant Fibres: cotton, flax, hemp, sisal and other raw vegetable materials used in textiles
8	ocr	Other Crops: live plants; cut flowers and flower buds; flower seeds and fruit seeds; vegetable seeds, beverage and spice crops, unmanufactured tobacco, cereal straw and husks, unprepared, whether or not chopped, ground, pressed or in the form of pellets; swedes, mangolds, fodder roots, hay, lucerne (alfalfa), clover, sainfoin, forage kale, lupines, vetches and similar forage products, whether or not in the form of pellets, plants and parts of plants used primarily in perfumery, in pharmacy, or for insecticidal, fungicidal or similar purposes, sugar beet seed and seeds of forage plants, other raw vegetable materials
9	ctl	Cattle: cattle, sheep, goats, horses, asses, mules, and hinnies; and semen thereof
10	oap	Other Animal Products: swine, poultry and other live animals; eggs, in shell (fresh or cooked), natural honey, snails (fresh or preserved) except sea snails; frogs' legs, edible products of animal origin n.e.c., hides, skins and furskins, raw , insect waxes and spermaceti, whether or not refined or coloured
11	rmk	Raw milk
12	wol	Wool: wool, silk, and other raw animal materials used in textile
13	frs	Forestry: forestry, logging and related service activities
14	fsh	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing
15	col	Coal: mining and agglomeration of hard coal, lignite and peat
16	oil	Oil: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
17	gas	Gas: extraction of crude petroleum and natural gas (part), service activities incidental to oil and gas extraction excluding surveying (part)
18	omn	Other Mining: mining of metal ores, uranium, gems. other mining and quarrying
19	cmt	Cattle Meat: fresh or chilled meat and edible offal of cattle, sheep, goats, horses, asses, mules, and hinnies. raw fats or grease from any animal or bird.
20	omt	Other Meat: pig meat and offal. preserves and preparations of meat, meat offal or blood, flours, meals and pellets of meat or inedible meat offal; greaves
21	vol	Vegetable Oils: crude and refined oils of soya-bean, maize (corn),olive, sesame, ground-nut, olive, sunflower-seed, safflower, cotton-seed, rape, colza and canola, mustard, coconut palm, palm kernel, castor, tung jojoba, babassu and linseed, perhaps partly or wholly hydrogenated,inter-esterified, re-esterified or elaidinised. Also margarine and similar preparations, animal or vegetable waxes, fats and oils and their fractions, cotton linters, oil-cake and other solid residues resulting from the extraction of vegetable fats or oils; flours and meals of oil seeds or oleaginous fruits, except those of mustard; degras and other residues resulting from the treatment of fatty substances or animal or vegetable waxes.

Source: Center for Global Trade Analysis.

Appendix 2 (continued)

Number	Code	Description
22	mil	Milk: dairy products
23	pcr	Processed Rice: rice, semi- or wholly milled
24	sgr	Sugar
25	ofd	Other Food: prepared and preserved fish or vegetables, fruit juices and vegetable juices, prepared and preserved fruit and nuts, all cereal flours, groats, meal and pellets of wheat, cereal groats, meal and pellets n.e.c., other cereal grain products (including corn flakes), other vegetable flours and meals, mixes and doughs for the preparation of bakers' wares, starches and starch products; sugars and sugar syrups n.e.c., preparations used in animal feeding, bakery products, cocoa, chocolate and sugar confectionery, macaroni, noodles, couscous and similar farinaceous products, food products n.e.c.
26	b_t	Beverages and Tobacco products
27	tex	Textiles: textiles and man-made fibres
28	wap	Wearing Apparel: Clothing, dressing and dyeing of fur
29	lea	Leather: tanning and dressing of leather; luggage, handbags, saddlery, harness and footwear
30	lum	Lumber: wood and products of wood and cork, except furniture; articles of straw and plaiting materials
31	ppp	Paper & Paper Products: includes publishing, printing and reproduction of recorded media
32	p_c	Petroleum & Coke: coke oven products, refined petroleum products, processing of nuclear fuel
33	crp	Chemical Rubber Products: basic chemicals, other chemical products, rubber and plastics products
34	nmm	Non-Metallic Minerals: cement, plaster, lime, gravel, concrete
35	i_s	Iron & Steel: basic production and casting
36	nfm	Non-Ferrous Metals: production and casting of copper, aluminium, zinc, lead, gold, and silver
37	fmp	Fabricated Metal Products: Sheet metal products, but not machinery and equipment
38	mvh	Motor Vehicles: cars, lorries, trailers and semi-trailers
39	otn	Other Transport Equipment: Manufacture of other transport equipment
40	ele	Electronic Equipment: office, accounting and computing machinery, radio, television and communication equipment and apparatus
41	ome	Other Machinery & Equipment: electrical machinery and apparatus n.e.c., medical, precision and optical instruments, watches and clocks
42	omf	Other Manufacturing: includes recycling
43	ely	Electricity: production, collection and distribution
44	gdt	Gas Distribution: distribution of gaseous fuels through mains; steam and hot water supply
45	wtr	Water: collection, purification and distribution
46	cns	Construction: building houses factories offices and roads
47	trd	Trade: all retail sales; wholesale trade and commission trade; hotels and restaurants; repairs of motor vehicles and personal and household goods; retail sale of automotive fuel

Source: Center for Global Trade Analysis.

Appendix 2 (continued)

Number	Code	Description
48	otp	Other Transport: road, rail ; pipelines, auxiliary transport activities; travel agencies
49	wtp	Water transport
50	atp	Air transport
51	cmn	Communications: post and telecommunications
52	ofi	Other Financial Intermediation: includes auxiliary activities but not insurance and pension funding (see next)
53	isr	Insurance: includes pension funding, except compulsory social security
54	obs	Other Business Services: real estate, renting and business activities
55	ros	Recreation & Other Services: recreational, cultural and sporting activities, other service activities; private households with employed persons (servants)
56	osg	Other Services (Government): public administration and defense; compulsory social security, education, health and social work, sewage and refuse disposal, sanitation and similar activities, activities of membership organizations n.e.c., extra-territorial organizations and bodies
57	dwe	Dwellings: ownership of dwellings (imputed rents of houses occupied by owners)

Source: Center for Global Trade Analysis.

Appendix 3: Macroeconomic Growth Variable Estimate (%)

2001-2007	Population[1]	GDP[2]	Unskilled[3]	Skilled[3]	Capital[3]
China	4	48.1	5.4	21.1	66.1
Indonesia	9.226	40.586	19.936	51.8	36.141
Japan	0.2	12.4	1	-2.9	17.4
Korea	3.3	29.7	-6.9	22.6	30.6
ASEAN	8.2	30.9	12.7	36.9	26.1
NAFTA	6.133333	17.36667	9.133333	14.16667	22.53333
R_Asia	7.866667	31.56667	11.2	26.83333	33.8
R_OECD	4.166667	17.1	4.933333	4	21.6
ROW	7.7	21.375	8.05	23.9	20.45
2007-2012					
China	3	33	4.1	20.4	45
Indonesia	5.95	30.17	14.24	37	25.817
Japan	-1	8.4	1.5	-4	13.2
Korea	1.7	23.9	8.4	30.2	24.9
ASEAN	5.7	24.6	9.7	27.9	23.4
NAFTA	4.266667	16.2	9.166667	11.8	17.66667
R_Asia	5.6	25.06667	7.066667	18.73333	27.3
R_OECD	2.3	15.46667	4	1.266667	17.1
ROW	5.825	17.9	7.375	18.275	17.575

Source: 1) United Nations (2006), 2) World Bank (2007), 3) Dimaranan, Ianchovichina and Martin (2007) and Mukhopadhyay and Thomassin (2008).

Appendix 3 (continued)

2012-2017	Population[1]	GDP[2]	Unskilled[3]	Skilled[3]	Capital[3]
China	3	32.5	3.6	20.4	39.4
Indonesia	4.63	31.94	14.24	37	25.82
Japan	-1.5	8	0.7	-4	11.8
Korea	1.1	23.1	11.2	30.2	24.4
ASEAN	5.1	24	9.4	24	23.9
NAFTA	3.833333	16.16667	9.9	10	17.23333
R_Asia	4.9	24.2	6.833333	17.43333	26.23333
R_OECD	1.866667	15.03333	4.466667	-0.06667	16.53333
ROW	5.55	17.75	6.85	15.225	17.525
2017-2022					
China	3	32.5	3.5	16.5	36.3
Indonesia	4.09	31.94	14.24	37	25.82
Japan	-1.5	8	-0.5	-2.5	10.7
Korea	1	23	12.7	26	24
ASEAN	5	24	10	19.5	24
NAFTA	3.833333	16.16667	10.33333	7.9	16.96667
R_Asia	4.833333	24.16667	7	15.23333	25.56667
R_OECD	1.833333	15	4.7	-0.23333	16.06667
ROW	5.575	17.75	7.25	12.5	17.625

Source: 1) United Nations (2006), 2) World Bank (2007), 3) Dimaranan, Ianchovichina and Martin (2007) and Mukhopadhyay and Thomassin (2008).