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# The Impact of Trade Costs in Indonesian Agri-food Sectors: An Interregional CGE Analysis

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# THE IMPACT OF TRADE COSTS IN INDONESIAN AGRI-FOOD SECTORS: AN INTERREGIONAL CGE ANALYSIS

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ABSTRACT

An interregional Computable General Equilibrium (CGE) approach is used to measure the impact of variable internal trade costs have on regional consumer welfare and interregional market integration within the Indonesian economy. Existing high interregional price differences in the agri-food markets suggest the presence of variable internal trade costs, which serve as effective barriers to interregional trade. Given the important role of agri-food markets in both food security and income generation for rural households, these price differences can have significant welfare impacts on both producers and consumers. Reducing the costs of trade between Indonesia's various regions could facilitate interregional trade. Trade costs consist of various components, such as trade and transport margins, which vary in their welfare and distribution effects; as such, reducing each cost component is likely to yield different effects on regional welfare. To assess the extent to which aggregate trade costs may contribute to observed interregional price differences in Indonesia's agri-food markets, an interregional CGE modeling framework is used to separately analyze the individual impacts of trade margin and transport margin on trade flow within the Indonesian Economy.

The interregional SAM-based CGE model (IRSAM) constructed by Resosudarmo et al. (2009) for the Indonesian economy is used in this analysis. IRSAM divides the economic activities for each of Indonesia's five major economic regions into 35 production sectors, 6 labor classifications, 2 types of capital, 2 types of household, local government and companies, and maintains other national accounts. In this analysis, the trade and transportation margins between regions originally imbedded in the trade and transportation sectors of the IRSAM were netted out of these sectors and isolated into separate margin accounts unique to each industry and region.

Three interregional trade flow simulations are performed using the modified CGE model and the simulated output is subsequently evaluated relative to the existing baseline condition. The three simulations individually examine the economic impact of a reduction in trade margin or transport margin on a variety of micro and macroeconomic variables used to estimate policy induced trade flow and welfare impacts in each region. Specifically, the impact of trade costs under three scenarios is considered: (1) reduce trade margin to 50% of its baseline value for all agri-food commodities; (2) reduce transport margin to 50% of its baseline value for all agri-food commodities; and (3) reduce transport margin to 10% of its baseline value for all (not just agri-food) commodities.

Results from these simulations varied depend upon which type of trade costs was adjusted. Reducing trade margin has higher impact to the increase of regional GDP, compared to reducing transport margin. It suggest that reducing trade margin or "soft infrastructure" margin offers the more effective approach to improving economic outcomes across Indonesia's regions. Also, reducing trade margin improved the poverty incidence for residence in all regions; however, the primary beneficiaries of this policy were those live in urban areas.

DEDICATION

I dedicate this work to my parents, Mrs. Yosini Deliana and Mr. M. Rum Ali, and my sister, Ms. Ira Adiyati Rum.

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# CHAPTER ONE

## INTRODUCTION

The Republic of Indonesia is located in the South-East Asian Archipelago. This nation spans over 3,400 miles along the equator, and consists of more than 17,500 islands making it the largest archipelago country in the world. It also is among the world's most populous nations. Indonesia is home to more than 231 million people making it the world's fourth most populous country (BPS, 2009).

Indonesia's economy grew impressively from the 1970's through to the mid-1990's. In the early years of this period, growth was due largely to its strong natural resource endowments of energy reserves and mineral deposits. During the later years, high economic growth rates were achieved through regulatory reform designed, in particular, to stimulate employment in the trade and finance sectors. By the end of this period, Indonesia was recognized as a newly industrialized economy and an emerging market.

All of this, however, was prior to the Asian Financial Crisis (1997-98). During the crisis, Indonesia's economy fell sharply and there was a significant devaluation Indonesia's currency and equity. In 1998, inflation rates reached 77% and the economy contracted by 13.7%. Through intervention of the International Monetary Fund (IMF), and significant economic, structural and governance reforms, price volatility was tempered and growth eventually resumed. Today, Indonesia's economic outlook looks promising. Indonesia's economy is the second largest in Southeast Asia and generally considered to be well-managed. Despite the global economic downturn, Indonesia's economy is predicted to expand at a rate of six percent in 2010 and 2011. This growth is largely attributed to robust domestic consumption and investment, and expanding exports (Rumbaugh and Lipscomb, 2010), and enabled Indonesia to be the only country in the G20 to lower its public debt-to-GDP ratio in 2009.

These positive national outcomes, however, mask considerable regional differences in economic performance. As widely a dispersed nation of islands, not surprisingly, there are numerous and distinct ethnic, linguistic, and religious groups. Further, the trade and colonial settlement patterns across Indonesia's 33 provinces vary considerably. Combined, these factors have resulted in the evolution of relatively disaggregated interregional markets which are supported by infrastructure of variable quality.

These practical realities have a significant impact on Indonesia's food markets. The United Nations classifies Indonesia as a Developing Country (DC). More than 13 percent of Indonesians live below the poverty line and approximately half of all household are near the national poverty line of 22 USD per month (World Bank, 2011). At a national level, in late 2010, "increasing inflation driven by higher and increasingly volatile food prices, posed an increasing challenge to economic policy makers and threatened to push millions of the near-poor below the poverty line" (CIA, 2010).

This problem of high and volatile food prices is exasperated at a regional level where, even during stable economic periods, there are significant differences in the price of agri-food across Indonesia's regions.

At the national level, Indonesia has sufficient food production (Apriyantono, 2009). At a regional level, however, not all regions have the same endowment of agricultural productive capacity. This, combined with variable quality transportation infrastructure, has contributed to regional variations in food prices and, as consequence food consumption. In turn, these high and variable food price differences have contributed to a lumpy distribution of the incidence of both food insecurity and poverty across Indonesia's regions.

The purpose of this study is to examine the extent to which a reduction in Indonesia's trade costs (trade margin and transport margin) can reduce interregional agri-food prices and, in doing so, facilitate improved food security.

## 1.1 Overview of Issues and Concepts

Interregional price differences in Indonesia's agri-food markets suggests the presence of variable internal trade costs, which serve as effective barriers to interregional trade. Given the important role of agri-food markets in both food security and income generation for rural households, these price differences can have a significant welfare impact. Reducing the costs of trade between Indonesia's various regions, could facilitate interregional trade. Trade costs, however, consist of various components, such as trade and transport margins, which vary in their welfare and distribution effects; as such, reducing each cost component is likely to yield different effects on regional welfare. For that reason, to assess the extent to which trade costs may contribute to the interregional price differences seen in agri-food markets, it is useful to separately analyze the impacts of each of these two costs in an interregional model framework.

An interregional Computable General Equilibrium (CGE) framework can be used to measure the impact of trade costs on welfare and interregional market integration. One of the key advantages of this approach is that CGE models treat the economy as a system of many interrelated markets in which the equilibrium outcomes of all endogenous variables are determined simultaneously. By applying an exogenous shock to this system, or changing the model structure, policy changes can be introduced. As such, CGE models can be used to predict the long-run impact of a policy change on an economy.

The basic CGE model framework can be extended in several ways. Of relevance to the current analysis, the standard national economy CGE model can be disaggregated into a regionalized model. In this approach, multiple sub-national economies, which each consist of multiple sectors interconnected through trade, movement of factor production, and government transfers linked. Thus, regional interactions are explicitly modeled, and regional imbalances and inter-regional feedback are captured.

The CGE approach is appropriate for capturing differential impacts of reducing trade costs on each region in Indonesia. Previous work by Kuhn (2005), and Resosudarmo et al. (2009), suggest a promising approach for this analysis. Kuhn (2005) analyzed the impact of trade costs to the Russian agri-food sectors using an interregional Computable General Equilibrium (CGE) model. This model consists of two stylized regions, one with surplus a food supply and one with a deficit food supply. In this model, the Russian national Social Accounting Matrix (SAM) is aggregated into six sectors: agriculture, food industry, energy, raw materials, manufacturing, and services. Kuhn evaluated three alternative scenarios for reducing trade costs: reducing external tariffs, reducing transport costs, and reducing transaction costs. Overall his results suggest that reducing transaction cost of trade is a promising way to achieve a better functioning food market in Russian. Kuhn also found that results differed between these two regions, depending on which trade cost component was reduced.

To evaluate the impact of regionally differentiated trade costs, a regionalized model of Indonesia is required. Resosudarmo et al. (2009) developed an interregional CGE model for Indonesia, called IRSA-Indonesia5. This model consists of thirty-five economics sectors, in each of five regions which comprise the major islands in Indonesia. This model can be used to understand the impact of imposing certain policy changes on various national and regional macro and micro indicators. However, this model cannot be used to analyze the impact of trade costs into the economy since it was not built for this purpose.

Building upon this literature, it is possible to analyze the impact of trade costs on welfare and interregional market integration using an interregional CGE framework. It can be used for policy evaluation purposes and predicting the impact of certain changes to a regional economy. One of the advantages of the interregional CGE model is that it is an economic model that treats the economy as a system of many interrelated markets in which the equilibrium outcomes of all endogenous variables is simultaneously determined. Regional interaction is captured through the interregional CGE framework, by modeling regional imbalances and feedback effects from other regions.

## 1.2 Research Objectives

The goal of this study is to quantify the impact of trade costs on the Indonesian regional economy. Significant differences exist in purchaser prices across the regions and between agricultural surplus and deficit regions regarding food supply. This is often indicative of high regional trade costs. The analysis utilizes the IRSA-Indonesia5 interregional CGE model developed by Resosudarmo et al. (2009). This model divides Indonesia into five representative regions reflected within an interregional Social Accounting Matrix (SAM). The model is modified in this analysis to explicitly examine the impact of trade costs differentials on regional welfare.

Simulations are carried out to quantify the impact of different trade cost components on Indonesian agri-food markets. The trade cost components –transports and trade margins on agri-food trade are simulated in the model. The simulations are comparative-static experiments since we only use the economy condition at 2005.

The first simulation decreases the trade margin from distribution activities of agri-food commodities. The second simulation reduces transport margin for the shipment of agri-food commodities. The third simulation reduces transport margin for the shipment of all commodities.

## 1.3 Organization of Thesis

The remainder of this study is organized as follows. Chapter Two further describes the Indonesian economy, discusses food security and poverty issues, and provides an overview of the relevant interregional CGE literature. Chapter Three describes the data and required model modification for this study. Chapter Four presents the results of the baseline analysis and outcomes for several simulations used to estimate the impact of various approaches to reducing trade and transport margins. Finally, Chapter Five reviews the analysis. Draws general conclusions and provides suggestions for future research.

# CHAPTER TWO

# LITERATURE REVIEWS

## 2.1 Introduction to Indonesia

Indonesia is located in Southeast Asia. It extends over 3,400 miles along the equator and consists of more than 17,500 islands, which make it the largest archipelago country in the world. The major islands are Java, Sumatra, Kalimantan, Sulawesi, and Papua. The country shares land borders with Malaysia on Borneo, Papua New Guines on the island of New Guinea, and East Timor on the island of Timor. It shares maritime borders across Singapore, Malaysia, and Philippines to the north, and with Australia to the south. The nation's capital city, Jakarta lies in the lowland of West Java and is the nation's largest city, followed by Surabaya, Medan, Balikpapan, and Makassar.

Indonesia consists of 1,901,931 square kilometers, which make it the 16$^{th}$ largest country in the world (BPS, 2009). The edges of the Pacific, Eurasian, and Australian tectonic plates reside below Indonesia and are responsible for numerous volcanoes and earthquakes. A benefit of volcanic activity is high soil fertility especially in Java-Bali region. Similar to many tropical countries, Indonesia has only two seasons, wet and dry. The highest precipitation level is roughly 2000-4500 mm in the western parts of Sumatra, Java, Kalimantan, Sulawesi and Papua. Humidity is generally high around 80% and the mean daily temperature range for Jakarta is 79-86 F.

In 2009, the national population was around 231 million people (BPS, 2009), making Indonesia the 4th most populous country in the world after China, India, and the United States. The national average population density is 122 individuals per square kilometer. Java-Bali, represents only 6% of its total national land area, but has a population density of 725 individuals per square kilometer, the greatest density in Indonesia (BPS, 2009). In contrast, Papua-West Papua, represents 26% of the total national land area, but has a population density less than 30 people per square kilometer. The majority of the people live in the islands of Java and Bali. The high population density on these islands is central to Indonesia's population problems.

Indonesia consists of 33 provinces, including five provinces with special status. Each province has its own legislature and governor, and it is subdivided into districts, and sub-districts. Sumatra consists of 10 provinces, Java-Bali consists of 9 provinces, Kalimantan consists of 4 provinces, Sulawesi consists of 6 provinces, Papua and Maluku (later called Eastern Indonesia) consists of 4 provinces. In 2001, Indonesia shifted from a highly centralistic government system to a highly decentralized one. Greater authority was delegated to the 33 provinces and 400 plus districts, in the areas of education, agriculture, industry, trade and investment, and infrastructure. The central government continues to be responsible for security, foreign relations, monetary and fiscal policies. The five special provinces (DKI Jakarta, Aceh, DI Jogyakarta, Papua, and West Papua) have greater legislative privilege and more autonomy from the central government than other provinces. Appendix A explains the classification of these provinces.

### 2.1.1 Economy of Indonesia

The Indonesia economy is the largest in Southeast Asia. The World Indicator Database (World Bank, 2010) lists the Indonesia Gross Domestic Product based on PPP calculations in 2010 was 1,027,427 Million USD; the 15th largest economy in the world, and the largest in Southeast Asia. It is one of the emerging markets in the world and Indonesia becomes part of the G-20 major economies, the only representative from Southeast Asia. The Indonesian economy is strongly impacted by its government. More than 150 state-owned enterprises are run by the government. The price of many basic products, such as agri-food, electricity and fuel, are controlled.

Indonesia's economy has rapidly grown over the last thirty years. Per capita GDP increased from 600 USD in 1980 to almost 3000 USD in 2010. Domestic consumption is a driving force behind the country's economic growth which is the most rapid in Southeast Asia. Table 2.1 outlines the GDP growth rate by sectors during 2006-2009. It shows that Indonesia GDP has grown in real terms across all sectors. The communication sector experienced the highest growth from 26.03% in 2006 to 28.51% in 2008, and heavily contributed to total economic growth in these years.

Figure 2.1 illustrated the unemployment rate from 1984 to 2010 (IMF, 2010). Beginning in 2005, after the new government was elected in 2004, the unemployment rate turns downward. Despite the overall reduction in the national unemployment rate, disparities in unemployment remain high between regions (BPS, 2009). In 2008, the highest unemployment rate was in West Java at 24%, followed by Central Java and East

Java, both at 13%, and the lowest unemployment rate was in West Sulawesi, at less than 1%.

**Table 2.1** Growth Rate of GDP at 2000 Constant Market Prices by Sector (adapted from BPS 2009)

| | Growth Rate of GDP at 2000 Constant Price (%) | | | |
|---|---|---|---|---|
| Industrial Sectors | 2006 | 2007 | 2008 | 2009 |
| Agriculture, Livestock, Forestry, Fishery | 3.36 | 3.43 | 4.77 | 3.75 |
| Mining and Quarrying | 1.70 | 2.02 | 0.51 | 2.41 |
| Manufacturing Industry | 4.59 | 4.67 | 3.66 | 1.50 |
| Electricity, Gas, and Water | 5.76 | 10.33 | 10.92 | 13.45 |
| Construction | 8.34 | 8.61 | 7.31 | 6.34 |
| Trade, Hotel, and Restaurant | 6.42 | 8.41 | 7.23 | 0.21 |
| Transportation | 6.61 | 2.82 | 2.71 | 4.42 |
| Communication | 26.03 | 28.74 | 31.32 | 28.51 |
| Financing, Real Estate, and Services | 6.16 | 6.60 | 6.45 | 7.10 |
| GDP | 5.50 | 6.28 | 6.06 | 4.21 |

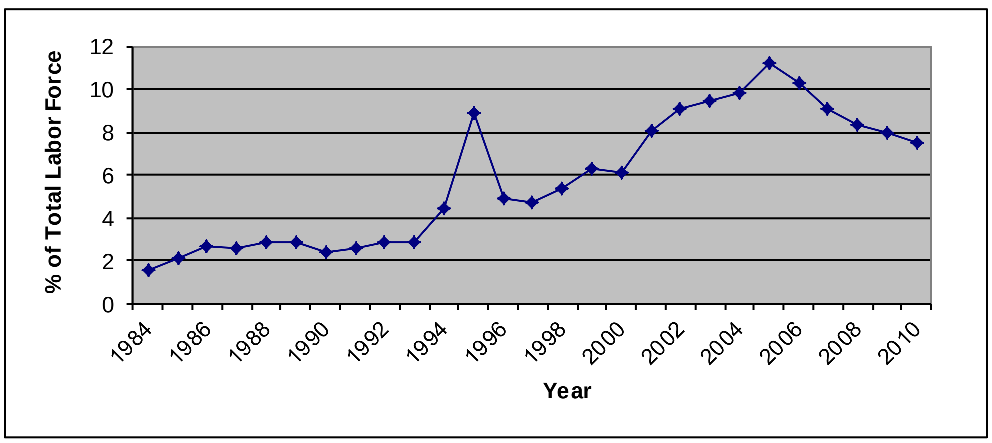


**Figure 2.1** Unemployment Rate from 1984 to 2010 (adapted from IMF 2010)

**Table 2.2** Employment by Region and Main Industry in 2008 (adapted from BPS 2009)

| | Region | | | | |
|---|---|---|---|---|---|
| Main Industry | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern |
| Agriculture, Forestry, Fisheries | 9,483,765 | 22,585,369 | 3,125,107 | 3,676,967 | 1,460,498 |
| Mining | 270,294 | 509,216 | 195,139 | 58,205 | 37,686 |
| Manufacturing Industry | 1,483,091 | 5,471,891 | 317,369 | 382,819 | 69,638 |
| Electricity, Gas, and Water | 41,981 | 123,702 | 12,534 | 15,992 | 6,905 |
| Construction | 1,037,879 | 3,378,235 | 269,603 | 329,334 | 69,893 |
| Wholesale Trade, Retail Trade, Restaurant and Hotel | 3,682,243 | 14,204,811 | 1,023,753 | 1,148,020 | 182,490 |
| Transportation, Storage, Communication | 1,162,294 | 3,889,173 | 274,678 | 423,817 | 117,122 |
| Financing, Insurance, Real Estate, and Business Services | 165,047 | 1,244,128 | 53,299 | 66,960 | 15,387 |
| Public Services | 2,499,536 | 8,791,594 | 681,209 | 879,454 | 248,024 |
| **Total** | 19,826,130 | 60,198,119 | 5,952,691 | 6,981,568 | 2,207,643 |

According to BPS(2009), people in all regions mainly work in the agriculture sector, which includes forestry and fishery, and account for 42 percent of the total employment. Most individuals in Java-Bali work in the agriculture, forestry and fishery sectors. Sumatra and Java-Bali have a higher concentration of economic activities than Kalimantan, Sulawesi and Eastern Indonesia. It makes Sumatra and Java-Bali the destination work center. Wholesale trade and retail trade also play an important role in providing employment.

BPS defines poor people as a person whose per capita expenditure on food per month is below the poverty line. The food poverty line refers to the daily minimum requirement of 2,200 kcal per capita per day. Figure 2.2 shows the percentage trend for poor people between 1996-2009. Considerable fluctuation exists over time, but the percentage of rural poor is always greater than urban poor. The effect of financial crisis is reflected by the two highest percentages in 1998 and 1999. In the late 2005, Indonesia faced a small crisis due to world oil price and imports, makes the trend turns upward in

2006. Starting 2006, the percentage of poor people indicated a decrease, especially poor people who live in rural area. We can also see that the wealth disparity indicated to have smaller gap between rural and urban area.

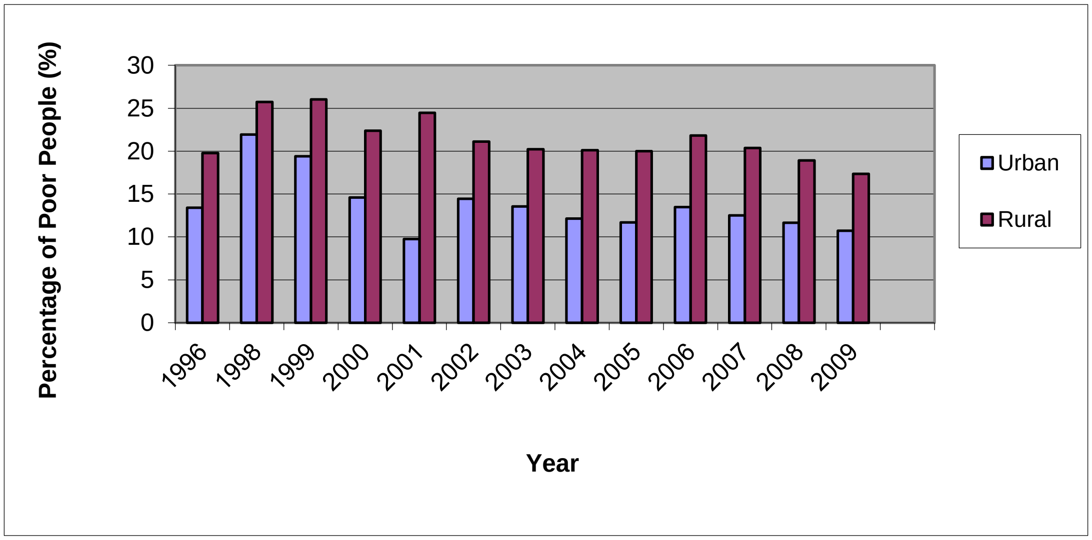


**Figure 2.2** Percentage of Poor in Rural and Urban Areas in Indonesia (adapted from BPS 2009; data reflect 1996 to 2009)

**Table 2.3** Value of Export and Import by Commodity Group (adapted BPS 2009)

| | Exports (Million USD) | | | Imports (Million USD) | | |
|---|---|---|---|---|---|---|
| Commodity Group | 2006 | 2007 | 2008 | 2006 | 2007 | 2008 |
| Food and Live Animal | 5,124 | 5,880 | 7,916 | 4,708 | 6,883 | 7,920 |
| Beverage and Tobacco | 359 | 448 | 550 | 232 | 330 | 478 |
| Raw Materials | 13,059 | 14,988 | 14,844 | 3,619 | 4,468 | 7,381 |
| Mineral Fuels, and Lubricants | 27,619 | 29,210 | 39,779 | 19,026 | 21,994 | 30,651 |
| Animal and Vegetable Oils | 6,191 | 9,999 | 15,062 | 76 | 83 | 127 |
| Chemicals | 5,134 | 6,738 | 7,453 | 8,732 | 10,064 | 15,988 |
| Manufactured Goods | 17,190 | 18,912 | 20,463 | 7,699 | 9,611 | 20,158 |
| Machinery and Transport Equipment | 14,120 | 15,226 | 17,342 | 15,371 | 19,038 | 42,725 |
| Miscellaneous Manufactured Articles | 11,453 | 12,001 | 12,767 | 1,593 | 1,990 | 3,728 |
| Others | 547 | 695 | 839 | 4 | 8 | 36 |
| Total | 100,798 | 114,100 | 137,020 | 61,065 | 74,473 | 129,197 |

The national value of exports and imports for 2006 to 2008 is reported in Table 2.3. For this period, the value of imports and exports has increased. Thus, Indonesia now more strongly linked to international trade than before. The major export commodities are mineral fuel and lubricants and the dominant import commodities are machinery and transport equipment, and mineral fuel and lubricants. In 2008, Indonesia exports mineral fuel and manufactured goods at the value of 39,799 million USD and 20,463 million USD, respectively. In the same year, Indonesia imported mineral fuel and machinery and transport equipment at the value of respectively, 30,651 million USD and 42,725 million USD.

### 2.1.2 Indonesia by Regions

As previously discussed, we classify Indonesia into five regions: Sumatra, Java-Bali, Kalimantan, Sulawesi, and Eastern Indonesia, as shown in Appendix B. According to Indonesia’s regional outlook in 2007 (BPS, 2008), Java-Bali has the highest Regional Gross Domestic Product (RGDP) of 2,015 Trillion Rupiah compared to Eastern Indonesia which has RGDP of 112.3 Trillion Rupiah, less than five percent of Java-Bali. It shows that there is disparity economic activity across regions. Eastern Indonesia is less develops than Western Indonesia, especially compare to Java-Bali. However, RGDP per capita in Eastern Indonesia is greater than Java-Bali due to the difference of population density. In 2007, Kalimantan has the lowest percentage of poor people, about 10.31% compare to Eastern Indonesia with 28.10% of poor people, the poorest region in Indonesia. More detail can be found in Table 2.4.

**Table 2.4** Indonesia's Regional Outlook (adapted from BPS 2008, 2009)

| Region | Regional Outlook in 2007 | | | | Population Density (people per sq. km) | |
|---|---|---|---|---|---|---|
| | GRDP (in Trillion Rupiah) | GRDP per capita (in Thousand Rupiah) | Growth of GRDP per capita | Percentage of poor people | 2005 | 2009 |
| Sumatra | 742,02 | 17,979 | 2,8 | 18,51 | 1,071 | 1,154 |
| Java-Bali | 2,015,62 | 16,050 | 4,1 | 16,52 | 16,905 | 17,586 |
| Kalimantan | 321,94 | 25,494 | 2,8 | 10,31 | 147 | 156 |
| Sulawesi | 132,28 | 9,241 | 4,7 | 16,11 | 539 | 569 |
| Eastern Indo | 112,37 | 10,210 | 4,8 | 28,10 | 62 | 67 |

Java-Bali has 16,905 people per sq. km in 2005, a huge different compare to Eastern Indonesia which only have 62 people per sq. km. Then in 2009, the population density for Java-Bali moves to 17,586 people per sq. km, or increases 681 people per sq. km, compare to Eastern Indonesia, which only moves to 67 people per sq. km, or increase 2 people per sq. km. It indicates that overtime more people live or move to Java-Bali.

Also, from this table we can see that there is unbalance development between regions within the country. Facing with this trend, the governments need to continue to improve regional development to reduce poverty and ensure an adequate standard of living for the population in all regions. Development of transportation and trade linkages between regions are also needed since it will allow industries to improve their comparative advantages. Disparities between regions need to be reduced as they can affect to the stability of the nation.

Resosudarmo, et. al (2007) analyzed the inter-regional trade linkages by using the simple regional input-output table. It shows that most of the region needs can be fulfilled by their own region. However, geographical proximity seems to affect the level of trade between the regions.

**Table 2.5** 2005 Aggregated Interregional Input-Output in Trillion Rupiah (reproduced from Resosudarmo et al. 2007)

| Input \ Output | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Indo | Final Demand | Output |
|---|---|---|---|---|---|---|---|
| Sumatra | 374.72 | 111.00 | 14.18 | 0.07 | 0.11 | 556.47 | 1057.18 |
| Java-Bali | 66.89 | 1191.71 | 16.74 | 16.21 | 11.30 | 1930.30 | 3233.14 |
| Kalimantan | 8.20 | 74.37 | 143.88 | 5.47 | 1.23 | 213.24 | 446.40 |
| Sulawesi | 0.66 | 10.49 | 0.84 | 60.67 | 2.20 | 117.98 | 192.83 |
| Eastern Indonesia | 0.45 | 25.68 | 0.19 | 0.68 | 36.07 | 91.32 | 154.40 |
| Import | 26.61 | 214.30 | 11.18 | 2.02 | 4.47 | 175.37 | 433.95 |
| Value Added | 579.65 | 1605.60 | 258.75 | 107.71 | 99.02 | | |

Java-Bali is the biggest trading partner to all regions, followed by Sumatra, the second largest regional economy. Kalimantan seems to have no strong trade partner since Java-Bali and Sumatra only contribute small values of trade to Kalimantan. Sulawesi and Eastern Indonesia need to be supplied by Java-Bali to fulfill their needs. However, Eastern Indonesia has higher trade linkages with world import, around 4.47 Trillion Rupiah, compare to interregional trade Sumatra as the closest region, i.e. 2.2 Trillion Rupiah. This shows that Indonesian market is not well integrated due to an in balance developments in transportation and trade linkages within the country.

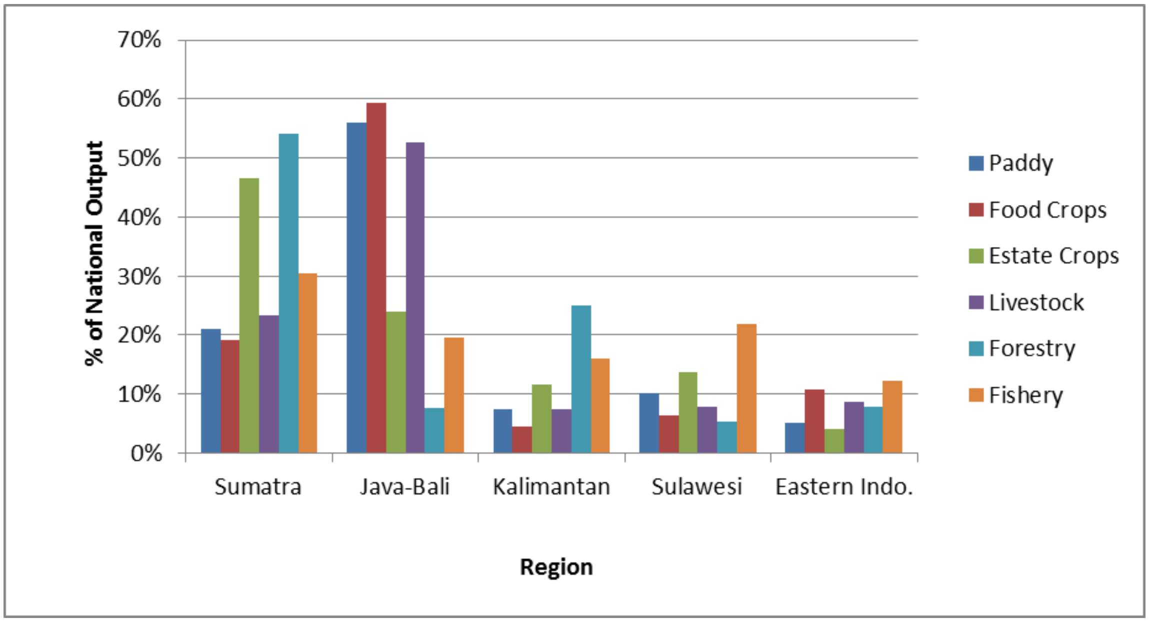


**Figure 2.3** Sectoral Output (adapted from IRSAM 2005)

More specific, we can see the characteristic of within each regional economy in agri-food sectors by using the representation of sectoral output and sectoral input from interregional SAM. Sectoral output is presented in term of national output sector and sectoral input is presented in term of national value added. For agri-food sectors, we broke down into 6 sectors: paddy, food crops, estate crops, livestock, forestry, and fishery. Food crops include beans, maize, root crops and vegetable and fruits sectors. Estate crops include rubber, sugarcane, coconut, oil palm, tobacco, coffee, tea, clove, fibber crops sectors.

Figure 2.3 show that Java-Bali produces higher output for all agri-food sectors, except for estate crops, forestry and fishery sectors. Sumatra has the highest estate crops production because it is the center for palm oil plantations. Sumatra has the second highest output for all agri-food sectors. Collectively Java-Bali and Sumatra account for over 88% of the national agri-food sectors. The other regions are dependent on their regional production. Moreover, Java-Bali and Sumatra have the lowest purchaser prices compared to other regions.

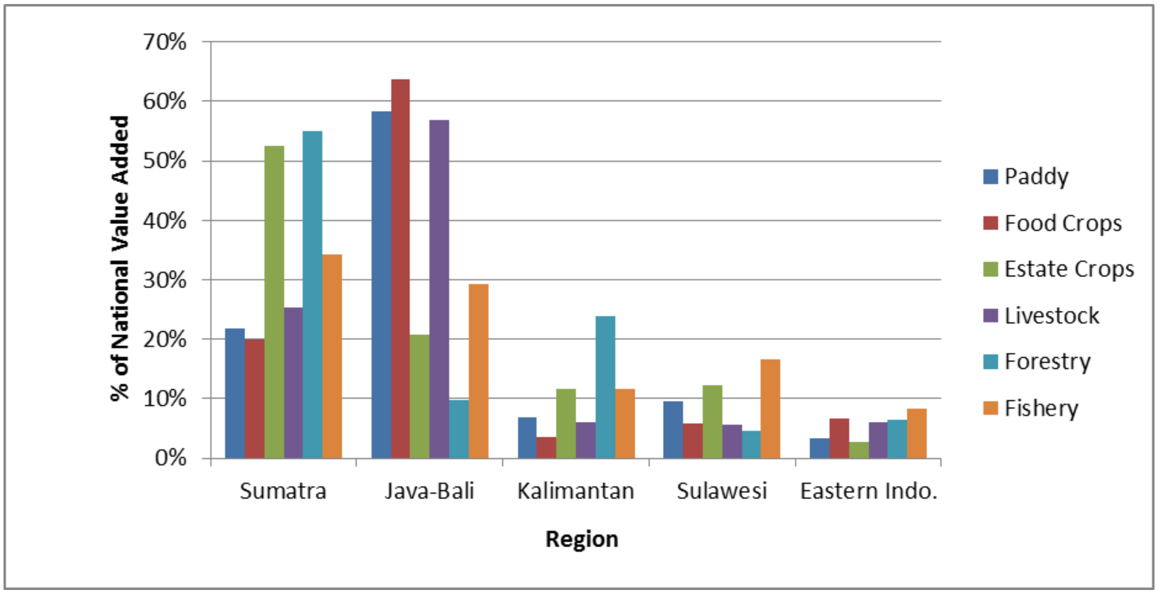


**Figure 2.4** Sectoral Input (adapted from IRSAM 2005)

Figure 2.4 show that Java-Bali is the most intensive user of the national's capital and labor stock. Food crop sector uses most of these inputs followed by paddy and livestock in agri-food sectors. Sumatra used more inputs on capital and labors in estate crops sector than in other agri-food sectors. Kalimantan uses more in capital and labor in estate crops followed by forestry sector. It is relevant since this region has the second largest output for forestry sector, after Sumatra. Sulawesi use more capital and labor in estate crops and fishery sectors, compare to forestry and livestock sectors. Eastern Indonesia uses more capital and labor in food crops and fishery sectors.

From the two figures above, Java-Bali produces the largest amount of output as also uses the largest capital and labor. In contrast, Kalimantan, Sulawesi and Eastern Indonesia produces the least amount of output as also uses the least amount of output and also used the least capital and labor. This sectoral and input reflects substantial differences in economic well-being of people across the regions.

**Table 2.6** Transportation by Road, Rail and Water in 2007 (adapted from BPS 2009)

| | Road | Rail | Cargo on Port | |
|---|---|---|---|---|
| Regions | Total Length (km) | Loaded (1000 ton) | Unloaded (1000 ton) | Loaded (1000 ton) |
| Sumatra | 141,553 | 13,155 | 37,642 | 47,104 |
| Java-Bali | 142,091 | 17,273 | 70,525 | 73,836 |
| Kalimantan | 44,348 | - | 62,369 | 68,305 |
| Sulawesi | 70,464 | - | 7,455 | 7,825 |
| Eastern Indonesia | 20,680 | - | 3,805 | 849 |
| Total | 419,136 | 30,428 | 181,796 | 197,920 |

Now we want try to see the quality of infrastructure in each region using the available indicators and how it relates to the results from previous description. Table 2.6 outlined the condition of road, rail, and port in each region. The total length of roads for both Sumatra and Java-Bali is 141,553 km and 142,092 km, respectively. These regions have the highest length of road compare to other regions. They have railway transportation to support interregional trade, where Sumatra produced amount of ton loaded 13,155 thousand tons and Java-Bali produced amount of ton loaded 17,273 thousand tons. There is no railway transportation in other regions as comparison. They also have used water transportation since amount of ton loaded and unload in Sumatra and Java-Bali indicates large of freight, around 30-40 million tons and 70-75 million tons respectively. These transportation infrastructures become one of the factors these regions become the major economies in the country.

Kalimantan is known as a region that uses more water transportation to support their interregional trade. It can be shown from the capacity of unloaded and loaded cargo on port in Kalimantan reached 62,369 hundred ton and 68,305 hundred ton, respectively. The total length of roads in Kalimantan only 44,348 km, one third from what is in Java-Bali. This level is not an appropriate for their infrastructure considering that the total area of Kalimantan is four times larger than Java-Bali.

Sulawesi primarily uses road transportation because their total length of road is greater than for Kalimantan, and their water-based shipping is less. Eastern Indonesia used water transportation as their main transportation. Compared to other regions, this region has the minimum transportation infrastructure. It has only 20,680 km of road, one-seventh the road that Java-Bali has. An additional limitation is the small amount of ton that is loaded and unloaded at the port.

### 2.1.3 Characteristics of Trade

Interregional trade flows can be obtained from the previously introduced Table 2.5, the interregional I-O table. The I-O table captures the imbalanced value of trade among regions due to the poorly integrated regional markets. Trade imbalances in each region can be captured by the price differences for the same bundle of goods. To illustrate, consider the differences in cost for a 20-item food basket across regions as shown in Table 2.7. Note the wide variety of price differences for the same food basket for the 33 provinces reported in Table 2.7.

**Table 2.7** Cost of 20-item food basket in each province in Rupiah/Kg –sorted (produced from BPS, 2009)

| Province | Region | Cost of 20-item food basket | Province | Region | Cost of 20-item food basket |
|---|---|---|---|---|---|
| East Java | Java-Bali | 137,784 | Gorontalo | Sulawesi | 183,777 |
| Central Java | Java-Bali | 139,372 | West Sumatera | Sumatera | 184,033 |
| D.I. Yogyakarta | Java-Bali | 139,867 | South Kalimantan | Kalimantan | 189,366 |
| Bali | Java-Bali | 142,151 | East Nusa Tenggara | Java-Bali | 191,658 |
| South Sulawesi | Sulawesi | 156,969 | Nanggroe Aceh Darussalam | Sumatera | 194,603 |
| West Java | Java-Bali | 157,874 | Jambi | Sumatera | 200,100 |
| Lampung | Sumatera | 161,434 | Central Kalimantan | Kalimantan | 212,554 |
| Banten | Java-Bali | 162,880 | West Kalimantan | Kalimantan | 217,519 |
| Bengkulu | Sumatera | 166,177 | East Kalimantan | Kalimantan | 218,294 |
| Central Sulawesi | Sulawesi | 166,518 | Bangka Belitung Islands | Sumatera | 220,812 |
| West Nusa Tenggara | Java-Bali | 168,831 | Riau | Sumatera | 227,734 |
| South Sumatera | Sumatera | 173,732 | Riau Islands | Sumatera | 228,605 |
| North Sulawesi | Sulawesi | 175,562 | Papua | Eastern Indo | 266,328 |
| South East Sulawesi | Sulawesi | 176,557 | North Maluku | Eastern Indo | 281,994 |
| West Sulawesi | Sulawesi | 178,276 | Maluku | Eastern Indo | 293,088 |
| North Sumatra | Sumatera | 183,315 | West Papua | Eastern Indo | 305,322 |
| | | | National | | 193,979 |

Although, some provinces in one region spread across the range, we see that provinces in Java-Bali are concentrated in the lower cost level. In contrast, provinces in Eastern Indonesia tend to be grouped in the higher cost level. The interregional price differences indicate the presence of large trade costs, which restrict interregional trade opportunities.

The increase in food basket costs from the lowest cost province, East Java, to the highest cost province, West Papua, is 221%. Provinces in the Java-Bali region generally have the lowest costs, and the provinces in Sumatra exhibit the most variation in food basket cost. Kalimantan costs reside in the middle cost range and all have lower cost than any province in Eastern Indonesia. Although Sulawesi also has diverse price differences, it has no province that resides in either end of the cost range. Provinces in Eastern Indonesia have the highest costs. We predict that these high price differences in Indonesia are related to the deficiency of transportation and trade linkages.

Related to our findings about the characteristics of trade in Indonesia above, Anderson and van Wincoop (2004) found that trade costs negatively impact the volume of trade. High trade costs reduce trade volume since it will increase purchaser price. They emphasize the important of reducing trade costs particularly in transportation and other infrastructure services in general to promote and expand regional trade markets.

De (2006) noted that trade costs consists of all costs incurred in getting a good to the final user other than the marginal cost of producing the good itself, i.e. transportation costs, contract enforcement costs, and local distribution costs (wholesale and retail). In this study, we limit trade costs to transport costs (as part of the transport margin) and local distribution costs (as part of the trade margin).

As an illustration, for corn commodity, one of the items bundled in Table 2.7, the national average producer price is 4,747 Rupiah, while its consumer price is 6,761 Rupiah. So the cost of transportation, marketing, wholesaling and retailing represent an ad-valorem tax equivalent of 42.42 percent. Thus almost half of the purchaser price comes from trade costs, not from the marginal costs to produce this commodity. Hence, there is a clear need to analyze the trade costs, because reducing trade cost will increase social welfare and increase interregional trade.

## 2.2 Food security and Poverty

Food and Agriculture Organization (FAO) defined food security as a condition when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life (FAO, 1996). Physical and economic access to food is included into the concept of food security. In developing countries, initiatives that improve food security are highly valued economic development programs. FAO classifies food security into three dimensions: (1) availability of quantities of food in appropriate quality, and supplied through domestic production and imports, (2) accessibility of households and individuals to appropriate foods for a nutritious diet, and (3) affordability to individuals to consume food according to their respective socio-economic conditions and preferences.

Food security is a compound development issue; it is linked not only to health and malnutrition, but also to sustainable economic development, the environment, and trade. FAO described that the world agriculture produces 17 percent more calories per person today than before, means that there are sufficient food in the world to feed everyone adequately (FAO, 2002). Accessibility and affordability to consume enough food are still become the problems for many people in the world. Issues such as whether households receive access to food, how it is distributed within the country and whether that food is affordable, show that food security is clearly linked to trade and transportation.

Interregional trade within the country and international trade within the region can improve food security. Food gaps in some regions in the country can be filled through better interregional trade, especially in agricultural trade. As the trade efficiency increases, trade volume will increase and the purchaser price will decrease. Increased trade efficiency can be attained by reducing trade costs barriers.

Developing countries in Asia have focused on reducing international and interregional trade costs to increase their trade competitiveness in world market. Reducing trade costs has contributed to greater regional growth, market integration, and poverty alleviation (Duval & Utoktham, 2010).

In the 2010 Human Development Report, the United Nations Development Program (UNDP, 2010), Human Development Index (HDI) ranked Indonesia 108$^{th}$ among 169 countries. This composite index quantifies health care, education, and living standards; into a single statistic which can be used to reference social and economic development. This composite index incorporates measures on life expectancy at birth, mean years of schooling, expected year of schooling, and gross national income per capita to reflect human development.

As a developing country, Indonesia still faces problems in poverty, food security and malnutrition with disparities between provinces and districts. However, Indonesia has maintained its commitment to achieve the Millennium Development Goals (MDGs), which include decreasing by half the number of people living below 1 USD per day (PPP value), and people suffering from hunger by the year 2015. To determine whether a region is producing enough food for its people, availability and consumption per capita is needed. The Indonesian Ministry of Agriculture (MoA) has determined Indonesia has an agri-food production surplus when the per-capita availability of calories and protein is more than 2200 kcal and 57.00 grams, respectively (Suryana, 2008).

At national level, Indonesia is self-sufficient in per capita food consumption, with 2014.91 kcal and 57.66 protein grams. However, not all regions consume above the recommended level. From table 2.8, it is seem that two regions are deficit in food consumption: Java-Bali and Eastern Indonesia, and the rest of the regions are consuming the recommended consumption level.

**Table 2.8** Per Capita Food Availability and Consumption in 2007 (adapted from BPS 2008, Suryana 2008)

| Availability of per Capita Calories and Protein | | |
|---|---|---|
| | Calorie (kcal) | Protein (grams) |
| Total Availability | 3166 | 76.49 |
| Recommended | 2200 | 57.00 |
| Consumption per Capita Calorie and Protein | | |
| Region | Calorie (kcal) | Protein (grams) |
| Sumatra | 2099.32 | 58.36 |
| Java-Bali | 1998.91 | 57.92 |
| Kalimantan | 2071.16 | 59.29 |
| Sulawesi | 2046.87 | 55.78 |
| Eastern Indonesia | 1919.50 | 48.23 |
| Total Consumption | 2014.91 | 57.66 |
| Recommended | 2000.00 | 52.00 |

The ability of a household to obtain an adequate amount of food depends on household purchasing power. Households that do not have sustainable and adequate livelihoods have inadequate purchasing power and are vulnerable to food insecurity. If the proportion of poor people living in a region is high then the access to food decrease and food security is reduced.

The Indonesian government has made substantial efforts to reduce poverty in the country. BPS(2009) reported that during 1998-2009, the number of poor people in Indonesia decreased from 24.46 percent in 1998 to 14.15 percent. In 2009, the majority of the poor (64 percent) lived in rural areas and also almost 64% of the poor were concentrated in the Java-Bali region. Papua and West Papua (Eastern Indonesia) have the highest proportion of its population classified as poor, respectively 37.53 and 35.71 percent.

High poverty rate exist in Eastern Indonesia because most of the areas is not suitable for high yield crop production and their transportation infrastructure access is still underdeveloped. These twin issues have created significant areas of localized poverty. With geographical difficulties and poor market linkages, this region will experience lower economic opportunities and government development programs. Developing infrastructure, particularly seaport and airport transportation can help this region create more economy activities. The lack of transportation infrastructure results in high in trade and transportation costs.

### 2.2.1 Trade Costs related to Poverty

Trade costs which include transport margin (transportation costs) and trade margin (transaction costs and distribution costs), act as a barrier to interregional trade. In developing countries, besides cutting the benefit from trade, high trade costs also contribute to poverty. High trade costs prevent poor people from consuming primary commodities, such as agri-food commodities. As the price of agri-food commodities drop, household purchasing power will raise due to trade costs reduction, especially for rural household.

Related to interregional market in Indonesia, higher trade costs can inhibit interregional trade and reduce the potential volume of trade. Trade costs are higher in Indonesia because of the low quality of hard infrastructures such as seaports, airports, railways, road networks, and also low quality of soft infrastructures such as trade policies, procedures, and institution. Trade cost can be reduced by increasing the quality of hard and soft infrastructures. Infrastructure development enhances market efficiency since the marketing costs are reduced. Government policies are needed to encourage the appropriate level of infrastructure development, since it is generally cost prohibitive for private companies to undertake the needed investment.

Duval and Utoktham (2010) studied the interregional trade costs in Asia. They found that trade costs within Asia are high. Their results confirm the lack of economic and trade integration between Asian regions. They also found that Asian countries as a group may be more focused on reducing trade costs with developed countries and trading blocs outside rather than inside Asian regions. The highest interregional trade costs in Asia were found for North and Central Asia, followed by South Asia. Southeast Asia (including Indonesia) is found to have lower intra-subregional trade costs compare to other Asian subregions. They showed that interregional trade costs are consistently much higher than intra-subregional costs. This is consistent with the nature of trade costs that are a function of geographic distances.

Anderson and van Wincoop (2004) distinguished two major categories of trade costs: (1) costs imposed by government policy (such as tariff and quotas), and (2) costs imposed by the marketing environment (such as transportation, transaction, distribution, and the like). This study concentrates on the costs imposed by the marketing environment.

In their paper, they explained the reasons why trade costs are important. They mentioned that trade costs have a large magnitude. It is relevant to our calculation of trade costs in one example in Section 2.1.3 that it reaches to 42.42 percent as a representative ad valorem tax estimate. They note that trade costs are strongly linked to economic policy. They argue that direct policy instruments (such as tariff, quotas, and the like) are less important than indirect policy instruments (such as transport infrastructure investment, law enforcement, and related property right institutions, informational institutions, and regulations) in reducing trade costs. They also mention that trade costs are related to economic geography. Since Indonesia is an archipelago country, it is likely country faces high trade costs.

From the 2005 Indonesian Input Output Table by BPS(2005), trade cost is defined as the differences between transaction values at the consumer or purchaser level and those at the producers' level. The trade costs consist of the value of trade and transport margins. Trade margin is the profit accrued to wholesaler and retailers and transport margin is the costs which arise during the distributing of goods from producers to final consumers.

The goal of this study is to quantify the impact of trade costs on the Indonesia economy. Since there seem to be remarkable price differences between agri-food surplus and deficit regions regarding food availability and accessibility, we adopt a CGE framework that that takes regional aspects into account by dividing Indonesia into five representative regions. The CGE approach allows the measurement of welfare changes and interregional integration under alternative trade cost scenarios.

## 2.3 CGE and Interregional CGE

There are many economic modeling for policy impact analysis, starting from partial equilibrium model to complete equilibrium model. Computable General Equilibrium (CGE) is a complete equilibrium model. This model uses an equilibrium real world database of a national economy, reflected in Social Accounting Matrix (SAM) database. The SAM is an extended database from Input-Output (I-O) table. As a complete equilibrium model, CGE threats the economy as a system of many interrelated economic variables in which the equilibrium of all variables are determined simultaneously. Also, CGE model allows the system to have flexible prices, whereas in I-O and SAM analysis prices are fixed.

CGE model can be used to evaluate new instrument policies by introducing new set of endogenous or exogenous variables into the model. Endogenous variables mean that the variables have the initial benchmark from SAM. In this model, producer and consumer optimize their behavior as well as other institutions such as government and companies. Demand and supply function are derived simultaneously from optimization problem of production and households demand. Because this model can allow prices to be flexible, both producer and consumer decisions will response to the change in prices.

An equilibrium market is a market condition where the quantity of goods demanded and the quantity supplied are the same. CGE model allows all markets in the system to have an equilibrium state, which called a general equilibrium condition. CGE model consists of a system of mathematical equations which are derived from optimization problem of all agents' behaviors. Resosudarmo et al. (2009) explained that this system can be divided into five equation blocks: production, consumption, export-import, investment block and market clearing. All blocks represent the structure of their behaviors. Market clearing represents the market clearing condition to maintain balance transaction flows.

CGE model also can be built for interregional purpose. An interregional CGE model represents a multi-region economy within one framework. It allows all regions to interconnect through trade, movement of factors production, and institutions transfers such as government transfer to households. Resosudarmo et al. (2009) explained that there are two approaches to constructing an interregional CGE model: top-down and bottom-up approaches.

The top-down interregional CGE model reaches the general equilibrium condition at the national level. It means that the optimization problem is solved at national level. Then from the national outcomes, quantity variables are divided into regions by their share parameter. Therefore, the top-down approach account for regional variations in quantity but not in price among the regions.

Conversely, the bottom-up interregional CGE model reaches the general equilibrium condition at the regional level. It means that the optimization problem is solved at regional level. This model consists of independent sub-regional equilibrium models that are interconnected within one economy framework. Then from the regional outcomes, they are combined to estimate the aggregate national outcome. Therefore, it allows every regions to response for both quantity and price differently. This provides a means to analyze the impact of national shock on a specific regional economy. This approach is more appropriate for Indonesia economy since has economic disparities among the region within the country. However, bottom-up approach requires more data and computation compared to top-down approach. An interregional CGE model developed by Resosudarmo et al. (2009) uses this bottom-up approach.

The development of CGE model for Indonesia started from Indonesian CGE model developed by BPS, ISS, and CWFS (1986). They built a static CGE model for national economy based on national SAM. The next CGE model is developed by Behrman et al. (1988) which based on Input-Output (I-O) table. In the model, they had only limited classification of labor and household. However, they worked on the platform of GAMS software. The purpose of these CGE models was to analyze the structural adjustment program implemented by Indonesia as a response to the oil price.

Abimanyu (2000), Warr (2005) and Yusuf & Resosudarmo (2008) developed the following model of Indonesian CGEs. They derived the model of Australia ORANI model for Indonesian economy and worked on the platform of GEMPACK software. The purpose of these CGE models was to analyze the environmental policies. Azis (2000) developed a new dynamic financial CGE model for Indonesia. This model was used to analyze the impact of 1997-98 Asian financial crises on Indonesian economy. Resosudarmo (2008) also had built a dynamic CGE model for Indonesia. This model was used to analyze the impact of integrated pest management into the economy.

Wuryanto et al. (1999) developed the first interregional CGE model for Indonesia. This model divided regions into Java and non-Java on the production block, whereas on household demand block this model divided regions into Sumatra, Java, Kalimantan, Sulawesi, and the rest of Indonesia. It is a static CGE model and based on the interregional SAM for Indonesia and it worked on the platform of GAMS software.

The most recent interregional CGE model for Indonesia was developed by Resosudarmo et al. (2009), called IRSA-Indonesia5. This model can be used for static and dynamic analysis. This model divided the regions into Sumatra, Java, Kalimantan, Sulawesi and Eastern Indonesia on all blocks. The regions are interconnected by the flow of commodities, flow of factors of production, and flows of interregional transfer such as government transfer to households. In this model, each region also connected with the rest of the world such as import and export activities. It consists of 35 sectoral classifications within each region. This model is designed to estimate the impact economic policy has on various regional and national economic indicators of poverty and environmental quality. The model was not designed to impact of trade costs on interregional trade. In the next, chapter the adjustment made to this model for the purpose of using this model to estimate the impact of trade costs on interregional trade is presented.

### 2.3.1 Interregional Analysis of the Agri-food Sectors

High interregional price differences in Indonesia food markets indicate the presence of high internal trade costs, which function as effective barriers to interregional trade. Trade and transport margins are suspected to play a major role in constraining trade in the agri-food sectors. Supply chain problem and limited infrastructure on land, water, and air transportation in Indonesia contribute to high trade costs. A poorly integrated market across regions also contributes to high trade costs. Illegal interregional trade barriers driven by corrupt authorities also contribute to high trade costs to interregional trade (Kuhn, 2005).

Kuhn (2005) had analyzed the impact of trade costs to the Russian agri-food sector using an interregional CGE model. The model consists of two stylized regions, one with surplus food supplies and one with deficit food levels. He disaggregated the Russian national SAM into five sectors: agriculture, food industry, energy, raw materials, manufacturing, and services. He found different cost linkages between the two regions. He subsequently simulated three trade cost reductions: reducing external tariffs, reducing transport costs, and reducing transaction costs, and found that reducing trade transaction cost was the most efficient way to achieve a better functioning food market in Russian. He found that trade cost reductions mainly benefit to food deficit regions or regions that generally depend on domestic trade. However, surplus regions do not significantly gain from reduced food trade costs. He also assumed that emigration from food deficit regions to surplus regions can be prevented if the government reduces interregional trade costs.

# CHAPTER THREE

# METHODOLOGY

In this Chapter, the methodology and data used for this study are presented. As a starting point, the general structure of the Social Accounting Matrix (SAM) and Computable General Equilibrium (CGE) model are introduced. Data and existing SAMs and CGE models for Indonesia are then described. Following this, we will then explain how we modified Indonesia's Interregional SAM (IRSAM) and Interregional CGE (IRCGE) model to be applicable for trade costs analysis. We also show how these modifications are implemented in a General Algebraic Modeling System (GAMS). This Chapter concludes by introducing alternative model specifications explored in this analysis.

## 3.1 The Social Accounting Matrix

The Social Accounting Matrix (SAM) represents all activities in an economy in a given time; as such, it provides a snapshot of the socio-economic structure of an economy and its income distribution. Pyatt and Round (1979) explained that SAM records the flows between output, factor demand and income, and the decomposition of these relationship into separate effects. It summarizes the generation of income by activities of production and the distribution of income between social and institutional groups such as households, government and firms. Thus, a SAM can capture the distributional impacts of economic growth or policy changes across social and institutional groups.

As summarized by Round (2003b), a SAM has three main features. First, it is presented as a square matrix where the income and expenditure for each account are shown as a corresponding row and column of the matrix. Each transaction is represented by a separate cell; as such, when taken together, the complete matrix displays the linkages between agents in the economy. Second, it the SAM is comprehensive, in that it portrays all the economic activities of the system. Thirdly, a SAM is a flexible tool. Its structure permits more or less aggregation as needed to assess an issue of interest.

In general, SAM also provides information on the social structure within an economy, particularly information related to production structure, factors of production, household income distribution, and the expenditure pattern of institutions. One of the most important features of a SAM is the strict accounting identity of equality between row and column totals in the matrix. SAM explicitly portrays some of the most important market clearing conditions on the economy. In the SAM framework, every agent's expenditure has to be equal to its revenue (or income); each factor of production supplied has to be absorbed by industry and both government and household spending has to be equal to their respective incomes. Every good and service produced by industry is equal to what is demanded.

Figure 3.1 presents the general structure of a Social Accounting Matrix. As noted in this Figure, economic agent receipts are presented as matrix rows, and expenditures as columns. As this diagram represents a highly aggregated version of the SAM, each row and column reflect several accounts of that type. As an illustration, sub-matrix T13, reflects the aggregated amount of each production factor used in each production activity. Alternatively, this can be considered a measure of value added. Within a more disaggregated version of this SAM, production factors and activities would be more explicitly identified. For example, wages and salaries paid in exchange for the use of labor (of one or several types) are captured in this sub-matrix. Sub-matrix T21 shows the transfer payments from production factors to various institutions such as income earned by households. Sub-matrix T22 shows the transfer payments between institutions, such as subsidy payments from the government to households. Sub-matrix T32 shows the demand for goods and services by institutions, such as the amount of money paid by institutions to the production sector to buy goods and services. Sub-matrix T33 shows the demand for goods and services between and within industries.

| Receipts \ Expenditure | | Endogeous Accounts | | | Exogenous Account | Total |
|---|---|---|---|---|---|---|
| | | Production Factors | Institutions | Production Activities | | |
| Endogeous Accounts | Production Factors | | | T13 | T14 | y1 |
| | Institutions | T21 | T22 | | T24 | y2 |
| | Production Activities | | T32 | T33 | T34 | y3 |
| Exogenous Account | | T41 | T42 | T43 | T44 | y4 |
| Total | | y1 | y2 | y3 | y4 | |

**Figure 3.1** Social Accounting Matrix (reproduced from Resosudarmo et al. 2009)

In addition to its use as a descriptive tool, the SAM also serves as the database for computable general equilibrium (CGE) modeling. As explained in Section 2.3., it is important to notice that some theoretical features of a standard CGE model are also explicitly represented in a SAM. As the SAM is balanced, and is a reflection of a whole economy, it can be considered an initial equilibrium of the economy under consideration. Also reflected are the equality between industry costs and sales (zero-profit competitive condition), and the requirement that household budget constraints are satisfied. Before any simulation is conducted, a balanced and consistent SAM ensures all agents' income or receipts are spent, which in turn guarantees equilibrium, database balance, and nominal homogeneity of the CGE model. A CGE model exercise compares this initial equilibrium, with other equilibrium outcomes that result from introducing exogenous shocks to the model.

### 3.1.1 Social Accounting Matrix for Indonesia

The national SAM is published officially by Indonesia Statistics Office (BPS) every five years. The latest version of national SAM was released in 2005 and offered three levels of secotor aggregation. In their most disaggregated SAM, a 107x107 matrix is used to reflect: (1) two production factors –labor and non-labor, (2) three institution – households, companies, and government, (3) production sectors –24 sector classifications, (3) trade margin, (4) transport margin, (5) domestic commodities –24 commodity classifications, (6) import commodities –24 commodity classifications, (7) capital account, (8) indirect taxes, (9) subsidies, and (10) the rest of the world (ROW).

This version of SAM is restricted on the limited sectoral classification. This classification is sufficient as long as the analysis is just to compare the policy impact from or to these sectoral classes. Also, this is a national SAM consequently information about regional transaction flow cannot be captured here. The main data source that they used is 2005 Indonesia Input-Output Table, which is the information about the distribution of value added generated by trade activities. Other data sources include National Socio Economic Survey (SUSENAS), National Balance of Payment, Current Account, Population Census, and National Labor Force Survey (SAKERNAS).

Since this SAM represents a national economy, it records all economic transaction flows between agents in aggregate level. If we want to have more information about these economic transaction flows in more disaggregate level we need to have interregional SAM, instead of national SAM.

## 3.2 Interregional SAM (IRSAM)

While it is standard for Social Accounting Matrices to describe a national economy, it is also possible to develop interregional (sub-national) SAMs. The present analysis will use an Interregional SAM (IRSAM). In this type of SAM, a national economy is subdivided into geographic regions or 'blocks'. The regional economy described by a particular block may receive transfers from other blocks (other sub-national regions). Likewise, blocks within a region may also send payments to other sub-national regions. An IRSAM handles interregional trade flows in manner analogous to a standard national SAM.

### 3.2.1 Interregional SAM (IRSAM) in Indonesia

Given Indonesia's considerable inter-regional variability, to better explore the impact of trade and transport margins on Indonesia's food (in)security, it was decided that this analysis should proceed using an interregional rather than a national SAM. As a starting point, an Interregional SAM for Indonesia developed by Resosudarmo et al. (2009) was obtained. Some documentation of this IRSAM is available in Resosudarmo et al. 2007, 2008, and 2009. The Indonesian Interregional SAM constructed by these authors consists of five regions: Sumatra (RI), Java-Bali (R2), Kalimantan (R3), Sulawesi (R4), and Eastern Indonesia (R5). A map depicting these regions is presented in Appendix B. National accounts that cannot be assigned to regional location are accounted for in a national region (RN). The activities in each of these regions is disaggregated into 35 production sectors, 6 labor classifications, two types of capital (land and capital), two types of households (rural and urban), two types of other institutions (local government, companies), and other accounts such as tax, subsidies, and inventory. At the national level, three types of capital accounts that represenat central, local, and private capital accounts, a central government account, and additional accounts for tax and transfer payments are also included.

The 35 output sectors of this interregional SAM are described in Table 3.1. Agri-food industries are aggregated into six sectors: paddy, food crops, estate crops, livestock, forestry, and fishery. As is reflective of Indonesia's economy, energy and energy processing sectors are important and largely disaggregated. Other manufacturing (i.e. textiles and textile products, footwear), and a standard array of service sectors reflect

**Table 3.1** Sector Mapping

| No | 66 Sectors from I-O 2005 | No | 19 Sectors from I-O 2005 | No | 35 Sectors from IRSAM |
|---|---|---|---|---|---|
| 1 | Paddy | 1 | Paddy | 1 | Rice |
| 2 | Beans | 2 | Other food crops | 2 | Other Food Crops |
| 3 | Maize | | | | |
| 4 | Root Crops | | | | |
| 5 | Vegetables and fruits | | | | |
| 6 | Other food crops | | | | |
| 7 | Rubber | 3 | Other agriculture | 3 | Estate Crops/Plantations |
| 8 | Sugarcane | | | | |
| 9 | Coconut | | | | |
| 10 | Oil palm | | | | |
| 11 | Tobacco | | | | |
| 12 | Coffee | | | | |
| 13 | Tea | | | | |
| 14 | Clove | | | | |
| 15 | Fibber crops | | | | |
| 16 | Other estate crops | | | | |
| 17 | Other agriculture | | | | |
| 18 | Livestock | 4 | Livestock and its products | 4 | Livestock |
| 19 | Slaughtering | | | | |
| 20 | Poultry and its product | | | | |
| 21 | Wood | 5 | Forestry | 5 | Forestry |
| 22 | Other forest product | | | | |
| 23 | Fishery | 6 | Fishery | 6 | Fishery |
| 24 | Coal and metal ore mining | 7 | Mining and quarrying | 7 | Coal and Other Mining |
| 25 | Crude Oil, natural gas and geothermal mining | | | 8 | Oil, Gas, and Geothermal Mining |
| 26 | Other mining and quarrying | | | 7 | Coal and Other Mining |
| 28 | Manufacture of oil and fat | | | 10 | Palm Oil Processing |
| 27 | Manufacture of food processing and preserving | 8 | Manufacture of food, beverages and tobacco | 11<br>12 | Marine Capture Processing<br>Food and Bevarage Processing |
| 28 | Manufacture of oil and fat | | | | |
| 29 | Rice milling | | | | |
| 30 | Manufacture of flour, all kinds | | | | |
| 31 | Sugar factory | | | | |
| 32 | Manufacture of other food products | | | | |
| 33 | Manufacture of beverages | | | | |
| 34 | Manufacture of cigarettes | | | | |
| 35 | Yarn spinning | 9 | Other manufacturing | 13 | Textile and Textile Products |
| 36 | Manufacture of textile, wearing apparel and leather | | | 14 | Footware |
| 37 | Manufacture of bamboo, wood and rattan products | | | 15 | Wood, Rattan, and Bambo Products |
| 38 | Manufacture of paper, paper products, and cardboard | | | 16 | Pulp and Paper |
| 39 | Manufacture of fertilizer and perticide | | | 18 | Petrochemical Products |
| 40 | Manufacture of chemicals | | | | |
| 41 | Petroleum refinery | 10 | Petroleum refinery | 9 | Oil Refinery |
| 42 | Manufacture of rubber and plastic wares | 9 | Other manufacturing | 17 | Rubber and Rubber Products |
| 43 | Manufacture of non metallic mineral products | | | 24 | Other Industries |
| 44 | Manufacture of cement | | | 19 | Cement |
| 45 | Manufacture of basic iron and steel | | | 20 | Basic Metal |
| 46 | Manufacture of non ferrous basic metal | | | | |
| 47 | Manufacture of fabricated metal products | | | 21 | Metal Product |
| 48 | Manufacture of machine, electrical machinery and app | | | 22 | Electrical Equipment and Machinery |
| 49 | Manufacture of transport equipment and its repair | | | 23 | Vehicle |
| 50 | Manufacture of other products not elsewhere classified | | | 24 | Other Industries |
| 51 | Electricity, gas, and water supply | 11 | Electricity, gas, and water supply | 25 | Electricity, gas, and water supply |
| 52 | Construction | 12 | Construction | 26 | Construction |
| 53 | Trade | 13 | Trade | 27 | Trade |
| 54 | Restaurant and hotel | 14 | Restaurant and hotel | 28 | Hotel and Restaurant |
| 55 | Railway transport | 15 | Transport and communication | 29 | Land Transportation |
| 56 | Road transport | | | | |
| 57 | Water transport | | | 30 | Water Transportation |
| 58 | Air transport | | | 31 | Air Transportation |
| 59 | Services allied to transport | | | 35 | Other Services |
| 60 | Communication | | | 32 | Communication |
| 61 | Financial intermediaries | 16 | Financial intermediaries, real estate, and busine | 33 | Financial Sector |
| 62 | Real estate and business service | | | | |
| 63 | General government and defense | 17 | General government and defense | 34 | Government and Military |
| 64 | Social and community services | 18 | Other services | 35 | Other Services |
| 65 | Other services | | | | |
| 66 | Unspecified sector | 19 | Unspecified sector | | |

the remaining industrial sectors. The six labor classifications in this SAM include formal and informal agricultural, skilled, and unskilled labor

The 2005 Indonesia Interregional SAM by Resosudarmo et al. (2009) is based primarily on data provided by the 2005 Indonesian Interregional Input-Output (IRIO) table (Resosudarmo et al, 2007). The main sources of data sets for constructing this IRIO are the: 2000 Indonesian Input-Output (IO), 2000 Social Accounting Matrix (SAM), 2005 National Socio Economic Survey (SUSENAS), 2005 data describing provincial Gross Domestic Products (BPS), and the draft provincial I-O for 2005 available at the National Development Planning Agency (BAPPENAS). In addition to this information, further data was required to expand this I-O into a complete SAM. The additional data source used include the National and Regional Balance of Payments, Current Account, Population Census, National Labor Force Survey (SAKERNAS), Special Survey on Household Investment and Saving (SKTIR), Provinces Statistics, Welfare Statistics, and Indonesian Statistics.

Figure 3.2 illustrates the IRSAM in original form as presented by Resosudarmo et al. (2009). In this IRSAM table, the transaction data is divided into 36 interregional transaction flows which consist of 25 transaction flows between regions, and 11 transaction flows from/to national accounts. Each block represents the transaction flow from one region to another region; so, for example, R2R1 matrix records transaction flow from region R2 to region R1.

| | | R1 | R2 | R3 | R4 | R5 | RN |
|---|---|---|---|---|---|---|---|
| | | i1 i2 ... | | | | | |
| R1 | i1<br>i2<br>... | R1R1 | R1R2 | R1R3 | R1R4 | R1R5 | R1RN |
| R2 | | R2R1 | R2R2 | R2R3 | R2R4 | R2R5 | R2RN |
| R3 | | R3R1 | R3R2 | R3R3 | R3R4 | R3R5 | R3RN |
| R4 | | R4R1 | R4R2 | R4R3 | R4R4 | R4R5 | R4RN |
| R5 | | R5R1 | R5R2 | R5R3 | R5R4 | R5R5 | R5RN |
| RN | | RNR1 | RNR2 | RNR3 | RNR4 | RNR5 | RNRN |

Figure 3.2 Original IRSAM (reproduced from Resosudarmo et al. 2009)

Within an interregional SAM framework, agents within a region in the economy may receive transfer from agents who are in other regions but still in the same country. As with a standard national SAM, this interregional SAM displays all linkages between agents in the economy in a given time, and preserves the equality between row totals and column totals in the matrix. As such, overall, this interregional SAM adheres to the market clearing condition for all agents in all regions.

We classify agri-food sectors as a group of paddy, food crops, estate crops, livestock, forestry, and fishery. In this study we will concentrate to these agri-food sectors as a set. The 6 labor classifications in this version include formal agricultural labor, informal agricultural labor, formal skilled labor, informal skilled labor, and formal unskilled labor and informal unskilled labor.

## 3.3 Modification to IRSAM

To evaluate the impact of trade costs on Indonesia's internal food trade and availability, it was required that modifications be introduced into Resosudarmo et al. (2009) IRSAM. This section will describe the way in which trade and transport margins are introduced into the Interregional SAM.

In original IRSAM developed by Resosudarmo et al. (2009), the trade costs values are embedded with other activities in the trade sectors and transportation sectors. To examine the impact of these costs, the margins in these sectors need to be disentangled from actual trade and transportation activities and separately identified in the SAM. As such, it was required that the IRSAM be modified to: (1) adjust the values of in the trade and transportation vectors to only reflect the activities in those sectors, and (2) introduce additional rows and columns into the IRSAM to allow the trade and transport margin values to be explicitly represented.

Data concerning trade and transport margins is not explicitly available in the 2005 IRSAM, or in any other data sources for that year that the study author was able to locate. As such, as a starting point for these modifications, we return to the main data source used as a basis of the interregional SAM. This IRSAM was built using IRSAM 2005 which was constructed using an Interregional Input-Output (IRIO) table based on year 2000 data. For the purposes of the current analysis, only the latest I-O table which made use of 2005 data disaggregated into 66 economic sectors could be obtained (BPS, 2005). . From this information, a table of total transaction margins can be obtained. Total transaction flows valued at purchaser prices includes these margins, while those valued at producer prices do not. As such, we can calculate matrix of total transaction margins by subtracting matrix of total transaction flow at producer's prices from matrix of total transaction flow at consumer's prices. In doing so, we will have a 66 x 66 matrix of total transaction margins. This matrix represents the total margin that is being captured from transaction activities among 66 sectors.

The number and aggregation of economic sectors disaggregation in this 2005 I-O table are inconsistent with the 2005 IRSAM. As such, we need to map and aggregate 66 sectors from the I-O table into 35 sectors of the IRSAM. Table 3.1 depicts this sector mapping. It is worth noting that as trade and transportation are used only in the movement of agri-food and manufactured goods (not service sectors), in practice, total transaction values are only applicable to 24 of the 35 sectors in the IRSAM.

Following the mapping and aggregation of the 66 sectors into the 35 sector aggregation, we have a 35x35 matrix of total transaction margins. Dividing this matrix into the matrix of the total transaction flow at producer's prices by sector, the percentage of total transaction margins relative to their total transaction value is calculated.

This matrix of percent of sector-disaggregated trade margins relative to producer prices (for convenience PCT_MAT) was then used to estimate the value of margins in each of the 35 sectors in the IRSAM. First, it assumed that the percentage of margins relative to producer prices remained the same between years 2000 and 2005[1]. The PCT_MAT reflects a national average of the sector margins. To combine this information with the IRSAM then, the IRSAM was aggregated across regions to generate

[1] Given the relatively short window of time, this assumption in not unreasonable.

a national SAM. By multiplying PCT_MAT with this national SAM, a matrix of total transaction margin values was calculated. Trade costs consist of various components, such as customs tariffs, transport margins, and trade margins which include transaction costs. In this study, two components of trade costs are considered: transport margins and trade margins. The selection of these specific costs is largely due to the availability of this data Indonesia Statistics Office (BPS). Customs tariffs were not explicitly considered in this analysis due to their relatively limited impact on interregional trade.

In these steps, however, only a single (sector disaggregated) measure of trade costs is obtained. For the purposes of this analysis, this value needs to be disaggregated into margins which can be attributed to trade and transportation costs. Since we have the percentage of the total margin which can be attributed to trade and transportation costs from I-O table, this information is used to find the total national trade margin, $trd_c^N$, and the total national transport margin, $trs_c^N$ by sector (commodity) c. These total trade and transport margins can then be allocated across the five regions in of the IRSAM by multiplying the each margin by the share of the nation's trade undertaken by each region. Specifically this transformation can be described as:

$$trd_{c,r,d}^R = \frac{TRAD_{c,r,d}^R}{TRAD_c^N} \times trd_c^N \qquad (3.1)$$

where $trd_{c,r,d}^R$ denotes the trade margin at regional level for commodity *c*, occurred from region of origin *r*, to region of destination *d*. $TRAD_{c,r,d}^R$ denotes the flow of trade of each commodity *c*, from region of origin *r*, to region of destination *d*. $TRAD_c^N$ denotes the total trade of commodity $c$ in the whole of the nation $N$. Using the same approach, the transportation margin was also calculated as shown below:

$$trs_{c,r,d}^{R} = \frac{TR_{c,r,d}^{R}}{TR_{c}^{N}} \times trs_{c}^{N} \tag{3.2}$$

where $trs_{c,r,d}^{R}$ denotes the transport margin at regional level for commodity $c$, occurred from region of origin $r$, to region of destination $d$. $TR_{c,r,d}^{R}$ describes the total value transporting commodity $c$, from region of origin $r$, to region of destination $d$, and $TR_{c}^{N}$ describes the total national value of transporting commodity $c$. Thus overall, we will have a 25x24 matrix for each of trade and transportation margins reflecting the 24 traded sectors and trade with the nation $N$. The values of these margins are presented in Appendix C.

Through these steps, the value of the regional margin for each traded commodity c is calculated. However, since the original IRSAM had the margins included these margins in the valuation of the trade and transportation sectors, these margins need to be subtracted from the original matrix values. In addition, to explicitly incorporate the values of the margins, we will add two new rows and two new columns, one for each of TRD and TRS, into the modified IRSAM. A stylized depiction of this addition is shown in Figure 3.3 where the added margins are depicted in the shaded vectors. On net, with these changes the modified IRSAM will have the same row and column totals as the original version.

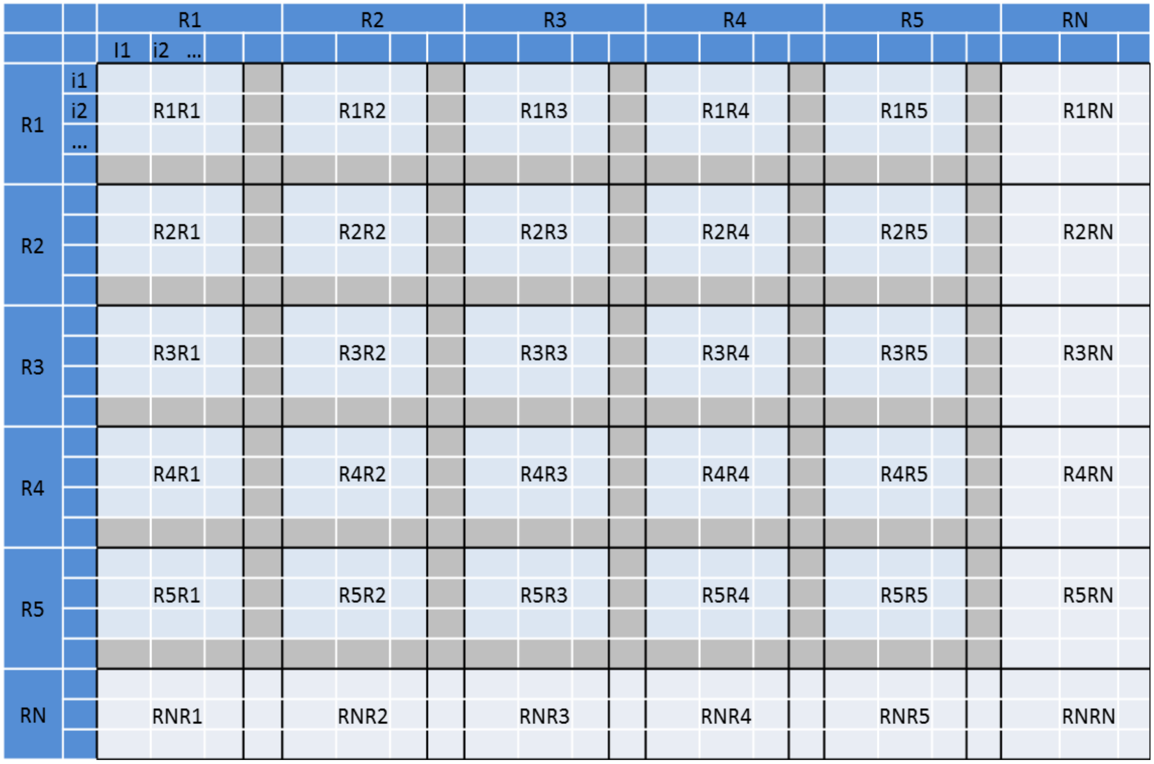

**Figure 3.3** Modified IRSAM

## 3.4 Interregional CGE (IRCGE)

The Interregional CGE models make use of an interregional SAM database that allows interregional trade flows and interregional institutional transfers. An Interregional CGE (IRCGE) model can be based on one of two approaches: a “bottom-up” model or a “top-down” model. In a “bottom-up” model, equilibrium of input and output is achieved at a regional level; these regional results are then aggregated together to find national results. This bottom-up approach allows prices as well as quantities to vary independently within each region. Further, this approach enables the impact of a policy shock to be applied to a single or group of regions, or to the whole economy. In the alternative ‘top-down’ approach, equilibrium conditions of input and output markets are found at the national level and regional results are assumed to be a proportion of this national outcome (Resosudarmo, et al. 2009).

In this study, we adopt an interregional CGE model for Indonesia developed by Resosudarmo et al. (2009), called IRSA-Indonesia5. This model makes use of the bottom-up approach CGE model. As is standard in CGE models, in this IRCGE model, consumers and producers are assumed to act in ways that will maximize their utility or profit respectively. The optimization procedure for demand uses a nested Constant Elasticity of Substitution (CES) function, and production is assumed to be characterized by a Leontief production function. Also, the institutional structure guiding the overall interactions of the economic agents is based on a competitive market assumption, where wages and prices are the only market signal observed by the actors. To more realistically represent the Indonesia's economic circumstances, this model includes an open economy assumption, which allows all commodities and capital to be imported and exported.

This model can be used to analyze the impact of national policy shock to the regional economy as well as the impact of specific regional policy shock to the national and regional economies. We can see different price and demand responses in every region responding the policy shocks. We derive two important optimization problems in this model, i.e. production and household demand blocks as shown in Appendix D.

## 3.5 Modification to IRCGE

To incorporate explicitly specified trade and transport margins, new and adjusted price, trade and transport equations must be incorporated into the model. In the following description, some key features to the IRSAM model are introduced and explained.

In prices equation block, we introduce consumer prices for interregional imported goods, $PQR_{c,r,d}$, which are described by:

$$PQR_{c,r,d} = P_{c,r}^{DOM} + trd_{c,r,d} + trs_{c,r,d} \tag{3.3}$$

where $P_{c,r}^{DOM}$ denotes producer prices in the source region, $trd_{c,r,d}$ denotes the trade margin and $trs_{c,r,d}$ denotes the transport margin from trade activities of commodity *c*, from origin region *r* to region destination *d*. We also modify prices of domestic region composite, $PQ_{c,d}^{DOM}$, to allow trade and transport margins take into account. It can be expressed by the following:

$$PQ_{c,d}^{DOM} \cdot XTRAD\_R_{c,d} = \sum_{r} \left( PQR_{c,r,d} \cdot XTRAD_{c,r,d} \right) \tag{3.4}$$

where $XTRAD\_R_{c,d}$ denotes demand for regional composite commodity *c* by users at region *d*, and $XTRAD_{c,r,d}$ denotes demand for commodity *c* produced by region *r* by users at region *d*. It captures all demand by users at region *d* for commodity *c* that is produced by region *r*. This equation shows that for each of commodity, the value purchased from all domestic regions has to be equal to the sum of the value demanded by all regions.

In transportation block of equations, we introduce transport sectors revenues, $REVTRS_{c,r,d}$, which come from interregional trade activities. The value of these revenues is depend on the transport margin and the value of the transported good as shown in the following:

$$REVTRS_{c,r,d} = XTRAD_{c,r,d} \cdot trs_{c,r,d} \tag{3.5}$$

These revenues from transport margin for interregional transport are transformed into a transportation commodity, $X_{tr,r}^{TRS}$, which has to be produced by the regional transportation sectors. Subscript *tr* is a sub-set of the set of commodities *c*, and denotes transportation by land, water and air. Each transportation sectors will have its regional transport costs (equal to revenues) sum from trade activities, $TRSINC_{tr,r}^{TRS}$, as shown in the following:

$$TRSINC_{tr,r} = \sum_{c,d} \left( REVTRS_{c,r,d} \cdot share_{tr,r} \right) \tag{3.6}$$

where $share_{tr,r}$ denotes the share parameter which distributes the interregional transport sectors revenues among the transportation sectors in each region. This regional transport costs sum is transformed into transportation sector demand by the following equation:

$$X_{tr,r}^{TRS} \cdot PQ\_S_{tr,r}^{TRS} = TRSINC_{tr,r} \tag{3.7}$$

where $X_{tr,r}^{TRS}$ denotes the transportation commodity, and $PQ\_S_{tr,r}^{TRS}$ denotes the composite price the transportation commodity *tr*, at region origin *r*.

In trade block, revenues are defined in a manner analogous to in the the transportation sectors. We introduce trade sector revenues, $REVTRD_{c,r,d}$, which come from interregional trade and is derived from multiplying the trade margin and the valued of traded goods according to the following:

$$REVTRD_{c,r,d} = XTRAD_{c,r,d} \cdot trd_{c,r,d} \tag{3.8}$$

These revenues from trade margin for interregional trade are transformed into a trade commodity, $X_r^{TRD}$, which has to be produced by the regional trade sectors. There is no subscription *tr* as in transportation commodity because there is only one commodity, trade. The regional trade costs sum from trade, $TRDINC_r^{TRD}$, is

$$TRDINC_r = \sum_{c,d} REVTRD_{c,r,d} \tag{3.9}$$

This regional trade costs sum is transformed into trade sector demand by the following equation

$$X_r^{TRD} \cdot PQ\_S_r^{TRD} = TRSINC_r \tag{3.10}$$

where $X_r^{TRD}$ denotes the transportation commodity, and $PQ\_S_r^{TRD}$ denotes the price composite of transportation commodity *tr*, at region origin *r* demanded by regional users. Additional detail about the model equation framework is presented in Appendix D.

## 3.6 Model Implementation in GAMS

The modified IRCGE model is implemented using the General Algebraic Modeling System (GAMS) programming software. This program offers a high-level modeling system for mathematical programming and optimization. In the GAMS program, problems are described by data, parameters and variables and solved through one among a variety of solvers.  In this study, we make use of the Mixed Complementarity Problems (MCP) solver since it can be applied to many applied economics problems including CGE modeling. In this study, we a modified version of the

Interregional CGE model developed by Resosudarmo et al. (2009) called IRSA-Indonesia5. A detailed technical note and manual manuscript for this model is described in Resosudarmo et al. (2009).

To modify the IRSA-Indonesia5 SAM as described in the previous subsection, we need to modify three main files of those used by this program: (1) benckmk.gms, (2) model.gms, and (3) simulation.gms. The benckmk.gms is used for reading SAM data and conducting variable benchmarking, parameter calibration, and checking the consistency of the model. Model.gms is used for declaring the model structure including variable declaration, variable initialization, and equation statements. The simulation.gms file is used for running the simulation. These three main files call on several other data and gms files. Additional details about this implementation are provided is explained in Appendix E.

## 3.7 Simulation

In this analysis, seeks to assess the effects of different trade costs on consumption and welfare of those in Indonesia's five regions. As described in the previous chapter, we predict that high and variable trade costs affect the extent of Indonesian agri-food market integration. In reducing these trade costs, it is anticipated that the volume of interregional trade would increase and the benefits of additional agri-food trade, such as increased food consumption and increased regional welfare would be enhanced. Finally, it will reduce regional disparities in growth and poverty.

As previously described, this analysis considers the impact of trade costs; specifically the impact of trade and transportation margins will be examined. We predict that reducing each of these components of trade costs will generate different economic impacts. Different geographical condition and quality of infrastructures in each region contribute toward different response to trade costs reductions. Infrastructures can be categorized into hard infrastructures such as seaport, airport, railways, road networks; and soft infrastructures such as trade policies, procedures, and institutions. One region that has lower quality of hard infrastructure might react more responsively to a reduction of transport margin. Also, a region that has lower quality in soft infrastructure might react more responsively to reduction of trade margin. Through a series of simulations, the impact of these cost components will be separately examined; a description of these simulations is summarized in Table 3.2.

**Table 3. 2** Summary of Trade Cost Simulations

| | Policy Shock | Magnitude Shock | Sector shock |
|---|---|---|---|
| Simulation 1 (SIM1) | Reduces trade margin | to 50% of the base value | Agri-food sectors |
| Simulation 2 (SIM2) | Reduces transport margin | to 50% of the base value | Agri-food sectors |
| Simulation 3 (SIM3) | Reduces transport margin | to 10% of the base value | All sectors |

Experiment 1 (SIM1) reduces trade margin applied to agri-food sector trade to 50% of its initial (base) value. Through this experiment, it is assumed that this reduction in trade margin is assumed to be achieved through an exogenously funded public service

investment that improves the efficiency of the trade sector and, in doing so, decreases costs of this sector. In this simulation, we only impose the shock to agri-food sector, *ag*, which is set of all the agri-food commodities includes paddy, food crops, estate/ plantation crops, livestock, and fishery. This shock is imposed by reducing the value of trade margin to 50% from its baseline value in every *ag* sector, described by the following:

$$trd_{c,r,d} \rightarrow trd_{ag,r,d} = trd_{ag,r,d} \times (0.5) \tag{3.9}$$

where '*ag*' $\in$ '*c*'. Selection of a 50% decrease in the trade margin reflects a substantial, but not impossible to achieve improvement in the efficiency of trade in this sector. Selection of this level of trade margin reduction is also guided, in part, by a desire to compare the findings of this study with those of Kuhn (2005) who also reduced this margin by 50% in his tests of of Russian trade margins. It is anticipated that this reduction in trade margins will have a stronger trade and consumption effect in regions where the trade margin was initially larger.

Experiment 2 (SIM2) reduces transport margin for shipments of agricultural products and processed food to 50% of its baseline value. Here again, we assume an exogenously induced and funded improvement in the transportation infrastructure which results in a decrease in the transport margin in interregional trade. Thus, it is anticipated that reducing the transport margin increase interregional trade; particularly in those commodities with a high transport margin burden, and will thereby increase the benefits from regions specializing in the production of goods for which they have a comparative advantage. As with SIM1, in this scenario we also only impose this shock to agri-food sectors, *ag*, according to the following:

$$trs_{c,r,d} \rightarrow trs_{ag,r,d} = trs_{ag,r,d} \times (0.5) \tag{3.10}$$

In this equation, the new transport margin for *ag* sectors is reduced to be one-half (50%) of its original value. The rationale for the amount of this margin reduction is the same as that described for SIM 1.

Experiment 3 (SIM3), is similar to experiment 2 (SIM2) in that it reduces transportation margins. Unlike SIM 2, however, where margins were reduced only to agricultural sectors, in SIM3 transport margins on the shipment of all products are reduced to 10% of their baseline values. Reducing transport margin to all sectors is reasonable given infrastructure development usually is not industry specific and offers benefit to all the sectors in the economy. Here we impose this shock to all sectors, *c*, as shown in the following:

$$trs_{c,r,d} \rightarrow trs_{c,r,d} = trs_{c,r,d} \times (0.1) \tag{3.11}$$

In this equation, we set the new transport margin for all sectors to be 10% of the original transport margin. A 90% decrease in transport margin was selected for this simulation to explore the outcomes of a 'best case' transportation efficiency improvement.

# CHAPTER FOUR

# RESULTS AND ANALYSIS

## 4.1 Overview

In this chapter, we will discuss the result of our analysis. We conduct three simulations on this modified CGE model; each result will be described by regional indicators. As a starting point of comparison, a baseline analysis is run. This analysis reflects the economy in its current (as of 2005) conditions. A series of simulations are then conducted; economic ‘shocks’, which serve as proxies for various policy changes, and which are applied through changing model parameter values are then introduced. The outcome of these results are then compared to the initial (baseline) equilibrium outcome conditions by using ratio change. It is the level value of the variable divided by its baseline.

The simulations examined in this analysis reduce the margin applied to trade activities and/or transport activities. Each simulation also varies by what commodities the shock is applied to and the magnitude of the shock. The results of the baseline analysis and these key alternative economic specifications are described below. This chapter will conclude by comparing and contrasting the results of these analyses.

## 4.2 Baseline Analysis

In this section, we display the baseline outcomes of the model. These results are generated without imposing any shock to this model and offers results of the initial equilibrium conditions. This baseline analysis results will be described through considering the following macroeconomic indicators at regional level: private consumption, government consumption, regional GDP (valued at market prices) and net indirect taxes.

**Table 4.1** Macroeconomic Outcomes on Regional Aggregation – Baseline Analysis

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Private Consumption | 2074.22 | 263.66 | 49.88 | 32.74 | 30.54 |
| Gov. Consumption | 131.79 | -29.65 | 11.41 | 10.91 | -13.23 |
| GDP at Market Price | 483.98 | 1143.64 | 224.91 | 80.92 | 98.63 |
| Net Indirect Taxes | 8.11 | 44.66 | -36.46 | 3.22 | 3.98 |

Results presented in Table 4.1, reflect that Java-Bali has the highest regional domestic product when compared to Indonesia's other regions. This is accurate as Java-Bali is the most economically prosperous (when considering per-capita income) and populous of the five considered regions. In considering private consumption, Sumatra and Java-Bali have higher values of consumption, and Eastern Indonesia has the lowest level. These results are consistent on a per capita basis and are as would be expected given the significant number of people in Eastern Indonesia who live below the poverty line. However, in this study we come out with large value in private consumption for Sumatra. The possible reason for this baseline inconsistency with the SAM is because we still have some errors in the model. Java-Bali still plays a major role to the national GDP. Java-Bali and Eastern Indonesian have negative value on their local government consumption; in these cases, government consumption converted to public use and it will be treated as negative government consumption. If government spending that originally been treated as government consumption is converted to public use, for example government facilities such as buildings are sold to commercial operator, this would be treat as negative government consumption. Thus negative government consumption implies that the consumption is converted to private consumption.

Indicators of regional production and demand are described in Tables 4.2 through 4.5. Given that the role of the agricultural sector is of particular interest to this study, these tables will highlight outcomes for this sector. Table 4.2 presents producer prices at the production region of origin. In comparing prices across regions, it can be seen that Sumatra and Java-Bali have the lowest producer price for paddy and Eastern Indonesia has the highest price. Both indicators are reasonable since Java-Bali and Sumatra has the highest production of paddy (as shown in Figure 2.3), and Eastern Indonesia has highest production costs (information is taken from *Agricultural Producer Price Statistics in Indonesia* –BPS, 2009).

**Table 4.2** Baseline Producer Prices at Region of Origin

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rice | 0.31 | 0.58 | 0.62 | 0.62 | 0.62 |
| Food Crops | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 |
| Estate Crops | 0.62 | 0.62 | 0.62 | 0.62 | 0.62 |
| Livestock | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 |
| Forestry | 0.34 | 0.34 | 0.34 | 0.34 | 0.34 |
| Fishery | 0.61 | 0.61 | 0.61 | 0.61 | 0.61 |

**Table 4.3** Baseline Purchaser Prices at Region of Destination

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rice | 0.59 | 1.16 | 1.23 | 1.24 | 1.21 |
| Food Crops | 1.23 | 1.26 | 1.25 | 1.25 | 1.22 |
| Estate Crops | 1.23 | 1.25 | 1.24 | 1.24 | 1.22 |
| Livestock | 1.07 | 1.10 | 1.07 | 1.10 | 1.06 |
| Forestry | 0.65 | 0.64 | 0.57 | 0.66 | 0.64 |
| Fishery | 1.23 | 1.27 | 1.22 | 1.23 | 1.20 |

Table 4.3 shows the purchaser price at region of destination. The purchasing price for paddy in Kalimantan, Sulawesi and Eastern Indonesia is relatively high compared to the analogous prices in Sumatra and Java-Bali. These results are expected. In considering the trade and transport margins on paddy, we find that these margins are generally higher in less developed compared to more developed regions. It can be shown that there are price differences among the regions especially between paddy surplus region, Sumatra and paddy deficit region, Eastern Indonesia. For livestock, Java-Bali has the highest price level compared to other regions. As Java-Bali is the most populated region, demand for this commodity is likewise high. For fishery products, Eastern

Indonesia has the lowest purchaser price compared to other regions. This outcome is also expected given that this region has a sufficient surplus in fish and fish product that they can supply their own needs which required less trade costs compared trading from other regions.

**Table 4.4** Baseline Demand for Domestically Produced Commodities

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rice | 13.60 | 43.89 | 1.80 | 2.12 | 1.49 |
| Food Crops | 20.15 | 52.17 | 3.57 | 3.74 | 4.27 |
| Estate Crops | 29.16 | 46.96 | 3.85 | 3.60 | 2.04 |
| Livestock | 15.72 | 44.92 | 3.15 | 2.15 | 2.24 |
| Forestry | 10.77 | 15.87 | 6.10 | 1.59 | 0.87 |
| Fishery | 13.47 | 16.96 | 3.15 | 4.08 | 2.06 |

Table 4.4 shows the demands for domestically produced agri-food commodities across regions. We can see that Sumatra and Java-Bali have high demand for agri-food commodities compare to other regions. In contrast, Eastern Indonesia has the lowest demand for domestic agri-food commodities. These results are as would be expected given the relative distribution of population and the poor across Indonesia's regions.

**Table 4.5** Demand for Domestic Commodities Disaggregated by Region and Relative Rurality – Baseline Analysis

| | Sumatra | | Java-Bali | | Kalimantan | | Sulawesi | | Eastern Ind. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban |
| Food Crops | 5.35 | 7.17 | 14.07 | 17.99 | 1.14 | 1.55 | 1.27 | 1.55 | 1.40 | 1.98 |
| Estate Crops | 2.09 | 2.09 | 5.76 | 5.19 | 0.33 | 0.46 | 0.39 | 0.53 | 0.51 | 0.76 |
| Livestock | 3.68 | 4.08 | 9.22 | 12.34 | 0.83 | 1.23 | 0.49 | 0.59 | 0.57 | 0.82 |
| Forestry | 0.10 | 0.10 | 0.32 | 0.47 | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 | 0.03 |
| Fishery | 3.79 | 4.02 | 4.16 | 5.27 | 1.03 | 1.43 | 1.27 | 1.72 | 0.49 | 0.69 |

Alternatively we can examine characteristics of demand by the demand location – namely whether the source of demand is rooted in rural or urban areas. As presented in Table 4.5, when consumption is disaggregated into these areas, similar and expected patterns of consumption emerge. Sumatra and Java-Bali have the highest demand for the composite agri-food commodity compared to other regions. Further, these results suggest that the demand for food is almost consistently higher in urban areas than in rural areas. Due to the relative population distribution, and relative distribution of the poor across regions (recall Figure 2.2), these results are expected.

**Table 4.6** Disposable Income and Household Saving Disaggregated by Region and Relative Rurality – Baseline Analysis

| Household Disposable Income | | | | | |
|---|---|---|---|---|---|
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 93.55 | 298.70 | 23.83 | 20.54 | 18.38 |
| Urban | 132.32 | 396.59 | 34.31 | 26.78 | 26.70 |
| **Household Saving** | | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 4.65 | 15.63 | 1.24 | 1.04 | 0.94 |
| Urban | 9.64 | 30.12 | 2.64 | 1.93 | 1.96 |

Table 4.6 presents results describing household disposable income and saving disaggregated by region and by relative rurality. In all regions, urban household have more disposable income and saving when compare to rural households. This outcome is reasonable since urban household have better job opportunities and living standards than those in rural areas. Sumatra and Java-Bali have much higher household disposable

income and saving compared to other regions. This shows us that there are disparities in income distribution across regions.

**Table 4.7** Real Consumption and Poverty Incidence Disaggregated by Region and Relative Rurality – Baseline Analysis

| Real Consumption | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rural | 73.46 | 204.90 | 16.20 | 12.44 | 16.45 |
| Urban | 107.94 | 271.35 | 23.45 | 16.37 | 23.93 |

| Baseline Poverty Incidence | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rural | 17.63 | 21.11 | 12.74 | 18.32 | 30.34 |
| Urban | 13.87 | 12.10 | 7.93 | 7.05 | 20.58 |

Table 4.7 presents the real consumption and poverty incidence determined through the baseline analysis. Real Consumption is calculated by dividing the level of household disposable income by household specific CPI where varies across regions and types of household. Java-Bali has the highest real consumption followed by Sumatra, compared to other regions. Not surprisingly that urban household has higher real consumption than rural household across all regions. To get poverty incidence, we use the same poverty line in Resosudarmo et al. (2009) as shown in Table 4.8. In the baseline for poverty incidence, rural households has higher incidence than urban households. Eastern Indonesia has the highest poverty incidence since it is less developed than other regions. Java-Bali has high poverty incidence since it has more population than other regions.

**Table 4.8** Regional Poverty Line (adapted from Resosudarmo et al. 2009)

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rural Household | 2065.59 | 2939.93 | 1525.31 | 1047.35 | 1927.56 |
| Urban Household | 4438.82 | 3076.93 | 3257.65 | 3245.83 | 5884.13 |

## 4.3 Simulation 1: Reduce Trade Margin for Agri-food Sectors

In this section, we will impose different shock to the equilibrium condition and see how the macroeconomic and microeconomic indicators change in regional level. To analyze the impact of trade costs on economic outcomes in Indonesia, the first simulation reduces the trade margin to 50% from the baseline. All the macroeconomic indicators in baseline will also be used to see the ratio change from imposing this shock. In Table 4.9 we can see the impact of trade margin shock to the equilibrium in regional level. Ratio change less than one implies that the new level value is greater than its initial value after imposing the shock. Also, ratio change greater than one apply in the opposite way.

**Table 4.9** Macroeconomic Outcomes Regionally Disaggregated and Their Ratio Change from Baseline Value under Simulation 1

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Private Consumption | 253.68 | 903.61 | 64.14 | 55.09 | 44.12 |
| *Ratio Change* | *0.12* | *3.43* | *1.29* | *1.68* | *1.44* |
| Gov. Consumption | 40.28 | 72.40 | 14.96 | 16.48 | 7.80 |
| *Ratio Change* | *0.31* | *-2.44* | *1.31* | *1.51* | *-0.59* |
| GDP at Market Price | 550.19 | 1576.23 | 245.16 | 102.22 | 101.85 |
| *Ratio Change* | *1.14* | *1.38* | *1.09* | *1.26* | *1.03* |
| Net Indirect Taxes | 8.24 | 112.61 | -37.03 | 3.09 | 3.33 |
| *Ratio Change* | *0.13* | *67.95* | *-0.57* | *-0.13* | *-0.65* |

From Table 4.9 we can see that the impact of this shock is quite different among the regions. In private consumption, Sumatra has negative impact due to the trade margin shock. It means that private consumption in Sumatra region will fall in aggregate. However, in other regions reducing trade margin will increase their private consumption in aggregate. The highest change occurs in Java-Bali where the population is concentrated most. Government consumption also moves to the same direction as private consumption. Java-Bali, Kalimantan, and Sulawesi indicate an increasing government spending compare to Sumatra and Eastern Indonesia. Negative value in the ratio change is coming from their baseline value. This results shows that reducing trade margin will give incentive to these local governments to consume more.

We can also see that regional GDP (RGDP) also increase in all regions as their response to the trade margin shock. From here we can understand that reducing trade margin will promote more economic efficiency and then further can increase economic development. Since all regions give positive response to the shock, then reducing trade margin will make every region better off without make any region worse off.

**Table 4.10** Ratio Change in Producer Prices at Region of Origin from Baseline Value under Simulation 1

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rice | 1.57 | 0.89 | 0.85 | 0.85 | 0.85 |
| Food Crops | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Estate Crops | 0.84 | 0.84 | 0.84 | 0.84 | 0.84 |
| Livestock | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| Forestry | 1.33 | 1.33 | 1.32 | 1.33 | 1.33 |
| Fishery | 0.86 | 0.87 | 0.87 | 0.86 | 0.86 |

Now in the microeconomic indicator at aggregate regional, we also can see the change relative to their baseline. From Table 4.10, we can see the change of producer price relative to the baseline. We already have the baseline from previous section, so here we display the ratio change of producer price level under policy shock SIM1. Most of these prices decrease from their baseline level since the ratio is less than one. There are exception for forestry commodity where it responses by increasing in their price due to the reduction of trade margin. It means that producer in forestry commodity will increase their production costs knowing that trade margin is decreasing. For paddy commodity, Kalimantan, Sulawesi and Eastern Indonesia move more responsive to this shock by decreasing their price more than other regions.

**Table 4.11** Ratio Change in Purchaser Prices at Region of Destination from Baseline Value under Simulation 1

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rice | 1.62 | 0.89 | 0.85 | 0.84 | 0.86 |
| Food Crops | 0.86 | 0.84 | 0.85 | 0.84 | 0.86 |
| Estate Crops | 0.85 | 0.84 | 0.85 | 0.85 | 0.85 |
| Livestock | 0.97 | 0.95 | 0.97 | 0.95 | 0.97 |
| Forestry | 1.37 | 1.39 | 1.51 | 1.36 | 1.38 |
| Fishery | 0.87 | 0.84 | 0.87 | 0.87 | 0.87 |

From Table 4.11, we can see the ratio change of purchaser price at regional of destination. We can see that most of the ratio here is less than one, it means that the price response positively to the decrease in trade margin. This is the new equilibrium price after imposing the shock. The consumer will get lower price on these agriculture commodities due to this policy shock. If we compare to Table 4.10, the ratio change of purchaser price is greater than the producer price. This is reasonable since the purchaser prices need to be higher than producer prices.

**Table 4.12** Ratio Change in Demand for Domestically Produced Commodities from Baseline Value under Simulation 1

| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|
| Rice | 1.00 | 1.13 | 1.13 | 1.19 | 1.08 |
| Food Crops | 1.11 | 1.23 | 1.17 | 1.20 | 1.10 |
| Estate Crops | 1.09 | 1.15 | 1.11 | 1.13 | 1.07 |
| Livestock | 1.08 | 1.22 | 1.11 | 1.23 | 1.09 |
| Forestry | 1.01 | 0.98 | 0.69 | 1.04 | 0.97 |
| Fishery | 1.14 | 1.40 | 1.12 | 1.15 | 1.09 |

From Table 4.12 we can see that in overall the demand for domestic sourcing commodities increase from their baseline since their ratio is more than 1. It means that demand for domestic commodities response positively to reduction of trade margin. It results are in line with the ones in Table 4.11. As the purchaser price decrease due to the policy shock, the demand for domestic commodities also certainly increases due to the decrease of the purchaser price. Consumer will increase their demand in agriculture commodities since their price becomes less than ones before imposing trade margin shock.

**Table 4.13** Ratio Change in Demand for Domestic Commodities Disaggregated by Region and Relative Rurality from Baseline Value under Simulation 1

| | | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
|---|---|---|---|---|---|---|
| Food Crops | Rural | 1.15 | 1.15 | 1.12 | 1.10 | 1.06 |
| | Urban | 1.16 | 1.26 | 1.14 | 1.19 | 1.10 |
| Estate Crops | Rural | 1.11 | 1.13 | 1.11 | 1.13 | 1.07 |
| | Urban | 1.11 | 1.19 | 1.11 | 1.12 | 1.06 |
| Livestock | Rural | 1.15 | 1.22 | 1.10 | 1.20 | 1.08 |
| | Urban | 1.11 | 1.23 | 1.10 | 1.31 | 1.09 |
| Forestry | Rural | 0.98 | 1.00 | 1.00 | 0.99 | 0.94 |
| | Urban | 1.05 | 0.93 | 1.00 | 0.97 | 1.05 |
| Fishery | Rural | 1.19 | 1.35 | 1.13 | 1.15 | 1.11 |
| | Urban | 1.15 | 1.37 | 1.12 | 1.14 | 1.14 |

Table 4.13 shows the ratio change of demand for domestic commodities disaggregated by region and relative rurality. It can show us more information about the increasing demand due to policy implementation. Most of the ratio is greater than one, but we can see the different magnitude of increasing of demand for agri-food commodities by relative rurality type: rural and urban household. For crop commodity, urban households require more demand than rural households. For livestock commodity, urban households in Java-Bali, Sulawesi, and Eastern Indonesia demand more on this

commodity more than their rural households. Also for fishery, urban households in Java-Bali and Eastern Indonesia demand on this commodity than their rural households. These results can show that this implementation of reduction trade margin policy can impact positively to urban households for certain regions and commodities.

**Table 4.14** Ratio Change in Household Disposable Income and Household from Baseline Value under Simulation 1

| Household Disposable Income | | | | | |
|---|---|---|---|---|---|
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 1.13 | 1.28 | 1.11 | 1.18 | 1.04 |
| Urban | 1.17 | 1.39 | 1.13 | 1.31 | 1.07 |
| **Household Saving** | | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 1.13 | 1.28 | 1.11 | 1.18 | 1.04 |
| Urban | 1.17 | 1.39 | 1.13 | 1.31 | 1.07 |

Table 4.14 shows the ratio change of household disposable income and household saving. We see that urban and rural household income increase by the shock in all regions since both have the ratio greater than one. It means that their income can sustain with the increasing demand of domestic agriculture commodities. This is reasonable since in Table 4.13 there are increasing in demand for these commodities.

**Table 4.15** Ratio Change in Real Consumption and Poverty Incidence from Baseline Value under Simulation 1

| Real Consumption | | | | | |
|---|---|---|---|---|---|
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 0.83 | 0.90 | 0.88 | 0.87 | 1.03 |
| Urban | 0.82 | 0.88 | 0.88 | 0.86 | 1.03 |
| **Poverty Incidence** | | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 0.63 | 0.40 | 0.41 | 0.45 | 0.69 |
| Urban | 0.58 | 0.34 | 0.32 | 0.28 | 0.66 |

Table 4.15 shows the ratio change in real consumption and poverty incidence from their baseline value. Eastern Indonesia is the only region that has ratio greater than one. It means that Eastern Indonesia increase their real consumption compares to other regions due to this policy shock. Ratio of poverty incidence in all regions both in rural and urban household are less than one. It means that decreasing trade margin into the economy is a good policy since it will reduce the poverty incidence.

## 4.4 Simulations 2 and 3: Reduce Transport Margin for Agri-food Sectors and All Sectors

In this section we will explain the result of simulation on reducing transport margin. There are two simulations that we will discuss: SIM2, about reducing transport margin to 50% from the baseline only on agriculture commodities and SIM3, about reducing transport margin to 10% from the baseline on all commodities. We will use the same indicators as in SIM1 so that then in the end we can compare all the simulation.

**Table 4.16** Macroeconomic Outcomes on National Aggregation and Their Ratio Change from Baseline Value under Simulation 2 and Simulation 3

| | National | |
|---|---|---|
| | SIM2 | SIM3 |
| Private Consumption | 572.05 | 1318.77 |
| *Ratio Change* | *0.23* | *0.54* |
| Gov. Consumption | 61.94 | 196.79 |
| *Ratio Change* | *0.42* | *1.32* |
| GDP at Market Price | 1209.28 | 2374.13 |
| *Ratio Change* | *0.38* | *0.75* |
| Net Indirect Taxes | 63.33 | 106.00 |
| *Ratio Change* | *22.2* | *64.87* |

*Note:*
*Ratio Change reflects the increase or decrease from the values obtained during the baseline analysis. It is calculated by dividing its new level value by its baseline value.*

Table 4.16 shows the macroeconomic aggregate in national level, both from SIM2 and SIM3. We can see that both simulations fall down in their private consumption. However, decreasing transport margin to 10% to all commodities will give less decrease in private consumption, compare to decreasing transport margin to 50% only to agriculture commodities. It means that it is better to implement policy on SIM3 rather than SIM2. It is reasonable because in real situation, it is hard to just decreasing transport margin only on agriculture commodities since all commodities distribution is related to the same infrastructure facilities. It also can be explained from the national GDP at market price, that SIM2 has less GDP level than the ones in SIM3.

From Table 4.17 we can see the same macroeconomic indicators in more disaggregated level into five regions. We can see that under SIM2, there is an increase change in private consumption relative to the baseline on all regions except for Sumatra.

It means that by reducing transport margin, private consumption will increase in the region. This result is reasonable because transport margin can burden economic efficiency and thus can affect to private consumption. However, if we compare to SIM2, SIM3 eventually has greater change of private consumption relative to the baseline. It means that reducing transport margin to 10% to all commodities gives more macroeconomics advantages than reducing transport margin to 50% from the baseline only to agriculture commodities. This holds true through all regions. Under SIM2, the change in their regional GDP has lower value. It means that reducing transport cost only to agriculture commodities will not help increase their regional GDP. Now, under SIM3, the change in their regional GDP has positive value. It means that reducing transport cost to all commodities to 10 % will give higher increase in their regional GDP.

**Table 4.17** Macroeconomic Outcomes Regionally Disaggregated and Their Ratio Change from Baseline Value under Simulation 2 and Simulation 3

| | SIM2 | | | | |
|---|---|---|---|---|---|
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Private Consumption | 165.18 | 287.19 | 50.46 | 36.26 | 32.94 |
| *Ratio Change* | *0.08* | *1.09* | *1.01* | *1.11* | *1.08* |
| Gov. Consumption | 17.02 | -16.76 | 10.84 | 10.80 | 2.71 |
| *Ratio Change* | *0.13* | *0.57* | *0.95* | *0.99* | *-0.20* |
| GDP at Market Price | 475.78 | 1100.27 | 219.07 | 85.53 | 90.50 |
| *Ratio Change* | *0.98* | *0.96* | *0.97* | *1.06* | *0.92* |
| Net Indirect Taxes | 9.33 | 70.72 | -41.44 | 3.36 | 3.90 |
| *Ratio Change* | *1.22* | *26.66* | *-4.98* | *0.14* | *-0.08* |

| | SIM3 | | | | |
|---|---|---|---|---|---|
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Private Consumption | 253.42 | 902.12 | 64.12 | 55.04 | 44.06 |
| *Ratio Change* | *0.12* | *3.42* | *1.29* | *1.68* | *1.44* |
| Gov. Consumption | 40.26 | 72.31 | 14.96 | 16.47 | 7.78 |
| *Ratio Change* | *0.31* | *-2.44* | *1.31* | *1.51* | *-0.59* |
| GDP at Market Price | 549.85 | 1574.35 | 245.11 | 102.17 | 101.88 |
| *Ratio Change* | *1.14* | *1.38* | *1.09* | *1.26* | *1.03* |
| Net Indirect Taxes | 8.24 | 112.47 | -37.04 | 3.09 | 3.33 |
| *Ratio Change* | *1.02* | *2.52* | *1.02* | *0.96* | *0.84* |

*Note:*
*Ratio Change reflects the increase or decrease from the values obtained during the baseline analysis. It is calculated by dividing its new level value by its baseline value.*

**Table 4.18** Ratio Change in Producer Prices at Region of Origin from Baseline Value under Simulation 2 and Simulation 3

| | SIM2 | | | | | SIM3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R1 | R2 | R3 | R4 | R5 | R1 | R2 | R3 | R4 | R5 |
| Rice | 0.73 | 0.98 | 1.00 | 1.01 | 1.00 | 1.57 | 0.89 | 0.85 | 0.85 | 0.85 |
| Food Crops | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Estate Crops | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| Livestock | 1.08 | 1.08 | 1.08 | 1.08 | 1.07 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| Forestry | 0.91 | 0.91 | 0.91 | 0.91 | 0.91 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 |
| Fishery | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 |

*Note:*
*R1, R2, R3, R4, R5 denote Sumatra, Java-Bali, Kalimantan, Sulawesi, and Eastern Indonesia, respectively*

From Table 4.18 we can see that under SIM2 producer price in every region does not response to the shock, except for paddy commodity in region Sumatra and Java-Bali. It means that imposing shock by reducing transport margin only on agriculture commodity will not give significant effects to most of the regions. Differ from SIM2, under SIM3 producer price in every region gives positive response to the shock, expect for paddy commodity in region Sumatra. This result gives us some evidence that reducing transport margin to all commodities –to 10% from the baseline can give better results in economic efficiency. The costs for producers to produce agriculture commodities decline as we cut the transport margin to 10% to all commodities.

**Table 4.19** Ratio Change in Purchaser Prices at Region of Destination from Baseline Value under Simulation 2 and Simulation 3

| | SIM2 | | | | | SIM3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R1 | R2 | R3 | R4 | R5 | R1 | R2 | R3 | R4 | R5 |
| Rice | 0.71 | 0.98 | 1.00 | 0.99 | 1.02 | 1.62 | 0.90 | 0.86 | 0.85 | 0.86 |
| Food Crops | 1.00 | 1.00 | 1.00 | 0.99 | 1.01 | 0.86 | 0.85 | 0.85 | 0.85 | 0.86 |
| Estate Crops | 1.00 | 1.01 | 1.00 | 1.00 | 1.01 | 0.86 | 0.85 | 0.85 | 0.85 | 0.86 |
| Livestock | 1.07 | 1.09 | 1.08 | 1.07 | 1.10 | 0.98 | 0.95 | 0.97 | 0.96 | 0.97 |
| Forestry | 0.90 | 0.89 | 0.83 | 0.89 | 0.91 | 1.37 | 1.39 | 1.52 | 1.37 | 1.39 |
| Fishery | 1.00 | 1.00 | 0.99 | 0.99 | 1.01 | 0.87 | 0.84 | 0.88 | 0.87 | 0.88 |

*Note:*
*R1, R2, R3, R4, R5 denote Sumatra, Java-Bali, Kalimantan, Sulawesi, and Eastern Indonesia, respectively*

The ratio change of purchaser price from the baseline at regional of destination can be shown from Table 4.19. Under SIM2, purchaser price for paddy commodity in region Sumatra, Java-Bali, and Sulawesi decline as their response to a reduction of transport margin on agriculture sectors. Eastern Indonesia seems to be less responsive to this shock since most of the ratio change is greater than one. Now if we impose the system by reducing transport margin to all commodities under SIM3, we get positive responses from all regions. Under SIM3 for paddy commodity, Java-Bali less responsive to the policy shock since their regional price decrease less than other regions. For Kalimantan, Sulawesi and Eastern Indonesia, purchaser prices response more by decreasing around 15% from their baseline. This result gives us information that these three regions will get more economic advantages from this policy.

**Table 4.20** Ratio Change in Demand for Domestically Produced Commodities from Baseline Value under Simulation 2 and Simulation 3

| | SIM2 | | | | | SIM3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | R1 | R2 | R3 | R4 | R5 | R1 | R2 | R3 | R4 | R5 |
| Rice | 1.06 | 1.00 | 1.02 | 1.07 | 0.91 | 1.01 | 1.13 | 1.14 | 1.19 | 1.09 |
| Food Crops | 1.01 | 0.97 | 1.00 | 1.04 | 0.95 | 1.12 | 1.24 | 1.17 | 1.20 | 1.10 |
| Estate Crops | 1.00 | 0.98 | 1.00 | 1.04 | 0.95 | 1.09 | 1.16 | 1.11 | 1.13 | 1.07 |
| Livestock | 0.99 | 0.92 | 0.97 | 1.02 | 0.87 | 1.09 | 1.23 | 1.12 | 1.24 | 1.10 |
| Forestry | 1.00 | 0.98 | 1.03 | 1.04 | 0.92 | 1.02 | 0.99 | 0.70 | 1.05 | 0.97 |
| Fishery | 0.99 | 0.95 | 1.00 | 1.03 | 0.90 | 1.15 | 1.40 | 1.13 | 1.16 | 1.10 |

*Note:*
*R1, R2, R3, R4, R5 denote Sumatra, Java-Bali, Kalimantan, Sulawesi, and Eastern Indonesia, respectively*

Table 4.20 shows us the ratio change of demand for domestically produced commodities from the baseline at region of destination. We can see here that the demand response in all regions follows the purchaser price behavior that we discuss from Table 4.19. As the purchaser price decrease, the demand for domestic sourcing has to be increase and this table show that this condition holds true. Under SIM2, Sulawesi has the highest demand than other regions for agri-food commodities. It means that this policy shock will give outcome to Sulawesi the most. In the other side, Eastern Indonesia has the lowest demand for agri-food commodities than other regions. Thus if we only look demand perspective, by imposing shock on transport margin only to agriculture sectors will make one region better off, but at the same time will also make other region worse off. Different results we get when we impose policy shock under SIM3. Here all regions have the ratio greater than one means that their demand for agriculture domestic sourcing will increase as their response to the reduction of transport margin to 10% from their baseline on all commodities.

Table 4.21 shows the ratio change for agri-food commodities disaggregated by relative rurality. Overall, both simulations, SIM2 and SIM3, give the same information that urban households are more affected by the policy shock than rural households. However, under SIM3, the ratio change of household demand in all regions is greater than one. It is reasonable since in the Table 4.19 we show that the purchaser price for agriculture domestic commodities is greater under SIM3 is less than ones under SIM2.

**Table 4.21** Ratio Change in Demand for Domestic Commodities Disaggregated by Region and Relative Rurality from Baseline Value under Simulation 2 and Simulation 3

| | | SIM2 | | | | | SIM3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | R1 | R2 | R3 | R4 | R5 | R1 | R2 | R3 | R4 | R5 |
| Food Crops | Rural | 0.98 | 0.98 | 0.99 | 1.01 | 0.97 | 1.15 | 1.15 | 1.12 | 1.10 | 1.06 |
| | Urban | 0.99 | 0.97 | 0.99 | 1.02 | 0.95 | 1.16 | 1.26 | 1.14 | 1.19 | 1.10 |
| Estate Crops | Rural | 0.99 | 0.98 | 0.99 | 1.01 | 0.97 | 1.11 | 1.13 | 1.11 | 1.13 | 1.07 |
| | Urban | 0.99 | 0.98 | 0.99 | 1.01 | 0.97 | 1.11 | 1.19 | 1.11 | 1.12 | 1.06 |
| Livestock | Rural | 0.92 | 0.92 | 0.95 | 0.97 | 0.84 | 1.15 | 1.22 | 1.10 | 1.20 | 1.08 |
| | Urban | 0.94 | 0.93 | 0.95 | 0.99 | 0.85 | 1.12 | 1.23 | 1.10 | 1.32 | 1.09 |
| Forestry | Rural | 1.00 | 0.99 | 0.99 | 1.00 | 0.98 | 0.98 | 1.00 | 1.00 | 0.99 | 0.94 |
| | Urban | 0.99 | 1.02 | 0.99 | 0.94 | 1.02 | 1.05 | 0.94 | 1.00 | 0.98 | 1.05 |
| Fishery | Rural | 0.98 | 0.96 | 1.00 | 1.01 | 0.94 | 1.19 | 1.35 | 1.13 | 1.15 | 1.11 |
| | Urban | 0.99 | 0.96 | 1.00 | 1.01 | 0.93 | 1.15 | 1.37 | 1.12 | 1.14 | 1.14 |

*Note:*
*R1, R2, R3, R4, R5 denote Sumatra, Java-Bali, Kalimantan, Sulawesi, and Eastern Indonesia, respectively*

Under SIM3, there are special cases where demand from rural household is greater than their urban household. For fishery commodity, rural household in Sumatra, Kalimantan, and Sulawesi have the ratio change greater than their urban household under this policy shock. This result show us that for this commodity, rural households that live in these regions will response more demand due to the reduction of transport margin to all commodities. Therefore, we can recognize that this policy will affect more to rural households in regions Sumatra, Kalimantan, and Sulawesi and also affect more to urban households in regions Java-Bali and Eastern Indonesia.

Table 4.22 shows household disposable income and household saving from both simulations. For the ratio change of household disposable income from the baseline, SIM3 gives higher ratio change than SIM2. This means that the impact of transport margin reduction on all sectors to household income is better than the same reduction by only on agriculture sectors.

**Table 4.22** Ratio Change in Household Disposable Income and Household Saving from Baseline Value under Simulation 2 and Simulation 3

| Household Disposable Income | | | | | |
|---|---|---|---|---|---|
| | SIM2 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 0.97 | 0.94 | 0.99 | 1.03 | 0.91 |
| Urban | 0.97 | 0.93 | 0.99 | 1.05 | 0.90 |
| | SIM3 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 1.13 | 1.28 | 1.10 | 1.18 | 1.04 |
| Urban | 1.17 | 1.39 | 1.13 | 1.30 | 1.07 |
| Hosehold Saving | | | | | |
| | SIM2 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 0.97 | 0.94 | 0.99 | 1.03 | 0.91 |
| Urban | 0.97 | 0.93 | 0.99 | 1.05 | 0.90 |
| | SIM3 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 1.13 | 1.28 | 1.10 | 1.18 | 1.04 |
| Urban | 1.17 | 1.39 | 1.13 | 1.30 | 1.07 |

Under SIM2, Sulawesi has the highest ratio change of household disposable income than other regions. It gives sign that by policy under SIM2, this region has the most gain from the policy. In the other hand, under SIM3 Java-Bali has the highest ratio change of household disposable income than other regions. It means that if the government what to impose reduction on transport margin to all sectors then the impact will be an increasing household income in all region, especially most in Java-Bali, since this region has the highest ratio compare to others.

**Table 4.23** Ratio Change in Real Consumption and Poverty Incidence from Baseline Value under Simulation 2 and Simulation 3

| Real Consumption | | | | | |
|---|---|---|---|---|---|
| | SIM2 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 0.61 | 0.47 | 0.57 | 0.56 | 0.65 |
| Urban | 0.61 | 0.41 | 0.56 | 0.50 | 0.63 |
| | SIM3 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 0.82 | 0.89 | 0.87 | 0.87 | 1.03 |
| Urban | 0.82 | 0.87 | 0.87 | 0.85 | 1.02 |
| Poverty Incidence | | | | | |
| | SIM2 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 1.07 | 1.07 | 1.08 | 0.87 | 1.28 |
| Urban | 1.03 | 1.04 | 1.07 | 0.75 | 1.50 |
| | SIM3 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rural | 0.62 | 0.40 | 0.40 | 0.45 | 0.69 |
| Urban | 0.58 | 0.34 | 0.32 | 0.28 | 0.66 |

This table shows the ratio change in real consumption and poverty incidence from the baseline. From real consumption in both simulations, we can see that most region have ratio less than one except Eastern Indonesia. This signifies that under both simulations, their real consumption will go down as response to the policy shock. Under

SIM3, region Eastern Indonesia instead has ratio greater than one. It means that under this policy shock, Eastern Indonesia will response to have higher real consumption than other regions. Reduction of transport margin in all commodities, will give higher gain to this region particularly. From poverty incidence, SIM2 reduces the level of poverty incidence only in region Sulawesi. In contrast, SIM3 reduces the level of poverty incidence in all region especially in region Java-Bali and Kalimantan. We can also see that the level of poverty incidence in urban area decreases more than in rural area. This gives us important information that reduction transport margin in all commodities will affect poverty level most in urban area than in rural area.

## 4.5 Comparison of Simulation Results

In this section, we will show overall picture of our simulation. The purpose of this is to see the differences outcome from three simulations that we make. We will use the same indicators both in macro and micro level for regional level. However here we only display 5 indicators: nominal macroeconomic aggregate regional, purchaser price at region of destination, household demand for domestically produced commodities, real consumption and poverty incidence. All values are represented relative to their baseline. This will help us to determine the impact of reducing trade cost into the economy. Baseline analysis forms normal simulation without any shock being imposed to the model. It will become our baseline for our simulations. SIM1 forms simulation in reducing trade margin to 50% from the baseline. SIM2 and SIM3 are both form simulation in reducing transport margin from the baseline. The difference is that SIM2 reduces transport margin to 50% only to agriculture commodities; differ from SIM3 which reduces transport margin to 10% but to all commodities in the system.

**Table 4.24** Comparison of Macroeconomic Outcomes disaggregated by Region and Their Ratio Change from Baseline across All Simulations

| | SIM1 | | | | |
|---|---|---|---|---|---|
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Private Consumption | 253.68 | 903.61 | 64.14 | 55.09 | 44.12 |
| *Ratio Change* | *0.12* | *3.43* | *1.29* | *1.68* | *1.44* |
| GDP at Market Price | 550.19 | 1576.23 | 245.16 | 102.22 | 101.85 |
| *Ratio Change* | *1.14* | *1.38* | *1.09* | *1.26* | *1.03* |
| | SIM2 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Private Consumption | 165.18 | 287.19 | 50.46 | 36.26 | 32.94 |
| *Ratio Change* | *0.08* | *1.09* | *1.01* | *1.11* | *1.08* |
| GDP at Market Price | 475.78 | 1100.27 | 219.07 | 85.53 | 90.5 |
| *Ratio Change* | *0.98* | *0.96* | *0.97* | *1.06* | *0.92* |
| | SIM3 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Private Consumption | 253.42 | 902.12 | 64.12 | 55.04 | 44.06 |
| *Ratio Change* | *0.12* | *3.42* | *1.29* | *1.68* | *1.44* |
| GDP at Market Price | 549.85 | 1574.35 | 245.11 | 102.17 | 101.88 |
| *Ratio Change* | *1.14* | *1.38* | *1.09* | *1.26* | *1.03* |

*Note:*
*Ratio Change reflects the increase or decrease from the values obtained during the baseline analysis. It is calculated by dividing its new level value by its baseline value.*

Here we only display private consumption and regional GDP at market price for nominal macroeconomic aggregate regional. We will compare these three simulation outcomes in the same table. It is relevant to compare SIM1 and SIM2 because both simulations reduce the trade costs only to agriculture sectors, differ from SIM3 where we reduce the trade costs to all sectors. Under private consumption, SIM1 generates higher change relative to their baseline compare to SIM2. With the same magnitude of shock and the same commodity to be shock, the outcome from SIM1 is better then. This result clarifies that reducing trade margin to 50% generate higher private consumption than reducing transport margin to 50% from the baseline on agri-food commodities. Next, we compare SIM1 and SIM3 that have different scenarios. Under SIM3, we impose the shock to the equilibrium by reducing transport margin to 10% to all sectors. We can see from this table that both simulations, SIM1 and SIM3, generate almost the same level of change in private consumption and in regional GDP at market price. So in the next tables, we will see microeconomic indicators from these simulations.

In Table 4.25 we can see that the outcome on the purchaser price at regional destination from three different simulations. It is clear that SIM1 is better than SIM3 since it generates lower purchaser price relative to their baseline. If we compare SIM1 to SIM3 we can see that SIM1 has slightly lower purchaser price for paddy commodity in region Kalimantan, Sulawesi and Eastern Indonesia. In the other hand, for livestock and fishery commodities, we can see that SIM3 has slightly lower purchaser price than SIM1. It means that for these two commodities, transports margin gives more impact to the market price than its trade margin.

**Table 4.25** Comparison of Ratio Change in Purchaser Prices at Region of Destination from Baseline Value across All Simulations

| | SIM1 | | | | |
|---|---|---|---|---|---|
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rice | 1.63 | 0.90 | 0.85 | 0.85 | 0.86 |
| Livestock | 0.98 | 0.96 | 0.97 | 0.96 | 0.98 |
| Fishery | 0.87 | 0.84 | 0.88 | 0.87 | 0.88 |
| | SIM2 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rice | 0.71 | 0.98 | 0.99 | 0.98 | 1.02 |
| Livestock | 1.07 | 1.09 | 1.08 | 1.07 | 1.10 |
| Fishery | 0.99 | 1.00 | 0.99 | 0.99 | 1.01 |
| | SIM3 | | | | |
| | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Rice | 1.62 | 0.90 | 0.86 | 0.85 | 0.86 |
| Livestock | 0.98 | 0.95 | 0.97 | 0.95 | 0.97 |
| Fishery | 0.87 | 0.84 | 0.88 | 0.87 | 0.88 |

**Table 4.26** Comparison of Ratio Change in Household Demand for Domestic Commodities from Baseline Value across All Simulations.

| | | SIM1 | | | | |
|---|---|---|---|---|---|---|
| | | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Food Crops | Rural | 1.16 | 1.15 | 1.13 | 1.11 | 1.07 |
| | Urban | 1.16 | 1.26 | 1.15 | 1.20 | 1.10 |
| Livestock | Rural | 1.15 | 1.22 | 1.10 | 1.20 | 1.08 |
| | Urban | 1.12 | 1.23 | 1.10 | 1.32 | 1.10 |
| | | SIM2 | | | | |
| | | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Food Crops | Rural | 0.98 | 0.98 | 0.99 | 1.01 | 0.97 |
| | Urban | 0.99 | 0.97 | 0.99 | 1.02 | 0.96 |
| Livestock | Rural | 0.92 | 0.92 | 0.95 | 0.98 | 0.85 |
| | Urban | 0.95 | 0.93 | 0.96 | 0.99 | 0.85 |
| | | SIM3 | | | | |
| | | Sumatra | Java-Bali | Kalimantan | Sulawesi | Eastern Ind. |
| Food Crops | Rural | 1.16 | 1.15 | 1.13 | 1.11 | 1.07 |
| | Urban | 1.16 | 1.26 | 1.15 | 1.20 | 1.10 |
| Livestock | Rural | 1.16 | 1.22 | 1.12 | 1.21 | 1.09 |
| | Urban | 1.12 | 1.24 | 1.10 | 1.32 | 1.10 |

**Table 4.27** Comparison of Ratio Change in Real Consumption and Poverty Incidence from Baseline Value across All Simulations

| | Real Consumption | | | | | Poverty Incidence | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SIM1 | | | | | SIM1 | | | | |
| | R1 | R2 | R3 | R4 | R5 | R1 | R2 | R3 | R4 | R5 |
| Rural | 0.830 | 0.901 | 0.880 | 0.874 | 1.030 | 0.628 | 0.401 | 0.407 | 0.454 | 0.690 |
| Urban | 0.824 | 0.881 | 0.877 | 0.858 | 1.026 | 0.582 | 0.342 | 0.322 | 0.277 | 0.666 |
| | SIM2 | | | | | SIM2 | | | | |
| | R1 | R2 | R3 | R4 | R5 | R1 | R2 | R3 | R4 | R5 |
| Rural | 0.610 | 0.471 | 0.571 | 0.561 | 0.657 | 1.070 | 1.074 | 1.085 | 0.872 | 1.283 |
| Urban | 0.615 | 0.418 | 0.562 | 0.509 | 0.630 | 1.038 | 1.045 | 1.072 | 0.751 | 1.503 |
| | SIM3 | | | | | SIM3 | | | | |
| | R1 | R2 | R3 | R4 | R5 | R1 | R2 | R3 | R4 | R5 |
| Rural | 0.829 | 0.898 | 0.879 | 0.873 | 1.031 | 0.629 | 0.403 | 0.409 | 0.455 | 0.690 |
| Urban | 0.823 | 0.878 | 0.876 | 0.857 | 1.027 | 0.583 | 0.346 | 0.324 | 0.282 | 0.666 |

*Note:*
*R1, R2, R3, R4, R5 denote Sumatra, Java-Bali, Kalimantan, Sulawesi, Eastern Indonesia, respectively*

From Table 4.26, we can see that under SIM1 for food crop commodity, the household demand in both rural and urban types are the same with ones under SIM3. However, for livestock commodity under SIM3, their demand in both types of household is slightly higher than the ones in SIM1. This is appropriate because livestock trade depend more on transportation sectors. Table 4.27 shows us the ratio change in real consumption and in poverty incidence from all simulations. There is different real consumption across regions because this model calculates the real consumption by dividing household disposable incomes by household specific CPI which varies across regions and types of household.

From real consumption indicator, we can see in that only region R5 has increase their real consumption due to the policy shock under SIM1 and SIM3. However, the magnitude of this change is slightly different. For region Sumatra, Java-Bali, Kalimantan and Sulawesi the magnitude of this change is higher under SIM1. For region Eastern Indonesia, the magnitude of this change is higher under SIM3. This means that Eastern Indonesia has more concern in transport margin barriers than trade margin barriers likes other regions. From poverty incidence, we can see that only region Eastern Indonesia has the same level of decline in poverty incidence between SIM1 and SIM3. Furthermore, remaining regions under SIM1 eventually have more level of decline in poverty incidence under SIM1 than under SIM3, both in rural and urban area.

# CHAPTER FIVE

# CONCLUSION AND FURTHER RESEARCH

## 5.1 Conclusions

At the national level, Indonesia has sufficient food production to satisfy its domestic food needs. At a regional level, however, not all regions have the same endowment of agricultural productive capacity. This, combined with variable quality transportation infrastructure, has contributed to regional variations in food prices and, as consequence food consumption. In turn, these high and variable food price differences have contributed to a lumpy distribution of the incidence of both food insecurity and poverty across Indonesia's regions.

In examining regional prices, agricultural products across Indonesia's regions were found to have highly variable regional prices differences. This significant deviation from market price parity suggests that high and variable interregional trade costs exist. This outcome is expected given that Indonesia consists of a geographic archipelago that poses natural barriers to interregional trade. The purpose of this study is to analyze the impact of interregional trade costs on welfare and interregional market integration in the Indonesia economy.

This analysis makes use of a Computable General Equilibrium (CGE) framework to analyze the impact of trade costs. This framework is a comprehensive economic model that explicitly defines economic agents in an economy, and treats the economy as a system of many interrelated markets. Importantly, among its major advantages, CGE models can be used to assess the impact of policies and predict the impact of proposed policy changes. Trade policy evaluation is among its most frequent applications. In this study, we use an Interregional CGE (IRCGE) to assess the impact of interregional trade costs. A five-region Indonesia IRCGE model developed by Resosudarmo et al. (2009), the IRSA-Indonesia5, was the basis of the model used in this analysis. This model, however, could not be directly used evaluate the impact of interregional trade costs analysis since the database and the model do not explicitly include trade costs components. As such, as a starting place for this current study, both the Interregional Social Accounting Matrix (IRSAM) and IRCGE model developed by Resosudarmo et al were modified for use in this study. Following this, the impact of various components of trade costs in Indonesia's interregional trade and food consumption are evaluated. Specifically, the impact of trade costs under three scenarios is considered: (1) reduce trade margin to 50% of its baseline value for all agri-food commodities (SIM1); (2) reduce transport margin to 50% of its baseline value for all agri-food commodities (SIM2); and (3) reduce transport margin to 10% of its baseline value for all (not just agri-food) commodities (SIM3).

As anticipated, results from these simulations varied depend upon which type of trade costs were adjusted, which sectors the trade cost change was applied to, and the magnitude of the trade cost change. Under SIM1 in which trade margins were reduced in the agri-food sectors, the GDP in all regions was found to be higher than in the baseline analysis; this result indicates that reducing trade margins is a potentially effective means to improve Indonesia's economic outcomes, regardless of whether the region is a net importer or exporter of agri-food goods. By lowering the transport margins in agricultural sectors (SIM2), we find out that for all regions except Sulawesi, regional GDP decreases from its baseline values after the shock is imposed. This result is in stark contrast to the finding from SIM1. Even when conditioned on the relative magnitude of the size of trade and transportation margins are taken into consideration, and these results suggest that reducing trade, or "soft infrastructure" margins, offers the more effective approach to improving economic outcomes across Indonesia's regions.

The third simulation explores the market outcomes when transportation margins are uniformly reduced by 90% across all economic sectors. This scenario was meant to reflect a 'best case' outcome for Indonesia's economy should significant resources be directed to improving the country's hard infrastructure. Under SIM3, we find out that, for three of Indonesia's five regions, regional GDP improves after this transportation cost is reduced. For Sulawesi and Eastern Indonesia, however, their regional GDP decreases as a result of this change. As these regions are already those with the highest incidence of poverty, this is an important outcome that is worth further exploration.

Another interesting outcome relates to the impact of reduced trade costs on the poverty incidence. For SIM1, where trade margins were reduced for the agricultural sector, the poverty incidence decreased. Importantly, and not surprisingly, while the poverty incidence for residence in all regions improved, the primary beneficiaries of the improved efficiency of this sector were those live in urban areas. A similar pattern of findings, and a nearly equivalent impact on the incidence of poverty was predicted after a very significant 90% reduction in the transport margin applied to all sectors (SIM3).

The results of this study will be useful to policy makers in Indonesia's government. This is especially true for Ministry of Agriculture (MoA) since reducing poverty, food insecurity, and regional disparities are among the MoA priorities and remains as a major challenge. This study can show how trade costs can affect interregional trade within the regions and consequently affect to market integration and poverty alleviation. In general, if Indonesia's government has as a goal to reduce poverty alleviation levels, then these results show that it is better for the government to reduce trade margins to 50% in agri-food sectors (SIM1) than to introduce a policy of reducing the transport margin to 10% in all sectors (SIM3). This recommendation is due to the relative impacts on GDP which are higher under SIM1than under SIM3, with very comparable changes in the incidence of poverty. These results provide additional evidence of that trade costs on agri-food sectors play an important role in interregional trade flows within Indonesia.

## 5.2 Further Research

Several opportunities exist to extend this current analysis. At present this analysis disaggregates trade costs from the value of traded goods, and allocates these costs across economic sectors in a manner proportionate to the volume of trade in each region and sector. This assumption did not consider either the impact of relative distance on the cost of trade between regions or regional variations in the quality of trading institutions (soft infrastructure). To enable a more realistic assessment of the impact of trade than is possible with the simplified approach that we use here, in future research we recommend alternative methods of allocating these costs be considered.

We also suggest for further research explores the impact that requiring a means to pay for each trade cost reduction (a compensation scheme) has on the anticipated economic benefits of reducing these costs. Reducing the cost of trade is not costless. As described by Kuhn (2005), measures to improve the soft and hard infrastructure needed to facilitate trade includes the establishment of market information systems, the establishment of quality norms, better training and salaries for civil servants, legal system improvements, and other similar elements. For simplicity, as a starting point, an instrument could be introduced that imposes a higher federal tax on some targeted (or all) sectors to finance the trade infrastructure improvements. Inevitably, as a consequence of increasing taxes, total welfare will decrease. This analysis could explore the relative welfare impacts to producers, and consumers in different regions as a result of alternative policy compensation options.

Finally, this analysis considers only domestic trade costs and assumes that international trade costs are embedded in the prices of commodities supplied to and sourced from 'Rest of World' (RoW) markets. While it is recognized that the impact of international trade costs will have a more muted impact on interregional trade flows, additional work to explicitly include export and import trade margins would permit a more holistic examination of the impact of trade costs on Indonesia.

APPENDICES

## APPENDIX A

## Classification 33 Provinces

Table A.1 Classification 33 Provinces

| No | Province | No | Region |
|---|---|---|---|
| 1 | Nanggroe Aceh Darussalam | 1 | Sumatra (R1) |
| 2 | North Sumatra | | |
| 3 | West Sumatra | | |
| 4 | Riau | | |
| 5 | Jambi | | |
| 6 | South Sumatra | | |
| 7 | Bengkulu | | |
| 8 | Lampung | | |
| 9 | Kepulauan Bangka Belitung | | |
| 10 | Kepulauan Riau | | |
| 11 | DKI Jakarta | 2 | Java-Bali (R2) |
| 12 | West Java | | |
| 13 | Central Java | | |
| 14 | D.I. Jogyakarta | | |
| 15 | East Java | | |
| 16 | Banten | | |
| 17 | Bali | | |
| 18 | West Nusa Tenggara | | |
| 19 | East Nusa Tenggara | | |
| 20 | West Kalimantan | 3 | Kalimantan (R3) |
| 21 | Central Kalimantan | | |
| 22 | South Kalimantan | | |
| 23 | East Kalimantan | | |
| 24 | North Sulawesi | 4 | Sulawesi (R4) |
| 25 | Central Sulawesi | | |
| 26 | South Sulawesi | | |
| 27 | South Eash Sulawesi | | |
| 28 | Gorontalo | | |
| 29 | West Sulawesi | | |
| 30 | Maluku | 5 | Eastern Indonesia (R5) |
| 31 | North Maluku | | |
| 32 | West Papua | | |
| 33 | Papua | | |

APPENDIX B

Map of Indonesia

Figure B.1 Map of Indonesia (adapted from BPS 2009)

# APPENDIX C

## Transport and Trade Margin

Table C.1 Transport Margin (part 1)

| | PADDY | CROPS | ESTCR | ANIMA | FORES | FISHE | OILGS | OTMIN | OILRE | PALMO | FOSEA | FOODB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R1R1 | 19,971.08 | 16,039.90 | 64,093.50 | 194,254.48 | 20,861.58 | 63,349.39 | 2,968.72 | 44,324.78 | 20,040.33 | 217,152.12 | 144,024.59 | 807,483.55 |
| R2R1 | 1,009.01 | 535.25 | 2,633.92 | 9,828.04 | 1,333.38 | 3,311.87 | 228.56 | 2,532.51 | 1,400.55 | 16,800.52 | 7,373.25 | 31,696.90 |
| R3R1 | 686.16 | 348.64 | 1,105.38 | 6,555.36 | 716.35 | 1,974.94 | 126.37 | 1,608.18 | 789.81 | 8,800.97 | 4,086.68 | 18,313.00 |
| R4R1 | 51.54 | 28.20 | 152.09 | 564.80 | 45.74 | 185.49 | 7.23 | 44.40 | 62.86 | 973.86 | 401.12 | 1,567.59 |
| R5R1 | 27.29 | 15.09 | 88.50 | 300.58 | 26.32 | 101.23 | 4.15 | 24.56 | 35.16 | 547.30 | 223.43 | 866.64 |
| | | | | | | | | | | | | |
| R1R2 | 770.83 | 706.97 | 698.22 | 16,273.92 | 218.92 | 802.18 | 46.94 | 3,748.40 | 1,953.88 | 1,395.74 | 6,743.53 | 125,444.96 |
| R2R2 | 64,875.97 | 42,607.59 | 20,819.97 | 443,504.22 | 4,332.42 | 60,082.40 | 607.42 | 28,131.85 | 36,739.04 | 31,574.49 | 164,025.28 | 2,467,958.62 |
| R3R2 | 475.17 | 570.71 | 566.12 | 20,812.58 | 175.27 | 855.56 | 46.83 | 2,511.36 | 1,292.30 | 1,591.04 | 7,547.69 | 731,614.95 |
| R4R2 | 45.42 | 75.25 | 55.31 | 1,739.17 | 13.07 | 97.28 | 2.70 | 61.44 | 48.78 | 136.24 | 696.04 | 11,604.87 |
| R5R2 | 18.90 | 32.15 | 23.31 | 671.37 | 5.48 | 40.21 | 2.49 | 25.93 | 20.74 | 70.93 | 291.23 | 5,098.62 |
| | | | | | | | | | | | | |
| R1R3 | 234.87 | 306.40 | 1,679.20 | 2,694.06 | 1,258.62 | 954.00 | 101.19 | 9,618.95 | 5,268.69 | 1,901.34 | 449.96 | 4,596.13 |
| R2R3 | 309.46 | 452.94 | 1,709.78 | 3,818.77 | 1,306.89 | 1,493.06 | 97.24 | 8,269.53 | 6,521.92 | 3,001.73 | 768.69 | 5,787.53 |
| R3R3 | 7,375.81 | 3,629.18 | 23,861.00 | 54,132.27 | 9,451.00 | 22,396.70 | 1,131.69 | 139,605.93 | 76,906.52 | 26,464.29 | 10,189.65 | 99,672.29 |
| R4R3 | 32.82 | 50.13 | 167.74 | 409.43 | 129.87 | 164.36 | 8.86 | 737.08 | 660.97 | 337.12 | 83.25 | 601.54 |
| R5R3 | 18.49 | 28.61 | 95.54 | 228.31 | 74.37 | 91.87 | 4.77 | 411.43 | 361.17 | 192.21 | 44.64 | 336.31 |
| | | | | | | | | | | | | |
| R1R4 | 16.94 | 12.89 | 13.19 | 165.29 | 10.03 | 67.82 | 0.00 | 46.45 | 0.00 | 73.50 | 60.57 | 374.43 |
| R2R4 | 307.72 | 253.28 | 321.44 | 2,927.50 | 155.78 | 1,212.37 | 0.08 | 489.54 | 0.00 | 949.62 | 709.15 | 4,117.49 |
| R3R4 | 333.66 | 81.05 | 252.02 | 1,873.47 | 25.11 | 1,303.98 | 0.06 | 349.07 | 0.00 | 497.05 | 634.73 | 3,341.76 |
| R4R4 | 10,719.14 | 5,118.27 | 17,202.72 | 48,556.85 | 2,126.70 | 35,417.41 | 4.30 | 27,881.55 | 0.00 | 17,865.75 | 24,445.00 | 158,417.44 |
| R5R4 | 19.91 | 6.87 | 22.51 | 111.17 | 2.00 | 78.45 | 0.01 | 31.57 | 0.00 | 41.35 | 45.17 | 235.09 |
| | | | | | | | | | | | | |
| R1R5 | 1.85 | 1.97 | 1.34 | 1.24 | 6.85 | 6.51 | 0.12 | 9.23 | 0.00 | 4.61 | 5.96 | 4.64 |
| R2R5 | 8.70 | 30.04 | 17.06 | 35.30 | 50.76 | 128.33 | 0.00 | 2,679.32 | 0.00 | 1.67 | 122.91 | 197.71 |
| R3R5 | 5.45 | 23.60 | 14.57 | 39.84 | 14.70 | 181.19 | 0.00 | 2,096.96 | 0.00 | 1.00 | 71.34 | 235.36 |
| R4R5 | 7.39 | 26.90 | 18.62 | 37.67 | 16.29 | 141.76 | 0.00 | 2,640.69 | 0.00 | 1.43 | 93.96 | 169.49 |
| R5R5 | 5,367.98 | 9,127.48 | 3,794.71 | 60,944.64 | 2,542.21 | 21,296.73 | 34.25 | 193,210.18 | 626.71 | 283.12 | 13,546.65 | 90,901.90 |
| SUM | 112,691.56 | 80,109.37 | 139,407.75 | 870,480.33 | 44,899.72 | 215,735.09 | 5,424.01 | 471,090.89 | 152,729.44 | 330,659.01 | 386,684.48 | 4,570,638.82 |

Table C.2 Transport Margin (part 2)

| | TEXTL | SHOES | WOODS | PULPP | RUBBR | CHEMI | CEMNT | BMETL | METAL | MACHI | VEHIC | OTIND |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R1R1 | 29,026.05 | 2,999.46 | 396,147.22 | 1,195,325.47 | 160,666.61 | 26,088.90 | 33,938.50 | 70,829.89 | 31,093.47 | 38,640.78 | 965.66 | 96,828.85 |
| R2R1 | 1,552.52 | 60.75 | 21,261.74 | 58,224.15 | 1,615.00 | 1,630.32 | 750.56 | 1,354.21 | 1,715.59 | 1,991.28 | 58.60 | 5,161.20 |
| R3R1 | 877.40 | 40.98 | 8,455.81 | 27,629.77 | 19,958.97 | 940.08 | 487.13 | 0.00 | 810.85 | 966.96 | 27.79 | 2,072.02 |
| R4R1 | 82.40 | 3.83 | 1,255.85 | 3,314.43 | 843.00 | 87.85 | 44.33 | 58.82 | 100.14 | 103.96 | 3.14 | 306.27 |
| R5R1 | 45.70 | 2.04 | 731.19 | 1,899.19 | 480.84 | 48.56 | 23.79 | 32.05 | 57.33 | 59.67 | 1.80 | 179.15 |
| | | | | | | | | | | | | |
| R1R2 | 18,141.94 | 4,882.06 | 16,396.75 | 304,496.67 | 12,124.85 | 0.00 | 1,224.95 | 1,456.39 | 3,668.21 | 40,900.56 | 15,343.28 | 15,676.15 |
| R2R2 | 760,993.40 | 183,431.46 | 807,112.56 | 681,218.71 | 270,214.11 | 220,896.07 | 74,341.28 | 67,061.87 | 90,920.47 | 979,205.44 | 293,815.37 | 449,451.95 |
| R3R2 | 19,167.37 | 2,884.77 | 13,008.98 | 262,309.84 | 13,779.93 | 6,959.82 | 1,200.95 | 1,188.57 | 4,167.72 | 130,921.08 | 18,054.72 | 14,782.60 |
| R4R2 | 1,406.46 | 177.76 | 1,548.78 | 3,772.16 | 953.87 | 485.34 | 117.67 | 80.94 | 278.74 | 2,969.56 | 1,381.19 | 1,166.34 |
| R5R2 | 720.42 | 73.94 | 708.76 | 1,583.30 | 408.49 | 325.62 | 47.91 | 47.39 | 111.02 | 1,270.70 | 1,277.60 | 551.73 |
| | | | | | | | | | | | | |
| R1R3 | 54.54 | 0.00 | 19,013.87 | 7,548.87 | 900.45 | 1,325.62 | 0.00 | 84.80 | 0.00 | 0.00 | 80.29 | 955.45 |
| R2R3 | 60.73 | 0.00 | 28,786.90 | 14,075.94 | 1,267.30 | 2,117.35 | 0.00 | 148.09 | 0.00 | 0.00 | 77.30 | 798.05 |
| R3R3 | 1,752.04 | 0.00 | 692,862.86 | 151,772.91 | 18,690.36 | 23,586.86 | 0.00 | 782.49 | 0.00 | 0.00 | 2,270.46 | 18,784.59 |
| R4R3 | 5.88 | 0.00 | 3,066.01 | 1,517.15 | 138.15 | 225.91 | 0.00 | 17.22 | 0.00 | 0.00 | 7.17 | 68.35 |
| R5R3 | 3.18 | 0.00 | 1,664.62 | 791.65 | 78.62 | 121.09 | 0.00 | 9.95 | 0.00 | 0.00 | 3.94 | 37.09 |
| | | | | | | | | | | | | |
| R1R4 | 3.67 | 0.00 | 316.41 | 19.88 | 1.12 | 0.63 | 52.57 | 12.96 | 9.27 | 0.99 | 5.22 | 67.50 |
| R2R4 | 41.41 | 0.00 | 3,557.76 | 224.12 | 0.00 | 6.47 | 545.30 | 146.44 | 93.68 | 9.81 | 57.55 | 739.47 |
| R3R4 | 34.37 | 0.00 | 2,586.43 | 148.77 | 8.76 | 6.10 | 391.75 | 143.11 | 70.40 | 7.59 | 38.40 | 600.40 |
| R4R4 | 1,604.59 | 0.00 | 112,441.65 | 8,587.79 | 520.92 | 168.50 | 23,872.63 | 5,223.90 | 3,729.51 | 448.89 | 1,808.87 | 29,729.64 |
| R5R4 | 2.51 | 0.00 | 224.05 | 13.90 | 0.84 | 0.43 | 39.33 | 9.70 | 6.65 | 0.69 | 3.21 | 51.81 |
| | | | | | | | | | | | | |
| R1R5 | 0.74 | 0.00 | 9.15 | 2.62 | 0.86 | 4.08 | 0.00 | 0.26 | 0.16 | 0.00 | 1.03 | 0.53 |
| R2R5 | 4.27 | 0.00 | 245.83 | 8.96 | 0.85 | 1.79 | 0.00 | 0.85 | 2.37 | 0.00 | 3.63 | 9.58 |
| R3R5 | 3.93 | 0.00 | 9.38 | 8.03 | 0.69 | 1.60 | 0.00 | 0.53 | 0.76 | 0.00 | 4.09 | 8.30 |
| R4R5 | 4.25 | 0.00 | 13.50 | 9.17 | 0.90 | 2.05 | 0.00 | 0.78 | 0.97 | 0.00 | 3.32 | 9.63 |
| R5R5 | 3,190.69 | 0.00 | 31,296.32 | 3,535.77 | 266.18 | 196.42 | 0.00 | 418.79 | 66.23 | 0.00 | 1,606.50 | 9,240.62 |
| SUM | 838,780.49 | 194,557.05 | 2,162,722.38 | 2,728,039.23 | 502,921.66 | 285,227.46 | 137,078.65 | 149,110.01 | 136,903.54 | 1,197,497.97 | 336,900.14 | 647,277.28 |

## Table C.3 Trade Margin (part 1)

| | PADDY | CROPS | ESTCR | ANIMA | FORES | FISHE | OILGS | OTMIN | OILRE | PALMO | FOSEA | FOODB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R1R1 | 47,027.51 | 112,952.39 | 279,857.25 | 1,206,899.68 | 103,028.65 | 493,014.52 | 443.89 | 71,582.93 | 71,248.96 | 2,263,292.92 | 1,342,444.41 | 3,591,201.03 |
| R2R1 | 218.95 | 438.81 | 6,201.80 | 5,204.81 | 3,584.13 | 7,777.22 | 19.65 | 1,330.75 | 1,509.28 | 37,901.70 | 65,197.98 | 61,815.70 |
| R3R1 | 92.30 | 179.53 | 2,726.84 | 2,131.11 | 1,591.48 | 3,273.71 | 8.59 | 457.01 | 519.00 | 12,610.73 | 29,440.84 | 27,021.04 |
| R4R1 | 52.93 | 102.96 | 1,563.79 | 1,222.15 | 912.68 | 1,877.42 | 4.92 | 262.09 | 297.64 | 7,232.03 | 16,883.80 | 15,496.09 |
| R5R1 | 67.49 | 131.28 | 1,993.98 | 1,558.35 | 1,163.75 | 2,393.87 | 6.28 | 334.18 | 379.52 | 9,221.48 | 21,528.33 | 19,758.87 |
| | | | | | | | | | | | | |
| R1R2 | 356.30 | 1,421.43 | 157.02 | 6,953.99 | 129.78 | 1,039.83 | 1.00 | 101.93 | 156.09 | 537.31 | 2,759.13 | 41,285.20 |
| R2R2 | 157,209.56 | 354,666.19 | 87,162.27 | 2,648,451.70 | 18,828.82 | 393,393.76 | 667.24 | 72,057.15 | 75,303.90 | 366,470.43 | 1,691,145.48 | 21,987,165.16 |
| R3R2 | 703.13 | 3,674.91 | 342.02 | 20,229.77 | 439.63 | 2,656.34 | 1.38 | 223.14 | 323.00 | 643.22 | 4,836.43 | 80,666.61 |
| R4R2 | 238.70 | 1,290.38 | 117.69 | 7,187.94 | 158.28 | 931.52 | 0.44 | 76.83 | 110.39 | 197.82 | 1,611.89 | 27,344.69 |
| R5R2 | 213.05 | 1,151.74 | 105.05 | 6,415.68 | 141.28 | 831.44 | 0.39 | 68.58 | 98.53 | 176.56 | 1,438.71 | 24,406.82 |
| | | | | | | | | | | | | |
| R1R3 | 129.63 | 161.07 | 380.00 | 1,046.27 | 198.30 | 686.89 | 0.61 | 753.74 | 719.15 | 722.84 | 568.68 | 3,277.69 |
| R2R3 | 425.97 | 524.29 | 1,049.89 | 3,116.89 | 533.02 | 1,980.94 | 1.47 | 2,229.48 | 1,739.23 | 2,219.37 | 1,787.62 | 10,519.26 |
| R3R3 | 18,980.10 | 25,005.12 | 79,929.89 | 297,112.98 | 54,989.52 | 162,162.85 | 197.18 | 144,000.19 | 235,145.91 | 229,720.74 | 87,463.23 | 487,002.34 |
| R4R3 | 114.62 | 143.66 | 384.62 | 1,003.69 | 204.35 | 674.90 | 0.66 | 726.96 | 788.42 | 677.29 | 522.69 | 2,959.79 |
| R5R3 | 134.91 | 169.08 | 452.70 | 1,181.35 | 240.52 | 794.36 | 0.78 | 855.64 | 927.98 | 797.17 | 615.21 | 3,483.69 |
| | | | | | | | | | | | | |
| R1R4 | 11.02 | 13.93 | 24.87 | 101.12 | 3.39 | 113.17 | 0.00 | 19.18 | 0.00 | 92.16 | 113.48 | 297.16 |
| R2R4 | 158.39 | 218.68 | 375.58 | 1,456.60 | 44.85 | 1,640.07 | 0.01 | 259.57 | 0.00 | 1,309.73 | 1,879.43 | 4,844.12 |
| R3R4 | 106.47 | 126.69 | 232.42 | 975.40 | 34.40 | 1,087.29 | 0.00 | 192.26 | 0.00 | 896.57 | 989.32 | 2,623.79 |
| R4R4 | 24,457.95 | 30,686.92 | 52,222.78 | 239,045.39 | 7,888.68 | 272,386.49 | 0.69 | 36,201.59 | 0.00 | 165,529.19 | 219,173.66 | 549,567.47 |
| R5R4 | 83.41 | 99.26 | 182.09 | 764.20 | 26.95 | 851.86 | 0.00 | 150.63 | 0.00 | 702.44 | 775.11 | 2,055.66 |
| | | | | | | | | | | | | |
| R1R5 | 5.60 | 1.36 | 1.77 | 4.14 | 5.69 | 7.81 | 0.37 | 1.27 | 0.00 | 16.84 | 25.44 | 15.71 |
| R2R5 | 116.74 | 357.93 | 98.60 | 1,420.20 | 301.68 | 1,896.85 | 0.00 | 1,412.11 | 0.00 | 121.04 | 13,443.61 | 17,598.21 |
| R3R5 | 145.68 | 476.12 | 131.32 | 2,037.34 | 461.18 | 2,806.21 | 0.00 | 1,833.90 | 0.00 | 184.99 | 20,554.04 | 24,753.84 |
| R4R5 | 424.36 | 1,386.90 | 382.52 | 5,934.63 | 1,343.38 | 8,174.29 | 0.01 | 5,342.00 | 0.01 | 538.88 | 59,872.38 | 72,106.09 |
| R5R5 | 10,062.15 | 46,746.00 | 10,566.54 | 286,406.05 | 8,781.39 | 130,776.37 | 6.42 | 210,660.90 | 3,376.80 | 962.61 | 43,426.47 | 329,376.27 |
| SUM | 261,536.94 | 582,126.62 | 526,643.31 | 4,747,861.43 | 205,035.79 | 1,493,229.99 | 1,361.99 | 551,134.00 | 392,643.80 | 3,102,776.04 | 3,628,497.34 | 27,386,642.32 |

Table C.4 Trade Margin (part 2)

| | TEXTL | SHOES | WOODS | PULPP | RUBBR | CHEMI | CEMNT | BMETL | METAL | MACHI | VEHIC | OTIND |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R1R1 | 247,637.36 | 5,602.29 | 1,184,558.38 | 1,347,922.45 | 982,687.84 | 152,362.75 | 50,099.40 | 145,341.15 | 130,335.63 | 305,921.36 | 10,144.65 | 329,081.65 |
| R2R1 | 2,444.07 | 9.39 | 37,300.91 | 77,365.35 | 25,435.33 | 1,588.58 | 122.62 | 1,401.83 | 3,258.76 | 11,466.34 | 282.58 | 10,283.06 |
| R3R1 | 1,044.89 | 4.28 | 15,856.28 | 35,276.68 | 8,694.59 | 596.62 | 45.30 | 0.00 | 1,434.58 | 5,229.06 | 111.38 | 4,532.90 |
| R4R1 | 599.23 | 2.46 | 9,093.29 | 20,230.55 | 4,986.19 | 342.15 | 25.98 | 214.15 | 822.71 | 2,998.77 | 63.87 | 2,599.54 |
| R5R1 | 764.07 | 3.13 | 11,594.75 | 25,795.72 | 6,357.83 | 436.28 | 33.12 | 273.06 | 1,049.03 | 3,823.70 | 81.44 | 3,314.64 |
| | | | | | | | | | | | | |
| R1R2 | 17,015.90 | 4,255.84 | 523,872.89 | 578,590.95 | 8,746.38 | 0.00 | 118.10 | 805.78 | 713.03 | 12,882.29 | 8,899.59 | 8,615.73 |
| R2R2 | 4,647,692.50 | 443,737.40 | 1,210,948.85 | 571,330.00 | 2,034,789.48 | 1,326,042.77 | 131,126.13 | 167,068.08 | 309,472.66 | 7,011,586.53 | 3,551,436.34 | 1,510,829.92 |
| R3R2 | 33,776.66 | 8,299.45 | 531,919.21 | 531,872.99 | 16,466.73 | 15,220.91 | 166.60 | 1,446.98 | 1,230.58 | 23,900.07 | 8,261.68 | 16,512.92 |
| R4R2 | 11,476.08 | 2,812.58 | 5,069.78 | 3,875.16 | 5,550.98 | 5,117.53 | 53.28 | 484.16 | 409.06 | 8,038.55 | 2,346.62 | 5,581.64 |
| R5R2 | 10,243.11 | 2,510.40 | 4,525.09 | 3,458.82 | 4,954.60 | 4,567.71 | 47.56 | 432.15 | 365.11 | 7,174.90 | 2,094.51 | 4,981.95 |
| | | | | | | | | | | | | |
| R1R3 | 152.99 | 0.00 | 9,181.89 | 663.00 | 865.36 | 462.46 | 0.00 | 3.36 | 0.00 | 0.00 | 286.53 | 514.83 |
| R2R3 | 514.16 | 0.00 | 29,989.34 | 1,676.45 | 2,966.43 | 1,136.54 | 0.00 | 11.57 | 0.00 | 0.00 | 943.40 | 1,698.68 |
| R3R3 | 11,827.55 | 0.00 | 1,327,429.23 | 199,678.00 | 121,458.15 | 148,012.53 | 0.00 | 2,071.68 | 0.00 | 0.00 | 23,654.83 | 58,994.26 |
| R4R3 | 132.49 | 0.00 | 8,163.89 | 709.02 | 735.18 | 502.58 | 0.00 | 2.84 | 0.00 | 0.00 | 252.92 | 453.55 |
| R5R3 | 155.94 | 0.00 | 9,608.93 | 834.52 | 865.31 | 591.54 | 0.00 | 3.34 | 0.00 | 0.00 | 297.68 | 533.83 |
| | | | | | | | | | | | | |
| R1R4 | 6.21 | 0.00 | 153.63 | 6.36 | 2.15 | 0.74 | 29.82 | 3.45 | 10.19 | 1.21 | 10.62 | 54.85 |
| R2R4 | 106.58 | 0.00 | 2,197.40 | 114.82 | 0.00 | 10.23 | 548.21 | 47.50 | 176.83 | 22.21 | 176.19 | 977.36 |
| R3R4 | 52.54 | 0.00 | 1,488.56 | 51.29 | 17.11 | 7.34 | 236.50 | 34.26 | 85.35 | 9.58 | 92.51 | 448.45 |
| R4R4 | 11,234.56 | 0.00 | 278,634.29 | 11,499.79 | 3,908.03 | 1,202.49 | 53,733.28 | 9,521.71 | 11,742.46 | 2,177.19 | 13,778.06 | 134,003.71 |
| R5R4 | 41.16 | 0.00 | 1,166.24 | 40.18 | 13.40 | 5.75 | 185.29 | 26.84 | 66.87 | 7.51 | 72.48 | 351.35 |
| | | | | | | | | | | | | |
| R1R5 | 13.37 | 0.00 | 22.73 | 13.50 | 12.81 | 18.24 | 0.00 | 5.90 | 0.00 | 0.00 | 10.45 | 3.05 |
| R2R5 | 895.99 | 0.00 | 3,824.94 | 169.11 | 0.00 | 0.00 | 0.00 | 17.96 | 10.82 | 0.00 | 639.15 | 397.58 |
| R3R5 | 1,198.82 | 0.00 | 5,795.33 | 219.89 | 31.52 | 0.00 | 0.00 | 21.39 | 16.58 | 0.00 | 806.74 | 529.65 |
| R4R5 | 3,492.09 | 0.00 | 16,881.37 | 640.53 | 91.82 | 365.04 | 0.00 | 62.31 | 48.31 | 0.00 | 2,349.98 | 1,542.82 |
| R5R5 | 23,339.58 | 0.00 | 84,114.17 | 4,238.31 | 1,363.40 | 921.43 | 0.00 | 932.27 | 86.02 | 0.00 | 7,687.03 | 32,049.81 |
| SUM | 5,025,857.89 | 467,237.22 | 5,313,391.38 | 3,416,273.44 | 3,231,000.62 | 1,659,512.20 | 236,571.17 | 330,233.70 | 461,334.58 | 7,395,239.27 | 3,634,781.25 | 2,128,887.73 |

# APPENDIX D

## IRSA-Indonesia5

We will describe the structure model of IRSA-Indonesia5 taken from the technical note and manual for this model provided by Resosudarmo et al. (2009). Before we continue, we need to mention the subscription notation that they used in their model. Notation *c* for commodity, *d* for destination of commodity in domestic region, *f* for factor of productions, labors, and capital, *h* for households, *i* for industry, *r* for course of commodity in domestic region, and *s* for source of commodity, composite between domestic region and import. We will only explain two blocks that are important to understand the model: production block and household demand block. We also derive their optimization problem respect to their constraint.

### Production block:

Production block captures the relationship between inputs and outputs. This model used a nested CES-Leontief production function in each sector. In this model, the structure of the production is the same for all sectors. The inputs are divided into two categories: the composite of primary factors (labor and capital) which come from domestic market, and the intermediate good which come from both domestic and import. So by using CES-Leontief production function, industries separate their optimization problem between minimization cost for composite primary factors and intermediate goods. It can be shown in Figure D.1.

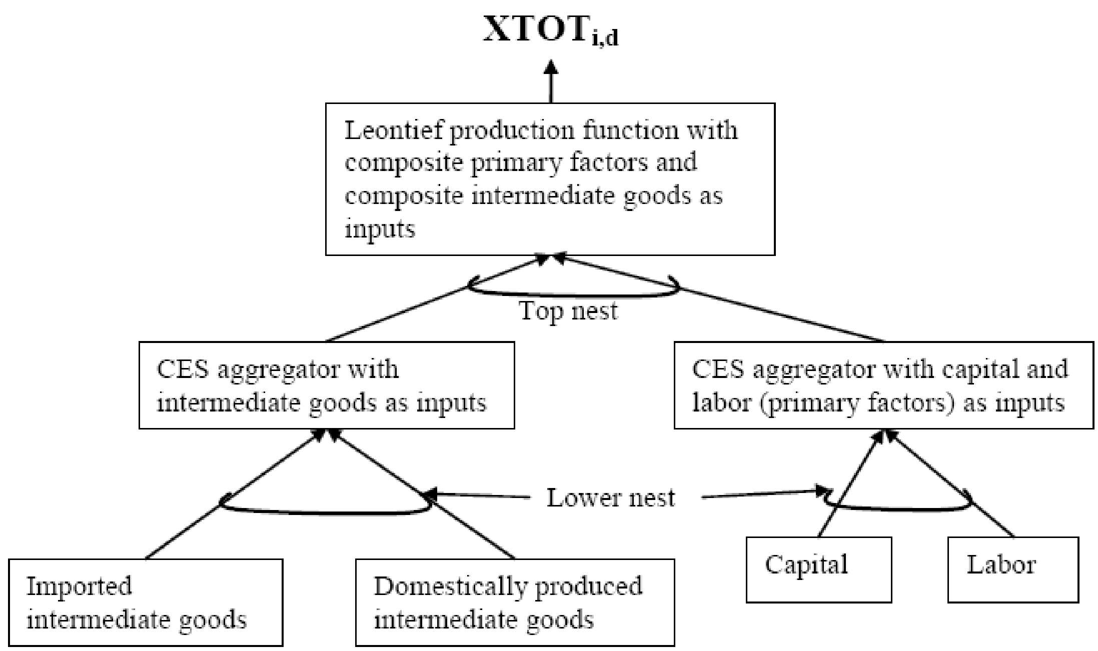


Figure D.1 Optimization Problem for Industry (reproduced from Resosudarmo et al. 2009)

At the lower nest, industries face two different optimization problems, as explain above. At the top nest, industries minimize it production costs by using Leontief production function, as presented as in the following

$$\max_{\{XPRIM_{i,d}, XINT\_S_{c,i,d}\}} f\left(XPRIM_{i,d}, XINT\_S_{c,i,d}\right) = PPRIM_{i,d} \bullet XPRIM_{i,d} + \sum_{c} PINT\_S_{c,d} \bullet XINT\_S_{c,i,d}$$
$$s.t.$$
$$XTOT_{i,d} = \min\left(XPRIM_{i,d}, XINT\_S_{c,i,d}\right) \tag{D.1}$$

where *XTOT(i,d)* is output for industry *i* at destination region *d*, *XINT_S(c,i,d)* is the intermediate good, and *PINT_S(c,d)* is the price for the intermediate input. The use of intermediate goods and primary factors is assumed to be proportional to the output level of the produced commodity.

The optimization problem for composite primary factors for each industry can be represented as follows:

$$\min_{\{XFAC_{f,i,d}\}} f\left(XFAC_{f,i,d}\right) = \sum_f PFAC_{f,d} \bullet XFAC_{f,i,d}$$
$$s.t.$$
$$XPRIM_{i,d} = CES\left[XFAC_{f,i,d} \mid \sigma_i\right] \tag{D.2}$$

where *PFAC(j,d)* is a factor price. Here all industries face the same prices of primary factors. *XFAC(f,i,d)* is the demand for primary factor, *XPRIM(i,d)* is the composite of primary factors and $CES\left[XFAC_{f,i,d} \mid \sigma_i\right]$ is a CES functional form that represents the relationship between the primary factors.

They solved the problem by firstly, represent the model into more simplified. For the lowest nest optimization problem, they use this form as follows:

$$\min_{\{X_{f,i}\}} f\left(X_{f,i}\right) = \sum_f P_f X_{f,i}$$
$$s.t.$$
$$Y_{i,d} = \left(\alpha_{i,f}^{-\rho} \sum_f \delta_{f,i} X_{f,i}^{-\rho}\right)^{-\frac{1}{\rho}} \tag{D.3}$$

*P(f)* is the price of primary factor and *X(f,i)* is the demand for primary factor *f* in industry *i*. Here we can write the Lagrange function from this problem as follows:

$$L = \sum_f P_f X_{f,i} + \lambda \left( Y - \left[ \alpha_{i,f}^{-\rho} \sum_f \delta_{f,i} X_{f,i}^{-\rho} \right]^{-\frac{1}{\rho}} \right)$$

The first order necessary conditions with respect to all primary factors for this optimization are:

$$\frac{\partial L}{\partial X_k} = P_k - \lambda \frac{1}{\rho}\left[ \alpha_{i,f}^{-\rho} \sum_f \delta_f X_f^{\rho} \right]^{-\frac{1}{\rho}-1} \bullet \rho \alpha_k^{-\rho} \delta_k X_k^{-\rho-1} = 0$$

$$\frac{\partial L}{\partial X_f} = P_f - \lambda \frac{1}{\rho}\left[ \alpha_{i,f}^{-\rho} \sum_f \delta_f X_f^{\rho} \right]^{-\frac{1}{\rho}-1} \bullet \rho \alpha_f^{-\rho} \delta_f X_f^{-\rho-1} = 0$$

if we divide the first equation to the second equation of these FONC give

$$\frac{P_k}{P_f} = \left( \frac{\alpha_k}{\alpha_f} \right)^{-\rho} \frac{\delta_k}{\delta_f} \left( \frac{X_f}{X_k} \right)^{1+\rho}$$

or we can rearrange this equation to

$$X_f = \left( \left( \frac{\alpha_f}{\alpha_k} \right)^{\rho} \frac{\delta_k}{\delta_f} \frac{P_f}{P_k} \right)^{-\frac{1}{(\rho+1)}} X_k \tag{D.4}$$

Substitution of the last expression into the production function in (D.3) yields

$$X_k \sum_f P_f \left( \left( \frac{\alpha_f}{\alpha_k} \right)^{\rho} \frac{\delta_k}{\delta_f} \frac{P_f}{P_k} \right)^{-\frac{1}{(\rho+1)}} = Y$$

$$\Rightarrow X_k = Y \left( \frac{\alpha_k}{\alpha_f} \right)^{-\frac{\rho}{(\rho+1)}} \delta_k^{\frac{1}{1+\rho}} \sum_f P_f \left( \frac{P_k}{P_f} \delta_f \right)^{-\frac{1}{(1+\rho)}} \tag{D.5}$$

Since all industries have the same production function, the last expression is the demand for all industries. That is

$$X_{f,i} = Y\alpha_i^{-\frac{\rho}{(\rho+1)}}\delta_{f,i}^{\frac{1}{1+\rho}}\left(\frac{P_k}{\tilde{P}}\right)^{-\frac{1}{(1+\rho)}} \tag{D.6}$$

where $\tilde{P} = \left(\sum_f P_f^{(1+\rho)}\delta_f^{-1}\right)^{-\frac{1}{(1+\rho)}}$ and $\alpha_i = \dfrac{\alpha_k}{\alpha_f}$. This results can be applied to the demand of primary factors, *XFAC(f,i,d)*, as in (D.6) as follows:

$$XFAC_{f,i,d} = \alpha_i^{-\frac{\rho}{\rho+1}} XPRIM_{i,d}\delta^{\frac{1}{\rho+1}}\left(\frac{PFAC_{f,d}}{PPRIM_{i,d}}\right)^{-\frac{1}{(1+\rho)}} \tag{D.7}$$

where *PPRIM(i,d)* is the price of composite primary factors paid by industry *i* in region *d*. Here the price of composite primary factors for each industry is different since each industry has different combination of primary factors. We can use the method for primary factors to solve the optimization problem for the intermediate goods.

However, the intermediate goods can be produced either domestically or imported. Because this model using bottom-up approach, the authors treat different way depend on source regions. So they built the demand for each commodity from composite source regions: domestic and import. More detail in the Manual book.

Household demand block:

In this model, they use the standard assumption for an open economy model, called Armingtion assumption. It assumes that imperfect substitution can have different prices in different countries (Plassmann, 2004). This assumption can allow the price of input factors to differ across regions. If the market is competitive, then difference in input prices will lead to differences in output prices.

The pattern of optimization problem for households is similar to the one we have above in which the commodities that they demand can come from domestic and import. In this model, the optimization problem can be solved by finding the demand for every specific commodity as a composite of domestic and import. It can be shown in Figure D.2.

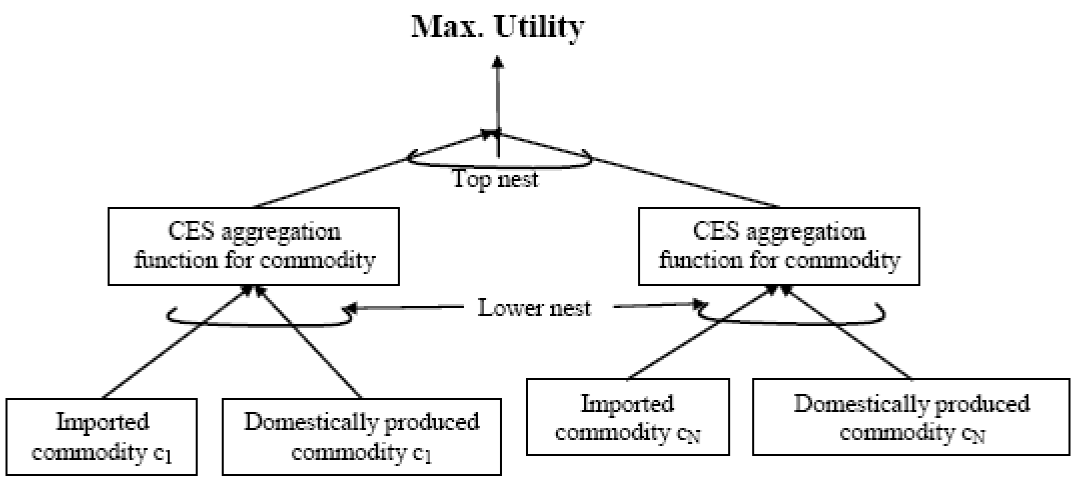


Figure D.2 Optimization Problem for Households (reproduced from Resosudarmo et al. 2009)

The authors use Stone-Geary utility function to describe household preferences. In the top nest, household will maximize his utility subject tohis budget constraint as shown below:

$$\begin{aligned}
&Max\ \ U_{h,d} = \prod_{c}\left( XHOU_S_{c,h,d} - \gamma_{c,h,d} \right)^{\beta_{c,h,d}} \\
&s.t. \\
&EH_{h,d} = \sum_{c} PQ_S_{c,d} \bullet XHOU_S_{c,h,d}
\end{aligned} \tag{D.21}$$

We can simplify this problem by defining new variables

$$\begin{aligned}
&Y_{c,h,d} = XHOU_S_{c,h,d} - \gamma_{c,h,d} \\
&FH_{h,d} = \sum_{c} PQ_S_{c,d} .Y_{c,h,d}
\end{aligned} \tag{D.22}$$

Now the consumer choice problem becomes

$$\begin{aligned}
&Max\ \ U_{h,d} = \prod_{c}\left( Y_{c,h,d} \right)^{\beta_{c,h,d}} \\
&s.t.\ FH_{h,d} = \sum_{c} PQ_S_{c,d} .Y_{c,h,d}
\end{aligned} \tag{D.23}$$

where $FH_{h,d} = EH_{h,d} - \sum_{c} PQ\_S_{c,d} .\gamma_{c,h,d}$ . This is a conventional Cobb-Douglass demand function. We can write the Lagrange function for this optimization problem as

$$L = \prod_{c}\left( Y_{c,h,d} \right)^{\beta_{c,h,d}} - \lambda\left( \sum_{c} PQ\_S_{c,d} .Y_{c,h,d} - FH_{h,d} \right)$$

Taking the FOC, yield

$$\frac{\partial L}{\partial Y_{c,h,d}} = 0 \Rightarrow \frac{\beta_{c,h,d}}{Y_{c,h,d}} U\left( Y_{c,h,d} \right) = \lambda .PQ\_S_{c,d}$$

and taking $c = \{i, j\}$ , we can get

$$\frac{\beta_{i,h,d}}{Y_{i,h,d}} U\left( Y_{i,h,d} \right) = \lambda .PQ\_S_{i,d} \Leftrightarrow \frac{\beta_{j,h,d}}{Y_{j,h,d}} U\left( Y_{j,h,d} \right) = \lambda .PQ\_S_{j,d}$$

For any pair of goods *i* and *j* we have

$$\frac{\beta_{i,h,d}}{\beta_{j,h,d}} = \frac{Y_{i,h,d}.PQ\_S_{i,d}}{Y_{j,h,d}.PQ\_S_{j,d}}$$

substitute to $FH_{h,d} = \sum_c PQ\_S_{c,d}.Y_{c,h,d}$ , we will get

$$\sum_c PQ\_S_{c,d}.Y_{c,h,d} = \sum_i \frac{\beta_{i,h,d}}{\beta_{j,h,d}} Y_{j,h,d}.PQ\_S_{j,d} = FH_{h,d}$$

$$Y_{j,h,d}.PQ\_S_{j,d}.\sum_i \frac{\beta_{i,h,d}}{\beta_{j,h,d}} = FH_{h,d} \Rightarrow Y_{j,h,d} = \frac{\beta_{j,h,d}}{\sum_i \beta_{i,h,d}} \frac{FH_{h,d}}{PQ\_S_{j,d}} = \beta_{c,h,d} \frac{FH_{h,d}}{PQ\_S_{j,d}}$$

Thus, transform back to the original variables yields the

$$XHOU\_S_{c,h,d} = \gamma_{c,h,d} + Y_{c,h,d} = \gamma_{c,h,d} + \beta_{c,h,d} \frac{FH_{h,d}}{PQ\_S_{j,d}}$$

$$XHOU\_S_{c,h,d} = \gamma_{c,h,d} + \frac{\beta_{c,h,d}}{PQ\_S_{j,d}} \left( EH_{h,d} - \sum_c PQ\_S_{c,d}.\gamma_{c,h,d} \right) \tag{D.24}$$

where $EH_{h,d}$ is the household disposable income that is defined as in the following identity condition:

$$EH_{h,d} = \left( 1 - \sum_{i=hh} \sum_{i=r} strhh_{hh,r,h,d} - strhr_{h,d} - \sum_{i=r} strgr_{h,d,r} \right). \left(1 - savh_{h,d}\right).\left(1 - ytaxh_{h,d}\right).YH_{h,d} \tag{D.25}$$

where $strhh_{hh,r,h,d}, strhr_{h,d}, strgr_{h,d,r}, savh_{h,d}, ytaxh_{h,d}$ are the share parameters. Equation (D.24) declares a linear expenditure system (LES) of the demand for commodity *c*, from household *h*, at region of destination *d*.

APPENDIX E

Model Modification in GAMS

Figure E.1 Modification for benchmk.gms

```
PQR0(c,r,d)        Purchaser price from reg. r to reg. of dest. d
XDR0(c,r,d)        Sourcing of regional demand from regional
TRD(c,r,d)         Trade margin
TRS(c,r,d)         Transport margin
REVTRD0(c,r,d)     Trade costs=revenue d for interregional trade
TRDINC0(r)         Revenue of regional trade sectors -channeled to TRADE
TRDDEM0(c,r)       TRADE demand caused by trade activities
REVTRS0(c,r,d)     Transport revenue d for interregional trade to d
TRSINC0(c,r)       Revenue of regional tr sectors - channelled to tr
TRSDEM0(c,r)       Commodity composition of transport procurement
SHARE(c,r)         Share of Transportation
;

TRD(c,r,d)$XTRAD0(c,r,d) = SAM(r,'TRD',d,c)/XTRAD0(c,r,d);
TRS(c,r,d)$XTRAD0(c,r,d) = SAM(r,'TRS',d,c)/XTRAD0(c,r,d);

PQR0(c,r,d) = 1 + TRD(c,r,d) + TRS(c,r,d);
PQ0(c,'dom',d) = sum(r,PQR0(c,r,d)*XTRAD0(c,r,d))/XTRAD_R0(c,d);
PQ0(c,'imp',d) = 1.2;

REVTRD0(c,r,d) = SAM(r,'TRD',d,c);
TRDINC0(r) = CHECKSAM('rows',r,'TRADE');
TRDDEM0('TRADE',r) = TRDINC0(r)/PQ_S0('TRADE',r);

REVTRS0(c,r,d) = SAM(r,'TRS',d,c);
TRSINC0(tr,r) = CHECKSAM('rows',r,tr);
TRSDEM0(tr,r) = SUM((d,c),SAM(r,c,d,tr))/PQ_S0(tr,r);
SHARE(tr,r) = SUM(d,SAM(r,tr,d,tr))/SUM((d,rt),SAM(r,rt,d,rt));
```

Figure E.2 Modification for model.gms

```
variable
PQR(c,r,d), REVTRD(c,r,d), TRDINC(r),
TRDDEM(c,r), REVTRS(c,r,d), TRSINC(c,r), TRSDEM(c,r)\
;

PQ.L(c,'dom',d) = PQ0(c,'dom',d);
PQ.L(c,'imp',d) = PQ0(c,'imp',d);
PQR.L(c,r,d) = PQR0(c,r,d);

XD.L(c,'dom',d) = XD0(c,'dom',d);
XD.L(c,'imp',d) = XD0(c,'imp',d);

REVTRD.L(c,r,d) = REVTRD0(c,r,d);
TRDINC.L(r) = TRDINC0(r);
TRDDEM.L('TRADE',r) = TRDDEM0('TRADE',r);

REVTRS.L(c,r,d) = REVTRS0(c,r,d);
TRSINC.L(tr,r) = TRSINC0(tr,r);
TRSDEM.L(tr,r) = TRSDEM0(tr,r);

equations
e_pqr(c,r,d), pq_dom(c,d)
e_revtrd(c,r,d), e_trdinc(r), e_trddem(c,r)
e_revtrs(c,r,d), e_trsinc(c,r), e_trsdem(c,r)
;

e_pqr(c,r,d)..          PQR(c,r,d) =e= PDOM(c,r) + TRD(c,r,d) + TRS(c,r,d);
e_pq_dom(c,d)..
                PQ(c,'dom',d)*XTRAD_R(c,d) =e= SUM(r,PQR(c,r,d)*XTRAD(c,r,d));

e_revtrd(c,r,d)..       REVTRD(c,r,d) =e= XTRAD(c,r,d)*TRD(c,r,d);
e_trdinc(r)..           TRDINC(r) =e= SUM((c,d),REVTRD(c,r,d));
e_trddem('TRADE',r)..TRDDEM('TRADE',r)*PQ_S('TRADE',r) =e= TRDINC(r);

e_revtrs(c,r,d)..       REVTRS(c,r,d) =e= XTRAD(c,r,d)*TRS(c,r,d);
e_trsinc(tr,r)..        TRSINC(tr,r) =e= SUM((c,d),REVTRS(c,r,d))*SHARE(tr,r);
e_trsdem(tr,r)..        TRSDEM(tr,r)*PQ_S(tr,r)  =e= TRSINC(tr,r);
```

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