An Inter-regional CGE Model to Assess the Impacts of Tariff Reduction and Fiscal Decentralization on Regional Economy: The Case of Indonesia*

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Abstract The objectives of this paper are twofold. First, we construct a new interregional Computable General Equilibrium (CGE) model with three regions in Indonesia. This model is the interregional CGE model based on the 1995 Interregional Social Accounting Matrix (IRSAM). Second, we evaluate the impacts of tariff reduction and fiscal decentralization on these regional economies as well as on the entire Indonesian economy. Scenario 1 of the import tariff cut shows the tariff reduction reduces in tariff revenue and decreases in the imported goods price, but in industry activity, exports sectors such as the textile sector in Java benefits, while

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import competing sectors are more likely to suffer damage. From these scenarios of fiscal decentralization policy, we found that scenario 3 of decentralized government spending in Sumatra is better than Scenario 2 of more equal decentralized government spending in outer Java and Scenario 4 of more decentralized government spending in the rest of Indonesia for fiscal decentralization policies.

Key words: interregional CGE model, interregional Social Accounting Matrix, tariff cut, fiscal decentralization, Indonesia

1. Introduction

During the late 1980s and the 1990s, Indonesia achieved relatively successful economic development and underwent remarkable structural changes in production and trade as a result of deregulation and a policy shift toward export-oriented industries. This rapid economic growth caused the regional income inequality. In 1996, Java region including DKI Jakarta, representing merely 6% of Indonesia's land area, accounted for about 60% of total population and 66% of total non-oil and gas GDP, while Sulawesi where is the poor region, accounted for a mere 7% of total population and 4.6% of total non-oil and gas GDP. The per capita non-oil and gas GDP (in million Rp) of Sumatra, Java-Bali, Kalimantan, Sulawesi, and the rest of Indonesia were 1.626, 2.063, 2.553, 1.219, 1.026, respectively. The per capita non-oil and gas GDP of the richest province (Jakarta) was almost ten times as large as that of the poorest province (East Nusatenggara).¹⁾

However, after the Asian currency crisis in 1997, Indonesian economy has many economic problems, including regional disparity, higher cost of imports, and declining competitiveness in manufactured exports. The high degree of centralization for Java that has constituted a major issue for the government since the 1970s further puts pressure on the need for reforms.²⁾

In response to these push factors, the Indonesian government embarked on the 1999 "Big Bang" reforms of its fiscal system and changed the share of regional government spending in total government spending from 10 percent to 30 percent since 2000.³⁾ More recently, the government plans for more radical reforms to improve international competitiveness through trade liberalization. In the light of these developments, it is deemed necessary for the Indonesian government to evaluate in very comprehensive terms, the impacts of fiscal decentralization on both the economies of its constituent regions as well as on the entire Indonesian economy.

These difficult tasks can carry out by using one of the suitable tools, namely, an Inter-Regional Computable General Equilibrium (IRCGE) Model. The CGE model built on the renewed recognition of the importance of relative prices for allocation of resources and of equity issues such as income distribution between income groups has been widely used as a modeling tool for the analy-

1) See BPS (1997) and Akita (2002).

2) See Brodjonegoro (2002).

3) See Alm, Aten and Bahl (2001) and Silver, Azis and Schroeder (2001).

sis of tax reforms, trade liberalization, resource allocation and economic reform in developing countries.⁴⁾

Numerous studies using a macro CGE model have analyzed many economic issues in Indonesia.⁵⁾ However, there are a few IRCGE Models for Indonesia [see Hidayat (1991), Temenggung (1995), Wuryanto (1996) and Watanuki (1996)]. Hidayat's (1991) interregional social accounting matrix (IRSAM) for Indonesia was one of the first trials to be developed. Temenggung (1995) constructed the first Indonesian IRCGE model in which modified Hidayat's IRSAM and basically used the CGE model by Thorbecke (1992). The second IRCGE model for Indonesia was developed by Wuryanto (1996). It was an IRCGE model for fiscal decentralization in which the Indonesian economy was divided into only two regions, Java and outer Java. Thus, we extend this model to the three regions IRCGE model in order to evaluate the impacts of a tariff reduction and fiscal decentralization on the economies of its constituent regions as well as on the entire Indonesian economy.

This paper is organized as follows. Section 2 describes the IRCGE model and mechanisms through which tariff cut and fiscal decentralization impacts the regional economy. Section 3 reports the analysis of impacts of scenarios on tariff reduction and fiscal decentralization. Finally, we present our findings and conclude the paper.

2. The Inter-Regional CGE Model

The IRCGE model in this study follows closely that of Wuryanto (1996) and Resosudarmo, et al. (1999). The primary data sources of our model are the 1995 regional input-output table and the 1995 Interregional Social Accounting Matrix (IRSAM) of Indonesia.⁶⁾ Since the regional economy of the outer Islands (Sumatra, Kalimantan, and Irian Jaya) is dominated by oil/gas and natural resources as above-mentioned, we divide the Indonesian economy into three regions (Java, Sumatra and the rest of Indonesia region). Furthermore, in Java, the per capita non-oil and gas GDP (in million Rp) of DKI Jakarta, east Java, central Java and west Java were 7.062, 1.751, 1.300, 1.724, respectively in 1996, there was within-province inequality among Java region. Thus, the Java region is divided into three micro regions (east Java, central Java and west Java).

For each macro regions, there are 15 different production sectors which are (1) Food Crop (FOODC), (2) Estate Crop (ESTAT), (3) Livestock (LIVES), (4) Forestry (FORES), (5) Fishery (FISHR), (6) Mining (MININ), (7) Food Processing (FOODP), (8) Textile (TEXTL), (9) Wood Processing and Construction (WOODP), (10) Paper, Metal and Machine Products (PAPER), (11) Chemical and Basic Metal Products (CHEMI), (12) Water and Utility (WATER), (13) Trade, Hotel,

4) See Abbink, G.A., M.C. Braber and S.I. Cohen (1995) and Azis (1997).

5) For example, see Abbink et al. (1995), Iwan Azis (1997, 2000), and Resosudarmo et al. (1999).

6) The 1995 IRSAM was constructed by Badan Pusat Statistik (BPS) in Indonesia and JICA team (K. Nidaira and S. Tokunaga) in March 1999, see Nidaira (2000) for the 1995 Regional SAM.

Figure 1 Macro and Micro Regions in the IRCGE Model

and Restaurant (TRADE), (14) Transport and Communication (TRANS), and (15) Other Services (SERVI).

This IRCGE model is specified in nine blocks: (1) sectoral production and intermediate input, (2) factor market and income, (3) regional commodity markets, (4) institutional income and expenditure, (5) government, (6) saving and investment, (7) gross domestic product, (8) price structure, and (9) market equilibrium conditions.⁷⁾

2.1. Production and Intermediate Input and Factor Market and Income Blocks

In the sectoral production and intermediate input blocks, the production sector in each macro region is divided into 15 sectors, and the classification follows exactly the sectoral classification of the IRSAM for 1995. In Eq. 1 the production function in each sector and each region is postulated as a homogenous CES (constant elasticity of substitution) type. The primary production factors are aggregate labor (Lg_i) and capital stocks ($\bar{K}_i$). Aggregate labor demand is assumed to be mobile intersectorally, but not interregionally. The capital stocks in each sector are assumed to be fixed and immobile both intersectorally and interregionally. The intermediate inputs use intraregional and interregional coefficients, and there is no substitution between intermediate inputs and production

7) The system of equations and definition of parameters and variables in the IRCGE model of Indonesia is in appendices A and B.

factors, and consequently, no substitution among the intermediate inputs in Eq. 2.⁸⁾

In the factor market and income block, the factor market specification follows exactly the IRSAM classification. There are five categories for labor demand, corresponding to the regional categories of households. To be used in the sectoral production function in each macro region, the corresponding micro region labor demand (L_{hi}) must first be aggregated. In this circumstance, the aggregated labor demand by sector (Lg_i) for each macro region, which appears as an argument in production function, is postulated using a Cobb-Douglas type function in Eq. 3.

To obtain the sectoral labor demand in each micro region (L_{hi}), the sectoral production function is derived according to the profit maximization principle. The results from the derivation show that the sectoral labor demand in each micro region depends on the average wage in the corresponding category, fixed labor demand proportionality (ld_{hi}), and the value added price in the corresponding sector (PN_i) in Eq. 4.

The sectoral wage equation employed in this study follows that applied by Thorbecke (1992). According to his work, the sectoral wage rates derived econometrically by taking into account the prevailing situation in the 1980s, are strongly influenced by the inflation rate ($PQINDEX$), the price of the sectoral output (PX_i), and the growth in labor productivity ($\overline{OX}_i/Lg_i$) in Eq. 5. An important implication that underlies the formulation of the wage equations is that labor market segmentation exists in Indonesia with wages being strongly sector specific.

The average wage rates (W_h) for each labor category are formulated based on the sectoral wage rates (Ws_i) and share ($\omega\phi_{hi}$) for each type of labor category in each sector in Eq. 6. The labor supply in each labor category is assumed to be fixed and in Eq. 7 some labor slack is assumed to have prevailed (in the forms of unemployment or underemployment) in 1995. Labor and capital income, defined respectively in Eq. 8 and Eq. 9, are specified according to each micro region based on the fixed labor and capital income proportionality (wd_h and kd_h , respectively).

2.2. Regional Commodity Market Block

In the regional commodity market block, the commodity flow incorporates simultaneously the demand and supply side of the regional economies as in Figure 2. In the demand block, the sectoral composite goods demand is postulated using the Armington rule, which allows imperfect substitution between domestically demanded goods (XD_i) and imported goods (XM_i) in the corresponding sector.

Applying cost minimization principles, the optimal level of imported goods can be obtained, as

8) This model is a static and short-run model in which the capital stocks in each industry for the production function is assumed to be fixed, but the labor demand is assumed to be mobile intersectorally but not interregionally. Our assumption is based on the fact that this paper is concerned with the short-term analysis of tariff reduction and reallocation of regional government consumption. In future work, we extend this model to a dynamic model with an interregional labor migration.

Figure 2 Flow of Regional Goods between Java and Sumatra

seen in Eq. 11. The demand level for imported goods depends on the ratio of the price of domestically demanded goods (PD_i) to the price of imported goods (PM_i), and the demand for domestically demanded goods.

The sectoral level of domestically demanded goods (XD_i) is also postulated using the Armington rule, which allows imperfect substitution between intraregionally demanded goods (XS_i^{rr}) and interregionally imported goods (XS_i^{rr}) in Eq. 12. Again, applying cost minimization principles, the optimal level of interregionally imported goods can be obtained. As shown in Eq. 13, the demand level for interregionally imported goods depends on the ratio of the price of domestically produced goods (PX_i^r) to the price of interregionally imported goods (PX_i^{rr}), and the demand level for intraregionally demanded goods.

On the supply side, the total sectoral domestic supply in each region is determined simply by aggregating the intraregional supply (XS_i^{rr}) and interregional supply (XS_i^{rr}) as shown in Eq. 14. The

total sectoral supply in each region is formed by aggregating the total domestic supply (XS_i^r) with the export supply (XE_i^r) in Eq. 15. The sectoral export supply level in each region is determined by an export function formulated to depend on the ratio of the price of domestically produced goods (PX_i^r) to the world price of exported goods (PE_i^r) in Eq. 16.

2.3. Institutional Income and Expenditures and Government Blocks

In the institutional income and expenditures block, institutions in this paper include regional household groups, divided into five categories (corresponding to the number of micro regions), and companies, categorized into three categories (corresponding to the number of macro regions).

The total regional household income comes from a fixed proportion of each micro region labor income (YL_h) and a fixed proportion of each micro region capital income (YK_h), including the capital income from overseas ($\overline{kbrw}_h$) in Eq. 17.

The national direct tax rates in Eqs. 19 and 24 that are applied in this model are average tax rates for each of the micro regions that are derived directly from the 1995 IRSAM table. The definitions of regional household disposable income and household savings are straightforward. Household savings in each micro region (HS_h) is formulated linearly as dependent on regional household disposable income with a fixed marginal propensity to save calibrated from the 1995 IRSAM table in Eq. 20.

Household consumption demand in each micro region (HC_{hi}^r) is positively correlated with disposable income less household savings and negatively correlated with the regional composite good prices (P_i^r) in Eq. 21. The companies in each macro region receive income (YC^r) from a proportion of the micro region capital income, from exogenous transfers of income among companies ($\overline{comtrf}^r$) and from exogenous transfers from abroad ($\overline{rwc}^r$) in Eq. 22. The company disposable income in each macro region (YCD^r) is defined in Eq. 23. The company savings in each macro region (CS^r) is defined as linearly dependent on the disposable income with a fixed marginal propensity to save calibrated from the 1995 IRSAM table in Eq. 25.

In the government block, the total government revenue is the sum of the government revenues in the three regions in Eq. 26. The government in each region receives income (CGR^r) from a fixed proportion of micro region capital income, national direct taxes, from net national indirect taxes ($IDT^r - SUB^r$), import tariffs (TM^r), and from the exogenous remittance from abroad ($\overline{grw}^r$).

The total government current expenditure (CGE) is the sum of the government expenditures in the three regions in Eq. 32. The expenditures (CGE^r) of government in each region, postulated to be equal to revenue, comprises the expenditure for government consumption ($CGTC^r$), exogenous direct transfers to regional households ($\overline{cgt}_h$), exogenous direct transfers between governments ($\overline{govtr}^r$), exogenous government debt service for foreign borrowing ($\overline{gdebts}^r$), and savings ($CGSV^r$) in Eq. 33.

2.4. Saving and Investment and Gross Domestic Product Blocks

Having determined the savings behavior for each institutional account, the total savings (TS) definition is specified in Eq. 35 in the saving and investment block. The total savings is the sum of household savings, company savings, government savings and foreign savings in Eqs. 36 and 37. In Eq. 38, the government investment expenditure for each region ($RGINVD^r$) is determined by a fixed proportion. The government investment expenditure in each sector by origin ($GINVO_i^r$) is determined endogenously by proportions derived from the IRSAM table in Eq. 39.

Total regional private investment by destination ($RPINVD^r$) is determined endogenously by the current total output in the corresponding region, previous year total output in the same region, and the annual interest rate ($IRATE$) in Eq. 40. To obtain the regional private investment by origin ($RPINVO^r$), the amount of total regional private investment by destination must be pre-multiplied by regional capital coefficient matrix ($IMATT^r$) in Eq. 41. The amount of total regional private investment by destination multiplied by the sectoral proportions derived from the IRSAM table gives the sectoral private investment by origin ($PINVO_i^r$) in Eq. 42. The final equation specifies the total investment ($TINV$), which incorporates private and the government investments in Eq. 43.

In the gross domestic product block, the block of equations contains only definitions for the gross regional domestic product at market values ($GRDP^r$) from the income approach side and the gross domestic product (GDP). The gross regional domestic product is defined as the sum of the regional production by sector multiplied by the corresponding net (or value added) price, plus the income from net indirect taxes and tariff revenues in Eq. 44. The value of the gross domestic product is generated by adding the gross regional domestic products at market value in Eq. 45.

2.5. Price and Market Equilibrium Conditions Blocks

In the price block, the model specifies eight generally straightforward definitions of price structure. In treating the import and export market, the model employs a “small country” assumption. As a consequence, the world prices for imports and exports are taken as exogenous variables.

The sectoral imported goods prices by macro region (PM_i^r) are equal to the world imported goods prices ($\overline{pwm}_i$) measured in domestic currency and adjusted for indirect taxes (idt_i^r), import tariff (tim_i^r), and trade and transport margins (ttm_i^r) in Eq. 46. The sectoral exported goods prices (PE_i^r) by macro region are postulated as proportionally related to the world export goods prices ($\overline{pwe}_i$), adjusted for indirect taxes and trade and transport margins in Eq. 47.

On the supply side, there are definitions for the sectoral producer prices (PX_i^r) and value-added prices (PN_i^r) by macro region. The sectoral producer price by macro region is determined by calculating the average of the domestic price (PD_i^r) and export price (PE_i^r), weighted by the sectoral output of the region in Eq. 48.

The value-added price by macro region is postulated to be interrelated not only to the producer price, but also to the markets of intermediate inputs from both intraregional and interregional indus-

tries in Eq. 49. On the demand side, the model incorporates the composite goods price (P_i^r) specification by macro region. The sectoral composite goods price is determined by calculating the average of the domestic price and the imported goods price in Eq. 50. The price of capital by macro region (PK_i^r) is defined as the average of the composite goods prices weighted by the proportion of sectoral government and private investments in the region in Eq. 51.

The last two price equations specify the domestic price index ($PXINDEX^r$) and the general price index ($PQINDEX_i^r$) in each macro region. The definition of the domestic price index in each region is determined by calculating the average of the producer prices (PX_i^r) weighted by the proportion of sectoral supply (ωx_i^r). The definition of the general price index in each region is determined by calculating the average of the composite goods prices (P_i^r) weighted by the proportion of the sectoral demand (ωq_i^r).

Under the market equilibrium conditions, this block of equations defines the closure rules or system constraints that the model economy must satisfy. The first condition concerns equilibrium in the product market. This equilibrium is formulated by the Leontief material balance equilibrium condition. Therefore, the total supply of composite goods i in r must equal the sum of intermediate demand and final consumption demand by both the private and the government (public) sector in Eq. 54.

The second condition concerns equilibrium in the external market. The model specifies that the sum of sectoral exports abroad by region, plus the institutional (the regional household, companies, and government) remittance from abroad, plus the government and private foreign borrowings must equal the sum of sectoral imports abroad by region, plus repatriated profits, plus capital (service) payments to the rest of the world, plus the government foreign debt service in Eq. 55. The exchange rate (ER) argument does not appear in this equation, because the equilibrium condition is stated in US\$ currency.

The third condition is related to the central government budget constraints to finance investment expenditures. Eq. 56 expresses that the deficits of the government investment expenditure are financed by foreign borrowing ($CGFBR$). The final equilibrium concerns the situation in which the total savings must always be equal to the total investment in Eq. 57.

In order to obtain the optimal solutions of this IRCGE model, all equations must be solved simultaneously in such a way that all the markets are clear.⁹⁾ Tables 1 shows the results of this optimal solution for the main variables as a baseline.¹⁰⁾

9) GAMS release 2.5-optimization program was used in this paper.

10) The values of this optimal solution as a baseline are different from actual values, as we assume that price index and exchange rates are unit. Although this static IRCGE model is useful to examine how this optimal solution will be altered with changes in the policy variables, in future work, it is necessary to extend this model to a dynamic IRCGE model in which will not use these strict assumptions.

3. Policy Scenario Results

As we obtained the baseline for the IRCGE model, in this section, we examine the impacts of tariff reduction and fiscal decentralization on regional economy in Indonesia with a view of the policy directions for a development plan in which the Indonesian government conducts policy reforms toward a market oriented economy.¹¹⁾ The performance of the Indonesian economy under each of the four policy scenarios is compared to that of the base run and is shown as percentage change, compared to base run.

3.1. Tariff Reduction

First, to analyze the impact of an import tariff cut for the trade liberalization policy on the regional economy, we conducted the following scenario analysis:

Scenario 1: Import tariff reduction

In scenario 1, the direct effects with the import tariff cut (the tariff decreasing by 50% in 1995) show a reduction in tariff revenue and reduction in the imported goods price in Table 1. The import tariff cut affects the real gross regional domestic products (GRDP) in each region directly through definition Eq. 44 of GRDP. However, since tariff cut lowers the imported goods price and the composite goods price, the value-added price increases due to cost reduction.¹²⁾ Then, in industry activity, exports sectors such as the textile sector in Java benefits, while import competing sectors are more likely to suffer damage as was noted by Haddad (1999) as in Figure 3 to Figure 5.

Thus, the real GRDP of Java increases more than that of outer Java (Sumatra and the rest of Indonesia). The regional government revenue in Java is slightly decreasing, but government expenditure of Java does not change. Similarly, in macro economy, the central government revenue is decreasing by 8.9%, central government expenditure does not change, and thus central government borrowing from abroad numerous increases by 20%.

Table 1 summarizes the this scenario results for the main macro variables. The real GDP increases by 0.33%, but the central government revenue decreases by 8.96%. Regarding the price index, the regional price indices decrease from -1.16% (the rest of Indonesia) to -1.38% (Java).

3.2. Fiscal Decentralization

Next, in order to analyze the impact of a reallocation of regional government consumption for a fiscal decentralization policy on the regional economy,¹³⁾ we conducted the following scenario analyses:¹⁴⁾

11) See Alm, Aten and Bahl (2001), Brodjonegoro and Martinez-Vazquez (2002), and Silver, Azis, and Schroeder (2001).

12) For the impact of tariff reduction on the prices, see Tokunaga, Sun and Dung (2003).

Table 1. The Impacts of Trade Reduction and Fiscal Decentralization

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Real GDP				
Macro GDP	0.33	-0.21	0.15	-0.58
Java GRDP	0.41	-2.08	-1.49	-2.65
Sumatra GRDP	0.18	2.47	5.68	-0.83
Rest of Indonesia GRDP	0.22	3.36	-0.30	7.01
Government budget				
Central Gov. revenue	-8.96	-3.86	0.37	-8.03
Java Reg.Gov.revenue	-3.22	-4.25	-0.08	-8.29
Sumatro Reg.Gov.revenue	-6.01	-2.59	2.59	-7.58
Rest of Indonesia Reg.Gov.revenue	43.84	18.72	-1.83	-0.46
 Cen. Gov. expenditure	 0	 0	 0	 0
Java Reg.Gov.expenditure	0	-59.92	-59.92	-59.92
Sumatro Reg.Gov.expenditure	0	74.96	149.93	0
Rest of Indodesia Reg.Gov.expenditure	0	64.94	0	129.87
 Cen. Gov. saving	 -13.49	 -4.83	 0.91	 -10.52
Java Reg.Gov.saving	-31.18	547.06	592.94	502.94
Sumatro Reg.Gov.saving	-10.79	-64.89	-129.18	-9.13
Rest of Indonesia Reg.Gov.saving	-16.72	73.34	0.16	146.21
 Foreign savings in private sector	 -6.62	 -29.17	 0.60	 -62.95
 Central government foreign borrowing	 20.33	 5.9	 6.65	 9.22
Price Index				
Java Price index	-1.38	-3.86	-0.34	-7.62
Sumatra Price index	-1.19	-1.64	3.71	-7.04
Rest of Indonesia Price index	-1.16	-1.91	0.05	-4.11

Notes:unit is percentage change as compared to base run.

13) National governmental spending consists of routine and development budgets. In this paper, we focus on regional government consumption in the routine budgets as a fiscal decentralization policy. The reason is the Indonesian government embarked on the 1999 reforms of its fiscal system and changed the share of regional government spending in total government spending from 10% to 30% since 2000. The analysis of development budget is one of the remaining challenges.

14) In the four cases, the other exogenous variables were fixed as in 1995.

Figure 3 Production Effects of a 50% Tariff Reduction: Java

Figure 4 Production Effects of a 50% Tariff Reduction: Sumatra

Figure 5 Production Effects of a 50% Tariff Reduction: the rest of Indonesia

Scenario 2: more equal decentralized government spending in outer Java. That is, the regional government consumption in Java decreasing by Rp. 100 billion and the regional government consumption in Sumatra and the regional government consumption in the rest of Indonesia increasing by Rp. 50 billion, respectively.

Scenario 3: decentralized government spending in Sumatra. That is, the regional government consumption in Java decreasing by Rp. 100 billion and the regional government consumption in Sumatra only increasing by Rp. 100 billion.

Scenario 4: more decentralized government spending in the rest of Indonesia. That is, the regional government consumption in Java decreasing by Rp. 100 billion and the regional government consumption in the rest of Indonesia only increasing by Rp. 100 billion.

In scenario 2 of more equal decentralized government spending among outer regions, Figure 6 shows that the regional government expenditure in Java is decreased by 59.9%, and that of Sumatra and the rest of Indonesia are increased by 74.9% and by 64.9% respectively. Consequently, as shown in Figure 7, the growth rates of GRDP in Java and total GDP in Indonesia are down by -2.08% and -0.21% respectively, but the growth rates of GRDP in Sumatra and the rest of Indonesia are up 2.47% and 3.36% respectively. Similarly, as shown in Figure 8, the regional government revenue in Java and central government revenue decrease and that of the rest of Indonesia only increases. In addition, foreign private capital inflow decreases but the central government borrowing from abroad increases. Regarding the price index, the regional price indices in Java and Sumatra are down by 3.86% and 1.64% respectively. Thus, we found that Indonesian economy has a distinct java-concentrated structure.

From scenario 3 that the government reallocates Rp. 100 billion of Java's regional government consumption to Rp. 100 billion of Sumatra's regional government consumption, we can get results that the growth rates of GRDP in Sumatra and total GDP are up by 5.68% and by 0.15% respectively, although the growth rates of GRDP in Java and the rest of Indonesia are -1.49% and -0.3% respectively in Figure 7. Similarly, as shown in Figure 8, the regional government revenue in Sumatra and central government revenue increase, although the regional government revenues in

Figure 6 The Impacts of Fiscal Decentralization on Gov. Expenditure

Figure 7 The Impacts of Fiscal Decentralization on GRDP

Figure 8 The Impacts of Fiscal Decentralization on Gov. Revenue

Java and the rest of Indonesia decrease slightly. In addition, foreign private capital inflow increases slightly and the central government borrowing from abroad increases by 6.7%. Regarding the price index, the regional price index in Java is down by 0.34%, but the regional price indices in Sumatra and the rest of Indonesia are up by 3.71% and 0.05% respectively. Thus, we found that in this scenario Sumatra's economy has a trade-off between growth rate and inflation.

From scenario 4 that the government reallocates Rp.100 billion of Java's regional government consumption to Rp. 100 billion of the regional government consumption in the rest of Indonesia, we can get results that the growth rate of GRDP in the rest of Indonesia is only up by 7.01%, although the growth rates of GRDP in Java, Sumatra and total GDP are -2.65%, -0.83% and -0.58% respectively in Figure 7. However, the regional government revenues in three regions and central government revenue decrease as shown in Figure 8. In addition, foreign private capital inflow rapidly decreases by 62.9% and the central government borrowing from abroad increases by 6.7%. Regarding the price index, the regional price indices in Java, Sumatra and the rest of Indonesia are down 7.62%, 7.04 and 4.11% respectively.

From scenarios 3 and 4, we found that linkages from Sumatra to Java are stronger than those from the rest of Indonesia to Java. However, the central government borrowing from abroad is increasing rapidly in both scenario 3 and scenario 4 and the private capital inflow is drastically decreasing in scenario 4. This suggests that when policy planners introduce fiscal decentralization policy, they must be mindful of the status of various indicators such as national and regional variables.

From these scenarios of fiscal decentralization policy, we found that scenario 3 of decentralized government spending in Sumatra is better than Scenario 2 of more equal decentralized government

spending and Scenario 4 of more decentralized government spending in the rest of Indonesia in order to improve the regional inequality.

4. Conclusion

We have constructed a new interregional CGE model with three regions (Java, Sumatra and the rest of Indonesia) in Indonesia. This model is the interregional CGE model based on the 1995 Interregional Social Accounting Matrix (IRSAM). Then, we have evaluated the impacts of import tariff reduction and fiscal decentralization on these regional economies as well as on the entire Indonesian economy.

From scenario 1 of the import tariff reduction by 50% in 1995, we found that the direct effects of the import tariff decreasing are a reduction in tariff revenue and the imported goods price. The tariff cut affects the real GRDP in each region directly through Eq. 44. However, since tariff cuts lower the imported goods price and the composite goods price, the value-added price increases due to cost reduction. Export sectors such as the textile sector in Java benefit in industry activity, while import competing sectors are more likely to suffer damage. Thus, the real GRDP of Java increases more than in outer Java. As the regional government revenue of Java slightly decreases and government expenditure of Java does not change, central government borrowing from abroad increases. Regarding the price index, the regional price index is decreasing from -1.16% (the rest of Indonesia) to -1.38% (Java).

On the other hand, we conducted the following three scenarios of fiscal decentralization: scenario 2 of more equal decentralized government spending in outer Java, scenario 3 of decentralized government spending in Sumatra, and scenario 4 of more decentralized government spending in the rest of Indonesia. From scenario 2, we found that Indonesian economy has a distinct java-concentrated structure. From scenarios 3 and 4, we found that linkages from Sumatra to Java are stronger than those from the rest of Indonesia to Java. However, the central government borrowing from abroad is increasing rapidly in both scenario 3 and scenario 4 and the private capital inflow is drastically decreasing in scenario 4. This suggests that when policy planners introduce fiscal decentralization policy, they must be mindful of the status of various indicators such as national and regional variables. From these scenarios of fiscal decentralization policy, we found that scenario 3 of decentralized government spending in Sumatra is better than Scenario 2 of more equal decentralized government spending and Scenario 4 of more decentralized government spending in the rest of Indonesia in order to improve the regional inequality.

Thus, we conclude that an Inter-regional CGE model is useful to evaluate the impact of tariff reduction policy and fiscal decentralization policy on the regional economies as well as on the entire Indonesian economy.

A few points are noteworthy for the direction of future research. First, this model assumes a

static and short-run model in which the capital stocks in each industry for the production function is assumed to be fixed, but the labor demand is assumed to be mobile intersectorally but not interregionally. In future work, we extend this model to a dynamic model with an interregional labor migration. Second, more effort should be made to construct the monopolistic competition model to reflect the agglomeration economies in Java. Third, this model is specified in the real economy, and cannot analyze the effects of the financing sector on regional economies. Hence, we should extend this model to an IRCGE model with a financial sector.

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Appendix A: System of Equations

This appendix presents a complete set of mathematical expression of the interregional CGE model. Endogenous variables are denoted by name in capital letters, and exogenous variables by names in capital letters with a bar. Subscripts and superscripts used in this appendix include: i and j are sectors, h and h' are household categories, r and r' are regions.

A. 1 Sectoral Production and intermediate input

$$1. X_i^r = \alpha_i^r \left[\alpha_i^r (Lg_i^r)^{\delta_i^r} + (1 - \alpha_i^r) (\bar{K}_i^r)^{\delta_i^r} \right]^{(1/\delta_i^r)}$$

$$2. INT_i^r = \sum_{j=1}^{15} (a_{ij}^{rr} X_j^r) + \sum_{j=1}^{15} (a_{ij}^{r'r} X_j^{r'})$$

A. 2 Factor Market and Income

$$3. Lg_i^r = \prod_{h=1}^{h \in r} (L_{hi})^{ld_{hi}}$$

$$4. L_{hi} = \frac{X_i^r P N_i^r \alpha_i^r ld_{hi} (Lg_i^r)^{\delta_i^r}}{w d_{hi} W_h \left[\alpha_i^r (Lg_i^r)^{\delta_i^r} + (1 - \alpha_i^r) (\bar{K}_i^r)^{\delta_i^r} \right]}; h \in r$$

$$5. W_{Si}^r = (PQINDEX^r)^{\mu_{1i}} (1 + PX_i^r)^{\mu_{2i}} \left(1 + \frac{\bar{OX}_i^r}{Lg_i^r} \right)^{\mu_{3i}}$$

$$6. W_h = \bar{OW}_h \sum_{i=1}^{15} (\omega \phi_{hi}^r W_{Si}^r)$$

$$7. U_h = \bar{L}_{Sh} - \sum_{i=1}^{15} L_{hi}$$

$$8. YL_h = \left(\sum_{i=1}^{15} L_{hi} \right) wd_{hi} W_h$$

$$9. YK_h = \left\{ \sum_{i=1}^{15} (PN_i^r X_i^r) - \left(\sum_{i=1}^{15} L_{hi} \right) wd_{hi} W_h \right\} kd_h$$

A. 3 Regional Commodity Market

$$10. Q_i^r = bq_i^r \left[\beta_i^r (XD_i^r)^{-\epsilon_i^r} + (1 - \beta_i^r) (XM_i^r)^{-\epsilon_i^r} \right]^{(-1/\epsilon_i^r)}$$

$$11. XM_i^r = XD_i^r \left\{ \left[PD_i^r (1 + idt_i^r + ttm_i^r) / PM_i^r \right] \left[\beta_i^r / (1 - \beta_i^r) \right] \right\}^{1/(1+\epsilon_i^r)}$$

$$12. XD_i^r = cd_i^r \left[\chi_i^{rr} (XS_i^{rr})^{-\phi_i^r} + \chi_i^{r'r} (XS_i^{r'r})^{-\phi_i^r} \right]^{(-1/\phi_i^r)}$$

$$13. XS_i^{r'r} = (cd_i^r)^{(-\phi_i^r/(1+\phi_i^r))} (\chi_i^{r'r} PX_i^r / PX_i^{r'r})^{(1/(1+\phi_i^r))} XD_i^r$$

$$14. XS_i^r = XS_i^{rr} + XS_i^{r'r}; \text{ if } XS_i^{r'r} = 0 \Rightarrow XS_i^r = XS_i^{rr}$$

$$15. X_i^r = XS_i^r + XE_i^r; \text{ if } XE_i^r = 0 \Rightarrow X_i^r = XS_i^r$$

$$16. XE_i^r = ex_i^r [PE_i^r / PX_i^r]^{r_i^r}$$

A. 4 Institutional Income and Expenditure

$$17. YH_h = \sum_{h'=1}^5 (fl_{hh'} YL_h) + \sum_{h'=1}^5 (fkh_{hh'} (YK_h + kbrw_h ER)) + \sum_{h'=1}^5 \overline{hti}_{hh'} + \sum_{r=1}^3 \overline{coth}_h^r + \sum_{r=1}^3 \overline{cgth}_h^r + ER \overline{rwth}_h$$

$$18. YHD_h = YH_h - TNH_h - \sum_{h'=1}^5 \overline{htp}_{hh'} - \overline{deph}_h$$

$$19. TNH_h = tnh_h YH_h$$

$$20. HS_h = hs0_h + hs1_h YHD_h$$

$$21. HC_{hi}^r = \phi_{hi}^r \left[(YHD_h - HS_h) / P_i^r \right]$$

$$22. YC^r = \sum_{h'=1}^5 (fkc_{hh'} (YK_h + kbrw_h ER)) + \overline{comtrf}^r + \overline{rwc}^r ER$$

$$23. YCD^r = YC^r - TNC^r - \overline{repat}^r ER - \overline{depc}^r$$

$$24. TNC^r = tnc^r YC^r$$

$$25. CS^r = cs0^r + cs1^r YCD^r$$

A. 5 Government

$$26. CGR = \sum_{r=1}^3 CGR^r$$

$$27. CGR^r = \sum_{h=1}^5 \left(fkg_{hh} \left(YK_h + \overline{kbrw_h ER} \right) \right) + NTX^r + IDT^r - SUB^r + TM^r + \overline{grw}^r ER$$

$$28. NTX^r = tnh_h YH_h + \sum_{r'=1}^3 \left(tnc^{rr'} YC^r \right)$$

$$29. IDT^r = \sum_{i=1}^{15} idt_i^r \left(PD_i^r XD_i^r + ER \overline{pwm_i}^r XM_i^r + PE_i^r XE_i^r \right)$$

$$30. SUB^r = \sum_{i=1}^{15} \left(P_i^r cgs_i^r CGR^r \right)$$

$$31. TM^r = \sum_{i=1}^{15} tim_i^r \left(XM_i^r ER \overline{pwm_i}^r \right)$$

$$32. CGE = \sum_{r=1}^3 CGE^r$$

$$33. CGE^r (= CGR^r) = \sum_{h=1}^5 \overline{cgh}_h^r + \sum_{r'=1}^3 \overline{govtp}^{rr'} + CGTC^r + \overline{dep_g}^r + CGSV^r + \overline{gdebt_s}^r$$

$$34. CGTC^r = \sum_{i=1}^{15} \left(P_i^r cgc_i^r \overline{CGCON}^r \right)$$

A. 6 Saving and Investment

$$35. TS = TS^g + TS^p$$

$$36. TS^g = \sum_{h=1}^5 \left(\overline{shsg}_h HS_h \right) + \sum_{r=1}^3 \left(\overline{scsg}_r CS_g^r \right) + \sum_{r=1}^3 \left(\overline{sgsg}_r CGSV^r \right) + CGFBR \times ER$$

$$37. TS^p = \sum_{h=1}^5 \left(\left(1 - \overline{shsg}_h \right) HS_h \right) + \sum_{r=1}^3 \left(\left(1 - \overline{scsg}_r \right) CS_g^r \right) + \sum_{r=1}^3 \left(\left(1 - \overline{sgsg}_r \right) CGSV^r \right) + FBOR \times ER$$

$$38. RGINVD^r = \overline{IMATG}^r TS^g$$

$$39. GINVO_i^r = cgt_i^r RGINVD^r$$

$$40. RPINVD^r = \psi_0^r \left(\sum_{i=1}^{15} X_i^r \right)^{\psi_1^r} \left(\sum_{i=1}^{15} \overline{OX}_i^r \right)^{\psi_2^r} IRATE^{\psi_3^r}$$

$$41. RPINVO^r = \sum_{r=1}^3 \left(IMATT^{rr'} RPINVD^{r'} \right)$$

$$42. PINVO_i^r = pinv_i^r RPINVO^r$$

$$43. TINV = \sum_{r=1}^3 \sum_i^{15} \left(P_i^r GINVO_i^r \right) + \sum_{r=1}^3 \sum_i^{15} \left(P_i^r PINVO_i^r \right)$$

A. 7 Gross Domestic Product

$$44. GRDP^r = \sum_{i=1}^{15} \left(X_i^r PN_i^r \right) + IDT^r - SUB^r + TM^r$$

$$45. GDP = \sum_{r=1}^3 GRDP^r$$

A. 8 Price Structure

$$46. PM_i^r = ER \overline{pwm}_i^r (1 + idt_i^r + tim_i^r + ttm_i^r)$$

$$47. PE_i^r = ER \overline{pwe}_i^r / (1 + idt_i^r + ttm_i^r)$$

$$48. PX_i^r = (PD_i^r XS_i^r + PE_i^r XE_i^r) / X_i^r$$

$$49. PN_i^r = PX_i^r - \sum_{j=1}^{15} (a_{ij}^{rr} P_j^r) - \sum_{j=1}^{15} (a_{ij}^{r'r} P_j^{r'})$$

$$50. P_i^r = (PD_i^r XS_i^r (1 + idt_i^r + ttm_i^r) + PM_i^r XM_i^r) / Q_i^r$$

$$51. PK^r = \sum_{i=1}^{15} ((PINVO_i^r + GINVO_i^r) / (RPINVO^r + RGINO^r)) P_i^r$$

$$52. PXINDEX^r = \sum_{i=1}^{15} (\omega x_i^r PX_i^r)$$

$$53. PQINDEX^r = \sum_{i=1}^{15} (\omega q_i^r P_i^r)$$

A. 9 Market Equilibrium Conditions

$$54. Q_i^r = \sum_{j=1}^{15} (a_{ij}^{rr} X_j^r) + \sum_{j=1}^{15} (a_{ij}^{r'r} X_j^{r'}) + \sum_{h=1}^{h \in P} HC_{hi}^r + cgc_i^r \overline{CGCON} + \overline{tradm}_i^r / P_i^r \\ + GINVO_i^r + PINVO_i^r$$

$$55. \sum_{r=1}^3 \sum_{i=1}^{15} (XE_j^r \overline{pwe}_i^r) + \sum_{r=1}^3 \overline{grw}^r + \sum_{h=1}^5 \overline{kbrw}_h + \sum_{h=1}^5 \overline{rwth}_h + \sum_{r=1}^3 \overline{rwc}^r + CGFBR + FBOR \\ = \sum_{r=1}^3 \sum_{i=1}^{15} (XM_j^r \overline{pwm}_i^r) + \sum_{r=1}^3 \overline{repat}_h + \sum_{h=1}^5 \overline{kprw}_h + \overline{gdebt}_s$$

$$56. (CGFBR \times ER) = \sum_{r=1}^3 RGINVD^r - \sum_{r=1}^3 CGSV^r$$

$$57. TS = TINV$$

Appendix B: List of Parameters and Variable

αx_i^r	Shift parameter in production function
α_i^r	Share parameter in Production function
δ_i^r	Sectoral elasticities in Production function
a_{ij}^{rr}	Input-output coefficients
ld_{hi}	Labor demand proportionality
wd_{hi}	Wage proportionality
$\mu 1_i, \mu 2_i$	Price elasticity in the wage function
$\mu 3_i$	Productivity elasticity in the wage function

$\omega\varphi_{hi}^r$	Sectoral weight of wage by micro region
kd_{hi}	Capital income proportionality
bq_i^r	Shift parameter in CET Armington for import
β_i^r	Share parameter in CET Armington for imports
ε_i^r	Sectoral elasticities in Armington exponent for imports
idt_i^r	Rates of indirect taxes
ttm_i^r	Rates of trade and transport margin
cd_i^r	Shift parameter in CET Armington for interregional trade
χ_i^{rr}	Share parameter in CET Armington for interregional trade
ϕ_i^r	Sectoral elasticities in Armington exponent for interregional trade
ex_i^r	Shift parameter for export
γ_i^r	Sectoral elasticities for export
$fl_{hh'}$	Coefficient of household labor income in micro region
$fk_{hh'}$	Coefficient of household capital income in micro region
tnh_h	Rates of direct household taxes
$hs0_h$	Constant term in household saving
$hs1_h$	Marginal propensity to save in household
φ_{hi}^r	Coefficient of household consumption
$fk_{hh'}$	Coefficient of companies capital income in micro region
$tnc^{rr'}$	Rates of direct company taxes
$cs0^r$	Constant term in companies saving
$cs1^r$	Marginal propensity to save in companies
$fk_{g_{hh'}}$	Coefficient of government capital income in micro region
cgs_i^r	Coefficient of government subsidies in region
tim_i^r	Rate of import tariff
cgc_i^r	Coefficient of government sectoral consumption in region
$\overline{shsg}_h$	Share of household saving for government investment
$\overline{scsg}_r$	Share of company saving for government investment
$\overline{sgsg}_r$	Share of government saving for government investment
$\overline{IMATG}^r$	Government investment share in region
cgi_i^r	Distribution of government investment by sector in region
ψ_0^r	Constant term in investment
ψ_1^r	Exponent of current total output in investment
ψ_2^r	Exponent of previous year total output in investment
ψ_3^r	Exponent of interest rate in investment
$IMATT^{rr'}$	Capital coefficient matrix for total regional private investment
$pinv_i^r$	Distribution of private investment by sector in region

$\omega t x_i^r$	Index weighting for regional domestic price index
$\omega t q_i^r$	Index weighting for regional composite price index

Variables

X_i^r	Output by sector in region
$\bar{K}_i^r$	Sectoral capital stock in region (exogenous)
Lg_i^r	Sectoral labor demand in region
INT_i^r	Intermediate inputs by sector in region
L_{hi}	Sectoral labor demand in micro region
$\overline{OX}_i^r$	Previous year sectoral output in region (exogenous)
$\bar{L}s_h$	Sectoral labor supply in micro region (exogenous)
U_h	Unemployment in micro region
YL_h	Regional labor income in micro region
YK_h	Regional capital income in micro region
XD_i^r	Domestic demanded goods by sector in region
XM_i^r	Imported goods from abroad by sector in region
XS_i^{rr}	Intra-regionally supplied goods by sector in region
$XS_i^{r'r}$	Inter-regionally supplied goods by sector in region
XS_i^r	Domestic supplied goods by sector in region
XE_i^r	Exported goods by sector in region
YH_h	Household income
$\overline{kbrw}_h$	Household capital borrowing from abroad (exogenous)
$\overline{hti}_{hh'}$	Household income from inter - household transfer (exogenous)
$\overline{coth}_h$	Household income from companies direct transfers (exogenous)
$\overline{cgth}_h$	Household income from government direct transfers (exogenous)
$\overline{rwth}_h$	Household income from abroad direct transfers (exogenous)
YHD_h	Household disposable income
TNH_h	Household direct taxes to government
$\overline{htp}_{hh'}$	Household payment to inter-household transfer (exogenous)
$\overline{deph}_h$	Household payment to capital depreciation (exogenous)
HS_h	Household savings
HC_h^r	Household consumption by sector by micro region
YC^r	Companies income in region
$\overline{comtrf}^r$	Companies income from inter-companies transfer (exogenous)
$\overline{rwc}^r$	Companies capital borrowings from abroad (exogenous)
YCD^r	Companies disposable income
TNC^r	Companies direct taxes to government
$\overline{repat}^r$	Companies payment to repatriated profits (exogenous)

$\overline{depc^r}$	Companies payment to capital deprecation (exogenous)
CS^r	Companies savings
CGR	Total Government revenues
CGR^r	Government revenues in region
NTX^r	National direct taxes of government in region
IDT^r	Indirect taxes of government in region
SUB^r	Government subsidy to production sector in region
TM^r	Tariff revenues in region
$\overline{grw}$	Government remittance from abroad (exogenous)
CGE	Government current expenditures
CGE^r	Government current expenditures in region
$CGTC^r$	Government total current consumption in region
$\overline{govtp^{rr}}$	Government payment to transfer between government in region
$\overline{gdebts^r}$	Government debt payment to abroad in region (exogenous)
$\overline{depg^r}$	Government payment to capital deprecation in region (exogenous)
$CGSV^r$	Government saving in region
$\overline{CGCON}$	Government total consumption (exogenous)
TS	Total saving
TS^g	Saving for government investment
TS^p	Saving for private investment
$CGFBR$	Government net foreign borrowings
$FBOR$	Foreign saving in private sector
$RGINVD^r$	Government investment in region
$GINVO_i^r$	Government investment in region by sector
$IRATE$	Annual interest rate
$RPINVD^r$	Private investment by destination in region
$RPINVO^r$	Private investment by origin in region
$PINVO_i^r$	Private investment for sector by origin
$TINV$	Total investment
$GRDP^r$	Gross regional domestic product in region
GDP	Gross domestic product
Q_i^r	Quantity demanded commodity by sector in region
$\overline{tradm_i^r}$	Sectoral trade margin by region (exogenous)
$\overline{kprw_h}$	Capital payments abroad (exogenous)
$\overline{OW_h}$	Previous year average wage coefficient in region (exogenous)
W_h	Average wage in micro region
Ws_i^r	Sectoral wage in region

PK_i^r	Sectoral capital price in region
PN_i^r	Sectoral value added price in region
PD_i^r	Sectoral domestic price in region
PM_i^r	Sectoral import price in region
PE_i^r	Sectoral export price in region
PX_i^r	Sectoral producer price in region
P_i^r	Sectoral composite price in region
$PXINDEX^r$	Regional domestic price index in region
$PQINDEX^r$	Regional composite price index in region
$\overline{pwe}_i^r$	Domestic world price of exported goods (exogenous)
$\overline{pwm}_i^r$	Domestic world price of imported goods (exogenous)
ER	US\$ exchange rate