The Impacts of Trade Liberalization Policy on the Regional Economy in Indonesia : An Inter-Regional Computable General Equilibrium Model*

Suminori Tokunaga (University of Tsukuba)

Sun Lin (Institute of Social Science in Shanghai)

Nguyen Tien Dung (Nagoya University)

1. Introduction

In this paper, we examine the impacts of the trade liberalization policy on regional economy in Indonesia, following the 1995 Inter-regional Social Accounting Matrix (IRSAM)[1]. In this model, the Indonesia economy is divided into three regions such as Java, Sumatra and other region. Furthermore Java region is divided into three micro regions (east Java, central Java and west Java). We focus on the real side of the regional economy, and convey a comparative static-type of analysis.

This paper is organized as follows. Section 2 describes the Inter-Regional Computable General Equilibrium (IRCGE) model. Section 3 reports the analysis of impacts of some simulations of the trade liberalization policy. Finally we present our concluding remarks.

2. The IRCGE model

The primary data source were the 1995 regional input-output (IO) table of Indonesia and the 1995 Interregional Social Accouting Matrix (SAM) of Indonesia. The basic model in this study follows closely that of Resosudarmo, Wuryanto, Hewings, and Saunders (1999), Wuryanto (1996), in which they were basically the CGE model by Thorbecke's (1992) and divided only two regions of Java and outer Java. Since the regional economy of outer Islands such as Sumatra, Kalimantan and Irian Jaya is dominated by oil/gas and natural, we divide Indonesia economy into three regions of Java, Sumatra and other region in this IRCGE model. This IRCGE model with three regions is specified in nine blocks : (1) spectoral 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[2].

In the secotral production and intermediate inputs block, 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. The production function in each sector and each region is postulated as a homogenous CES (constant elasticity of substitution) type in (E-1). The primary production factors are aggregate labor (Lg_i) and capital stocks ($\overline{K}_i$). Aggregate labor demand is assumed to be mobile inter-sectorally, but not interregionally. The capital stocks in each sector are assumed to be fixed and immobile both inter-sectorally and inter-regionlly. The intermediate inputs are using intra-regional and interregional coefficients, and there is no substitution between intermediate inputs and production factors, and consequently, there is no substitution among the intermediate inputs themselves in (E-2).

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 categories regional of households. To be used in the sectoral production function in each macro region, the corresponding micro region's 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 the Cobb-Douglas type of function (E-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 result from the derivation shows 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 (E-4). The sectoral wage equation employed in this study follows that applied by Thorbecke (1992). According to his work, the sectoral wage rates, which are 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 ($\overline{OX}_i/Lg_i$) (E-5). An import implication that underlies the formulation of the wage equations is that labor market segmentation exists in Indonesia, with wage 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 ($\omega\varphi_{hi}$) for each type of labor category in each sector (E-6). The labor supply in each labor category is assumed to be fixed, and it is assumed that some labor slack prevailed (in the forms of unemployment or underemployment) in 1995 (E-7). Labor and capital income, which is defined respectively in (E-8) and (E-9), is specified according to each micro region based on the fixed labor and capital income proportionality (wd_h and kd_h, respectively).

In the regional commodity market block, the commodity flows incorporate simultaneously the demand and supply side of the

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[2]The system of equations and definition of parameters and variables in IRCGE model of Indonesia will be in appendix A and appendix B.

regional economies. In the demand block, the sectoral composite goods demand is postulated using the Armington rule, which allows imperfect substitution between domestically demanded goods (XD) and imported goods (XM) in the corresponding sector (E-10). Applying cost minimization principles, the optimal level of imported goods can be obtained, as can be seen in equation (E-11). The demand level for imported goods depends on the ratio of the price of domestically demanded goods (PD) to the price of imported goods (PM), 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}) (E-12). Again, applying cost minimization principles, the optimal level of interregionally imported goods can be obtained. As shown in equation (E-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 (E-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) (E-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 (E-16).

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

In the government block, the total government revenue is the sum of government's revenues in three regions in (E-26). The government in region receives its income (CGR^r) from a fixed proportion of each of micro-region's capital income, from national direct taxes, from net national indirect taxes ($IDT^r - SUB^r$, E-29 and E-30), from import tariffs (TM^r, E-31), and from the exogenous remittance from abroad ($\overline{grw}^r$) in (E-27). The total government current expenditure (CGE) is the sum of government's expenditures in three regions in (E-32). The expenditure (CGE^r) of government in region, which is postulated to be equal to its revenue, comprises the expenditure for government consumption ($CGTC^r$(E-33)), exogenous direct transfers to regional household ($\overline{cgth}_h$), exogenous direct transfers between governments ($\overline{govtp}^r$), exogenous government debt service for foreign borrowing ($\overline{gdebts}^r$), and savings ($CGSV^r$) (E-32).

In the saving and investment block, having determined the savings behavior for each institutional account, the total savings (TS) definition is specified in equation (E-35). The total savings is the sum of household savings, com-

pany savings, government saving and foreign saving in (E-36) and (E-37). In equation (E-38), the government investment expenditure in region ($\overline{RGINVD^r}$) is determined by a fixed proportion. As can be seen, the government investment expenditure in each sector of origin ($GINVO_i^r$) is determined endogenously by proportions derived from the IRSAM table in (E-39).

Total regional private investment by destination ($RPINVD^r$) in this study 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 (E-40). To obtain the regional private investment by origin ($PRINVO^r$), the amount of total regional private investment by destination must be pre-multiplied by regional capital coefficient matrix ($IMATT^{rr}$) in (E-41). The amount of total regional private investment by destination multiplied by the sectoral proportions derived from the IRSAM table makes the sectoral private investment by origin ($PINVO_i^r$) in (E-42). The final equation specifies the total investment ($TINV$), which incorporates private investment and the government's investments in (E-43).

In the gross domestic product block, this 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 (PE_i^r), plus the income from net

indirect taxes in (E-44). The value of the gross domestic product is generated by add up the gross regional domestic product at the market value in (E-45).

In the price block, the model specifies eight definitions of price structure, which are generally straightforward. 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 (E-46). The sectoral exported goods prices (PE_i^r) by macro region are postulated to be proportionally related to the world export goods prices ($\overline{pwe_i}$), adjusted for indirect taxes and trade and transport margins in (E-47).

In 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 in 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 (E-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 the government) remittance from abroad, plus the government and private foreign borrowings must equal to the sum of sectoral imports abroad by region, plus repatriated profits, plus capital (service) payments to the rest of the world, and plus the government foreign debt service (E-55). It can be seen that 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's budget constraints to finance investment expenditures. Equation (E-56) expresses that the deficits of the government investment expenditure is financed through foreign borrowing ($CGFBR$). And the final equilibrium is concerning the situation in which the total (or aggregate) savings must always be equal to the total investment in (E-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[3].

3. Policy Simulation of Trade Liberalization

As we got the good baseline simulation results for the IRCGE model, in this section, we examine the impacts of the trade liberalization policy on regional economy in Indonesia, in

view of the policy direction for development plan in which Indonesian government is conducting the policy reforms towards market oriented economy.

To analyze the impact of a tariff reduction for the trade liberalization policy on the regional economy, we conducted the simulation analysis that the tariff is decreasing by 50% in 1995 and the other exogenous variables are fixed in 1995.

In simulation, we found that the direct effects with the tariff cut are the reduction in tariff revenue and the reduction in the imported goods price. The tariff cut affects the real gross regional domestic products (GRDP) in each region directly through definition equation (E-44) of GRDP. However, since tariff cut lowers the imported goods price and the composite goods price, the value-added price is increasing due to cost reduction. Then, in industry activity, exports sectors such as textile sector in Jawa benefit, while import-competing sectors are more likely to suffer damage in Figure 1A-1C as was noted by Haddad (1999). Thus, the real GRDP of Java is increasing than in outer-Java (Sumatra and other region). The regional government revenue of Java is slightly decreasing, but government expenditure of Java does not change, thus central government borrowing from abroad is increasing. Table 1a summarizes the simulation results on main macro variables. The real GDP is increasing by 0.33 %, but the central government revenue is decreasing by 8.96 %. Regarding the price index, the regional the price index is decreasing ranging from −1.16

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[3]we utilize the GAMS release 2.5 optimization program.

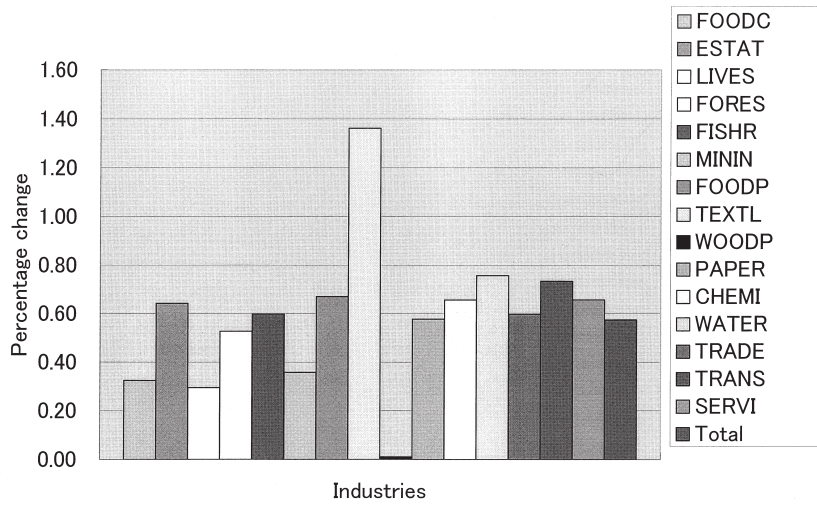## Figure 1a   Production Effects of a 50% Tariff Reduction : Java

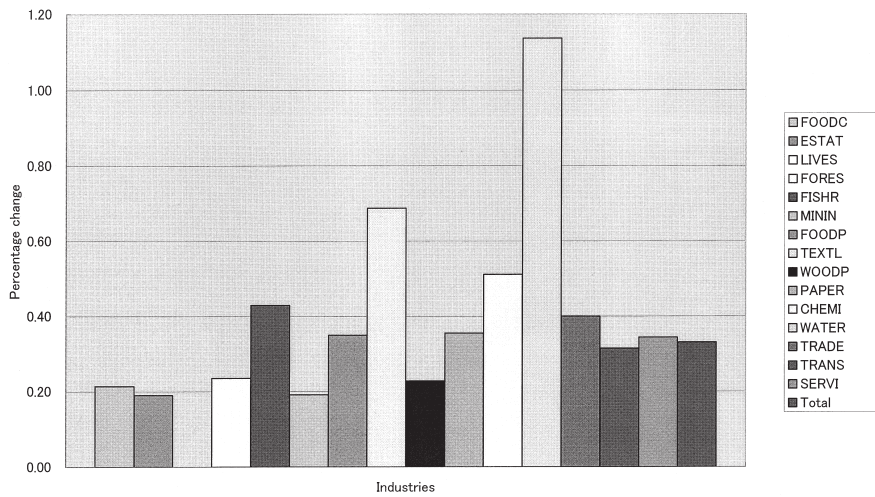## Figure 1b   Production Effects of a 50% Tariff Reduction : Sumatra

Figure 1c   Production Effects of a 50% Tariff Reduction : Other
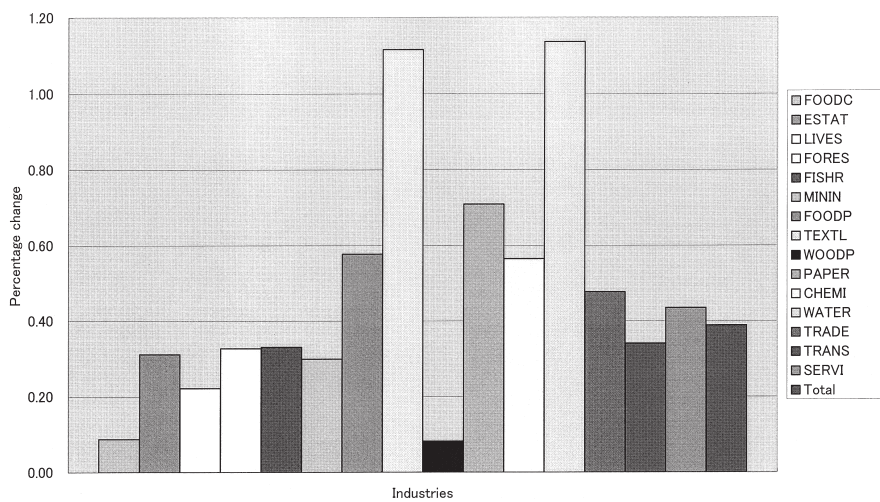
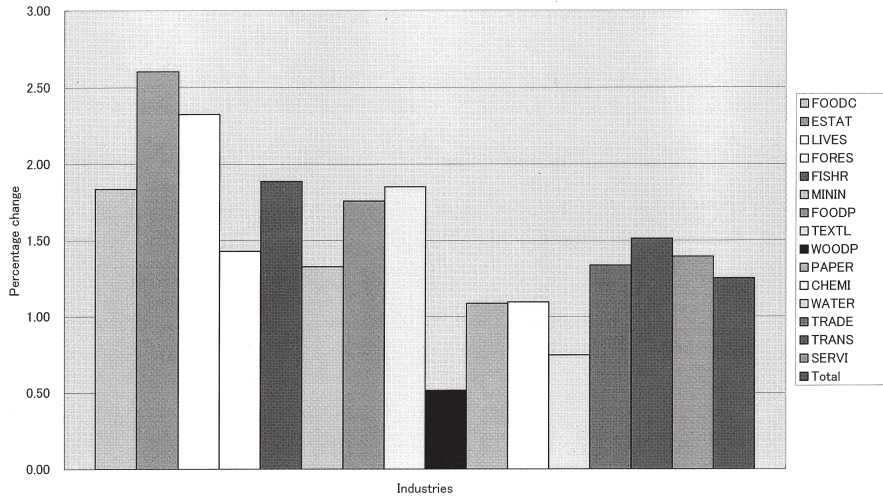## Figure 2a Imports Effects of a 50% Tariff Reduction : Java

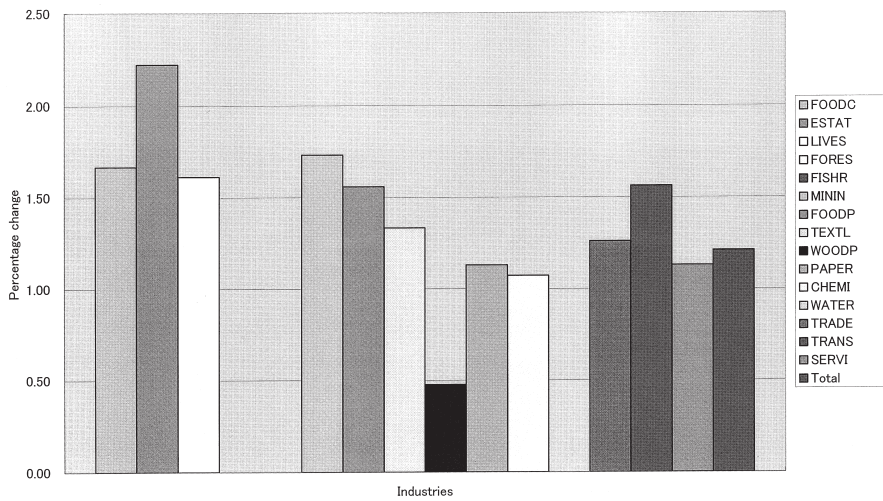## Figure 2b Imports Effects of a 50% Tariff Reduction : Sumatra

Figure 2c Imports Effects of a 50% Tariff Reduction : Other
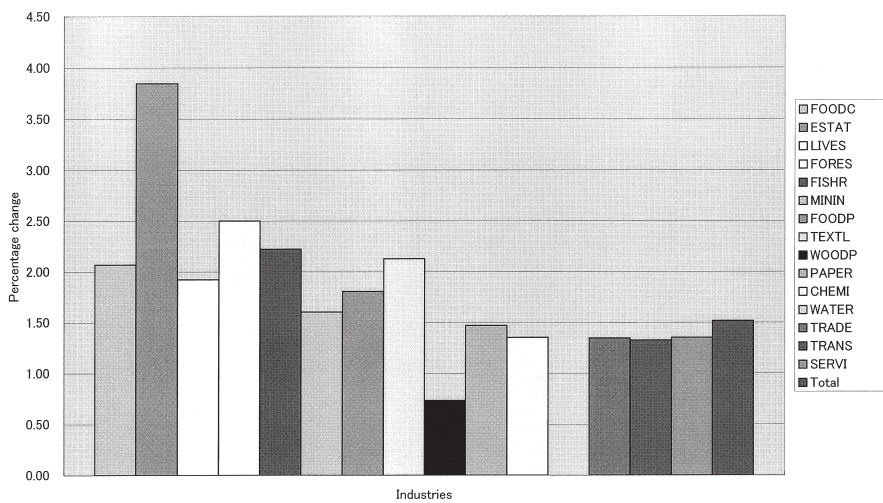
Figure 3a　Prices Effects of a 50% Tariff Reduction : Java
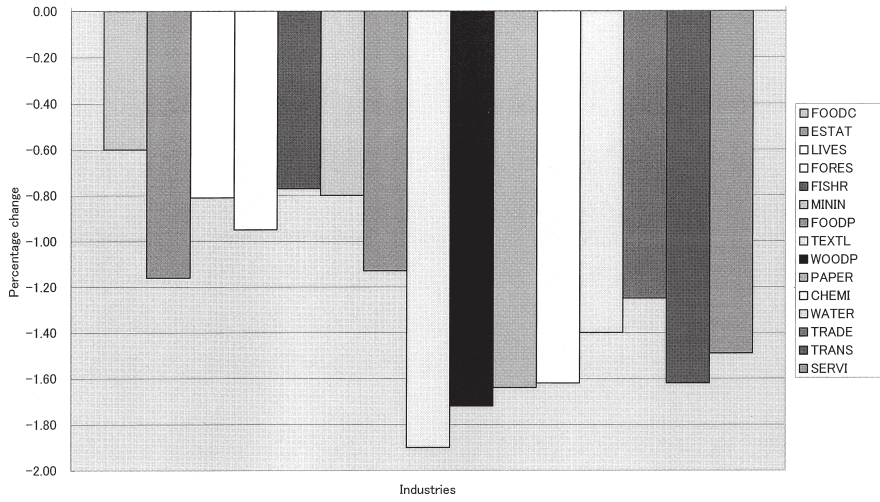

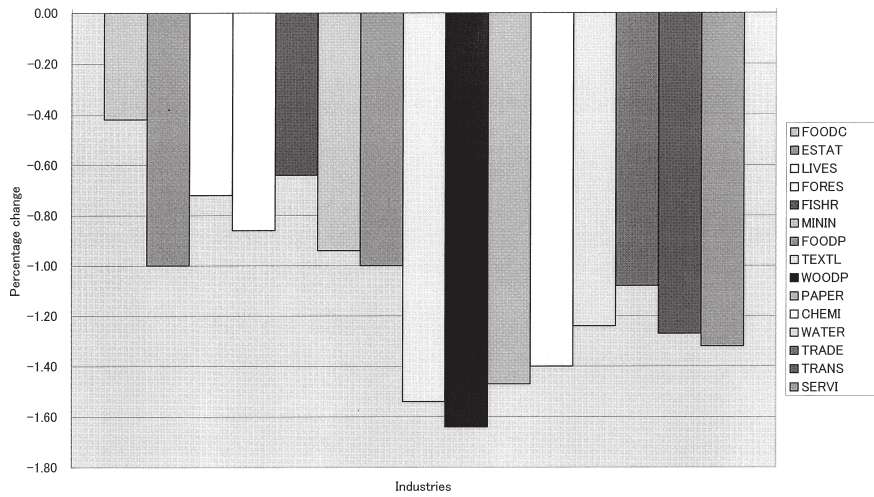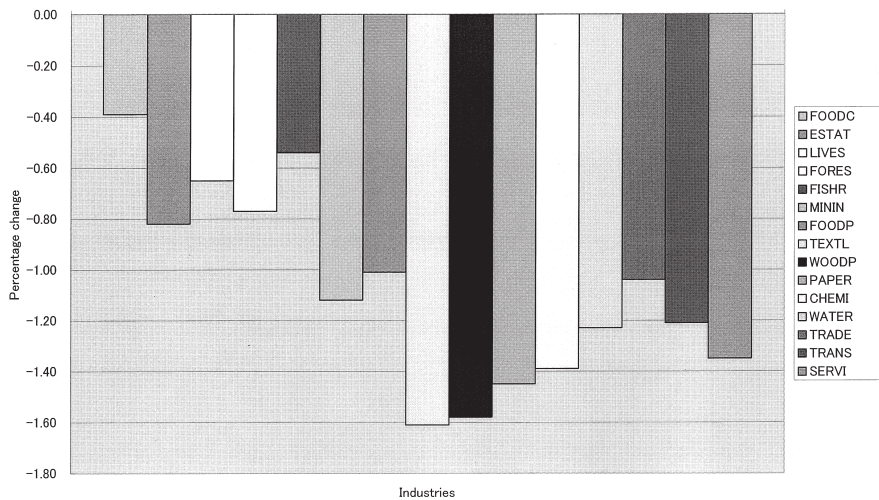## Figure 3b　Prices Effects of a 50% Tariff Reduction : Sumatra

Figure 3c　Prices Effects of a 50% Tariff Reduction : Other

% (other region) to -1.38% (Java).

4．Conclusion

In this paper, following the 1995 Interregional Social Accounting Matrix (IRSAM), we constructed an interregional Computable General Equilibrium (IRCGE) Model for three regions of Java, Sumatra and other region in Indonesia, and examined the impacts of the trade liberalization on regional economy.

From simulation of the tariff reduction by 50% in 1995, we found that the direct effects with the tariff cut are the reduction in tariff revenue and the reduction in the imported goods price. The tariff cut affects the real GRDP in each region directly through equation (E-44). However, since tariff cut lowers the imported goods price and the composite goods price, the value-added price is increasing due to cost reduction. Then, in industry activity, exports sectors such as textile sector in Jawa benefit, while import-competing sectors are more likely to suffer damage. Thus, the real GRDP of Java is increasing than in outer-Java. The regional government revenue of Java is slightly decreasing, but government expenditure of Java does not change, thus central government borrowing from abroad is increasing. Regarding the price index, the regional the price index is decreasing ranging from -1.16 % (other region) to -1.38% (Java).

References

Alm, James, Robert Aten and Roy Bahl, "Can Indonesia Decentralize Successfully？ Plans, Problems and Prospects," *Bulletin of Indonesian Economic Studies*, Vol. 37, No. 1, 2001, pp. 83-102.

Agenor, Pierre-Richard and Peter J. Montiel, *Development Macroeconomics*, second edition, Princeton University Press, 1999.

Azis, Iwan, J., "Impacts of Economic Reform on Rural-Urban Welfare : A General Equilibrium Framework," *Review of Urban & Regional Development Studies*, Vol. 9, No. 1, 1997, pp. 1-19.

Fukuchi, Takao and Suminori Tokunaga, "Simulation Analysis of Exchange Rate Dynamics : The Case of Indonesia," *The Developing Economies*, Vol. XXXVIII, No. 1, March 1999, pp. 35-58.

Hulu, E. and G. J. D. Hewings, "The Development and use of interregional input-output models for Indonesia under conditions of limited information," *Review of Regional Development Studies*, Vol. 5, 1993, pp. 135-153.

Wuryanto, Luky Eko, *Fiscal Decentralization and Economic Performance in Indonesia : An Interregional Computable General Equilibrium Approach*, Ph. D. Dissertation of Cornell University, 1996 May.

Nidaira, Kouichi, "An Analysis of the Regional Structure in Indonesia by SAM", *Studies in Regional Science*, 2000.

Robinson, S., "Multisectoral Models," in *Handbook of Development Economics*, H. Chenery and T. N. Srinivasan (eds.), Vol. 2, North-Holland, New York, 1989, pp. 885-947.

Resosudarmo, B. P., L. E. Wuryanto, G. J. D. Hewings, and L. Saunders, "Decentralization and Income Distribution in the Inter Regional Indonesia Economy" in Hewings, G. J. D, M. Sonis, M. Madden, and Y. Kimura, *Understanding and Interpreting Economic* Structure, Springer Verlag, Heidelberg, 1999.

Silver, Christopher, Iwan J. Azis, and Larry Schroeder, "Intergovernmental Transfers and Decentralization in Indonesia," *Bulletin of Indonesian Economic Studies*, Vol. 37, No. 3, 2001, pp. 345-362.

Thorbecke, E., *Adjustment and Equity in Indonesia*. Paris : OECD Publication, 1992.

Tokunaga, Suminori, "Primary Commodity, FDI and

Economic Development in Indonesia," *The Journal of International and Regional Economics*, Vol. 1, 2000, pp. 130-154.

Tokunaga, Suminori and Sun Lin, "An Interregional Computable General Equilibrium Model for Indonesia," *The Journal of International and Regional Economics*, Vo2. 1, 2001, pp. 93-108.

Appendix A System of Equations

A.   Sectoral Production and intermediate input

1.   Sectoral production function:

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

2.   Sectoral intermediate inputs:

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

B.   Factor Market and Income

3.   Sectoral labor demand by region:

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

4.   Sectoral labor demand in micro region:

$$L_{hi} = \frac{X_i^r . PN_i^r . \alpha_i^r \, ld_{hi} . \left(Lg_i^r \right)^{\delta_i^r}}{wd_{hi} . W_h . \left[\alpha_i^r \left(Lg_i^r \right)^{\delta_i^r} + \left(1-\alpha_i^r \right)\left(\overline{K}_i^r \right)^{\delta_i^r} \right]} \quad ; h\in r$$

5.   Secotoral wage eqution by region:

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

6.   Average wage by micro region:

$$W_h = \overline{OW}_h . \sum_{j=1}^{15} \left(\omega\varphi_{hj}^r . W_{Sj}^r \right)$$

7.   Labor supply balance by micro region:

$$\overline{Ls}_h = \sum_{j=1}^{15} L_{hi} + U_h$$

8.   Labor income by micro region:

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

9.   Capital income by micro region:

$$YK_h = \left\{ \sum_{j=1}^{15} \left(PN_j^r . X_j^r \right) - \left(\sum_{j=1}^{15} L_{hi} \right) . wd_{hi} . W_h \right\} . kd_h$$

C.   Regional Commodity Market

10. Regional total goods demand:

$$Q_i^r = bq_i^r \left[\beta_i^r \left(XD_i^r \right)^{-\varepsilon_i^r} + \left(1 - \beta_i^r\right)\left(XM_i^r \right)^{-\varepsilon_i^r} \right]^{\left(-1/\varepsilon_i^r\right)} \quad ; \quad \text{if} \quad XM_i^r = 0 \Rightarrow Q_i^r = XD_i^r$$

11. Regional import from abroad:

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

12. Regional Domestic demand:

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

$$\text{if} \quad XS_i^{r'r} = 0 \Rightarrow XD_i^r = XS_i^{rr}$$

13. Regional Domestic import:

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

14. Regional Domestic supply:

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

15. Regional total supply:

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

16. Regional export:

$$XE_i^r = ex_i^r \left[PE_i^r / PX_i^r \right]^{\gamma_i^r}$$

D. Institutional Income and Expenditure

17. Household income

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

18. Household disposable income:

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

19. Household nat.direct taxes:

$$TNH_h = tnh_h . YH_h$$

20. Household savings:

$$HS_h = hs0_h + hs1_h . YHD_h$$

21. Household consumption:

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

22. Companies income:

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

23. Companies disposable income:

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

24. Companies nat.direct taxes:

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

25. Companies savings:

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

E. Government

26. Total government revenues:

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

27. Government revenues in region:

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

28. Total national direct taxes in regional:

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

29. Total national indirect taxes in regional:

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

30. Subsidies to prod. cativities:

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

31. Tariff revenues in region:

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

32. Total government current expenditure:

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

33. Government current expenditure in region:

$$CGE^r (= CGR^r) = \sum_{h=1}^{5} \overline{cgth}_h^r + \sum_{r'=1}^{3} \overline{govtp}^{rr'} + CGTC^r + \overline{depg}^r + CGSV^r + \overline{gdebts}^r$$

34. Government current consumption in region:

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

F. Saving and Investment

35. Total savings definition:

$$TS = TS^g + TS^p$$

36. Savings for government investment:

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

37. Savings for private investment:

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

38. Government investment expenditure in region:

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

39. Government investment expenditure in sector:

$$GINVO_i^r = cgi_i^r.RGINVD^r$$

40. Regional Private investment by destination:

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

41. Regional Private investment by origin:

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

42. Private investment by sector of origin:

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

43. Total investment definition:

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

G. Gross Domestic Product

44. Gross regional domestic product

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

45. Gross domestic product

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

H. Price Structure

46. Imported goods price:

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

47. Exported goods price:

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

48. Producer price:

$$PX_i^r = \left(PD_i^r . XS_i^r + PE_i^r . XE_i^r \right) \big/ X_i^r)$$

49. Definition of value-added price:

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

50. Composite goods price:

$$P_i^r = \left(PD_i^r . XS_i^r . \left(1 + idt_i^r + ttm_i^r \right) + PM_i^r . XM_i^r \right) \big/ Q_i^r)$$

51. Price of capital:

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

52. Domestic price index:

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

53. General price index:

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

I. Market Equilibrium Conditions

54. Composite goods equilibrium:

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

$$\sum_{h=1}^{h \in r} HC_{hi}^r + cgc_i^r \overline{CGCON} + \overline{tradm}_i^r / P_i^r + GINVO_i^r + PINVO_i^r$$

55. External market equilibrium(in US$):

$$\sum_{r=1}^{3} \sum_{i=1}^{15} \left(XE_j^r . \overline{pwe}_i^r \right) + \sum_{r=1}^{3} \overline{grw}^r + \sum_{h=1}^{5} \overline{kbrw}_h + \sum_{h=1}^{5} \overline{rwth}_h + \sum_{r=1}^{3} \overline{rwc}^r + CGFBR + FBOR$$

$$=$$

$$\sum_{r=1}^{3} \sum_{i=1}^{15} \left(XM_j^r . \overline{pwm}_i^r \right) + \sum_{r=1}^{3} \overline{repat}_h + \sum_{h=1}^{5} \overline{kprw}_h + \overline{gdebts}$$

56. Central government investment expenditure balance:

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

57. Savings-investment balance:

$$TS = TINV$$

Appendix B List of Parameters and Variable

A. Parameters

ax_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 income proportionality
wd_{hi}	Wage proportionality
$\mu 1_i, \mu 2_i$	Price eleasticity in the wage function
$\mu 3_i$	Productivity eleasticity in the wage function
$\omega\varphi_{hi}^r$	Sectoral wegiht 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
ϕ_i^r	Sectoral elasticities in Armington exponent for interregional trade
ex_i^r	Shift parameter in Export function
γ_i^r	Sectoral elasticities for export function
$fl_{hh'}$	Coefficient of household labor income in micro region
$fkh_{hh'}$	Coefficient of household capital income in micro region
tnh_h	Rates of direct household taxes
$hs0_h$	Constrant term in household saving function
$hs1_h$	Marginal propensity to save of household
φ_{hi}^r	Constrants in household consumption function
$fkc_{hh'}$	Coefficient of companies capital income in micro region
$tnc^{rr'}$	Rates of direct company taxes
$cs0^r$	Constrant term in companies aving function
$cs1^r$	Marginal propensity to save of companies

$fkg_{hh'}$	Coefficient of government capital income in micro region
cgs_i^r	Coefficient of government prod activity subsidies in region
tim_i^r	Rate of import tariff
cgc_i^r	Coefficient of government sectoral consumpation in region
$\overline{shsg}_h$	Share of household saving for government capital
$\overline{scsg}_r$	Share of company saving for government capital
$\overline{sgsg}_r$	Share of government saving for government capital
$\overline{IMATG}^r$	Government investment share for region
cgi_i^r	Distribution of government investment by sector
ψ_0^r	Constant term in investment function
ψ_1^r	Exponent of current total output in investment function
ψ_2^r	Exponent of previous year total output in region
ψ_3^r	Exponent of interset rate in investment function
$IMATT^{rr'}$	Capital coefficient matrix for total regional private investment
$pinv_i^r$	Distribution of private investment by sector of origin
ωtx_i^r	Index weighting for producer price index
ωtq_i^r	Index weighting for consumer price index

B. **Variables**

X_i^r	Output by sector in region
$\overline{K}_i^r$	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)
$\overline{Ls}_h$	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 imported goods by sector in region

$XS_i^{r'r}$	Inter-regionally imported 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 deprication(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 deprication(exogenous)
CS^r	Companies savings
CGR	Total Government revenues
CGR^r	Revenues of government in region
NTX^r	National direct taxes of government in region
IDT^r	Government income from region indiect taxes
SUB^r	Government subsidy to production sector by 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 consumpation in region
$\overline{govtp}^{r'r}$	Government payment to transfer between government in regions
$\overline{gdebts}^r$	Government debt payments to abroad(exogenous)
$\overline{depg}^r$	Government payment to capital deprication(exogenous)
$CGSV^r$	Government savings
$\overline{CGCON}$	Government total consumpation(exogenous)
TS	Total savings
TS^g	Savings for government investment
TS^p	Savings for private investment
$CGFBR$	Government net foreign borrowings
$FBOR$	Foreign savings in private sector
$RGINVD^r$	Government investment expenditure in region
$GINVO_i^r$	Government investment expenditure in region by sector
$IRATE$	Annual interest rate in 1995
$RPINVD^r$	Private investment by destination in region
$RPINVO^r$	Privite investment by origin in region
$PINVO_i^r$	Private investment by sector of 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)

C.	Prices
$\overline{OW}_h$	Previous year average wage coefficient in region(exogenous)
W_h	Average wage in micro region
Ws_i^r	Sectoral wage in micro region
PK_i^r	Price of capital 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 in 1995