An Interregional Computable General Equilibrium Model for Indonesia*

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1. Introduction

In this paper, following the 1995 Inter-regional Social Accounting Matrix (IRSAM), we will build an interregional Computable General Equilibrium (IRCGE) Model for Indonesia. In this model, the Indonesia economy is divided into Sumatra, Java 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 conveys a comparative static type of analysis.[1]

The behavior specification of the equations established in this paper basically draws on the framework of the interregional CGE model developed by Luky Eko Wuryanto (1996) in his work for 2 regions 15 industries IRCGE Model in Indonesi.[2] The division of the equations for

the IRCGE model is specified in nine blocks: (1) sectoral production and intermediate input, (2) factor market and income, (3) intra-regional and inter-regional commodity markets, (4) institutional income and expenditure, (5) government in regional, (6) savings and investments, (7) gross domestic products, (8) price structure, and (9) market equilibrium conditions.

This paper is organized as follows. The IRCGE model will be presented in section 2. Some concluding remarks will be made in section 3. The system of equations and definition of parameters and variables of IRCGE model in Indonesia will be in appendix A and appendix B.

2. Characteristics of the model

Secotral Production and Intermediate inputs

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 (E-1).[3] The primary production factors to be considered are (aggregate) labor (Lg_i) and 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 include intra-and inter-regional, and there is no substitution between intermediate inputs and production factors, and consequently, there is no substitution among the intermediate inputs themselves (E-2).

Factor Market and Income

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

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[3]Equation number in Appendix A

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) (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 (W_{si}) 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).

Regional Commodity Market

The commodity flows incorporate simultaneously the demand and supply side of the 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 $(XS_i^{r'r}, XS_i^{r''r})$ (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 $(PX_i^{r'r}, PX_i^{r''r})$, 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 $(XS_i^{rr'}, XS_i^{rr''})$, 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) (E-16).

Institutional Income and Expenditures

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). The total regional household income comes from a fixed proportion of each micro-region's labor income (YL_h) and a fixed proportion of each micro-region's capital income (YK_h), include the capital income from oversea $(\overline{kbrw_h})$. In addition, the regions household income comes from several exogenous direct transfers namely from the government $(\overline{cgth_h})$, from among the regional household themselves $(\overline{hti_h})$, from the companies $(\overline{coth_h})$, and from the rest of the world $(\overline{rwth_h})$ (E-17). It should be noted that the regional household classification in this study does not incorporate income or socio-economic classification. Consequently, the national tax rates that are applied in this model are average tax rates for each of the micro-regions that are derived directly from the IRSAM for 1995 table.

The definitions of regional household disposable income and household savings are straightforward. Household disposable income (YHD_h) is defined as a function of national direct taxes $(TNH_h$ (E-19)), the exogenous total household payments for transfers among

the households themselves $(\overline{htp_h})$, and the household deprecation $(\overline{deph_h})$ (E-18). Household savings in each micro region (HS_h) is formulated as linearly as dependent on regional household disposable income, with a fixed marginal propensity to save calibrated from the IRSAM for 1995 table (E-20). HS_h is divided into saving for government capital and saving for private capital by a fixed proportion $(\overline{shsg_h})$. Household consumption demand in each micro region (HC_h) is derived from household utility function. Hence, household consumption demand in each micro region is positively correlated with its disposable income less household savings and negatively correlated with the regional composite good prices (P_i^r) (E-21).

Companies in each macro region receive income (YC^r) from proportion of the micro-region's capital income, from exogenous transfers income among companies $(\overline{comtrf^r})$, and from exogenous transfers from abroad $(\overline{rwc^r})$ (E-22). The companies' disposable income in each macro region (YCD^r) is formulated as a function of national direct taxes for companies $(TNC^r$ (E-24)$)$, exogenous repatriated profits $(\overline{repat^r})$, and the company deprecation $(\overline{depc^r})$ (E-23). The companies' 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 IRSAM for 1995 table (E-25). As household saving, CS^r is divided into saving for government capital and saving for private capital by a fixed proportion $(\overline{scsg^r})$.

Government

The total government revenue is the sum of government's revenues in three regions (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 $(NTX^r$, E-28), from transfer between government in regions $(\overline{govti^r})$, from net national indirect taxes $(IDT^r-SUB^r$, E-29, E-30), from import tariffs $(TM^r$, E-31), and from the exogenous remittance from abroad $(\overline{grw^r})$ (E-27). The total government current expenditure (CGE) is the sum of government's expenditures in three regions (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-34)$)$, 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-33). As household saving, $CGSV^r$ is divided into saving for government capital and saving for private capital by a fixed proportion $(\overline{sgsg^r})$.

Savings and investment

Having determined the savings behavior for each institutional account, the total savings (TS) definition is specified in equation (E-35). The total savings for government capital (TSg) is defined as a sum of each institution's saving for government investment (E-36). The total savings for private capital (TSp) is defined as a sum of each institution's saving for

private investment (E-37).

The equations (E-38) define the specification of the government investment expenditure $(RGINVD^r)$, is determined exogenous by a fixed proportion $(\overline{IMATG^r})$. As can be seen, the government investment expenditure $(GINVO^r_i)$ in sector is determined endogenously by proportions derived from the IRSAM table (E-39).

Total regional private investment by macro region $(RPINVD^r)$ in this study is determined endogenously. Its magnitude is postulated to depend on the current total output in the corresponding region, previous year total output in the same region, and the annual interest rate $(IRATE^r)$. Since the E-40 yields the amount of total regional private investment by destination $(RPINVD^r)$, in order to obtain the values of total regional investment by origin $(RPINVO^r)$, the former has to be pre-multiplied by regional capital coefficient matrix $(IMATT^{rr})$ (E-41). To obtain the sectoral investment by origin $(PINVO^r)$ in each macro region, the regional investment by origin must by multiplied by the sectoral proportions derived from the IRSAM table (E-42).)

The final equation specifies the total investment $(TINV)$, which incorporates private investment, and the government's investments (E-43).

Gross Domestic Product

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 (PN^r_i), plus the income from net indirect taxes (E-44). The value of the gross domestic product is generated by add up the gross regional domestic product at the market value (E-45).

Price Structure

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^r_i) are equal to the world imported goods prices $(\overline{pwm_i})$, measured in domestic currency and adjusted for indirect taxes (idt^r_i), import tariff (tim^r_i), and trade and transport margins (ttm^r_i) (E-46).

The sectoral exported goods prices (PE^r_i) 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 (E-47).

On the supply side, there are definitions for the sectoral producer prices (PX^r_i) and value-added prices (PN^r_i) by macro region. The sectoral producer price by macro region is determined by figuring the average of the domestic price (PD^r_i) and export price (PE^r_i), weighted by the sectoral output of the region (E-48). The value-added price by macro

region in postulated to be interrelated not only to the producer price, but also to the markets of intermediate inputs from both intraregional and interregional industries (E-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 figuring the average of the domestic price and the imported goods price (E-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 (E-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 (E-52) is determined by figuring the average of the producer prices (PX_i^r), weighted by the proportion of the sectoral supply (ωtx_i^r). The definition of the general price index in each region (E-53) is determined by figuring the average of the composite goods prices (P_i^r), weighted by the proportion of the sectoral demand (ωtq_i^r).

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. There-fore, 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 (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$ cur-rency.

The third condition is related to the central government's budget constraints to finance investment expenditures. Equation E-56 ex-presses 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 (E-57).

3. Concluding Remarks

In this paper, following the 1995 Inter-regional Social Accounting Matrix (IRSAM), we construct an interregional Computable General Equilibrium (IRCGE) Model for In-

donesia. In this model, the Indonesia economy was divided into Sumatra, Java and other region, furthermore Java region is divided into three micro regions (east Java, central Java and west Java). The behavior specification of the equations established in this paper basically draws on the framework of the inter-regional CGE model developed by Luky Eko Wuryanto (1996) in his work for 2 regions 15 industries IRCGE Model of Indonesia. The division of the equations for the IRCGE model is specified in nine modules : (1) total sectoral and intermediate production, (2) factor market and income, (3) intraregional and interregional commodity markets, (4) institutional income and expenditure, (5) government in regional, (6) savings and investments, (7) gross domestic products, (8) price structure, and (9) market equilibrium. In this research, our purposes are to analyze the central government investment policy in Indonesia's 3 regions of Sumatra, Java and Other region. For these purposes, we need the detail data of central and local government investment in every region, and the detail data of central government investment in region by category of destinations. In 1995 Indonesia IRSAM, we can't get these data now. Also, we have some other troubles with the data in 1995 Indonesia IRSAM. Therefore, as a future task of this research is to improve the database of model and finish the simulations of the Indonesia central government investment policy in region.

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Appendix A   System of Equations

System of Equations,

A. Sectoral Production and intermediate input

1. Sectoral production function :

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

2. Sectoral intermediate inputs :

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

B. Factor Market and Income

3. Sectoral labor aggregation by region:

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

4. Profit maximization:

$$L_{hi} = \frac{X_i^r \cdot PN_i^r \cdot \alpha_i^r \cdot ld_{hi} \cdot (Lg_i^r)^{\delta_i^r}}{wd_{hi} \cdot W_h \cdot [\alpha_i^r (Lg_i^r)^{\delta_i^r} + (1 - \alpha_i^r)(\overline{K_i^r})^{\delta_i^r}]} \; ; \; h \in r$$

5. Sectoral wage eqution by region:

$$W_{S_i}^r = (PQINDEX^r)^{\mu_{1i}} \cdot (1 + PX_i^r)^{\mu_{2i}} \cdot \left(1 + \frac{\overline{OX_i^r}}{Lg_i^r}\right)^{\mu_{3i}}$$

6. Average wage by micro region:

$$W_h = \overline{OW_h} \cdot \sum_{j=1}^{15} (\omega\varphi_{hj}^r \cdot W_{S_j}^r)$$

7. Labor supply balance by micro region:

$$\overline{L}_{S_h} = \sum_{j=1}^{15} L_{hi} + U_h$$

8. Labor income by micro region:

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

9. Capital income by micro region:

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

C. Regional Commodity Market

10. Composite goods demand:

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

11. Regional import from abroad:

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

12. Domestic goods demand:

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

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

13. Regional Domestic import:

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

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

14. Regional Domestic supply:

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

15. Regional total supply:

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

16. Regional export :

$$XE_i^r = ex_i^r [PE_i^r / PX_i^r]^{n^r}$$

D. Institutional Income and Expenditure

17. Household income

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

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 :

$$TNH_h = tnh_h \cdot YH_h$$

20. Household savings :

$$HS_h = hs0_h + hs1_h \cdot YHD_h$$

21. Household consumpation :

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

22. Companies income :

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

23. Companies disposable income :

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

24. Companies nat. direct taxes :

$$TNC^r = tnc^r \cdot YC^r$$

25. Companies savings :

$$CS^r = cs0^r + cs1^r \cdot YCD^r$$

E. Government

26. Total government revenues :

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

27. Government revenues in regional :

$$CGR^r = \sum_{h=1}^{5} (fkgh_{hh'}(YK_h + \overline{kbrw}_h \cdot ER)) + NTX^r + \sum_{r'=1}^{3} \overline{govti}^{rr'} + IDT^r - SUB^r + TM^r + \overline{grw}^r \cdot ER$$

28. Total national direct taxes in regional :

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

29. Total national indirect taxes in regional :

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

30. Subsidies to prod. cativities:

$$SUB^r = \sum_{i=1}^{15} (P_i^r \cdot \overline{cgs_i^r} \cdot CGR^r)$$

31. Tariff revenues in regional:

$$TM^r = \sum_{i=1}^{15} \overline{tim_i^r} \cdot (XM_i^r \cdot ER \cdot \overline{pwm_i^r})$$

32. Total government current expenditure:

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

33. Government current expenditure in regional:

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

34. Government current consumption in regional:

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

F. Saving and Investment

35. Total savings definition:

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

36. Savings for government investment:

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

37. Savings for private investment:

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

38. Government investment expenditure in region:

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

39. Government investment expenditure in sector:

$$GINVO_i^r = \overline{cgi_i^r} \cdot RGINVD^r$$

40. Private investment by destination:

$$RPINVD^r = \psi_0^r \cdot (\sum_{i=1}^{15} X_i^r)^{\psi_1 r} \cdot (\sum_{i=1}^{15} \overline{OX_i^r})^{\psi_2 r} \cdot IRATE^{\psi_3 r}$$

41. Private investment by origin:

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

42. Private investment by sector of origin:

$$PINVO_i^r = \overline{pinv_i^r} \cdot RPINVO^r$$

43. Total investment definition:

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

G. Gross Domestic Product

44. Gross regional domestic product

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

45. Gross domestic product

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

H. Price Structure

46. Imported goods price:

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

47. Exported goods price:

$$PE_i^r = ER \cdot \overline{pwe}_i^r / (1 + idt_i^r + tim_i^r)$$

48. Producer price:

$$PX_i^r = (PD_i^r \cdot XS_i^r + PE_i^r \cdot XE_i^r) / X_i^r)$$

49. Definition of value-added price:

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

50. Composite goods price:

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

51. Price of capital:

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

52. Dopmestic price index:

$$PXINDEX^r = \sum_{i=1}^{15}(\omega tx_i^r \cdot PX_i^r)$$

53. General price index:

$$PQINDEX^r = \sum_{i=1}^{15}(\omega tq_i^r \cdot P_i^r)$$

I. Market Equilibrium Conditions

54. Composite goods equilibrium:

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

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

55. External market equilibrium (in US$) :

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

$$= \sum_{r=1}^{3} \sum_{i=1}^{15} (XM_i^r \cdot \overline{pwm_i^r}) + \sum_{r=1}^{3} \overline{repat_h} + \sum_{h=1}^{5} \overline{kprw_h} + \overline{gdebts}$$

56. Central government investment expenditure balance :

$$(CGFBR.ER) = \sum_{r=1}^{3} RGINVO^r - TS^g$$

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
ax_{ij}^{rr}	Input-output coefficients
ld_{hi}	Labor income proportionality
wd_{hi}	Wage proportionality
$\mu1_i, \mu2_i$	Price eleasticity in the wage function
$\mu3_i$	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 by micro region
$fkh_{hh'}$	Coefficient of household capital income by micro region
tnh_h	Rates of direct household taxes
hsO^r	Constrant term in household saving function
$hs1^r$	Marginal propensity to save of household

φ_{hi}^r	Constrants in household consumption function
$fkc_{hh'}$	Coefficient of companies capital income by micro region
$tnc^{rr'}$	Rates of direct company taxes
csO^r	Constrant term in companies aving function
$cs1^r$	Marginal propensity to save of companies
$fkg_{hh'}$	Coefficient of government capital income by micro region
cgs_i^r	Coefficient of government prod activity subsidies by region
$tim_i^r\nu$	Rate of import tariff
cgc_i^r	Coefficient of govenment sectoral consumpation by 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 bu 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 by region
$\overline{K}_i^r$	Sectoral capital stock by region (exogenous)
Lg_i^r	Sectoral labor demand by region (regional labor aggregation)
INT_i^rint (i, r)	Intermediate demand by sector by region
L_{hi}	Sectoral labor demand by micro region
$\overline{OX}_i^r$	Previous year sectoral output by region (exogenous)
$\overline{L}_s^h$	Sectoral labor supply by micro region (exogenous)
U_h	Unemployment by micro region
YL_h	Regional labor income by micro region
YK_h	Regional capital income by micro region
XD_i^r	Domestic demanded goods by sector by region
XM_i^r	Imported goods by sector by region

XS_i^{rr}	Interregionally imported goods by sector by region
$XS_i^{r'r}$	Interregionally imported goods by sector by region
$XS_i^{r''r}$	Interregionally imported goods by sector by region
XS_i^r	Domestic supplied goods by sector by region
$XS_i^{rr'}$	Interregionally exported goods by sector by region
$XS_i^{rr''}$	Interregionally exported goods by sector by region
XE_i^r	Exported goods by sector by region
YH_h	Household income
$\overline{kbrw}_h$	Household capital borrowing from abroad (exogenous)
$\overline{htt}_{hh'}$	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 consumpation demand by sector by micro region
YC^r	Companies income
$\overline{comtrf}^r$	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 govenment
$\overline{repat}^r$	Companies payment to repatriated profits (exogenous)
$\overline{depc}_h$	Companies payment to capital deprication (exogenous)
CS^r	Comoanies savings
CGR	Total Government revenues
CGR^r	Revenues of government in region
NTX^r	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	Government income from region total import traiff
$\overline{grw}$	Government remittance from abroad (exogenous)
CGE	Government current expenditures
CGE^r	Current expenditures of government in region

$CGTC^r$	Government total current consumpation demand
$\overline{govtp}^{rr}$	Government payment to transfer between government in regions
$\overline{gdebt}$	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 capital
TS^p	Savings for ptivate capital
$CGFBR$	Government net foreign borrowings
$FBOR$	Foreign savings in privite sector
$RPINVD^r$	Government total investment expenditure by region
$GPINVO_i^r$	Government investment expenditure by region by sector
$IRATE$	Annual interest rate in 1995
$RINVD^r$	Privite investment by sector of origin
$PINVO_i^r$	Region Privite investment by sector of origin
$TINV$	Total investment
$GRDP^r$	Gross regional domestic product by region
GDP	Gross domestic product
Q_i^r	Quantity demanded commodity by sector by region
$\overline{trsdm}_i^r$	Sectoral trade margin by region (exogenous)
$\overline{kprw}_h$	Capital payments abroad (exogenous)

C. Prices

$\overline{OW}_h$	Average wage coefficient by region (exogenous)
W_h	Sectoral wage by micro region
Ws_i^r	Sectoral real wage by micro region in the base
PK_i^r	Price of capital by region
PN_i^r	Sectoral value added price by region
PD_i^r	Sectoral domestic price by region
PM_i^r	Sectoral import price by region
PE_i^r	Sectoral export price by region
PX_i^r	Sectoral producer price by region
P_i^r	Sectoral composite price by region
$PXINDEX^r$	Regional domestic price index by region
$PQINDEX^r$	Regional composite price index by region

$\overline{pwe}_i$ Domestic world price of exported goods (exogenous)

$\overline{pwm}_i$ Domestic world price of imported goods (exogenous)

ER US$ exchange rate in 1995