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**An Interregional Computable General Equilibrium Model  
for Indonesia:  
Simulations of the Government Regional Investment Policy**

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# An Interregional Computable General Equilibrium Model for Indonesia: Simulations of the Government Regional Investment Policy

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## 1. Introduction

In this paper, following the 1995 Interregional Social Accounting Matrix (IRSAM), we will built an interregional Computable General Equilibrium (IRCGE) Model for Indonesia, and apply it to analyze the government regional investment policy. In this model, Indonesia economy is divided into to Sumatra, Java and other region, furthermore Java region is divided into three micro regions (east Java, central Java and west Java). This model focuses on the real side of the regional economy, and conveys a comparative static-type of analysis.<sup>1</sup>

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 of Indonesia<sup>2</sup>. The division of equations for the IRCGE model is specified in nine modules: total sectoral and intermediate production, factor market and income, intraregional and interregional commodity markets, institutional income and expenditure, government in regional, savings and investments, gross domestic products, price structure, and market equilibrium.

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

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<sup>1</sup> This 1995 IRSAM was made by Badan Pusat Statistik (BPS) in Indonesia and JICA (Prof. Koichi Nidaira and S, Tokunaga) in March 1999.

<sup>2</sup> Ph.D. Dissertation (Cornell University, 1996) is written by Luky Eko Wuryanto.

## 2. Characteristics of the model

### *Sectoral 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)<sup>3</sup>. The primary production factors to be considered are (aggregate) labor ( $L_g$ ) and stocks ( $\bar{K}_i$ ). 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 interregionally. The intermediate inputs include intra- and interregional, 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 ( $L_m$ ) must first be aggregated. In this circumstance, the aggregated labor demand by sector ( $L_g$ ) 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 ( $L_m$ ), 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 ( $L_{d_m}$ ), and the value added price in the corresponding sector ( $P_N$ )(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 ( $POINDEX$ ), the price of the sectoral output ( $P_X$ ), and the growth in labor productivity ( $\overline{OX}/L_g$ )(E-5). An import implication that

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<sup>3</sup> Equation number in Appendix A

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 ( $w_i$ ) for each labor category are formulated based on the sectoral wage rates ( $w_s$ ) and share ( $\omega\phi_{hi}$ ) 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 ( $wd_i$  and  $kd_i$ , respectively).

### *Regional Commodity Market*

The structure of commodity flows in the regional market is outlined in Figure 2.1. As can be seen, 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 ( $XS_i^r$ ) and interregionally imported goods ( $XS_i^{r'}$ ,  $XS_i^{r''}$ ) (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 ( $PX_i^{r'}$ ,  $PX_i^{r''}$ ), 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 ( $XS_i^r$ ) and interregional supply ( $XS_i^{r'}$ ,  $XS_i^{r''}$ ), 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 ( $PX'_i$ ) to the world price of exported goods ( $PE'_i$ )(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 ( $YL_i$ ) and a fixed proportion of each micro-region's capital income ( $YK_i$ ), include the capital income from oversea ( $\overline{kbrw}_i$ ). In addition, the regions household income comes from several exogenous direct transfers namely from the government ( $\overline{cgth}_i$ ), from among the regional household themselves ( $\overline{hth}_i$ ), from the companies ( $\overline{coth}_i$ ), and from the rest of the world ( $\overline{rwh}_i$ ) (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 ( $YHD_i$ ) is defined as a function of national direct taxes ( $TNH_i$ , (E-19)), the exogenous total household payments for transfers among the households themselves ( $\overline{hth}_i$ ), and the household depreciation ( $\overline{deph}_i$ )(E-18). Household savings in each micro region ( $HS_i$ ) 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).  $HS_i$  is divided into saving for government capital and saving for private capital by a fixed proportion ( $\overline{shsg}_i$ ). Household consumption demand in each micro region ( $HC_i$ ) 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 ( $P'_i$ )(E-21).

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

### *Government*

The total government revenue is the sum of government's revenues in three regions (E-26). The government in region receives its income ( $CGR'$ ) from a fixed proportion of each of micro-region's capital income, from national direct taxes ( $NTX'$ , E-28), from transfer between government in regions ( $\overline{govit}'$ ), from net national indirect taxes ( $IDT' - SUB'$ , E-29, E-30), from import tariffs ( $TM'$ , E-31), and from the exogenous remittance from abroad ( $\overline{grw}'$ ) (E-27). The total government current expenditure ( $CGE$ ) is the sum of government's expenditures in three regions (E-32). The expenditure ( $CGE'$ ) of government in region, which is postulated to be equal to its revenue, comprises the expenditure for government consumption ( $CGTC'$  (E-34)), exogenous direct transfers to regional household ( $\overline{cgh}_s$ ), exogenous direct transfers between governments ( $\overline{govip}'$ ), exogenous government debt service for foreign borrowing ( $\overline{gdebis}'$ ), and savings ( $CGSV'$ ) (E-33). As household saving,  $CGSV'$  is divided into saving for government capital and saving for private capital by a fixed proportion ( $\overline{sgsg}'$ ).

### *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 ( $TS_g$ ) is defined as a sum of each institution's saving for government investment (E-36). The total savings for private capital ( $TS_p$ ) 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 ( $RGINVD'$ ), is determined exogenous by a fixed proportion ( $\overline{IMATG}'$ ). As can be seen, the government investment expenditure ( $GINVO'$ ) in sector is determined endogenously by proportions derived from the IRSAM table (E-39).

Total regional private investment by macro region ( $RPINVD'$ ) 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 ( $IRATE'$ ). Since the E-40 yields the amount of total regional private investment by destination ( $RPINVD'$ ), 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 ( $IMATT^r$ ) (E-41). To obtain the sectoral investment by origin ( $PINVO^r$ ) in each macro region, the regional investment by origin must be 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 ( $PN_i^r$ ), 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 ( $PM_i^r$ ) 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 ( $im_i^r$ ), and trade and transport margins ( $ttm_i^r$ ) (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 (E-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 figuring the average of the domestic price ( $PD_i^r$ ) and export price ( $PE_i^r$ ), weighted by the sectoral output of the region (E-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 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 ( $PK_r'$ ) 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 ( $PQINDEX_r'$ ) 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 ( $PX_r'$ ), weighted by the proportion of the sectoral supply ( $\omega tx_r'$ ). The definition of the general price index in each region (E-53) is determined by figuring the average of the composite goods prices ( $P_r'$ ), weighted by the proportion of the sectoral demand ( $\omega tq_r'$ ).

#### *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. 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 (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 (E-57).



### 3. The Government Regional Investment Policy Simulations and Concluding Remarks

In this section, the government regional investment policy will be discussed. Before do that, let's view the structure of government regional investment (table 3.1) .

Table3.1 The structure of government regional investment(1995)

	Value(million Rp.)	Share(%)
National	25901	100.00
Sumatra	6699	25.86
Java	12780	49.34
Other Reg.	6421	24.79

The dataset in table 3.1 comes from 1995 Indonesia IRSAM. As can be seen, we have only a little information about the government investment expenditures. 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:

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

2. Sectoral intermediate inputs:

$$INT_i^r = \sum_{j=1}^{15} (\alpha_{ij}^{r,r} X_j^r) + \sum_{j=1}^{15} (\alpha_{ij}^{r,r} X_j^r) + \sum_{j=1}^{15} (\alpha_{ij}^{r,r} X_j^r)$$

B. Factor Market and Income

3. Sectoral labor aggregation by region:

$$Lg_i^r = \prod_{h=1}^{hr} (L_{hi})^{d_{hi}}$$

4. Profit maximization:

$$L_{hi} = \frac{X_i^r \cdot PN_i^r \cdot \alpha_i^r \cdot d_{hi} \cdot (Lg_i^r)^{\delta_i^r}}{wd_{hi} \cdot W_h \cdot \left[ \alpha_i^r (Lg_i^r)^{\delta_i^r} + (1 - \alpha_i^r) (\bar{K}_i^r)^{\delta_i^r} \right]}; h \in r$$

5. Sectoral wage equation by region:

$$W_{Si}^r = (PQINDEX^r)^{\mu_1} \cdot (1 + PX_i^r)^{\mu_2} \cdot \left( 1 + \frac{\overline{OX}_i^r}{Lg_i^r} \right)^{\mu_3}$$

6. Average wage by micro region:

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

7. Labor supply balance by micro region:

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

8. Labor income by micro region:

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

9. Capital income by micro region:

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

C. Regional Commodity Market

10. Composite goods demand:

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

11. Regional import from abroad:

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

12. Domestic goods demand:

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

if  $X_{S_i^{r'r}} + X_{S_i^{r''r}} = 0 \Rightarrow XD_i^r = X_{S_i^{rr}}$

13. Regional Domestic import:

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

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

14. Regional Domestic supply:

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

15. Regional total supply:

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

16. Regional export:

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

D. Institutional Income and Expenditure

17. Household income

$$YH_h = \sum_{h=1}^5 (fl_{hi} \cdot YL_h) + \sum_{h=1}^5 (fkh_{hi} \cdot (YK_h + \overline{kbrw}_h \cdot ER)) + \sum_{h=1}^5 \overline{hti}_{hi} + \sum_{r=1}^3 \overline{coth}_h + \sum_{r=1}^3 \overline{cgh}_h + ER \cdot \overline{rwth}_h$$

18. Household disposable income:

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

19. Household nat.direct taxes:

$$TNH_h = tnh_h \cdot YH_h$$

20. Household savings:

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

21. Household consumption:

$$HC_h^r = \phi_h^r \left[ (YHD_h - HS_h) / P_i^r \right]$$

22. Companies income:

$$YC^r = \sum_{h=1}^5 \left( fkc_{hi} \cdot (YK_h + \overline{kbrw}_h \cdot ER) \right) + \overline{comtrf}^r + \overline{rvc}^r \cdot ER$$

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 regional:

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

28. Total national direct taxes in regional :

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

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 regional:

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

32. Total government current expenditure:

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

33. Government current expenditure in regional:

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

34. Government current consumption in regional:

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

F. Saving and Investment

35. Total savings definition:

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

36. Savings for government investment:

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

37. Savings for private investment:

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

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. 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. Private investment by origin:

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

42. Private investment by sector of origin:

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

43. Total investment definition:

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

G. Gross Domestic Product

44. Gross regional domestic product

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

45. Gross domestic product

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

H. Price Structure

46. Imported goods price:

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

47. Exported goods price:

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

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. Domestic price index:

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

53. General price index:

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

## I. Market Equilibrium Conditions

54. Composite goods equilibrium:

$$Q_i^r = \sum_{j=1}^{15} (a_{ij}^{rr} \cdot X_j^r) + \sum_{j=1}^{15} (a_{ij}^{r'r} \cdot PX_j^{r'}) + \sum_{j=1}^{15} (a_{ij}^{r''r} \cdot PX_j^{r''}) + \sum_{h=1}^{her} HC_{hi}^r + cgc_i^r \cdot \overline{CGCON} + \overline{trsdm}_i / P_i^r + \overline{dep}_i^r + GINVO_i^r + PINVO_i^r$$

55. External market equilibrium (in US\$):

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

55. Central government investment expenditure balance:

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

57. Savings-investment balance:

$$TS = TINV$$

Appendix B  
List of Parameters and variable

A.	Parameters
$\alpha_i^r$	Shift parameter in production function
$\alpha_i^r$	Share parameter in Production function
$\delta_i^r$	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 elasticity in the wage function
$\mu 3_i$	Productivity elasticity in the wage function
$\omega \phi_{hi}^r$	Sectoral weight of wage by micro region
$kd_{hi}$	Capital income proportionality
$bq_i^r$	Shift parameter in CET Armington for import
$\beta_i^r$	Share parameter in CET Armington for imports
$\varepsilon_i^r$	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
$\chi_i^{rr}$	Share parameter in CET Armington for interregional
$\phi_i^r$	Sectoral elasticities in Armington exponent for interregional trade
$ex_i^r$	Shift parameter in Export function
$\gamma_i^r$	Sectoral elasticities for export function
$f_{hi}$	Coefficient of household labor income by micro region
$fkh_{hi}$	Coefficient of household capital income by micro region
$tnh_h$	Rates of direct household taxes
$hs0^r$	Constraint term in household saving function
$hsl^r$	Marginal propensity to save of household
$\phi_{hi}^r$	Constraints in household consumption function
$fkc_{hi}$	Coefficient of companies capital income by micro region
$tnc^{rr}$	Rates of direct company taxes
$cs0^r$	Constraint term in companies saving function
$csl^r$	Marginal propensity to save of companies

$fk g_{hi}$	Coefficient of government capital income by micro region
$cgs_i^r$	Coefficient of government prod activity subsidies by region
$tim_i^r$	Rate of import tariff
$cgc_i^r$	Coefficient of government sectoral consumption 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
$\psi_0^r$	Constant term in investment function
$\psi_1^r$	Exponent of current total output in investment function
$\psi_2^r$	Exponent of previous year total output bu region
$\psi_3^r$	Exponent of interset rate in investment function
$IMATT^r$	Capital coefficient matrix for total regional private investment
$pinv_i^r$	Distribution of private investment by sector of origin
$\omega tx_i^r$	Index weighting for producer price index
$\omega tq_i^r$	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)
$INT_i^r$	Intermediate demand by sector by region
$L_h$	Sectoral labor demand by micro region
$\overline{OX}_i^r$	Previous year sectoral output by region(exogenous)
$\overline{Ls}_h$	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
$XS_i^r$	Interregionally imported goods by sector by region



$XS_i^{r'}$	Interregionally imported goods by sector by region
$XS_i^{r'}$	Interregionally imported goods by sector by region
$XS_i^r$	Domestic supplied goods by sector by region
$XS_i^{r'}$	Interregionally exported goods by sector by region
$XS_i^{r'}$	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)
$\overline{hit}_{hh}$	Household income from inter-household transfer(exogenous)
$\overline{coth}_h$	Household income from companies direct transfers(exogenous)
$\overline{cgt}_h$	Household income from government direct transfers(exogenous)
$\overline{rwh}_h$	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 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 government
$\overline{repat}^r$	Companies payment to repatriated profits(exogenous)
$\overline{depc}_h$	Companies payment to capital depreciation(exogenous)
$CS^r$	Companies 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 indirect taxes
$SUB^r$	Government subsidy to production sector by region
$TM^r$	Government income from region total import traff

$\overline{grw}$	Government remittance from abroad(exogenous)
$CGE$	Government current expenditures
$CGE^r$	Current expenditures of government in region
$CGTC^r$	Government total current consumption demand
$\overline{govtp}^{r,r}$	Government payment to transfer between government in regions
$\overline{gdebt}$	Government debt payments to abroad(exogenous)
$\overline{depg}^r$	Government payment to capital depreciation(exogenous)
$CGSV^r$	Government savings
$\overline{CGCON}$	Government total consumption(exogenous)
$TS$	Total savings
$TS^g$	Savings for government capital
$TS^p$	Savings for private capital
$CGFBR$	Government net foreign borrowings
$FBOR$	Foreign savings in private 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
$RINVD^r$	Private investment by sector of origin
$PINVO_i^r$	Region Private 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)
<b>C.</b>	<b>Prices</b>
$\overline{OW}_h$	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

$PD'_i$	Sectoral domestic price by region
$PM'_i$	Sectoral import price by region
$PE'_i$	Sectoral export price by region
$PX'_i$	Sectoral producer price by region
$P'_i$	Sectoral composite price by region
$PXINDEX'$	Regional domestic price index by region
$PQINDEX'$	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