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Multi-Country and Multi-Sector Modeling for the World Economy

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Abstract

This paper intends to formulate multi-country and multi-sector model for the Asian International Input Output system of Institute of Developing Economies from micro foundation; a) households maximize their utility functions under budget constraint, b) producers maximize their profits, resulting in yielding factor demands of materials and labors, and sector prices via conjectural variation which was originated by R.Frisch. In environment of multi-country(R countries exist) and multi-sector (N sectors exist), we have N international oligopolistic markets of differentiated commodities supplied by R producers. Model system described above is demand oriented.

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1. Introduction

After the World War II, econometricians have tried to construct macroeconometric models mainly in the US. After the Vietnam War, the first oil shock struck the world economy resulting in mess. Reflecting such a situation it has been changing the world of academism at the same time.

Following such a tendency, the first movement of economic modeling post 1970s is marked by Lucas critique in 1976. Macroeconomic modeling is requested to have micro foundation for seeking stability of “deep parameter.”

The second movement is to introduce stochastic elements for the disturbance terms of behavioral equations. Original contribution goes back to R.Frisch’s random shock theory in 1933, and Adelmans have revived the theory in 1959 in their computer simulation using Klein-Goldberger Model, and about ten years later leading econometricians at that time as well as L.R.Klein have recongnized, using couples of large scale econometric models, necessity of stochastic term in the econometric models in 1969. [R.Frisch,1933][F.Adelman and I.Adelman,1959][B.G.Hickman(edi.),1972]

In the late 1970s, an Asian International Input Output Table was first created by Institute of Developing Economies of Japan, and the Table has stimulated me to construct world model on the Table, tough multi-country econometric model were already existed.

After the World War II, econometricians have constructed various types of models on national economy.

Single-country and single-sector model (SCSS type model) is named macromodel, for which much effort has been directed. The model has two kinds; a) demand oriented and b) supply oriented. (See Table 1)

Table 1

The main roll of model is explaining production and price simultaneously. The SCSS_D determines production by demand and price largely by compiling cost. Keynesian model is typical in this category, leading production by describing aggregate demand factors such as consumption and investment etc. while price is prescribed by nominal wage rate equalizing marginal productivity of labor with real wage rate. L.R.Klein has tried to replace marginal productivity by average productivity, which resulted in determining price by unit labor cost.[L.R.Klein,1983] On the contrary, SCSS_S determines production by production function (labor, capital, etc.), and price by market's demand/supply nexus. Economic growth model falls in this category.

An attempt to approach national economy by decompose macro-economy into sectors has been first made by W.Leontief, which is called single-country and multi-sector model (SCMS type model, See Table 1 also). After W.Leontief, sophisticated models have been made. [G.Fromm and L.R.Klein,1975] [WEFA,1982] In this model also, two kinds of models are distinguished; a) SCMS_D and b) SCMS_S. The latter has been first made by L.Johansen while the former by W.Leontief. [L.Johansen,1960] Recent CGE model belongs to SCMS_S. Superiority of SCMS model to SCSS model is macro and micro economics being united together in SCMS model. On modeling multi-sector economy, researchers have payed much attention to theoretical development in production and cost function since 1980s.

When one seeks to investigate national economy, one sometimes needs to consider international interrelationship among countries. This approach is called multi-country and single-sector model (MCSS type model, See Table 1), which has been pioneered by L.R.Klein's Project LINK. Altough LINK model has mostly demand oriented macro-models for individual economy (MCSS_D), it is possible to construct MCSS model by supply oriented way (MCSS_S).

The fourth type model is multi-country and multi-sector model (MCMS type model, See Table 1), which has been first made also by W.Leontief (MCMS_D).[W.Leontief and F.Duchin,1983] Superiority of MCMS model to MCSS model is to be able to argue international trade such as inter-industry trade or intra-industry trade in MCMS system.

The MCMS model also has two kinds; a) MCMS_D and b) MCMS_S. International CGE model (e.g. G-TAP and G-Cubed) belong to MCMS_S. C.Almon work is MCMS_D. [C.Almon,1991] Our model, to be described in preceding section, is MCMS_D.

In the last of this section we want to point out that multi-sector approaches should adopt theoretical developments recent years from industrial organization, micro-economics and international trade. Conversely, above three fields concentrates market in isolation ignoring mutual interconnection. They shut their eyes to difference between intermediate goods and final goods. [J.Tirole,1988]

The next section will show an Asian International Input Output Table and section 3 will explain theoretical framework for MCMS system from micro foundation.

2. Asian International Input Output Table in Local Currency and in Constant Price

Asian International Input Output Table (AIIO Table) has been published in dollar term for every five years; tables of 1985, 1990, 1995 and 2000 are now available.[IDE,1993][IDE,1998][IDE,2001][IDE,2006a][IDE,2006b]

We are going to convert tables of dollar term into those of local currency and of constant price in advance. The reasons of conversion are explained below with focus on the dubiousness on domestic economic transaction in dollar term.

a) Decision making in real term and in local currency

Economic decision making in model has to be formulated in real term. In this connection we have two alternatives: real term in dollar and real term in local currency. Most private and public economic agents are considered to make decisions in local currency; for examples, decisions in production and in consumption are made in real term of local currency.

b) Foreign exchange market of local currency

If people in related Asian countries use dollar in domestic economic transaction, they live in dollar oriented world, and we do not need to have foreign exchange market. Yet, this is fictitious.

c) Monetary policy in individual country's local currency

If people use dollar in domestic transaction, there is no need of issuing local currency and of no need of having own monetary policy like Luxembourg people in use of Belgium franc in old times. However they have their own central bank.

Generally, Asian International Input Output table have two aspects; a) the one is expressing demand side, and b) the other supply side. In line with this, we provide tables; table 2 and table 3 are for demand side of intermediate demand and final demand respectively, and table 4 for supply side.

Table 2

Table 3

Table 4

Our model for MCMS system has several features.

a) Model in local currency and in real term

Most behavioral equations in our model are presented in local currency and in real term.

b) Differ from CGE

Basic drawback of CGE is based on fictitious assumptions: full employment, perfect competition and constant returns to scale in consumption and production.[J.B.Shoven and J.Whalley,1992] The second one is not to absorb information from sample data in the estimation behavioral equations, instead they use calibration using one period data.

c) Endogenize domestic saving

Household saving, namely future consumption, is taken explicitly in our household last commodity.

d) Attach new kind of innovation to producer’s cost function

Cost function additionally has price related variable except output and input prices.

e) Introduce R.Frisch’s conjectural variation for price determination

From micro foundation we employ profit maximization for determining price in virtue of conjectural variation of R.Frisch for empirical application.

3. Multi-Country and Multi-Sector Modeling for an Asian International Input Output System

In this section, we try to construct MCMS system, having an Asian International Input Output Table (AIIO) of Institute of Developing Economies (IDE) in mind. The IDE's Asian IO Tables in dollar term is converted into tables in local currency and in constant price. We already have mentioned converting process from dollar based original nominal Asian IO Tables into the Tables in local currency and in constant price. [T.Yano and H.Kosaka, 2008]

The importance is to give platform of unified system where macro- and micro-economics could be argued. As international trade of inter-industry or intra-industry requires framework of multi-country and multi-sector, then the common place must be provided for discussion. Whereas this section tries to expose MCMS system, arguments closely concern with international trade.

Old theory of international trade has centered on international exchange of goods between different markets of dissimilar countries based on constant returns to scale and factor endowment as inter-industry trade. But, T.Negishi has opened a possibility of international trade based on increasing returns to scale from Marshallian externality.[T.Negishi,1969a] Ten years later, P.R.Krugman has proposed another possibility of international trade of Chamberlain's monopolistic competition following Dixit-Stiglitz formulation of industrial organization, also based on increasing returns to scale.[P.R.Krugman,1979] Third possibility has been made by J.A.Brander and P.Krugman on the concept of Cournot oligopoly on the homogeneous market.[J.A.Brander and P.Krugman,1983] These three attempts are called intra-industry trade.

Now we come to fourth possibility. It is well known that automobile industry, exchanging automobiles between advanced countries as bilateral trade, is a typical industry producing highly differentiated goods of horizontal sense in the same market. (See, for example, [P.K.Goldberg, 1995]) We should note automobile industry is not one counterpart of inter-industry trade because it has increasing returns to scale. Then the fourth possibility of intra-industry trade exists in market of horizontal differentiation with increasing returns to scale. Such cases are frequently seen in air transportation service and financial service between advanced and similar countries. Yet, positive gains on both related trading countries' welfare of household from international trade have not been assured theoretically on the one hand, and not been denied on the other hand, to my knowledge. And that, gains from international trade has been said to be multi-dimensional, which is outlined in section 3.9. In the real world, products of vertical and horizontal differentiation have been widely traded.

In addition to supply side of international trade above mentioned, demand side is already familiar in similar tastes across countries as Linderian effect. [S.B.Linder, 1961] (See details in Household Behavior)

Then we are going to expose our MCMS model on the published data of AIIO, so that we could easily operate econometric implementation. Our global framework on international trade has, therefore, two folds.

a) Oligopoly Market of Horizontal Differentiation

International market of inhomogeneous commodity is introduced into MCMS system.

b) Multi-Commodity Markets of Block Recursive Interconnection

The differentiated markets are interconnected in block recursive way by input output nexus.

In the first we assume the following.

Assumption 01: Country and Sector

We suppose to have R countries (or regions), each having N sectors.

In applying MCMS model to Asian Input Output System(AIOS), included countries and regions are Indonesia, Singapore, Malaysia, Thailand, Philippines, China, Korea, Taiwan, Japan, and US(i.e. R=10). Included sectors are aggregated into six categories: 1)Agriculture, livestock, forestry, and fishery; 2)Mining, quarrying, and utilities (electricity, gas, and water supply); 3)Manufacturing; 4)Construction; 5)Trade and transportation; 6)Services(N=6).

Assumption 02: Oligopoly Market of Horizontal Differentiation with R Suppliers

The h-th country is supposed to have unique firm producing single i-th commodity of horizontally differentiation, caused by border, with different price p_i^h which is expressed in local currency. Then i-th commodity market has totally R suppliers.

Assumption 03: N Oligopoly Markets of Interconnection

From the Assumptions 01-02 we have N world commodity markets which are interconnected in block-recursive way by intermediate transactions, each commodity market being horizontally differentiated.

3.1 World Commodity Market of Horizontal Differentiation

The unique firm in h-th country provides horizontally differentiated i-th commodity for the internationally oligopolistic market. As they provides horizontally differentiated products for i-th market, R differentiated prices are formed. As is well known in input output system, equation below is market equilibrium that unique firm of producing i-th commodity in h-th economy faces. Left hand side stands for supply and right hand side for demand, and both are expressed in constant price and in local currency of h-th country.

$$X_i^h = \sum_{j=1}^{N}\sum_{k=1}^{R} x_{ij}^{hk} + \sum_{k=1}^{R} CP_i^{hk} + \sum_{k=1}^{R} G_i^{hk}$$
$$+ \sum_{k=1}^{R} I_i^{hk} + \sum_{k=1}^{R} IV_i^{hk} + E_i^h + Q_i^h$$
$$i = 1,.., N; h = 1,.., R \qquad (3.01)$$

X_i^h : i-th Commodity produced by World Oligopoly Firm in h-th Country

x_{ij}^{hk} : Intermediate Demand for i-th Commodity in h-th Country
by j-th Oligopoly Firm in k-th Country

CP_i^{hk} : Private Consumption for i-th Commodity of h-th Country
by k-th Country

G_i^{hk} : Government Consumption for i-th Commodity of h-th Country
by k-th Country

I_i^{hk} : Private Investment for i-th Commodity of h-th Country
by k-th Country

IV_i^{hk} : Inventory Investment for i-th Commodity of h-th Country
by k-th Country

E_i^h : Export for i-th Commodity of h-th Country

Q_i^h : Statistical Discrepancy for i-th Commodity of h-th Country

3.2 Household Behavior

This sub-section will explain consumption (CP_i^{hk}) and related behaviors of household from micro foundation, and deals with household of k-th country as a unit.

Now, household earns wage from working in production of j-th sector in k-th country, then wage rate (w_j^k) and labor demand (L_j^k) of j-th sector in k-th country are determined as are seen below. As earned wage and property income (Y_r^k) totalizes disposable income (M^k), we will have the accounting identity.

<u>Definition of Nominal Disposable Income in k-th Country</u>

$$M^k = \sum_{j=1}^{N} w_j^k L_j^k + Y_r^k \tag{3.02}$$

Looking at theoretical development for consumption of commodity, we have Stone's linear expenditure system (LES), Rotterdam model and an ideal demand system (AIDS). Analytical feature of AIDS approach is, like an analogy of argument that cost function of production a prior given leads to factor demands via Shephard's lemma, household expenditure function a prior given leads to demands of commodities via Shephard's lemma.

Thus expenditure function possesses all the information on commodity demand in itself. In considering factors governing commodity demand except income and prices, we must inquire for expenditure function.

a) Cohort and Life Cycle

While cohort asks the time when consumer was born, life cycle asks consumer's age. Effects of cohort and life cycle on consumption are seen in categorized consumptions by ages. As both factors would shifts household utility, expenditure function would have factors inside. A.S.Deaton and C.Paxson have investigated inequality of consumption from the viewpoint of cohort and life cycle. [A.S.Deaton and C.Paxson,1994]

b) Habit Formation - Dynamics in Consumption -

Persistence of consumption for particular commodities comes from habit formation in consumption. Expenditure function for expressing habit formation holds consumption with time lag. (See, for example, [L.A.Blanciforti and R.D.Green,1983])

c) Family

Difference of family form would affect economic activity, and also consumption of commodity. In the pioneering work of E.Engel, family charactering index is made in "equivalence scale," which is put into expenditure function. (See [R.Ray,1986])

d) Advertisement

Advertisement or sale promotion activity to stimulate demands of consumers is big in the real world while economics has tendency of ignoring it in theoretical development. As advertisement would enter household utility, expenditure function would have such variables. [E.A.Selvanathan and K.W.Clements,1995(chapter 7)]

e) Population

It is often said decrease of production population of age15-age64 tends to be responsible for stalemate of Japanese economy recent years. This is an evidence of expenditure function dependent on population. [R.Ray,1996]

f) Consumption of Leisure - Labor Supply -

As, a special commodity, Ballard et al introduced leisure in household utility, then they deduced labor supply. [C.L.Ballard, D.Fullerton, J.B.Shoven and J.Whalley,1985]

g) Recent Tendency for Food Consumption

Recent tendency of caring health shows distortion in disaggregated food consumption as is seen in vegetarians or consumer preferring foods less cholesterol. Study reflecting this tendency should include index of cholesterol in the utility of this consumer. (See, for example, [D.J.Brown and L.Schrader,1990])

h) Future Consumption - Household Saving -

As a final extension we are going to introduce future consumption in the last commodity, namely household saving. Following C.L.Ballard et al, we endogenize future consumption in much the same way. [C.L.Ballard, D.Fullerton, J.B.Shoven and J.Whalley,1985]

Argument like linear expenditure system (LES) without future consumption is that consumer expends all the income. In reality we have saving. Then, LES approach is considered to have two-step decision makings; a) saving decision is predetermined, b) secondly expenditure for commodities is made afterwards. Yet, in this approach, saving process is described in explicit. As we intend to endogenize household saving, we state that disposable income goes to consumptions of N commodities and increase of saving (future consumption) which is treated as (N+1)-th commodity. For this purpose we define price of future consumption in the first.

Definition of Price of Future Consumption in k-th Country

Price of future consumption (p_f^k) in k-th country is defined as weighted average of domestic consumption for N goods at recent year.

$$p_f^k = \sum_{i=1}^{N} \left(\frac{CP_i^{kk*}}{\sum_{\mu=1}^{N} CP_\mu^{kk*}} \right) p_i^k \tag{3.03}$$

CP_i^{kk*} : Consumption of i-th Commodity produced by i-th Sector

in k-th Country in recent year

p_i^k : Price of i-th Commodity in k-th Country

Note that we use, in weighting coefficients of (3.03), prices of domestic goods ignoring the other countries' prices. Note also that we possibly take geometric average or rational expectation for future price in (3.03) instead of arithmetic average.

Now we face with optimal decision on allocation of disposable income over (N+1) commodities in k-th country's household. The k-th country's household is supposed to decide optimal allocation of disposable income over i-th commodity (C_i^{hk}) and future consumption (C_f^k) by maximizing household utility under its budget constraint expressed in nominal k-th country's currency.

$$M^k = \sum_{h=1}^{R}\sum_{i=1}^{N} p_i^{hk*} CP_i^{hk} + p_f^k CP_f^k \qquad (3.04)$$

$p_i^{hk*} = (1+t_i^k)\left(\dfrac{e^k}{e^h}\right)(1-s_i^h)\, p_i^h = (1+t_i^k)\left(\dfrac{e^k}{e^h}\right) p_i^{h*}$: Price of p_i^h received

by k-th Country

s_i^h : Rate of Export Subsidy of i-th Commodity in k-th Country

CP_i^{hk} : k-th Household Consumption of i-th Commodity produced

by i-th Sector in h-th Country

CP_f^k : k-th Household Future Consumption

e^k, e^h : Foreign Exchange Rates of k-th and h-th Country

per Dollar respectively

Future consumption leads to an increase of saving.

$$\Delta S^k = p_f CP_f^k \qquad (3.05)$$

$$S^k = S_{-1}^k + \Delta S^k \qquad (3.06)$$

Equation (3.06) determines total amount of saving (S^k). Yet, we do not touch contents of saving, namely, its portfolio. Total saving will become non-derivative saving, then we may have financial model. Yet, we do not explain it. (See Appendix A1)

Property income is determined by the following equation.

$$Y_r^k = \zeta_0^k + \zeta_1^k (r^k S_{-1}^k) \tag{3.07}$$

r^k : Long-term Interest Rate in k-th Country

Now, in determining optimal demand for i-th commodity (CP_i^{hk}) and future consumption(CP_f^k) in k-th country, we will employ AIDS model.[A.S.Deaton&J.Muellbauer,1980](See Appendix A2)

AIDS for MCMS System

AIDS model is now applied to MCMS system with deleting γ_{ij} in Appendix A2. Hence the nominal share against disposable income in k-th household could be simply shown below.

$$\omega_i^{hk} = \frac{p_i^{hk*} CP_i^{hk}}{M^k} = \alpha_i^{hk} + \beta_i^{hk} \log\left(\frac{M^k}{\prod_{\tau=1}^{R} \prod_{l=1}^{N} \left(p_l^{\tau k*}\right)^{\alpha_l^{\tau k}} \cdot \left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}} \right)$$

$$i = 1,..,N; h = 1,..,R \tag{3.08}$$

The other factors of shifting consumer demand such as advertisement, sale promotion activities, product innovation and transportation are assumed to be all expressed in α_i^{hk} .

$$\alpha_i^{hk} = \alpha_i^{hk}(sm_i^{hk}) \tag{3.09}$$

Above equation for i=N+1=7 is future consumption.

$$\omega_f^k = \frac{p_f^k CP_f^k}{M^k} = \alpha_f^k + \beta_f^k \log\left(\frac{M^k}{\prod_{\tau=1}^{R}\prod_{l=1}^{N}\left(p_l^{\tau k*}\right)^{\alpha_l^{\tau k}} \cdot \left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}} \right)$$

(3.10)

In these formulations, other factors affecting consumption are expressed in α_f^k. We note AIDS model needs to have three conditions.

(α) $\sum_{h=1}^{R}\sum_{i=1}^{N}\omega_i^{hk} = 1$

(β) $\sum_{h=1}^{R}\sum_{i=1}^{N}\alpha_i^{hk} = 1$

(γ) $\sum_{h=1}^{R}\sum_{i=1}^{N}\beta_i^{hk} = 0$

<u>Income Elasticity of Demand</u> (home country k)

$$\eta_i^{hk} = \frac{\partial\left(\log CP_i^{hk}\right)}{\partial\left(\log M^k\right)} = 1 + \frac{\beta_i^{hk}}{\omega_i^{hk}} \qquad (3.11)$$

$\eta_i^{hk} < 1$: Non-elastic Goods (Goods of Necessity)

$\eta_i^{hk} > 1$: Elastic Goods (Goods of Luxury)

$\eta_i^{hk} < 0$: Inferior Goods

<u>Price Elasticity of Share Demand in Marshall Sense</u> (home country k)

$$\eta_{i,\mu}^{hk,\eta} = \frac{\partial\left(\log \omega_i^{hk}\right)}{\partial\left(\log p_\mu^{\eta k*}\right)} = -\delta_{i,\mu}^{hk,\eta} - \frac{\alpha_\mu^\eta \beta_i^{hk}}{\omega_i^{hk}} \tag{3.12}$$

a) Self-elasticity of Share Demand $\eta_{i,i}^{hk,h} = -\frac{\alpha_i^h \beta_i^{hk}}{\omega_i^{hk}}$ (3.12a)

$\left|\eta_{i,i}^{hk,h}\right| < 1$: Non-elastic Goods (Goods of Necessity)

$\left|\eta_{i,i}^{hk,h}\right| > 1$: Elastic Goods (Goods of Luzury)

In case of $\mathrm{h} = \mathrm{k}$, self-elasticity is that of home-made commodity.

b) Cross-elasticity of Share Demand $\eta_{i,\mu}^{hk,\eta} = -\delta_{i,\mu}^{hk,\eta} - \frac{\alpha_\mu^\eta \beta_i^{hk}}{\omega_i^{hk}}$ (3.12b)

$\eta_{i,\mu}^{hk,\eta} > 0 : CP_i^{hk}$ is gross substitute of $CP_\mu^{\eta k}$.

$\eta_{i,\mu}^{hk,\eta} < 0 : CP_i^{hk}$ is gross complement of $CP_\mu^{\eta k}$.

In case of $\mathrm{i} = \mu$, cross-elasticity is cross-country elasticity of the same market of horizontal differentiation; but, in case of $\mathrm{i} \neq \mu$, cross-elasticity is that across different markets.

3.3 Producer's Behavior

International oligopolistic firm, producing j-th differentiated commodity in k-th country, determines intermediate demand, employment and price by profit maximization. For this purpose, profit of international oligopolistic firm of producing j-th commodity in k-th country is described below. We use argument by W.E.Diewert and K.J.Fox.[3] [W.E.Diewert and K.J.Fox,2004]

Consider now the profit of j-th firm in k-th country in local currency.

$$\max_{p_j^k} \max_{x_{ij}^{hk}, L_j^k} \pi_j^k = \max_{p_j^k} \max_{x_{ij}^{hk}, L_j^k} \{ p_j^k (X_j^k) X_j^k - \sum_{h=1}^{R} \sum_{i=1}^{N} p_i^{hk*} x_{ij}^{hk} - w_j^k L_j^k \}$$

$$= \max_{p_j^k} \{ p_j^k (X_j^k) X_j^k + \max_{x_{ij}^{hk}, L_j^k} \{ -\sum_{h=1}^{R} \sum_{i=1}^{N} p_i^{hk*} x_{ij}^{hk} - w_j^k L_j^k \} \}$$

$$= \max_{p_j^k} \{ p_j^k (X_j^k) X_j^k - \min_{x_{ij}^{hk}, L_j^k} \{ \sum_{h=1}^{R} \sum_{i=1}^{N} p_i^{hk*} x_{ij}^{hk} + w_j^k L_j^k \}$$

$$= \max_{p_j^k} \{ p_j^k (X_j^k) X_j^k - C_j^k (X_j^k, p, t) \} \qquad j = 1,.., N; k = 1,.., R \tag{3.13}$$

p_i^{hk*}: Price of p_i^h received by k-th Country

t_i^k : Tariff Rate of i-th Commodity imposed by k-th Country

e^k, e^h; Foreign Exchange Rate of k-th and h-th Country

$p_j^k (X_j^k)$: Inverse Demand Function of j-th Commodity in k-th Country

C_j^k : Cost Function of j-th Firm in k-th Country (Nominal in local Currency)

Note that price p_i^{hk*} has tariff rate t_i^k which is taken account for fraction of tariff against total production because total tariff in AIOS is accounted separately.

[3] Although W.E.Diewert and K.J.Fox have treated domestic input output system, we are going to

Cost Function

We will exemplify cost minimization under constraint of Cobb/Douglas production function. (See detail in Appendix A3) Yet, as is used in preceding research, we will employ an approach of deriving factor demand equation by Shephard lemma given cost function a priori. According this line, we will consider M.A.Fuss type cost function, which is a generalization of Leontief cost function.[M.A.Fuss,1977](See Appendix A4) Among a number of literatures, an application, for example, for automobile industry can be found in M.A.Fuss and L.Waverman.[M.A.Fuss and L.Waverman,1992]

For a special case of M.A.Fuss, we will take Generalized Ozaki cost function following Nakamura. [S.Nakamura,1990] (See Appendix A5) The Generalized Ozaki cost function in our MCMS has the form below, in which the second term refers to wage. Terms of time trend stands for Hicks neutral technological change. Note that we neglect terms of case $i \neq j$ in M.A.Fuss.

$$C_j^k(X_j^k, p, w) = \sum_{\eta=1}^{R}\sum_{\mu=1}^{N} b_{1\eta\mu}^k(p)\, p_\mu^{\eta k*}(X_j^k)^{b_{1\eta\mu}^k(X)} e^{b_{1\eta\mu}^k(t)t} + b_2^k(w) w_j^k (X_j^k)^{b_2^k(X)} e^{b_2^k(t)t}$$

$$j = 1,..,N; k = 1,..,R \qquad (3.14)$$

X_j^k: Output of j-th Sector in k-th Country

$p_\mu^{\eta k}$:Price of μ -th Sector in η -th Country received by k-th Country

w_j^k: Wage Rate of j-th Sector in k-th Country

t: Time Index used to capture Effects of Disembodied Technical Change

$b_{1\eta\mu}^k(p)$, $b_{1\eta\mu}^k(X)$, $b_{1\eta\mu}^k(t)$, $b_2^k(w)$, $b_2^k(X)$, $b_2^k(t)$: Unkown Parameters

treat MCMS system.

Now, by Shephard's lemma, we obtain the intermediate and labor demand equations respectively.

$$x_{ij}^{hk} = \frac{\partial C_j^k}{\partial p_i^{hk*}} = b_{1hi}^k(p)(X_j^k)^{b_{1hi}^k(X)} e^{b_{1hi}^k(t)t} \tag{3.15}$$

$$L_j^k = \frac{\partial C_j^k}{\partial w_j^k} = b_2^k(w)(X_j^k)^{b_2^k(X)} e^{b_2^k(t)t} \tag{3.16}$$

These equations have alternative expressions for estimation.

$$\log x_{ij}^{hk} = \log b_{1hi}^k(p) + b_{1hi}^k(X)\log X_j^k + b_{1hi}^k(t)t \tag{3.17}$$

$$\log L_j^k = \log b_2^k(w) + b_2^k(X)\log X_j^k + b_2^k(t)t \tag{3.18}$$

Equation (3.15)-(3.16) or (3.17)-(3.18) are estimated in use of an Asian International Input Output data. In this connection we could note that the cost function (3.14) can be directly estimable if sufficient data is available.

Other comments are available; shift factor of intermediate demand could be expressed, in $\log b_{1hi}^k(p)$, by transportation distance, product innovation, and by immigration in $\log b_2^k(w)$.

Substitution and Complementarity of Intermediate Demands

Definition of substitution and complementarity for two inputs is stated.

$$\frac{\partial x_{ij}^{hk}}{\partial p_{\mu}^{\eta k*}} > 0 \text{ : substitutive}$$

$$\frac{\partial x_{ij}^{hk}}{\partial p_{\mu}^{\eta k*}} < 0 \text{ : complementary}$$

$$\mu \neq i \tag{3.19}$$

x_{ij}^{hk} : Factor Demand of i-th Commodity in h-th Country by j-th Sector in k-th Country

$p_{\mu}^{\eta k*}$: Price of μ -th Commodity in η -th Country received by k-th Country

Allen's elasticity of substitution in MCMS is the following. (See Appendix A6)

$$\sigma_{i\mu,j}^{h\eta,k} = \frac{\left(\frac{\partial x_{ij}^{hk}}{\partial p_{\mu}^{\eta k*}}\right) C_j^k}{x_{ij}^{hk} x_{\mu j}^{\eta k}} = \frac{\left(\frac{\partial x_{ij}^{hk}}{\partial (1+t_i^h)(e^h/e^\eta)\, p_{\mu}^{\eta k*}}\right) C_j^k}{x_{ij}^{hk} x_{\mu j}^{\eta k}} \tag{3.20}$$

<u>Innovation attached to Cost Function</u>

We will identify technical progress which is attached to the cost function and its corresponding factor demand equations. The term of time trend expresses technical progress of Hicks neutrality. In this connection, S.Shishido classifies three kinds of technical progress. [S.Shishido,1990]

A Type: Price Independent Technical Progress

This type is related to S of R.Stone's RAS method. The progress not saves particular factors such as labor, but saves all factors independently from prices of factors and production price. We exemplify a) reducing cost by introducing innovative technology, b) quality control or total quality control and c) IT innovation. Cost function holds term of time trend for expressing this technical progress.

B Type: Technical Progress depending on Output Price

Cost reducing behavior, done by management efforts, reacts to reduction of output price, but does not aim at reducing particular factor demands. These behaviors, caused by globalization and currency appreciation mainly after 1990s, could be seen in most manufacturing industries in Japan.

Following Allen's elasticity of substitution in AIOS, same kind of index is made to express reducing x_{ij}^{hk} against p_j^k reduction.

$$\sigma_{ij}^{hk} = \frac{\left(\dfrac{\partial x_{ij}^{hk}}{\partial p_j^k}\right) C_j^k}{x_{ij}^{hk} X_j^k} = \frac{\left(\dfrac{\partial x_{ij}^{hk}}{\partial X_j^k}\right)\left(\dfrac{\partial X_j^k}{\partial p_j^k}\right) C_j^k}{x_{ij}^{hk} X_j^k} \tag{3.21}$$

C Type: Technical Progress depending on Input Price

This type is related to R of R.Stone's RAS method, and is aroused from rise of factor price such as material (e.g., rise of oil price), labor and capital. Allen's elasticity of substitution (3.19) in MCMS is applicable.

Cost function embodying B-type technology is modified in account of above consideration in the following way.

$$C_j^k(X_j^k, p, w) = \sum_{\eta=1}^{R}\sum_{\mu=1}^{N} b_{1\eta\mu}^k(p) p_\mu^{\eta k*} (p_j^{k(e)})^{b_{2\eta\mu}^k(pj)} (X_j^k)^{b_{1\eta\mu}^k(X)} \exp b_{1\eta\mu}^k(t)t$$

$$+b_3^k(w)w_j^k(p_j^{k(e)})^{b_{3ki}^k(pj)}(X_j^k)^{b_3^k(X)}\exp b_{1\eta\mu}^k(t)t \tag{3.22}$$

X_j^k: Output in j-th Sector of k-th Counry

p_μ^η: Price in μ -th Sector of η -th Country

$p_j^{k(e)}$: Expected Price of p_j^k

w_j^k: Wage Rate in j-th Sector of k-th Counry

t: Time Index used to capture Effects of Disembodied Technical Change

$b_{1\eta\mu}^k(p)$, $b_{1\eta\mu}^k(X)$, $b_{1\eta\mu}^k(t)$, $b_2^k(w)$, $b_2^k(X)$, $b_2^k(t)$: Parameters

The Shephard's lemma yields again intermediate and labor demands respectively as:

$$x_{ij}^{hk}=\frac{\partial C_j^k}{\partial p_i^{hk*}}=\frac{\partial C_j^k}{\partial\left(1+t_i^k\right)\left(\frac{e^k}{e^h}\right)p_i^h}=b_{1hj}^k(p)(p_j^{k(e)})^{b_{2hj}^k(pj)}(X_j^k)^{b_{1hj}^k(X)}\exp b_{1hj}^k(t)t \tag{3.23}$$

$$L_j^k=\frac{\partial C_j^k}{\partial w_j^k}=b_2^k(w)(p_j^{k(e)})^{b_{2hj}^k(pj)}(X_j^k)^{b_2^k(X)}\exp b_2^k(t)t \tag{3.24}$$

Estimated coefficients of (3.23) and (3.24) enable us to have coefficients of corresponding cost function. Equations (3.23) and (3.24) also take logarithm form as:

$$\log x_{ij}^{hk}=\log b_{1hj}^k(p)+b_{2hj}^k(pj)\log(p_j^{k(e)})+b_{1hj}^k(X)\log(X_j^k)+b_{1hj}^k(t)t \tag{3.25}$$

$$\log L_j^k=\log b_2^k(w)+b_2^k(X)\log X_j^k+b_{2hj}^k(pj)\log p_j^{k(e)}+b_2^k(t)t \tag{3.26}$$

<u>Economy of Scale</u>

$$SE_j^k = \frac{AC_j^k}{MC_j^k} = \frac{C_j^k \big/ X_j^k}{MC_j^k} \tag{3.27}$$

$$MC_j^k = \frac{\partial C_j^k(X_j^k, p, w)}{\partial X_j^k} \text{ : Marginal Cost}$$

<u>Rate of Technical Progress</u>

Formula of technical progress of j-th sector in k-th country in virtue of cost function is product of two elements associated with cost function where left hand side is unknown, but elements of right hand side are computed in ease. (See Appendix A7)

$$\frac{\partial \log f_j^k(x,t)}{\partial t} = -\left(\frac{\partial \log C_j^k(X_j^k, p,t)}{\partial t}\right) \times \frac{1}{\dfrac{\partial \log C_j^k(X_j^k, p,t)}{\partial \log X_j^k}} \tag{3.28}$$

<u>Total Factor Productivity(TFP)</u>

TFP of j-th sector in k-th country is straightforward from Appendix A8.

$$\frac{d \log TFP_j^k}{dt} = \frac{d \log X_j^k}{dt} - \frac{d \log C_j^k(X_j^k, p, R(t))}{dt} \tag{3.29}$$

$$\frac{d \log C_j^k}{dt} = \left(\frac{\partial \log C_j^k}{\partial \log X_j^k}\right)\left(\frac{d \log X_j^k}{dt}\right) + \sum_{h=1}^{R}\sum_{i=1}^{N}\left(\frac{\partial \log C_j^k}{\partial \log p_i^{hk*}}\right)\left(\frac{d \log p_i^{hk*}}{dt}\right)$$

$$+\left(\frac{\partial \log C_j^k}{\partial \log R(t)}\right)\left(\frac{d \log R(t)}{dt}\right) \tag{3.30}$$

Pricing Differentiated Products of International Oligopolistic Firms

Profit maximization (3.12) forces oligopoly firms to determine oligopolistic prices.

$$\frac{\partial \pi_j^k}{\partial p_j^k} = \frac{\partial \{ p_j^k X_j^k - C_j^k (X_j^k, p, t)\}}{\partial p_j^k} \quad j = 1,., N; k = 1,., R \qquad (3.31)$$

Condition for optimization is the following, which is going to determine sector price in the final step.(See Appendix A9 for second order condition of optimization.)

$$X_j^k + p_j^k \times \frac{\partial X_j^k}{\partial p_j^k} = \frac{\partial C_j^k (X_j^k, w)}{\partial X_j^k} \times \frac{\partial X_j^k}{\partial p_j^k} \qquad j = 1,., N; k = 1,., R \qquad (3.32)$$

As we have $\partial X_j^k \big/ \partial p_j^k$ in both sides of (3.32), we evaluate it in referring (3.01) with exchanging h with k and replacing i by j.

$$\frac{\partial X_j^k}{\partial p_j^k} = \frac{\partial \left[\sum_{l=1}^{N} \sum_{h=1}^{R} x_{jl}^{kh} + \sum_{h=1}^{R} CP_j^{kh} + \sum_{h=1}^{R} G_j^{kh} + \sum_{h=1}^{R} I_j^{kh} + \sum_{h=1}^{R} IV_j^{kh} + E_j^k + Q_j^k \right]}{\partial p_j^k}$$

$$= \frac{\partial \sum_{l=1}^{N} \sum_{h=1}^{R} x_{jl}^{kh}}{\partial p_j^k} + \frac{\partial \sum_{h=1}^{R} CP_j^{kh}}{\partial p_j^k} + \frac{\partial \sum_{h=1}^{R} G_j^{kh}}{\partial p_j^k} + \frac{\partial \sum_{h=1}^{R} I_j^{kh}}{\partial p_j^k} + \frac{\partial \sum_{h=1}^{R} IV_j^{kh}}{\partial p_j^k} + \frac{\partial E_j^k}{\partial p_j^k} + \frac{\partial Q_j^k}{\partial p_j^k}$$

$$= 0 + \frac{\partial \sum_{h=1}^{R} CP_j^{kh}}{\partial p_j^k} + 0 + 0 + 0 + 0 + 0 \qquad j = 1,., N; k = 1,., R \qquad (3.33)$$

We have derivative $\partial CP_j^{kh} \big/ \partial p_j^k$ from Appendix A10.

$$\frac{p_j^{kh*}}{M^h} \left(\frac{\partial CP_j^{kh}}{\partial p_j^k} \right) = - \frac{(1 + t_j^h) \left(\frac{e^h}{e^k} \right) (1 - s_j^k) CP_j^{kh}}{M^h}$$

$$-\beta_j^{kh}\left(\frac{\alpha_j^{kk}\left(p_j^{kk*}\right)^{\alpha_j^{kk}-1}+\prod_{\tau\neq k}^{R}\alpha_j^{\tau k}\left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}-1}(1+t_j^k)\left(\frac{e^k}{e^\tau}\right)(1-s_j^\tau)\left(\lambda_j^k\right)\cdot\left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}{\prod_{\tau=1}^{R}\left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}}\cdot\left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}\right) \quad (3.34)$$

$$\frac{\partial p_j^\tau}{\partial p_j^k}=\lambda_j^k\neq 0(unkown) \qquad j=1,.,N;k=1,.,R;\tau=1,..,R$$

$$\frac{\partial p_l^\tau}{\partial p_j^k}=0 \qquad j=1,.,N;k=1,.,R;l=1,.,j-1,j+1,.,N;\tau=1,..,R$$

Estimating Conjectural Variation

Inserting (3.33) and (3.34) into (3.32), we could estimate $N\times R$ unknown conjectural variations λ_j^k for j and k. Conjectural variations in (3.32) ensures to satisfy optimization condition in sample period.[4] (See [G.Iwata, 1974])[5] Reasons why sector production does not go to infinity by profit maximization in case of increasing return of scale rest on ceiling of household budget and on supply constraint of capital. And reason of sector production not going to zero in case of decreasing return of scale, possibly seen in agricultural sector, is on existence of commodities of necessity for human life. We could see other possibilities; a) no profit maximization, e.g. value-added maximization or b) no optimization behavior, e.g. decision making by rule. Then optimal prices are expected to stay at finite value within zero and infinity. In realism of individual oligopoly market, as differentiated firms are separated by price and space, equilibrium is also expected to stay in the same region.

[4] Unless conjectural variation, empirical first order condition (3.32) is not satisfied.

By letting notations of marginal cost and price elasticity of demand be;

$$MC_j^k = \frac{\partial C_j^k}{\partial X_j^k} \qquad \varepsilon_j^k = -\frac{\partial X_j^k}{\partial p_j^k} \times \frac{p_j^k}{X_j^k}, \tag{3.35}$$

we leads to price determination equation.

$$\frac{p_j^k - MC_j^k}{p_j^k} = \frac{1}{\varepsilon_j^k} \tag{3.36}$$

Finally we have mark-up price determination.

$$p_j^k = \left(\frac{\varepsilon_j^k}{\varepsilon_j^k - 1}\right) MC_j^k = \mu_j^k MC_j^k \qquad j = 1,.,N; k = 1,.,R \tag{3.37}$$

System of equations (3.37) determine $N \times R$ sector prices simultaneously given $N \times R$ exogenous conjectural variations λ_j^k, which are obtained in (3.32).

We should note that the oligopolistic market of above description is called Bertrand equilibrium, price being strategic variable. In contrast, perfect competition has sector production X_j^k is strategic variable, and price p_j^k is determined so as to balance market (3.01). The latter competition is called Cournot equilibrium.

Definition of Price at Macro Level

$$p^k = \sum_{i=1}^{N} \left(\frac{X_i^{k*}}{\sum_{\mu=1}^{N} X_\mu^{k*}} \right) p_i^k \tag{3.38}$$

[5] G.Iwata has treated homogeneous commodity market of oligopolistic flat glass in Japanese economy.

$X_i^{k*} : X_i^k$ at base year

Price at macro level is weighted average of sectoral prices in which sectoral productions in average weights are used at base year.

Wage Rate

Wage rate of j-th sector in k-th country is simply determined by productivity of labor and expected price.[W.J.McKibbin and J.Nguyen,2004]

$$w_j^k = \left(p^{k(e)}\right)^{\beta^k} \left(\frac{X_j^k}{L_j^k}\right)^{\xi_j^k} \qquad p^{k(e)} = \sum_{i=1}^{N} \left(\frac{X_i^{k*}}{\sum_{\mu=1}^{N} X_\mu^{k*}} \right) p_i^k \tag{3.39}$$

X_i^{k*} : Production of i-th Commodity in k-th Country at base year

Expected price is now formed by weighted average of domestic sector production at base year. Another note is possible that we use rational expectation for that.

Definition of Non Occupation Ratio

Labor force LF^k in k-th country minus total of occupation labor of j-th sector L_j^k in k-th country makes non occupation labor, and non occupation ratio is easily defined.

$$UR^k = \frac{LF^k - \sum_{j=1}^{N} L_j^k}{LF^k} \tag{3.40}$$

3.4 Fixed Investment

Two different actors are involved on fixed investment (I_i^{hk});

$$I_i^{hk} = I1_i^{hk} + I2_i^{hk} \tag{3.41}$$

I_i^{hk} : Flow of i-th Commodity from h-th Country for Fixed Investment to k-th Country

$I1_i^{hk}$: Foreign Direct Investment of i-th Commodity of h-th Country

$I2_i^{hk}$: Demand of i-th Commodity of h-th Country by k-th Country

Note that, whereas the former actor is firms of h-th country, the latter actor is firms of k-th country. Unfortunately, only I_i^{hk} is observable. As, in ideal, both decision making on the two investments (internal and external) should be explained by profit maximization in (3.31), long term decision making now is separated from that of short time for the moment in this modeling.

Foreign Direct Investment(FDI)

Total foreign direct investment FDI^h of h-th country is assumed to be given exogenously. Now the total amount FDI^h is to be invested to foreign countries in view of their growth and benefit of transportation, which is made in the following.

$$FDI^{hk} = wf^{hk} FDI^h \tag{3.42}$$

FDI^{hk} : h-th Country Distribution to k-th Country

wf^{hk} : Distribution Coefficient depending on Growth and Benefit of Transportation

Secondly, distribution to i-th commodity is made by the following.

$$I1_i^{hk} = w_i \left(\frac{e^k}{e^h} \right) FDI^{hk} \tag{3.43}$$

w_i : distribution coefficient for i-th commodity common

to all countries

Then, we have the following by the above two equations (3.42)-(3.43).

$$I1_i^{hk}(t) = w_i \left(\frac{e^k}{e^h} \right) FDI^{hk} = w_i \left(\frac{e^k}{e^h} \right) wf^{hk} FDI^h \tag{3.44}$$

<u>Domestic Investment</u>

We further assume total amount of domestic investment $I2^k$ also as given exogenously. Composition of commodities for domestic investment is as follows using common coefficient.

$$I2_i^k = w_i I2^k \tag{3.45}$$

Decision of suppliers of i-th commodity is made by price and benefit of transportation.

$$I2_i^{hk} = wr^{hk} I2_i^k = wr^{hk} w_i I2^k \tag{3.46}$$

wr^{hk} : Coefficient of Suppliers

Finally we have decision equation of I_i^{hk} by the use of (3.41), (3.44) and (3.46).

$$I_i^{hk} = I1_i^{hk} + I2_i^{hk} = w_i \left(\frac{e^k}{e^h} \right) wf^{hk} FDI^h + wr^{hk} w_i I2^k$$

$$= w_i \left(\left(\frac{e^k}{e^h} \right) wf^{hk} FDI^h + wr^{hk} I2^k \right) \tag{3.47}$$

Total volume I_i^{hk} is explained by the two exogenous variables (FDI^h , $I2^k$).

3.5 Inventory Investment

Although it is possible to treat inventory investment IV_i^{hk} as exogenous variable, we dare to endogenize it. It is well known inventory investment contains both planned IVP_i^{hk} and unplanned IVU_i^{hk}. Unfortunately both are unobservable.

$$IV_i^{hk} = IVP_i^{hk} + IVU_i^{hk} \tag{3.48}$$

Planned inventory investment is assumed to be dependent on root of total production.

$$IVP_i^{hk} = wp_i^h (\prod_{j=1}^{N} X_j^k)^{\frac{1}{2N}} \tag{3.49}$$

Regression equation for determining unobservable variable IVP_i^{hk} is;

$$IV_i^{hk} = wp_i^h (\prod_{j=1}^{N} X_j^k)^{\frac{1}{2N}} + u_i^{hk} \quad i = 1,.,N; h = 1,.,R \; . \tag{3.50}$$

Residual of the regression (3.50) is assumed to be unobservable unplanned inventory. Then we have the following.

$$RESIDU_i^{hk} = IV_i^{hk} - w\hat{p}_i^h (\prod_{j=1}^{N} X_j^k)^{\frac{1}{2N}} = IVU_i^{hk} \quad i = 1,.,N; h = 1,.,R \tag{3.51}$$

$w\hat{p}_i^h$: Estimated Value of wp_i^h

Total of unplanned inventory in k-th country is demand/supply gap of k-th country at macro level.

$$GAP^k = \sum_{h=1}^{R} \sum_{i=1}^{N} IVU_i^{hk} \; , \tag{3.52}$$

Then, its plus signifies excess supply and minas excess demand.

3.6 Government

Four kinds of modeling are suggested for the government expenditure; a) exogenous variable, b) simple conventional modeling of fiscal policy response function, c) micro foundation of setting government utility function like household, and finally d) dealing government as the leader of Stackelberg game using optimal control theory.[G.C.Chow, 1975] Now we take government expenditure as exogenous. However, another note also could be given that important variables like defense spending should be endogenized in isolation from the other expenditure. (See [L.R.Klein, M.Gronicki and H.Kosaka,1992],[H.Kosaka,1993])

3.7 Export to Other Region

Export is also exogenous. Yet, we retain possibility of linking export with other MCMS system like EU.(See [A.R.Hoen,2002])

3.8 Determining Foreign Exchange Rate

B.G.Hickman has proposed a model for foreign exchange rate in multi-country system. [B.G.Hickman,1983]

$$\log e^k = a_0^k + a_1^k \log\left(\frac{p^k}{p^{US}}\right) + a_2^k\left(r^k - r^{US}\right) + a_3^k\left(\frac{BAL^k}{p^k Z^k}\right) \tag{3.53}$$

e^k : k-th country's Foreign Exchange Rate per Dollar

p^k : k-th country's Price at Macro Level

p^{US} : US Price at Macro Level

r^k : k-th country's Long-term Interest Rate

r^{US} : US Long-term Interest Rate

BAL^k : k-th country's Current Balance

$p^k Z^k$: k-th country's Nominal GDP

If individual government has no external intervention for foreign exchange market, formulation (3.53) does work. However, another consideration has to be added for (3.53) in government intervention for the market. We suppose individual country has its currency basket in controlling exchange rate in the market. While currency basket has two calculations methods, we take arithmetic calculation for applying regression analysis.

<u>Formulating Exchange Rate incorporated Currency Basket</u>

We begin with taking simple example of currency basket composed of Dollar(weight 50%), Euro(weight 35%) and Yen(weight 15%) which shows 10 per Dollar with assuming 2 Euro/$ and 250 Yen/$ at base year.

Currency unit(x) has to satisfy the following at base year.

$$10 = x_1(1) + x_2(2) + x_3(250) \quad \text{at base year} \tag{3.54}$$

Then, we have from (3.54);

$$1 = x_1\left(\frac{1}{10}\right) + x_2\left(\frac{2}{10}\right) + x_3\left(\frac{250}{10}\right). \tag{3.55}$$

Currency unit is determined;

$$x_1\left(\frac{1}{10}\right) = 0.5 \qquad x_2\left(\frac{2}{10}\right) = 0.35 \qquad x_3\left(\frac{250}{10}\right) = 0.15 \tag{3.56}$$

$$x_1 = 5 \qquad x_2 = 1.75 \qquad x_2 = 0.06 \tag{3.57}$$

Basket currency would fluctuate so as to show 10 at base year.

$$E = 5\times 1 + 1.75\times M + 0.06\times Y \tag{3.58}$$

M : Euro Rate/\$ Y : Yen Rate/\$

Referring above example, we generalize currency basket in use of unknown weights. As in the example (3.54), following equation exists at base year in which we have basket weight of Euro ρ_1, weight of Yen ρ_2, and weight of Dollar $1-\rho_1-\rho_2$.

$$B^* = x_1 + x_2 M^* + x_3 Y^* \tag{3.59}$$

B^* : Basket Currency/\$ at base year

M^* : Euro/\$ at base year

Y^* : Yen/\$ at base year

$1-\rho_1-\rho_2$: Dollar Weight (unknown)

ρ_1: Euro Weight (unknown)

ρ_2: Yen Weight (unknown)

As is the same way of (3.55), (3.56) and (3.57), we have;

$$1 = x_1\left(\frac{1}{B^*}\right) + x_2\left(\frac{M^*}{B^*}\right) + x_3\left(\frac{Y^*}{B^*}\right). \tag{3.60}$$

$$x_1\left(\frac{1}{B^*}\right) = 1-\rho_1-\rho_2 \qquad x_2\left(\frac{M^*}{B^*}\right) = \rho_1 \qquad x_3\left(\frac{Y^*}{B^*}\right) = \rho_2 \tag{3.61}$$

$$x_1 = (1-\rho_1-\rho_2)B^* \qquad x_2 = \rho_1\left(\frac{B^*}{M^*}\right) \qquad x_3 = \rho_2\left(\frac{B^*}{Y^*}\right) \tag{3.62}$$

Then basket currency fluctuation is below;

$$B = (1-\rho_1-\rho_2)B^* + \rho_1\left(\frac{B^*}{M^*}\right)M + \rho_2\left(\frac{B^*}{Y^*}\right)Y\ . \qquad (3.63)$$

Basket currency now is incorporated into constant term in k-th exchange rate (3.53).

$$\log e^k = (1-\rho_1^k-\rho_2^k)B^* + \rho_1^k\left(\frac{B^*}{M^*}\right)M + \rho_2^k\left(\frac{B^*}{Y^*}\right)Y$$

$$+a_1^k \log\left(\frac{p^k}{p^{US}}\right) + a_2^k\left(r^k - r^{US}\right) + a_3^k\left(\frac{BAL^k}{p^k Z^k}\right) \qquad (3.64)$$

Since, in case of $\rho_1 = \rho_2 = 0$, constant B^* would be average rate of k-th country, we rename B^* by e^{k*}.

And we extend reference countries of EC and Japan to general ones. Then we have general formulation of exchange rate.

$$\log e^k = (1-\rho_1^k-\rho_2^k)e^{k*} + \rho_1^k\left(\frac{e^{k*}}{e^{r1*}}\right)e^{r1} + \rho_2^k\left(\frac{e^{k*}}{e^{r2*}}\right)e^{r2}$$

$$+a_1^k \log\left(\frac{p^k}{p^{US}}\right) + a_2^k\left(r^k - r^{US}\right) + a_3^k\left(\frac{BAL^k}{p^k Z^k}\right) \qquad (3.65)$$

e^{r1}: Exchange Rate of Reference Country 1

e^{r2}: Exchange Rate of Reference Country 2

Determining base year beforehand, then it would be possible to estimate parameters $(\rho_1^k, \rho_2^k, a_1^k, a_2^k, a_3^k)$ given (e^{r1*}, e^{r2*}) by regression analysis. By the estimated result, we can see weights (ρ_1^k, ρ_2^k). And, by the use of dummy variable in the constant term, we can see time dependent weight. If we change weights by policy, we can also investigate policy simulation of exchange rate scenario. Final note is possibility of using more than four existing currencies. (See detail [T.Yano and H.Kosaka,2003])

In the end we try to link exchange rate model with MCMS system.

$$\log e^k = (1-\rho_1^k - \rho_2^k)e^{k*} + \rho_1^k\left(\frac{e^{k*}}{e^{r1*}}\right)e^{r1} + \rho_2\left(\frac{e^{k*}}{e^{r2*}}\right)e^{r2}$$

$$+ a_1^k \log\left(\frac{p^k}{p^{US}}\right) + a_2^k\left(r^k - r^{US}\right) + a_3^k\left(\frac{BAL^{k,US}}{\sum_{i=1}^{N} p_i^k X_i^k \Big/ e^k}\right) \tag{3.66}$$

$$BAL^{k,US} = \frac{\left(\sum_{j=1}^{N}\sum_{j=1}^{N} x_{ij}^{k,US} + \sum_{i=1}^{N} CP_i^{k,US} + \sum_{i=1}^{N} G_i^{k,US} + \sum_{i=1}^{N} I_i^{k,US} + \sum_{i=1}^{N} IV_i^{k,US}\right)\times p_i^k}{e^k}$$

$$-\left(\sum_{j=1}^{N}\sum_{j=1}^{N} x_{ij}^{US,k} + \sum_{i=1}^{N} CP_i^{US,k} + \sum_{i=1}^{N} G_i^{US,k} + \sum_{i=1}^{N} I_i^{US,k} + \sum_{i=1}^{N} IV_i^{US,k}\right)\times p_i^{US}$$

To close this sub-section, we will re-state endogenous and exogenous variables. Firstly the endogenous variables are sector price, intermediate demand, household consumption, real sector output all in local currency, foreign exchange rare; on the contrary, exogenous ones are foreign direct investment in total, domestic investment, government expenditure, export to the rest of the world, statistical discrepancy, US long-term interest rate.

3.9 Gains from International Trade

R.C.Feenstra has categorized three kinds of gains from international trade of monopolistic competition: [R.C.Feenstra, 2010]

Let us consider national economy without international trade, i.e., autarky economy where foreign commodities are excluded in consumption bundle of household and in intermediate demands. Let indirect household utility, sector production and sector price be $\tilde{u}_j^k$, $\tilde{X}_j^k$ and $\tilde{p}_j^k$ in j-th sector of k-th country in autarky ecnomy.

a) Gain in Household Welfare

The effect has been refereed to by various authors in inter-industry trade. Direct effect in our model is measured in indirect household utility change.

$$\mathrm{GU}^k = \sum_{j=1}^{R} \left(u_j^k - \tilde{u}_j^k \right) \tag{3.67}$$

b) Gain in Supply-side

Highlighting productivity in dynamic firm model allowing entry and exit for the market, M.J.Melitz has argued effect in supply-side which also contribute to change of welfare gains in the second step.[M.J.Melitz,2003] In our model, embodied cost function (3.22) will contribute to aggregate productivity change (3.29) in TFP. Our model estimates gains in supply-side by sector production beyond productivity change.

$$\mathrm{GX}^k = \sum_{j=1}^{R} \left(X_j^k - \tilde{X}_j^k \right) \tag{3.68}$$

c) Gain of Reducing Markups

R.C.Feenstra and D.E.Weinstein have shed light on price reduction.[R.C.Feenstra and D.E.Weinstein, 2010]

$$\mathrm{GP}^k = \sum_{j=1}^{R} \left(p_j^k - \tilde{p}_j^k \right) \tag{3.69}$$

4. Concluding Remarks

At the end we finish theoretical development of multi-country and multi-sectoral model for the Asian International Input Output system of Institute of Developing Economies completely from micro foundation in demand oriented view. For the second stage we are preparing for estimated results of our model and some simulations analysis.

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Appendix A1: Linking with Financial System

We try to link financial system with MCMS system. We follow L.R.Klein and W.Krelle financial system (hereafter KK financial system) in considering link with MCMS system. (See [L.R.Klein and W.Krelle,1983])

a) Current Account

$$CUR^k = \frac{SUR^k}{e^k} \tag{A1.01}$$

CUR^k : Current Account Balance of k-th Country in US dollar

SUR^k : Current Account Balance of k-th Country in k-th Currency

e^k : Exchange Rate of k-th Country per Dollar

To link with $SUR^k(t)$ we define k-th country's trade balance.

<u>Definition of k-th Counry's Trade Balance</u>

$$BAL^{k,all} = \sum_{h=k}^{R}\sum_{i=1}^{N} p_i^k \left(\sum_{j=1}^{N} x_{ij}^{kh} + C_i^{kh} + G_i^{kh} + I_i^{kh} + IV_i^{kh} \right) + p_i^k \sum_{i=1}^{N} E_i^k$$

$$-\sum_{h\neq k}^{R}\sum_{i=1}^{N} p_i^h \left(\frac{e^k}{e^h} \right) \left(\sum_{j=1}^{N} x_{ij}^{hk} + C_i^{hk} + G_i^{hk} + I_i^{hk} + IV_i^{hk} \right) - \sum_{i=1}^{N} e^k MX_i^k$$

MX_i^k : Import from the Other Countries and Regions

in US dollar (A1.02)

SUR^k is linked with $BAL^{k,all}$ by bridge equation.

$$SUR^k = SUR^k(BAL^{k,all}) \tag{A1.03}$$

b) Capital Account

$$CAP^k = CAP^k[CUR^k, r^k, r^{US}, \dot{p}^k, \dot{p}^{US}] \tag{A1.04}$$

CAP^h : Capital Account Balance of k-th Country in US Dollar

r^h : Long-term Interest Rate of k-th Country

r^{US} : US Long-term Interest Rate

$\dot{p}^k$: Inflation Rate of k-th Country

$\dot{p}^{US}$: US Inflation Rate

c) Overall Balance of Payment (Definition)

$$ALL^k = CUR^k + CAP^k \quad \text{(A1.05)}$$

ALL^k : Overall Balance Payment of k-th Country in US Dollar

d) Increase of Net Foreign Asset of Central Bank

$$\Delta NFA^k = ALL^k e^k \quad \text{(A1.06)}$$

ΔNFA^k : Increase of Net Foreign Asset of Central Bank in k-th Currency

e) Net Foreign Asset of Central Bank (Definition)

$$NFA^k = \Delta NFA^k + NFA^k_{-1} \quad \text{(A1.07)}$$

NFA^k : Net Foreign Asset of Central Bank of k-th Currency

f) Net Domestic Asset

$$NDA^k = NDA^k[\sum_{i=1}^{N} X_i^k, p^k, NFA^k] \quad \text{(A1.08)}$$

NDA^k : Net Domestic Asset of Central Bank in k-th Currency

The KK financial system use real GDP in palace of total sector production in (A1.08).

g) Reserve Money (Definition)

$$RM^k = NDA^k + NFA^k \quad \text{(A1.09)}$$

RM^k : Reserve Money of k-th Country in k-th Currency

h) Money Supply

$$MS^k = m^k RM^k \quad \text{(A1.10)}$$

m^k : Credit Multiplier of k-th Country in k-th Currency

Although Credit Multiplier in the KK financial system is exogenous, we try to pose it as a function of household saving (3.06).

$$m^k = m^k[\dot{S}^k] \quad \text{(A1.11)}$$

$\dot{S}^k$: Increasing Rate of Household Saving of k-th Country

i) Long-term Interest Rate

The KK financial system use real GDP in place of total sector production in their IS/LM system.

$$\frac{MS^k}{p^k} = MD^k[\sum_{i=1}^{N} X_i^k, r^k] \quad \text{(A1.12)}$$

Hence equation of determining long-term interest rate is below;

$$r^k = f^k[\sum_{i=1}^{N} X_i^k, \frac{MS^k}{p^k}]. \quad \text{(A1.13)}$$

Now we add two more explanatory variables (interest rate of policy instrument and US long-term interest rate) to (A1.13) because of existence of long-term interest rate parity among US and other countries, and of influence from short-term financial market.

$$r^k = f^k[\sum_{i=1}^{N} X_i^k, \frac{MS^k}{p^k}, r^{US}, rm^k] \quad \text{(A1.14)}$$

rm^k : Money Market Rate of Policy Instrument in k-th Country(exogenous)

In the final step of closing the system, KK financial system states US long-term interest rate is determined in the following way.

j) Excess Demand of World Capital

Sum up NFA^h other than US by converting local currency to dollar term;

$$DIFF(t) = \sum_{h \neq US} \frac{NFA^h(t)}{e^h(t)} \tag{A1.15}$$

assuming that NFA^h goes to US government bond market.

$$CAL(\tau) = \begin{cases} -\eta & \text{if } DIFF > \alpha \\ 0 & \text{if } -\alpha < DIFF < \alpha \\ +\eta & \text{if } DIFF < -\alpha \end{cases}$$

$$r^{US}(\tau) = r^{US}(\tau - 1) + CAL(\tau) \tag{A1.16}$$

Above τ stand for iteration step τ. If $DIFF$ has positive small value greater than α, world capital flows go to US government bond market, and US interest rate goes down by η. Inversely, if $DIFF$ has negative small value less than $-\alpha$, world capital flows go out from government bond market, and US interest rate goes up by η. In the meanwhile US long-term interest rate would have no change. Thus, differing from the other countries' interest rate, determination of US interest rate has different mechanism.

As formulation of US long-term interest rate, (A1.15) and (A1.16), is not easy to be estimated econometrically, it would be possible US interest rate is treated as exogenous.

Appendix A2: Optimal Demand for Commodities by Household

Indirect Utility Function and Roy's Theorem

Now we are supposed to have n commodities. If we suppose household utility for n commodities, and suppose to optimize utility under budget constraint, then we have optimal consumption for i-th commodity in Marshallian sense. Substituting optimal consumption into utility function gives indirect utility function, which is dependent on budget constraint and prices.

Inversely, if we have indirect utility function, we easily obtain optimal consumption of i-th commodity by fraction of the two partial derivatives of indirect utility with respect to budget constraint and prices. This proposition is called Roy's theorem. Jorgenson et al. proposed translog type as an indirect utility function.

Dual Problem

Whereas the primal problem, above mentioned, is utility maximization under budget constraint in determining optimal commodity demand, dual problem is budget minimization (cost minimization) under utility level unchanged. The derived optimal commodity demand is called Hicksian demand, and minimized cost, substituted Hicksian demand, is called expenditure function.

Indirect utility function and expenditure function are inverse functional relationship.

AIDS model, proposed by Deaton et al., could be described in the following, setting expenditure function $C(u, p)$ as translog type.

$$C(u, p) = e^{a(p)+ub(p)} \tag{A2.01}$$

$$a(p) = \sum_{i=1}^{n} \alpha_i \log p_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \log p_i \log p_j \tag{A2.02}$$

$$b(p) = \beta_0 \prod_{i=1}^{n} p_i^{\beta_i} \tag{A2.03}$$

$$\sum_{i=1}^{n} \alpha_i = 1 \qquad \sum_{i=1}^{n} \beta_i = 0 \qquad \sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} = 0 \tag{A2.04}$$

Putting (A2.02) and (A2.03) into (A2.01) gives us the following equation by taking logarithm on both sides.

$$\log C(u,p) = \log M = a(p) + ub(p)$$

$$= \sum_{i=1}^{n} \alpha_i \log p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \log p_i \log p_j + u\beta_0 \prod_{i=1}^{n} p_i^{\beta_i} \qquad \text{(A2.5)}$$

From above equation (A2.05), we obtain for utility in indirect form;

$$u = \frac{\log M - \sum_{i=1}^{n} \alpha_i \log p_i - \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \log p_i \log p_j}{\beta_0 \prod_{i=1}^{n} p_i^{\beta_i}} \qquad \text{(A2.6)}$$

In (A2.6) we take interest in the case $\gamma_{ij} = 0$, which is re-written down below and is used for MCMS system.

$$u = \frac{\log M - \sum_{i=1}^{n} \log p_i^{\alpha_i}}{\beta_0 \prod_{i=1}^{n} p_i^{\beta_i}} = \frac{\log \dfrac{M}{\prod_{i=1}^{n} p_i^{\alpha_i}}}{\beta_0 \prod_{i=1}^{n} p_i^{\beta_i}}$$

Then Shephard’s lemma indicates optimal demand for i-th commodity:

$$\frac{\partial C}{\partial p_i} = q_i . \qquad \text{(A2.07)}$$

<u>The Optimal Demand for i-th Commodity in Relative Share(Share Demand Equation)</u>

$$w_i = \frac{p_i q_i}{M} = \alpha_i + \beta_i \log \frac{M}{P} + \sum_{\eta=1}^{n} \gamma_{i\eta} \log p_\eta \qquad M = \sum_{i=1}^{n} p_i q_i \qquad \text{(A2.08)}$$

$$\log P = \sum_{\eta=1}^{n} \alpha_\eta \log p_\eta + \frac{1}{2} \sum_{\eta=1}^{n} \sum_{\mu=1}^{n} \gamma_{\eta\mu} \log p_\eta \log p_\mu \quad \text{translog type}$$

<u>Elasticity of Demand against Expenditure</u>

$$\eta_i = \frac{\partial(\log q_i)}{\partial(\log M)} = 1 + \frac{\beta_i}{w_i} \qquad \text{(A2.09)}$$

$\eta_i < 1$: Non-elastic Goods (Goods of Necessity)

$\eta_i > 1$: Elastic Goods (Goods of Luxury)

$\eta_i < 0$: Inferior Goods

Elasticity of Share Demand against Price in Marshall Sense

$$\eta_{ij} = \frac{\partial(\log w_i)}{\partial(\log p_j)} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i}\left\{\alpha_j + \sum_{l=1}^{n} \gamma_{jl} \log p_l\right\} \qquad \text{(A2.10)}$$

Self Elasticity of Share Demand $\qquad \eta_{ii} = \frac{\gamma_{ii}}{w_i} - \frac{\beta_i}{w_i}\left\{\alpha_i + \sum_{l=1}^{n} \gamma_{jl} \log p_l\right\}$

$|\eta_{ii}| < 1$: Non-elastic Goods (Goods of Necessity)

$|\eta_{ii}| > 1$: Elastic Goods (Goods of Luxury)

Cross Elasticity of Share Demand $\qquad \eta_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i}\left\{\alpha_j + \sum_{l=1}^{n} \gamma_{jl} \log p_l\right\}$

$\eta_{ij} > 0$: q_i is gross substitute of p_j.

$\eta_{ij} < 0$: q_i is gross complement of p_j.

Appendix A3: Cost Function associated with Cobb-Douglas Production Function

Cobb-Douglas production function for MCMS system is the following.

$$X_j^k = A_j^k \left(L_j^k\right)^{\alpha_j^k(L)} \prod_{h=1}^{R} \prod_{i=1}^{N} \left(x_{ij}^{hk}\right)^{\alpha_{ij}^{hk}(X)} \qquad \text{(A3.01)}$$

X_j^k : Output of j-th Sector in k-th Country

A_j^k : Efficiency Parameter of j-th Sector in k-th Country

L_j^k : Employment of j-th Sector in k-th Country

x_{ij}^{hk} : i-th Intermediate Commodity purchased by j-th Sector in k-th Country

$\alpha_j^k(L), \alpha_{\mu j}^{\eta k}(X)$: Fixed Parameters

Cost for firm of producing j-th commodity in k-th country

$$C_j^k = w_j^k L_j^k + \sum_{h=}^{R} \sum_{i=1}^{N} p_i^{hk*} x_{ij}^{hk} \qquad p_i^{hk*} = \left(1 + t_i^k\right)\left(\frac{e^k}{e^h}\right) p_i^h \qquad \text{(A3.02)}$$

p_i^h : Price of i-th Commodity in h-th Country

w_j^k : Wage Rate of j-th Sector in k-th Country

t_i^k : Tariff Rate of i-th Commodity imposed by k-th Country

e^k : Exchange Rate of k-th Country (base year)

is to be minimized.

A firm of j-th sector in k-th country solves the following cost minimization problem.

$$\text{Min} \quad C_j^k = w_j^k L_j^k + \sum_{\eta=}^{R} \sum_{\mu=1}^{N} p_\mu^{\eta *} x_{\mu j}^{\eta k} \qquad \text{(A3.03)}$$

Subject to

$$X_j^k = A_j^k \left(L_j^k\right)^{\alpha_j^k(L)} \prod_{\eta=}^{R} \prod_{\mu=1}^{N} \left(x_{\mu j}^{\eta k}\right)^{\alpha_{\mu j}^{\eta k}(X)} \qquad \text{(A3.04)}$$

For this purpose, let Lagrangian be;

$$J_j^k = w_j^k L_j^k + \sum_{\eta=}^{R}\sum_{\mu=1}^{N} p_\mu^{\eta k*} x_{\mu j}^{\eta k} + \lambda_j^k \left(X_j^k - A_j^k \left(L_j^k\right)^{\alpha_j^k(L)} \prod_{\eta=}^{R}\prod_{\mu=1}^{N}\left(x_{\mu j}^{\eta k}\right)^{\alpha_{\mu j}^{\eta k}(X)} \right)$$

Then the first order conditions for optimization holds.

$$w_j^k = \lambda_j^k \alpha_j^k(L) \frac{X_j^k}{L_j^k} \tag{A3.05}$$

$$p_i^{hk*} = \lambda_j^k \alpha_{ij}^{hk}(X) \frac{X_j^k}{x_{ij}^{hk}} \quad \text{(h = 1, 2, …, r; i = 1, 2, …, n)} \tag{A3.06}$$

$$X_j^k = A_j^k \left(L_j^k\right)^{\alpha_j^k(L)} \prod_{\eta=}^{R}\prod_{\mu=1}^{N}\left(x_{\mu j}^{\eta k}\right)^{\alpha_{\mu j}^{\eta k}(X)} \tag{A3.07}$$

Combining equations (A3.05) and (A3.06) yields:

$$\frac{w_j^k}{p_i^{hk*}} = \frac{\alpha_j^k(L)}{\alpha_{ij}^{hk}(X)} \frac{x_{ij}^{hk}}{L_j^k} \tag{A3.08}$$

Solving equation (A3.08) for L_j^k gives:

$$L_j^k = \frac{\alpha_j^k(L)}{\alpha_{ij}^{hk}(X)} \frac{p_i^{hk*}}{w_j^k} x_{ij}^{hk} \tag{A3.09}$$

Manipulating equation (A3.06), we also have:

$$\frac{p_i^{hk*}}{p_l^{qk*}} = \frac{\alpha_{ij}^{hk}(X)}{\alpha_{lj}^{qk}(X)} \frac{x_{lj}^{qk}}{x_{ij}^{hk}} \tag{A3.10}$$

Solving equation (A3.10) for x_{ij}^{qk} gives:

$$x_{ij}^{hk} = \frac{\alpha_{ij}^{hk}(X)}{\alpha_{lj}^{qk}(X)} \frac{p_l^{qk*}}{p_i^{hk*}} x_{lj}^{qk} \tag{A3.11}$$

Substituting equation (A3.11) into equation (A3.09) gives:

$$L_j^k = \frac{\alpha_j^k(L)}{\alpha_{lj}^{qk}(X)} \frac{p_l^{qk*}}{w_j^k} x_{lj}^{qk} \tag{A3.12}$$

Substituting equations (A3.11) and (A3.12) into equation (A3.07) gives:

$$X_j^k = A_j^k \left[\frac{\alpha_j^k(L)}{w_j^k}\right]^{\alpha_j^k(L)} \left[\frac{p_l^{qk*}}{\alpha_{lj}^{qk}(X)} x_{lj}^{qk}\right]^{\alpha_j^k(L)+\sum_{\eta=}^{r}\sum_{\mu=1}^{n}\alpha_{\mu j}^{\eta k}(X)} \prod_{\eta=}^{R}\prod_{\mu=1}^{N}\left[\frac{\alpha_{\mu j}^{\eta k}(X)}{p_\mu^{\eta k*}}\right]^{\alpha_{\mu j}^{\eta k}(X)}$$

(A3.13)

Subsequently, the expression for χ_{lj}^{qk} can be obtained by rearranging equation (A3.13) as:

$$x_{lj}^{qk} = \left(\frac{X_j^k}{A_j^k}\right)^{\frac{1}{\phi_j^k}} \left(\frac{w_j^k}{\alpha_j^k(L)}\right)^{\frac{\alpha_j^k(L)}{\phi_j^k}} \left(\frac{\alpha_{lj}^{qk}(X)}{p_l^{qk*}}\right) \prod_{\eta=}^{R}\prod_{\mu=1}^{N}\left[\frac{p_\mu^{\eta k*}}{\alpha_{\mu j}^{\eta k}(X)}\right]^{\frac{\alpha_{\mu j}^{\eta k}(X)}{\phi_j^k}}$$

(A3.14)

$$\phi_j^k = \alpha_j^k(L) + \sum_{\eta=}^{r}\sum_{\mu=1}^{n}\alpha_{\mu j}^{\eta k}(X).$$

Replacing, respectively, the subscripts h and i with q and l of equations (A3.14) gives:

$$x_{ij}^{hk} = \left(\frac{X_j^k}{A_j^k}\right)^{\frac{1}{\phi_j^k}} \left(\frac{w_j^k}{\alpha_j^k(L)}\right)^{\frac{\alpha_j^k(L)}{\phi_j^k}} \left(\frac{\alpha_{ij}^{hk}(X)}{p_i^{hk*}}\right) \prod_{\eta=}^{R}\prod_{\mu=1}^{N}\left[\frac{p_\mu^{\eta k*}}{\alpha_{\mu j}^{\eta k}(X)}\right]^{\frac{\alpha_{\mu j}^{\eta k}(X)}{\phi_j^k}}$$

Substituting equation (A3.14) into (A3.12) yields the expression for labor demand of j-th sector in k-th country as:

$$L_j^k = \left(\frac{X_j^k}{A_j^k}\right)^{\frac{1}{\phi_j^k}} \left[\frac{\alpha_j^k(L)}{w_j^k}\right]^{\frac{\sum_{\eta=}^{r}\sum_{\mu=1}^{n}\alpha_{\mu j}^{\eta k}(X)}{\phi_j^k}} \prod_{\eta=}^{R}\prod_{\mu=1}^{N}\left[\frac{p_\mu^{\eta k*}}{\alpha_{\mu j}^{\eta k}(X)}\right]^{\frac{\alpha_{\mu j}^{\eta k}(X)}{\phi_j^k}} \tag{A3.15}$$

Equation (A3.15) and substituting the resultant into equation (A3.02) gives the following cost function:

$$C_j^k = \phi_j^k \left(\frac{X_j^k}{A_j^k} \right)^{\frac{1}{\phi_j^k}} \left[\frac{w_j^k}{\alpha_j^k(L)} \right]^{\frac{\alpha_j^k(L)}{\phi_j^k}} \prod_{\eta=}^{R} \prod_{\mu=1}^{N} \left[\frac{p_\mu^{\eta k*}}{\alpha_{\mu j}^{\eta k}(X)} \right]^{\frac{\alpha_{\mu j}^{\eta k}(X)}{\phi_j^k}} \qquad \text{(A3.16)}$$

Equation (A3.16) is cost function associated with Cobb-Douglas production function.

Following Shephard’s lemma, we have factor demand equation.

$$\frac{\partial C_j^k}{\partial p_i^{hk*}} = x_{ij}^{hk} \qquad \text{(A3.17)}$$

Although it is possible to develop cost function with fixed capital, we postpone it.

Appendix A4: Cost Function and Factor Demands by M.A.Fuss

M.A.Fuss proposed a generalized Leontief cost function which comprises Leontief cost function as a special case. [M.A.Fuss,1977]

$$C(y, p, t) = \sum_i \sum_j h_{ij}(y,t) \sqrt{p_i} \sqrt{p_j} \qquad \text{(A4.01)}$$

y : Output p : Input Price $h_{ij}(y,t)$: Symmetric and Concave

Successors of M.A.Fuss have specified $h_{ij}(y,t)$ in various way. E.Berndt&M.S.Khaled and W.E.Diewert&T.Wales are among them. [E.Berndt and M.S.Khaled,1979] [W.E.Diewert and T.Wales,1987]

Appendix A5: Generalized Ozaki Cost Function

S.Nakamura, another successor of M.A.Fuss, exposed a mathematical form of $h_{ij}(y,t)$ in Fuss cost function, and named Generalized Ozaki cost function. [S.Nakamura,1990]

$$C(y,p,t)=\sum_i \sum_j b_{ij} y^{b_{yij}} \sqrt{p_i}\sqrt{p_j} \exp(b_{tij}t)$$

$$=[\sum_i b_{ii} p_i y^{b_{yi}} \exp(b_{ti}t) + \sum_{i \neq j} b_{ij} \sqrt{p_i p_j}\, y^{b_y} \exp(b_t t)] \qquad \text{(A5.01)}$$

$$h_{ii}(y,t) = b_{ii} y^{b_{yi}} \exp(b_{ti}t) \qquad \text{for } i = j \qquad \text{(A5.02)}$$

$$h_{ij}(y,t) = b_{ij} y^{b_y} \exp(b_t t) \qquad \text{for } i \neq j \qquad \text{(A5.03)}$$

Appendix A6: Substitution and Complementarity

Definition of substitution and complement for two inputs is stated.

$$\frac{\partial x_i}{\partial p_j} > 0 \quad \text{: substitutive} \qquad \text{(A6.01)}$$

$$\frac{\partial x_i}{\partial p_j} < 0 \quad \text{: complementary} \qquad i \neq j;\ i, j = 1, \ldots, n.$$

x_i : i-th Input p_j : j-th Input Price

Allen's elasticity of substitution gives rate of substitution.

$$\sigma_{ij} = \frac{\left(\frac{\partial x_i}{\partial p_j}\right) C}{x_i x_j} \qquad i \neq j \quad ; \quad i, j = 1, \ldots, n \qquad \text{(A6.02)}$$

Alternative expression of Allen's elasticity of substitution is restated.

$$\sigma_{ij} = \frac{\partial \log x_i \big/ \partial \log p_j}{S_j} \qquad \text{(A6.03)}$$

$$\frac{\partial \log x_i}{\partial \log p_j} = \left(\frac{\partial x_i}{\partial p_j}\right)\left(\frac{p_j}{x_i}\right)$$

$$S_j = \frac{w_j x_j}{C}$$

Elasticity of substitution has symmetrical property $\sigma_{ij} = \sigma_{ji}$.

Appendix A7: Technical Progress in Cost Function

If cost function $C(y, p, t)$ is decreasing in time t, there exists progressive technical change, and $\frac{\partial \log C(y, p, t)}{\partial t} = \lambda(w, y, t)$ is called cost diminution.

By the nature of cost function, relation holds.

$$\left(\frac{\partial C(y, p, t)}{\partial t}\right) = -\left(\frac{\partial C(y, p, t)}{\partial y}\right)\left(\frac{\partial f(x, t)}{\partial t}\right) \tag{A7.01}$$

Multiplying average cost on both side yields the following.

$$\frac{\left(\frac{\partial C(y, p, t)}{\partial t}\right)\left(\frac{C}{y}\right)}{\frac{\partial C(y, p, t)}{\partial y}} = -\left(\frac{\partial f(x, t)}{\partial t}\right)\left(\frac{C}{y}\right) \tag{A7.02}$$

Rearranging terms in (A7.02) gives important formula.

$$-\left(\frac{\partial \log C(y, p, t)}{\partial t}\right) \times \frac{1}{\frac{\partial \log C(y, p, t)}{\partial \log y}} = \frac{\partial \log f(x, t)}{\partial t} \tag{A7.03}$$

First term in left hand side : $\frac{\partial \ln c(w, y, t)}{\partial t} = \lambda(w, y, t)$ cost diminution

Second term in left hand side : $\dfrac{\left(\dfrac{C}{y}\right)}{\dfrac{\partial C(y,p,t)}{\partial y}} = \dfrac{AC}{MC} = \dfrac{1}{\dfrac{\partial \log C(y,p,t)}{\partial \log y}} = e$

Scale elasticity

Right hand side : $T(x,t) = \dfrac{\partial \log f(x,t)}{\partial t}$ rate of technical progress

Formula (A7.03) could be restated in abbreviation.

$$T(x(y,p,t),t) = -\lambda(y,p,t)e(y,p,t) \tag{A7.04}$$

When one looks at technical progress $T(x,t)$ by virtue of cost function, one needs to look at cost diminution and scale elasticity at the same time.

Appendix A8: Total Factor Productivity (TFP)

Definition of TFP is stated below.

$$TFP = \frac{y}{C(y,p,R(t))} \quad \text{or} \quad \log TFP = \log y - \log C(y,p,R(t)) \tag{A8.01}$$

$$C(t) = C[y, p_1, .., p_n, R(t)]$$

Hence differencing TFP with respect to time yields the following.

$$\frac{d \log TFP}{dt} = \frac{d \log y}{dt} - \frac{d \log C(y,p,R(t))}{dt} \tag{A8.02}$$

$$\frac{d \log C(y,p,R(t))}{dt} = \left(\frac{\partial \log C}{\partial \log y}\right)\left(\frac{d \log y}{dt}\right) + \sum_{i=1}^{n}\left(\frac{\partial \log C}{\partial \log p_i}\right)\left(\frac{d \log p_i}{dt}\right) + \left(\frac{\partial \log C}{\partial \log R(t)}\right)\left(\frac{d \log R(t)}{dt}\right) \tag{A8.03}$$

Appendix A9: Second Order Condition of Optimization

We restate profit maximization.

$$\frac{\partial \pi_j^k}{\partial p_j^k} = \frac{\partial \{ p_j^k X_j^k - C_j^k (X_j^k, p, t)\}}{\partial p_j^k} \qquad j = 1,., N; k = 1,., R \tag{A9.01}$$

As the first order condition of optimization is

$$X_j^k + p_j^k \times \frac{\partial X_j^k}{\partial p_j^k} = MC_j^k \times \frac{\partial X_j^k}{\partial p_j^k}, \tag{A9.02}$$

we have the second order condition.

$$\frac{\partial^2 \pi_j^k}{\partial (p_j^k)^2} = \frac{\partial \left[X_j^k + p_j^k \times \frac{\partial X_j^k}{\partial p_j^k} - MC_j^k \times \frac{\partial X_j^k}{\partial p_j^k} \right]}{\partial p_j^k} \tag{A9.03}$$

$$= \frac{\partial X_j^k}{\partial p_j^k} + \frac{\partial X_j^k}{\partial p_j^k} + p_j^k \times \frac{\partial^2 X_j^k}{\partial (p_j^k)^2} - \frac{\partial MC_j^k}{\partial p_j^k} \times \frac{\partial X_j^k}{\partial p_j^k} - MC_j^k \times \frac{\partial^2 X_j^k}{\partial (p_j^k)^2}$$

$$= 2\frac{\partial X_j^k}{\partial p_j^k} + \left(p_j^k - MC_j^k\right) \times \frac{\partial^2 X_j^k}{\partial (p_j^k)^2} - \frac{\partial MC_j^k}{\partial p_j^k} \times \frac{\partial X_j^k}{\partial p_j^k}$$

$$= \left(2 - \frac{\partial MC_j^k}{\partial p_j^k} \right) \times \frac{\partial X_j^k}{\partial p_j^k} + \left(p_j^k - MC_j^k\right) \times \frac{\partial^2 X_j^k}{\partial (p_j^k)^2}$$

$$= \left(2 - \frac{\partial MC_j^k}{\partial p_j^k} \right) \times \frac{\partial X_j^k}{\partial p_j^k} + \left(p_j^k - MC_j^k\right) \times \frac{\partial^2 X_j^k}{\partial (p_j^k)^2} > 0$$

Rearranging the first order condition of (A9.02), we have:

$$\left(p_j^k - MC_j^k\right) = -X_j^k \Big/ \frac{\partial X_j^k}{\partial p_j^k} \tag{A9.04}$$

Hence the second order condition is the following.

$$\frac{\partial^2 \pi_j^k}{\partial (p_j^k)^2} = \left(2 - \frac{\partial MC_j^k}{\partial p_j^k} \right) \times \frac{\partial X_j^k}{\partial p_j^k} - X_j^k \times \frac{\partial p_j^k}{\partial X_j^k} \times \frac{\partial^2 X_j^k}{\partial (p_j^k)^2}$$

$$= \left(2 - \frac{\partial MC_j^k}{\partial p_j^k} \right) \times \frac{\partial X_j^k}{\partial p_j^k} - X_j^k \times \frac{\partial X_j^k}{\partial p_j^k}$$

$$= \left(2 - \frac{\partial MC_j^k}{\partial p_j^k} - X_j^k \right) \times \frac{\partial X_j^k}{\partial p_j^k} < 0 \tag{A9.05}$$

The derivative $\partial^2 \pi_j^k \big/ \partial (p_j^k)^2$ becomes diagonal element of Hessian matrix.

Appendix A10: Evaluation of $\partial \sum_{h=1}^{R} CP_j^{kh} \Big/ \partial p_j^k$

Now we have;

$$\left(\frac{p_j^{kh*} CP_j^{kh}}{M^h} \right) = \left(\alpha_j^{kh} + \beta_j^{kh} \log \left(\frac{M^h}{\prod_{\tau=1}^{R} \prod_{l=1}^{N} \left(p_l^{\tau k*} \right)^{\alpha_l^{\tau k}} \cdot \left(p_f^k \right)^{\alpha_{N+1}^{\tau k}}} \right) \right) \tag{A10.01}$$

$$p_j^{\tau k*} = (1 + t_j^k) \left(\frac{e^k}{e^\tau} \right) (1 - s_j^\tau) p_j^\tau . \tag{A10.02}$$

Partial derivatives of both sides of (A10.01) leads the following equation.

$$\frac{\partial \left(\frac{p_j^{kh*} CP_j^{kh}}{M^h} \right)}{\partial p_j^k} = \frac{\partial \left(\alpha_j^{kh} + \beta_j^{kh} \log \left(\frac{M^h}{\prod_{\tau=1}^{R} \prod_{l=1}^{N} \left(p_l^{\tau k*} \right)^{\alpha_l^{\tau k}} \cdot \left(p_f^k \right)^{\alpha_{N+1}^{\tau k}}} \right) \right)}{\partial p_j^k} \tag{A10.03}$$

Then, evaluating derivatives of (A10.03) enables us to have the following equation, assuming that producer's conjectural variations of the same product for the other producers (i.e. of other countries) are made, but variations for other products are zeros.

$$\frac{(1 + t_j^h) \left(\frac{e^h}{e^k} \right) (1 - s_j^k) CP_j^{kh} + p_j^{kh*} \left(\frac{\partial CP_j^{kh}}{\partial \partial p_j^k} \right)}{M^h}$$

$$= \frac{\partial \left(- \beta_j^{kh} \log \left(\prod_{\tau=1}^{R} \prod_{l=1}^{N} \left(p_l^{\tau k*} \right)^{\alpha_l^{\tau k}} \cdot \left(p_f^k \right)^{\alpha_{N+1}^{\tau k}} \right) \right)}{\partial p_j^k} = - \frac{\partial \left(\beta_j^{kh} \log \left(\left(p_j^{kk*} \right)^{\alpha_j^{kk}} + \prod_{\tau \neq k}^{R} \left(p_j^{\tau k*} \right)^{\alpha_j^{\tau k}} \cdot \left(p_f^k \right)^{\alpha_{N+1}^{\tau k}} \right) \right)}{\partial p_j^k}$$

$$=-\beta_j^{kh}\left(\frac{\alpha_j^{kk}\left(p_j^{kk*}\right)^{\alpha_j^{kk}-1}+\prod_{\tau\neq k}^{R}\alpha_j^{\tau k}\left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}-1}\left(\frac{\partial p_j^{\tau k*}}{\partial p_j^k}\right)\cdot\left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}{\prod_{\tau=1}^{R}\left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}}\cdot\left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}\right)$$

$$=-\beta_j^{kh}\left(\frac{\alpha_j^{kk}\left(p_j^{kk*}\right)^{\alpha_j^{kk}-1}+\prod_{\tau\neq k}^{R}\alpha_j^{\tau k}\left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}-1}(1+t_j^k)\left(\frac{e^k}{e^\tau}\right)(1-s_j^\tau)\left(\frac{\partial p_j^{\tau}}{\partial p_j^k}\right)\cdot\left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}{\prod_{\tau=1}^{R}\left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}}\cdot\left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}\right)$$

$$=-\beta_j^{kh}\left(\frac{\alpha_j^{kk}\left(p_j^{kk*}\right)^{\alpha_j^{kk}-1}+\prod_{\tau\neq k}^{R}\alpha_j^{\tau k}\left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}-1}(1+t_j^k)\left(\frac{e^k}{e^\tau}\right)(1-s_j^\tau)\left(\lambda_j^k\right)\cdot\left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}{\left(p_j^{kk*}\right)^{\alpha_j^{kk}}+\prod_{\tau\neq k}^{R}\left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}}\cdot\left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}\right). \qquad \text{(A10.04)}$$

$$\frac{\partial p_j^\tau}{\partial p_j^k}=\lambda_j^k\neq 0(unkown)\ \tau=1,..,R \qquad \text{(A10.05)}$$

$$\frac{\partial p_l^\tau}{\partial p_j^k}=0 \qquad l=1,.,j-1,\ j+1,.,N;\tau=1,..,R \qquad \text{(A10.06)}$$

Coefficients (A10.05) are R.Frisch's conjectural variation of j-th producer in k-th country to j-th producer in τ -th country, which is common to all j-producers.

Finally we will deduce the equation.

$$\frac{p_j^{kh*}}{M^h}\left(\frac{\partial CP_j^{kh}}{\partial p_j^k}\right)=-\frac{(1+t_j^h)\left(\frac{e^h}{e^k}\right)(1-s_j^k)CP_j^{kh}}{M^h}$$

$$- \beta_j^{kh} \left(\frac{\alpha_j^{kk} \left(p_j^{kk*}\right)^{\alpha_j^{kk}-1} + \prod_{\tau \neq k}^{R} \alpha_j^{\tau k} \left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}-1} (1+t_j^k) \left(\frac{e^k}{e^\tau}\right) (1-s_j^\tau) \left(\lambda_j^k\right) \cdot \left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}}{\prod_{\tau=1}^{R} \left(p_j^{\tau k*}\right)^{\alpha_j^{\tau k}} \cdot \left(p_f^k\right)^{\alpha_{N+1}^{\tau k}}} \right) \quad \text{(A10.07)}$$

Table 1 Typology of Models

	Demand Oriented	Supply Oriented
Single-Country Single-Sector	SCSS_D	SCSS_S
Single-Country Multi-Sector	SCMS_D	SCMS_S
Multi-Country Single-Sector	MCSS_D	MCSS_S
Multi-Country Multi-Sector	MCMS_D	MCMS_S

Table 2 Layout of Demand Side: Intermediate Demand unit=local currency in constant price

		Indonesia			Malaysia			Philippines			Singapore			Thailand			China			Taiwan			Korea			Japan			US			local currency
		sector 1	.	sector N	sector 1	.	sector N	sector 1	.	sector N	sector 1	.	sector N	sector 1	.	sector N	sector 1	.	sector N	sector 1	.	sector N	sector 1	.	sector N	sector 1	.	sector N	sector 1	.	sector N	
Indonesia	sector 1	X^{II}_{11}	.	X^{II}_{1N}	X^{IM}_{11}	.	X^{IM}_{1N}	X^{IP}_{11}	.	X^{IP}_{1N}	X^{IS}_{11}	.	X^{IS}_{1N}	X^{IT}_{11}	.	X^{IT}_{1N}	X^{IC}_{11}	.	X^{IC}_{1N}	X^{IW}_{11}	.	X^{IW}_{1N}	X^{IK}_{11}	.	X^{IK}_{1N}	X^{IJ}_{11}	.	X^{IJ}_{1N}	X^{IU}_{11}	.	X^{IU}_{1N}	Rupiah
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{II}_{N1}	.	X^{II}_{NN}	X^{IM}_{N1}	.	X^{IM}_{NN}	X^{IP}_{N1}	.	X^{IP}_{NN}	X^{IS}_{N1}	.	X^{IS}_{NN}	X^{IT}_{N1}	.	X^{IT}_{NN}	X^{IC}_{N1}	.	X^{IC}_{NN}	X^{IW}_{N1}	.	X^{IW}_{NN}	X^{IK}_{N1}	.	X^{IK}_{NN}	X^{IJ}_{N1}	.	X^{IJ}_{NN}	X^{IU}_{N1}	.	X^{IU}_{NN}	Rupiah
Malaysia	sector 1	X^{MI}_{11}	.	X^{MI}_{1N}	X^{MM}_{11}	.	X^{MM}_{1N}	X^{MP}_{11}	.	X^{MP}_{1N}	X^{MS}_{11}	.	X^{MS}_{1N}	X^{MT}_{11}	.	X^{MT}_{1N}	X^{MC}_{11}	.	X^{MC}_{1N}	X^{MW}_{11}	.	X^{MW}_{1N}	X^{MK}_{11}	.	X^{MK}_{1N}	X^{MJ}_{11}	.	X^{MJ}_{1N}	X^{MU}_{11}	.	X^{MU}_{1N}	Ringgit
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{MI}_{N1}	.	X^{MI}_{NN}	X^{MM}_{N1}	.	X^{MM}_{NN}	X^{MP}_{N1}	.	X^{MP}_{NN}	X^{MS}_{N1}	.	X^{MS}_{NN}	X^{MT}_{N1}	.	X^{MT}_{NN}	X^{MC}_{N1}	.	X^{MC}_{NN}	X^{MW}_{N1}	.	X^{MW}_{NN}	X^{MK}_{N1}	.	X^{MK}_{NN}	X^{MJ}_{N1}	.	X^{MJ}_{NN}	X^{MU}_{N1}	.	X^{MU}_{NN}	Ringgit
Philippines	sector 1	X^{PI}_{11}	.	X^{PI}_{11}	X^{PM}_{11}	.	X^{PM}_{1N}	X^{PP}_{11}	.	X^{PP}_{1N}	X^{PS}_{11}	.	X^{PS}_{1N}	X^{PT}_{11}	.	X^{PT}_{1N}	X^{PC}_{11}	.	X^{PC}_{1N}	X^{PW}_{11}	.	X^{PW}_{1N}	X^{PK}_{11}	.	X^{PK}_{1N}	X^{PJ}_{11}	.	X^{PJ}_{1N}	X^{PU}_{11}	.	X^{PU}_{1N}	Piso
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{PI}_{N1}	.	X^{PI}_{NN}	X^{PM}_{N1}	.	X^{PM}_{NN}	X^{PP}_{N1}	.	X^{PP}_{NN}	X^{PS}_{N1}	.	X^{PS}_{NN}	X^{PT}_{N1}	.	X^{PT}_{NN}	X^{PC}_{N1}	.	X^{PC}_{NN}	X^{PW}_{N1}	.	X^{PW}_{NN}	X^{PK}_{N1}	.	X^{PK}_{NN}	X^{PJ}_{N1}	.	X^{PJ}_{NN}	X^{PU}_{N1}	.	X^{PU}_{NN}	Piso
Singapore	sector 1	X^{SI}_{11}	.	X^{SI}_{1N}	X^{SM}_{11}	.	X^{SM}_{1N}	X^{SP}_{11}	.	X^{SP}_{1N}	X^{SS}_{11}	.	X^{SS}_{1N}	X^{ST}_{11}	.	X^{ST}_{1N}	X^{SC}_{11}	.	X^{SC}_{1N}	X^{SW}_{11}	.	X^{SW}_{1N}	X^{SK}_{11}	.	X^{SK}_{1N}	X^{SJ}_{11}	.	X^{SJ}_{1N}	X^{SU}_{11}	.	X^{SU}_{1N}	Singapore Dollar
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{SI}_{N1}	.	X^{SI}_{NN}	X^{SM}_{N1}	.	X^{SM}_{NN}	X^{SP}_{N1}	.	X^{SP}_{NN}	X^{SP}_{N1}	.	X^{SS}_{NN}	X^{ST}_{N1}	.	X^{ST}_{NN}	X^{SC}_{N1}	.	X^{SC}_{NN}	X^{SW}_{N1}	.	X^{SW}_{NN}	X^{SK}_{N1}	.	X^{SK}_{NN}	X^{SJ}_{N1}	.	X^{SJ}_{NN}	X^{SJ}_{N1}	.	X^{SJ}_{NN}	Singapore Dollar
Thailand	sector 1	X^{TI}_{11}	.	X^{TI}_{1N}	X^{TM}_{11}	.	X^{TM}_{1N}	X^{TP}_{11}	.	X^{TP}_{1N}	X^{TS}_{11}	.	X^{TS}_{1N}	X^{TT}_{11}	.	X^{TT}_{1N}	X^{TC}_{11}	.	X^{TC}_{1N}	X^{TW}_{11}	.	X^{TW}_{1N}	X^{TK}_{11}	.	X^{TK}_{1N}	X^{TJ}_{11}	.	X^{TJ}_{1N}	X^{TU}_{11}	.	X^{TU}_{1N}	Baht
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{TI}_{N1}	.	X^{TI}_{NN}	X^{TM}_{N1}	.	X^{TM}_{NN}	X^{TP}_{N1}	.	X^{TP}_{NN}	X^{TS}_{N1}	.	X^{TS}_{NN}	X^{TT}_{N1}	.	X^{TT}_{NN}	X^{TC}_{N1}	.	X^{TC}_{NN}	X^{TW}_{N1}	.	X^{TW}_{NN}	X^{TK}_{N1}	.	X^{TK}_{NN}	X^{TJ}_{N1}	.	X^{TJ}_{NN}	X^{TU}_{N1}	.	X^{TU}_{NN}	Baht
China	sector 1	X^{CI}_{11}	.	X^{CI}_{1N}	X^{CM}_{11}	.	X^{CM}_{1N}	X^{CP}_{11}	.	X^{CP}_{1N}	X^{CS}_{11}	.	X^{CS}_{1N}	X^{CT}_{11}	.	X^{CT}_{1N}	X^{CC}_{11}	.	X^{CC}_{1N}	X^{CW}_{11}	.	X^{CW}_{1N}	X^{CK}_{11}	.	X^{CK}_{1N}	X^{CJ}_{11}	.	X^{CJ}_{1N}	X^{CU}_{11}	.	X^{CU}_{1N}	Yuan
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{CI}_{N1}	.	X^{CI}_{NN}	X^{CM}_{N1}	.	X^{CM}_{NN}	X^{CP}_{N1}	.	X^{CP}_{NN}	X^{CS}_{N1}	.	X^{CS}_{NN}	X^{CT}_{N1}	.	X^{CT}_{NN}	X^{CC}_{N1}	.	X^{CC}_{NN}	X^{CW}_{N1}	.	X^{CW}_{NN}	X^{CK}_{N1}	.	X^{CK}_{NN}	X^{CJ}_{N1}	.	X^{CJ}_{NN}	X^{CU}_{N1}	.	X^{CU}_{NN}	Yuan
Taiwan	sector 1	X^{WI}_{11}	.	X^{WI}_{1N}	X^{WM}_{11}	.	X^{WM}_{1N}	X^{WP}_{11}	.	X^{WP}_{1N}	X^{WS}_{11}	.	X^{WS}_{1N}	X^{WT}_{11}	.	X^{WT}_{1N}	X^{WC}_{11}	.	X^{WC}_{1N}	X^{WW}_{11}	.	X^{WW}_{1N}	X^{WK}_{11}	.	X^{WK}_{1N}	X^{WJ}_{11}	.	X^{WJ}_{1N}	X^{WU}_{11}	.	X^{WU}_{1N}	Taiwan Dollar
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{WI}_{N1}	.	X^{WI}_{NN}	X^{WM}_{N1}	.	X^{WM}_{NN}	X^{WP}_{N1}	.	X^{WP}_{NN}	X^{WS}_{N1}	.	X^{WS}_{NN}	X^{WT}_{N1}	.	X^{WT}_{NN}	X^{WC}_{N1}	.	X^{WC}_{NN}	X^{WW}_{N1}	.	X^{WW}_{NN}	X^{WK}_{N1}	.	X^{WK}_{NN}	X^{WJ}_{N1}	.	X^{WJ}_{NN}	X^{WU}_{N1}	.	X^{WU}_{NN}	Taiwan Dollar
Korea	sector 1	X^{KI}_{11}	.	X^{KI}_{1N}	X^{KM}_{11}	.	X^{KM}_{1N}	X^{KP}_{11}	.	X^{KP}_{1N}	X^{KS}_{11}	.	X^{KS}_{1N}	X^{KT}_{11}	.	X^{KT}_{1N}	X^{KC}_{11}	.	X^{KC}_{1N}	X^{KW}_{11}	.	X^{KW}_{1N}	X^{KW}_{11}	.	X^{KK}_{1N}	X^{KJ}_{11}	.	X^{KJ}_{1N}	X^{KU}_{11}	.	X^{KU}_{1N}	Won
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{KI}_{N1}	.	X^{KI}_{NN}	X^{KM}_{N1}	.	X^{KM}_{NN}	X^{KP}_{N1}	.	X^{KP}_{NN}	X^{KS}_{N1}	.	X^{KS}_{NN}	X^{KT}_{N1}	.	X^{KT}_{NN}	X^{KC}_{N1}	.	X^{KC}_{NN}	X^{KW}_{N1}	.	X^{KW}_{NN}	X^{KK}_{N1}	.	X^{KK}_{NN}	X^{KJ}_{N1}	.	X^{KJ}_{NN}	X^{KU}_{N1}	.	X^{KU}_{NN}	Won
Japan	sector 1	X^{JI}_{11}	.	X^{JI}_{1N}	X^{JM}_{11}	.	X^{JM}_{1N}	X^{JP}_{11}	.	X^{JP}_{1N}	X^{JS}_{11}	.	X^{JS}_{1N}	X^{JT}_{11}	.	X^{JT}_{1N}	X^{JC}_{11}	.	X^{JC}_{1N}	X^{JW}_{11}	.	X^{JW}_{1N}	X^{JK}_{11}	.	X^{JK}_{1N}	X^{JJ}_{11}	.	X^{JJ}_{1N}	X^{JU}_{11}	.	X^{JU}_{1N}	Yen
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{JI}_{N1}	.	X^{JI}_{NN}	X^{JM}_{N1}	.	X^{JM}_{NN}	X^{JP}_{N1}	.	X^{JP}_{NN}	X^{JS}_{N1}	.	X^{JS}_{NN}	X^{JT}_{N1}	.	X^{JT}_{NN}	X^{JC}_{N1}	.	X^{JC}_{NN}	X^{JW}_{N1}	.	X^{JW}_{NN}	X^{JK}_{N1}	.	X^{JK}_{NN}	X^{JJ}_{N1}	.	X^{JJ}_{NN}	X^{JU}_{N1}	.	X^{JU}_{NN}	Yen
US	sector 1	X^{UI}_{11}	.	X^{UI}_{1N}	X^{UM}_{11}	.	X^{UM}_{1N}	X^{UP}_{11}	.	X^{UP}_{1N}	X^{US}_{11}	.	X^{US}_{1N}	X^{UT}_{11}	.	X^{UT}_{1N}	X^{UC}_{11}	.	X^{UC}_{1N}	X^{UW}_{11}	.	X^{UW}_{1N}	X^{UK}_{11}	.	X^{UK}_{1N}	X^{UJ}_{11}	.	X^{UJ}_{1N}	X^{UU}_{11}	.	X^{UU}_{1N}	Dollar
.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	X^{UI}_{N1}	.	X^{UI}_{NN}	X^{UM}_{N1}	.	X^{UM}_{NN}	X^{UP}_{N1}	.	X^{UP}_{NN}	X^{US}_{N1}	.	X^{US}_{NN}	X^{UT}_{N1}	.	X^{UT}_{NN}	X^{UC}_{N1}	.	X^{UC}_{NN}	X^{UW}_{N1}	.	X^{UW}_{NN}	X^{UK}_{N1}	.	X^{UK}_{NN}	X^{UJ}_{N1}	.	X^{UJ}_{NN}	X^{UU}_{N1}	.	X^{UU}_{NN}	Dollar

Table 4 **Layout of Supply Side** **unit=local currency in current price**

		Indonesia			Malaysia			Philippines			Singapore			Thailand			China			Taiwan			Korea			Japan			US		
		sector 1	.	**sector N**	**sector 1**	.	**sector N**	**sector 1**	.	**sector N**	**sector 1**	.	**sector N**	**sector 1**	.	**sector N**	**sector 1**	.	**sector N**	**sector 1**	.	**sector N**	**sector 1**	.	**sector N**	**sector 1**	.	**sector N**	**sector 1**	.	**sector N**
Indonesia	**sector 1**	$p_1^{II*}x_{11}^{II}$	.	$p_1^{II*}x_{1N}^{II}$	$p_1^{IM*}x_{11}^{IM}$	.	$p_1^{IM*}x_{1N}^{IM}$	$p_1^{IP*}x_{11}^{IP}$	.	$p_1^{IP*}x_{1N}^{IP}$	$p_1^{IS*}x_{11}^{IS}$	.	$p_1^{IS*}x_{1N}^{IS}$	$p_1^{IT*}x_{11}^{IT}$	.	$p_1^{IT*}x_{1N}^{IT}$	$p_1^{IC*}x_{11}^{IC}$	.	$p_1^{IC*}x_{1N}^{IC}$	$p_1^{IW*}x_{11}^{IW}$	.	$p_1^{IW*}x_{1N}^{IW}$	$p_1^{IK*}x_{11}^{IK}$	.	$p_1^{IK*}x_{1N}^{IK}$	$p_1^{IJ*}x_{11}^{IJ}$	.	$p_1^{IJ*}x_{1N}^{IJ}$	$p_1^{IU*}x_{11}^{IU}$	.	$p_1^{IU*}x_{1N}^{IU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{II*}x_{N1}^{II}$	.	$p_N^{II*}x_{NN}^{II}$	$p_N^{IM*}x_{N1}^{IM}$	.	$p_N^{IM*}x_{NN}^{IM}$	$p_N^{IP*}x_{N1}^{IP}$	.	$p_N^{IP*}x_{NN}^{IP}$	$p_N^{IS*}x_{N1}^{IS}$	.	$p_N^{IS*}x_{NN}^{IS}$	$p_N^{IT*}x_{N1}^{IT}$	.	$p_N^{IT*}x_{NN}^{IT}$	$p_N^{IC*}x_{N1}^{IC}$	.	$p_N^{IC*}x_{NN}^{IC}$	$p_N^{IW*}x_{N1}^{IW}$	.	$p_N^{IW*}x_{NN}^{IW}$	$p_N^{IK*}x_{N1}^{IK}$	.	$p_N^{IK*}x_{NN}^{IK}$	$p_N^{IJ*}x_{N1}^{IJ}$	.	$p_N^{IJ*}x_{NN}^{IJ}$	$p_N^{IU*}x_{N1}^{IU}$	.	$p_N^{IU*}x_{NN}^{IU}$
Malaysia	**sector 1**	$p_1^{MI*}x_{11}^{MI}$	.	$p_1^{MI*}x_{1N}^{MI}$	$p_1^{MM*}x_{11}^{MM}$	.	$p_1^{MM*}x_{1N}^{MM}$	$p_1^{MP*}x_{11}^{MP}$	.	$p_1^{MP*}x_{1N}^{MP}$	$p_1^{MS*}x_{11}^{MS}$	.	$p_1^{MS*}x_{1N}^{MS}$	$p_1^{MT*}x_{11}^{MT}$	.	$p_1^{MT*}x_{1N}^{MT}$	$p_1^{MC*}x_{11}^{MC}$	.	$p_1^{MC*}x_{1N}^{MC}$	$p_1^{MW*}x_{11}^{MW}$	.	$p_1^{MW*}x_{1N}^{MW}$	$p_1^{MK*}x_{11}^{MK}$	.	$p_1^{MK*}x_{1N}^{MK}$	$p_1^{MJ*}x_{11}^{MJ}$	.	$p_1^{MJ*}x_{1N}^{MJ}$	$p_1^{MU*}x_{11}^{MU}$	.	$p_1^{MU*}x_{1N}^{MU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{MI*}x_{N1}^{MI}$	.	$p_N^{MI*}x_{NN}^{MI}$	$p_N^{MM*}x_{N1}^{MM}$	.	$p_N^{MM*}x_{NN}^{MM}$	$p_N^{MP*}x_{N1}^{MP}$	.	$p_N^{MP*}x_{NN}^{MP}$	$p_N^{MS*}x_{N1}^{MS}$	.	$p_N^{MS*}x_{NN}^{MS}$	$p_N^{MT*}x_{N1}^{MT}$	.	$p_N^{MT*}x_{NN}^{MT}$	$p_N^{MC*}x_{N1}^{MC}$	.	$p_N^{MC*}x_{NN}^{MC}$	$p_N^{MW*}x_{N1}^{MW}$	.	$p_N^{MW*}x_{NN}^{MW}$	$p_N^{MK*}x_{N1}^{MK}$	.	$p_N^{MK*}x_{NN}^{MK}$	$p_N^{MJ*}x_{N1}^{MJ}$	.	$p_N^{MJ*}x_{NN}^{MJ}$	$p_N^{MU*}x_{N1}^{MU}$	.	$p_N^{MU*}x_{NN}^{MU}$
Philippines	**sector 1**	$p_1^{PI*}x_{11}^{PI}$	.	$p_1^{PI*}x_{1N}^{PI}$	$p_1^{PM*}x_{11}^{PM}$	.	$p_1^{PM*}x_{1N}^{PM}$	$p_1^{PP*}x_{11}^{PP}$	.	$p_1^{PP*}x_{1N}^{PP}$	$p_1^{PS*}x_{11}^{PS}$	.	$p_1^{PS*}x_{1N}^{PS}$	$p_1^{PT*}x_{11}^{PT}$	.	$p_1^{PT*}x_{1N}^{PT}$	$p_1^{PC*}x_{11}^{PC}$	.	$p_1^{PC*}x_{1N}^{PC}$	$p_1^{PW*}x_{11}^{PW}$	.	$p_1^{PW*}x_{1N}^{PW}$	$p_1^{PK*}x_{11}^{PK}$	.	$p_1^{PK*}x_{1N}^{PK}$	$p_1^{PJ*}x_{11}^{PJ}$	.	$p_1^{PJ*}x_{1N}^{PJ}$	$p_1^{PU*}x_{11}^{PU}$	.	$p_1^{PU*}x_{1N}^{PU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{PI*}x_{N1}^{PI}$	.	$p_N^{PI*}x_{NN}^{PI}$	$p_N^{PM*}x_{N1}^{PM}$	.	$p_N^{PM*}x_{NN}^{PM}$	$p_N^{PP*}x_{N1}^{PP}$	.	$p_N^{PP*}x_{NN}^{PP}$	$p_N^{PS*}x_{N1}^{PS}$	.	$p_N^{PS*}x_{NN}^{PS}$	$p_N^{PT*}x_{N1}^{PT}$	.	$p_N^{PT*}x_{NN}^{PT}$	$p_N^{PC*}x_{N1}^{PC}$	.	$p_N^{PC*}x_{NN}^{PC}$	$p_N^{PW*}x_{N1}^{PW}$	.	$p_N^{PW*}x_{NN}^{PW}$	$p_N^{PK*}x_{N1}^{PK}$	.	$p_N^{PK*}x_{NN}^{PK}$	$p_N^{PJ*}x_{N1}^{PJ}$	.	$p_N^{PJ*}x_{NN}^{PJ}$	$p_N^{PU*}x_{N1}^{PU}$	.	$p_N^{PU*}x_{NN}^{PU}$
Singapore	**sector 1**	$p_1^{SI*}x_{11}^{SI}$	.	$p_1^{SI*}x_{1N}^{SI}$	$p_1^{SM*}x_{11}^{SM}$	.	$p_1^{SM*}x_{1N}^{SM}$	$p_1^{SP*}x_{11}^{SP}$	.	$p_1^{SP*}x_{1N}^{SP}$	$p_1^{SS*}x_{11}^{SS}$	.	$p_1^{SS*}x_{1N}^{SS}$	$p_1^{ST*}x_{11}^{ST}$	.	$p_1^{ST*}x_{1N}^{ST}$	$p_1^{SC*}x_{11}^{SC}$	.	$p_1^{SC*}x_{1N}^{SC}$	$p_1^{SW*}x_{11}^{SW}$	.	$p_1^{SW*}x_{1N}^{SW}$	$p_1^{SK*}x_{11}^{SK}$	.	$p_1^{SK*}x_{1N}^{SK}$	$p_1^{SJ*}x_{11}^{SJ}$	.	$p_1^{SJ*}x_{1N}^{SJ}$	$p_1^{SU*}x_{11}^{SU}$	.	$p_1^{SU*}x_{1N}^{SU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{SI*}x_{N1}^{SI}$	.	$p_N^{SI*}x_{NN}^{SI}$	$p_N^{SM*}x_{N1}^{SM}$	.	$p_N^{SM*}x_{NN}^{SM}$	$p_N^{SP*}x_{N1}^{SP}$	.	$p_N^{SP*}x_{NN}^{SP}$	$p_N^{SS*}x_{N1}^{SS}$	.	$p_N^{SS*}x_{NN}^{SS}$	$p_N^{ST*}x_{N1}^{ST}$	.	$p_N^{ST*}x_{NN}^{ST}$	$p_N^{SC*}x_{N1}^{SC}$	.	$p_N^{SC*}x_{NN}^{SC}$	$p_N^{SW*}x_{N1}^{SW}$	.	$p_N^{SW*}x_{NN}^{SW}$	$p_N^{SK*}x_{N1}^{SK}$	.	$p_N^{SK*}x_{NN}^{SK}$	$p_N^{SJ*}x_{N1}^{SJ}$	.	$p_N^{SJ*}x_{NN}^{SJ}$	$p_N^{SU*}x_{N1}^{SU}$	.	$p_N^{SU*}x_{NN}^{SU}$
Thailand	**sector 1**	$p_1^{TI*}x_{11}^{TI}$	.	$p_1^{TI*}x_{1N}^{TI}$	$p_1^{TM*}x_{11}^{TM}$	.	$p_1^{TM*}x_{1N}^{TM}$	$p_1^{TP*}x_{11}^{TP}$	.	$p_1^{TP*}x_{1N}^{TP}$	$p_1^{TS*}x_{11}^{TS}$	.	$p_1^{TS*}x_{1N}^{TS}$	$p_1^{TT*}x_{11}^{TT}$	.	$p_1^{TT*}x_{1N}^{TT}$	$p_1^{TC*}x_{11}^{TC}$	.	$p_1^{TC*}x_{1N}^{TC}$	$p_1^{TW*}x_{11}^{TW}$	.	$p_1^{TW*}x_{1N}^{TW}$	$p_1^{TK*}x_{11}^{TK}$	.	$p_1^{TK*}x_{1N}^{TK}$	$p_1^{TJ*}x_{11}^{TJ}$	.	$p_1^{TJ*}x_{1N}^{TJ}$	$p_1^{TU*}x_{11}^{TU}$	.	$p_1^{TU*}x_{1N}^{TU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{TI*}x_{N1}^{TI}$	.	$p_N^{TI*}x_{NN}^{TI}$	$p_N^{TM*}x_{N1}^{TM}$	.	$p_N^{TM*}x_{NN}^{TM}$	$p_N^{TP*}x_{N1}^{TP}$	.	$p_N^{TP*}x_{NN}^{TP}$	$p_N^{TS*}x_{N1}^{TS}$	.	$p_N^{TS*}x_{NN}^{TS}$	$p_N^{TT*}x_{N1}^{TT}$	.	$p_N^{TT*}x_{NN}^{TT}$	$p_N^{TC*}x_{N1}^{TC}$	.	$p_N^{TC*}x_{NN}^{TC}$	$p_N^{TW*}x_{N1}^{TW}$	.	$p_N^{TW*}x_{NN}^{TW}$	$p_N^{TK*}x_{N1}^{TK}$	.	$p_N^{TK*}x_{NN}^{TK}$	$p_N^{TJ*}x_{N1}^{TJ}$	.	$p_N^{TJ*}x_{NN}^{TJ}$	$p_N^{TU*}x_{N1}^{TU}$	.	$p_N^{TU*}x_{NN}^{TU}$
China	**sector 1**	$p_1^{CI*}x_{11}^{CI}$	.	$p_1^{CI*}x_{1N}^{CI}$	$p_1^{CM*}x_{11}^{CM}$	.	$p_1^{CM*}x_{1N}^{CM}$	$p_1^{CP*}x_{11}^{CP}$	.	$p_1^{CP*}x_{1N}^{CP}$	$p_1^{CS*}x_{11}^{CS}$	.	$p_1^{CS*}x_{1N}^{CS}$	$p_1^{CT*}x_{11}^{CT}$	.	$p_1^{CT*}x_{1N}^{CT}$	$p_1^{CC*}x_{11}^{CC}$	.	$p_1^{CC*}x_{1N}^{CC}$	$p_1^{CW*}x_{11}^{CW}$	.	$p_1^{CW*}x_{1N}^{CW}$	$p_1^{CK*}x_{11}^{CK}$	.	$p_1^{CK*}x_{1N}^{CK}$	$p_1^{CJ*}x_{11}^{CJ}$	.	$p_1^{CJ*}x_{1N}^{CJ}$	$p_1^{CU*}x_{11}^{CU}$	.	$p_1^{CU*}x_{1N}^{CU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{CI*}x_{N1}^{CI}$	.	$p_N^{CI*}x_{NN}^{CI}$	$p_N^{CM*}x_{N1}^{CM}$	.	$p_N^{CM*}x_{NN}^{CM}$	$p_N^{CP*}x_{N1}^{CP}$	.	$p_N^{CP*}x_{NN}^{CP}$	$p_N^{CS*}x_{N1}^{CS}$	.	$p_N^{CS*}x_{NN}^{CS}$	$p_N^{CT*}x_{N1}^{CT}$	.	$p_N^{CT*}x_{NN}^{CT}$	$p_N^{CC*}x_{N1}^{CC}$	.	$p_N^{CC*}x_{NN}^{CC}$	$p_N^{CW*}x_{N1}^{CW}$	.	$p_N^{CW*}x_{NN}^{CW}$	$p_N^{CK*}x_{N1}^{CK}$	.	$p_N^{CK*}x_{NN}^{CK}$	$p_N^{CJ*}x_{N1}^{CJ}$	.	$p_N^{CJ*}x_{NN}^{CJ}$	$p_N^{CU*}x_{N1}^{CU}$	.	$p_N^{CU*}x_{NN}^{CU}$
Taiwan	**sector 1**	$p_1^{WT*}x_{11}^{WI}$	.	$p_1^{WI*}x_{1N}^{WI}$	$p_1^{WM*}x_{11}^{WM}$	.	$p_1^{WM*}x_{1N}^{WM}$	$p_1^{WP*}x_{11}^{WP}$	.	$p_1^{WP*}x_{1N}^{WP}$	$p_1^{WS*}x_{11}^{WS}$	.	$p_1^{WS*}x_{1N}^{WS}$	$p_1^{WT*}x_{11}^{WT}$	.	$p_1^{WT*}x_{1N}^{WT}$	$p_1^{WT*}x_{11}^{WT}$	.	$p_1^{WT*}x_{1N}^{WT}$	$p_1^{WW*}x_{11}^{WW}$	.	$p_1^{WW*}x_{1N}^{WW}$	$p_1^{WK*}x_{11}^{WK}$	.	$p_1^{WK*}x_{1N}^{WK}$	$p_1^{WJ*}x_{11}^{WJ}$	.	$p_1^{WJ*}x_{1N}^{WJ}$	$p_1^{WU*}x_{11}^{WU}$	.	$p_1^{WU*}x_{1N}^{WU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{WT*}x_{N1}^{WI}$	.	$p_N^{WI*}x_{NN}^{WI}$	$p_N^{WM*}x_{N1}^{WM}$	.	$p_N^{WM*}x_{NN}^{WM}$	$p_N^{WP*}x_{N1}^{WP}$	.	$p_N^{WP*}x_{NN}^{WP}$	$p_N^{WS*}x_{N1}^{WS}$	.	$p_N^{WS*}x_{NN}^{WS}$	$p_N^{WT*}x_{N1}^{WT}$	.	$p_N^{WT*}x_{NN}^{WT}$	$p_N^{WC*}x_{N1}^{WC}$	.	$p_N^{WC*}x_{NN}^{WC}$	$p_N^{WW*}x_{N1}^{WW}$	.	$p_N^{WW*}x_{NN}^{WW}$	$p_N^{WK*}x_{N1}^{WK}$	.	$p_N^{WK*}x_{NN}^{WK}$	$p_N^{WJ*}x_{N1}^{WJ}$	.	$p_N^{WJ*}x_{NN}^{WJ}$	$p_N^{WU*}x_{N1}^{WU}$	.	$p_N^{WU*}x_{NN}^{WU}$
Korea	**sector 1**	$p_1^{KI*}x_{11}^{KI}$	.	$p_1^{KI*}x_{1N}^{KI}$	$p_1^{KM*}x_{11}^{KM}$	.	$p_1^{KM*}x_{1N}^{KM}$	$p_1^{KP*}x_{11}^{KP}$	.	$p_1^{KP*}x_{1N}^{KP}$	$p_1^{KS*}x_{11}^{KS}$	.	$p_1^{KS*}x_{1N}^{KS}$	$p_1^{KT*}x_{11}^{KT}$	.	$p_1^{KT*}x_{1N}^{KT}$	$p_1^{KC*}x_{11}^{KC}$	.	$p_1^{KC*}x_{1N}^{KC}$	$p_1^{KW*}x_{11}^{KW}$	.	$p_1^{KW*}x_{1N}^{KW}$	$p_1^{KK*}x_{11}^{KK}$	.	$p_1^{KK*}x_{1N}^{KK}$	$p_1^{KJ*}x_{11}^{KJ}$	.	$p_1^{KJ*}x_{1N}^{KJ}$	$p_1^{KU*}x_{11}^{KU}$	.	$p_1^{KU*}x_{1N}^{KU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{KI*}x_{N1}^{KI}$	.	$p_N^{KI*}x_{NN}^{KI}$	$p_N^{KM*}x_{N1}^{KM}$	.	$p_N^{KM*}x_{NN}^{KM}$	$p_N^{KP*}x_{N1}^{KP}$	.	$p_N^{KP*}x_{NN}^{KP}$	$p_N^{KS*}x_{N1}^{KS}$	.	$p_N^{KS*}x_{NN}^{KS}$	$p_N^{KT*}x_{N1}^{KT}$	.	$p_N^{KT*}x_{NN}^{KT}$	$p_N^{KC*}x_{N1}^{KC}$	.	$p_N^{KC*}x_{NN}^{KC}$	$p_N^{KW*}x_{N1}^{KW}$	.	$p_N^{KW*}x_{NN}^{KW}$	$p_N^{KK*}x_{N1}^{KK}$	.	$p_N^{KK*}x_{NN}^{KK}$	$p_N^{KJ*}x_{N1}^{KJ}$	.	$p_N^{KJ*}x_{NN}^{KJ}$	$p_N^{KU*}x_{N1}^{KU}$	.	$p_N^{KU*}x_{NN}^{KU}$
Japan	**sector 1**	$p_1^{JI*}x_{11}^{JI}$	.	$p_1^{JI*}x_{1N}^{JI}$	$p_1^{JM*}x_{11}^{JM}$	.	$p_1^{JM*}x_{1N}^{JM}$	$p_1^{JP*}x_{11}^{JP}$	.	$p_1^{JP*}x_{1N}^{JP}$	$p_1^{JS*}x_{11}^{JS}$	.	$p_1^{JS*}x_{1N}^{JS}$	$p_1^{JT*}x_{11}^{JT}$	.	$p_1^{JT*}x_{1N}^{JT}$	$p_1^{JC*}x_{11}^{JC}$	.	$p_1^{JC*}x_{1N}^{JC}$	$p_1^{JW*}x_{11}^{JW}$	.	$p_1^{JW*}x_{1N}^{JW}$	$p_1^{JK*}x_{11}^{JK}$	.	$p_1^{JK*}x_{1N}^{JK}$	$p_1^{JJ*}x_{11}^{JJ}$	.	$p_1^{JJ*}x_{1N}^{JJ}$	$p_1^{JU*}x_{11}^{JU}$	.	$p_1^{JU*}x_{1N}^{JU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{JI*}x_{N1}^{JI}$	.	$p_N^{JI*}x_{NN}^{JI}$	$p_N^{JM*}x_{N1}^{JM}$	.	$p_N^{JM*}x_{NN}^{JM}$	$p_N^{JP*}x_{N1}^{JP}$	.	$p_N^{JP*}x_{NN}^{JP}$	$p_N^{JS*}x_{N1}^{JS}$	.	$p_N^{JS*}x_{NN}^{JS}$	$p_N^{JT*}x_{N1}^{JT}$	.	$p_N^{JT*}x_{NN}^{JT}$	$p_N^{JC*}x_{N1}^{JC}$	.	$p_N^{JC*}x_{NN}^{JC}$	$p_N^{JW*}x_{N1}^{JW}$	.	$p_N^{JW*}x_{NN}^{JW}$	$p_N^{JK*}x_{N1}^{JK}$	.	$p_N^{JK*}x_{NN}^{JK}$	$p_N^{JJ*}x_{N1}^{JJ}$	.	$p_N^{JJ*}x_{NN}^{JJ}$	$p_N^{JU*}x_{N1}^{JU}$	.	$p_N^{JU*}x_{NN}^{JU}$
US	**sector 1**	$p_1^{UI*}x_{11}^{UI}$	.	$p_1^{UI*}x_{1N}^{UI}$	$p_1^{UM*}x_{11}^{UM}$	.	$p_1^{UM*}x_{1N}^{UM}$	$p_1^{UP*}x_{11}^{UP}$	.	$p_1^{UP*}x_{1N}^{UP}$	$p_1^{US*}x_{11}^{US}$	.	$p_1^{US*}x_{1N}^{US}$	$p_1^{UT*}x_{11}^{UT}$	.	$p_1^{UT*}x_{1N}^{UT}$	$p_1^{UC*}x_{11}^{UC}$	.	$p_1^{UC*}x_{1N}^{UC}$	$p_1^{UW*}x_{11}^{UW}$	.	$p_1^{UW*}x_{1N}^{UW}$	$p_1^{UK*}x_{11}^{UK}$	.	$p_1^{UK*}x_{1N}^{UK}$	$p_1^{UK*}x_{11}^{UK}$	.	$p_1^{UK*}x_{1N}^{UK}$	$p_1^{UU*}x_{11}^{UU}$	.	$p_1^{UU*}x_{1N}^{UU}$
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	$p_N^{UI*}x_{N1}^{UI}$	.	$p_N^{UI*}x_{NN}^{UI}$	$p_N^{UM*}x_{N1}^{UM}$	.	$p_N^{UM*}x_{NN}^{UM}$	$p_N^{UP*}x_{N1}^{UP}$	.	$p_N^{UP*}x_{NN}^{UP}$	$p_N^{US*}x_{N1}^{US}$	.	$p_N^{US*}x_{NN}^{US}$	$p_N^{UT*}x_{N1}^{UT}$	.	$p_N^{UT*}x_{NN}^{UT}$	$p_N^{UC*}x_{N1}^{UC}$	.	$p_N^{UC*}x_{NN}^{UC}$	$p_N^{UW*}x_{N1}^{UW}$	.	$p_N^{UW*}x_{NN}^{UW}$	$p_N^{UK*}x_{N1}^{UK}$	.	$p_N^{UK*}x_{NN}^{UK}$	$p_N^{UJ*}x_{N1}^{UJ}$	.	$p_N^{UJ*}x_{NN}^{UJ}$	$p_N^{UU*}x_{N1}^{UU}$	.	$p_N^{UU*}x_{NN}^{UU}$
wage		$w_1^I L_1^I$	.	$w_N^I L_N^I$	$w_1^M L_1^M$	.	$w_N^M L_N^M$	$w_1^P L_1^P$	.	$w_N^P L_N^P$	$w_1^S L_1^S$	.	$w_N^S L_N^S$	$w_1^T L_1^T$	.	$w_N^T L_N^T$	$w_1^C L_1^C$	.	$w_N^C L_N^C$	$w_1^W L_1^W$	.	$w_N^W L_N^W$	$w_1^K L_1^K$	.	$w_N^K L_N^K$	$w_1^J L_1^J$	.	$w_N^J L_N^J$	$w_1^U L_1^U$	.	$w_N^U L_N^U$
production		$p_1^I XX_1^I$	.	$p_N^I XX_N^I$	$p_1^M XX_1^M$	.	$p_N^M XX_N^M$	$p_1^P XX_1^P$	.	$p_N^P XX_N^P$	$p_1^S XX_1^S$	.	$p_N^S XX_N^S$	$p_1^T XX_1^T$	.	$p_N^T XX_N^T$	$p_1^C XX_1^C$	.	$p_N^C XX_N^C$	$p_1^W XX_1^W$	.	$p_N^W XX_N^W$	$p_1^K XX_1^K$	.	$p_N^K XX_N^K$	$p_1^J XX_1^J$	.	$p_N^J XX_N^J$	$p_1^U XX_1^U$	.	$p_N^U XX_N^U$
local currency	.	**Rupiah**	.	**Rupiah**	**Ringgit**	.	**Ringgit**	**Piso**	.	**Piso**	**Singapore Dollar**	.	**Singapore Dollar**	**Baht**	.	**Baht**	**Yuan**	.	**Yuan**	**Taiwan Dollar**	.	**Taiwan Dollar**	**Won**	.	**Won**	**Yen**	.	**Yen**	**Dollar**	.	**Dollar**

Table 3 Layout of Demand Side: Final Demand unit=local currency in constant price

		Private Consumption									
		Indonesia	Malasia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	US
Indonesia	sector 1	CP^{II}_{1}	CP^{IM}_{1}	CP^{IP}_{1}	CP^{IS}_{1}	CP^{IT}_{1}	CP^{IC}_{1}	CP^{IW}_{1}	CP^{IK}_{1}	CP^{IJ}_{1}	CP^{IU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{II}_{N}	CP^{IM}_{N}	CP^{IP}_{N}	CP^{IS}_{N}	CP^{IT}_{N}	CP^{IC}_{N}	CP^{IW}_{N}	CP^{IK}_{N}	CP^{IJ}_{N}	CP^{IU}_{N}
Malaysia	sector 1	CP^{MI}_{1}	CP^{MM}_{1}	CP^{MP}_{1}	CP^{MS}_{1}	CP^{MT}_{1}	CP^{MC}_{1}	CP^{MW}_{1}	CP^{MK}_{1}	CP^{MJ}_{1}	CP^{MU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{MI}_{N}	CP^{MM}_{N}	CP^{MP}_{N}	CP^{MS}_{N}	CP^{MT}_{N}	CP^{MC}_{N}	CP^{MW}_{N}	CP^{MK}_{N}	CP^{MJ}_{N}	CP^{MU}_{N}
Philippines	sector 1	CP^{PI}_{1}	CP^{PM}_{1}	CP^{PP}_{1}	CP^{PS}_{1}	CP^{PT}_{1}	CP^{PC}_{1}	CP^{PW}_{1}	CP^{PK}_{1}	CP^{PJ}_{1}	CP^{PU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{PI}_{N}	CP^{PM}_{N}	CP^{PP}_{N}	CP^{PS}_{N}	CP^{PT}_{N}	CP^{PC}_{N}	CP^{PW}_{N}	CP^{PK}_{N}	CP^{PJ}_{N}	CP^{PU}_{N}
Singapore	sector 1	CP^{SI}_{1}	CP^{SM}_{1}	CP^{SP}_{1}	CP^{SS}_{1}	CP^{ST}_{1}	CP^{SC}_{1}	CP^{SW}_{1}	CP^{SK}_{1}	CP^{SJ}_{1}	CP^{SU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{SI}_{N}	CP^{SM}_{N}	CP^{SP}_{N}	CP^{SS}_{N}	CP^{ST}_{N}	CP^{SC}_{N}	CP^{SW}_{N}	CP^{SK}_{N}	CP^{SJ}_{N}	CP^{SU}_{N}
Thailand	sector 1	CP^{TI}_{1}	CP^{TM}_{1}	CP^{TP}_{1}	CP^{TS}_{1}	CP^{TT}_{1}	CP^{TC}_{1}	CP^{TW}_{1}	CP^{TK}_{1}	CP^{TJ}_{1}	CP^{TU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{TI}_{N}	CP^{TM}_{N}	CP^{TP}_{N}	CP^{TS}_{N}	CP^{TT}_{N}	CP^{TC}_{N}	CP^{TW}_{N}	CP^{TK}_{N}	CP^{TJ}_{N}	CP^{TU}_{N}
China	sector 1	CP^{CI}_{1}	CP^{CM}_{1}	CP^{CP}_{1}	CP^{CS}_{1}	CP^{CT}_{1}	CP^{CC}_{1}	CP^{CW}_{1}	CP^{CK}_{1}	CP^{CJ}_{1}	CP^{CU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{CI}_{N}	CP^{CM}_{N}	CP^{CP}_{N}	CP^{CS}_{N}	CP^{CT}_{N}	CP^{CC}_{N}	CP^{CW}_{N}	CP^{CK}_{N}	CP^{CJ}_{N}	CP^{CU}_{N}
Taiwan	sector 1	CP^{WI}_{1}	CP^{WM}_{1}	CP^{WP}_{1}	CP^{WS}_{1}	CP^{WT}_{1}	CP^{WC}_{1}	CP^{WW}_{1}	CP^{WK}_{1}	CP^{WJ}_{1}	CP^{WU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{WI}_{N}	CP^{WM}_{N}	CP^{WP}_{N}	CP^{WS}_{N}	CP^{WT}_{N}	CP^{WC}_{N}	CP^{WW}_{N}	CP^{WK}_{N}	CP^{WJ}_{N}	CP^{WU}_{N}
Korea	sector 1	CP^{KI}_{1}	CP^{KM}_{1}	CP^{KP}_{1}	CP^{KS}_{1}	CP^{KT}_{1}	CP^{KC}_{1}	CP^{KW}_{1}	CP^{KK}_{1}	CP^{KJ}_{1}	CP^{KU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{KI}_{N}	CP^{KM}_{N}	CP^{KP}_{N}	CP^{KS}_{N}	CP^{KT}_{N}	CP^{KC}_{N}	CP^{KW}_{N}	CP^{KK}_{N}	CP^{KJ}_{N}	CP^{KU}_{N}
Japan	sector 1	CP^{JI}_{1}	CP^{JM}_{1}	CP^{JP}_{1}	CP^{JS}_{1}	CP^{JT}_{1}	CP^{JC}_{1}	CP^{JW}_{1}	CP^{JK}_{1}	CP^{JJ}_{1}	CP^{JU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{JI}_{N}	CP^{JM}_{N}	CP^{JP}_{N}	CP^{JS}_{N}	CP^{JT}_{N}	CP^{JC}_{N}	CP^{JW}_{N}	CP^{JK}_{N}	CP^{JJ}_{N}	CP^{JU}_{N}
US	sector 1	CP^{UI}_{1}	CP^{UM}_{1}	CP^{UP}_{1}	CP^{US}_{1}	CP^{UT}_{1}	CP^{UC}_{1}	CP^{UW}_{1}	CP^{UK}_{1}	CP^{UJ}_{1}	CP^{UU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	CP^{UI}_{N}	CP^{UM}_{N}	CP^{UP}_{N}	CP^{US}_{N}	CP^{UT}_{N}	CP^{UC}_{N}	CP^{UW}_{N}	CP^{UK}_{N}	CP^{UJ}_{N}	CP^{UU}_{N}

		Government Expenditure									
		Indonesia	Malasia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	US
Indonesia	sector 1	G^{II}_{1}	G^{IM}_{1}	G^{IP}_{1}	G^{IS}_{1}	G^{IT}_{1}	G^{IC}_{1}	G^{IW}_{1}	G^{IK}_{1}	G^{IJ}_{1}	G^{IU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{II}_{N}	G^{IM}_{N}	G^{IP}_{N}	G^{IS}_{N}	G^{IT}_{N}	G^{IC}_{N}	G^{IW}_{N}	G^{IK}_{N}	G^{IJ}_{N}	G^{IU}_{N}
Malaysia	sector 1	G^{MI}_{1}	G^{MM}_{1}	G^{MP}_{1}	G^{MS}_{1}	G^{MT}_{1}	G^{MC}_{1}	G^{MW}_{1}	G^{MK}_{1}	G^{MJ}_{1}	G^{MU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{MI}_{N}	G^{MM}_{N}	G^{MP}_{N}	G^{MS}_{N}	G^{MT}_{N}	G^{MC}_{N}	G^{MW}_{N}	G^{MK}_{N}	G^{MJ}_{N}	G^{MU}_{N}
Philippines	sector 1	G^{PI}_{1}	G^{PM}_{1}	G^{PP}_{1}	G^{PS}_{1}	G^{PT}_{1}	G^{PC}_{1}	G^{PW}_{1}	G^{PK}_{1}	G^{PJ}_{1}	G^{PU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{PI}_{N}	G^{PM}_{N}	G^{PP}_{N}	G^{PS}_{N}	G^{PT}_{N}	G^{PC}_{N}	G^{PW}_{N}	G^{PK}_{N}	G^{PJ}_{N}	G^{PU}_{N}
Singapore	sector 1	G^{SI}_{1}	G^{SM}_{1}	G^{SP}_{1}	G^{SS}_{1}	G^{ST}_{1}	G^{SC}_{1}	G^{SW}_{1}	G^{SK}_{1}	G^{SJ}_{1}	G^{SU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{SI}_{N}	G^{SM}_{N}	G^{SP}_{N}	G^{SS}_{N}	G^{ST}_{N}	G^{SC}_{N}	G^{SW}_{N}	G^{SK}_{N}	G^{SJ}_{N}	G^{SU}_{N}
Thailand	sector 1	G^{TI}_{1}	G^{TM}_{1}	G^{TP}_{1}	G^{TS}_{1}	G^{TT}_{1}	G^{TC}_{1}	G^{TW}_{1}	G^{TK}_{1}	G^{TJ}_{1}	G^{TU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{TI}_{N}	G^{TM}_{N}	G^{TP}_{N}	G^{TS}_{N}	G^{TT}_{N}	G^{TC}_{N}	G^{TW}_{N}	G^{TK}_{N}	G^{TJ}_{N}	G^{TU}_{N}
China	sector 1	G^{CI}_{1}	G^{CM}_{1}	G^{CP}_{1}	G^{CS}_{1}	G^{CT}_{1}	G^{CC}_{1}	G^{CW}_{1}	G^{CK}_{1}	G^{CJ}_{1}	G^{CU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{CI}_{N}	G^{CM}_{N}	G^{CP}_{N}	G^{CS}_{N}	G^{CT}_{N}	G^{CC}_{N}	G^{CW}_{N}	G^{CK}_{N}	G^{CJ}_{N}	G^{CU}_{N}
Taiwan	sector 1	G^{WI}_{1}	G^{WM}_{1}	G^{WP}_{1}	G^{WS}_{1}	G^{WT}_{1}	G^{WC}_{1}	G^{WW}_{1}	G^{WK}_{1}	G^{WJ}_{1}	G^{WU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{WI}_{N}	G^{WM}_{N}	G^{WP}_{N}	G^{WS}_{N}	G^{WT}_{N}	G^{WC}_{N}	G^{WW}_{N}	G^{WK}_{N}	G^{WJ}_{N}	G^{WU}_{N}
Korea	sector 1	G^{KI}_{1}	G^{KM}_{1}	G^{KP}_{1}	G^{KS}_{1}	G^{KT}_{1}	G^{KC}_{1}	G^{KW}_{1}	G^{KK}_{1}	G^{KJ}_{1}	G^{KU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{KI}_{N}	G^{KM}_{N}	G^{KP}_{N}	G^{KS}_{N}	G^{KT}_{N}	G^{KC}_{N}	G^{KW}_{N}	G^{KK}_{N}	G^{KJ}_{N}	G^{KU}_{N}
Japan	sector 1	G^{JI}_{1}	G^{JM}_{1}	G^{JP}_{1}	G^{JS}_{1}	G^{JT}_{1}	G^{JC}_{1}	G^{JW}_{1}	G^{JK}_{1}	G^{JJ}_{1}	G^{JU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{JI}_{N}	G^{JM}_{N}	G^{JP}_{N}	G^{JS}_{N}	G^{JT}_{N}	G^{JC}_{N}	G^{JW}_{N}	G^{JK}_{N}	G^{JJ}_{N}	G^{JU}_{N}
US	sector 1	G^{UI}_{1}	G^{UM}_{1}	G^{UP}_{1}	G^{US}_{1}	G^{UT}_{1}	G^{UC}_{1}	G^{UW}_{1}	G^{UK}_{1}	G^{UJ}_{1}	G^{UU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	G^{UI}_{N}	G^{UM}_{N}	G^{UP}_{N}	G^{US}_{N}	G^{UT}_{N}	G^{UC}_{N}	G^{UW}_{N}	G^{UK}_{N}	G^{UJ}_{N}	G^{UU}_{N}

		Investment									
		Indonesia	Malasia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	US
Indonesia	sector 1	I^{II}_{1}	I^{IM}_{1}	I^{IP}_{1}	I^{IS}_{1}	I^{IT}_{1}	I^{IC}_{1}	I^{IW}_{1}	I^{IK}_{1}	I^{IJ}_{1}	I^{IU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{II}_{N}	I^{IM}_{N}	I^{IP}_{N}	I^{IS}_{N}	I^{IT}_{N}	I^{IC}_{N}	I^{IW}_{N}	I^{IK}_{N}	I^{IJ}_{N}	I^{IU}_{N}
Malaysia	sector 1	I^{MI}_{1}	I^{MM}_{1}	I^{MP}_{1}	I^{MS}_{1}	I^{MT}_{1}	I^{MC}_{1}	I^{MW}_{1}	I^{MK}_{1}	I^{MJ}_{1}	I^{MU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{MI}_{N}	I^{MM}_{N}	I^{MP}_{N}	I^{MS}_{N}	I^{MT}_{N}	I^{MC}_{N}	I^{MW}_{N}	I^{MK}_{N}	I^{MJ}_{N}	I^{MU}_{N}
Philippines	sector 1	I^{PI}_{1}	I^{PM}_{1}	I^{PP}_{1}	I^{PS}_{1}	I^{PT}_{1}	I^{PC}_{1}	I^{PW}_{1}	I^{PK}_{1}	I^{PJ}_{1}	I^{PU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{PI}_{N}	I^{PM}_{N}	I^{PP}_{N}	I^{PS}_{N}	I^{PT}_{N}	I^{PC}_{N}	I^{PW}_{N}	I^{PK}_{N}	I^{PJ}_{N}	I^{PU}_{N}
Singapore	sector 1	I^{SI}_{1}	I^{SM}_{1}	I^{SP}_{1}	I^{SS}_{1}	I^{ST}_{1}	I^{SC}_{1}	I^{SW}_{1}	I^{SK}_{1}	I^{SJ}_{1}	I^{SU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{SI}_{N}	I^{SM}_{N}	I^{SP}_{N}	I^{SS}_{N}	I^{ST}_{N}	I^{SC}_{N}	I^{SW}_{N}	I^{SK}_{N}	I^{SJ}_{N}	I^{SU}_{N}
Thailand	sector 1	I^{TI}_{1}	I^{TM}_{1}	I^{TP}_{1}	I^{TS}_{1}	I^{TT}_{1}	I^{TC}_{1}	I^{TW}_{1}	I^{TK}_{1}	I^{TJ}_{1}	I^{TU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{TI}_{N}	I^{TM}_{N}	I^{TP}_{N}	I^{TS}_{N}	I^{TT}_{N}	I^{TC}_{N}	I^{TW}_{N}	I^{TK}_{N}	I^{TJ}_{N}	I^{TU}_{N}
China	sector 1	I^{CI}_{1}	I^{CM}_{1}	I^{CP}_{1}	I^{CS}_{1}	I^{CT}_{1}	I^{CC}_{1}	I^{CW}_{1}	I^{CK}_{1}	I^{CJ}_{1}	I^{CU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{CI}_{N}	I^{CM}_{N}	I^{CP}_{N}	I^{CS}_{N}	I^{CT}_{N}	I^{CC}_{N}	I^{CW}_{N}	I^{CK}_{N}	I^{CJ}_{N}	I^{CU}_{N}
Taiwan	sector 1	I^{WI}_{1}	I^{WM}_{1}	I^{WP}_{1}	I^{WS}_{1}	I^{WT}_{1}	I^{WC}_{1}	I^{WW}_{1}	I^{WK}_{1}	I^{WJ}_{1}	I^{WU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{WI}_{N}	I^{WM}_{N}	I^{WP}_{N}	I^{WS}_{N}	I^{WT}_{N}	I^{WC}_{N}	I^{WW}_{N}	I^{WK}_{N}	I^{WJ}_{N}	I^{WU}_{N}
Korea	sector 1	I^{KI}_{1}	I^{KM}_{1}	I^{KP}_{1}	I^{KS}_{1}	I^{KT}_{1}	I^{KC}_{1}	I^{KW}_{1}	I^{KK}_{1}	I^{KJ}_{1}	I^{KU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{KI}_{N}	I^{KM}_{N}	I^{KP}_{N}	I^{KS}_{N}	I^{KT}_{N}	I^{KC}_{N}	I^{KW}_{N}	I^{KK}_{N}	I^{KJ}_{N}	I^{KU}_{N}
Japan	sector 1	I^{JI}_{1}	I^{JM}_{1}	I^{JP}_{1}	I^{JS}_{1}	I^{JT}_{1}	I^{JC}_{1}	I^{JW}_{1}	I^{JK}_{1}	I^{JJ}_{1}	I^{JU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{JI}_{N}	I^{JM}_{N}	I^{JP}_{N}	I^{JS}_{N}	I^{JT}_{N}	I^{JC}_{N}	I^{JW}_{N}	I^{JK}_{N}	I^{JJ}_{N}	I^{JU}_{N}
US	sector 1	I^{UI}_{1}	I^{UM}_{1}	I^{UP}_{1}	I^{US}_{1}	I^{UT}_{1}	I^{UC}_{1}	I^{UW}_{1}	I^{UK}_{1}	I^{UJ}_{1}	I^{UU}_{1}
	.	.	.	.	.	.	.	.	.	.	.
	sector N	I^{UI}_{N}	I^{UM}_{N}	I^{UP}_{N}	I^{US}_{N}	I^{UT}_{N}	I^{UC}_{N}	I^{UW}_{N}	I^{UK}_{N}	I^{UJ}_{N}	I^{UU}_{N}

		Inventory Investment										Export	Statistical Discrepancy	Total Output	Local Currency
		Indonesia	Malasia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	US				
Indonesia	sector 1	IV^{II}_{1}	IV^{IM}_{1}	IV^{IP}_{1}	IV^{IS}_{1}	IV^{IT}_{1}	IV^{IC}_{1}	IV^{IW}_{1}	IV^{IK}_{1}	IV^{IJ}_{1}	IV^{IU}_{1}	EX^{I}_{1}	Q^{I}_{1}	XX^{I}_{1}	Rupiah
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{II}_{N}	IV^{IM}_{N}	IV^{IP}_{N}	IV^{IS}_{N}	IV^{IT}_{N}	IV^{IC}_{N}	IV^{IW}_{N}	IV^{IK}_{N}	IV^{IJ}_{N}	IV^{IU}_{N}	EX^{I}_{N}	Q^{I}_{N}	XX^{I}_{N}	Rupiah
Malaysia	sector 1	IV^{MI}_{1}	IV^{MM}_{1}	IV^{MP}_{1}	IV^{MS}_{1}	IV^{MT}_{1}	IV^{MC}_{1}	IV^{MW}_{1}	IV^{MK}_{1}	IV^{MJ}_{1}	IV^{MU}_{1}	EX^{M}_{1}	Q^{M}_{1}	XX^{M}_{1}	Ringgit
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{MI}_{N}	IV^{MM}_{N}	IV^{MP}_{N}	IV^{MS}_{N}	IV^{MT}_{N}	IV^{MC}_{N}	IV^{MW}_{N}	IV^{MK}_{N}	IV^{MJ}_{N}	IV^{MU}_{N}	EX^{M}_{N}	Q^{M}_{N}	XX^{M}_{N}	Ringgit
Philippines	sector 1	IV^{PI}_{1}	IV^{PM}_{1}	IV^{PP}_{1}	IV^{PS}_{1}	IV^{PT}_{1}	IV^{PC}_{1}	IV^{PW}_{1}	IV^{PK}_{1}	IV^{PJ}_{1}	IV^{PU}_{1}	EX^{P}_{1}	Q^{P}_{1}	XX^{P}_{1}	Piso
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{PI}_{N}	IV^{PM}_{N}	IV^{PP}_{N}	IV^{PS}_{N}	IV^{PT}_{N}	IV^{PC}_{N}	IV^{PW}_{N}	IV^{PK}_{N}	IV^{PJ}_{N}	IV^{PU}_{N}	EX^{P}_{N}	Q^{P}_{N}	EX^{P}_{N}	Piso
Singapore	sector 1	IV^{SI}_{1}	IV^{SM}_{1}	IV^{SP}_{1}	IV^{SS}_{1}	IV^{ST}_{1}	IV^{SC}_{1}	IV^{SW}_{1}	IV^{SK}_{1}	IV^{SJ}_{1}	IV^{SU}_{1}	EX^{S}_{1}	Q^{S}_{1}	XX^{S}_{1}	Singapore Dollar
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{SI}_{N}	IV^{SM}_{N}	IV^{SP}_{N}	IV^{SS}_{N}	IV^{ST}_{N}	IV^{SC}_{N}	IV^{SW}_{N}	IV^{SK}_{N}	IV^{SJ}_{N}	IV^{SU}_{N}	EX^{S}_{N}	Q^{S}_{N}	XX^{S}_{N}	Singapore Dollar
Thailand	sector 1	IV^{TI}_{1}	IV^{TM}_{1}	IV^{TP}_{1}	IV^{TS}_{1}	IV^{TT}_{1}	IV^{TC}_{1}	IV^{TW}_{1}	IV^{TK}_{1}	IV^{TJ}_{1}	IV^{TU}_{1}	EX^{T}_{1}	Q^{T}_{1}	XX^{T}_{1}	Baht
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{TI}_{N}	IV^{TM}_{N}	IV^{TP}_{N}	IV^{TS}_{N}	IV^{TT}_{N}	IV^{TC}_{N}	IV^{TW}_{N}	IV^{TK}_{N}	IV^{TJ}_{N}	IV^{TU}_{N}	EX^{T}_{N}	Q^{T}_{N}	XX^{T}_{N}	Baht
China	sector 1	IV^{CI}_{1}	IV^{CM}_{1}	IV^{CP}_{1}	IV^{CS}_{1}	IV^{CT}_{1}	IV^{CC}_{1}	IV^{CW}_{1}	IV^{CK}_{1}	IV^{CJ}_{1}	IV^{CU}_{1}	EX^{C}_{1}	Q^{C}_{1}	XX^{C}_{1}	Yuan
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{CI}_{N}	IV^{CM}_{N}	IV^{CP}_{N}	IV^{CS}_{N}	IV^{CT}_{N}	IV^{CC}_{N}	IV^{CW}_{N}	IV^{CK}_{N}	IV^{CJ}_{N}	IV^{CU}_{N}	EX^{C}_{N}	Q^{C}_{N}	XX^{C}_{N}	Yuan
Taiwan	sector 1	IV^{WI}_{1}	IV^{WM}_{1}	IV^{WP}_{1}	IV^{WS}_{1}	IV^{WT}_{1}	IV^{WC}_{1}	IV^{WW}_{1}	IV^{WK}_{1}	IV^{WJ}_{1}	IV^{WU}_{1}	EX^{W}_{1}	Q^{W}_{1}	XX^{W}_{1}	Taiwan Dollar
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{WI}_{N}	IV^{WM}_{N}	IV^{WP}_{N}	IV^{WS}_{N}	IV^{WT}_{N}	IV^{WC}_{N}	IV^{WW}_{N}	IV^{WK}_{N}	IV^{WJ}_{N}	IV^{WU}_{N}	EX^{W}_{N}	Q^{W}_{N}	XX^{W}_{N}	Taiwan Dollar
Korea	sector 1	IV^{KI}_{1}	IV^{KM}_{1}	IV^{KP}_{1}	IV^{KS}_{1}	IV^{KT}_{1}	IV^{KC}_{1}	IV^{KW}_{1}	IV^{KK}_{1}	IV^{KJ}_{1}	IV^{KU}_{1}	EX^{K}_{1}	Q^{K}_{1}	XX^{K}_{1}	Won
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{KI}_{N}	IV^{KM}_{N}	IV^{KP}_{N}	IV^{KS}_{N}	IV^{KT}_{N}	IV^{KC}_{N}	IV^{KW}_{N}	IV^{KK}_{N}	IV^{KJ}_{N}	IV^{KU}_{N}	EX^{K}_{N}	Q^{K}_{N}	XX^{K}_{N}	Won
Japan	sector 1	IV^{JI}_{1}	IV^{JM}_{1}	IV^{JP}_{1}	IV^{JS}_{1}	IV^{JT}_{1}	IV^{JC}_{1}	IV^{JW}_{1}	IV^{JK}_{1}	IV^{JJ}_{1}	IV^{JU}_{1}	EX^{J}_{1}	Q^{J}_{1}	XX^{J}_{1}	Yen
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{JI}_{N}	IV^{JM}_{N}	IV^{JP}_{N}	IV^{JS}_{N}	IV^{JT}_{N}	IV^{JC}_{N}	IV^{JW}_{N}	IV^{JK}_{N}	IV^{JJ}_{N}	IV^{JU}_{N}	EX^{J}_{N}	Q^{J}_{N}	XX^{J}_{N}	Yen
US	sector 1	IV^{UI}_{1}	IV^{UM}_{1}	IV^{UP}_{1}	IV^{US}_{1}	IV^{UT}_{1}	IV^{UC}_{1}	IV^{UW}_{1}	IV^{UK}_{1}	IV^{UJ}_{1}	IV^{UU}_{1}	EX^{U}_{1}	Q^{U}_{1}	XX^{U}_{1}	Dollar
	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	sector N	IV^{UI}_{N}	IV^{UM}_{N}	IV^{UP}_{N}	IV^{US}_{N}	IV^{UT}_{N}	IV^{UC}_{N}	IV^{UW}_{N}	IV^{UK}_{N}	IV^{UJ}_{N}	IV^{UU}_{N}	EX^{U}_{N}	Q^{U}_{N}	XX^{U}_{N}	Dollar