Impact of Asian Financial Liberalization using Asian International Input-Output Model

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ABSTRACT

This paper aims at measuring degree of international financial liberalization of nine Asian countries, as well as, evaluating its impact on sector output and economic growth. The study scopes on the nine Asian countries, which have been through or in process of financial liberalization. The nine Asian countries are Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Taiwan, Korea and Japan. The analysis integrates financial model with Asian International Input-Output model, in which change in degree of financial liberalization can transmit impact to real sector in international input-output model and impact on real sector can also interlink back to the financial model as well.

KEYWORDS: Financial Liberalization, International Input-Output Model, Asian countries

JEL CODES: C51(Model construction and estimation) , C53 (Forecasting and other model application)

1. Introduction

After Asian crisis, there has been widespread doubt about merit of international financial liberalization. This policy has been implemented since the late 1980's and was accused as one of causes of the crisis. Edwards (2001) assessed effect of financial liberalization on economic growth using cross-country data. The study estimated average real GDP growth using measure of financial openness and other variables that affect economic performance as explanatory variables. The study found that countries with higher degree of financial openness had higher economic growth than the ones with restricted capital mobility. In contrary, Vlachos and Waldenstrom (2005) evaluated impact of international financial liberalization at industrial level across countries. The study estimated industrial output growth as a function of (1) degree of external dependence (measure created by Rajan and Zingales: 1989) multiply by degree of financial liberalization, (2) degree of external dependence multiply by level financial development, and (3) other factors relating to industrial growth. The study found no higher growth on industries that highly depended on external financing in countries with higher degree of financial liberalization. Using aggregate or industrial level type of data yielded different results. The impact of international financial liberalization is still ambiguous and remains an issue for policy implication.

This study focuses on output at industrial level data as well as at national level using data of Asian international input-output tables developed by Institute of Developing Economies and Japan External Trade Organization (IDE-JETRO). The financial model consists of measure of

degree of international financial liberalization and relevant financial variables including interest rate, net capital flow, exchange rate, and expected exchange rate. Later, financial model is interlinked with Asian International Input-Output model and impact on industrial and aggregate output will be determined.

2. Measure of degree of international financial liberalization

Before considering impact of international financial liberalization, measure of degree of international financial liberalization should be clearly specified. Nevertheless, there are several approaches to measure degree of international financial liberalization. Firstly, *saving-investment correlation approach* was introduced by Feldstein and Horioka (1980). With perfect financial liberalization, there should be low correlation between domestic saving and domestic investment, as fund could move freely across countries to take advantage of investment opportunities. The study assessed relation between saving rate and investment rate using estimated equation (1).

$$\left(\frac{I}{Y}\right)_i = a + b\left(\frac{S}{Y}\right)_i \quad (1)$$

where $\left(\frac{I}{Y}\right)_i$ is ratio of domestic investment to GDP in country i and $\left(\frac{S}{Y}\right)_i$ is the ratio of domestic saving to GDP.

Secondly, *Interest Parity Conditions (IPC)* refers to equalization of expected return between domestic and foreign assets, see equation (2).

$$(1 + r_t) = E_t\left((1 + r_t^*) * (e_{t+1}/e_t)\right) \quad (2)$$

where r_t and r_t^* are the domestic and foreign interest rate rates respectively. e_t is exchange rate in term of domestic currency per U.S. dollar. (e_{t+1} refers to next period.) E_t is expectation operator. Monteil (1994) measured degree of financial liberalization basing on return differential, see equation (3).

$$d_t = (1 + r_t) - \left((1 + r_t^*) * (e_{t+1} / e_t)\right) \tag{3}$$

Since the expected value of $\left((1 + r_t^*) * (e_{t+1} / e_t)\right)$ was not observable, the measure was based on the ex post rate of return. Under international financial liberalize market, the mean value of the return differential should be zero and the deviation from mean should be serially uncorrelated. Degree of international financial liberalization was measured by the ratio of its mean absolute deviation from IPC to the mean of the exchange rate corrected foreign interest rate. If the ratio has relatively low value, degree of international financial liberalization is high. The study found mixed result from high to low level international financial liberalization depending on country.

Thirdly, Edwards and Khan (1985) and Haque and Montiel (1990) measured degree of financial openness as the extent to which domestic interest rates were linked to foreign interest rates. The model assumed that the domestic market clearing interest rate (r) is a weight average of uncovered interest parity interest rate, foreign exchange rate adjust by expected change in exchange rate $\left(r^* + \dot{e}\right)$, and autarky interest rate where financial market is completely closed $\left(r^{/}\right)$.

$$r = \varphi\left(r^* + \dot{e}\right) + (1 - \varphi) r^{/} \qquad \text{; where } 0 \le \varphi \le 1 \tag{4}$$

The parameter φ indicates degree of international financial liberalization. If $\varphi = 1$, financial

market is completely liberalized internationally, domestic market-clearing interest rate is equal to its uncovered parity value. If $\varphi = 0$, financial market is completely closed domestically. Later, the autarky interest rate $\left(r^{/}\right)$ is determined under autarky money market equilibrium.

Fourthly, Ghosh and Ostry (1995) utilized *consumption smoothing approach* to assess degree of international financial liberalization. If the degree of international financial liberalization was high, the economy should be able to completely smooth consumption in the face of shocks. This implied that current account should be used as a buffer to smooth aggregate consumption in the face of shocks to national cash flow, defined as output less investment less government expenditure. If cash flow was expected to fall overtime, it would be optimal to run current account surplus in order to be able to consume more in the future. On the other hand, if cash flow was expected to grow overtime, it would be optimal to run current account deficit. The study employed Granger causality test, whether current account would able to predict subsequent movement in national cash flow. Then the study estimated optimal capital flow and compared optimal capital flow with actual data of current account to test statistical property of the estimated parameters.

Finally, Quinn (1997) constructed *cross country indicators* for degree of financial liberalization. Quinn index measured various aspects of financial regulation basing on *Annual Report on Exchange Arrangements and Exchange Restriction* published by IMF. Quinn index had value from 0 (the lowest degree of international financial liberalization) to 4 (the highest degree of international financial liberalization).

3. International Financial Model

After reviewing on several approaches toward measure of degree of international financial liberalization, the study employed the measure based on *interest parity condition (IPC)* and *determination of domestic interest rate* (Edwards and Khan, 1985) and (Haque and Montiel, 1990). The rationale is that interest rate and exchange rate play an important role in both financial model and Asian International Input-Output model. So the measure of degree of financial liberalization should be closely related with the two variables to facilitate the simulation and inter-linkage of the two models.

The determination of domestic market clearing interest rate (r) is a weight average of the two interest rates representing completely liberalized financial market $(r^{*}+\dot{e})$ and completely closed financial market (r').

$$r = \varphi(r^{*}+\dot{e}) + (1-\varphi)r' \quad ; \quad 0 \le \varphi \le 1 \tag{4}$$

As autarky interest rate (r') is unobservable, r' would be recovered using expression of money supply (MS) identity;

$$MS = DC + R = DC + R_{-1} + \Delta R \tag{5}$$

where *MS* is domestic money supply, *DC* is the stock of domestic credit outstanding, *R* is stock of international reserve held by central bank, R_{-1} is stock of international reserve in previous period, ΔR is change in international reserve. According to balance of payment identity;

$$CA + NKI = \Delta R \tag{6}$$

where *CA* is current account, *NKI* is net capital inflow. Substitute eq (6) into eq (5);

$$MS = DC + R_{-1} + CA + NKI \tag{7}$$

Money supply corresponding to completely closed financial market (MS') refers to the situation when there is no movement of fund into and out of the country $(NKI = 0)$. So it could be express as;

$$MS' = DC + R_{-1} + CA = MS - NKI \tag{8}$$

Suppose money demand (MD) has conventional functional form;

$$\log(MD/P) = \alpha_0 - \alpha_1 r + \alpha_2 \log(rGDP) + \alpha_3 \log(MS_{-1}/P_{-1}) \tag{9}$$

where MD/P is real money demand. $rGDP$ is real gross domestic product. $\alpha_1, \alpha_2, \alpha_3 > 0$. Then, interest rate corresponding to closed financial market (r') is derived from money market equilibrium equating money supply with money demand, $\log\left(\frac{MS_t'}{P_t}\right) = \log\left(\frac{MD_t}{P_t}\right)$.

$$\log\left(\frac{MS'}{P}\right) = \alpha_0 - \alpha_1 r' + \alpha_2 \log(rGDP) + \alpha_3 \log\left(\frac{MS_{-1}}{P_{-1}}\right) \tag{10}$$

$$r' = (\alpha_0/\alpha_1) - (1/\alpha_1)\log\left(\frac{MS'}{P}\right) + (\alpha_2/\alpha_1)\log(rGDP) + (\alpha_3/\alpha_1)\log\left(\frac{MS_{-1}}{P_{-1}}\right) \tag{11}$$

Finally, r' would be substituted back into eq (4), resulting in final functional from for domestic interest rate determination.

$$r = \varphi(r_{U.S.} + \dot{e}) + (1-\varphi)\left(\frac{\alpha_0}{\alpha_1}\right) - (1-\varphi)\left(\frac{1}{\alpha_1}\right)\log\left(\frac{MS'}{P}\right) + (1-\varphi)\left(\frac{\alpha_2}{\alpha_1}\right)\log(rGDP) + (1-\varphi)\left(\frac{\alpha_3}{\alpha_1}\right)\log\left(\frac{MS_{-1}}{P_{-1}}\right) \tag{12}$$

Econometrically estimated eq(12) expression would yield an estimated value of degree of

international financial liberalization, parameter φ.

Regarding other financial variables within the international financial model, the expected future exchange rate $\left(E\left(e_{t+1}\right)\right)$, current value of exchange rate $\left(e_t\right)$, and net capital inflow $\left(NKI_t\right)$ would be estimated. Using to calculate expected change in exchange rate, $\dot{e} = \left(E\left(e_{t+1}\right) - e_t\right)/e_t$, the expected exchange rate of next period is assumed to follow adaptive expectation, where current value of exchange rate and past value of exchange rate determine expected future exchange rate.

$$E\left(e_{t+1}\right) = \zeta_0 + \zeta_1 e_t + \zeta_2 e_{t-1} + \zeta_3 e_{t-2} \tag{13}$$

Current value of exchange rate is assumed to follow the Filatov-Klein exchange rate model written as;

$$\ln e_t = \beta_0 + \beta_1 \ln\left(P_t / P_{U.S.,t}\right) + \beta_2\left(r_t - r_{U.S.,t}\right) + \beta_3\left(CA_t / GDP_t\right) \tag{14}$$

where P_t is domestic general price level, $P_{U.S.,t}$ is general price level of the United States.

Net capital inflow $\left(NKI_t\right)$ is determined by current account and different between domestic and the world interest rate under interest parity condition (IPC). Under perfect financial liberalization, interest parity condition must be satisfied, meaning equalization of expected return between domestic and the rest of the world.

$$\left(1 + r_t\right) = E_t\left(\left(1 + \left(r_{US}\right)_t\right) * \left(e_{t+1} / e_t\right)\right) \tag{15}$$

Regarding net capital inflow under liberalized financial market, when domestic interest rate is higher than IPC interest rate, $\left(1 + r_t\right) > E_t\left(\left(1 + \left(r_{US}\right)_t\right) * \left(e_{t+1} / e_t\right)\right)$, there would be massive capital inflow up to infinity. In reality, net capital inflow is positively related (but not have infinite value) with the two

interest rate differential (d_t).

$$d_t = (1 + r_t) - E_t\left((1 + (r_{US})_t) * (e_{t+1}/e_t)\right) \quad (16)$$

Then net capital flow could be represented as following functional form;

$$NKI_t = \vartheta_0 - \vartheta_1 CA_t + \vartheta_2 d_t \qquad : \vartheta_1, \vartheta_2 > 0 \quad (17)$$

In sum, international financial model consists of 4 estimated equations for each economy, namely, domestic interest rate (eq (12)), expected exchange rate (eq (13)), exchange rate (eq (14)), and net capital flow (eq(17)). The measure of degree of international financial liberalization can be recovered after estimation domestic interest rate, eq(12). Then, the study will simulate the case when φ increases by 25% as a case study for increasing degree of international financial liberalization. The impact on interest rate and exchange rate will be transmitted to Asian international input output (AIIO) model.

4. Asian International Input Output (AIIO) Model

The important variables that play critical role in Asian international input-output model are sector output and sector price. To incorporate exchange rate and interest rate into the model, this study associates exchange rate with sector price determination. On the other hand, interest rate affects sector output via determination of final demands, namely private consumption and investment. This section attempts to explain the entire modeling process starting from data preparation to model construction. In particular, the following steps are implemented in the study.

Step1 : Converting variables in AIIO table from U.S. dollar to national currency

Step2 : Determining sector price and incorporating exchange rate into sector price

Step3: Converting all variables in current price into those of constant price

Step4: Estimating final demand equations and incorporating the interest rate into these equations

Step5: Estimating intermediate demands and output determination

Step6: Linking with International financial model

Step1: Converting variables in AIIO table from U.S. dollar to national currency

Asian international input-output (AIIO) model is based on 4 data set of AIIO table in 1985, 1990, 1995, and 2000. The AIIO table recorded all variables representing economic activities of the nine Asian countries and the United States in term of U.S. dollar. However, among the nine Asian economies, most of them do not hold fixed exchange rate with the U.S. dollar. Moreover, most of production and consumption decision are made in domestic currency rather than in U.S. dollar. Hence, the AIIO model is constructed in national currency of each country and all variables in AIIO table must be converted into national currency using exchange rate data from International Financial Statistics published by International Monetary Fund.

Step2: Determining sector price and incorporating exchange rate into sector price

Sector price is determined by zero profit condition where total revenue equals to total cost, see equation (18).

$$xv_j^k = \sum_i \sum_h xv_{ij}^{hk} + va_j^k \tag{18}$$

where xv_j^k is total revenue of the j[th] industry in the k[th] economy. xv_{ij}^{hk} is intermediate input cost of the i[th] commodity from the h[th] economy using in production of the j[th] sector in the k[th] economy. va_j^k is value added of the j[th] sector in the k[th] economy.

Total revenue is sector price multiply by sector output, $xv_j^k = p_j^k x_j^k$, where p_j^k is sector price of the j[th] industry in the k[th] economy. x_j^k is sector output of the j[th] sector in the k[th] economy. Intermediate input cost is import price multiply by intermediate input demand, $xv_{ij}^{hk} = q_{ij}^{hk} x_{ij}^{hk}$, where $q_{ij(h)}^k$ is import price of the i[th] commodity from the h[th] economy to the j[th] sector production in the k[th] economy. x_{ij}^{hk} is intermediate input of the i[th] commodity from the h[th] economy using in production of the j[th] sector in the k[th] economy.

Next, this study calculates value added price, pva_j^k, from United Nations data of nominal and real GDP by sector in national currencies. Then the study computes sector GDP deflator by divided nominal sector GDP with real sector GDP. Sector GDP could be compatible with sector value added in input-output framework and the identity of sector value added price under AIIO framework could be expressed as.

$$pva_j^k = \frac{xv_j^k - \sum_i \sum_h xv_{ij}^{hk}}{\frac{xv_j^k}{p_j^k} - \sum_i \sum_h \frac{xv_{ij}^{hk}}{q_{ij}^{hk}}} \tag{19}$$

The exchange rate is incorporate into equation (19) via import price of intermediate input, $q_{ij(h)}^k$. The import price of the i[th] commodity import from the h[th] origin defines as the sector

price of the i[th] sector from h[th] economy converting from h[th] currency unit into k[th] currency unit, $q_{ij}^{hk} = \frac{p_i^h e^k}{e^h}$, where e^k is exchange rate of the k[th] currency unit/U.S. $ and e^h is exchange rate of the h[th] currency unit/U.S.$. Now, the exchange rate is incorporate in intermediate input price and equation (19) could be rewritten as;

$$pva_j^k = \frac{xv_j^k - \sum_i \sum_h xv_{ij}^{hk}}{\frac{xv_j^k}{p_j^k} - \sum_i \sum_h \frac{xv_{ij}^{hk}}{\left(p_i^h * e^k / e^h\right)}} \tag{20}$$

Rearranging equation (20) results in:

$$p_j^k = \frac{xv_j^k}{\sum_h \sum_i \frac{xv_{ij}^{hk}}{\left(p_i^h * e^k / e^h\right)} + \frac{xv_j^k - \sum_i \sum_h xv_{ij}^{hk}}{pva_j^k}} \tag{21}$$

Solving equation (21) for all sectors and all countries would yield the sector price in AIIO model.

Step3: Converting all variables in current price into those of constant price

After calculating the sector prices, all variables are ready to convert from current price in national currency to constant price in national currency. By dividing nominal variable by sector price, the outcome would be real variables. Conversion from current price to constant price is necessary for determination of sector output representing as

$$X = AX + F \tag{22}$$

where X is vector of gross output. A is technical coefficient matrix. F is matrix of final demand.

Step4: Estimating final demands and incorporating the interest rate into these equations

Final demand is classified into 4 categories, $M = C,G,I,V$, private consumption (c), government consumption (g), investment (i), and inventory (v). Matrix of final demand could be expressed as $F = \left[f^{k}_{iM(h)} \right]$, where $f^{k}_{iM(h)}$ is M category of final demand of the k[th] economy for the i[th] commodity imported from the h[th] economy. This study determines private consumption and investment endogenously. Government consumption and inventory, however, are assumed fixed according to AIIO table year 2000.

a) Private Consumption Demand

Private consumption of the k[th] economy is defined as $cpr^{k} \equiv \sum_{i} \sum_{h} f^{k}_{iC(h)}$. Private consumption demand is a function of real national wage income $\left(\frac{wage^{k}}{pc^{k}} \right)$ and its real interest rate $\left(r^{k} - \ln pc^{k} \right)$. Real national wage income in the k[th] economy is calculated as the summation of sector wage $\left(\sum_{j} wage^{k}_{j} \right)$ divided by average consumer price $\left(pc^{k} \right)$. Real interest rate for private consumption of the k[th] economy is nominal interest rate minus rate of change in consumer price $\left(r^{k} - \ln pc^{k} \right)$. The study would econometrically estimate private demand function in equation (23) using pool data from AIIO tables.

$$\log\left(cpr^{k} \right) = \lambda 1^{k} + \lambda 1^{k} \log\left(\frac{wage^{k}}{pc^{k}} \right) + \lambda 2^{k} \left(r^{k} - \ln pc^{k} \right) \qquad (23)$$

After estimating aggregate private consumption $\left(cpr^{k} \right)$, private consumption by commodity must also be determined $\left(cpr^{k}_{i} \right)$. Define private consumption of the i[th] commodity of the k[th]

economy and its consumption share as $cpr_i^k \equiv \sum_h f_{iC(h)}^k$, $scp_i^k \equiv \frac{cpr_i^k}{cpr^k}$. Consumption share of the i[th] commodity is assumed to have constant elasticity of substitution (CES) among each other, expressing as

$$scp_i^k = \gamma_c^k \left[pc_i^k / pc^k \right]^{\mu_c^k} \quad (24)$$

pc_i^k is consumer price of the i[th] commodity in the k[th] economy. pc^k is weighted average of pc_i^k . γ_c^k, μ_c^k are behavioral parameters. μ_c^k represents elasticity of substitution among the consumption commodity in the k[th] economy. The study would econometrically estimated private consumption by commodity using functional form in equation (25)

$$\log\left(scp_i^k\right) = \vartheta 0_i^k + \vartheta 1_i^k \log\left(pc_i^k / pc^k\right) \quad (25)$$

where the estimate value of $\vartheta 1_i^k$ represents elasticity of substitution.

After estimating private consumption by commodity, the study applies Armington(1969)'s trade elasticity approach to determine share of private consumption by import origin.

$$s_{iC(h)}^k = \gamma_{ic}^k \left[p_{iC(h)}^k / pc_i^k \right]^{\mu_{ic}^k} \quad (26)$$

$s_{iC(h)}^k$ is trade share of the ith commodity imported from the hth economy for private consumption in the kth economy. $s_{iC(h)}^k \equiv f_{iC(h)}^k \Big/ \sum_h f_{iC(h)}^k$ $p_{iC(h)}^k$ is import price of the ith commodity from the hth economy for private consumption in the kth economy; $p_{iC(h)}^k = \left(p_i^h * e^k / e^h\right)$. pc_i^k is weighted average of $p_{iC(h)}^k$. $\gamma_{ic}^k, \mu_{ic}^k$ are behavioral parameters. μ_{ic}^k is elasticity of substitution of the ith consumption commodity among various import origin. The study would estimate the following expression:

$$\log\left(s^{k}_{iC(h)}\right) = \delta 0^{k}_{iC} + \delta 1^{k}_{iC} \log\left(p^{k}_{iC(h)} / p^{k}_{iC}\right) \quad (27)$$

The summarize of private consumption at aggregate level $\left(cpr^{k}\right)$, at commodity level $\left(cpr^{k}_{i}\right)$, and at import origin level $\left(f^{k}_{iC(h)}\right)$ are illustrated in Figure1.

(Figure 1 near here)

b) Investment demand

Investment demand of the k[th] economy $\left(ir^{k} \equiv \sum_{i}\sum_{h} f^{k}_{iI(h)}\right)$ is determined by total output of the k[th] economy and real interest rate. Total outpu the k[th] economy is summation of sector output, $\sum_{j} x^{k}_{j}$. The real interest rate for investment of the k[th] economy is nominal interest rate minus rate of change in average price of investment good $\left(r - \ln pi^{k}\right)$. Equation (28) would be estimated.

$$\log\left(ir^{k}\right) = \iota 0^{k} + \iota 1^{k} \log\left(\sum_{j} x^{k}_{j}\right) + \iota 2^{k}\left(r - \ln pi^{k}\right) \quad (28)$$

After aggregate investment has been determined, investment by commodity $\left(ir^{k}_{i} \equiv \sum_{h} f^{k}_{iI(h)}\right)$ must be identified. The commodity composition of investment is assumed to be fixed proportion, non vary with the change in relative price of the i[th] commodity. Investment demand by commodity is determined from $ir^{k}_{i} = sir^{k}_{i} * ir^{k}_{i}$, where sir^{k}_{i} is investment share by commodity at the year 2000.

$$\overline{sir^{k}_{i}} = \left(\sum_{h} f^{k}_{iI(h)} \Big/ \sum_{i}\sum_{h} f^{k}_{iI(h)}\right)_{t=2000} \quad (29)$$

Similar to private consumption demand, the study applies Armington's trade elasticity approach to determine commodity investment demand classified by import origin, the expression shown in equation (30).

$$\log\left(s^{k}_{iI(h)}\right) = \delta 0^{k}_{iI} + \delta 1^{k}_{iI} \log\left(p^{k}_{iI(h)} \big/ p^{k}_{iI}\right) \tag{30}$$

where $s^{k}_{iI(h)} \equiv f^{k}_{iI(h)} \Big/ \sum_{h} f^{k}_{iI(h)}$. $p^{k}_{iI(h)}$ is import price of the i[th] commodity from the h[th] economy for investment of the k[th] economy, $p^{k}_{iI(h)} = \left(p^{h}_{i} * e^{k} / e^{h}\right)$. pi^{k}_{i} is average price of the i[th] investment commodity in the k[th] economy, measuring as weight average of $p^{k}_{iI(h)}$. The summarize of investment equations are illustrated in Figure 2

(Figure 2 near here)

Step5: Estimating intermediate demands and output determination

From the determination of gross output, $X = AX + F$, intermediate demand is expressed as AX. Each element in A could be written as:

$$a^{k}_{ij(h)} = x^{k}_{ij(h)} \big/ x^{k}_{j} \tag{31}$$

where $a^{k}_{ij(h)}$ is technical coefficient identifying how much the i[th] commodity from the h[th] economy is used in one unit of production of the j[th] sector in the k[th] economy. $x^{k}_{ij(h)}$ is intermediate input of the i[th] commodity from the hth economy using in production of the j[th] sector in the k[th] economy. x^{k}_{j} is gross output of the jth sector in the kth economy. Define a^{k}_{ij} as:

$$a^{k}_{ij} = \sum_{h} x^{k}_{ij(h)} \Big/ x^{k}_{j} \tag{32}$$

where $\sum_{h} x^{k}_{ij(h)}$ is summation of intermediate input of the ith commodity from various source. In the model, a^{k}_{ij} is assumed as constant at the year 2000, while $a^{k}_{ij(h)}$ could vary depending on import prices and domestic price of the input. Similar to the case of final demand, the study applies Armington's constant elasticity approach to indicate intermediate input share from various origin,

see equation (33).

$$\log\left(s^{k}_{ij(h)}\right) = \delta 0^{k}_{ij} + \delta 1^{k}_{ij} \log\left(q^{k}_{ij(h)} \big/ p^{k}_{ij}\right) \qquad (33)$$

where $s^{k}_{ij(h)} \equiv x^{k}_{ij(h)} \big/ x^{k}_{ij}$, $q^{k}_{ij(h)}$ is import price of the ith commodity from the hth economy to the jth sector production in the kth economy. p^{k}_{ij} is weight average of $q^{k}_{ij(h)}$. Intermediate demand equations could be summarized as shown in figure 3.

(Figure 3 near here)

After finished estimating final demand equations and intermediate demand equations, the gross output determination would be calculated using $X = AX + F$.

Step6: Linking with International Financial Model

After simulating increase in degree of financial liberalization in international financial model, estimated values of interest rate and exchange rate would become explanatory variables in AIIO model. Interest rate affects aggregate private consumption and aggregate investment demands, while exchange rate effects sector price determination and trade share of intermediate and final demands consumption. Now, the impact on sector outputs, aggregate outputs, sector price and general price level could be identified. Nevertheless, impact of change of aggregate output (rgdp), general price level (pgdp), as well as trade balance (export minus import) from the AIIO model could also impact net capital inflow (NKI), exchange rate (e), and interest rate (r). The simulation result from AIIO model will feedback into international financial model. The two

models will be run until they converge with each other. Finally, the result of increasing in degree of financial liberalization on sector and aggregate production will be identified.

(Figure 4 near here)

5. Estimation of degree of financial liberalization

All variables in the financial model are based on quarterly data (1980-2005) from International Financial Statistics published by International Monetary Fund (IMF). Data on interest rate are based on the lending rate representing long term interest rate for investment decision. The rate on long term government bond could be a very good candidate representing the long term interest rate but data are missing in many Asian countries. So this study decided to use the lending rate as long term interest rate.

The international financial model is build as a simultaneous equation system using two-stage least square (2SLS) estimation method. In estimation procedure, the estimated value of parameter that has incorrect sign is removed from equation. The estimated equations of domestic interest rate are illustrated in table 1. The coefficient of $\left(r_{U.S.}+\dot{e}\right)$ is the estimated value of degree of financial liberalization $\left(\varphi\right)$. In most countries, the estimate values are statistically significant at 0.1 level, except for Philippines and Japan. The estimated values of all parameters $\left(\varphi,\alpha_0,\alpha_1,\alpha_2,\alpha_3\right)$could be recovered as shown in table 2. Degree of financial liberalization is relatively high in Singapore (0.314), and Taiwan (0.475), whereas it is relatively low in China (0.052). For the rest of Asian countries, degree of financial liberalization is relatively moderate.

(Table1 and Table 2 near here)

6. Scenario analysis of increasing in degree of financial liberalization

After recovering the value of the parameters in interest rate determination, the study focuses on scenario analysis where there is 25% increasing in degree of financial liberalization holding other parameters constant. Increase in degree of capital mobility results in declining in the interest rates across Asian countries. Reduction in the interest rate leads to increase in real Gross Domestic Product (see table 3). Among Asian countries, Indonesia is a country that gains the highest benefit from increasing degree of financial liberalization. The rise in real GDP is up to 1.147%. For other countries, the benefit of increasing degree of financial liberalization in term of economic growth is relatively low, ranging from 0.022% in China to 0.205% in Japan.

(Table3 near here)

Regarding change in sector production, construction is the sector that receives most of benefit from rising degree of financial liberalization as construction is major component of investment, highly sensitive to decline in interest rate. Construction has the first rank in rising of production in most of the Asian countries; see table 4. Tradable sectors are the sectors that receive moderate level of benefit from rising degree of financial liberalization. Lower interest rate in many Asian economies causes slightly depreciation in those economies. Tradable sectors are indirectly benefited from depreciation as these sectors can gain more foreign market share. So increasing in production would concentrate on tradable rather than non-tradable. Services sector has the lowest

rank in increasing in production in most of the Asian countries; see table 4.

(Table4 near here)

7. Conclusion and Limitation of the study

The study emphasizes on modeling financial system in Asian economies, as well as, modeling the real sector using international input output model. The empirical study is mainly based on econometrically estimated equation system. Regarding financial model, this study found out that Singapore and Taiwan had the highest degree of capital mobility among the nine Asian economies. In Singapore and Taiwan, domestic interest rate is co-movement with the world interest rate adjusting for gain and loss in exchange rate. On the other hand, the interest rate in China tends to move independently from the world interest rate. The impact on aggregate production and sector production is evaluated by interlink international financial model with international input output model. Increasing in degree of financial liberalization tends to benefit most Asian economies, especially Indonesia. Construction is the sector that receives most of benefit from higher degree of financial liberalization.

Regarding limitation of the study, the model does not take into account of capital structure of each production sector, whether the sector is highly depend on domestic or foreign funding. The limitation is due to lack of data on capital structure at sector level across many Asian countries. It will be fruitful for further study to collect these data and apply into modeling framework.

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9. Figures and Tables

Figure 1 Private Consumption Equations

Aggregate private consumption: $\log(cpr^k) = \lambda 1^k + \lambda 1^k \log\left(\frac{wage^k}{pc^k}\right) + \lambda 2^k \left(r^k - \ln pc^k\right)$

Private consumption by commodity: $cpr_i^k = scp_i^k * cpr^k$;

where $\log(scp_i^k) = \vartheta 0_i^k + \vartheta 1_i^k \log\left(pc_i^k / pc^k\right)$

Private consumption by import origin: $f_{iC(h)}^k = s_{iC(h)}^k * cpr_i^k$:

where $\log(s_{iC(h)}^k) = \delta 0_{iC}^k + \delta 1_{iC}^k \log\left(p_{iC(h)}^k / p_{iC}^k\right)$

Figure 2 Investment Equations

Aggregate investment: $\log(ir^k) = \iota 0^k + \iota 1^k \log\left(\sum_j x_j^k\right) + \iota 2^k \left(r - \ln pi^k\right)$

Investment by commodity: $ir_i^k = sir_i^k * ir_i^k$; where $\overline{sir_i^k} = \left(\sum_h f_{iI(h)}^k \Big/ \sum_i \sum_h f_{iI(h)}^k\right)_{t=2000}$

Investment by import origin: $f_{iI(h)}^k = s_{iI(h)}^k * ir_i^k$:

where $\log(s_{iI(h)}^k) = \delta 0_{iI}^k + \delta 1_{iI}^k \log\left(p_{iI(h)}^k / p_{iI}^k\right)$

Figure 3 Intermediate demand Equations

Intermediate demand by commodity: $x_{ij}^k = a_{ij}^k * x_j^k$; where $\overline{a_{ij}^k} = \left(\sum_h x_{ij(h)}^k \Big/ x_j^k\right)_{t=2000}$

Intermediate demand by import origin: $x_{ij}^{hk} = s_{ij(h)}^k * x_{ij}^k$;

where $\log(s_{ij(h)}^k) = \delta 0_{ij}^k + \delta 1_{ij}^k \log\left(q_{ij(h)}^k / p_{ij}^k\right)$

Figure 4 International Financial and AIIO Model

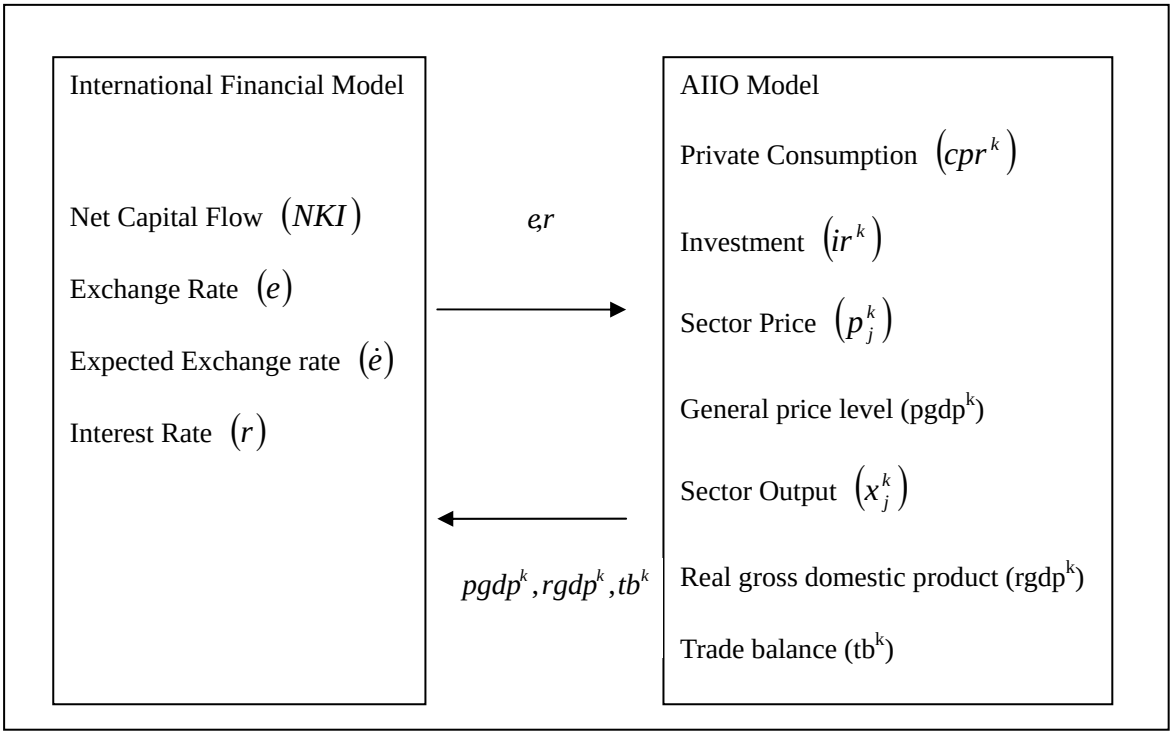

Table 1 Estimation of domestic interest rate (eq.(12)) using 2SLS

Indonesia $r = 3.231 + 0.234(r_{U.S.} + \dot{e}) - 0.158\log(MS'/P) + 0.020\log(MS/P)_{-1} + 0.183d1997$ (1.676)* (-0.955) (0.135) (1.484)* Adjusted R-square = 0.434 D.W. = 1.060
Malaysia $r = 0.997 + 0.181(r_{U.S.} + \dot{e}) - 0.079\log(MS'/P) + 0.062\log(MS/P)_{-1} + 0.026d9798$ (1.517)* (-2.041)** (1.584)* (2.019)** Adjusted R-square = 0.402 D.W. = 0.812
Philippines $r = 1.694 + 0.109(r_{U.S.} + \dot{e}) - 0.090\log(MS'/P) + 0.018\log(rgdp)$ (0.631) (-6.457)*** (1.308) Adjusted R-square = 0.487 D.W. = 0.521
Singapore $r = 0.733 + 0.314(r_{U.S.} + \dot{e}) - 0.005\log(MS'/P) + 0.004\log(MS/P)_{-1}$ (3.166)*** (-2.911)*** (0.784) Adjusted R-square = 0.739 D.W. = 1.199

Thailand

$$r = 1.264 + 0.204(r_{U.S.} + \dot{e}) - 0.047\log(MS'/P) + 0.002\log(MS/P)_{-1} + 0.075d9798$$

(1.464)* (-2.708)*** (0.147) (2.195)**

Adjusted R-square = 0.800 D.W. = 1.027

China

$$r = 2.094 + 0.052(r_{U.S.} + \dot{e}) - 0.155\log(MS'/P) + 0.182\log(rgdp)$$

(5.039)*** (-8.577)*** (7.221)***

Adjusted R-square = 0.500 D.W. = 0.783

Taiwan

$$r = 0.786 + 0.475(r_{U.S.} + \dot{e}) - 0.026\log(MS'/P) + 0.006\log(MS/P)_{-1}$$

(6.954)*** (-2.020)** (1.638)*

Adjusted R-square = 0.526 D.W. = 0.926

Korea

$$r = 1.176 + 0.246(r_{U.S.} + \dot{e}) - 0.028\log(MS'/P) + 0.0001\log(MS/P)_{-1} + 0.107d9798$$

(1.911)* (-2.868)*** (0.066) (4.991)***

Adjusted R-square = 0.417 D.W. = 1.147

Japan

$$r = -0.718 + 0.104(r_{U.S.} + \dot{e}) - 0.076\log(MS'/P) + 0.337\log(rgdp) - 0.114d1986 + 0.081d8587$$

(0.812) (-3.884)*** (1.989)** (-2.515)** (1.569)*

Adjusted R-square = 0.383 D.W. = 0.880

Note that the value in parenthesis is t-statistics

*the sign * stands for statistically significant at 0.1 level of significant*

*the sign ** stands for statistically significant at 0.05 level of significant*

*the sign *** stands for statistically significant at 0.01 level of significant*

d8587 stands for dummy variable from 1985:q4 to 1987:q1.

d9798 stands for dummy variable from 1997:q3 to 1998:q2

$d1997$ *stands for dummy variable from 1997:q3 onward.*

Table2 The expected value of parameter in eq(12)

	φ	α_0	α_1	α_2	α_3
Indonesia	0.234	20.502	4.860	0.000	0.127
Malasia	0.181	12.697	10.426	0.000	0.784
Philippines	0.109	18.858	9.915	0.197	0.000
Singapore	0.314	139.122	130.161	0.000	0.685
Thailand	0.204	26.680	16.805	0.000	0.045
China	0.052	13.499	6.112	1.175	0.000
Taiwan	0.475	30.030	20.057	0.000	0.241
Korea	0.246	41.817	26.806	0.000	0.004
Japan	0.104	-9.429	11.764	4.428	0.000

Table3 Percentage change in real Gross Domestic Product (RGDP) and real wage

	real GDP	real wage
Indonesia	1.147	1.231
Malaysia	0.070	0.068
Philippines	0.066	0.063
Singapore	0.063	0.065
Thailand	0.080	0.075
China	0.022	0.021
Taiwan	0.136	0.137
Korea	0.122	0.125
Japan	0.205	0.213

Table 4 Percentage change in sector production

	Agriculture	Mining and utility	Manufacturing	Construction	Trade and transport	Services
Indonesia	1.159	0.694	1.055	2.922	1.178	0.964
Malaysia	0.077	0.103	0.068	0.132	0.068	0.040
Philippines	0.076	0.072	0.065	0.156	0.071	0.044
Singapore	0.045	0.063	0.066	0.138	0.044	0.047
Thailand	0.078	0.085	0.079	0.184	0.090	0.048
China	0.019	0.026	0.025	0.024	0.024	0.011
Taiwan	0.162	0.178	0.128	0.368	0.158	0.119
Korea	0.120	0.119	0.118	0.254	0.107	0.101
Japan	0.201	0.210	0.223	0.397	0.220	0.160