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Chapter 17

An empirical study on interdependency of CO2 emissions in the Asia-Pacific region



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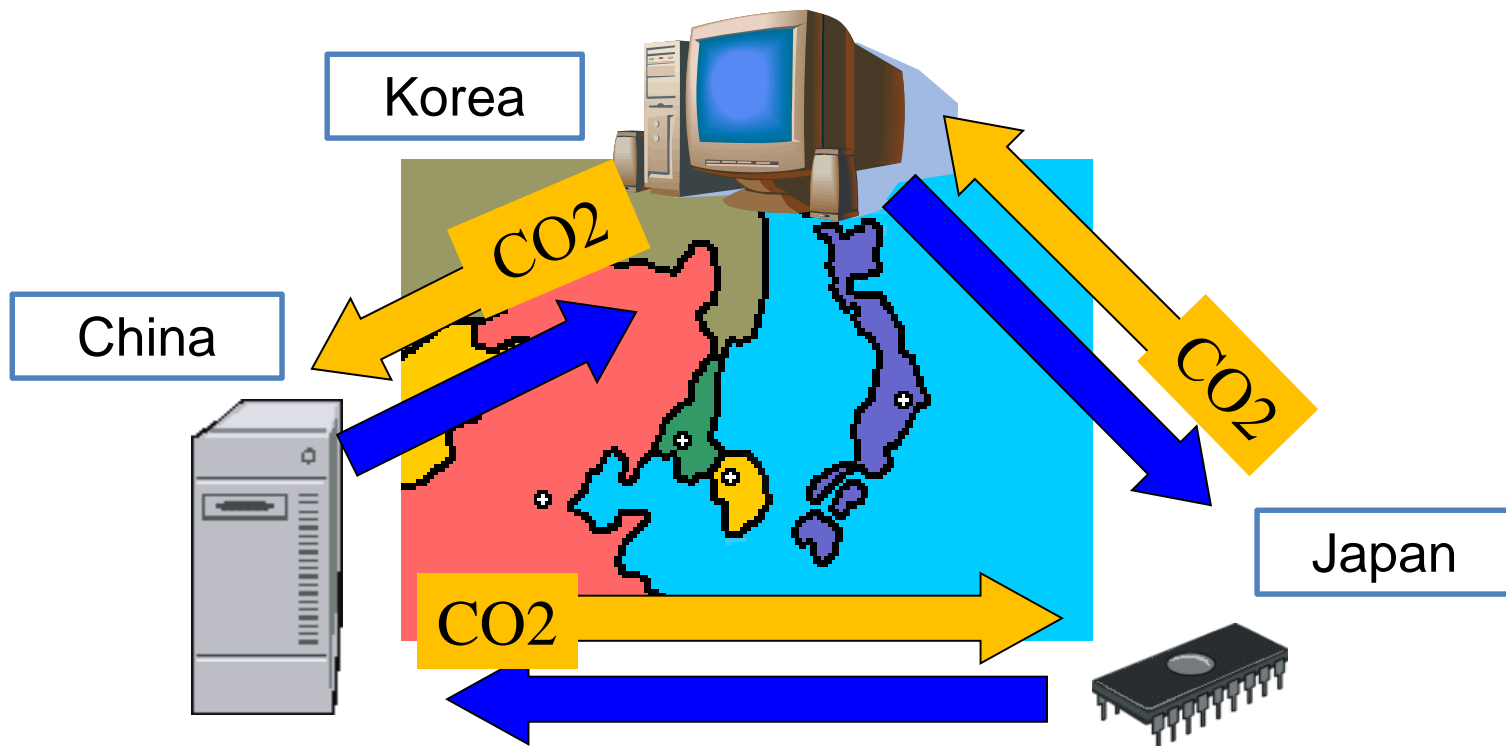


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Purpose of the research 1

- Economic Globalization
 - Production process is NOT self-contained
- Carbon leakage

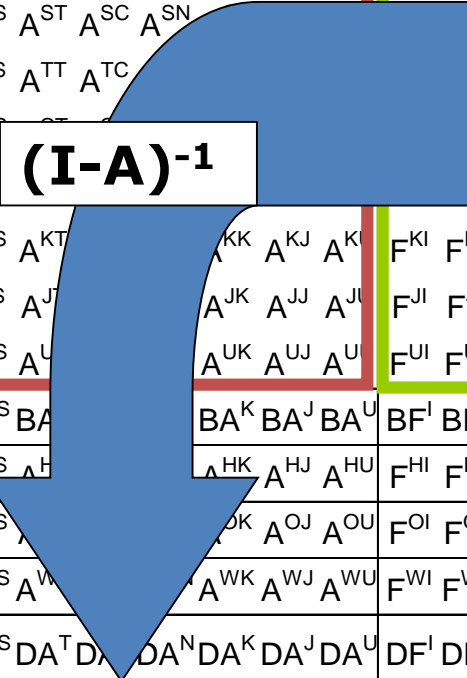


Purpose of the research 2

- Who really emits CO₂?
 1. Fossil energy production criterion
 2. Fossil energy consumption criterion
(=final goods production criterion)
 3. Final goods consumption criterion
- “Fossil energy consumption criterion”
is currently used in the world
→ Is that fair for developing countries?

Asian International Input-Output Table

	Intermediate Demand (A)										Final Demand (F)										Export (L)			Statistical Discrepancy (QX)	Total Outputs (XX)	
	Indonesia (AI)	Malaysia (AM)	Philippines (AP)	Singapore (AS)	Thailand (AT)	China (AC)	Taiwan (AN)	Korea (AK)	Japan (AJ)	U.S.A. (AU)	Indonesia (FI)	Malaysia (FM)	Philippines (FP)	Singapore (FS)	Thailand (FT)	China (FC)	Taiwan (FN)	Korea (FK)	Japan (FJ)	U.S.A. (FU)	Export to Hong Kong (LH)	Export to EU (LO)	Export to R.O.W. (LW)			
Indonesia	A ^{II}	A ^{IM}	A ^{IP}	A ^{IS}	A ^{IT}	A ^{IC}	A ^{IN}	A ^{IK}	A ^{IJ}	A ^{IU}	F ^{II}	F ^{IM}	F ^{IP}	F ^{IS}	F ^{IT}	F ^{IC}	F ^{IN}	F ^{IK}	F ^{IJ}	F ^{IU}	L ^{IH}	L ^{IO}	L ^{IW}	Q ^I	X ^I	
Malaysia	A ^{MI}	A ^{MM}	A ^{MP}	A ^{MS}	A ^{MT}	A ^{MC}	A ^{MN}	A ^{MK}	A ^{MJ}	A ^{MU}	F ^{MI}	F ^{MM}	F ^{MP}	F ^{MS}	F ^{MT}	F ^{MC}	F ^{MN}	F ^{MK}	F ^{MJ}	F ^{MU}	L ^{MH}	L ^{MO}	L ^{MW}	Q ^M	X ^M	
Philippines	A ^{PI}	A ^{PM}	A ^{PP}	A ^{PS}	A ^{PT}	A ^{PC}	A ^{PN}	A ^{PK}	A ^{PJ}	A ^{PU}	F ^{PI}	F ^{PM}	F ^{PP}	F ^{PS}	F ^{PT}	F ^{PC}	F ^{PN}	F ^{PK}	F ^{PJ}	F ^{PU}	L ^{PH}	L ^{PO}	L ^{PW}	Q ^P	X ^P	
Singapore	A ^{SI}	A SM	A ^{SP}	A ^{SS}	A ST	A ^{SC}	A ^{SN}				F ^{SI}	F SM	F ^{SP}	F ^{SS}	F ST	F ^{SC}	F ^{SN}	F ^{SK}	F ^{SJ}	F ^{SU}	L ^{SH}	L ^{SO}	L ^{SW}	Q ^S	X ^S	
Thailand	A ^{TI}	A TM	A ^{TP}	A ^{TS}	A ^{TT}	A ^{TC}					F ^{TI}	F TM	F ^{TP}	F ^{TS}	F ^{TT}	F ^{TC}	F ^{TN}	F ^{TK}	F ^{TJ}	F ^{TU}	L TH	L ^{TO}	L ^{TW}	Q ^T	X ^T	
China	A ^{CI}	A ^{CM}	A ^{CP}	A ^{CS}	A ^{CT}						F ^{CI}	F ^{CM}	F ^{CP}	F ^{CS}	F ^{CT}	F ^{CC}	F ^{CN}	F ^{CK}	F ^{CJ}	F ^{CU}	L ^{CH}	L ^{CO}	L ^{CW}	Q ^C	X ^C	
Taiwan	A ^{NI}	A ^{NM}	A ^{NP}	A ^{NS}							F ^{NI}	F ^{NM}	F ^{NP}	F ^{NS}	F ^{NT}	F ^{NC}	F ^{NN}	F ^{NK}	F ^{NJ}	F ^{NU}	L ^{NH}	L ^{NO}	L ^{NW}	Q ^N	X ^N	
Korea	A ^{KI}	A ^{KM}	A ^{KP}	A ^{KS}	A ^{KT}						F ^{KI}	F ^{KM}	F ^{KP}	F ^{KS}	F ^{KT}	F ^{KC}	F ^{KN}	F ^{KK}	F ^{KJ}	F ^{KU}	L ^{KH}	L ^{KO}	L ^{KW}	Q ^K	X ^K	
Japan	A ^{JI}	A ^{JM}	A ^{JP}	A ^{JS}	A ^{JT}						F ^{JI}	F ^{JM}	F ^{JP}	F ^{JS}	F ^{JT}	F ^{JC}	F ^{JN}	F ^{JK}	F ^{JJ}	F ^{JU}	L ^{JH}	L ^{JO}	L ^{JW}	Q ^J	X ^J	
U.S.A.	A ^{UI}	A ^{UM}	A ^{UP}	A ^{US}	A ^{UT}						F ^{UI}	F ^{UM}	F ^{UP}	F ^{US}	F ^{UT}	F ^{UC}	F ^{UN}	F ^{UK}	F ^{UJ}	F ^{UU}	L ^{UH}	L ^{UO}	L ^{UW}	Q ^U	X ^U	
Freight and Insurance (BF)	BA ^I	BA ^M	BA ^P	BA ^S	BA ^T			BA ^K	BA ^J	BA ^U	BF ^I	BF ^M	BF ^P	BF ^S	BF ^T	BF ^C	BF ^N	BF ^K	BF ^J	BF ^U						
Import from Hong Kor (CH)	A ^{HI}	A ^{HM}	A ^{HP}	A ^{HS}	A ^{HT}			A ^{HK}	A ^{HJ}	A ^{HU}	F ^{HI}	F ^{HM}	F ^{HP}	F ^{HS}	F ^{HT}	F ^{HC}	F ^{HN}	F ^{HK}	F ^{HJ}	F ^{HU}						
Import from EU (CO)	A ^{OI}	A ^{OM}	A ^{OP}	A ^{OS}	A ^{OT}			A ^{OK}	A ^{OJ}	A ^{OU}	F ^{OI}	F ^{OM}	F ^{OP}	F ^{OS}	F ^{OT}	F ^{OC}	F ^{ON}	F ^{OK}	F ^{OJ}	F ^{OU}						
Import from the R.O.W. (CW)	A ^{WI}	A ^{WM}	A ^{WP}	A ^{WS}	A ^{WT}			A ^{WK}	A ^{WJ}	A ^{WU}	F ^{WI}	F ^{WM}	F ^{WP}	F ^{WS}	F ^{WT}	F ^{WC}	F ^{WN}	F ^{WK}	F ^{WJ}	F ^{WU}						
Duties and Import Commodity Taxes (DT)	DA ^I	DA ^M	DA ^P	DA ^S	DA ^T			DA ^N	DA ^K	DA ^J	DA ^U	DF ^I	DF ^M	DF ^P	DF ^S	DF ^T	DF ^C	DF ^N	DF ^K	DF ^J	DF ^U					
Value Added (VV)	V ^I	V ^M	V ^P	V ^S	V ^T	V ^C	V ^N	V ^K	V ^J	V ^U																
Total Inputs (XX)	X ^I	X ^M	X ^P	X ^S	X ^T	X ^C	X ^N	X ^K	X ^J	X ^U																

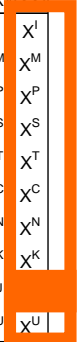


Calculation of Environmental Load

- Direct environmental load
: Energy production criterion
- Total output of energy \times emission coefficient

2000 Asian international input-output table

code	Intermediate Demand (A)										Final Demand (F)										Export (L)			Statistical Discrepancy (QX)	Total Outputs (XX)	
	(AI)	(AM)	(AP)	(AS)	(AT)	(AC)	(AN)	(AK)	(AJ)	(AU)	(FI)	(FM)	(FP)	(FS)	(FT)	(FC)	(FN)	(FK)	(FJ)	(FU)	(LH)	(LO)	(LW)			
Indonesia	A ^{II}	A ^{IM}	A ^{IP}	A ^{IS}	A ^{IT}	A ^{IC}	A ^{IN}	A ^{IK}	A ^{IJ}	A ^{IU}	F ^{II}	F ^{IM}	F ^{IP}	F ^{IS}	F ^{IT}	F ^{IC}	F ^{IN}	F ^{IK}	F ^{IJ}	F ^{IU}	L ^{IH}	L ^{IO}	L ^{IW}	Q ^I	X ^I	
Malaysia	A ^{MI}	A ^{MM}	A ^{MP}	A ^{MS}	A ^{MT}	A ^{MC}	A ^{MN}	A ^{MK}	A ^{MJ}	A ^{MU}	F ^{MI}	F ^{MM}	F ^{MP}	F ^{MS}	F ^{MT}	F ^{MC}	F ^{MN}	F ^{MK}	F ^{MJ}	F ^{MU}	L ^{MH}	L ^{MO}	L ^{MW}	Q ^M	X ^M	
Philippines	A ^{PI}	A ^{PM}	A ^{PP}	A ^{PS}	A ^{PT}	A ^{PC}	A ^{PN}	A ^{PK}	A ^{PJ}	A ^{PU}	F ^{PI}	F ^{PM}	F ^{PP}	F ^{PS}	F ^{PT}	F ^{PC}	F ^{PN}	F ^{PK}	F ^{PJ}	F ^{PU}	L ^{PH}	L ^{PO}	L ^{PW}	Q ^P	X ^P	
Singapore	A ^{SI}	A SM	A ^{SP}	A ^{SS}	A ST	A ^{SC}	A ^{SN}	A ^{SK}	A ^{SJ}	A ^{SU}	F ^{SI}	F SM	F ^{SP}	F ^{SS}	F ST	F ^{SC}	F ^{SN}	F ^{SK}	F ^{SJ}	F ^{SU}	L ^{SH}	L ^{SO}	L ^{SW}	Q ^S	X ^S	
Thailand	A ^{TI}	A TM	A ^{TP}	A ^{TS}	A ^{TT}	A ^{TC}	A ^{TN}	A ^{TK}	A ^{TJ}	A ^{TU}	F ^{TI}	F TM	F ^{TP}	F ^{TS}	F ^{TT}	F ^{TC}	F ^{TN}	F ^{TK}	F ^{TJ}	F ^{TU}	L TH	L ^{TO}	L ^{TW}	Q ^T	X ^T	
China	A ^{CI}	A ^{CM}	A ^{CP}	A ^{CS}	A ^{CT}	A ^{CC}	A ^{CN}	A ^{CK}	A ^{CJ}	A ^{CU}	F ^{CI}	F ^{CM}	F ^{CP}	F ^{CS}	F ^{CT}	F ^{CC}	F ^{CN}	F ^{CK}	F ^{CJ}	F ^{CU}	L ^{CH}	L ^{CO}	L ^{CW}	Q ^C	X ^C	
Taiwan	A ^{NI}	A ^{NM}	A ^{NP}	A ^{NS}	A ^{NT}	A ^{NC}	A ^{NN}	A ^{NK}	A ^{NJ}	A ^{NU}	F ^{NI}	F ^{NM}	F ^{NP}	F ^{NS}	F ^{NT}	F ^{NC}	F ^{NN}	F ^{NK}	F ^{NJ}	F ^{NU}	L ^{NH}	L ^{NO}	L ^{NW}	Q ^N	X ^N	
Korea	A ^{KI}	A ^{KM}	A ^{KP}	A ^{KS}	A ^{KT}	A ^{KC}	A ^{KN}	A ^{KK}	A ^{KJ}	A ^{KU}	F ^{KI}	F ^{KM}	F ^{KP}	F ^{KS}	F ^{KT}	F ^{KC}	F ^{KN}	F ^{KK}	F ^{KJ}	F ^{KU}	L ^{KH}	L ^{KO}	L ^{KW}	Q ^K	X ^K	
Japan	A ^{JI}	A ^{JM}	A ^{JP}	A ^{JS}	A ^{JT}	A ^{JC}	A ^{JN}	A ^{JK}	A ^{JJ}	A ^{JU}	F ^{JI}	F ^{JM}	F ^{JP}	F ^{JS}	F ^{JT}	F ^{JC}	F ^{JN}	F ^{JK}	F ^{JJ}	F ^{JU}	L ^{JH}	L ^{JO}	L ^{JW}	Q ^J	X ^J	
U.S.A.	A ^{UI}	A ^{UM}	A ^{UP}	A ^{US}	A ^{UT}	A ^{UC}	A ^{UN}	A ^{UK}	A ^{UJ}	A ^{UU}	F ^{UI}	F ^{UM}	F ^{UP}	F ^{US}	F ^{UT}	F ^{UC}	F ^{UN}	F ^{UK}	F ^{UJ}	F ^{UU}	L ^{UH}	L ^{UO}	L ^{UW}	Q ^U	X ^U	
Freight and Insurance(BF)	BA ^I	BA ^M	BA ^P	BA ^S	BA ^T	BA ^C	BA ^N	BA ^K	BA ^J	BA ^U	BF ^I	BF ^M	BF ^P	BF ^S	BF ^T	BF ^C	BF ^N	BF ^K	BF ^J	BF ^U						
Import from Hong Kor(CH)	A ^{HI}	A ^{HM}	A ^{HP}	A ^{HS}	A ^{HT}	A ^{HC}	A ^{HN}	A ^{HK}	A ^{HJ}	A ^{HU}	F ^{HI}	F ^{HM}	F ^{HP}	F ^{HS}	F ^{HT}	F ^{HC}	F ^{HN}	F ^{HK}	F ^{HJ}	F ^{HU}						
Import from EU	A ^{OI}	A ^{OM}	A ^{OP}	A ^{OS}	A ^{OT}	A ^{OC}	A ^{ON}	A ^{OK}	A ^{OJ}	A ^{OU}	F ^{OI}	F ^{OM}	F ^{OP}	F ^{OS}	F ^{OT}	F ^{OC}	F ^{ON}	F ^{OK}	F ^{OJ}	F ^{OU}						
Import from the R.O.(CW)	A ^{WI}	A ^{WM}	A ^{WP}	A ^{WS}	A ^{WT}	A ^{WC}	A ^{WN}	A ^{WK}	A ^{WJ}	A ^{WU}	F ^{WI}	F ^{WM}	F ^{WP}	F ^{WS}	F ^{WT}	F ^{WC}	F ^{WN}	F ^{WK}	F ^{WJ}	F ^{WU}						
Duties and Import Commodity Taxes	(DT)	DA ^I	DA ^M	DA ^P	DA ^S	DA ^T	DA ^C	DA ^N	DA ^K	DA ^J	DA ^U	DF ^I	DF ^M	DF ^P	DF ^S	DF ^T	DF ^C	DF ^N	DF ^K	DF ^J	DF ^U					
Value Added	(VV)	V ^I	V ^M	V ^P	V ^S	V ^T	V ^C	V ^N	V ^K	V ^J	V ^U															
Total Inputs	(XX)	X ^I	X ^M	X ^P	X ^S	X ^T	X ^C	X ^N	X ^K	X ^J	X ^U															



Calculation of Environmental Load

- Direct environmental load
: final energy use criterion
- Total energy use \times emission coefficient

2000 Asian international input-output table

	Intermediate Demand (A)										Final Demand (F)										Export (L)				Statistical Discrepancy	Total Outputs
	Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	U.S.A.	Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	U.S.A.	Export to Hong Kong	Export to EU	Export to R.O.W.	(QX)		
code	(AI)	(AM)	(AP)	(AS)	(AT)	(AC)	(AN)	(AK)	(AJ)	(AU)	(FI)	(FM)	(FP)	(FS)	(FT)	(FC)	(FN)	(FK)	(FJ)	(FU)	(LH)	(LO)	(LW)	(QX)	(XX)	
Indonesia (AI)	A ^{II}	A ^{IM}	A ^{IP}	A ^{IS}	A ^{IT}	A ^{IC}	A ^{IN}	A ^{IK}	A ^{IJ}	A ^{IU}	F ^{II}	F ^{IM}	F ^{IP}	F ^{IS}	F ^{IT}	F ^{IC}	F ^{IN}	F ^{IK}	F ^{IJ}	F ^{IU}	L ^{IH}	L ^{IO}	L ^{IW}	Q ^I	X ^I	
Malaysia (AM)	A ^{MI}	A ^{MM}	A ^{MP}	A ^{MS}	A ^{MT}	A ^{MC}	A ^{MN}	A ^{MK}	A ^{MJ}	A ^{MU}	F ^{MI}	F ^{MM}	F ^{MP}	F ^{MS}	F ^{MT}	F ^{MC}	F ^{MN}	F ^{MK}	F ^{MJ}	F ^{MU}	L ^{MH}	L ^{MO}	L ^{MW}	Q ^M	X ^M	
Philippines (AP)	A ^{PI}	A ^{PM}	A ^{PP}	A ^{PS}	A ^{PT}	A ^{PC}	A ^{PN}	A ^{PK}	A ^{PJ}	A ^{PU}	F ^{PI}	F ^{PM}	F ^{PP}	F ^{PS}	F ^{PT}	F ^{PC}	F ^{PN}	F ^{PK}	F ^{PJ}	F ^{PU}	L ^{PH}	L ^{PO}	L ^{PW}	Q ^P	X ^P	
Singapore (AS)	A ^{SI}	A SM	A ^{SP}	A ^{SS}	A ST	A ^{SC}	A ^{SN}	A ^{SK}	A ^{SJ}	A ^{SU}	F ^{SI}	F SM	F ^{SP}	F ^{SS}	F ST	F ^{SC}	F ^{SN}	F ^{SK}	F ^{SJ}	F ^{SU}	L ^{SH}	L ^{SO}	L ^{SW}	Q ^S	X ^S	
Thailand (AT)	A ^{TI}	A TM	A ^{TP}	A ^{TS}	A ^{TT}	A ^{TC}	A ^{TN}	A ^{TK}	A ^{TJ}	A ^{TU}	F ^{TI}	F TM	F ^{TP}	F ^{TS}	F ^{TT}	F ^{TC}	F ^{TN}	F ^{TK}	F ^{TJ}	F ^{TU}	L TH	L ^{TO}	L ^{TW}	Q ^T	X ^T	
China (AC)	A ^{CI}	A ^{CM}	A ^{CP}	A ^{CS}	A ^{CT}	A ^{CC}	A ^{CN}	A ^{CK}	A ^{CJ}	A ^{CU}	F ^{CI}	F ^{CM}	F ^{CP}	F ^{CS}	F ^{CT}	F ^{CC}	F ^{CN}	F ^{CK}	F ^{CJ}	F ^{CU}	L ^{CH}	L ^{CO}	L ^{CW}	Q ^C	X ^C	
Taiwan (AN)	A ^{NI}	A ^{NM}	A ^{NP}	A ^{NS}	A ^{NT}	A ^{NC}	A ^{NN}	A ^{NK}	A ^{NJ}	A ^{NU}	F ^{NI}	F ^{NM}	F ^{NP}	F ^{NS}	F ^{NT}	F ^{NC}	F ^{NN}	F ^{NK}	F ^{NJ}	F ^{NU}	L ^{NH}	L ^{NO}	L ^{NW}	Q ^N	X ^N	
Korea (AK)	A ^{KI}	A ^{KM}	A ^{KP}	A ^{KS}	A ^{KT}	A ^{KC}	A ^{KN}	A ^{KK}	A ^{KJ}	A ^{KU}	F ^{KI}	F ^{KM}	F ^{KP}	F ^{KS}	F ^{KT}	F ^{KC}	F ^{KN}	F ^{KK}	F ^{KJ}	F ^{KU}	L ^{KH}	L ^{KO}	L ^{KW}	Q ^K	X ^K	
Japan (AJ)	A ^{JI}	A ^{JM}	A ^{JP}	A ^{JS}	A ^{JT}	A ^{JC}	A ^{JN}	A ^{JK}	A ^{JJ}	A ^{JU}	F ^{JI}	F ^{JM}	F ^{JP}	F ^{JS}	F ^{JT}	F ^{JC}	F ^{JN}	F ^{JK}	F ^{JJ}	F ^{JU}	L ^{JH}	L ^{JO}	L ^{JW}	Q ^J	X ^J	
U.S.A. (AU)	A ^{UI}	A ^{UM}	A ^{UP}	A ^{US}	A ^{UT}	A ^{UC}	A ^{UN}	A ^{UK}	A ^{UJ}	A ^{UU}	F ^{UI}	F ^{UM}	F ^{UP}	F ^{US}	F ^{UT}	F ^{UC}	F ^{UN}	F ^{UK}	F ^{UJ}	F ^{UU}	L ^{UH}	L ^{UO}	L ^{UW}	Q ^U	X ^U	
Freight and Insurance (BF)	BA ^I	BA ^M	BA ^P	BA ^S	BA ^T	BA ^C	BA ^N	BA ^K	BA ^J	BA ^U	BF ^I	BF ^M	BF ^P	BF ^S	BF ^T	BF ^C	BF ^N	BF ^K	BF ^J	BF ^U						
Import from Hong Kor (CH)	A ^{HI}	A ^{HM}	A ^{HP}	A ^{HS}	A ^{HT}	A ^{HC}	A ^{HN}	A ^{HK}	A ^{HJ}	A ^{HU}	F ^{HI}	F ^{HM}	F ^{HP}	F ^{HS}	F ^{HT}	F ^{HC}	F ^{HN}	F ^{HK}	F ^{HJ}	F ^{HU}						
Import from EU (CO)	A ^{OI}	A ^{OM}	A ^{OP}	A ^{OS}	A ^{OT}	A ^{OC}	A ^{ON}	A ^{OK}	A ^{OJ}	A ^{OU}	F ^{OI}	F ^{OM}	F ^{OP}	F ^{OS}	F ^{OT}	F ^{OC}	F ^{ON}	F ^{OK}	F ^{OJ}	F ^{OU}						
Import from the R.O.W. (CW)	A ^{WI}	A ^{WM}	A ^{WP}	A ^{WS}	A ^{WT}	A ^{WC}	A ^{WN}	A ^{WK}	A ^{WJ}	A ^{WU}	F ^{WI}	F ^{WM}	F ^{WP}	F ^{WS}	F ^{WT}	F ^{WC}	F ^{WN}	F ^{WK}	F ^{WJ}	F ^{WU}						
Duties and Import Commodity Taxes (DT)	DA ^I	DA ^M	DA ^P	DA ^S	DA ^T	DA ^C	DA ^N	DA ^K	DA ^J	DA ^U	DF ^I	DF ^M	DF ^P	DF ^S	DF ^T	DF ^C	DF ^N	DF ^K	DF ^J	DF ^U						
Value Added (VV)	V ^I	V ^M	V ^P	V ^S	V ^T	V ^C	V ^N	V ^K	V ^J	V ^U																
Total Inputs (XX)	X ^I	X ^M	X ^P	X ^S	X ^T	X ^C	X ^N	X ^K	X ^J	X ^U																

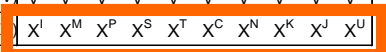
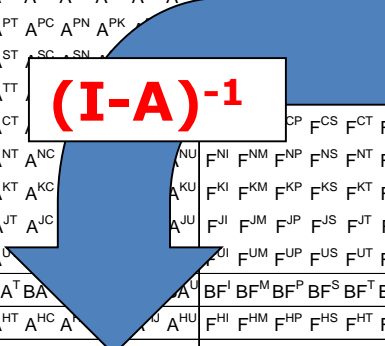
◎ Calculation of Environmental Load

- Direct and indirect environmental load
: Final goods consumption criterion
- Output Inducement \times emission coefficient

2000 Asian international input-output table

	Intermediate Demand (A)										Final Demand (F)										Export (L)				Total Outputs
	Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	U.S.A.	Indonesia	Malaysia	Philippines	Singapore	Thailand	China	Taiwan	Korea	Japan	U.S.A.	Export to Hong Kong	Export to EU	Export to R.O.W.	Statistical Discrepancy	
code	(AI)	(AM)	(AP)	(AS)	(AT)	(AC)	(AN)	(AK)	(AJ)	(AU)	(FI)	(FM)	(FP)	(FS)	(FT)	(FC)	(FN)	(FK)	(FJ)	(FU)	(LH)	(LO)	(LW)	(QX)	(XX)
Indonesia (AI)	A ^{II}	A ^{IM}	A ^{IP}	A ^{IS}	A ^{IT}	A ^{IC}	A ^{IN}	A ^{IK}	A ^{IJ}	A ^{IU}	F ^{II}	F ^{IM}	F ^{IP}	F ^{IS}	F ^{IT}	F ^{IC}	F ^{IN}	F ^{IK}	F ^{IJ}	F ^{IU}	L ^{IH}	L ^{IO}	L ^{IW}	Q ^I	X ^I
Malaysia (AM)	A ^{MI}	A ^{MM}	A ^{MP}	A ^{MS}	A ^{MT}	A ^{MC}	A ^{MN}	A ^{MK}	A ^{MJ}	A ^{MU}	F ^{MI}	F ^{MM}	F ^{MP}	F ^{MS}	F ^{MT}	F ^{MC}	F ^{MN}	F ^{MK}	F ^{MJ}	F ^{MU}	L ^{MH}	L ^{MO}	L ^{MW}	Q ^M	X ^M
Philippines (AP)	A ^{PI}	A ^{PM}	A ^{PP}	A ^{PS}	A ^{PT}	A ^{PC}	A ^{PN}	A ^{PK}			F ^{PI}	F ^{PM}	F ^{PP}	F ^{PS}	F ^{PT}	F ^{PC}	F ^{PN}	F ^{PK}		F ^{PU}	L ^{PH}	L ^{PO}	L ^{PW}	Q ^P	X ^P
Singapore (AS)	A ^{SI}	A SM	A ^{SP}	A ^{SS}	A ST	A ^{SC}	A ^{SN}				F ^{SI}	F SM	F ^{SP}	F ^{SS}	F ST	F ^{SC}	F ^{SN}			F ^{SU}	L ^{SH}	L ^{SO}	L ^{SW}	Q ^S	X ^S
Thailand (AT)	A ^{TI}	A TM	A ^{TP}	A ^{TS}	A ^{TT}						F ^{TI}	F TM	F ^{TP}	F ^{TS}	F ^{TT}	F ^{TC}	F ^{TN}	F ^{TK}	F ^{TJ}	F ^{TU}	L TH	L ^{TO}	L ^{TW}	Q ^T	X ^T
China (AC)	A ^{CI}	A ^{CM}	A ^{CP}	A ^{CS}	A ^{CT}						F ^{CI}	F ^{CM}	F ^{CP}	F ^{CS}	F ^{CT}	F ^{CC}	F ^{CN}	F ^{CK}	F ^{CJ}	F ^{CU}	L ^{CH}	L ^{CO}	L ^{CW}	Q ^C	X ^C
Taiwan (AN)	A ^{NI}	A ^{NM}	A ^{NP}	A ^{NS}	A ^{NT}	A ^{NC}					F ^{NI}	F ^{NM}	F ^{NP}	F ^{NS}	F ^{NT}	F ^{NC}	F ^{NN}	F ^{NK}	F ^{NJ}	F ^{NU}	L ^{NH}	L ^{NO}	L ^{NW}	Q ^N	X ^N
Korea (AK)	A ^{KI}	A ^{KM}	A ^{KP}	A ^{KS}	A ^{KT}	A ^{KC}					F ^{KI}	F ^{KM}	F ^{KP}	F ^{KS}	F ^{KT}	F ^{KC}	F ^{KN}	F ^{KK}	F ^{KJ}	F ^{KU}	L ^{KH}	L ^{KO}	L ^{KW}	Q ^K	X ^K
Japan (AJ)	A ^{JI}	A ^{JM}	A ^{JP}	A ^{JS}	A ^{JT}	A ^{JC}					F ^{JI}	F ^{JM}	F ^{JP}	F ^{JS}	F ^{JT}	F ^{JC}	F ^{JN}	F ^{JK}	F ^{JJ}	F ^{JU}	L ^{JH}	L ^{JO}	L ^{JW}	Q ^J	X ^J
U.S.A. (AU)	A ^{UI}	A ^{UM}	A ^{UP}	A ^{US}	A ^{UT}						F ^{UI}	F ^{UM}	F ^{UP}	F ^{US}	F ^{UT}	F ^{UC}	F ^{UN}	F ^{UK}	F ^{UJ}	F ^{UU}	L ^{UH}	L ^{UO}	L ^{UW}	Q ^U	X ^U
Freight and Insurance (BF)	BA ^I	BA ^M	BA ^P	BA ^S	BA ^T	BA ^C	BA ^N	BA ^K	BA ^J	BA ^U	BF ^I	BF ^M	BF ^P	BF ^S	BF ^T	BF ^C	BF ^N	BF ^K	BF ^J	BF ^U					
Import from Hong Kor (CH)	A ^{HI}	A ^{HM}	A ^{HP}	A ^{HS}	A ^{HT}	A ^{HC}					F ^{HI}	F ^{HM}	F ^{HP}	F ^{HS}	F ^{HT}	F ^{HC}	F ^{HN}	F ^{HK}	F ^{HJ}	F ^{HU}					
Import from EU (CO)	A ^{OI}	A ^{OM}	A ^{OP}	A ^{OS}	A ^{OT}	A ^{OC}	A ^{ON}	A ^{OK}	A ^{OJ}	A ^{OU}	F ^{OI}	F ^{OM}	F ^{OP}	F ^{OS}	F ^{OT}	F ^{OC}	F ^{ON}	F ^{OK}	F ^{OJ}	F ^{OU}					
Import from the R.O.W. (CW)	A ^{WI}	A ^{WM}	A ^{WP}	A ^{WS}	A ^{WT}	A ^{WC}	A ^{WN}	A ^{WK}	A ^{WJ}	A ^{WU}	F ^{WI}	F ^{WM}	F ^{WP}	F ^{WS}	F ^{WT}	F ^{WC}	F ^{WN}	F ^{WK}	F ^{WJ}	F ^{WU}					
Duties and Import Commodity Taxes (DT)	DA ^I	DA ^M	DA ^P	DA ^S	DA ^T	DA ^C	DA ^N	DA ^K	DA ^J	DA ^U	DF ^I	DF ^M	DF ^P	DF ^S	DF ^T	DF ^C	DF ^N	DF ^K	DF ^J	DF ^U					
Value Added (VV)	V ^I	V ^M	V ^P	V ^S	V ^T	V ^C	V ^N	V ^K	V ^J	V ^U															
Total Inputs (X)	X ^I	X ^M	X ^P	X ^S	X ^T	X ^C	X ^N	X ^K	X ^J	X ^U															

$(I-A)^{-1}$



Environmental load of Energy & CO2

- CO2 trade matrix
 - Amount of CO2 missions
 - From which country To which country
- Taking only fossil energies into account
 - Coal, Petroleum, Natural gas
 - CO2 emission of industrial process are not considered
 - Other GHG and carbon sinks in forests are not considered either

Fossil fuel and CO2 emission

Ton/TOE	CO2	Carbon
Coal	4.018	1.096
Petroleum	3.313	0.903
Natural Gas	2.317	0.632

- Total CO2 Emission
 - Each energy consumption × the emission coefficient

Transaction Table for Environmental Load

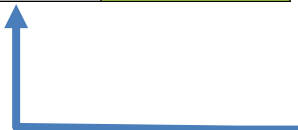
- Columns: regions that generated final demand
- Rows: the regions that consumed energy
- ①—②: “Trade Balance” for Energy and CO2 emission

	In	Ma	Ph
Indonesia	21.0	0.1	0.1
Malaysia	0.0	6.3	① 0.1
Philippines	0.0	② 0.1	6.7

① Malaysia's CO2 export to Philippine's



② Philippine's CO2 export to Malaysia



Energy Transaction matrix in 1985

(Unit: million TOE)

	In	Ma	Ph	Si	Th	Ch	Ta	Ko	JPN	USA	ROW	Total
Indonesia	21.0	0.1	0.1	0.2	0.0	0.1	0.0	0.1	1.2	0.8	1.3	25.0
Malaysia	0.0	6.3	0.1	0.3	0.1	0.1	0.0	0.1	0.4	1.3	2.7	11.5
Philippines	0.0	0.1	6.7	0.0	0.0	0.0	0.0	0.0	0.3	0.7	1.0	8.9
Singapore	0.2	0.3	0.0	2.2	0.1	0.0	0.0	0.0	0.4	0.5	3.8	7.6
Thailand	0.0	0.1	0.0	0.0	11.2	0.1	0.0	0.0	0.3	0.4	2.6	14.7
China	0.4	0.5	0.4	1.1	0.5	367.6	0.1	0.1	7.1	6.2	27.3	411.2
Taiwan	0.1	0.1	0.0	0.1	0.1	0.3	12.1	0.1	0.9	4.9	4.0	22.8
Korea	0.1	0.1	0.1	0.1	0.1	0.0	0.1	22.3	1.3	3.6	7.0	34.6
Japan	0.8	0.5	0.1	0.5	0.6	4.0	0.8	1.4	241.4	16.1	25.0	291.2
USA	0.8	0.7	0.3	0.7	0.4	2.3	1.29	2.1	9.4	1,343.9	104.1	1,466.1
Total	23.4	8.7	7.7	5.3	13.0	374.6	14.4	26.2	262.7	1,378.5	178.9	2,293.5

Energy Transaction matrix in 2000

(Unit: million TOE)

	In	Ma	Ph	Si	Th	Ch	Ta	Ko	Japan	USA	ROW	Total
Indonesia	61.5	0.8	0.4	0.7	0.7	1.7	0.9	1.4	5.3	6.5	17.8	97.7
Malaysia	0.4	17.4	0.4	1.6	0.6	1.6	0.8	0.7	3.9	7.7	16.7	51.8
Philippines	0.0	0.1	14.0	0.0	0.1	0.2	0.2	0.2	1.0	2.3	3.7	21.9
Singapore	0.2	0.5	0.3	6.1	0.3	0.8	0.4	0.3	0.7	1.6	10.7	21.8
Thailand	0.2	0.4	0.2	0.4	33.5	0.8	0.4	0.3	2.5	4.0	13.5	56.1
China	1.2	1.3	0.5	1.4	1.6	650.9	2.6	5.2	27.6	52.4	105.1	849.7
Taiwan	0.2	0.3	0.2	0.2	0.4	4.0	40.5	0.4	2.3	5.7	16.0	70.3
Korea	0.6	0.4	0.4	0.3	0.4	5.6	1.1	103.0	5.3	8.3	30.0	155.3
Japan	0.4	0.6	0.2	0.6	0.7	2.4	1.5	1.4	274.7	10.0	20.6	313.1
USA	0.6	0.9	0.5	0.9	0.9	4.1	3.2	3.8	13.4	1,658.6	161.7	1,848.6
Total	65.3	22.6	17.1	12.2	39.2	672.2	51.6	116.6	336.8	1,757.0	395.8	3,486.4

Energy Transaction matrix in 2005

(Unit: million TOE)

	In	Ma	Ph	Si	Th	Ch	Ta	Ko	Japan	USA	ROW	Total
Indonesia	90.0	1.0	0.3	1.5	1.4	3.0	0.9	2.7	5.0	6.4	7.1	119.3
Malaysia	0.6	26.4	0.3	2.3	1.1	2.5	0.7	1.0	2.6	7.9	15.1	60.6
Philippines	0.1	0.2	17.0	0.1	0.2	0.8	0.3	0.4	1.2	2.9	1.5	24.6
Singapore	0.3	0.7	0.2	5.5	0.5	1.1	0.4	0.4	0.5	1.5	11.4	22.7
Thailand	0.8	1.1	0.4	0.9	59.8	3.0	0.7	0.9	4.2	6.5	8.3	86.5
China	4.0	3.7	1.3	4.8	3.7	1,030.3	5.2	14.3	44.6	91.3	160.5	1,363.7
Taiwan	0.3	0.4	0.1	0.3	0.5	5.9	40.7	0.8	2.2	5.9	22.4	79.5
Korea	0.5	0.5	0.2	0.4	0.4	6.4	0.9	99.8	3.7	6.6	11.2	130.7
Japan	0.8	0.9	0.4	1.0	1.4	6.7	2.7	3.8	332.3	13.7	17.2	380.8
USA	0.8	1.0	0.4	1.4	1.1	6.6	2.8	5.8	14.5	1,706.1	50.7	1,791.1
Total	98.1	35.9	20.6	18.2	70.2	1,066.5	55.1	129.9	410.7	1,848.7	305.6	4,059.5

CO2 Transaction matrix in 1985

(Unit: million Ton)

	In	Ma	Ph	Si	Th	Ch	Ta	Ko	JPN	USA	ROW	Total
Indonesia	64.9	0.2	0.2	0.6	0.1	0.4	0.1	0.2	3.5	2.4	3.9	76.4
Malaysia	0.1	20.0	0.3	1.0	0.2	0.2	0.1	0.3	1.4	4.1	8.2	35.9
Philippines	0.0	0.3	22.9	0.1	0.1	0.1	0.1	0.1	1.0	2.4	3.5	30.6
Singapore	0.6	1.0	0.0	7.3	0.5	0.1	0.1	0.1	1.3	1.8	12.5	25.3
Thailand	0.0	0.2	0.0	0.1	35.7	0.2	0.1	0.1	0.8	1.3	8.6	47.2
China	1.7	2.0	1.5	4.1	1.8	1,403.0	0.2	0.3	27.0	23.6	104.0	1,569.2
Taiwan	0.4	0.3	0.1	0.4	0.3	1.2	42.3	0.4	3.1	17.2	14.0	79.6
Korea	0.4	0.3	0.2	0.3	0.2	0.1	0.2	78.2	4.5	13.0	24.8	122.1
Japan	2.7	1.6	0.3	1.7	2.0	14.1	2.7	4.9	810.9	55.6	85.9	982.5
USA	2.5	2.2	0.9	2.3	1.2	7.5	4.2	6.7	30.6	4,427.6	332.3	4,818.0
Total	73.3	28.2	26.4	17.9	42.1	1,426.9	50.0	91.3	884.0	4,548.9	597.7	7,786.8

CO2 Transaction matrix in 2000

(Unit: million Ton)

	In	Ma	Ph	Si	Th	Ch	Ta	Ko	JPN	USA	ROW	Total
Indonesia	184.1	2.3	1.2	2.1	2.0	5.0	2.8	3.9	15.9	19.4	52.9	291.6
Malaysia	1.1	46.8	1.1	4.6	1.8	4.5	2.3	2.1	11.4	22.5	48.0	146.2
Philippines	0.1	0.3	49.1	0.2	0.3	0.8	0.5	0.5	3.4	8.0	12.9	76.0
Singapore	0.5	1.8	1.1	19.7	1.0	2.5	1.2	0.9	2.4	5.1	35.0	71.2
Thailand	0.7	1.2	0.5	1.2	103.7	2.5	1.2	0.9	7.8	12.6	42.0	174.3
China	4.6	4.8	1.9	5.3	6.2	2,466.4	9.9	19.5	104.3	198.5	399.4	3,220.8
Taiwan	0.8	1.1	0.6	0.6	1.3	14.2	143.0	1.5	8.3	20.1	56.2	247.7
Korea	1.9	1.2	1.3	1.0	1.3	19.5	4.0	356.2	18.3	28.7	103.3	536.8
Japan	1.3	2.1	0.8	1.9	2.4	8.4	5.1	4.9	919.1	34.1	70.4	1,050.6
USA	1.9	2.8	1.6	2.9	3.0	13.1	10.4	12.0	43.0	5,448.3	518.5	6,057.5
Total	197.1	64.5	59.2	39.5	122.9	2,537.0	180.3	402.6	1,133.8	5,797.2	1,338.7	11,872.8

CO2 Transaction matrix in 2005

(Unit: million Ton)

	In	Ma	Ph	Si	Th	Ch	Ta	Ko	JPN	USA	ROW	Total
Indonesia	284.0	3.0	1.0	4.7	4.2	9.6	2.7	8.1	15.6	20.2	22.2	375.1
Malaysia	1.6	76.2	0.8	6.7	3.2	7.1	2.1	3.0	7.7	22.7	44.5	175.6
Philippines	0.2	0.7	57.7	0.4	0.7	2.8	0.9	1.3	4.0	9.7	5.1	83.4
Singapore	0.9	2.2	0.6	15.9	1.7	3.6	1.1	1.2	1.7	4.6	35.8	69.2
Thailand	2.4	3.6	1.3	2.8	181.5	9.2	2.1	2.7	13.0	20.0	25.7	264.1
China	15.5	14.1	4.8	18.8	14.2	3,954.7	20.3	55.1	172.2	353.3	621.2	5,244.3
Taiwan	1.0	1.5	0.4	1.0	1.9	21.2	144.3	3.0	7.7	21.1	78.7	281.8
Korea	1.8	1.6	0.8	1.3	1.4	22.3	3.0	341.9	12.7	22.5	38.4	447.8
Japan	2.8	3.2	1.3	3.4	4.9	23.2	9.1	13.0	1,112.5	47.2	59.2	1,279.7
USA	2.5	3.1	1.2	4.3	3.5	20.9	8.8	18.4	46.3	5,618.0	161.4	5,888.5
Total	312.8	109.3	70.0	59.3	217.1	4,074.5	194.4	447.6	1,393.2	6,139.1	1,092.2	14,109.6

Energy and CO2 Trade Balance 1

- Total energy consumption & CO2 emissions
 - Top3: USA, China, and Japan
 - China's growth is remarkable
- Characteristics: Japan and USA
 - 1980s: goods producer and goods consumer
= The two country induced the other countries' energy consumption, at the same time, the others induced the two countries' energy consumption
 - 2000s: shifted their position to goods consumer (induced more energy consumption in the other countries.)

Energy and CO2 Trade Balance 2

- Characteristics: China
 - In 2000: “Factory in the Asia-Pacific region”
 - 23.4% of China’s energy consumption (around 850toe) was induced by foreign demand
 - In 2005: “CO2 provider and demander”
 - China is becoming like USA or Japan in 1985

Policy implication

- Final Goods consumption criterion
 - Burden sharing among developed countries and developing countries
 - Low carbon incentive for developing countries
- International agreement (in UNFCCC)
 - Introduction of “carbon invoice” is new type of International environmental cooperation
 - China may agree to have a cap for CO₂ emissions