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TECHNOLOGICAL DISTANCE BETWEEN INDONESIA AND BRAZIL: A COMPARATIVE STUDY OF TECHNICAL INPUT STRUCTURE

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I. INTRODUCTION

IN this paper we compare input-output tables and their technical coefficients for Indonesia and Brazil, and define the technological distance between the two countries based on a new measure. Such a study can check the basic assumption of convergence theory, and clarify further the globalizing movement of the world economy.

When Indonesia started its Second 25-Year Long-Term Development Plan (PJP II) in 1994, it planned to increase its per capita income to U.S.$3,800 in twenty-five years, which is nearly the current level for Brazil. In a sense this made Brazil the reference or target country for economic development, and the economic distance between the two was thirty years measured in terms of per capita income. When two countries are following a similar path of industrialization, we can imagine that the changing trend of technical coefficients is also similar although many idiosyncratic factors give various disturbances in creating this similarity. We therefore assume that Indonesian technological know-how is catching up to that of Brazil with a time lag of fifteen–twenty years. In this paper we try to empirically check this assumption. Of course the structure of technical coefficients is manifested in a matrix. So when tables are available in Indonesia and Brazil for different time dates, our problems is how to compare the two matrices to check their similarity. This is a complex and tedious task. We can start by comparing each coefficient, then each sectoral input structure, and finally of all the coefficients (entire matrix) altogether. The comparison at each stage and the conclusion may or may not be similar. But our final purpose is to obtain useful knowledge about the similarity of the technical structures in the two countries, and the possibility to infer the future technical structure of Indonesia based on the information of changes that have taken place in Brazil's technical structure.

If knowledge or technologies are in principle internationally public goods and available to every country, the country lagging behind in terms of per capita income

can catch up faster to front-runners based on their cheaper wages. Based on such a vision of conversion theory, the technological distance, when properly measured, must be smaller than the economic distance. We intend to check this assumption empirically for these two countries.[1]

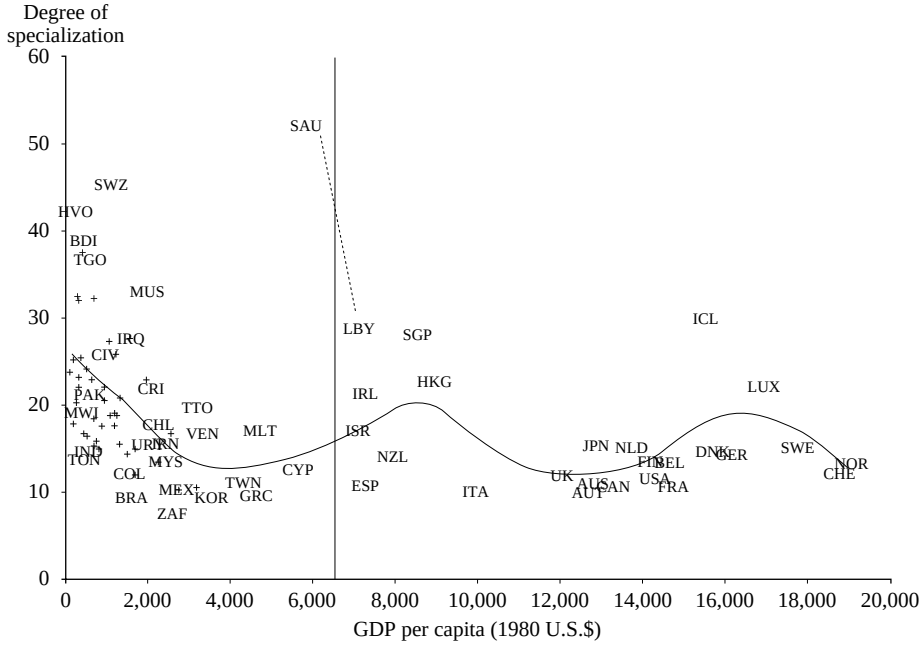
This paper will proceed as follows. In Section II we compare Indonesia and Brazil, and explain why we have chosen Brazil as a suitable reference country. In Section III, we explain the results of a comparison of the leading input coefficient. In Section IV we explain the results of a comparison of the sectoral technical coefficient vectors, and the matrices of their weighted average. Section V contains our summary and conclusions.

II. COMPARISON OF THE INDONESIAN AND BRAZILIAN ECONOMIES

Countries tend to follow a common course of change in their industrial structure. Figure 1 refers to a diagram taken from the annual report of the United Nations Industrial Development Organization (UNIDO 1992), and shows a cross-sectional trend of change in the manufacturing sector. It exhibits a double-V type trend in the relation between the degree of specialization (DS), which is the average of the squared sum of subsectoral shares, and the level of per capita GDP (in 1990 U.S. dollars). When a country starts to industrialize at a low per capita income, the DS can be as high as 20–30 because the manufacturing sector mainly consists of a few simple activities like textile weaving, food and beverage, and wood-products processing. In the course of economic development, the DS gradually decreases as new complex activities like chemical processing and heavy industries grow, the manufacturing sector becomes more diversified, and the per capita GDP rises to about the U.S.$4,000 level. After passing that level, V-shaped trend once again appears as some countries cultivate their own strategically important subsectors based on their new comparative advantage structures. Indonesia and Brazil have been following this common trend. Figure 1 also suggests that many idiosyncratic factors including demographic and geographic size exert a strong influence and in some cases cause a substantial divergence from the common trend. Fortunately the size of the population in Indonesia (200 million) and Brazil (160 million) is quite big, and the extent of their territory (about twenty-four times of Japan) is also similar. So we can expect that such disturbances might be minor when comparing the two countries. (Important exceptions are small economies like Hong Kong, Lux-

[1] We tried to measure the technological distance based on input coefficients. There are many other possible ways of measuring. One can observe the capital-labor ratio like Alauddin and Tisdell (1988), size distribution like Nugent and Nabli (1992), systematic competitiveness like Meyer and Stamer (1992), or directly analyze the diffusion process like Lücke (1993).

Fig. 1. Trend of Specialization and Development, 1990

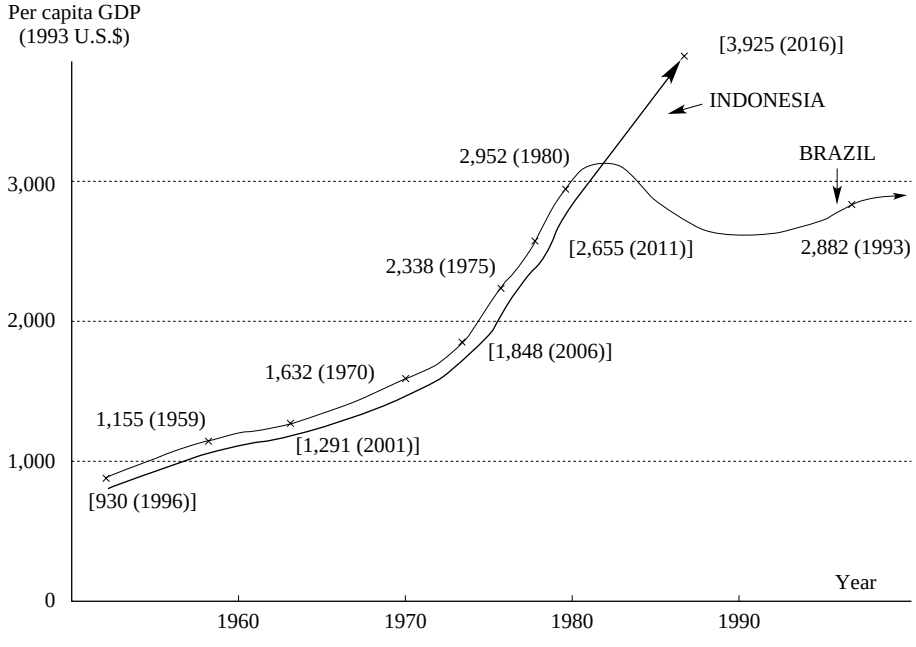


Sources: UNIDO (1992), p. 17, quoting United Nations National Accounts Statistics and UNIDO database.
Note: AUS: Australia, AUT: Austria, BDI: Burundi, BEL: Belgiun, BRA: Brazil, CAN: Canada, CHE: Switzerland, CHL: Chile, CIV: Côte d'Ivoire, COL: Colombia, CRI: Costa Rica, CYP: Cyprus, DNK: Denmark, ESP: Spain, FIN: Finland, FRA: France, GER: Germany, GRC: Greece, HKG: Hong Kong, HVO: Burkina Faso, ICL: Iceland, IND: India, IRL: Ireland, IRN: Iran, Islamic Republic of, IRQ: Iraq, ISR: Israel, ITA: Italy, JPN: Japan, KOR: Republic of Korea, LBY: Libyan Arab Jamahiriya, LUX: Luxembourg, MLT: Malta, MUS: Mauritius, MWI: Malawi, MYS: Malaysia, NLD: Netherlands, NOR: Norway, NZL: New Zealand, PAK: Pakistan, SAU: Saudi Arabia, SGP: Singapore, SWE: Sweden, SWZ: Swaziland, TGO: Togo, TON: Tonga, TTO: Trinidad and Tobago, TWN: Taiwan Province, UK: United Kingdom, URY: Uruguay, USA: United States, VEN: Venezuela, ZAF: South Africa.

embourg, Iceland, and Singapore. They became highly industrialized based on a few selected branches without realizing a diversified sectoral structure, thus the degree of specialization is always high.)

Figure 2 shows the growth of per capita GDP based on 1993 prices. Brazil stood at U.S.$1,155 in 1959 and grew to U.S.$2,952 in 1980 before entering into the lost decade of the 1980s and recovery in the 1990s. Indonesia was at U.S.$930 in 1996, and was predicted to grow to U.S.$2,655 in 2011 and U.S.$3,925 in 2016 if it could have successfully realized rapid industrialization without the economic turmoil af-

Fig. 2. Economic Development: Brazil and Indonesia



ter 1997.[2] Without this turmoil Indonesia would have reached U.S.$1,155 in 1997 (thirty-eight years after Brazil), U.S.$1,632 in 2004 (thirty-four years after Brazil), U.S.$2,338 in 2008 (thirty-three years after Brazil), and U.S.$2,952 in 2012 (thirty-two years after Brazil).

Patel (1964) compared the time for a lagging country to catch up to the same per

[2] The values of per capita GDP for Brazil were calculated from the official figures by the International Monetary Fund. According to the 1994 yearbook, the relevant figures were as follows. (The figures based on 1993 prices were converted from 1958 base figures when necessary.)

Year	Real GDP per Capita (U.S.$)		Exchange Rate
	(P1993)	(P1958)	
1959	1,155	195.35	1.510E–10
1970	1,632	275.75	4.594E–9
1975	2,338	395.50	8.127E–06
1980	2,952	499.31	5.271E–05
1993	2,882	487.49	88.45

The figures for Indonesia until 2018 are from a conditional projection based on the JICA (Japan International Cooperation Agency) Study Team model in the JICA project for the long-term projection of the Indonesian economy. That project sought to construct a long-term programming model to check the feasibility, consistency, and optimality of a twenty-five-year long-term plan. The study team constructed a nonlinear programming model which contained 650 variables [five

capita income level of an advanced country. He defined this as the economic distance between two countries. For example the United States reached a per capita income of U.S.$200 (1952–54 prices) in 1832 while Japan reached to that level at 1955; the economic distance between the two countries was 123 years. In a similar manner, we could define the technological distance between two countries as X years when a lagging country realizes a similar technical structure as that of an advanced country after X years. In this way we are interested in measuring the economic distance between manufacturing sectors in Brazil and Indonesia.

The next problem is the complex structure of sectoral decomposition and technologies. We can quickly access the different decompositional structures through a radar diagram. Figures 3 and 4 show the changes of value added in 1980–85, 1985–90, and 1990–93 for major sectors in the manufacturing sector of Indonesia and Brazil. The biggest and most rapidly growing subsectors are as follows:

Biggest subsectors in value-added (*1990*)*:*

Indonesia: 353 (petroleum refineries), 321 (textiles), 311 (food products), 331 (wood and wood products), 314 (tobacco);

Brazil: 311 (food products), 382 (non-electrical machinery), 383 (electrical machinery), 371 (iron and steel), 321 (textiles);

Rapidly growing subsectors (*1980–90*)*:*

Indonesia: 381 (metal products), 371 (iron and steel), 356 (plastic products), 33 (wood products, furniture), 34 (paper and printing);

Brazil: 323, 324 (leather, footwear), 355 (rubber products), 383 (electrical machinery), 372 (nonferrous metal).

Both countries have a large population and large geographical size. But the leading growth sectors are clearly different. The core subsectors in Indonesia are still light manufacturing, while in Brazil they are the heavy manufacturing subsectors. In this sense Brazil's industrial structure is much more diversified.

The difference in sectorial structure between two countries can be explained in part by the difference in development stage between the two, even when the two countries follow the common course of change. But the many idiosyncratic factors of each country influence the development of each sector which can make the decompositional structures and the technological level of each sector different, even if two countries are similar in demographic and geographical size.

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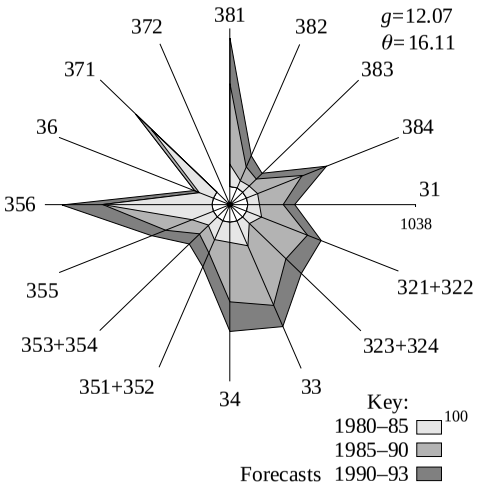
kinds (output, consumption, investment, exports, and imports for final use), five periods (of five years each), twenty-eight sectors] for the national version, and 1,300 variables for the two-region version. The team calculated the optimum solutions to maximize the target function under structural constraints. The nonlinear target function was a sum of the consumption component and the capital stock of the last period, while the main structural constraints were skilled labor, capital and foreign currency. In that project, the future technical coefficients until the year 2018 were projected by the RECRAS-QP method based on the Japanese input-output table. But it was strongly felt that the changing trend of input coefficients had to also be cross-checked based on the trend in a suitable developing country. In this paper we adopted Brazil as the reference country.

Fig. 3. Structural Change of the Indonesian Manufacturing Sector

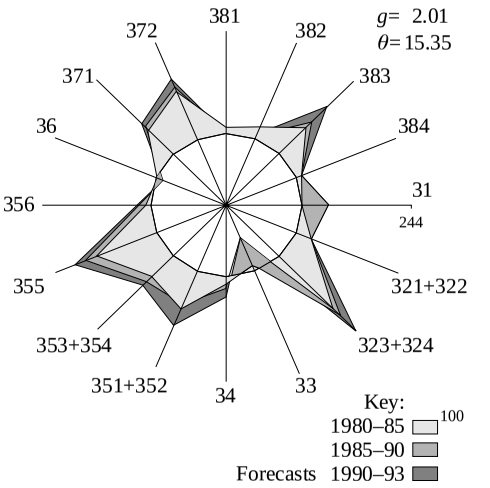
(Index of value added: 1980=100)



	1980	1985	1990
GDP: na, c (1980 U.S.$ million)	78,013	99,479	134,223
Per capita (1980 U.S.$) /na, c	517	595	728
Manufacturing share (%) /na (current prices)	13.0	16.0	18.8 /e
Manufacturing:			
Value added /na, c (1980 U.S.$ million)	10,133	18,632	30,765
Industrial production index	100	108	174
Value added (U.S.$ million)	4,368	8,098 /e	12,554 /e
Gross output (U.S.$ million)	13,205	22,559	38,538 /e
Employment (1,000)	963	1,672	2,378 /e
—Profitability: (in % of gross output)			
Intermediate input (%)	69	69	71 /e
Wages and salaries (%)	7	7	6 /e
Operating surplus (%)	25	24	23 /e

Fig. 4. Structural Change of the Brazilian Manufacturing Sector

(Index of value added: 1980=100)



	1980	1985	1990
GDP: /na, c (1980 U.S.$ million)	233,962	254,528	280,690
Per capita (1980 U.S.$) /na, c	1,929	1,878	1,865
Manufacturing share (%) /na (current prices)	30.2	30.7	30.2 /e
Manufacturing:			
Value added /na, c (1980 U.S.$ million)	79,245	76,318	78,003
Industrial production index	100	98	103
Value added (U.S.$ million)	71,690	74,568	118,743 /e
Gross output (U.S.$ million)	176,174	169,004	382,411 /e
Employment (1,000)	4,449	4,067	3,962 /e
—Profitability: (in % of gross output)			
Intermediate input (%)	59	56	69 /e
Wages and salaries (%)	7	9	9 /e
Operating surplus (%)	34	35	22 /e

—Productivity: (U.S.$)						
Gross output/worker		11,290		12,401	15,357	/e
Value added/worker		3,519		3,880	4,467	/e
Average wage		743		921	935	/e
—Structural indices:						
Structural change θ (5-year average in degrees)		12.26		11.69 /e	6.71	/e
as a percentage of average θ in 1970–75		104		99 /e	57	/e
MVA growth rate/θ		1.10		1.36	1.82	
Degree of specialization		20.5		16.6	16.0	
—Value added: (U.S.$ million)						
311	Food products	376		870	1,283	/e
313	Beverages	51		77	80	/e
314	Tobacco products	649		741	1,158	/e
321	Textiles	420		687	1,373	/e
322	Wearing apparel	15		105	244	/e
323	Leather and fur products	5		14	15	/e
324	Footwear	26		31	94	/e
331	Wood and wood products	239		612	1,230	/e
332	Furniture and fixtures	6		18	51	/e
341	Paper and paper products	43		110	269	/e
342	Printing and publishing	51		92	156	/e
351	Industrial chemicals	145		385	475	/e
352	Other chamical products	241		430	486	/e
353	Petroleum refineries	978		1,611 /e	1,933	/e
354	Mescellaneous petroleum and coal products	—		—	—	/e
355	Rubber products	164		328	516	/e
356	Plastic products	25		175	148	/e
361	Pottery, china, and earthenware	8		24	49	/e
362	Glass and glass products	36		98	58	/e
369	Other non-metal mineral products	200		262	222	/e
371	Iron and steel	107		469 b	742 b	/e
372	Nonferrous metals	—		b	b	
381	Metal products	118		278	732	/e
382	Non-electrical machinery	53		76	108	/e
383	Electrical machinery	180		246	291	/e
384	Transport equipment	217		331	769	/e
385	Professional and scientific equipment	2		4	7	/e
390	Other manufacturing industries	13		24	64	/e

Source: UNIDO (1992), p. A-55.
Note: For original sources, footnotes, and commnets, see “Technical notes” of UNIDO (1992), pp. A-3–A-4.

—Productivity: (U.S.$)						
Gross output/worker		39,599		41,559	95,181	/e
Value added/worker		16,144		18,337	29,973	/e
Average wage		2,773		3,720	9,015	/e
—Structural indices:						
Structural change θ (5-year average in degrees)		4.04		6.03	3.10	/e
as a percentage of average θ in 1970–75		70		104	53	/e
MVA growth rate /θ		1.63		0.94	–0.21	
Degree of specialization		9.0		9.9	9.9	
—Value added: (U.S.$ million)						
311	Food products	7,996		9,259	12,559	/e
313	Beverages	1,375		957	1,120	/e
314	Tobacco products	495		587	780	/e
321	Textiles	4,860		4,799	8,151	/e
322	Wearing apparel	2,307		2,035	3,450	/e
323	Leather and fur products	309		464	805	/e
324	Footwear	985		1,665	2,964	/e
331	Wood and wood products	1,903		1,220	1,215	/e
332	Furniture and fixtures	1,087		949	1,017	/e
341	Paper and paper products	2,238		2,260	3,953	/e
342	Printing and publishing	1,901		1,496	2,498	/e
351	Industrial chemicals	3,428		4,417	6,952	/e
352	Other chamical products	3,544		4,451	7,173	/e
353	Petroleum refineries	3,075		4,307	7,546	/e
354	Mescellaneous petroleum and coal products	1,216		572	1,015	/e
355	Rubber products	941		1,420	2,548	/e
356	Plastic products	1,994		1,728	3,133	/e
361	Pottery, china, and earthenware	190		168	249	/e
362	Glass and glass products	558		525	806	/e
369	Other non-metal mineral products	3,447		2,617	3,997	/e
371	Iron and steel	4,128		4,927	8,461	/e
372	Nonferrous metals	1,115		1,564	2,678	/e
381	Metal products	3,599		3,168	4,786	/e
382	Non-electrical machinery	7,171		6,964	10,425	/e
383	Electrical machinery	4,536		5,598	10,122	/e
384	Transport equipment	5,625		4,954	7,936	/e
385	Professional and scientific equipment	453		660	1,141	/e
390	Other manufacturing industries	1,216		837	1,264	/e

Source: The same as in Fig. 3.
Note: The same as in Fig. 3.

These observations suggest that the comparison of technological levels and features can be done at different levels of aggregation, and the conclusion can differ for different levels. Some sectors could be technologically more advanced in countries with lower incomes. So we are interested in comparison at three levels. Below we will first analyze the leading input coefficients, then in Section IV the technical input coefficient vectors and the whole matrices of the two countries.

III. COMPARISON OF LEADING COEFFICIENTS

In this section we examine all the subsectors. The Appendix Table lists the twenty-eight subsectors from the more disaggregated sixty-six subsectors in Indonesia. We use the same twenty-eight subsectors in Indonesia and Brazil, and reconstruct twenty-eight-sector input-output (I-O) tables. There are twenty-three nonagricultural sectors. Among them public administration and defense (26) and non-specified (28) have been eliminated. We compared the activity or technical coefficient vectors for the remaining twenty-one subsectors. We compared seven technical coefficient matrices based on the nominal I-O Tables: four Brazilian matrices (1975, 1980, 1985, and 1990) and three Indonesian matrices (1985, 1990, and 1993).

We indicate the technical input coefficients from ith sector to jth sector as $a(i, j)$, and denote the number of samples (numbering seven matrices noted above as k). We calculated the average, $m(i, j)$, and standard deviation, $s(i, j)$, of the technical coefficients of jth sector over the seven samples. We define the major coefficient ($a^*(j)$) of jth sector as the largest coefficient among $m(i, j)$.

$$a^*(j) = \mathrm{Max}(m(i, j)), \quad (j = 6, \ldots, 27, \text{ except } 26). \tag{1}$$

The major coefficients are as follows.

(Sector 6, Crude oil and natural gas), (Sector 25, Banking and other services)
$a^*(6) = a(25, 6)$: $m(25, 6) = 0.04802$, $s(25, 6) = 0.04741$,
$a(6, 6)$: $m(6, 6) = 0.01686$, $s(6, 6) = 0.02705$. [4th]

(Sector 7, Non–crude oil and natural gas), (Sector 12, Chemicals and rubber)
$a^*(7) = a(12, 7)$: $m(12, 7) = 0.07432$, $s(12, 7) = 0.02442$,
$a(7, 7)$: $m(7, 7) = 0.05192$, $s(7, 7) = 0.03475$. [2nd]

(Sector 8, Food processing), (Sector 1, Farm food crops)
$a^*(8) = a(1, 8)$: $m(1, 8) = 0.20396$, $s(1, 8) = 0.11203$,
$a(8, 8)$: $m(8, 8) = 0.15196$, $s(8, 8) = 0.05477$. [2nd]

(Sector 9, Textiles), (Sector 12, Chemicals and rubber)
$a^*(9) = a(9, 9)$: $m(9, 9) = 0.39213$, $s(9, 9) = 0.01640$,
$a(12, 9)$: $m(12, 9) = 0.11116$, $s(12, 9) = 0.02206$. [2nd]

(Sector 10, Wood processing), (Sector 4, Forestry)
$a^*(10) = a(4, 10)$: $m(4, 10) = 0.14626$, $s(4, 10) = 0.14512$,
$a(10, 10)$: $m(10, 10) = 0.12943$, $s(10, 10) = 0.06009$. [2nd]

(Sector 11, Paper and printing), (Sector 22, Wholesale and retail trade)
$a^*(11) = a(11, 11)$: $m(11, 11) = 0.31467$, $s(11, 11) = 0.04310$,
$a(22, 11)$: $m(22, 11) = 0.05747$, $s(22, 11) = 0.03387$. [2nd]
(Sector12, Chemicals and rubber), (Sector 6, Crude oil and natural gas)
$a^*(12) = a(12, 12)$: $m(12, 12) = 0.22751$, $s(12, 12) = 0.06452$,
$a(6, 12)$: $m(6, 12) = 0.19107$, $s(6, 12) = 0.13162$. [2nd]
(Sector 13, Non-metallic minerals), (Sector 7, Non–crude oil and natural gas)
$a^*(13) = a(7, 13)$: $m(7, 13) = 0.12364$, $s(7, 13) = 0.06653$,
$a(13, 13)$: $m(13, 13) = 0.11123$, $s(13, 13) = 0.07442$. [2nd]
(Sector 14, Iron and steel), (Sector 12, Chemicals and rubber)
$a^*(14) = a(14, 14)$: $m(14, 14) = 0.36489$, $s(14, 14) = 0.10549$,
$a(12, 14)$: $m(12, 14) = 0.05687$, $s(12, 14) = 0.02939$. [2nd]
(Sector 15, Nonferrous basic metal products) (Sector 7, Non–crude oil and gas)
$a^*(15) = a(15, 15)$: $m(15, 15) = 0.27269$, $s(15, 15) = 0.06776$,
$a(7, 15)$: $a(7, 15) = 0.15547$, $s(7, 15) = 0.08669$. [2nd]
(Sector 16, Fabricated metal products), (Sector 14, Iron and steel)
$a^*(16) = a(14, 16)$: $m(14, 16) = 0.24426$, $s(14, 16) = 0.03459$,
$a(16, 16)$: $m(16, 16) = 0.07421$, $s(16, 16) = 0.02523$. [3rd]
(Sector 17, Machines and electric machines), (Sector 16, Fabricated metal products)
$a^*(17) = a(17, 17)$: $m(17, 17) = 0.32469$, $s(17, 17) = 0.14540$,
$a(16, 17)$: $m(16, 17) = 0.04572$, $s(16, 17) = 0.03319$. [2nd]
(Sector 18, Transport equipment), (Sector 14, Iron and steel)
$a^*(18) = a(18, 18)$: $m(18, 18) = 0.31589$, $s(18, 18) = 0.04540$,
$a(14, 18)$: $m(14, 18) = 0.06461$, $s(14, 18) = 0.02231$. [2nd]
(Sector 19, Other manufacturing), (Sector 22, Wholesale and retail trade)
$a^*(19) = a(19, 19)$: $m(19, 19) = 0.05288$, $s(19, 19) = 0.03249$,
$a(22, 19)$: $m(22, 19) = 0.03864$, $s(22, 19) = 0.03319$. [2nd]
(Sector 20, Electricity, gas, and water supply), (Sector 12, Chemicals and rubber)
$a^*(20) = a(20, 20)$: $m(20, 20) = 0.19508$, $s(20, 20) = 0.08000$,
$a(12, 20)$: $m(12, 20) = 0.12954$, $s(12, 20) = 0.12894$. [2nd]
(Sector 21, Construction), (Sector 13, Non-metallic minerals)
$a^*(21) = a(13, 21)$: $m(13, 21) = 0.10938$, $s(13, 21) = 0.03796$,
$a(21, 21)$: $m(21, 21) = 0.02216$, $s(21, 21) = 0.02434$. [10th]
(Sector 22, Wholesale and retail trade), (Sector 12, Chemicals and rubber)
$a^*(22) = a(12, 22)$: $m(12, 22) = 0.07121$, $s(12, 22) = 0.06432$,
$a(22, 22)$: $m(22, 22) = 0.00951$, $s(22, 22) = 0.00408$. [6th]
(Sector 23, Restaurant and hotel trade), (Sector 8, Food processing)
$a^*(23) = a(8, 23)$: $m(8, 23) = 0.18469$, $s(8, 23) = 0.04384$,
$a(23, 23)$: $m(23, 23) = 0.05520$, $s(23, 23) = 0.04376$. [2nd]
(Sector 24, Transport), (Sector 12, Chemicals and rubber)
$a^*(24) = a(12, 24)$: $m(12, 24) = 0.14081$, $s(12, 24) = 0.04919$,

$a(24, 24)$: $m(24, 24) = 0.07897$, $s(24, 24) = 0.03577$. [2nd]

(Sector 25, Banking and other finance), (Sector 21, Construction)

$a^*(25) = a(25, 25)$: $m(25, 25) = 0.07469$, $s(25, 25) = 0.03146$,
$a(21, 25)$: $m(21, 25) = 0.03239$, $s(21, 25) = 0.01792$. [2nd]

(Sector 27, Other services), (Sector 12, Chemicals and rubber)

$a^*(27) = a(12, 27)$: $m(12, 27) = 0.05882$, $s(12, 27) = 0.05078$,
$a(27, 27)$: $m(27, 27) = 0.03523$, $s(27, 27) = 0.04688$. [2nd]

(a) Among the major coefficients of twenty-one sectors, the sector's own input coefficient was biggest in ten sectors, and was second biggest in seven sectors. In other cases, these are ranked as third, fourth, sixth, and tenth. This implies that the sector's own input coefficient is the biggest in eight cases out of ten. This implies a high dependence on the sector's own inputs for most of the sectors, although we need to check whether this fact comes from the high degree of aggregation level.

(b) In Figure 5 we checked the changes of the major coefficients over time. Analyzing their changes, we grouped these twenty-one sectors into three categories listed below.

Type-A (Brazil leads–Indonesia lags): 6, 7, 8, 10, 12, 14, 20, 21, 22, and 24.
6 (crude oil and natural gas), 7 (non–crude oil and natural gas), 8 (food processing), 10 (wood processing), 12 (chemicals and rubber), 14 (iron and steel), 20 (electricity, gas, and water supply), 21 (construction), 22 (wholesale and retail trade), 24 (transport)

Type-B (two countries parallel): 9, 11, 15, 16, and 27.
9 (textiles), 11 (paper and printing), 15 (Nonferrous basic metal products), 16 (fabricated metal products), 27 (other services)

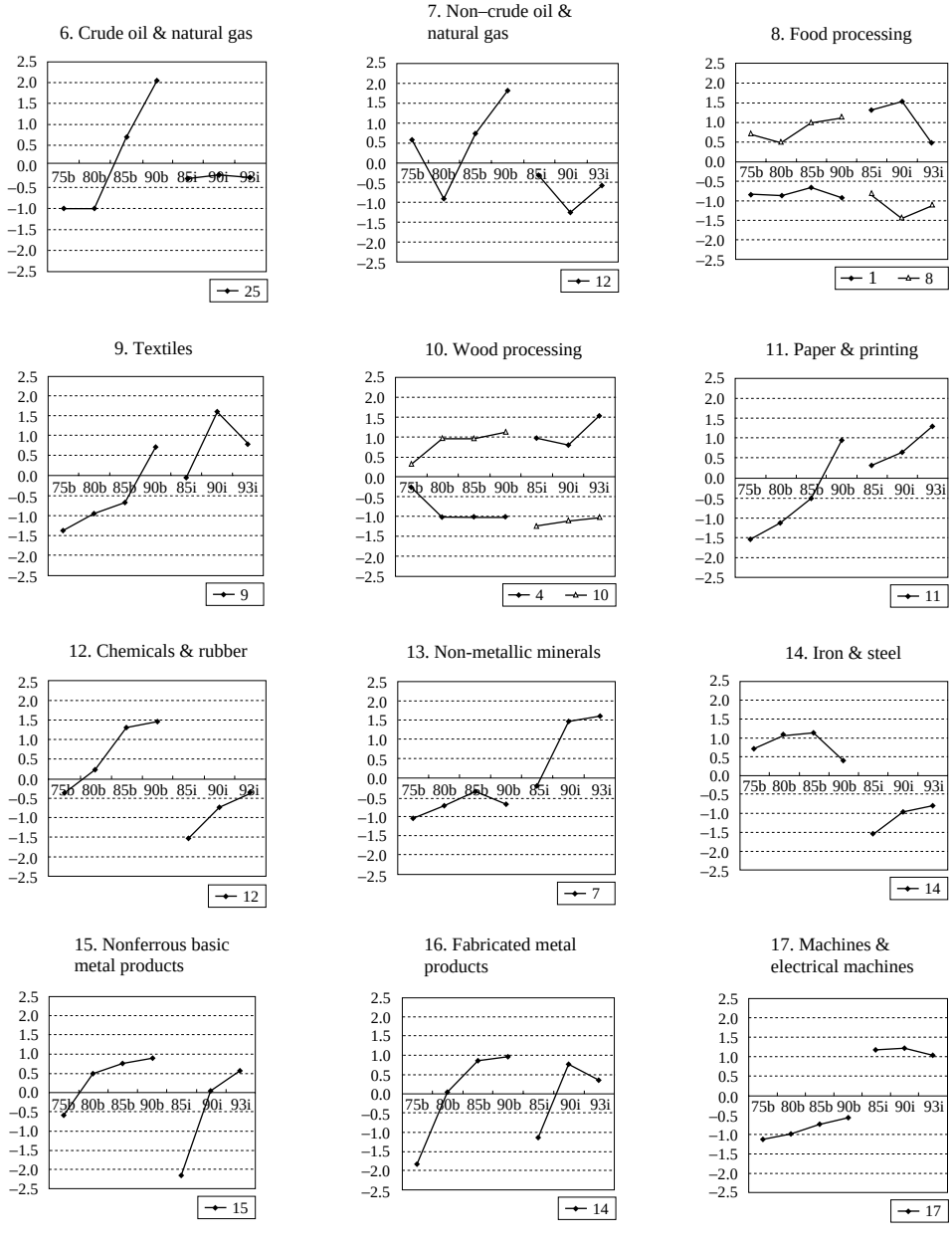
Type-C (Indonesia leads–Brazil lags): 13, 17, 18, 19, 23, and 25.
13 (chemicals and rubber), 17 (machines and electrical machines), 18 (transport equipment), 19 (other manufacturing), 23 (restaurant and hotel trade), 25 (banking and other finance)

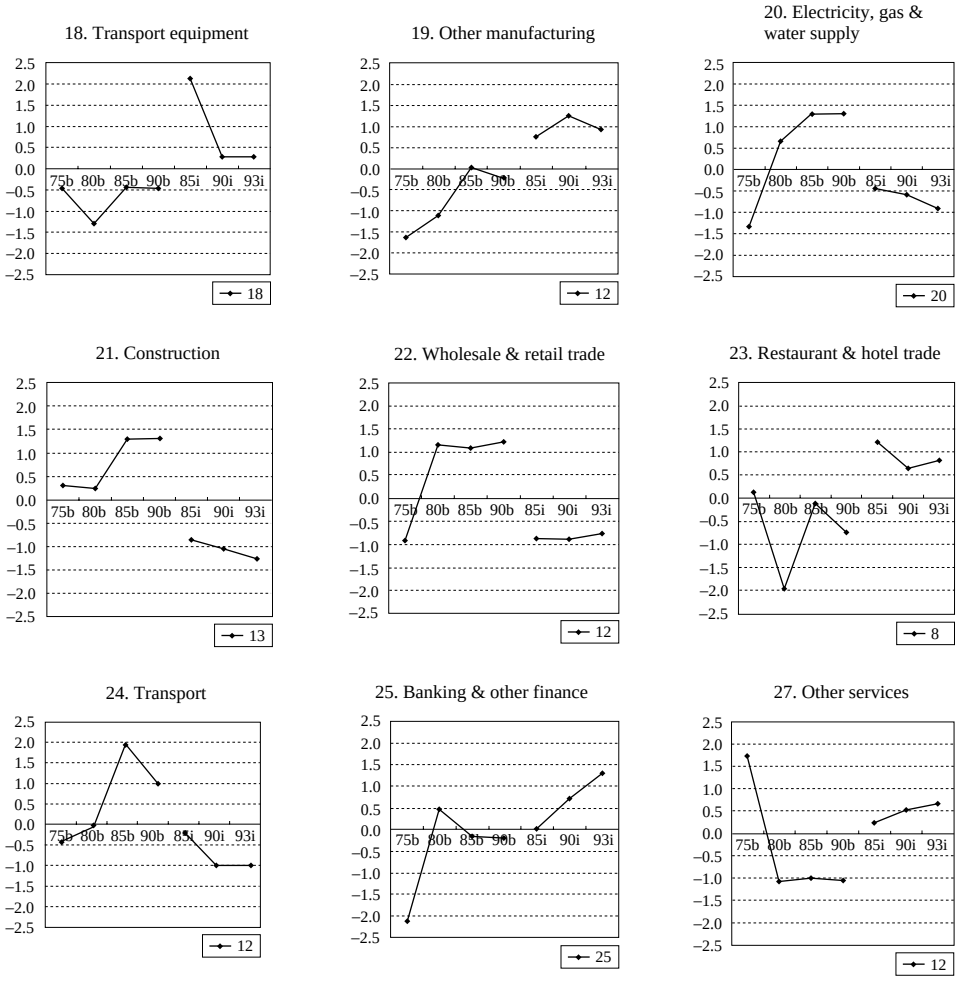
But in some cases the change is increasing or decreasing over time. Out of twenty-one sectors, in twelve (nine) sectors the major coefficient for Brazil is higher (lower) than the one for Indonesia, while in two sectors they are of similar values. Therefore, we cannot specify the leads and lags in the technological structure through such a comparison, especially because there exists countervailing trends in which the major coefficient is increasing but other non-major coefficients are decreasing.

IV. COMPARISON OF SECTORAL COEFFICIENT VECTORS

In this section we try to compare the sectoral technical coefficient vectors. We write the jth sector activity and the whole matrix of kth table as $Aj(k)$ and $A(k)$ respectively. We use two indices of similarity, COS (cosine) index and EIS index,

Fig. 5. Comparison of Major Coefficients: Brazil and Indonesia





Note: The number at the bottom of each figure is the number of supplying subsectors of intermediate inputs.

between the same sectoral technology vectors of the two different tables (k, m) (Beers and Linnemann 1991, p. 104).[3] The jth sector's technical coefficient vector is written as:

$$Aj(k) = (a1j(k), \ldots, anj(k))'. \qquad (2)$$

The similarity index of jth sector between kth and mth tables are defined as follows:

[3] There have been many preceding studies on the similarity of trade structure, including Finger and Kreinin (1979), Pomfret (1981), Kellman and Schroder (1983), and Doi (1991).

$$COS(j,\ k,\ m) = \text{Cosine between } Aj(k) \text{ and } Aj(m) \tag{3}$$

and

$$EIS(j,\ k,\ m) = 1 - Q(j,\ k,\ m), \tag{4}$$

$$\text{where } Q(j,\ k,\ m) = \sum_{S} \text{MIN}[asj(k)/Vj(k),\ asj(m)/Vj(m)], \tag{5}$$

$$Vj(k) = \sum_{S} asj(k), \quad Vj(m) = \sum_{S} asj(m). \tag{6}$$

Each of these indices takes zero and unity at the extreme, and takes a higher value when the similarity between the two vectors is high. Tables I and II show the calculated values of the COS and EIS indices for different combinations of input-output tables of the two countries shown at the left-hand side. The numbers at the right-hand side show the simple averages of the indices over possible combinations.

1. *Observations from the COS index*

Below is the list of two combinations for each sector which shows the highest and next highest index values.

	Sector	Highest Combination	Correlation	Next Highest Combination	Correlation
6.	Oil & gas	90B∗93I	0.8119	90B∗90I	0.8105
7.	Non–oil & gas	90B∗90I	0.8396	93B∗90I	0.8349
8.	Food	85B∗93I	0.7615	75B∗93I	0.7336
9.	Textiles	90B∗90I	0.9923	85B∗90I	0.9918
10.	Wood processing	70B∗90I	0.8763	70B∗85I	0.8752
11.	Paper	75B∗93I	0.9820	85B∗90I	0.9799
12.	Chemicals	85B∗93I	0.9702	85B∗90I	0.9052
13.	Non-metallic minerals	70B∗85I	0.9272	75B∗85I	0.8789
14.	Iron & steel	70B∗90I	0.9668	70B∗93I	0.9501
15.	Nonferrous basic metal products	85B∗93I	0.9156	80B∗93I	0.9101
16.	Fablicated metal prodpcts	75B∗90I	0.9526	70B∗90I	0.9497
17.	Machines	90B∗85I	0.9274	90B∗93I	0.9255
18.	Transport equip.	85B∗90I	0.9601	85B∗93I	0.9576
19.	Other manufacturing	70B∗90I	0.8833	75B∗90I	0.8543
20.	Electricity, gas & water supply	70B∗90I	0.8296	70B∗85I	0.8245
21.	Construction	75B∗85I	0.9055	70B∗85I	0.9043
22.	Wholesale	90B∗85I	0.7639	85B∗85I	0.7421
23.	Restaurant & hotel	70B∗85I	0.9068	75B∗85I	0.9035
24.	Transport	80B∗85I	0.8342	90B∗90I	0.8323
25.	Banking	80B∗90I	0.9810	80B∗93I	0.9719
27.	Other services	75B∗85I	0.7345	70B∗85I	0.7204

TABLE I

CALCULATED VALUES OF THE COS INDEX

No.	Brazil vs. Indonesia	Sector Number							
		6	7	8	9	10	11	12	13
1.	70b*85i	0.3606	0.7283	0.6228	0.9546	0.8752	0.9678	0.4970	0.9272
2.	70b*90i	0.2108	0.6323	0.5633	0.9500	0.8763	0.9755	0.6261	0.7064
3.	70b*93i	0.1624	0.5924	0.6604	0.9504	0.8496	0.9732	0.7623	0.6752
4.	75b*85i	0.6522	0.6843	0.7017	0.9891	0.7775	0.9784	0.3902	0.8789
5.	75b*90i	0.1971	0.8279	0.6430	0.9868	0.7395	0.9791	0.5380	0.6351
6.	75b*93i	0.1483	0.8372	0.7336	0.9847	0.7033	0.9820	0.7018	0.6028
7.	80b*85i	0.0663	0.4327	0.6633	0.9755	0.2506	0.8740	0.3801	0.6731
8.	80b*90i	0.0863	0.5217	0.6118	0.9767	0.2664	0.9062	0.5286	0.5814
9.	80b*93i	0.0740	0.5217	0.7028	0.9755	0.2061	0.9074	0.6883	0.5667
10.	85b*85i	0.5287	0.7445	0.7131	0.9901	0.2626	0.9423	0.8178	0.7558
11.	85b*90i	0.7649	0.8150	0.6665	0.9918	0.2794	0.9799	0.9052	0.6352
12.	85b*93i	0.7610	0.8021	0.7615	0.9907	0.2106	0.9736	0.9702	0.6117
13.	90b*85i	0.5563	0.7771	0.6480	0.9906	0.2533	0.9422	0.6654	0.7044
14.	90b*90i	0.8105	0.8396	0.5915	0.9923	0.2706	0.9799	0.7853	0.5504
15.	90b*93i	0.8119	0.8349	0.7032	0.9911	0.2040	0.9756	0.8978	0.5220
		14	15	16	17	18	19	20	21
1.	70b*85i	0.9457	0.5810	0.9142	0.8025	0.9077	0.7975	0.8245	0.9043
2.	70b*90i	0.9668	0.8018	0.9497	0.7938	0.9316	0.8833	0.8296	0.8814
3.	70b*93i	0.9501	0.7866	0.9414	0.7924	0.9410	0.8295	0.7854	0.8594
4.	75b*85i	0.9221	0.4812	0.9411	0.8740	0.9553	0.8448	0.6541	0.9055
5.	75b*90i	0.9443	0.6877	0.9526	0.8654	0.9571	0.8543	0.7759	0.8792
6.	75b*93i	0.9281	0.6796	0.9442	0.8616	0.9502	0.7971	0.7808	0.8580
7.	80b*85i	0.8911	0.7054	0.8314	0.8199	0.9033	0.5816	0.4726	0.8264
8.	80b*90i	0.9072	0.9039	0.9062	0.8168	0.9125	0.6055	0.6042	0.8107
9.	80b*93i	0.8906	0.9101	0.9029	0.8171	0.9114	0.5748	0.6119	0.7742
10.	85b*85i	0.8972	0.7280	0.8561	0.9086	0.9522	0.6996	0.4912	0.6781
11.	85b*90i	0.9172	0.9095	0.9424	0.9055	0.9601	0.7470	0.6220	0.7024
12.	85b*93i	0.9009	0.9156	0.9397	0.9061	0.9576	0.7206	0.6315	0.6534
13.	90b*85i	0.9078	0.6993	0.8541	0.9274	0.9434	0.6922	0.4449	0.6693
14.	90b*90i	0.9229	0.8864	0.9391	0.9249	0.9510	0.7338	0.5825	0.6841
15.	90b*93i	0.9095	0.8920	0.9366	0.9255	0.9485	0.7117	0.5982	0.6349
		22	23	24	25	27	Average		
1.	70b*85i	0.3038	0.9068	0.7982	0.4654	0.7204	0.7527		
2.	70b*90i	0.3235	0.8845	0.7469	0.5119	0.6552	0.7476		
3.	70b*93i	0.3089	0.8715	0.6870	0.5122	0.6675	0.7409		
4.	75b*85i	0.4192	0.9035	0.7098	0.3938	0.7345	0.7520		
5.	75b*90i	0.4469	0.8805	0.6691	0.3716	0.6552	0.7374		
6.	75b*93i	0.4368	0.8704	0.6109	0.3741	0.6677	0.7359		
7.	80b*85i	0.6806	0.8282	0.8342	0.9596	0.5583	0.6766		
8.	80b*90i	0.6560	0.7989	0.8194	0.9810	0.4444	0.6974		
9.	80b*93i	0.6642	0.7708	0.7881	0.9719	0.4633	0.6997		
10.	85b*85i	0.7421	0.7912	0.8005	0.9104	0.4158	0.7441		
11.	85b*90i	0.7079	0.7728	0.7955	0.9634	0.3312	0.7769		
12.	85b*93i	0.7117	0.7519	0.7765	0.9647	0.3581	0.7748		
13.	90b*85i	0.7639	0.8003	0.8088	0.9078	0.4329	0.7328		
14.	90b*90i	0.7305	0.7828	0.8323	0.9680	0.3403	0.7666		
15.	90b*93i	0.7351	0.7606	0.8251	0.9741	0.3678	0.7695		

TABLE II

CALCULATED VALUES OF THE EIS INDEX

No.	Brazil vs. Indonesia	Sector Number							
		6	7	8	9	10	11	12	13
1.	70b*85i	0.3104	0.5209	0.5724	0.7415	0.6432	0.8018	0.4167	0.7539
2.	70b*90i	0.2691	0.5232	0.5295	0.7181	0.6439	0.8081	0.4913	0.5909
3.	70b*93i	0.2394	0.5039	0.5607	0.7275	0.6077	0.7772	0.5583	0.5710
4.	75b*85i	0.4750	0.4986	0.6122	0.8742	0.6537	0.8067	0.3547	0.7317
5.	75b*90i	0.2271	0.6311	0.5453	0.8500	0.5557	0.8020	0.4363	0.5417
6.	75b*93i	0.2097	0.6584	0.5885	0.8535	0.5225	0.7996	0.5174	0.5184
7.	80b*85i	0.1079	0.3935	0.5714	0.7992	0.3344	0.6502	0.3624	0.5824
8.	80b*90i	0.1289	0.4908	0.5371	0.7953	0.3458	0.6706	0.4458	0.4948
9.	80b*93i	0.1234	0.4755	0.5950	0.8051	0.3039	0.6590	0.5097	0.4868
10.	85b*85i	0.4840	0.5683	0.5939	0.8785	0.3213	0.7427	0.6586	0.6815
11.	85b*90i	0.5107	0.6446	0.5664	0.8823	0.3524	0.8138	0.7595	0.5763
12.	85b*93i	0.5049	0.6277	0.6341	0.8835	0.3054	0.7540	0.8179	0.5679
13.	90b*85i	0.4657	0.5670	0.5621	0.8755	0.3184	0.7480	0.5526	0.6306
14.	90b*90i	0.5289	0.6445	0.5335	0.8852	0.3447	0.8140	0.6570	0.5645
15.	90b*93i	0.5230	0.6276	0.6099	0.8871	0.3006	0.7596	0.7279	0.5367
		14	15	16	17	18	19	20	21
1.	70b*85i	0.6735	0.4817	0.7313	0.4978	0.6469	0.6768	0.5947	0.7756
2.	70b*90i	0.7429	0.6482	0.7992	0.4806	0.7023	0.6741	0.6349	0.7794
3.	70b*93i	0.7112	0.6336	0.7768	0.4752	0.7258	0.6430	0.5962	0.7664
4.	75b*85i	0.6317	0.4639	0.7761	0.5827	0.7283	0.7102	0.5094	0.7338
5.	75b*90i	0.6686	0.5961	0.7966	0.5606	0.7473	0.6945	0.5738	0.7302
6.	75b*93i	0.6388	0.5710	0.7656	0.5460	0.7546	0.6481	0.5851	0.7234
7.	80b*85i	0.5481	0.5508	0.6399	0.5069	0.6425	0.5301	0.4101	0.7099
8.	80b*90i	0.5661	0.6902	0.7026	0.5005	0.6764	0.5415	0.4718	0.7077
9.	80b*93i	0.5467	0.7125	0.6849	0.5035	0.6896	0.5396	0.4608	0.6825
10.	85b*85i	0.5862	0.5842	0.6740	0.6003	0.7417	0.5932	0.3960	0.5901
11.	85b*90i	0.5930	0.6976	0.7639	0.5882	0.7774	0.6278	0.4623	0.6044
12.	85b*93i	0.5735	0.7199	0.7474	0.5876	0.7915	0.6370	0.4680	0.5631
13.	90b*85i	0.6392	0.5636	0.6676	0.6225	0.7185	0.5878	0.3646	0.5806
14.	90b*90i	0.6410	0.6759	0.7619	0.6108	0.7609	0.6107	0.4258	0.5894
15.	90b*93i	0.6217	0.6982	0.7442	0.6102	0.7745	0.6195	0.4355	0.5481
		22	23	24	25	27	Average		
1.	70b*85i	0.3431	0.6863	0.6185	0.3974	0.4978	0.5896		
2.	70b*90i	0.3536	0.6674	0.6244	0.4229	0.5047	0.6004		
3.	70b*93i	0.3344	0.6326	0.6029	0.4236	0.5116	0.5895		
4.	75b*85i	0.4609	0.6960	0.5220	0.4086	0.5250	0.6074		
5.	75b*90i	0.4637	0.6668	0.4956	0.4099	0.5127	0.5955		
6.	75b*93i	0.4488	0.6555	0.4637	0.4115	0.5195	0.5905		
7.	80b*85i	0.6266	0.6080	0.7039	0.8066	0.5427	0.5537		
8.	80b*90i	0.6111	0.5748	0.6861	0.8457	0.4493	0.5682		
9.	80b*93i	0.6125	0.5289	0.6554	0.8322	0.4545	0.5649		
10.	85b*85i	0.6534	0.5463	0.6605	0.7680	0.4821	0.6098		
11.	85b*90i	0.6540	0.5343	0.6383	0.8374	0.3988	0.6325		
12.	85b*93i	0.6555	0.5005	0.6132	0.8357	0.4029	0.6282		
13.	90b*85i	0.6684	0.5636	0.6780	0.7467	0.4638	0.5993		
14.	90b*90i	0.6723	0.5518	0.6882	0.8354	0.3903	0.6279		
15.	90b*93i	0.6737	0.5051	0.6626	0.8539	0.3991	0.6247		

2. *Observations from the EIS index*

Below is the list of combinations for each sector which shows the highest and next highest index value.

	Sector	Highest Combination	Correlation	Next Highest Combination	Correlation
6.	Oil & gas	90B*90I	0.5289	90B*93I	0.5230
7.	Non–oil & gas	75B*93I	0.6584	85B*90I	0.6446
8.	Food	85B*93I	0.6341	75B*85I	0.6121
9.	Textiles	90B*93I	0.8871	90B*90I	0.8852
10.	Wood processing	75B*85I	0.6537	70B*90I	0.6439
11.	Paper	90B*90I	0.8140	85B*90I	0.8138
12.	Chemicals	85B*93I	0.8179	85B*90I	0.7595
13.	Non-metallic minerals	70B*85I	0.7539	75B*85I	0.7317
14.	Iron & steel	70B*90I	0.7429	70B*93I	0.7112
15.	Nonferrous basic metal products	85B*93I	0.7199	80B*93I	0.7125
16.	Fabricated metal products	75B*90I	0.7966	70B*90I	0.7992
17.	Machines	90B*85I	0.6225	90B*90I	0.6108
18.	Transport equip.	85B*93I	0.7915	85B*90I	0.7774
19.	Other manufacturing	75B*85I	0.7102	75B*90I	0.6945
20.	Electricity, gas & water supply	70B*90I	0.6349	70B*93I	0.5962
21.	Construction	70B*90I	0.7794	70B*85I	0.7756
22.	Wholesale	90B*93I	0.6737	90B*90I	0.6723
23.	Restaurant & hotel	75B*85I	0.6960	70B*85I	0.6863
24.	Transport	80B*85I	0.7039	90B*90I	0.6882
25.	Banking	90B*93I	0.8539	80B*90I	0.8457
27.	Other services	80B*85I	0.5427	75B*85I	0.5250

The number of years by which Brazilian technology leads Indonesian technology are as follows:

	Sector	COS (Highest)	COS (Next Highest)	EIS (Highest)	EIS (Next Highest)	Average
6.	Oil & gas	3	0	0	3	1.5
7.	Non–oil & gas	0	0	18	5	5.8
8.	Food	8	18	8	10	11.0
9.	Textiles	0	5	3	0	2.0
10.	Wood processing	20	15	10	20	13.8
11.	Paper	18	5	0	5	7.0
12.	Chemicals	8	5	8	5	6.5
13.	Non-metallic minerals	15	10	15	10	12.5
14.	Iron & steel	20	23	20	23	21.5
15.	Nonferrous basic metal products	8	13	8	13	10.5

16.	Fabricated metal products	15	20	20	15	17.5
17.	Machines	–5	3	0	3	0.3
18.	Transport equip.	5	8	8	3	6.0
19.	Other manufacturing	20	15	10	15	12.5
20.	Electricty, gas & water supply	20	15	20	23	19.5
21.	Construction	10	15	20	5	12.5
22.	Wholesale	–5	0	3	0	–0.5
23.	Restaurant & hotel	15	10	10	15	12.5
24.	Transport	5	0	0	10	3.9
25.	Banking	10	13	3	5	8.0
27.	Other services	10	15	5	10	13.3
	Average	9.52	9.90	9.00	8.95	9.34

The simple average by which Brazilian technology leads is about nine years. We can classify all the cases into five groups:

Group (1): Brazil's lead is more than twenty years: 1 (14),
Group (2): Brazil's lead is fifteen–twenty years: 2 (16, 20),
Group (3): Brazil's lead is ten–fifteen years: 8 (8, 10, 13, 15, 19, 21, 23, 27),
Group (4): Brazil's lead is five–ten years: 5 (7, 11, 12, 18, 25),
Group (5): Brazil's lead is less than five years: 5 (6, 9, 17, 22, 24).

Our examination confirms that on the whole Brazil leads and Indonesia lags technologically. For sector (22), wholesale and trade sector, the average lead is –0.5 years, so there is practically no time lag. In sector (7) non–crude oil and natural gas, (11) paper and printing, (12) chemical products, (18) transport equipment, and (25) banking and finance, the Brazil's technical lead is relatively small. By contrast, for sector (14) iron and steel, (16) fabricated metal products, and (20) electricity, gas, and water sectors, Brazil's lead is more than fifteen years. In effect Brazil's lead varies by sector, and it is difficult to point out clear differences by industry groups, i.e., by light or heavy or chemical industries.

We will now examine the similarity between the two matrices. The simplest index may be the simple correlation coefficient between the technical coefficients of the two matrices, $R[A(k), A(m)]$.

$$R[A(k), A(m)] = \sum_{i,j}[aij(k) \cdot aij(m)]/[(\mathrm{SQR}(\sum_{i,j} aij(k)^2) \cdot (\mathrm{SQR}(\sum_{i,j} aij(m)^2)]. \quad (7)$$

But this simple measure does not reflect the different weight of sectroral activity. The weighted average of similarity indices of two activities is more informative. We write the weight (or share) of jth activity in kth and mth table as $W(j, k)$ and $W(j, m)$. The weight of jth activity can be defined by the arithmetic average $WA(j)$ of the two weights.

$$WA(j) = [W(j, k) + W(j, m)]/2 \quad (8)$$

We define the four weighted averages of the COS or EIS index based on two weights.

(1) Weighted-average COS measure

$$ACOS(k, m) = \sum WA(j) \cdot COS(j, k, m) \tag{9}$$

(2) Weighted-average EIS measure

$$AEIS(k, m) = \sum WA(j) \cdot EIS(j, k, m) \tag{10}$$

The results are as follows:

Combination (k, m)	$ACOS(k, m)$	$AEIS(k, m)$
70B∗85I	0.3556	0.3379
70B∗90I	0.3734	0.3508
70B∗93I	0.3881	0.3564
75B∗85I	0.5417	0.4968
75B∗90I	0.5672	0.4937
75B∗93I	0.5902	0.5044
80B∗85I	0.5321	0.4786
80B∗90I	0.5681	0.4970
80B∗93I	0.5949	0.5094
85B∗85I	0.5844	0.5270
85B∗90I	0.6282	0.5518
85B∗93I	0.6438	0.5599
90B∗85I	0.5535	0.5044
90B∗90I	0.6000	0.5361
90B∗93I	0.6226	0.5472

Based on these data, we propose two hypotheses: (1) the existence of a time lag in which the Indonesian structure is catching up to the Brazilian structure, where the similarity index shows the highest value when the lag $(m - k)$ matches this value, and (2) the existence of an increasing tendency of the similarity index over time. The latter implies a common trend that all developing countries catch up to the structure of advanced economies, while the former implies a trend of catching up among developing countries. We formalized the two hypotheses by two explanatory variables; the squared term of $(m - k - A)$ in which A implies the best-fitting time lag, and m (date of Indonesian table). The former (latter) is expected to influence the similarity index with a negative (positive) sign. We adopted the COS as the similarity index, and converted it to a logit form for regression, because its value is limited between zero and unity by definition. We varied the value of A and tried to find the equation with the best fit. The results are as follows:

$$\begin{aligned} \log[COS/(1 - COS)] = &-4.5987 - 0.2342 \cdot (m - k - 14) \cdot (m - k - 14) \\ &\quad (-6.50) \quad (-3.47) \\ &+ 0.06207 \cdot m + u, \\ &\quad (6.68) \end{aligned} \tag{11}$$

$$R^2 = 0.7959,\ RA^2 = 0.5805,\ R = 0.8922,\ RA = 0.7619,\ S = 0.1869,$$
$$\log[COS/(1 - COS)] = -4.8713 - 0.2246 \cdot (m - k - 15) \cdot (m - k - 15) \quad (-6.45) \quad (-3.50)$$
$$+ 0.06567 \cdot m + u, \quad (6.60) \qquad (12)$$
$$R^2 = 0.7976,\ RA^2 = 0.5835,\ R = 0.8931,\ RA = 0.7639,\ S = 0.1861,$$
$$\log[COS/(1 - COS)] = -5.0965 - 0.2135 \cdot (m - k - 16) \cdot (m - k - 16) \quad (-6.35) \quad (-3.49)$$
$$+ 0.06869 \cdot m + u, \quad (6.46) \qquad (13)$$
$$R^2 = 0.7970,\ RA^2 = 0.5823,\ R = 0.8927,\ RA = 0.7631,\ S = 0.1864.$$

(Note: R(RA) is the correlation coefficient before (after) correction for the degree of freedom. S is the standard deviation of error.)

When the lag is fifteen years, we observed the best fit. We define this time lag as the technological distance between the two economies in a similar manner as the economic distance. By equation (12), we can calculate the maximum value of the COS index to each m-value by setting A as fifteen (years) and specifying the value of m accordingly. The results are as follows:

Value of m (Date of Indonesian Table)	Maximum Value of COS Index
70	0.4313
75	0.5134
80	0.5944
85	0.6705
90	0.7386

After fifteen years Indonesia is still trying to catch up with Brazil, and there still structural differences which come from the historical and idiosyncratic factors. Thus the figures above suggest the maximum attainable degree of similarity. The actual changing trend of the COS index can be understood as a comparative dynamic converging process, in which the COS is approaching the maximum value in the transitory period, but the maximum value itself is changing over time.

V. SUMMARY AND CONCLUSIONS

Our main findings are as follows.

(1) *Smaller technological distance than economic distance*. The economic distance between Brazil and Indonesia measured by the time lag to attain similar per capita GDP level is about thirty-three years, and has decreased over time, while the technological distance measure by the input coefficient structure of the I-O table is fifteen years. The recently popular convergence hypothesis

claims that (i) the common worldwide technology is basically a public good available to every country without exclusion at relatively cheap cost, therefore (ii) a lagging economy with cheaper wages can catch up relatively quickly to advanced countries. The basic assumption of such an argument is that the technological distance between two countries is smaller than the difference measured by per capita GDP. Our findings are in accord with such a view.

(2) *Existence of idiosyncratic factors*. The existence of a maximum value for the COS similarity index implies that the technological differences essentially remain even after the elapse of the convergence time of fifteen years. This suggests that the convergence of technology differs greatly by subsectors. We can confirm this by the big differences between the highest COS values among subsectors: 0.7615 (food), 0.8763 (wood), 0.9923 (textiles). Of these three traditional subsectors, textiles utilize a very similar production technology in Brazil and Indonesia, but the food subsector employs a very different technology. (Another exception is "other manufacturing.")

(3) *Different trends for leading coefficients*. When the level of comparison got down to each coefficient, it was rather difficult to find general trends common to both countries, perhaps because many idiosyncratic factors come into play.

The comparative results suggest that the direct use of information from the Brazilian I-O table for projection of the Indonesian I-O table might be difficult. However, we can utilize them for some interesting comparative study. Such a comparison will also be useful to enrich our knowledge of how the input-output structure evolves over time in each country, and how changes over time can be decomposed into common international trends and idiosyncratic factors of different countries, and ultimately what the precise picture of technological progress in this world is like.

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APPENDIX TABLE

SUBSECTOR CLASSIFICATION: INDONESIA

No.	Subsector	66 I-O Code
1.	Farm food crops	1–6
2.	Estate crops	7–17
3.	Livestock	18, 20
4.	Forestry	21, 22
5.	Fisheries	23
6.	Crude oil and natural gas	25
7.	Non–crude oil and natural gas	24, 26
8.	Food processing	19, 27–34
9.	Textiles	35–36
10.	Wood processing	37
11.	Paper and printing	38
12.	Chemicals and rubber	39–42
13.	Non-metallic minerals	43–44
14.	Iron and steel	45
15.	Nonferrous basic metal products	46
16.	Fabricated metal products	47
17.	Machines and electrical machines	48
18.	Transport equipment	49
19.	Other manufacturing	50
20.	Electricity, gas, and water supply	51
21.	Construction	52
22.	Wholesale and retail trade	53
23.	Restaurant and hotel trade	54
24.	Transport	55–60
25.	Banking and other finance	61–62
26.	Public administration and defense	63
27.	Other services	64–65
28.	Non-specified sector	66

Note: The subsector classification for Brazil was made in accordance with that for Indonesia.