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"Revealed" Comparative Advantage in Japan and the United States**

Bela Balassa*

and

Marcus Noland*

Abstract

This paper examines the changing comparative advantage of Japan and the United States. Indices of "revealed" comparative advantage have been derived for 57 primary and 167 manufactured product categories. These indices have further been aggregated for 20 commodity groups. Data are further provided on high technology products.

During the period 1967−1983 Japan's pattern of specialization is found to have changed dramatically with Japan shifting from specialization in unskilled labor intensive goods to human capital intensive products while its comparative disadvantage increased in natural resources intensive products. The United States maintained its specialization in physical capital and human capital intensive goods while increasing its comparative advantage in natural resource intensive products. Both countries increased their comparative advantage in high techonlogy products.

I. Introduction

This paper analyzes the changing comparative advantage of Japan and the United States. This will be done through the examination of indices of "revealed" comparative advantage, derived for 57 primary and 167 manufactured product categories and aggregated for twenty commodity groups.[1]

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*Institute for International Economics, 11 Dupont Circle, NW Washington, DC 20036, U.S.A

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1. For earlier uses of the index of "revealed" comparative advantage, see Balassa 1965 and 1977.

Furthermore, changes in the commodity pattern of trade in high technology products in the overall trade of the two countries will be discussed.

In this paper, two indices of trade specialization have been employed. The export index of revealed comparative advantage(XRCA) has been defined as the ratio of a country's exports in a particular commodity category to its share in total merchandise exports :

$$(1)\quad XRCA = \frac{X_{ij}}{\sum_i X_{ij}} \Big/ \frac{\sum_i X_{ij}}{\sum_i \sum_j X_{ij}},$$

where X stands for exports, and the subscripts i and j refer to industry(product category) and country, respectively. The net export index has been defined as net exports divided by the sum of exports and imports for a particular industry.

$$(2)\quad NX_{ij} = \frac{X_{ij} - M_{ij}}{X_{ij} + M_{ij}},$$

where M refers to imports.

The net export index of revealed comparative advantage, is, however, affected by the country's overall trade balance. To facilitate intertemporal comparisons, the net export index has been normalized using the formula

$$(3)\quad NX'_{ij} = NX_{ij} + |NX_{ij} * NX_{Tj}| \text{ if } NX_{Tj} < 0,$$
$$NX'_{ij} = NX_{ij} - |NX_{ij} * NX_{Tj}| \text{ if } NX_{Tj} > 0,$$

where NX_{Tj} is the net export index of total trade for country j. This normalization imposes equiproportional adjustment to an aggregate trade balance surplus or deficit across all industries.[2]

The use of the net export index is superior to the export index of revealed comparative advantage on trade-theoretical grounds. This is because the former indicates the effects of comparative advantage on the relationship between exports and imports rather than on exports alone.

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2. Under this procedure, it is possible for the normalized net export index(NX'_{ij}) to exceed 1.0 in absolute value, if for instance the nonnormalized index(NX_{ij}) is 1.0 and the country has an aggregate trade deficit. In the tables, each index has been multiplied by 100 for purposes of presentation.

However, the net export index has the practical disadvantage of being affected by the idiosyncracies of national import protection; in the extreme, prohibitive protection will give rise to a net export index of 100 for a differentiated product, some of which is exported. Also, in the case of intermediate products, net exports are influenced by demand for purposes of further transformation in production for export. These considerations have led to the use of both export and net export indices in the follwing discussion of the changing pattern of revealed comparative advantage.

Revealed comparative advantage indices have been calculated for 57 primary and for 167 manufactured product categories. The results have been aggregated into twenty commodity groups, of which three represent primary products and seventeen manufactured goods. They are presented in Table 1 for the export index and in Table 2 for the net export index.

Estimates have been made for the years 1967, 1971, 1975, 1979, and 1983, so as to permit examining changes in revealed comparative advantage in four-year intervals. The "comparator" countries chosen for the estimation include eighteen industrial countries[3] and nineteen developing countries in whose exports manufactured goods accounted for at least 18 percent of total exports and exceeded $300 million in 1979.[4]

Ⅱ. The Revealed Comparative Advantages of Japan and the United States

The results reported in Tables 1 and 2 show the transformation of the structure of Japan's comparative advantage over time. At the beginning of the period, Japan's comparative advantage was in unskilled-labor intensive commodities, including textile mill products(for short, textiles), apparel and other finished textile products(for short, apparel), rubber and plastic products, leather and leather products, and stone, clay, and glass products.

All these commodity groups had capital-labor ratios, calculated by including physi-

3. Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, United Kingdom, and the United States.
4. Argentina, Brazil, Egypt, Greece, Hong Kong, Indonesia, Korea, Malaysia, Mexico, Morocco, Philippines, Portugal, Singapore, Spain, Taiwan, Thailand, Tunisia, Turkey, and Yugoslavia(India and Pakistan meet the criteria, but have not been included for lack of data while Indonesia has been added, although it meets the second criterion but not the first).

Table 1

Export Index of Revealed Comparative Advantage

	Japan					United States				
	1967	1971	1975	1979	1983	1967	1971	1975	1979	1983
Industry										
Food, Beverages, and Tobacco	50	48	23	22	18	211	195	262	260	264
Agricultural Raw Materials	15	11	9	7	5	237	332	331	406	396
Non−oil Mineral Products	15	18	17	26	20	221	244	284	301	286
Textile Mill Products	486	337	258	196	198	63	55	65	94	76
Apparel & Other Finished Textile Products	372	190	64	31	42	68	54	55	57	40
Lumber & Wood Products	96	50	20	11	7	105	110	143	130	122
Furniture & Fixtures	94	64	30	28	37	85	49	57	57	79
Paper & Allied Products	70	73	80	74	63	125	149	133	110	130
Printing & Publishing	57	59	44	56	82	225	218	198	204	132
Chemical & Allied Products	168	158	163	122	100	209	207	180	200	206
Rubber & Plastic Products	307	272	274	254	291	141	118	116	112	119
Leather & Leather Products	280	164	68	44	40	42	28	40	37	42
Stone, Clay, & Glass Products	333	211	183	192	196	128	120	101	105	104
Primary Metal & Allied Products	354	393	429	390	318	98	94	92	81	76
Fabricated Metal Products	262	240	226	209	210	187	147	156	149	142
Nonelectrical Machinery	115	135	157	215	247	263	263	260	272	289
Electrical Machinery	421	392	334	404	433	210	193	187	210	210
Transportation Equipment	273	300	365	368	3709	258	266	242	230	213
Instruments & Related Products	323	286	314	439	432	238	242	212	186	193
Misc. Manufacturing Products	355	238	164	145	206	95	111	111	103	103

Source : GATT tapes

Table 2

Export Index of Revealed Comparative Advantage

	Japan					United States				
	1967	1971	1975	1979	1983	1967	1971	1975	1979	1983
Industry										
Food, Beverages, and Tobacco	−61.7	−67.9	−82.5	−81.2	−89.4	0.4	−11.4	25.0	14.3	16.6
Agricultural Raw Materials	−91.2	−105.6	−94.9	−94.0	−105.0	27.0	49.0	48.4	62.3	67.8
Non−oil Mineral Products	−91.7	−10.5	−93.9	−88.9	−100.5	3.8	15.3	33.0	32.7	48.0
Textile Mill Products	90.7	67.9	56.9	27.5	45.0	−34.8	−48.2	16.1	−4.0	−30.6
Apparel & Other Finished Textile Products	96.5	69.0	−12.2	−60.2	−30.4	−53.2	−63.8	−57.1	−60.6	−71.2
Lumber & Wood Products	−30.9	−58.0	−86.0	−88.8	−100.2	−45.5	−52.2	−20.7	40.4	−40.6
Furniture & Fixtures	86.8	61.6	−15.7	−32.6	−13.8	−26.7	−63.4	−40.8	45.9	−47.5
Paper & Allied Products	70.3	64.0	60.5	44.0	20.4	−41.9	−28.3	−14.5	32.0	−27.8
Printing & Publishing	−16.7	0.6	−27.8	−12.9	24.1	38.6	34.4	36.3	32.1	19.9
Chemical & Allied Products	13.8	24.8	37.2	13.1	3.7	43.1	38.0	35.7	35.4	25.3
Rubber & Plastic Products	96.5	82.4	88.0	78.2	74.2	25.6	−10.4	−2.5	−28.9	−29.8
Leather & Leather Products	86.5	61.1	6.3	−34.9	−16.2	−76.2	−84.2	−78.4	72.7	−70.5
Stone, Clay, & Glass Products	88.9	71.9	73.1	68.4	66.4	3.4	−8.0	−0.3	16.3	−23.1
Primary Metal & Allied Products	54.9	75.9	87.5	79.8	66.1	−23.4	35.6	−19.5	−27.1	−40.8
Fabricated Metal Products	79.7	65.3	82.3	84.9	73.3	47.5	25.4	45.8	31.9	15.1
Nonelectrical Machinery	21.6	29.8	56.8	69.0	70.0	48.1	43.1	47.6	38.6	28.4
Electrical Machinery	79.3	70.0	75.2	77.9	73.8	20.7	−1.0	12.1	2.4	−12.3
Transportation Equipment	83.2	71.9	89.7	89.0	79.3	25.0	2.7	17.7	−1.3	−14.4
Instruments & Related Products	63.5	53.0	57.9	67.1	65.0	30.2	28.3	29.6	4.5	−3.9
Misc. Manufacturing Products	55.6	24.4	9.6	10.8	35.9	−39.6	−35.3	−22.9	−31.7	- 41.3
Total Net Exports as Percent of Trade	−5.5	9.8	−1.8	−3.7	8.1	7.5	−1.6	5.2	−8.9	−14.4

Source : GATT tapes

Note : The index measures net exports as a percentage of trade flow, corrected for aggregate net exports as a proportion of aggregate trade flow.

cal as well as human capital, less than three-fifths of the average for the manufacturing sector (Appendix Table 1).[5] At the same time, they had export indices of revealed comparative advantage ranging from 486(textiles) to 280(leather and leather products) and net export indices between 96(apparel and rubber and plastic products) and 87(leather and leather products).

Lumber and wood products are also unskilled-labor intensive but Japan is at a disadvantage in their production because of the lack of natural resources, which fact explains that its export index was less than 100 and the net export index was negative. Furniture, another unskilled-labor intensive product affected by the availability of natural resources, gives a mixed picture, with a low export index and a high net export index, possibly reflecting the existence of trade barriers in Japan.

Miscellaneous manufactured products also represent a special category. They are unskilled-labor intensive products, in the case of which Japan had a high export index but a net export index below the median for manufacturing industries. This is because the exports of musical instruments, games and toys, and clothing accessories were partly offset by the importation of jewelry and silverware, children's vehicles, and floor coverings.

The next category includes nonelectrical machinery, electrical machinery, transportation equipment, as well as instruments and related products. All these commodity groups are relatively skilled labor(human-capital) intensive, as indicated by the fact that the ratio of physical to human capital in their production is between one-third (electrical machinery) and three-fifths(transportation equipment) of the average for the manufacturing sector(Appendix Table 1).

Apart from nonelectrical machinery, the export index was between 421(electrical machinery) and 273(transportation equipment), with net export indices ranging from 79(electrical machinery) to 64(instruments and related products). While nonelectrical machinery represents an exception, with the two indices being 115 and 22, this may be explained by Japan's technical inability at the time of manufacturing advanced computers and office machinery, as well as certain specialized machines.

Among physical capital intensive products, for which the ratio of physical capital to labor is at least double of the average for the manufacturing sector(Appendix Table 1),

5. In conformity with the system of international trade classification, the data do not include food, beverages, and tobacco; agricultural raw materials; and non-oil mineral products. However, the average includes petroleum and coal products.

Japan had low export and net export indices for paper and allied products, while export indices exceeded 100 but net export indices were below the median for chemicals and primary metals.

In the case of chemicals, the divergence of the two indices is explained by Japan's trade deficit in synthetic rubber, biological and medicainal products, and various chemical preparations. Among primary metals, Japan exported steel where it had transportation cost advantages, owing to the use of the sea routs to import coking coal and iron ore and to export steel, while it imported specialized steel products.

Finally, in accordance with its poor land and mineral endowment, Japan had by far the lowest export indices in the three primary product groups and net export indices for these groups were also strongly negative. Thus, already in 1967, Japan was exchanging manufacturing goods for primary products while its manufactured exports were unskilled-labor intensive and, to a lesser extent, human-capital intensive.

Japan's comparative advantage was much transformed during the period under consideration. The largest change occurred in regard to apparel which is by far the most unskilled-labor intensive commodity group. Between 1967 and 1979, the export index for apparel decreased from 372 to 31 while the net export index shifted from 97 to −60, with a slight reversal in 1983 to 42 in the first case and to −30 in the second. Leather and leather products underwent comparable developments. The export and net export indices were 280 and 87 in 1967 and 40 and −16 in 1983.

Similar changes occurred in the case of textiles, stone, clay and glass products, and miscellaneous manufactured products. But these changes were of smaller magnitude, with the export indices remaining above 100 and exports continuing to exceed imports. And, there were practically no changes in regard to rubber and plastic products.

In turn, Japan greatly strengthened its comparative advantage in human-capital intensive products. The export indices of electrical machinery, transportation equipment, and instruments were about 400 in 1983 while the net export indices were in the 70−80 range. But, the largest increase occurred in regard to nonelectrical machinery, with the export index rising from 115 to 247, and the net export index from 22 to 72, between 1967 and 1983.

Increased specialization in human capital intensive products contrasts with reduced specialization in physical capital intensive products in Japan. Export indices declined in every case as did the net export indices, except for primary metals where the imports of steel products decreased.

Finally, Japan's comparative disadvantage increased further in natural resource prod-

ucts, whether in a primary form(food, beverages, and tobacco and agricultural raw materials) or in a transformed state(lumber and wood products and furniture). And while no change occurred in regard to non-oil mineral products, Japan had a pronounced comparative disadvantage in the commodity group already in 1967.

The results for Japan may be contrasted with those for the United States. In 1967, the U.S. comparative advantage was in three categories: primary products, physical-capital intensive products, and human-capital intensive products. Apart from primary metals, the export index of revealed comparative advantage exceeded 200 and the United States had a large export surplus in all these commodity groups.

By contrast, the export index was less than 100 and the United States had an import surplus in all unskilled-labor intensive commodity groups, except for rubber and plastic products and stone, clay, and glass products. Finally, an intermediate category consisted of transformed natural resource products, such as lumber and wood products and furniture, in which the U.S. had the benefit of the availability of natural resources, although some of them required the use of unskilled labor.

Between 1967 and 1983, with the exception of primary products, the United States increased its copmparative advantage in primary products. It also improved or, at least, maintained its comparative advantage in transformed primary products (lumber and wood products, and furniture).

The picture for other manufactures was less clear. The export index of comparative advantage for transportation equipment and instruments fell between 1967 and 1983, that for electrical machinery remained unchanged, and the index for nonelectrical machinery increased slighitly. Further, the deterioration of the net export index in all these commodity groups exceeded that of the overall average, although this may be related, in part, to increased intra-industry trade in these products.

Overall, Tables 1 and 2 are useful for highlighting the contrasts between Japan and the United States. Two points stand out. The first is the differing position of natural resource based products in the two countries. Japan had a comparative disadvantage in natural resource products which continued to decline over the sample period. The United States, on the other hand, increased its comparative advantage in these products over time. Second, Japan exhibited dramatic shifts in specialization within the manufacturing sector, moving from specialization in unskilled labor intensive products to human capital intensive products. These shifts stand out in comparison to the U.S., where major changes in specialization within manufacturing were not observed. Furthermore, as Japan has upgraded its pattern of specialization, it has increasingly become a competitor with the United States in human capital intensive high technology sectors. These

changes have attracted considerable attention, and warrant a more detailed analysis.

Ⅲ. Japanese and US Revealed Comparative Advantage in Higy Technology Products

For purposes of analysis, high technology products have been defined as products where the ratio of research and development expenditures to the value of output exceeded 3.5 percent in the mid-1970s in the United States. There are altogether nineteen such product categories; their export and net export indices of revealed comparative advantage are shown in Tables 3 and 4 in the order of the share of R&D expenditures. In addition, the overall rankings of the indices among the 167 manufacturing product categories are also reported.

The results show much variability, due in part to the considerable disaggregation of the data and in part to possible misclassifications. A case in point is computers where the United States ranks low in 1967 and 1971 and high in subsequent years while the opposite result obtains for calculating and accounting machines, probably due to changes in classification in reporting the data.

Nevertheless, some general conclusions emerge. It appears that, with few exceptions, the United States increased its comparative advantage in high-technology products over time. In fact, in 1983, these products occupied the first four places in terms of the revealed comparative advantage of the United States as defined by export indices(aircraft, aircraft engines, office machinery, steam engines and turbines) while such was the case for only one product group(aircraft) in 1967.[6]

The exceptions are photographic equipment and supplies, scientific instruments, calculating and accounting machines and medical instruments. In all these product categories, the United States lost and Japan gained comparative advantage, suggesting an inverse relationship between the two countries.

At the same time, except for seven product categorises, Japan increased its compartive advantage in high technology products as measured by the export index. The exceptions are aircraft, optical instruments, agricultural chemicals, synthetic fibers, cellulose fibers, and steam engines and turbines, for which the export index of revealed

6. There is only one such category(cellulose fibers) if use is made of the net export index of revealed comparative advantage but the results are, nevertheless, broadly similar. The following discussion will be based on the export indices alone.

Table 3

Export Index of Revealed Comparative Advantage

High Technology Products
(Rankings are shown in parentheses)

	Japan										United States									
	1967		1971		1975		1979		1983		1967		1971		1975		1979		1983	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Industry																				
Telephone & Telegraphic Equipment	101	120	190	71	199	54	249	41	335	37	85	124	61	129	84	118	127	94	147	82
Aircraft Engines	10	161	4	163	7	161	9	159	15	155	452	7	559	5	504	6	545	3	597	2
Aircraft	38	155	17	159	4	164	6	162	5	161	648	1	976	1	924	1	724	1	661	1
Computers	84	132	42	149	68	125	96	109	297	41	87	121	126	90	300	14	518	4	433	8
Photographic Equipment & Supplies	465	33	343	32	403	20	573	11	620	7	284	27	283	23	257	24	257	26	239	33
Drugs	67	140	62	137	43	137	52	130	44	136	175	72	161	70	152	70	189	50	244	31
Electronic Components	208	74	168	76	207	50	316	33	345	33	278	29	283	22	244	29	255	28	278	21
Optical Instruments	1,145	2	882	3	808	3	910	3	700	5	97	116	123	93	114	100	118	100	149	77
Agricultural Chemicals	137	98	91	222	82	113	74	125	106	108	202	52	225	37	223	35	360	11	382	11
Scientific Instruments	138	96	110	111	119	92	195	60	165	81	373	12	381	9	288	16	203	41	226	35
Calculating & Accounting Machines	99	123	433	24	718	4	1,076	2	1,098	2	455	6	424	7	68	178	57	141	86	118
Synthetic Fibres	473	31	361	27	517	14	327	32	286	42	138	94	184	59	121	92	284	22	167	59
Cellulosic Fibres	550	21	451	20	501	16	420	20	383	28	33	153	58	133	62	135	191	49	385	10
Platework & Boilers	206	75	262	49	253	36	233	48	227	57	33	25	203	46	260	22	216	40	244	32
Steam Engines & Turbines	188	84	212	62	204	51	250	40	132	92	287	87	196	52	264	21	326	14	594	4
Internal Combustion Engines	102	119	148	87	177	66	248	42	269	45	317	22	322	16	288	15	322	15	304	18
Office Machinery	89	127	73	135	75	119	137	88	139	77	420	9	576	4	534	4	497	6	544	3
Typewriters	194	80	211	64	170	69	261	38	558	11	101	108	47	140	54	142	113	105	149	76
Medical Instruments	128	104	144	90	142	82	157	76	151	82	365	13	340	10	312	13	286	21	316	17
Average		89		79		69		61		60		54		47		49		39		32

Source : GATT tapes

Note : (1) Revealed comparative advantage index; (2) ranking of revealed comparative advantage indices

Table 4

Export Index of Revealed Comparative Advantage

High Technology Products
(Rankings are shown in column2)

	Japan										United States									
	1967		1971		1975		1979		1983		1967		1971		1975		1979		1983	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Industry																				
Telephone & Telegraphic Equipment	72.4	77	84.9	17	89.8	22	92.4	15	82.9	27	18.3	86	-14.6	100	33.0	73	16.4	82	-19.7	100
Aircraft Engines	-80.3	161	-102.4	159	-82.2	155	-74.2	154	-76.5	156	51.2	44	64.7	29	62.4	29	62.0	27	53.3	27
Aircraft	-83.2	144	-91.5	156	-92.0	157	-85.9	158	-100.5	158	82.8	7	95.4	5	86.9	3	92.8	4	88.5	8
Computers	-29.2	149	-47.3	151	-54.8	150	18.6	133	56.3	81	34.0	68	10.0	98	67.8	25	79.9	8	54.6	25
Photographic Equipment & Supplies	74.8	76	57.4	77	68.0	62	76.4	50	72.9	55	41.2	59	35.5	60	42.4	62	21.3	77	0.1	76
Drugs	-44.4	155	53.8	154	-56.1	151	-53.9	145	-60.9	150	54.5	41	51.9	41	50.8	50	40.4	55	39.2	35
Electronic Components	48.7	107	27.4	117	44.5	89	58.2	79	58.9	78	47.0	51	37.4	57	23.4	86	7.4	90	3.9	82
Optical Instruments	97.6	28	80.8	34	85.8	32	87.6	29	75.5	46	-49.2	131	-36.3	121	-31.7	127	-28.3	124	-26.2	108
Agricultural Chemicals	36.8	113	9.7	133	23.6	110	25.4	109	51.3	81	73.5	17	71.5	23	52.7	46	71.9	14	71.4	14
Scientific Instruments	13.7	128	7.5	136	26.8	107	31.5	104	26.5	117	67.0	29	72.8	20	66.7	26	30.9	68	27.0	47
Calculating & Accounting Machines	-24.8	148	46.8	89	89.2	24	98.4	7	89.9	6	57.3	38	40.8	54	-58.6	141	-58.1	143	-55.0	138
Synthetic Fibres	104.7	7	88.0	8	99.2	5	64.6	70	78.7	39	15.5	89	48.1	49	60.7	31	93.1	3	46.4	31
Cellulosic Fibres	105.1	3	90.1	1	101.4	1	102.6	3	91.6	2	-44.9	127	8.1	96	22.1	90	88.9	6	105.7	3
Platework & Boilers	51.0	100	31.5	112	71.0	55	87.2	31	66.3	69	87.0	3	75.6	15	80.6	9	91.0	5	97.0	5
Steam Engines & Turbines	18.3	124	37.4	102	43.0	92	74.8	52	51.4	86	36.9	63	22.8	74	57.1	35	51.2	37	95.1	7
nternal Combustion Engines	68.8	92	72.9	52	85.6	35	89.7	25	84.5	21	24.5	80	1.4	93	13.7	95	16.1	83	-1.5	78
Office Machinery	-57.6	160	-53.6	153	0.2	126	33.0	101	47.3	94	60.5	35	71.7	22	55.7	38	51.1	39	25.7	48
Typewriters	29.4	117	32.8	110	58.2	81	14.1	37	86.8	14	-50.6	133	-68.6	142	-67.1	144	-50.2	138	-39.1	124
Medical Instruments	29.8	116	34.4	107	13.5	115		115	21.7	118	62,1	33	65.6	27	58.0	33	51.2	37	53.5	26
Average		100		94		79		71		70		57		56		54		52		49

Source : GATT tapes

Note : See Table 3

comparative advantage decreased between 1967 and 1983. These declines represent the mirror image of increases observed in the United States. At the same time, only calculating and accounting machines ranked among the first four in terms of export indices in 1983 in Japan.

An overall indicator of the importance of the high techology area in the two countries is the average rankings of the high technology products in the comparative advantage indexes for each country. As shown in Tables 3 and 4 this average rose over the sample period for both countries. In fact, high technology products appear to be relatively more important for the United States than Japan: the US averages were higher even at the beginning of the period(1967), than they were for Japan at the end(1983).

Nonetheless, perhaps the most striking thing in Tables 3 and 4 is the apparently complementary pattern of specialization of Japan and the United States within the high technology area. A crucial question then, is what determines this pattern? At least two explanations are consinstent with the data.

One porssibility is that the pattern of specialization reflects the strategic interactions of firms in internationally oligopolistic markets. U.S. revealed comparative advantage grew in categories in which product development and production is characterized by large sunk costs(aircraft, mainframe computers), while Japan made advances in industries with lower entry costs. Given the earlier specialization of the United States in high technology products, this pattern would be consistent with strategic trade-theoretic models in which existing firms use investment to precommit production and act as a deterrent to potential entrants. The efficacy of this strategy depends in part on the size of the sunk costs of production, with the greater the sunk costs, the greater the deterrent effect.

A complementary explanation of the pattern of specialization can be found by analyzing the type of R&D activities pursued in different industries. The notion here is that within the high techology area different industries exhibit different types of R&D activities, and that Japan and the United States have specialized in different industries according to comparative advantage. Kodama and Honda(1986) estimate a cross-section model which classifies industries according to three patterns of R&D activities. The fundamental insight of the model is that the rapidity of technological innovation in an industry can be characterized by the likelihood of "survivability" of a given research project as it moves from exploratory research to investment for production has begun, goes to zero. In the "science-based pattern," the likelihood of project cancellation remains constant throughout the life of the project. In between these extremes, is the

"high-technology pattern" in which the likelihood of project cancellation declines as the project progresses, but the probalility of termination always remains non-zero. Even at the point of investment, the introduction of competing technologies may lead to the termination of the project.

This perspective has implications for the pattern of specialization within the high technology area. science-based industries, such as chemicals, will be dominated by large firms which can finance the basic science research necessary for innovation. This may help explain why Japan still has not developed a strong comparative advantage in chemicals despite Japan's abundant endowments in human and physical capital.[7] Conversely, Japan has fared better in the "high technology pattern" industries where research is more product specific, and management of research achivities is more important. Areas of future Japanese specialization may be drugs, where the rise of biotechnologies may be shifting R&D activities in this industry from a "science-based" to a "high-tech" pattern(Kodama, 1986, p.294), and computer peripheral devices.

Ⅳ. Concluding Remarks

This paper has examined changes in the comparative advantage of the United States and Japan as "revealed" by indices of relative export shares and ratios of net exports. This has been done both by comparing the two sets of indices, and their changes over time.

Comparisons of export and net export indices show increased specialization in Japan in human-capital intensive products, at the expense of unskilled-labor intensive and natural resource products between 1967 and 1985. In turn, the United States became increasingly specialized in natural-resource intensive products.

An inspection of data for high technology product groups further shows that both countries have increased their comparative advantages in these product groups. At the same time, there is some evidence that the two countries specialized in different industries within high technology area. This may have been due to strategic trade considerations, and differences in the kinds of R&D activities pursued in different industries.

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7. Japan's unexpected weakness in chemicals has also been identified by Dixit(1987, p.7).

APPENDIX TABLE 1

Average Factor Intensities for 18 Aggregated Product Categories(Dollars)

Industry	P/L	H/L	R/L	P/B
Textile Mill Products	9404.	17814.	27219.	.528
Apparel & Other Textile Products	2024.	11967.	13991.	.169
Lumber & Wood Products	11266.	12184.	23449.	.925
Furniture & Fixtures	4520.	21678.	26198.	.209
Paper & Allied Produdts	57609.	40126.	97735.	1.436
Printing & Publishing	8417.	36191.	44607.	.233
Chemical & Allied Products	41417.	33031.	74448.	1.254
Petroleum & Coal Products	126110.	65629.	191739.	1.922
Rubber & Leather Products	10188.	18579.	28766.	.549
Leather & Leather Products	5860.	17281.	23142.	.339
Stone, Clay & Glass Products	11843.	10003.	21846.	1.184
Primary Metal & Allied Products	32937.	30130.	63066.	1.093
Fabricated Metal Products	9073.	27860.	36933.	.326
Nonelectrical Machinery	10045.	29011.	39056.	.346
Electrical Machinery	7122.	30836.	37958.	.231
Transportation Equipment	11602.	27067.	38669.	.429
Instruments & Related Products	11147.	41230.	52376.	.270
Misc. Manufacturing Products	5667.	17761.	23428.	.319
All Categories	20518.	28278.	48796.	.701

Note : The table shows average capita-labor ratios for individual commodity groups have been derived by weighting by the share of exports of individual product categories in the total exports for each commodity group aggregated over the countries under study. Physical capital (P) has been defined as the value of fixed investment and human capital(H) as the present value of the difference between the average wage and the unskilled wage while labor (L) has been measured in terms of margins.

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