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TRADE ISSUES IN TELECOMMUNICATIONS AND INFORMATION

THE EMPLOYMENT EFFECTS OF TRADE IN HIGH-TECHNOLOGY TELECOMMUNICATIONS AND INFORMATION PRODUCTS

VOLUME II

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PREFACE

This paper is one in a series of four on selected topics on trade in the goods and services of the telecommunications and information industries. Other papers in the series include:

Volume I	"United States Trade in the Merchandise of Information Industries" by Kenneth Leeson.
Volume III	"Promoting U.S. Trade in Telecommunications and Information Products with Developing Countries" by Kathleen M. White and C. Randall Jacobson;

We would like to thank Forrest Chisman and to acknowledge the assistance of those in other offices of the Department of Commerce, in other government agencies and in private industry who have provided helpful information to us and comments on earlier drafts. Of course, we take sole responsibility for any opinions expressed in these papers.

THE EMPLOYMENT EFFECTS OF TRADE

IN HIGH-TECHNOLOGY

TELECOMMUNICATIONS AND INFORMATION PRODUCTS

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THE EMPLOYMENT EFFECTS OF TRADE IN HIGH-TECHNOLOGY TELECOMMUNICATIONS AND INFORMATION PRODUCTS

The impact of international trade on U. S. domestic employment has become an issue of increasing concern as U. S. policy makers wrestle with the problem of a growing balance of payments deficit. Many studies have addressed this issue, with many conflicting results and recommendations. Evidence currently available, however, generally suggests that net trade (exports minus imports) in high-technology manufactured products[1] has a net positive effect on employment in the United States. Since several telecommunications and information products fit into the category of high-technology goods, it would seem that trade in these goods is desirable. This paper will use the results of a study that used empirical data and a simulation (input-output) model to examine the employment effects of increased

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The views and conclusions contained in this paper reflect those of the author, and should not be interpreted as necessarily representing the official policies or recommendations of the National Telecommunications and Information Administration, the U.S. Department of Commerce, or the U.S. Government.

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[1]The technological content of products has been measured in a number of different ways, such as the ratio of R&D by product field to shipments by product class, or the number of scientists and engineers in a given category as a percentage of total employment in that category, etc. The twelve telecommunications and information product categories discussed in this paper were selected to correspond as closely as possible to the fourteen 4-digit SIC product categories classified as "newer technology products" by Kenneth Leeson in "United States Trade in the Merchandise of Information Industries." In this paper, products classified as "newer technology" were those that rely heavily on electronic technologies as opposed to more conventional technologies. See Appendix for a comparison of the SIC code and product categories used in the input-output model.

trade in twelve selected high-technology telecommunications and information product categories.[2] These twelve categories are listed on Table 1 (p. 3).

Profile of the Industries

The value of trade for each industry in five years -- 1968, 1970, 1972, 1974, and 1975 -- is shown in Table 1. The twelve product categories differ considerably from one another in the degree to which trade is important to output and consumption. For instance, exports accounted for 22 per cent of output of computing machines in 1972, but for only 2 per cent of telephone and telegraph apparatus output. Fifteen per cent of domestic consumption of semiconductors was imported in 1972, while only 3 per cent of computing machines in 1972 was imported[3]. These differences, and differences in the sizes of the industries, mean that for each industry, the employment effects of trade are of varying importance. This should be kept in mind when figures indicating job opportunities due to trade or numbers of jobs associated with a million dollars worth of exports are presented.

Method of Analysis

The figures showing job opportunities due to foreign trade presented in the following tables (Tables 2, 3, and 4) are taken from a 1978 Labor Department analysis of the effect of manufacturing trade on U. S. employment. The Labor

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[2]The numerical data presented in this paper, unless otherwise noted, are from an analysis based on a 367-sector input-output model for the year of 1967 prepared by the Office of Foreign Economic Research, Bureau of International Labor Affairs, U. S. Department of Labor. Other studies using this analysis are Trade and Employment: A Special Report of the National Commission for Manpower Policy (Special Report No. 30, November 1978), and The Impact of Manufacturing Trade on Employment, a Report Prepared by Ruttenberg, Friedman, Kilgallon, Gutchess & Associates, Inc., for the Conference on the Employment Effects of International Trade, Washington, D.C., November 15, 1978.

[3]These figures are based on SIC code categories and may not be comparable to the figures in the input-output model. They were obtained from Kenneth Leeson, "United States Trade in the Merchandise of Information Industries," p. 24.

Table 1

VALUE OF TRADED MERCHANDISE IN

TWELVE PRODUCT CATEGORIES

(in millions of 1967 dollars)

Product Category	1968		1970		1972		1974		1975	
	Value of Exports	Value of Imports	Value of Exports	Value of Imports	Value of Exports	Value of Imports	Value of Exports	Value of Imports	Value of Exports	Value of Imports
Radio/Television Receiving Sets	$161.1	$938.9	$186.7	$1595.8	$275.9	$2486.4	$472.7	$2858.0	$473.2	$2239.1
Electron Tubes	122.0	264.7	171.6	371.1	191.2	560.2	284.0	651.0	289.7	533.8
Semiconductors	292.9	152.1	559.2	291.8	648.0	533.0	1470.3	1261.0	1249.5	1027.2
Electronic Components	612.3	388.7	984.8	605.6	1186.5	899.0	1923.6	1431.4	1801.9	1169.0
Electric Measuring Instruments	230.3	80.1	297.6	115.4	279.5	69.0	443.3	89.0	441.5	75.7
Computing Machines	782.0	141.9	1674.7	246.7	1752.6	242.5	2844.7	478.0	2771.4	423.9
X-Ray Apparatus	34.4	28.2	39.2	34.7	50.1	51.9	88.7	86.5	94.3	104.8
Engineering & Scientific Instruments	220.7	59.9	218.5	63.1	186.9	42.2	277.4	56.2	259.9	45.8
Electronic Equipment n.e.c.	46.3	100.8	62.7	119.9	68.7	149.2	123.0	155.8	123.4	110.7
Radio/Television Communication Equipment	684.1	242.6	730.3	289.1	756.3	358.2	1102.5	683.2	1163.8	740.5
Telephone/Telegraph Equipment	106.0	86.0	143.9	106.5	147.3	151.9	256.1	243.1	266.8	152.9
Phonograph Records	12.5	7.4	13.2	7.8	16.8	12.0	39.1	14.9	37.1	14.9
Total 12 Categories	$3304.6	$2491.3	$5082.4	$3847.5	$5559.8	$5555.5	$9325.4	$8008.1	$8972.5	$6638.3

Source: U.S. Department of Labor, Bureau of Economic Analysis, Input-Output Table, 1967 Benchmark

Department analysis applied annual U. S. trade data (the dollar value of exports and imports) and data on output per unit of labor input (productivity) to an input-output model that divides the economy into 367 industrial sectors. An input-output model is used to study economic relations among industries. In such a model, the output of any chosen industry is required as an input in other industries. Some of the output of the steel industry, for example, will serve as input for the automobile industry, the aerospace industries, the construction industries, and so on. In turn, the output of many industries will serve as input for the steel industry. An input-output model shows all of these relationships simultaneously—the total output of each industry in a given year and how that output is distributed as input over all other industries.

Since for any chosen year, the relationship between output and employment is essentially fixed for an industry, an input-output model can be used to show the employment effects of a change in output in an industry. In the context of trade, since imports to the United States are inputs for some industries and since exports from the United States are outputs of other industries, effects on levels of employment of changing trade patterns can be estimated using an input-output model.

In an input-output model, such as the one discussed here, employment is estimated, rather than counted. For this reason, the term "job opportunities" is used instead of "employment." The simplified model of the input-output table allows for the estimation of both direct and indirect effects of trade on "job opportunities," that is, the effect in the industry in question and the effects in all other industries that use the product as input.

In estimating the "job opportunities" (lost and gained) associated with a certain level of trade, it is first necessary to estimate what "job opportunity" levels would be if no trade took place at all. Since the assumption of no trade

would would have far-reaching impacts on employment levels in all industries, this estimation technique is subject to a great deal of error.

The no-trade estimate is one of many simplifying assumptions of the input-output model and the further analysis of the employment effects of trade. The most important assumptions and a detailed explanation of how the end figures in Tables 2, 3, and 4 were obtained are given below.

Assumptions of the input-output model.[4] The input-output model used in this analysis to calculate values is "domestic based," which means that input requirements for exports and imports are both assumed to be domestically produced. The input-output model also assumes a given technology with no substitution of factors of production possible. Capital requirements are ignored, and if output expands or declines, labor and material requirements increase or decrease by an amount proportional to the change in output. Expansions of output in particular industries are not limited by the lack of raw materials or workers with appropriate skills.

Technical coefficients are fixed in an input-output model according to the relationship existing in the base year. In this analysis, the base year was 1964.[5] In a rapidly advancing sector like telecommunications and information, the technical coefficients change constantly with the introduction of new products with new capabilities. Application of these coefficients to later years, up to 1975 in this analysis, must be considered a limit to the usefulness of the input-output model.

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[4]The remainder of this section is a shortened version of "Methodology and Assumptions" in The Impact of Manufacturing Trade on Sectoral Employment Patterns - A Progress Report, U. S. Department of Labor, 1978, pp. 7-14. To preserve continuity, quotation marks and page references are not used.

[5]A 1972-based input-output model is now available, but the U.S. Labor Department has not yet prepared complete data sets for its trade and employment project using this base year.

Assumptions of the analysis. The analysis is restricted to manufacturing trade and the estimates exclude refined petroleum and processed non-ferrous metals. Some effects of changes in trade are not considered in deriving the estimates of job opportunities. One is the effect of trade on domestic income, which may increase if exports expand and decrease if production is displaced by imports. Another is the effect trade has on real income by influencing wages and prices. These repercussions on income are ignored, and it is assumed that income in current dollars remains constant when the calculations of the effect of trade on "job opportunities" are made. Final change in equilibrium employment is not estimated because this depends on labor supply and other factors affecting labor demand.

The analysis assumes dollar-for-dollar substitution -- i.e., that every dollar that goes to pay for imports would be switched to U. S. products in the absence of imports. This probably understates the potential employment impact of going to no-trade, since a given value of imports probably represents more volume than the same value of domestically-produced goods.

Obtaining the estimates. The estimates were obtained by classifying imports on a Tariff Schedule of the United States (TSUS) basis and classifying exports according to the export schedule (Schedule B) by appropriate input-output sector and then deflating by sector to express them all in constant 1967 dollars. Imports were adjusted by cost-insurance-and-freight (CIF) margins, in order to obtain the final figures in dollars values actually spent by U. S. residents. A portion of the export value of each sector was allocated to domestic trade and transportation in order to reflect the services required to get the exports to port.

The deflated export and import values were then entered as final demands in the 367-sector input-output model, and the model was used to generate both the direct and indirect output requirements in each sector necessary to produce the

exports and the domestic goods comparable to imports. The employment requirements for these sectoral outputs were finally computed using annual output-employment ratios for each sector. "Job opportunity" gains are thus due to increased production for export in the United States, while "job opportunity" losses are due to increased imports -- because additional production for domestic consumption was not undertaken in the United States but lost to foreign competitors. Since "job opportunities" due to exports are regarded as positive and "job opportunities" due to imports are regarded as negative, the net loss or gain (when the losses are subtracted from the gains) indicates the net effect of trade on employment opportunities.

"Job Opportunities" Due to Trade

Table 1 (p. 3) shows that the level of trade increased for most of the product categories over the eight-year period. For all twelve categories together, the value of exports increased from $3,304.6 million in 1968 to $8,972.5 million in 1975,[6] while the value of imports increased from $2,491.3 million in 1968 to $6,638.3 million in 1975. Table 2 (p. 8) shows that as the level of trade in these products increased, so did the number of "job opportunities." The "job opportunities" due to exports for all twelve categories increased from 145,000 in 1968 to over 310,000 in 1975, while the net "job opportunity" gains due to trade increased from 49,000 to 105,000 over the same period.

Some product categories, such as electronic measuring instruments, electronic components, radio and television communication equipment, and

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[6] 1975 was a year of worldwide recession. Both the value of exports and the value of imports were greater in 1974 than in 1975.

Table 2

JOB OPPORTUNITIES[1] DUE TO TRADE

IN TWELVE PRODUCT CATEGORIES

Product Category	1968 Export Job Oppor-Tunities	1968 Import Job Oppor-Tunities	1968 Net Job Oppor-Tunities	1970 Export Job Oppor-Tunities	1970 Import Job Oppor-Tunities	1970 Net Job Oppor-Tunities	1972 Export Job Oppor-Tunities	1972 Import Job Oppor-Tunities	1972 Net Job Oppor-Tunities	1974 Export Job Oppor-Tunities	1974 Import Job Oppor-Tunities	1974 Net Job Oppor-Tunities	1975 Export Job Oppor-Tunities	1975 Import Job Oppor-Tunities	1975 Net Job Oppor-Tunities
Radio/TV Receiving Sets	4,356	25,388	(21,032)	4,249	36,319	(32,070)	5,748	51,804	(46,056)	9,071	54,845	(45,774)	6,964	32,950	(25,986)
Electron Tubes	4,880	10,585	(5,705)	6,126	13,247	(7,121)	6,639	19,452	(12,813)	9,850	22,579	(12,729)	8,831	16,274	(7,443)
Semiconductors	19,316	10,030	9,286	32,917	17,175	15,742	37,109	30,526	6,583	84,104	72,133	11,971	62,830	51,648	11,182
Electronic Components	27,903	17,711	10,192	40,060	24,635	15,425	46,954	35,579	11,375	76,034	56,579	19,455	62,607	40,617	21,990
Electric Measuring Instruments	12,151	4,225	7,926	14,622	5,672	8,950	12,403	3,062	9,341	23,039	4,626	18,413	21,327	3,656	17,671
Computing Machines	27,113	4,918	22,195	63,404	9,342	54,062	49,257	6,816	42,441	73,237	12,305	60,932	64,537	9,871	54,666
X-Ray Apparatus	1,174	961	213	1,234	1,091	143	1,431	1,481	(50)	2,698	2,633	65	2,589	2,876	(287)
Engineering & Scientific Instruments	11,644	3,160	8,484	10,585	3,057	7,528	7,687	1,737	5,950	10,900	2,207	8,693	9,884	1,743	8,141
Electronic Equip. n.e.c.	2,243	4,882	(2,639)	2,805	5,363	(2,558)	2,788	6,055	(3,267)	5,321	6,739	(1,418)	4,817	4,320	497
Radio/TV Communication Equipment	29,913	10,606	19,307	30,943	12,248	18,695	29,544	13,991	15,553	45,567	28,236	17,331	53,384	33,968	19,416
Telephone/ Telegraph Equipment	4,267	3,462	805	5,609	4,152	1,457	5,600	5,775	(175)	10,533	9,998	535	11,950	6,847	5,103
Phonograph Records	533	314	219	474	280	194	550	391	159	1,180	449	731	858	345	513
Total Twelve Categories	145,493	96,242	49,251	213,028	132,581	80,447	205,710	176,669	29,041	351,534	273,329	78,205	310,578	205,115	105,463

Source: U.S. Department of Labor, Bureau of Economic Analysis, Input-Output Table, 1967 Benchmark

[1]Direct labor required to produce the exports and imports of an industry and labor required in an industry to produce the exports and imports of all other indu industries.

computing equipment, show consistent positive net "job opportunities" due to increased levels of trade. Electric measuring instruments showed over 18,000 net "job opportunity" gains due to trade in 1974, while electronic components showed over 19,000 and radio and television communication equipment more than 17,000.

Computing equipment showed the greatest number of net "job opportunity" gains in each of the five years, increasing from 22,000 net "job opportunities" in 1968 to over 54,000 in 1975. This increase in net "job opportunities" took place despite the fact that the number of "job opportunities" lost due to imports in the computing equipment category increased from almost 5,000 in 1968 to over 12,000 in 1974. The large increase in net "job opportunity" gains indicates that increased levels of trade in this product category are beneficial to U. S. employment.

Radio and television receiving sets and electron tubes, on the other hand, are categories that show negative net "job opportunities." Net "job opportunity" losses in this product category increased from 21,000 in 1968 to almost 46,000 in 1974. This occurred despite the fact that "job opportunity" gains due to exports increased from 4,356 in 1968 to 9,071 in 1974, because the "job opportunities" lost to imports increased from 25,400 to almost 55,000 over the same period. This increase in "job opportunity" losses is due to the very rapid growth of the Japanese television manufacturing industry and the establishment by American companies of assembly plants in other countries where labor is less expensive.

Still other product categories, such as telephone and telegraph apparatus, wavered back and forth between positive and negative net "job opportunities." While the value of exports in telephone and telegraph apparatus increased from $106 million in 1968 to $267 million in 1975, the value of imports increased from $86 million to $153 million. The net "job opportunities" due to trade in this category went from a positive 1,457 in 1970 to a negative 175 in 1972, then increased to a positive 5,103 in 1975.

Numbers of "Job Opportunities" Associated with Exports

Table 3 (p. 11) indicates the number of worker-years of labor associated with one million dollars of exports (or imports) for each of the twelve product categories. These numbers were obtained by dividing the export "job opportunities" in Table 2 by the value of exports in Table 1 for each year.[7] Except in the categories of radio and TV communication equipment, telephone and telegraph equipment, and electric measuring instruments, there was a steady decline in the number of worker-years required to produce a million dollars worth of exports over the period 1968-1975. For instance, this figure declined from 35 to 23 worker-years in the computing machines category, from 27 to 15 worker-years in the radio and television receiving sets category, and from 43 to 23 worker-years in phonograph records.

For the most part, this decline can probably be accounted for by productivity gains, which have been significant for most high-technology industries. For instance, over the decade 1964-1975, the labor/output ratio in the radio and TV receiving set industry fell by 47 per cent, that for computing machines by 34 per cent, for semiconductors, electronic components and electron tubes by 35 per cent, and for electric measuring instruments by 12 per cent.

Direct and Indirect Employment Effects Due to Trade

Table 4 (p. 12) shows a breakdown of employment effects due to trade into direct and indirect effects for the four product categories showing the greatest positive net "job opportunities" gains over the period 1964 to 1975. This breakdown indicates that, as one would expect for high-technology goods, the indirect employment gains in other industries which produce intermediate goods

[7] The same number (rounded to the nearest whole number) can be obtained by dividing the import "job opportunities" by the value of imports for each year.

Table 3

LABOR REQUIREMENTS IN WORKER-YEARS

PER MILLION DOLLARS OF EXPORTS OR IMPORTS

USED IN ALL PRODUCTION RELATING TO MANUFACTURING TRADE

IN TWELVE INDUSTRIES*

Product Category	1968	1970	1972	1974	1975
Radio/Televison Receiving Sets	27	23	21	19	15
Electron Tubes	40	36	35	35	30
Semiconductors	66	59	57	57	50
Electronic Components	46	41	40	40	35
Electric Measuring Instruments	53	49	44	52	48
Computing Machines	35	38	28	26	23
X-Ray Apparatus	34	31	29	30	27
Engineering & Scientific Instruments	53	48	41	39	38
Electronic Equipment n.e.c.	48	45	41	43	39
Radio/Television Communication Equipment	44	42	39	41	46
Telephone/Telegraph Equipment	40	39	38	41	45
Phonograph Records	43	36	33	30	23
Average Twelve Industries	44	42	38	39	36

Source: U.S. Department of Labor, Bureau of Economic Analysis, Input-Output Table, 1967 Benchmark

*Rounded figures

Table 4

Net Job Impact Due to Trade
1964-1975:
Direct and Indirect Employment Effects

Product Category	Direct Employment*	Indirect Employment I*	Indirect Employment II*	Direct and Indirect I and II Employment*
Computing Machines	32,544	5,937	84,178	122,659
Elec. Meas. Instrumts.	11,670	1,104	10,924	23,698
Electronic Components	5,138	1,482	8,855	15,475
Semiconductors	4,961	1,236	4,340	10,537

* 1975 minus 1964

Direct = Direct labor required to produce the exports and imports of an industry.
Indirect I = Total indirect labor required in an industry to produce the exports and imports of all other industries.
Indirect II = Total indirect labor required of all other industries to produce the exports and imports of an industry.

(Source: Trade and Employment, Special Report #30 of the National Commission for Manpower Policy, November 1978, p. 35, Table 3.)

contributing to the exports and imports of the four product categories (Indirect II) are large compared with the direct employment gains in the four product categories. This type of indirect employment effect is not reflected in the figures in Table 2.

Effects of Foreign Direct Investment on Employment

Many corporations have chosen, because of lower wage costs or requirements by foreign governments that local production facilities be established, to locate production facilities in foreign countries, particularly in developing countries. The effect of foreign direct investment on the general level of exports and employment in the U. S. has been the subject of several studies, and the general finding is that ". . . U. S. foreign investment in manufactures in the developing countries are likely to have a net positive effect on U. S. jobs, and, in any case, favor employment in the higher skill categories."[8] This is because increased exports from selling components or industrial equipment to foreign affiliates may have a higher labor content than the exports lost to production abroad. The industries which experience net gains in exports with establishment of foreign affiliates tend to be the more R&D-intensive industries and the jobs created are weighted more heavily in the skilled, professional, and scientific categories. Although this finding ignores the possible long-term effects on employment of technology transfer, it indicates that trade in high-technology telecommunications and information products that involves foreign direct investment in developing countries should have a positive short-term effect on U. S. employment.

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[8]Jack N. Behrman and Raymond F. Mikesell, The Impact of Foreign Direct Investment on U. S. Export Competitiveness in Third World Market (Washington, D. C.: Georgetown University Center for Strategic and International Studies, 1980), p. 13. A good examination of both sides of the foreign direct investment issue and examples of the different methodologies used to study this issue can be found in The Impact of International Trade and Investment on Employment - Part IV: "Foreign Investment and Technology Transfer," Bureau of International Labor Affairs, U.S. Department of Labor, 1978, pp. 136-209.

Conclusion

Taking into account the possible unreliability of the data due to the assumptions of the input-output model, the evidence presented in this paper indicates that trade in high-technology telecommunications and information products generally has positive domestic employment effects, although for some industries within the high-technology category, such as television and radio receivers, the effects apparently are negative. The evidence indicates, more specifically, that indirect employment effects are important in these high-technology industries, that the number of "job opportunities" associated with a given value of exports or imports has declined over the years due to productivity gains, and that foreign direct investment in these high-technology industries probably has a positive short-term employment effect.

APPENDIX

Comparison of Standard Industrial Code (SIC)

And Input-Output Model Product Categories

Product Category	SIC Category Number	Input-Output Model Category Number
Radio/Television Receiving Sets	3671	5601
Radio/Television Receiving Type Electron Tubes, Except Cathode Ray	3671	
Cathode Ray Picture Tubes	3672	5701
Transmitting and Special Purpose Electron Tubes	3673	
Semiconductors	3674	5702
Electronic Components	3679	5703
Electronic Measuring Instruments	3611	5301
Electronic Computing Machines	3573	
Calculating and Accounting Machines except Electronic Computing Machines*	3574	5101
X-Ray Apparatus and Tubes	3693	5803
Engineering, Laboratory, and Scientific and Research Instruments and Equipment	3811	6201
Electronic Parts and Equipment, n.e.c.	5065	5805
Radio/Television Transmitting, Signalling and Detection Equipment	3662	5604

*This SIC category is not included in Kenneth Leeson's group of 14 high technology products.

APPENDIX (continued)

Product Category	SIC Category Number	Input-Output Model Category Number
Telephone and Telegraph Apparatus	3661	5603
Phonograph Records	3652	5602

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This study uses empirical data and a simulation model (input-output) to examine the employment effects of increased trade in twelve selected high technology telecommunications and information product categories.

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