4 Data Preview

One of the important goals of this book is to provide vivid and memorable images of the international economy. Four different media are used to construct these images—words, tables, graphs, and econometric data summaries. Econometric images may be viewed with suspicion because they depend on incredible assumptions and leave one wondering whether slightly different assumptions might not produce entirely different images. This concern leads to the extensive sensitivity analysis presented in subsequent chapters. The images in this preliminary chapter are formed from tables and graphs of the actual data, and the assumptions that underlie them are minimal. A considerable amount of care has gone into the selection of these displays, and it is hoped that they will prove to be an accurate and convenient source of information about the international economy. No comparable source exists.

Sections 4.1 and 4.2 discuss features such as correlation matrices and boxplots of the trade data and the resource data. Trade dependence profiles and resource abundance profiles that are located in appendix D are discussed in section 4.3. These displays clearly indicate the composition of trade and the relative abundance of resources, and they may, with some justification, leave a more lasting impression about the sources of comparative advantage than anything else in this book. Section 4.4 contains a discussion about the adequacy and the accuracy of the resource data. When exploring the first four sections it is wise to keep in mind that the data may have some serious inaccuracies. Finally, section 4.5 contains simple correlations between the trade data and the resource data. These serve as a "warm-up" for the econometric analysis of multiple correlations presented subsequently.

4.1 Net Export Data

This section reports features of the net export data of the 10 aggregates constructed in chapter 3. The questions that are answered with tables and graphs are

1. What is the relative importance of the 10 aggregates?
2. Can the data be further aggregated?
3. Which countries are the major traders?
4. How has the trade pattern changed over time?

Table 4.1
Aggregates shares[a]

AGG	1958	1960	1963	1966	1969	1972	1975
1. PETRO	.06	.06	.07	.07	.09	.10	.21
2. MAT	.06	.07	.07	.08	.10	.08	.07
3. FOR	.08	.08	.08	.07	.07	.07	.04
4. TROP	.12	.10	.10	.08	.08	.07	.05
5. ANL	.08	.08	.08	.07	.06	.07	.04
6. CER	.13	.15	.15	.15	.10	.11	.12
7. LAB	.04	.04	.04	.05	.09	.09	.06
8. CAP	.10	.09	.08	.09	.10	.11	.10
9. MACH	.28	.27	.29	.27	.27	.27	.27
10. CHEM	.06	.05	.06	.06	.06	.05	.05

a. Share $= \sigma_i / \sum \sigma_i$, σ_i = standard deviation of aggregate i.

Table 4.2
Aggregate correlation matrix (cross-country correlations, net export data): 1958

AGG \ AGG	1	2	3	4	5	6	7	8	9	10
1. PETRO	1.0									
2. MAT	.49	1.0								
3. FOR	.43	.75	1.0							
4. TROP	.83	.46	.45	1.0						
5. ANL	.56	.48	.54	.60	1.0					
6. CER	−.06	.33	.02	−.14	.29	1.0				
7. LAB	−.65	−.87	−.74	−.64	−.60	−.19	1.0			
8. CAP	−.67	−.81	−.63	−.65	−.66	−.38	.90	1.0		
9. MACH	−.75	−.63	−.71	−.86	−.73	.08	.78	.69	1.0	
10. CHEM	−.73	−.50	−.61	−.88	−.58	.26	.63	.59	.95	1.0

These questions are also partly answered by the trade dependence profiles discussed in section 3.

4.1.1 Behavior of the Aggregates

The relative importance of the aggregates is summarized by the standard deviations in table 4.1. Machinery maintains over time approximately a 27% share of trade. Petroleum rises dramatically from 6% in 1958 to 21% in 1975. This increase is offset by a reduction in forest products, tropical agriculture, and animal products. Of course these are shares of net export *values*, and no attempt is made to separate price changes from quantity changes.

The cross-country correlations of the aggregates in 1958 and 1975 are reported in tables 4.2 and 4.3. In 1958 the four manufactured aggregates

Table 4.3
Aggregate correlation matrix (cross-country correlations, net export data): 1975

AGG / AGG	1	2	3	4	5	6	7	8	9	10
1. PETRO	1.0									
2. MAT	.56	1.0								
3. FOR	.39	.63	1.0							
4. TROP	.70	.32	.21	1.0						
5. ANL	.49	.49	.30	.45	1.0					
6. CER	−.32	.43	.27	−.32	.04	1.0				
7. LAB	.24	−.40	−.21	.53	−.21	−.69	1.0			
8. CAP	−.60	−.87	−.55	−.42	−.45	−.46	.27	1.0		
9. MACH	−.85	−.62	−.81	−.83	−.57	.14	−.29	.69	1.0	
10. CHEM	−.70	−.29	−.42	−.84	−.81	.31	−.85	.42	.85	1.0

7–10 are positively correlated—success in exporting one tended to be associated with success in exporting the others. Similarly the first five nonmanufactured aggregates are positively correlated, cereals being the exception. In that year, it is tempting to form only three aggregates (raw materials, cereals and manufactured goods), and to conclude that countries abundant in natural resources exported raw materials, countries abundant in labor and capital exported the manufactured goods, and countries abundant in land and capital exported cereals.

By 1975 the labor intensive aggregate had broken away from the other manufactured commodities. Otherwise, the correlation matrix is much the same. What this suggests is a breaking down of the sharp distinction between developed and developing countries in terms of success in exporting manufactured products. This is further explored in tables 4.4 and 4.5, which indicate the sign of the aggregate net export data for 1958 and 1975. The manufactured aggregates are ordered to suggest a development process that begins with the export of aggregate 7, which requires primarily low skilled workers. The next rung up the ladder of commodities is aggregate 8, which requires capital. The more advanced countries, which are abundant in skills and capital, stand at the top and export 9 and 10. In 1958 a long list of countries imported all four aggregates. Seven countries exported aggregate 7 and imported the others. Austria and India exported 7 and 8 and imported 9 and 10; Belgium imported only 9. France, Germany, the United Kingdom, and the United States exported all four of these aggregates of manufactures; but the most advanced countries were Switzerland and The Netherlands. Although Chile and

Table 4.4
The ladder of development (sign of net exports of manufactured aggregates): 1958

Aggregates				
7	8	9	10	Countries
−	−	−	+	NETH
−	−	+	+	SWITZ
+	+	+	+	FRA, GER, UK, US
+	+	+	−	ITLY, JAP
+	+	−	+	BLUX
+	+	−	−	AUST, INDA
−	+	−	−	MEX
+	−	−	−	DEN, HOKO, ISRL, PORT, SLEO, SPAN, YUG
−	−	−	−	AFG, ARG, AUSL, BRAZ, BRUI, BURM, CAN, CLUM, CSTA, CYPR, DORE, ECUA, EGPT, LSAL, FIN, GANA, GRCE, HOND, ICE, INDO, IRE, JAMC, KORA, LIBR, LIBY, MALY, MLTA, MAUR, NETA, NUZE, NIGR, NOR, PANM, PERU, PLIP, SRIL, SING, SWE, THAI, TURK
−	−	−	+	CHLE, PRGY

Table 4.5
The ladder of development (sign of net exports of manufactured aggregates): 1975[a]

Aggregates				
7	8	9	10	Countries
−	−	−	+	NETH
−	−	+	+	SWITZ, US*
−	+	+	+	GER*, UK*
−	−	+	−	SWE*
+	+	+	+	FRA, JAP*
−	+	−	+	BLUX
+	+	+	−	ITLY
+	+	−	−	AUST, INDA, KOR*, SPAN*
+	−	−	−	BRAZ*, CLUM*, CYPR*, DEN, EGPT*, FIN*, GRCE*, HOKO, ISRL, MLTA*, PLIP*, PORT, SLEO[b], THAI*, TURK*, YUG
−	−	−	−	AFG,[b] ARG, AUSL, BRUI,[b] BRMA,[b] CHLE,[b] CSTA, CYPR,[b] ECUA,[b] LSAL,[b] GANA, HOND, ICE, INDO, IRE, LIBR, LIBY, MALY, MAUR,[b] MEX*,[b] NUZE, NIGR, NOR, PANM,[b] SRIL, SING
−	−	−	+	JAMC*

a. Asterisk indicates a change in the sign pattern since 1958.
b. Based on 1972 data.

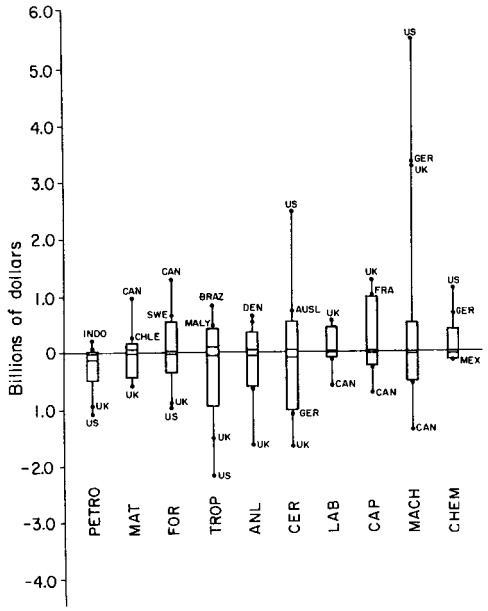

Figure 4.1
Boxplots of net export data: 1958.

Paraguay both had chemical exports in 1958, they are not placed at the top of the ladder because their chemical exports, sodium nitrate and extract of quebracho, respectively, are better classified as raw materials. Further explanation of these anomalies is provided later.

By 1975 things had changed considerably, with a large number of countries moving up this ladder of development by exporting aggregates 7 and 8 and in turn pushing the most industrialized countries out of these markets. It can be expected that the crowding of the markets of aggregates 7 and 8 causes serious adjustment problems for these most industrialized nations. The country that changed the most was Sweden, which moved from the lowest rung on the ladder to one of the highest rungs. Korea and Spain also exhibit relatively rapid changes in their trade patterns. Mexico was the only country that actually stepped down the ladder over this period. The anomalous countries in 1958, Chile and Paraguay, were no longer anomalous in 1975, but Jamaica had replaced them. Again, this is explained by the fact that the "chemical" export of Jamaica is actually a raw material (aluminum oxide).

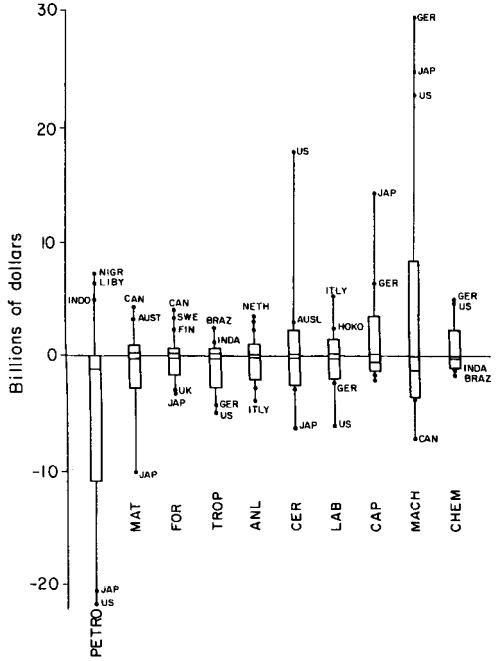

Figure 4.2
Boxplots of net export data: 1975.

The final data displays in this section are the boxplots of the net exports in figures 4.1 and 4.2. These boxplots indicate by points at least two of the extreme countries, and a third when there is a big gap between the second and the third. The remaining countries fall within or on the edge of the box. Both the upper quartile and the lower quartile of the distribution are indicated by horizontal lines. These lines are usually close to zero, which means that 75% of the countries are clustered together with relatively small net exports.

These boxplots reveal the importance of machinery trade and the increased importance of petroleum trade in 1975. The United States is often an outlier, but the trade of France, Germany, Japan (in 1975), and Canada is also very substantial in many commodities. These diagrams will be referred to again when the influence of outlying observations on the statistical inferences is discussed.

4.2 Resource Data

The collection of resource data on a large list of countries is a formidable task that necessarily involves compromises. The resources that will be used in the data analysis were selected from a longer list of potential variables on the basis of data availability, presumed economic importance (for example, polar and mountainous regions are excluded), statistical explanatory value (for example, forest area offers a poor explanation of net exports of forest products presumably because it does not distinguish tropical rain forests from cooler softwood forests), and parsimony (for example, the minerals are aggregated into a single index). A complete list of variables and a full description of sources and methods for compiling the data may be found in appendix B. The variables that have been selected are

1. *CAPITAL.* Accumulated and discounted gross domestic investment flows since 1948, assuming an average life of 15 years.
2. *LABOR 1.* Number of workers classified as professional or technical.
3. *LABOR 2.* Number of literate nonprofessional workers.
4. *LABOR 3.* Number of illiterate workers.
5. *LAND 1.* Land area in tropical rainy climate zone; comprises 30% of total area.
6. *LAND 2.* Land area in dry climate zone; comprises 30% of total area.
7. *LAND 3.* Land area in humid mesothermal climate zone (for example, California); comprises 15% of total area.
8. *LAND 4.* Land area in humid microthermal climate (for example, Michigan); comprises 17% of total area.
9. *COAL.* Value of production of primary solid fuels (coal, lignite, and brown coal).
10. *MINERALS.* Value of production of minerals: bauxite, copper, flourspar, ironore, lead, manganese, nickel, potash, pyrite, salt, tin, zinc. Table 4.6, which contains prices and values of these minerals, indicates that copper and iron ore make up about 50% of the value of minerals.
11. *OIL.* Value of oil and gas production.

This list includes measures of land, labor, capital, and natural resources. The major omission from this list is knowledge capital. Technological

Table 4.6
Prices and values of mineral resources

	Prices[a]		"World" production values (billions of current U.S. dollars)	
	1958	1975	1958	1975
Coal	9.79	35.26	11.47	40.12
Gas	3.15	35.79	1.36	41.30
Oil	9.78	49.98	6.50	67.04
Bauxite	11.37	11.32	.15	1.13
Copper	579.81	1,388.90	1.27	5.48
Fluor	55.12	104.72	.07	.30
Iron ore	8.47	18.36	.99	5.64
Lead	266.98	474.65	.42	1.01
Manganese	121.06	139.76	.21	.32
Nickel	1,631.40	4,806.03	.23	1.94
Phosphate	6.64	43.10	.11	2.02
Potash	21.00	49.21	.11	.66
Pyrite	9.84	25.29	.06	.11
Salt	11.46	15.60	.68	1.56
Tin	2,094.37	7,495.64	.22	.99
Zinc	227.29	858.91	.49	3.21
MINERALS composite[b]	.55	1.27	2.76	30.97

Source: Bureau of Mines, *Minerals Yearbook*, various years.
a. Dollars per metric ton, except for MINERALS composite, which is a 1972 quantity weighted index.
b. Excludes coal, gas, and oil.

inputs have been linked to comparative advantage in a number of studies, including Gruber, Mehta, and Vernon (1967), Keesing (1967), and Baldwin (1971, 1979). Technological inputs are here measured only by LABOR 1, the supply of professional/technical workers. The composition of this group is indicated in table 4.7, which is subsequently discussed in detail. This category is clearly too broad by its inclusion of "professionals" such as teachers and even economists. Perhaps more important, "technical" workers in advanced and in developing economies are treated as identical, but it seems quite likely that there are vast differences between them in knowledge capital. An alternative would be to use expenditure flows on education or on research and development as an indicator of knowledge capital, but the data on these expenditure flows are limited to the developed countries.

Table 4.6 reveals that the natural resources, COAL, MINERALS, and OIL, are comparable in economic value. Aggregation of COAL and OIL may seem sensible, but the distributions of these two resources across

Table 4.7
International Standard Classification of Occupations (ISCO), major group 0/1—professional, technical, and related workers (LABOR 1): 1968

0-1.	Physical scientists and related technicians
0-2/3.	Architects, engineers, and related technicians
0-4.	Aircraft and ships' officers
0-5.	Life scientists and related technicians
0-6/7.	Medical, dental, veterinary, and related workers
0-8.	Statisticians, mathematicians, systems analysts, and related technicians
0-9.	Economists
1-1.	Accountants
1-2.	Jurists
1-3.	Teachers
1-4.	Workers in religion
1-5.	Authors, journalists, and related writers
1-6.	Sculptors, painters, photographers, and related creative artists
1-7.	Composers and performing artists
1-8.	Athletes, sportsmen and related workers
1-9.	Professional, technical, and related workers not elsewhere classified

countries are quite different, and we shall let the data determine whether they have different impacts on the composition of trade. As it turns out, the distinction does seem important in 1958, though less so in 1975. Disaggregation of minerals would be desirable if the trade data were more disaggregated, but it seems unlikely that this would offer major improvements in our understanding of the determinants of our 10 trade aggregates.

Boxplots of the resource data are drawn in figures 4.3 and 4.4. These boxplots contain a horizontal line indicating the upper quartile of the distribution (75% of the countries fall below this line). These upper quartiles are all very low compared to the maximum, and all the resource data (and GNP) can be said to have a large cluster of countries near zero and a long upper tail. A few comments may be made about these boxplots.

CAPITAL. In 1958 the capital data include one extreme country (the United States) with a capital stock almost 10 times as large as the second largest country (France). The United States was still extreme in 1975, but had a capital stock only twice as large as the second largest country (Japan).

LABOR 1. The United States is an outlier in the distribution of professional workers in both 1958 and 1975. In 1958 the second most well endowed country, India, had 2.5 million workers in this category, com-

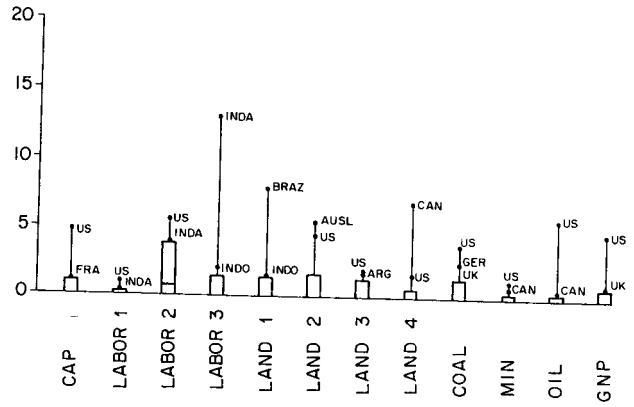

Figure 4.3
Boxplots of resource data: 1958.

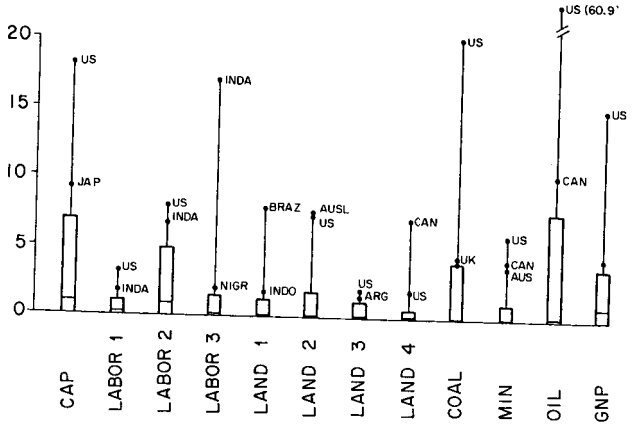

Figure 4.4
Boxplots of resource data: 1975.

pared with 7.7 in the United States. The 1975 figures are 13.6 million in United States and 7.4 in India.

LABOR 2. The United States had the greatest number of workers in the literate nonprofessional category, but Japan and India were not far behind.

LABOR 3. India was an extreme outlier in the distribution of illiterate workers, with 135 million in 1958 and 166 million in 1975. The second largest countries were Indonesia in 1958 with 21 million and Nigeria in 1975 with 18 million workers.

LAND 1. Brazil was an extreme outlier in the topical land distribution with 804 million hectares, compared with Indonesia's 167 million.

LAND 2. Australia and the United States were outliers in the distribution of LAND 2.

LAND 3. The LAND 3 distribution has a long tail including (in order) the United States, Argentina, Australia, and India.

LAND 4. Canada was the extreme outlier with 727 million hectares of LAND 4, compared with the United States's 138 million hectares, followed by Sweden's 41 million.

COAL. The United States was an outlier in coal production more so in 1975 then 1958. The other big producers were Germany, the United Kingdom, France, Japan and India in 1958, and Australia in 1975.

MINERALS. The United States was an extreme outlier. Canada also was an outlier, as was Australia in 1975.

OIL. The United States was a very extreme country, with oil production almost 20 times Canada's in 1958 and 6 times Canada's in 1975.

4.3 Trade Dependence and Resource Abundance Profiles

This section contains a discussion of the trade dependence and resource abundance profiles, which are collected together in appendix D. The form of these displays is suggested by the Heckscher-Ohlin-Vanek equations. One of the HOV equations for the $m \times m$ model takes the form $T_j = \sum_i \beta_{ji}(V_i - sV_{wi})$, where β_{ji} is an element of A^{-1}, the inverse of the matrix of factor intensities, and s is the GNP share Y/Y_w. This can be rewritten as

$$T_j/Y = \sum_i \beta_{ji}((V_i/Y) - (V_{wi}/Y_w)) = \sum_i \beta_{ji}(V_{wi}/Y_w)\left(\frac{V_i/Y}{V_{wi}/Y_w} - 1\right), \tag{4.1}$$

where T_j = net exports of commodity j, Y = GNP, V_i = endowment of resource i, Y_w = world GNP, and V_{wi} = world's endowment of resource i. In words, the trade dependence ratio T_j/Y is a linear function of the (centered) resource abundance ratios $(V_i/Y)/(V_{wi}/Y_w) - 1$.

This HOV equation serves as a theoretical foundation for a set of graphs that display the trade dependence ratios and the resource abundance ratios. First, the trade dependence ratios T_j/Y are collected into trade dependence profiles for each of 61 countries. These trade profiles are then sorted informally into three different groups depending on the pattern of trade in manufactures. These groups are meant to suggest the following questions: Why do all countries in a group have similar trade dependence profiles, and why do countries from different groups have dissimilar trade dependence profiles? These questions are partly answered by a study of the resource abundance ratios $(V_i/V_{iw})/(Y_i/Y_w) - 1$, which are collected into resource abundance profiles and displayed below the trade dependence profiles.

The impression I hope to leave is that exports of the natural resource products and the crops can be well explained by abundance of land or natural resources. The manufactured exports seem explainable by abundance in labor and capital. Whether this impression survives the rigors of formal statistical examination is the subject of the next chapter.

4.3.1 Trade Dependence Profiles

Trade dependence ratios (net exports relative to GNP) of the 10 commodity aggregates are collected into trade dependence profiles for 1958 and 1975, when data are available, and for other indicated years when the data are not available. In order to put all the countries on the same scale, the data have been transformed logarithmically by the function $Z = \text{sign}(T/Y) \times \ln(1 + 100|T/Y|)$. The correspondence between the numbers Z in the graphs and trade as a percentage of GNP may be found in appendix D.

These profiles, which may be found in appendix D, indicate the composition of trade. They also reveal the general level of trade dependence relative to GNP, since a country that is not very trade dependent will have

short bars in the profiles. Furthermore, surplus countries will have bars primarily to the right of the profile, deficit countries primarily to the left.

The 10 aggregates that are illustrated in these profiles are described in terms of their SITC categories in the previous chapter. Roughly speaking, these 10 aggregates form a development ladder, with the most industrialized countries concentrating their exports on the manufactured commodities. Countries are accordingly sorted into three groups, depending on the sign of the net exports of the manufacturing commodities. The most advanced group is composed of exporters of machinery or chemicals in either 1958 or 1975. The middle group is composed of countries that exported labor intensive or capital intensive manufactures in 1958 or 1975, but not machinery or chemicals. Countries in the third group had net imports of all four manufactured aggregates in both years.

The following detailed comments will be most understandable if the reader refers to the relevant profiles in appendix D.

Exporters of Machinery or Chemicals The exporters of chemicals or machinery in either 1958 or 1975 were Belgium-Luxembourg, France, Germany, Italy, Japan, The Netherlands, Sweden, Switzerland, the United Kingdom, and the United States. Chile and Paraguay had net exports of chemicals in 1958, and Jamaica had net exports of chemicals in 1975 for special reasons, and none of them is included in this category.

Generally speaking, the export earnings of these countries are concentrated in the manufactured commodities, though The Netherlands had substantial animal products exports, Sweden had forest product exports, and the United States had cereals exports. Trade profiles that are, roughly speaking, in the median of this group are France, Germany, and the United Kingdom in 1958 and Japan in 1975, each of which exported the four manufactured goods and imported all the others. Germany in 1975, Switzerland in both years, and the United Kingdom in 1975 were a step up the ladder of development, with export earnings concentrated on the last two or three manufactured aggregates. Italy in both years and Japan in 1958 were one step down the ladder, with exports concentrated on the first two or three aggregates of manufactures.

Between 1958 and 1975 these industrialized countries became somewhat more trade dependent, in particular, increasing their exports of machinery and chemicals, and either decreasing their exports or increasing their imports of labor intensive manufactures, thereby making way for the

economies below them on the ladder of development. There is even some suggestion that these countries are reducing their dependence on exports of capital intensive manufactures. Another change that is apparent in these trade dependence profiles is the increase in the cost of petroleum imports.

1. *Belgium-Luxembourg.* In 1958 Belgium's exports were heavily concentrated in capital intensive manufactures. All the nonmanufactures were imported at significant rates. By 1975 Belgium had become less dependent on labor intensive and capital intensive exports, replacing these with chemicals. Labor intensive manufactures that formerly had been a source of export earnings at a rate of almost 1% of GNP fell somewhat by 1975 and actually switched to become a modest import item in 1978 (not shown). Belgium had also become much more dependent on imports of petroleum and raw materials, but somewhat less dependent on imports of cereals. An anomalous change is the switch from importing to exporting animal products.

2. *France.* France is one of the least trade dependent countries in this group. In 1958 France had positive net exports of all four manufactured products and imports of all six nonmanufactured products. In 1975 the export dependence on both labor intensive and capital intensive manufactures was less, and on machinery was more. (By 1978 France was a net importer of labor intensive manufactures.) The petroleum bill rose considerably over this period, but cereals switched from a major import item to a modest export item. This is one of the few instances of sign changes in net exports of the four crop aggregates and is suggestive of an aggressive agricultural policy.

3. *Germany.* Germany in 1958 imported all the nonmanufactured products and exported all the manufactured products, with a heavy concentration on machinery. By 1975 the petroleum bill had increased substantially, and Germany had begun importing the labor intensive manufactures and exporting more machinery and chemicals. (The 1978 data also reveal less dependence on exports of capital intensive manufactures.)

4. *Italy.* In 1958 Italy was not very trade dependent, and was a step behind many of the countries in this group on the development ladder because of her imports of chemicals. The exports of tropical/Mediterranean agricultural goods are also distinctive. By 1975 trade dependence had increased by a factor of four or five, with the biggest increase in exports of labor

intensive manufactures, suggesting a step down on the ladder of commodities.

5. *Japan.* Japan, like Italy, in 1958 had imports of chemicals and had exports of an agricultural product. The 1975 picture is quite different, with increased trade dependence and with the pattern of the most advanced economies with much less dependence on exports of labor intensive manufactures and much more dependence on machinery exports. (By 1978 capital intensive manufactures had also fallen.)

6. *The Netherlands.* The Netherlands is something of an anomaly in combining chemical exports with substantial animal products exports. From 1958 to 1975 dependence on chemical exports did increase. Further evidence of the process of development is the increased dependence on imports of labor intensive manufactures, but the switch of raw materials from the import side to the export side is another anomaly (explainable by the discovery of natural gas).

7. *Sweden.* Sweden underwent a very dramatic change in the composition of trade. In 1958 it exported only forest products and small amounts of raw materials, but in 1975 it had substantial exports of machinery and in 1978 had exports of capital intensive manufactures as well, thereby catapulting itself into the group of industrialized countries. Further evidence of this change is the increased dependence on imports of the labor intensive manufactured commodity.

8. *Switzerland.* The most advanced pattern of trade is Switzerland, with exports of only machinery and chemicals. The further advancement of Switzerland over time is evidenced by the greatly increased dependence on imports of labor intensive manufactures and the increased dependence on exports of chemicals.

9. *The United Kingdom.* The United Kingdom exported the four manufactured aggregates and imported all the others. Countering a trend, trade dependence generally fell by 1975. The pattern of exports did shift in favor of chemicals and machinery, with the labor intensive manufactures being imported in 1975.

10. *The United States.* The United States was not very trade dependent, though somewhat more so in 1975 than 1958. In 1958 it exported all the manufactured products plus cereals. The swing by 1975 toward imports of labor intensive and capital intensive imports was substantial. This, together with increased dependence on petroleum imports, was offset by increases in machinery and cereals exports.

Exporters of Labor Intensive Manufactures and Capital Intensive Manufactures The group of exporters of labor intensive and capital intensive manufactures can be subdivided into three categories ordered by stage of development. There were four countries that were net exporters of capital intensive manufactures in 1958 and 1975: Austria, India, Korea, and Spain. These countries can be thought to be somewhat ahead in the development process of other countries in this middle group. Denmark, Hong Kong, Israel, Portugal, and Yugoslavia were exporters of labor intensive manufactures in both 1958 and 1975, but importers of all the other manufactured aggregates. These countries form a middle subgroup. Finally, Brazil, Colombia, Cyprus, Egypt, Finland, Greece, Malta, Sri Lanka, Thailand, and Turkey show evidence of industrialization by switching from importing to exporting the labor intensive manufactured aggregate.

1. *Austria.* Austria in 1958 had exports concentrated on the labor intensive and capital intensive manufactures and also on forest products. It had heavy imports of raw materials, cereals, and machinery. By 1975 the export items fell relative to GNP, especially labor intensive manufactures, which in 1978 were imported (not shown in appendix D). The import items generally grew relative to GNP, resulting in a substantial trade deficit. Though there is evidence of movement up the ladder of development in reduced exports of labor intensive manufactures, this is not accompanied by reduced dependence on machinery or chemical imports.

2. *Brazil.* Brazil was not very trade dependent. It depended in 1958 almost entirely on exports of tropical agricultural products. In 1975 it also exported labor intensive manufactures and cereals. In 1978 capital intensive manufactures were exported as well. This is evidence of fairly rapid industrialization.

3. *Colombia.* Colombia is very similar to Brazil. In 1958 it was very dependent on exports of tropical agricultural products and petroleum. By 1975 it was exporting also animal products and labor intensive manufactures.

4. *Cyprus.* Cyprus in 1958 exported raw materials and tropical agricultural products. From 1958 to 1975 labor intensive manufactures switched from being a major import to a major export item. Cyprus is a very trade dependent country.

5. *Denmark*. Denmark had a small amount of exports of labor intensive manufactures, but its heavy dependence on exports of animal products makes it much more similar to Ireland than to the other countries in this middle group.

6. *Egypt*. Egypt is difficult to classify since its trade pattern was erratic. In 1958, exports were very concentrated in cereals; in 1975 there were heavy imports of cereals and small exports of labor intensive manufactures. In 1978 exports were completely concentrated in petroleum.

7. *Finland*. Forest products were the primary export item of Finland in 1958. By 1975 it was exporting also labor intensive manufactures.

8. *Greece*. In 1958 Greece exported agricultural products, but by 1975 was exporting labor intensive manufactures, in part paying the bill for large imports of machinery. Cereals switched from being a large export item to a moderate import item.

9. *Hong Kong*. Hong Kong is a very unusual country. It is very trade dependent, increasingly so from 1958 to 1975. Its exports are completely concentrated in labor intensive manufactures, in excess of 20% of GNP in 1975.

10. *India*. India is one of the most advanced countries in this group in the sense of having exports of capital intensive manufactures. It also had export earnings from tropical agricultural products, raw materials, and labor intensive manufactures, though it was not very trade dependent.

11. *Israel*. Israel earned export earnings both from labor intensive manufactures and from tropical/Mediterranean agricultural products. The changes over time are small, though in 1975 it did have greater dependence on exports of labor intensive manufactures and more dependence on imports of machinery and chemicals. In both years, the trade deficit is substantial.

12. *Korea*. A trade deficit in 1958 allowed Korea to import all categories except for tiny exports of animal products. By 1975 Korea was exporting very large amounts of labor intensive manufactures and large amounts of capital intensive manufactures, and animal products as well. This is evidence of a very substantial increase in industrialization.

13. *Malta*. Malta in 1958 exported small amounts of raw materials and ran a large deficit. By 1975 it was exporting large amounts of labor intensive manufactures and was very trade dependent. Hong Kong and Malta had very similar trade compositions.

14. *Portugal*. Portugal barely had positive labor intensive exports in 1958, but had substantial exports in 1975. It also has export earnings from various agricultural commodities, which were used to finance large imports of machinery, cereals, and petroleum.

15. *Spain*. Spain had small amounts of exports of labor intensive manufactures in 1958, but had virtually all export earnings from tropical/Mediterranean agricultural products. It became substantially more industrialized by 1975, with export earnings concentrated on labor intensive manufactures and with the reduced dependence on exports of tropical/Mediterranean agricultural products. It also had begun to export the capital intensive manufactures.

16. *Sri Lanka*. Sri Lanka in 1958 had export earnings concentrated in tropical/Mediterranean agricultural products and had a trade profile very similar to Costa Rica, Dominican Republic, and Ecuador. Although in 1975 it continued to have export earnings concentrated in TROP, it also had receipts from labor intensive manufactures, and in that sense shows evidence of substantial industrialization. Also of note is the heavy imports of cereals.

17. *Thailand*. Thailand was a substantial exporter of cereals and tropical agricultural products in both years, and in 1975 it became a substantial exporter of labor intensive manufactures. Dependence on imports of capital intensive manufactures became less over this period, and dependence on imports of machinery became much more.

18. *Turkey*. Turkey, which was not very trade dependent, exported raw materials and agricultural products in 1958. Small amounts of labor intensive manufactures were exported in 1975, and imports of the other manufactures and petroleum rose substantially.

19. *Yugoslavia*. Yugoslavia's exports of labor intensive manufactures increased greatly from 1958 to 1975. It also has export earnings from forest and animal products. Trade dependence increased substantially from 1958 to 1975.

Importers of Manufactured Commodities The rest of the countries in the sample had net imports of all four of the aggregates of manufactured commodities in both years. Generally speaking, there is little change in their trade profiles between 1958 and 1975. They form a rather diverse group of countries, but seem sensibly separated into a subgroup of diver-

sified countries and a subgroup of specialized countries, the latter having export earnings concentrated on one or two commodities.

The diversified countries in this group are Afghanistan, Australia, Canada, Mexico, Norway, Paraguay, Peru, and the Philippines. Mexico is classified as an importer of manufactures because of its 1972 trade profile, but in 1958 it exported capital intensive manufactures. This is one of the few examples of a country stepping down the ladder of commodities.

The specialized countries can be divided into groups depending on their export items. Costa Rica, the Dominican Republic, Ecuador, El Salvador, Ghana, Honduras, Mauritius, and Panama specialized in tropical agricultural products. Jamaica, Liberia, Malaysia, and Singapore exported both tropical agricultural products and raw materials. Chile exported raw materials. Burma exported cereals (rice). Ireland exported animal products. Indonesia, Libya, and Nigeria exported petroleum and other products. Argentina, Iceland, and New Zealand exported animal products and cereals. [Note that Iceland's animal products are primarily fish (SITC 03). Its cereals are miscellaneous food preparations (SITC 10) and animal oils and fats (SITC 26). New Zealand's cereals are primarily textile fibers (SITC 26), for example, wool.]

There are three anomalies in this group of countries. Chile and Paraguay in 1958 and Jamaica in 1975 all had positive net exports of chemicals and might be classified in the most developed group. For each of these countries, positive net exports of chemicals are a result of large exports of some peculiar product that would be better classified as a raw material than as a chemical.

The Chilean export of chemicals in 1958 is an interesting case of a commodity in transition between two of the aggregates. In 1910 64% of the world's sodium nitrate (saltpeter) was mined in Chile.[1] Saltpeter is sometimes even called Chilean nitrate. Synthetic substitutes discovered after World War I slowly replaced Chilean nitrate until by 1960 Chilean production was only 1.5% of world output. But in 1958 the mining and export of Chilean nitrate was still sufficient to give Chile a positive balance of chemical exports. Sodium nitrate is classified under SITC 51. From the standpoint of this book it would have been better to allocate Chilean nitrate to the raw materials aggregate but retain synthetic nitrates in the chemicals aggregate. Over time this misclassification corrects itself because the synthetic nitrates came to dominate the market.

The other two anomalies are also caused by deficiencies in the aggregation scheme in that items are classified as "chemicals" that are better thought to be raw materials. Paraguay had very large exports of the extract of the quebracho tree, which is used for tanning and is classified with processed chemicals that are also used for tanning. Jamaica had large exports of aluminum oxide, which is extracted from bauxite ore. (Bauxite, on the other hand, is classified as a raw material.)

4.3.2 Resource Abundance Profiles

Resource abundance profiles may be found below the trade profiles in appendix D. The first 11 horizontal bars in these profiles indicate the resource abundance ratios $(V_i/V_{wi})/(Y/Y_w)$, that is, the ratio of the share of the resource to the GNP share. The last horizontal bar, labeled SIZE, indicates the country's GNP divided by GNP averaged over all countries in the given year. Several different transformations of these data were considered, and the one that produced the clearest displays was selected. If x represents a resource abundance ratio $(V_i/V_{wi})/(Y/Y_w)$, or the relative GNP $Y/\bar{Y}$, then what is graphed is $z = (5x - 5)/(x + 5)$. This function takes on the value -1 if $x = 0$ and 0 if $x = 1$, and it has an asymptotic value of 5 as x goes to infinity. The correspondence between the numbers in the graphs and the resource ratios may be found in appendix D. In the case of a resource, the graphed value is positive if the resource is abundant in the HOV sense, $V_i/V_{iw} > Y/Y_w$. In the case of the GNP variable, the graphed value of SIZE is positive if a country's GNP exceeds average GNP.

The usefulness of the absolute resource abundance ratios as indicators of factor abundance is limited to settings in which GNP is a linear function of the endowments of productive factors, that is, when we may write GNP as $Y = \sum w_i V_i$, where w_i is the return to factor i. Then the GNP share is a weighted average of the endowment shares with weights equal to world earnings of the factors, $Y/Y_w = \sum_i (w_i V_{wi})(V_i/V_{wi})/\sum_i w_i V_{wi}$. If an endowment share V_i/V_{wi} exceeds the GNP share, the country is abundantly supplied in factor i compared with other resources on the average, and according to the Heckscher-Ohlin-Vanek theorem, the country's net exports will embody positive amounts of the resource. An abundance ratio can also be expressed as the world "productivity" divided by home "productivity," $(Y_w/V_{wi})/(Y/V_i)$. For example, if the resource is labor, the abundance ratio is world GNP per worker divided by home country GNP per worker. A country is therefore said to be abundantly supplied in labor

if its labor productivity is less than the labor productivity of the world as a whole. This definition is a consequence of the fact that GNP is assumed to be a linear function of the endowments, and the only reason for relatively low labor productivity is relative scarcity of the other resources that form GNP. If GNP is a nonlinear function of the endowments, for example, if scale economies are important or if factor prices are not equalized, a comparison of a resource share with the GNP share will not reveal the abundance of the factor compared with other factors on the average. Pairwise comparisons of the abundance ratios are nonetheless appropriate, since they will reveal the relative abundance of the two resources considered.

There are measurement problems as well as conceptual problems with these resource abundance ratios. The world endowments of the resources and the world GNP are necessarily estimated inaccurately because the coverage of countries is incomplete. It may appear, for example, that a country is scarce in labor because we are overestimating world GNP per capita by excluding countries from the developing world without adequate data. It is in fact quite likely that countries that in our sample appear to have an abundance of in oil would actually be measured to have a scarcity if the major oil exporters were included. An error of this form would require proportional adjustment of the data for the selected resource of all countries.

If the GNP figure of a particular country is mismeasured, then the proper correction would be to adjust all of the resource abundance ratios upward if GNP is overestimated, or downward if GNP is underestimated. Even if GNP is measured accurately, this adjustment can be required by the Heckscher-Ohlin-Vanek theorem if there is trade imbalance, since the GNP ratio Y_i/Y_w should properly be replaced by the consumption share $(Y_i - B)/Y_w$, where B is the trade surplus. For most countries this correction is very small.

These conceptual and measurement concerns notwithstanding, a study of the resource profiles in comparison with the trade profiles is quite interesting. If the Heckscher-Ohlin model were correct, countries with similar trade dependence profiles would have similar resource abundance profiles. Indeed, this seems to be correct. Though there are many cases that seem unusual, it is exceedingly difficult to estimate multiple regressions visually, and we need to reserve judgment on the accuracy of the Heckscher-Ohlin model until the computer estimates in chapter 6 are discussed. Not surprisingly, much that can be seen visually is also detected by the formal econometrics.

The following detailed comments will be most understandable if the reader refers to the relevant profiles in appendix D.

Exporters of Machinery and Chemicals The countries with the most advanced trade dependence profiles in the sense of exporting machinery and chemicals are generally abundant in CAPITAL and in many cases scarce in everything else. The CAPITAL scarce countries in this group were Belgium-Luxembourg and Italy in 1958, the United States in 1975, and the United Kingdom in both years. The exporters of machinery and chemicals were also generally scarce in land and natural resources, but Belgium, Japan, and The Netherlands in 1958, the United States in 1975, and the United Kingdom in both years were all abundant in COAL. This hints at COAL reserves as a source of comparative advantage in manufactures, a finding that will come up again in chapter 6. An exception to the general scarcity of land is France in 1958, which was abundant in LAND 3. Sweden in both years was abundant in LAND 4 and MINERALS. This conforms nicely to the Swedish trade profiles, which have exports of forest products (associated with LAND 4) and raw materials (associated with MINERALS). (Note that although land area may remain unchanged, the land abundance ratio may change because the GNP share changes.) The countries that never exported any agricultural products (Germany, Switzerland, and the United Kingdom) seem to be among the poorest in land.

All three categories of labor were generally scarce in these most developed countries in 1975, but LABOR 1 and LABOR 2 were often abundant in 1958. The frequency with which LABOR 1 is measured to be scarce is cause for concern either about the meaning of the LABOR 1 category or about the resource abundance ratios as indicators of abundance. This finding, as discussed previously, could be summarized by saying that the productivity (output per worker) of LABOR 1 workers in the industrialized countries exceeds productivity in the developing countries. We can think of reasons why this is the case other than a relative abundance of other inputs in the industrialized countries. A comparison of the abundance ratios for the different labor groups may nonetheless be meaningful. Most countries were most abundant in the most highly skilled labor in the sense that LABOR 1 > LABOR 2 > LABOR 3, but

Germany in 1958 and Italy, Japan, and the United Kingdom in 1958 were more abundant in LABOR 2 than in LABOR 1.

The countries in this group that are smaller than the overall average (see the SIZE bar)—Belgium-Luxembourg, The Netherlands, Sweden, and Switzerland—have exports concentrated on one or two of the manufactured aggregates. This hints at scale economies as a source of comparative advantage, but because these are commodity aggregates, this suggestion should be viewed with some suspicion.

The resource abundance ratios of these countries were somewhat different in 1975 than in 1958. This is due principally to the relatively slow accumulation of capital in the United States and the rapid accumulation in the rest of the industrialized world. The effect of these differences in the rate of capital accumulation is to lower the GNP share of the United States and to increase it elsewhere. This will tend to increase the abundance ratios in the United States and to reduce them elsewhere. Labor, for example, becomes less scarce in the United States and less abundant in the other countries for this reason. Capital, however, which is the source of the changes in GNP shares, moves in the opposite direction, with the United States becoming less abundant and the other countries becoming more abundant.

The distinguishing characteristics of countries in this group are CAPITAL abundance combined with scarcity of most other resources. But there are many countries in the other two groups which according to our data also had an abundance of CAPITAL. From the list of countries that did export one or more of the manufactured commodities, the ones with a relative abundance of capital are Israel, Sweden, Cyprus, Finland, Malta in 1975, and Yugoslavia in 1958. Several countries that did not export any of the four manufactured aggregates also had CAPITAL abundance. These are Australia, Canada, Jamaica in 1958, Mauritius, New Zealand in 1958, Norway, Iceland, and Singapore in 1975. One thing that distinguishes these countries from the exporters of machinery and chemicals is the relative abundance of some other resource compared with CAPITAL. The CAPITAL abundant countries with no exports of manufactures generally have a very great abundance of land and minerals (for example, Australia, Canada, and Norway).

Exporters of Labor Intensive and Capital Intensive Manufactures The middle group of countries—the exporters of labor intensive and capital intensive manufactures—are generally abundant in LABOR. Korea is a good example. The exceptions include Austria, Denmark, and Finland, with LABOR abundance rather like the most advanced countries. Denmark is something of an overachiever in 1975 (it is scarce in everything). Israel is also an exception, with abundance in LABOR 1 but scarcity in LABOR 2 and LABOR 3.

The nonmanufactured products exported by this group seem very well explained by resource abundance. Sweden exports forest products because of abundance of LAND 4. Korea exports animal products, also because of LAND 4. Spain uses LAND 3 to produce tropical/Mediterranean agricultural products. Brazil uses LAND 1 and LAND 3 for the same. Colombia exports tropical agricultural products and petroleum because of LAND 1 and OIL resources. Cyprus has an abundance of LAND 3 and MINERALS, and exports tropical agricultural products and raw materials. Finland sells forest products grown on LAND 4. Greece has tropical agricultural exports and an abundance of LAND 3. Malta, like Hong Kong in more ways than one, is concentrated on labor intensive exports and has only labor abundance. Thailand uses LAND 1 to produce tropical agricultural products and cereals. (This is a case where rice might better have been allocated to another aggregate.) Portugal, which is well endowed with LAND 3, has exports of the tropical/Mediterranean agricultural products. Finally, Turkey, with an abundance of LAND 2 and 3, exports tropical agricultural products, animal products, and cereals.

Importers of the Manufactured Commodities It is to be suspected that a shortage of CAPITAL is the explanation for importing all the manufactured commodities. This seems correct for many of the countries, but there is a handful that had adequate CAPITAL relative to GNP or labor to justify the export of manufactured products. This list of countries includes Argentina, Australia, Canada, Denmark, Iceland, Ireland, New Zealand, and Norway. All of these countries are much more abundant in LAND than CAPITAL. CAPITAL scarcity, not necessarily relative to LABOR, therefore seems to account for dependence on imports of manufactured products. (More on this is in chapter 6.)

The diversified exporters do seem to have more balanced resource profiles than the specialized exporters. Animal product exporters have LAND 3 abundance. Tropical products exporters have LAND 1 abundance. The countries well endowed in MINERALS and/or OIL naturally export the

corresponding products. Note the abundance for many of these countries of LABOR 1, a fact that makes one suspicious of the "professional/technical" categorization. More comments on this are made in the next section.

Most countries in this group have little change in their resource profiles from 1958 to 1975. The ones with relatively rapid capital accumulation are Indonesia, Ireland, Liberia, Libya, Malaysia, and Singapore. The trade profiles of these countries do seem to conform in that dependence on imports of the labor intensive manufactures does diminish.

It would be possible to continue this discussion of the trade dependence profiles and the resource abundance profiles for many more pages. However, the intent of this section is not to provide a full examination of the relation between trade and endowments, since that is better done using multiple regression analysis, to be discussed. The intent of this relatively brief discussion is to entice the reader into a more careful study of these data displays, and to make visually clear that resource abundance is indeed a source of comparative advantage.

4.4 Notes on Data Accuracy

Both the trade data and the resource data have been carefully scrutinized over a period of several years as they have been used for a variety of purposes. Questions concerning the accuracy and usefulness of the trade data have been few and have always been resolved. (For example: Why does Iceland have animal products exports? Answer: Because fish are included in that aggregate.) The resource data, on the other hand, are a continuing source of concern. For example:

a. Many developing countries have an abundance of labor in the professional/technical category. The composition of this group is indicated in table 4.7. What probably accounts for the surprising abundance of LABOR 1 among the developing countries is the inclusion of teachers, doctors, and lawyers. These workers are likely to have a very different effect on the composition of trade than physical scientists, and disaggregation, if data permitted, would have been highly desirable.

b. Several developing countries, like Afghanistan, are more abundant in LABOR 1 than LABOR 2. LABOR 2 is a residual category formed by removing the illiterate workers and the professional workers from the total labor force. The literacy rate of the population as a whole is assumed to apply also to the labor force, whereas it seems quite likely that workers would have a higher literacy rate. Accordingly, LABOR 2 ought to be increased in many countries with low literacy rates and LABOR 3 decreased.

c. The division of labor into the three categories is intended to measure differences in human capital. The pure labor component is approximated by LABOR 3, the illiterate work force; labor embodying human capital is measured by LABOR 2 and LABOR 1. This categorization concentrates on explicit off-the-job accumulations of human capital and ignores both on-the-job training as well as experience and age-related changes in skills. The developing economies generally have a younger population and higher labor force participation rates among the young. For example, the percentage of population aged 15–30 in 1975 was 21% in Belgium, Italy, Norway, and the United Kingdom but was 26% or more in, among other countries Brazil, Costa Rica, Chile, and Nicaruaga (see table 4.8). The percentage of males aged 15–19, who are classified as "economically active," varies from lows of 32.9 in Sweden and 36.5 in Japan to highs of 71.4 in El Salvador and 77.8 in Paraguay. What this may mean is that our division of labor into the three categories fails to capture a part of human capital that happens to be positively correlated with the stage of development.

d. A further problem with the LABOR 1 category is that the censuses that are used to count the professional/technical workers are done intermittently, and the 1958 and 1975 data we have used are generally constructed by extrapolation, interpolation, and imputation; when needed, this group includes also a dash of salt and a sprinkle of pepper. (See appendix B for more details.) If you add to this the census errors, you begin to get rather uncomfortable about the division of labor into its three categories.

e. The total labor force defined by the International Labor Organization (ILO) as the "economically active" population is also questionable, since the definition of "economically active" can vary from country to country depending on the treatment of such things as

i. Casual, seasonal, part-time workers, and those engaged in looking for work.

ii. Nonmarket family labor, especially work on family owned farms in

Table 4.8
Population characteristics

	Labor force participation rates			Age composition (%)				Hours per week[a]
	Male	Female	Male, 15–19	0–15	15–30	30–60	60+	
Argentina	57.9	19.4	60.7	30	25	35	9	
Australia	56.8	26.7	55.8	29	25	34	12	40.6[b]
Austria	54.2	30.3	65.6	24	20	35	20	33.9
Belgium	54.2	21.9	41.3	24	21	36	19	35.4
Brazil	53.7	23.6	62.1	42	26	26	5	
Canada	53.4	28,3	30					
Chile	46.4	13.3	42.3	39	26	26	7	
Colombia	47.6	11.6	66.3	48	23	24	5	
Costa Rica	47.6	11.6	67.6	48	23	24	5	
Cyprus	56.3	27.5						43
Denmark	59.8	34.1	55.5	23	24	35	18	33.1
Dom. Rep.	46.1	15.9	55.1	48	24	23	5	
Egypt	51.2	4.2	58.6	43	23	27	6	
Equador	54.0	10.5						51
El Sal.	52.8	21.5	71.4	46	25	24	5	48.2[b]
Finland	55.2	37.5	43.6	24	26	35	14	38.4
France	55.9	28.0	42.8	24	22	36	19	42.7
Germany	59.2	30.0	66.9	25	21	38	16	40.5
Ghana				47	24	23	5	
Greece	54.3	20.2	46.4	25	21	38	16	42.7
Honduras				48	25	22	5	
Hong Kong	54.8	28.8	50.4	36	24	32	7	
Iceland	55.8	21.5						51.7
India	52.5	11.9	55.2	42	24	28	6	
Indonesia	46.0	22.0	48.9	44	24	32		
Ireland	55.6	19.4	50.7	31	22	31	16	41.3
Israel	50.2	18.3						37.9
Italy	54.3	19.6	52.0	24	21	38	17	
Jamaica					—			
Japan	63.2	39.1	36.5	24	28	38	11	39.7

Table 4.8 (continued)

	Labor force participation rates			Age composition (%)				Hours per week[a]
	Male	Female	Male, 15–19	0–15	15–30	30–60	60+	
Korea	42.8	23.2	45.9	42	25	28	5	50.0
Liberia					—			
Libya				44	24	32		
Luxembourg	57.3	19.5	54.9	22	21	39	19	40.9
Malta	53.4	13.4			—			
Malaysia				46	49	5		
Mauritius	50.5	12.5	64.1	40	28	26	5	
Mexico	43.6	10.2	49.9	45	25	23	6	45.6
Neta	45.3	23.4	37.7	40	26	26	7	
Netherlands				28	58	15		
New Zealand	54.9	23.3	57.1	32	24	32	13	37.2
Nicaragua	42.4	11.4	53.6	48	26	22	5	
Nigeria				43	32	22	3	
Norway	54.9	20.8	36.2	26[c]	21[d]	35	18	40.2
Panama	50.2	17.8	60.9	43	26	25	6	45.7
Paraguay	50.8	13.6	77.8	45	25	24	6	
Peru	45.3	11.8	39.8	44	26	24	6	
Philippines	46.0	21.3	52.4	43	27	24	5	46.6
Portugal	62.1	19.0	79.0	28	22	35	14	
Singapore				39	28	27	6	
Spain	57.5	13.4	65.9	28	22	36	14	42.8
Sri Lanka	49.3	18.8	48.6	39	28	26	6	
Sweden	54.7	29.9	32.9	21	23	37	20	36.6
Swiss	63.9	32.1	62.8	23	24	37	16	
Thailand	52.0	46.0	77.4	45	25	25	5	
U.K.	60.6	32.9	60.8	24	21	36	19	43.6[b]
U.S.	55.7	33.1	40.3	29	24	33	14	36.1
Yugoslavia	56.4	30.7	41.3	27	25	36	12	

Source: *Yearbook of Labor Statistics*, 1975.
a. Hours of work per week in nonagricultural sector, or manufacturing if not available.
b. Males only.
c. 0–16.
d. 16–30.

the less market-oriented economies, but also work in the home. The female labor force participation rate varies widely. For example, according to the ILO *Yearbook of Labor Statistics*, 1975, the proportion of women defined as "economically active" varied from 10.2% in Mexico to 39.1% in Japan (see table 4.8).

Furthermore, the total number of hours worked can vary depending on vacations, as well as on the number of hours worked per day. The variation of weekly hours across countries (table 4.8) is substantial, with the more developed countries having fewer hours, and probably more productive workers on the average because of reduced fatigue.

f. The capital measure is highly correlated with GNP. In 1958 the capital stock figures are virtually the same as the GNP figures, averaging across countries only 1% more. A larger wedge is driven between them by 1975, with capital averaging 50% more than GNP, but still the figures are disturbingly similar. This can also be seen in the resource profiles in which capital abundance figure rarely deviates much from zero. The capital stock figure is formed by accumulating and discounting investment flows over a 15-year period. Neither savings rates nor growth rates vary enough from country to country to drive much of a wedge between the capital data and the GNP data.

The capital estimates appear to be seriously underestimated if our 1958 number for the United States ($504 billion) is compared with Kendrick's number of $3,330 billion Kendrick (1976) goes to great lengths to include measures of all forms of wealth, many of which are excluded from the investment component of GNP. Kendrick's figure includes human intangible wealth (education, training, medical and health, and mobility), nonhuman intangibles (basic research and applied research and development), human tangibles (rearing costs of children) and nonhuman tangibles. For example, in 1966 he inflates the U.S. savings rate from the Commerce Department's number of 16.2% to 50.6%. Kendrick reports the much smaller number of $1,588.5 billion for nonhuman tangible wealth, of which $326.7 billion is land, which is wealth but not capital as we are using the term. If attention is restricted to the private domestic business economy, Kendrick's nonhuman tangible capital stock drops to $678.7 billion. If from this number the value of land is subtracted and the value of private residences is a added, a figure similar to our estimate of $504 billion might be obtained.

Table 4.9
Climate classification

A. Tropical rainy climates (LAND 1)
1. Tropical rainforest
2. Tropical savanna

B. Dry climates (LAND 2)
1. Steppe
a. Tropical and subtropical steppe
b. Middle latitude steppe
2. Desert
a. Tropical and subtropical
b. Middle latitude desert

C. Humid meso-thermal climates (LAND 3)
1. Mediterranean or dry summer subtropical
2. Humid subtropical
3. Marine west coast

D. Humid micro-thermal climates (LAND 4)
1. Humid continental, warm summer
2. Humid continental, cool summer
3. Subarctic

E. Polar climates
1. Tundra
2. Ice cap

F. Undifferentiated highlands

Another source is the Commerce Department's *Long Term Economic Growth*, which reports the following capital stock figures for 1958: consumer durables ($160.5 billion), residential structures ($304.2 billion), land ($203.2 billion), fixed business capital ($324.2 billion). Our number of $504 billion is not unlike the sum of residential structures and fixed business capital ($628.2 billion).

g. Total land area is divided into six components by inspection of the U.S. Air Force *Climatic Chart of the World* (see table 4.9). There is of course some error in this division, but there is also question whether the six categories of land are finely enough divided. LAND 4 includes humid continental land (warm summer and cool summers) and also subarctic land, much of which is not suited to agriculture. Canada and the United States are both well endowed with LAND 4, but much of Canada's is in the colder regions and is relatively unproductive. The influence of the Canadian observation on the productivity of LAND 4 is very substantial (chapter 6) and somewhat misleading because of this compositional problem. Generally speaking, two resources (for example, two categories of land) can be aggregated together if they have the same effect on trade and output, or if they are perfectly correlated across countries. Subarctic land can be expected to have a rather different effect on the composition

of output than humid continental land with a warm summer. And because the Canadian observation contrasts greatly with the United States, endowments of these two land subcategories are not very highly correlated. Aggregation, as a result, is not especially desirable. The aggregation of steppe and desert into LAND 2 may also be problematical. Given our aggregation of commodities, LAND 1 and LAND 3 do not have obvious aggregation flaws.

h. No attempt is made to distinguish the fertility of land, which creates yet another aggregation problem. Some preliminary statistical work with "arable land," "forest land," and "pasture land" from the FAO *Production Yearbook* was not too promising. The "forest land" variable fails to distinguish tropical (hardwood) forests from cooler softwood forests, yet most of the value of trade in forest products comes from the cooler areas. Arable land similarly fails to distinguish climate types, which is important since the trade aggregates seem to be associated with land of different climates. The use of pasture land is avoided since the division of land into various uses is an economic decision, endogenous to our model; the same comment applies to a lesser extent to arable land and forest land.

4.5 Cross-Country Correlations

Correlations of trade relative to GNP with endowments relative to GNP are reported in table 4.10 and correlations of trade per worker with endowments per worker are reported in table 4.11. These serve initially to identify important resources and to help select the graphs that are presented in appendix C.

The correlations reported in table 4.10 are somewhat easier to understand because they compare each resource with the composite of all resources measured by GNP. Concern over the inaccuracy of the GNP measurement makes the per worker correlations in table 4.11 also of interest. In table 4.11 petroleum trade and raw material trade have the highest correlations, not surprisingly with oil production and mineral output, respectively. Forest product net exports are highly correlated with LAND 4. Animal products net exports are almost as highly correlated with LAND 3. The other products have either disappointing or puzzling correlations. Tropical agricultural exports have fairly large correlations

Table 4.10
Correlations among trade/GNP and endowments/GNP[a]

	Capital	Labor 1	Labor 2	Labor 3	Land 1	Land 2	Land 3	Land 4	Coal	Minerals	Oil
1958											
PETRO	.05	.11	.18	.27	.25	−.02	−.09	.03	.19	.00	**.55**
MAT	−.14	.04	−.06	.16	.34	−.03	−.10	.03	−.23	**.96**	.04
FOR	.14	−.03	.02	−.02	.09	−.06	.07	**.53**	−.11	−.06	−.02
TROP	−.24	.19	.06	.24	**.28**	−.12	−.15	−.17	−.31	.30	−.01
ANL	.21	−.20	−.11	−.17	−.05	−.00	**.36**	.01	.05	−.16	−.05
CER	−.12	.20	**.38**	.29	.27	.00	.17	.05	−.04	−.03	.18
LAB	−.05	−.02	.07	−.11	−.10	−.11	−.03	−.05	.10	**−.22**	.02
CAP	.11	−.24	−.07	−.19	−.17	−.25	−.06	.04	**.55**	−.20	.16
MACH	.01	−.01	.14	−.06	−.08	**−.51**	−.03	−.01	.47	−.30	.11
CHEM	.14	−.06	.06	−.04	.07	−.25	.18	.11	**.39**	.00	.07
1975											
PETRO	−.27	.05	.01	.06	.04	.24	−.01	−.01	−.07	−.09	**.94**
MAT	−.03	.08	−.02	.11	.25	.04	−.03	.02	−.04	**.96**	.00
FOR	.10	.03	.08	.01	.15	−.05	.08	**.39**	−.06	.09	−.03
TROP	**−.28**	.19	.13	.15	.07	−.06	−.10	−.14	−.18	.08	−.10
ANL	.13	−.04	−.06	.01	−.00	.03	**.16**	−.02	.01	−.08	−.06
CER	−.04	−.01	.01	.03	**.18**	.10	.13	.12	.11	−.02	.06
LAB	−.04	−.04	.02	−.05	−.10	−.06	−.04	−.05	.06	−.14	**−.17**
CAP	−.01	−.06	.00	−.01	−.05	.01	.02	.06	**.31**	−.19	−.12
MACH	.10	−.02	−.01	.02	−.12	.06	−.02	.01	.25	**−.31**	−.15
CHEM	**.13**	−.10	−.08	−.05	−.03	.03	.03	.05	.09	−.00	−.01

a. Highest correlations in boldface.

with tropical land (LAND 1), but are better explained in terms of capital scarcity or mineral abundance. Cereals are associated with the land variables, but even more so with literate labor (LABOR 1 and LABOR 2) in 1975. None of the manufactured aggregates is associated positively to any great degree with any of the resources except COAL, which has its greatest impact on capital intensive manufactures (iron and steel). Machinery net exports are associated with scarcity of LAND 2 in 1958 and scarcity of minerals in 1975.

It is fair to conclude that table 4.10 promises adequate explanations of trade in the crops and raw materials, but leaves a large question mark about the source of comparative advantage in manufactured commodities.

Table 4.11
Correlations among trade per worker and endowments per worker

	Capital	Labor 1	Labor 2	Labor 3	Land 1	Land 2	Land 3	Land 4	Coal	Minerals	Oil
1958											
GNP	**.96**	.81	.59	−.64	−.24	.01	.27	.46	.53	.25	.62
PETRO	−.50	**−.68**	−.43	.46	.27	.01	−.47	−.18	−.09	−.08	.05
MAT	.08	−.09	.16	.15	.17	.00	−.12	.52	−.21	**.87**	.23
FOR	.31	.22	.15	−.16	−.06	−.05	−.19	**.61**	−.13	.23	.17
TROP	−.44	**−.46**	−.41	.43	.31	−.08	−.23	−.22	−.31	.04	−.17
ANL	.31	.26	.28	−.28	−.09	−.01	**.73**	.03	.04	−.10	−.04
CER	.29	−.03	.04	−.03	.16	.12	**.64**	.20	.11	.13	.20
LAB	−.31	−.19	−.02	.04	−.02	−.11	−.33	**−.37**	.09	−.31	−.11
CAP	−.23	−.16	−.03	.05	.04	−.13	**−.51**	−.21	.34	−.14	.03
MACH	−.28	−.23	−.05	.07	.04	−.25	**−.45**	−.31	.25	−.22	.05
CHEM	.04	−.08	.06	−.05	.03	−.17	**−.31**	−.02	.28	.06	.19
1975											
GNP	**.97**	.83	.43	−.53	−.33	.40	.21	.30	.36	.12	.40
PETRO	.15	−.05	−.34	.31	−.02	.94	−.07	−.02	−.06	−.05	**.98**
MAT	.06	.00	−.21	.19	.29	.36	.29	.32	.34	**.70**	.28
FOR	.23	.24	.07	−.11	−.05	−.14	−.16	**.49**	−.05	.16	−.10
TROP	**−.58**	−.44	−.26	.31	.28	−.27	−.21	−.23	−.06	.08	−.33
ANL	.27	.32	.22	−.25	−.09	−.10	**.69**	−.02	.01	−.05	−.12
CER	−.04	−.03	.09	−.08	.28	−.22	.45	.25	**.53**	.39	−.34
LAB	−.41	−.27	.14	−.08	−.02	−.47	−.18	−.15	−.09	−.12	**−.49**
CAP	−.15	−.19	.13	−.09	.09	−.53	−.19	−.07	.13	−.00	**−.57**
MACH	−.21	−.16	.09	−.05	.06	−.54	−.36	−.17	.06	−.10	**−.55**
CHEM	.02	−.04	.04	−.03	.02	−.15	**−.42**	−.08	.09	.06	−.15

a. Highest correlations in boldface.