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Research Note

An Empirical Analysis of Commodity Exchange in the International Economy: 1965–80

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Theories of trade and economic development assume that generic types of commodities move together in distinct patterns of international exchange. Using factor analysis, this research note examines the patterns of exports between nations and empirically identifies the "bundles" of exports which flow together in the circuits of world trade. The results are interpretable along a rough two-dimensional scale which contrasts "production" with "extraction" and "capital-intensive" with "labor-intensive" processing, and the pattern is remarkably stable between 1965 and 1980. The implications of these results with regard to theoretical notions about "unequal exchange" and "the new international division of labor" are discussed.

Empirical and theoretical debates about the nature, direction, composition, and effects of commodity trade flows have occupied an important place in the study of economic growth since the beginnings of British political economy in the eighteenth century. From the time of David Ricardo's classical formulation of the "law of comparative advantage" to contemporary neo-Marxist debates about "unequal exchange," writers have touted the key role which a country's exports play in the process of national development. The recent experiences of the Third World societies which have been most open to participation in international trade cast serious doubts on the sanguine assumptions of "comparative advantage" (Todaro, 1981: chapter 12). On the other hand, recent empirical cross-national research designed to assess the world-system/dependency-perspective argument—that export specialization and reliance on primary products lead to relative economic stag-

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nation—yields mixed results (see for example Delacroix, 1977; Walleri, 1978; Weede and Tiefenbach, 1981).

Attempts to deal with the relationship between export composition and economic growth or stagnation need explicitly to take on two key issues. One is the question of measurement. This involves devising a strategy which will meaningfully differentiate commodity trade flows on crucial dimensions, such as the level of processing. The second, more basic, problem is to theoretically identify the relevant dimensions to measure. A recent research note in this *Quarterly* provides both a cogent theoretical discussion of "the commodity problem and unequal exchange" and a defensible operationalization of a new measure of the level of processing of commodity exports (Firebaugh and Bullock, 1986).

This paper addresses the same issues in a very different manner. Instead of working with specific commodities exported by particular countries, we take the international *network* of commodity exchange as our unit of analysis. The study determines whether there are "bundles" of exports which flow together in the circuits of world trade and examines the stability in this pattern over a recent fifteen-year period. It allows us to address the measurement issue by discussing the implications our findings have for using the unprocessed/processed scale. While our analytical technique is largely inductive, the results also allow us to return to the theoretical debates. We argue that the consistent pattern of commodity bundles present over time in our data indicates that a unidimensional measurement of the level of processing may *not* adequately probe "the commodity problem."[1]

Measuring Levels of Processing

As noted above, the results of quantitative studies attempting to operationalize the commodity problem in terms of unequal exchange have resulted in ambiguous results. For instance, in a frequently cited study, Delacroix (1977), using a lagged panel regression design, finds no significant relationship between heavy reliance on unprocessed exports and economic underdevelopment. Similarly, Weede and Tiefenbach (1981) find that "vertical trade" measured using a raw material/processed-good scale fails to predict economic underdevelopment.

Recent papers argue that a basic flaw in the previous research lies in measurement error. They claim that particular caution is necessary when operationalizing the differences between raw materials and manufactured goods. Stokes and Jaffee (1982) critique Delacroix's work by pointing to inadequacies in the way he determined the differences between raw materials and manufactured goods. They assert that his categories of commodity types are too broad and that Delacroix is not clear about how he distinguishes between the nine levels of his processing scale. Devising their own six-weight scale, they replicate the earlier study and find that a less developed country's level of export processing is a significant predictor of subsequent GNP/capita (i.e., contrary to Delecroix, high export specialization in raw materials leads to low economic growth).

Stokes and Jaffee (1982), in turn, are criticized in the recent note by Firebaugh and Bullock (1986). The latter authors claim that while Stokes and Jaffee are on target in their critique of earlier research, their solution to the measurement of levels of

[1] Firebaugh and Bullock (1986: 334–36) provide a clear and concise discussion of the "commodity problem" which sketches its intellectual history, details some alternative formulations, and offers an empirical evaluation. The basic issue revolves around whether reliance on the export of primary products has a long-range negative effect on economic growth in Third World nations. Attempts to assess the putative detrimental impact of raw materials and agricultural exports have required researchers to develop measures, such as level of processing indexes, which provide classificatory schemes addressing the nature of international commodity flows.

processing is still unsatisfactory. Basically, Firebaugh and Bullock (1986) are sceptical of the Stokes-Jaffee index because the six levels are not adequately described in a way that can be operationalized; they complain that Stokes and Jaffee (1982) fail to "give sufficient information to reproduce" their estimates of level of processing (Firebaugh and Bullock, 1986: 338). To correct this problem, Firebaugh and Bullock (1986) describe the actual procedure which they use to determine level of processing for particular commodities using the idea of "transformation sequences" in some detail, including discussions about how they have classified some particularly problematic items. Firebaugh and Bullock (1986) concur with Stokes and Jaffee's substantive conclusion about the relationship between the level of processing and national development. Their results show that the six-level index (where 1 represents "unprocessed primary products" and 6 represents "highly processed manufactures"; Firebaugh and Bullock, 1986: 339) accounts for a significant amount of the variance in economic development for less developed countries, with high scores on their measure of processed exports positively associated with national per capita income.

There is little doubt that attempts to clarify the measurement issues and replicate previous studies are important contributions to this literature. Reported results of research relating commodity trade patterns to development outcomes obviously depend on operationalizing relevant measures such as the level of processing or some index of capital versus labor intensiveness with requisite reliability and validity. Virtually all of this research uses the same data source: the yearly Commodity Trade Statistics produced by the United Nations. These data follow the Standard International Trade Classification (SITC) format which hierarchically orders information on thousands of items from one-digit (most general) to five-digit (most specific) commodity types. These categories offer no intrinsic information on levels of processing, nor were they designed to do this. Indexes for gauging the degree of transformation or the technological/mechanical sophistication of production processes must be implicitly or explicitly established by researchers. Both Stokes and Jaffee (1982) and Firebaugh and Bullock (1986) argue persuasively that earlier investigators did not take sufficient care in doing this. Commodities were carelessly classified as relatively more or less processed, based on "common sense" rankings which often ignored or downplayed the internal heterogeneity of a category or demonstrated a lack of detailed knowledge about specific production sequences. Firebaugh and Bullock's (1986) most recent work gets to the crux of the issue when they point out that the essential problem has been specifying an index that can be replicated. Their strategy is to focus extensively on a few key commodities for each country which make up the bulk of its exports (75 percent or more).[2] The detailed description they provide of how they ranked specific commodities is designed both to justify their weightings and to give future researchers procedures to replicate.

Clearly Firebaugh and Bullock's (1986) meticulous effort to provide a clear, concise answer to the measurement problem is an improvement on earlier efforts. No doubt their careful delineation of transformation sequences sets a standard for future research attempting to tap the level of processing for particular commodities. But their sophisticated effort highlights a basic characteristic of all level of processing indexes—they ultimately rest on some qualitative judgments of their designers and therefore are always somewhat arbitrary. Both the number of levels (two? or six? or nine?) and the classification of particular commodities at specific ranks ultimately depend on subjective decisions by the investigators or their coders. The reason that

[2] Stokes and Jaffee (1982) also focus on a circumscribed range of export products in their effort to develop a more rigorous processing index. They used the top five exports of each country. Firebaugh and Bullock (1986) opt for 75 percent cut-off because they argue that the five leading exports often account for small and varying proportions of the total exports of a number of countries.

Stokes and Jaffee (1982) rated hats at level 3 and vegetable oil at level 2 is not intuitively obvious, nor is Firebaugh and Bullock's (1986) decision to score clothing at level 4 and preserved fruit and vegetables at level 2. Given certain assumptions, these ratings are defendable and even logically consistent. But, again, the real issue is replication. What specific criteria are used to determine the relative amount of transformation that occurred to each of these commodities? Firebaugh and Bullock (1986) make an earnest attempt to confront and grapple with this issue. But because of the aforementioned issues of (1) the subjective element entering into such operationalizations and (2) the difficulty in precisely quantifying "units" or "sequences" of transformation, we are sceptical that even they actually present a measurement methodology that is unambiguously replicatable.

An Alternative Research Strategy

Cognizant of the difficulties of devising a level of processing scale but interested in exploring the commodity problem, we decided to pursue a different research strategy. Our approach is inductive and our unit of analysis is the international trade network for *all* commodities at a particular SITC level of aggregation. So instead of trying to classify commodities using a processed/unprocessed index or measure of capital intensity, or manufacture/raw material scale, this study (1) attempts empirically to determine if bundles of exports flow together in the circuits of world trade, (2) determines whether these patterns remain stable over a recent fifteen-year period, and (3) allows us to discuss whether these clusters of commodities can be adequately interpreted along a simple processed/unprocessed product dimension. This procedure, therefore, provides an alternative empirical grounding for indexes which purport to measure sequences of transformation in the production of export commodities.

Data used in this study are from the Commodity Trade Statistics for the years 1965, 1970, and 1980. Since notions about both comparative advantage or unequal exchange are essentially relational ones involving flows from all countries, both developed and less developed, all nations which provided complete import and export data and had a population of over one million people in 1970 are included.[3] Instead of focusing on a few commodity types, this research looks at all two-digit SITC categories (table 1). Some of these two-digit categories contain a degree of internal heterogeneity which confounds attempts to gauge the level of processing (for instance, they may contain totally unprocessed raw materials or agricultural products, as well as more processed derivative commodities). This has prompted other researchers to use the three-digit classification (Stokes and Jaffee, 1982) and even more specific four- and five-digit divisions (Firebaugh and Bullock, 1986). Nevertheless, this level of aggregation has some important advantages. First, problems with measurement error and commodity definition may increase as researchers move to more specific SITC categories (Durand, 1953). Second, limiting the study to fifty-five two-digit categories keeps the analysis at a large but manageable scale, whereas examining all of the hundreds of three-digit commodities would create a methodological/data management monstrosity. Of course, if complete and accurate data on both imports and exports for all the countries were included in the analysis, the information on one would be identical to the other. Unfortunately this is

[3] This data is "self-reported" by each country to the United Nations. Unfortunately, it does not include complete data on commodity trade for most Eastern Bloc nations. Information on a number of Middle Eastern countries is missing as well. With reluctance we are forced to omit these countries from the analysis. Missing data and the size restriction limited the analysis to seventy-seven nations in 1965, eighty-six in 1970, and seventy-eight in 1980.

TABLE 1. Two-digit commodity trade categories: Standard International Trade Classification (SITC).

01	Meat and meat preparations
02	Dairy products and birds egg
03	Fish, crustaceans and molluscs, and preparations thereof
04	Cereals and cereal preparations
05	Vegetables and fruit
06	Sugar, sugar preparations and honey
07	Coffee, tea, cocoa, spices, and manufactures thereof
08	Feeding stuff for animals (not including unmilled cereals)
09	Miscellaneous edible products and preparations
11	Beverages
12	Tobacco and tobacco manufactures
21	Hides, skins and furskins, raw
22	Oil seeds and oleaginous fruit
23	Crude rubber
24	Cork and wood
25	Pulp and waste paper
26	Textile fibers (other than wool tops) and their wastes (not manufactured later)
27	Crude fertilizers and crude minerals (excluding coal, petroleum and precious stones)
28	Metalliferous ores and metal scraps
29	Crude animal and vegetable materials, n.e.s.
32	Coal, coke and briquettes
33	Petroleum, petroleum products and related materials
34	Gas, natural and manufactured
35	Electric current
41	Animal oils and fats
42	Fixed vegetable oils and fats
43	Animal and vegetable oils and fats, processed, and waxes of animal and vegetable origin
51	Organic chemicals
52	Inorganic chemicals
53	Dyeing, tanning, and coloring materials
54	Medicinal and pharmaceutical products
55	Essential oils and perfume materials; toilet, polishing and cleansing preparations
56	Fertilizers, manufactured
57	Explosives and pyrotechnic products
58	Artificial resins and plastic materials, and cellulose esters and ethers
59	Chemical materials and products, n.e.s.
61	Leather, leather manufactures, n.e.s. and dressed furskins
62	Rubber manufactures, n.e.s.
63	Cork and wood manufactures (excluding furniture)
64	Paper, paperboard, and articles of paper pulp, of paper or of paperboard
65	Textile yarn, fabrics, made-up articles, n.e.s., and related products
66	Nonmetallic mineral manufactures
67	Iron and steel
68	Nonferrous metals
69	Manufactures of metal, n.e.s.
71	Machinery—nonelectrical
72	Electrical machinery
73	Transportation equipment
81	Sanitary, plumbing, heating and lighting fixtures and fitting, n.e.s.
82	Furniture and parts thereof
83	Travel goods, handbags and similar containers
84	Articles of apparel and clothing accessories
85	Footwear
86	Scientific instruments, photographic apparatus, optical goods, watches and clocks
89	Miscellaneous manufactured articles, n.e.s.

Source: United Nations Statistical Office (1981), *Commodity Indexes for Standard International Trade: Revision 2*. New York: United Nations.

not the case. There are some discrepancies in the data: import and export figures do not always match exactly. Since the goal of this research is to get an image of the overall pattern of exchanges, import data are utilized because there is reason to believe that these figures are more accurate (Durand, 1953; Linnemann, 1966: 61–62).

An important assumption behind various theories relating trade to economic development—whether they emphasize comparative advantage or unequal exchange—is that different types of commodities are traded in distinct patterns along the processed/unprocessed, manufactured/raw material dimension. An important question then is, *do* commodities of certain sorts tend to move together from one country to another? Has the global division of labor developed in such a way that nations producing one type of industrial or agricultural product are also likely to supply the world market with other similar types of commodities? Notice that these are not questions about the attributes of any particular country's trade. They involve the "structural analysis" of the pattern of exchange between nations involved in world trade (see Tilly [1984] on the advantages of this sort of approach).

The basic objective of the analysis is to determine empirically whether, in fact, there are bundles of commodity exports which flow together in international trade circuits, are relatively stable over time, and are interpretable on axes that categories trade theorists have held to be important—for example, along the processed/unprocessed dimension. Factor analysis is the appropriate technique to address these problems, since our objective is to determine if commodity categories cluster together based on their similarity of flow between pairs of countries. The bilateral trade relationship, measured by the value of exchanges in U.S. dollars, between each matched pair of countries defines a case for the factor analysis. The variables are the fifty-five commodity trade categories. So the data for the factor analysis form a large matrix composed of vectors which contain information on the value of exchange between all exporting and importing nations for each of the commodity types.[4] A separate analysis is conducted for each of the three years. Since we are interested in discerning distinct clusters of commodity flows and are reluctant to assume any predetermined structure to the data, a principal component analysis is performed initially (Cureton and D'Agostino, 1983: chapter 12). Using a scree test with an eigenvalue of unity as a demarcation point, we find the first five components consistently significant in accounting for the total variance explained in the data for each year. An oblique rotation is then performed on these initial five components to derive a final solution.[5]

[4] In other words, the factor analysis is based on correlations between variables representing nation-to-nation import activity where a positive correlation between two variables means that countries which tend to import relatively high amounts of the first commodity from a particular partner country tend also to import relatively high amounts of the second commodity from the same other countries. The matrix dimensions vary slightly because of the different number of countries for each year, but in each case can be defined as: $n(n-1) \times 55$, where n is the total number of countries and 55 is the number of two-digit commodities. Thus, there are 5,852 cases for 1965; there are 7,310 cases for 1970; and there are 6,642 cases for 1980.

[5] The SPSSX statistical package was used to perform this analysis. The FACTOR procedure was run, initially using a VARIMAX rotation subcommand, and subsequently utilizing the OBLIMIN rotation subcommand. We believe that the rationale for using this two-step methodological strategy is a sound one. The orthogonal solution requires the underlying dimensions to be statistically independent. This restrictive assumption is not warranted in most cases. The oblique rotation allows the factors to be correlated in a way which maximizes the total explained variance. This is a more realistic assumption to incorporate in our final solution. Results using the two rotations are very similar. Nevertheless, it should be noted that while the choice of particular factor model, method of rotation, and rotation criterion probably would be unlikely to alter our main results, different techniques could change some of our specific findings. Further analysis is currently underway examining this data using alternative methods.

Empirical Results: Structure and Stability

Component grouping and loading scores for each of the three years appear in table 2. Table 3 provides the abbreviated names of the commodities which consistently load on the same factors. Two interesting patterns are evident in these tables. One is the stability of the commodity clusters over time. For each separate year's analysis five components are found which, while not identical over time, show a great deal of continuity. A summary measure of this is provided at the bottom of table 2, where we report the very high correlations between factor loading scores for all commodities. More descriptively, thirty-seven commodity categories (67 percent) load on the same factor for all three years; all but one (98 percent) group with the same component for at least two time points.[6] While fifteen years is not a long time period for a macrostructure like the pattern of global exchange, the high level of stability in the flow of bilateral trade is remarkable during this particular period of widely acknowledged changes in the world economy (i.e., the "global crisis" that followed the 1973 "oil shock" [see Amin, Arrighi, Frank, and Wallerstein, 1982], the move toward a "new international division of labor" [Frobel, Heinrichs, and Kreye, 1980], and the emergence of the "newly industrializing nations" [Caporaso, 1981]).

A second interesting pattern is found in the composition of the extracted components. Table 3 suggests that commodities may cluster in a way that is interpretable along a processed/unprocessed dimension. Products which load on the HI TECH/HEAVY MANUFACTURE factor using our inductive approach generally are items which Firebaugh and Bullock (1986) classify at level 4 or above—and two of the highest-loading two-digit commodities, nonelectrical machinery and transportation equipment, are products they rate as most processed (level 6). These commodities, broadly defined, are the products of capital-intensive industry and/or incorporate sophisticated technology. Similarly, commodities loading on the SIMPLE EXTRACTIVE or FOOD PRODUCTS factors never rate higher than level 3 on the Firebaugh-Bullock scale. These commodities clearly fit near the relatively unprocessed end of their continuum.

The other two components seem to fall somewhere in between in terms of either a processing scale or a measure of labor/capital intensity. Both separately and juxtaposed, these clusterings are theoretically interesting.

The LO WAGE/LIGHT MANUFACTURE factor contains a small, distinctive group of labor-intensive manufactured goods. Shoes, clothing, and luggage are the three commodities which consistently cluster together here over the entire period; furniture, leather products, and beverages join this group in 1980. The average Firebaugh-Bullock score for these goods is level 4. All of these products are traditional manufactures which can be assembled using low-wage labor with minimal levels of skill. This type of light manufacturing is precisely the kind of production most closely associated with the early stages of "industrialization in the periphery" (Caporaso, 1981). This transformation of Third World economies and the concomitant trend toward "capital flight" and "deindustrialization" in the advanced core nations is indicative of a "new industrial division of labor" (Frobel, Heinrichs, and Kreye, 1980; Bluestone and Harrison, 1982; Dixon, Jonas, and McCaughan, 1983). The clustering of several relatively low-processed, labor-intensive manufactures on a

[6] The one and two-time "changers" are a fairly diverse group of products. Most of them never load very heavily on any component. Crude rubber is the extreme example, as it is weakly associated first with the factor 3, then factor 1, and finally factor 5, but in each case its association with the component is tenuous at best. Some changes may be substantively more interesting. Furniture and leather goods both show moderately high loadings on factor 1 for 1965 and 1970, but then solidly load on factor 4 in 1980. As we shall suggest below, this may be related to a systematic modification in the global division of labor.

TABLE 2. Factor loadings of the commodity trade categories: 1965, 1970, 1980

	HI TECH/HEAVY MANUFACTURE			*SOPHISTICATED EXTRACTIVE*			*SIMPLE EXTRACTIVE*			*LO WAGE/LIGHT MANUFACTURE*			*FOOD PRODUCTS*		
	1965	*1970*	*1980*	*1965*	*1970*	*1980*	*1965*	*1970*	*1980*	*1965*	*1970*	*1980*	*1965*	*1970*	*1980*
71	.95	.89	.89	.39	.50	.34	.40	.46	.45	.31	.39	.38	—	—	.31
58	.92	.92	.81	.27	.30	—	.48	.39	.41	.40	.38	.44	.32	.47	.73
73	.89	.62	.82	.37	.78	.47	.27	.25	.25	.39	.35	.26	—	—	—
69	.89	.83	.94	.35	.50	.34	.26	.26	.31	.63	.66	.54	—	—	.38
86	.89	.87	.85	.25	.30	—	.39	.43	.41	.42	.48	.29	—	—	—
53	.87	.88	.85	—	—	—	.27	.30	.36	.28	.26	.34	—	—	.52
72	.86	.79	.90	.35	.44	.28	.39	.43	.45	.63	.68	.40	—	—	.31
81	.86	.81	.75	.25	.26	—	—	—	.25	.55	.53	.69	—	.27	.49
59	.85	.86	.81	.29	.29	—	.64	.65	.63	—	—	.31	.34	.34	.53
62	.84	.81	.87	.28	.39	.37	.34	.26	.27	.54	.59	.55	.36	.36	.41
52	.84	.63	.27	.33	.26	—	.36	.25	—	.28	—	—	.26	.52	.80
51	.83	.85	.77	.54	.49	.49	.58	.56	.56	.36	.40	.39	.30	.35	.61
55	.77	.83	.81	—	.27	—	.39	.46	.41	.41	.37	.44	.37	.40	.57
54	.74	.77	.75	—	—	—	.37	.50	.54	.25	.26	.39	.25	.25	.42
82	.69	.55	.62	.36	.73	.36	—	—	—	.54	.48	.76	.34	.28	.39
32	.66	.38	.32	—	—	—	.52	.83	.77	—	—	—	—	—	—
57	.58	.40	.59	.36	.89	.43	—	—	.26	.33	.31	.45	—	—	.27
61	.57	.60	.49	.31	.29	—	.28	—	.26	.56	.57	.75	.50	.52	.34
35	.55	.26	.35	—	—	—	—	—	—	—	—	—	—	—	.29
43	.52	.64	—	—	—	—	.28	.25	—	—	—	—	.41	.47	.44
09	.50	.66	.62	—	—	—	.49	.45	.42	—	.25	.39	—	.37	.70
64	—	.25	.46	.96	.96	.89	—	—	—	—	—	.27	—	—	.30
34	—	—	—	.92	.90	.82	—	—	—	—	—	—	—	.29	—
25	—	—	—	.91	.89	.90	—	.30	.35	—	—	—	—	—	—
24	—	—	—	.86	.69	.75	.32	.63	.52	—	—	—	—	—	—
03	—	.25	.37	.79	.77	.70	—	—	.49	.32	.42	—	.25	—	.29
28	.30	—	.29	.79	.59	.51	.43	.65	.69	—	—	—	.25	.25	.25
68	.38	.35	.66	.77	.70	.73	.36	.31	.45	.26	—	.29	.27	—	.40
27	.54	.49	.54	.77	.73	.52	.50	.62	.71	.27	.30	.32	.30	.29	.33
63	.32	.37	.47	.74	.60	.64	—	.46	.66	.60	.59	.45	—	—	.34
56	.31	—	.34	.74	.87	.81	—	—	—	—	—	—	—	—	.26
11	—	—	.45	.52	.49	.32	—	—	—	.34	.35	.53	—	—	.25
33	—	—	—	.31	.41	.25	—	—	—	—	—	—	—	—	—
22	.26	—	—	—	—	—	.85	.87	.83	—	—	—	—	—	—
41	.26	.25	.28	—	—	—	.83	.83	.71	—	—	—	.28	—	—
04	—	.27	.26	—	—	—	.81	.87	.86	—	—	—	—	—	—
08	.31	.36	.30	.32	.29	—	.66	.61	.61	—	—	—	.35	.32	.34
12	.30	.35	.31	—	—	—	.66	.55	.65	—	—	—	—	—	.42
21	.38	.33	.32	.43	.31	.29	.62	.75	.74	—	—	—	.42	.28	—
26	.28	.26	.33	—	—	—	.50	.51	.76	—	—	—	.42	.37	.25
42	—	—	—	—	—	—	.43	—	—	—	—	—	—	.40	.43
23	.27	.32	—	—	.26	—	.36	—	—	—	—	—	—	—	.33
84	.33	.36	.37	—	—	—	—	—	—	.93	.89	.86	—	.32	—
85	—	—	—	—	—	—	—	—	—	.86	.73	.90	—	—	—
83	.33	.29	.29	—	—	—	—	—	—	.84	.89	.87	—	—	—
65	.60	.73	.80	—	.28	—	—	—	.30	.78	.67	.68	.42	.47	.56
89	.76	.66	.86	.28	.31	.32	.30	.29	.33	.77	.81	.53	—	—	.26
67	.62	.68	.84	.35	.38	.31	—	—	—	.73	.66	.41	—	—	.33
66	.61	.67	.43	.25	.35	—	—	—	—	.63	.63	.32	.25	.27	—
01	—	—	.30	—	—	—	—	—	.38	—	—	—	.81	.71	.68
02	—	.37	.45	—	—	—	—	—	—	—	—	—	.79	.79	.79
29	.39	.46	.29	.38	.42	—	.26	—	—	.36	—	.27	.74	.80	.85
05	.41	.43	.42	—	—	—	.28	—	.38	.43	.41	.61	.52	.65	.59
06	—	—	—	—	—	—	—	—	.27	–	–	–	.37	.45	.31
07	—	—	—	—	—	—	—	—	—	—	—	—	.30	.36	.36
% total variance explained	36.6	37.8	37.7	10.5	10.0	6.3	7.3	8.1	9.1	5.1	4.0	4.7	3.6	4.8	5.0

Values underscored are the highest loading for the commodity for each year. Values less than .25 are not reported. Correlations between factor loading scores (Pearson's *r*): 1965/1970, r = .901; 1970/1980, r = .818; 1965/1980, r = .785. Total variance explained for each year: 1965, 63.1%; 1970, 64.8%; 1980, 62.8%. (See table 1 for commodity codes.)

TABLE 3. Consistent factor groups of commodity trade categories over time.*

Categories loading on the same component:	*HI TECH/HEAVY MANUFACTURE*	*SOPHISTICATED EXTRACTIVE*	*SIMPLE EXTRACTIVE*	*LO WAGE/LIGHT MANUFACTURE*	*FOOD PRODUCTS*
All 3 years	Machinery	Paper/paperboard	Oil seeds and oleaginous fruit	Clothing	Meat by-products
	Plastics and synthetics	Pulp/waste paper	Animal oil/fat	Footwear	Milk/eggs
	Metal manufactures	Gas, natural or manufactured	Cereals/cereal preparation	Luggage/handbags	Crude animal/vegt. material
	Scientific instruments	Cork and wood	Animal feed		Vegt./fruit
	Dyes	Fish/fish preparations	Tobacco		Sugar
	Electrical machinery	Nonferrous metals	Raw hides/skins		Coffee/tea/spices
	Chemical products	Fertilizers, manufactured	Textile fibers		
	Plumbing, heating and lighting fixtures	Petroleum and by-products			
	Rubber manufactures				
	Organic chemicals				
	Perfume/cleansing preparations				
	Pharmaceuticals				
	Electric current				
1965 & 1970	Inorganic chemicals	Crude fertilizers/minerals		Miscellaneous manufactures	
	Leather/leather manufactures	Beverages			
	Processed animal/vegt. oil	Cork/wood manufactures			
	Miscellaneous food products				
1970 & 1980	Textile yarn/fabric		Metal ore/scrap		Fixed vegt. oil and fats
	Iron/steel		Coal		
	Nonmetallic mineral manufactures				
1965 & 1980	Transportation equipment				
	Furniture				
	Explosives				

Crude rubber was the only commodity loading on a different component each year: 1965, Simple Extractive; 1970, Hi Tech/Heavy Manufacture; 1980, Food Products.

* Abbreviated category names used here. See table 1 for complete SITC definition.

common component indicates that these goods *do* flow together in international commerce, and is consistent with the argument that some countries may be specializing in labor-intensive export industrialization.[7]

The factor we have called SOPHISTICATED EXTRACTIVE also seems to be an intermediate cluster of commodities. These goods score somewhat lower on the Firebaugh-Bullock scale than those loading on the LO WAGE/LIGHT MANUFACTURE factor and most can be referred to as raw materials. But we would argue that the products clustered around the SOPHISTICATED EXTRACTIVE factor may require a greater degree of technological expertise or capital investment to export than the Firebaugh-Bullock scale suggests. Included here are paper and pulp, cork

[7] The movement of furniture, leather goods, and beverages into this group may be indicative of a particular industry's shift in the changing world division of labor, moving through the "product cycle" (Cumings, 1984). It will be interesting to see if other types of manufactured goods shift from factor 1 to factor 4 when data for 1985 and subsequent years can be analysed.

and wood, fish and fish preparations, gas, and oil.[8] A few of these items (paper, and some worked nonferrous metals) also rate level 4 on the Firebaugh-Bullock index. Most of these products, however, are exported in their unprocessed condition, with little transformation; accordingly, some (simply preserved fish, natural gas, phosphate fertilizer, crude oil) are level 1 commodities on the Firebaugh-Bullock index. Clearly, if the "crude" state of the actual good itself is the sole criterion for classifying these items, ranking them at the low end of a processing scale is indisputable. But when we take a broader view of the steps necessary to procure the commodities and prepare them for international trade, this scaling becomes somewhat problematic. Indeed, in certain instances some of these goods may be extracted and shipped using low-technology, labor-intensive techniques. But when they are produced in the quantity and quality necessary for international trade, relatively sophisticated machinery and economic organization are needed.[9] For instance, the commercial fishing industry requires fleets of ocean-going ships, sophisticated communication systems, and modern facilities for preserving the catch. None of this capital intensity shows up when we simply examine the product itself, but it *would* seem to be relevant to debates about "unequal exchange in the world market," which Mandel (1975: 66) conceptualizes as "the result of a difference of the average productivity of labor between two nations."

The above discussion suggests that, perhaps, level of processing indexes which merely examine the export *products* may seriously minimize the degree of capital intensity and technological complexity involved in the *organization* of export activity. For this reason, we would rank the SOPHISTICATED EXTRACTIVE and LO WAGE/LIGHT MANUFACTURE factors somewhere in the middle of a scale measuring capital intensity—with the raw material factor, arguably, ranking slightly higher on this scale.

Obviously, a cursory examination of the composition of the two bundles of commodities suggests that there is an additional difference between them that has nothing to do with either level of processing or capital intensity. The commodities in the SOPHISTICATED EXTRACTIVE category are all closely tied to the environmental resource base of the exporting nation, whereas the goods in the LO WAGE/LIGHT MANUFACTURE group are factory products more distal from an area's natural endowment. This introduces a new dimension into our attempt to array international trade commodities according to the emphasis on extraction versus production. This useful distinction is taken from recent work by Stephen Bunker (1984, 1985). He emphasizes that it is important to distinguish between extractive economic activities, which involve the procurement of natural resources, and production, which uses labor and capital to transform the matter and energy of those inputs into more finished goods. Commodities that are untransformed natural resources (regardless of the technology or capital-intensive nature of their mining or

[8] Our finding that petroleum consistently clusters with other commodities which can be broadly classified as capital-intensive raw materials deserves a brief comment. Obviously this commodity was of disproportionate importance in the world economy during the period under study, with a rapid rise in prices precipitating the international "oil shock." Despite petroleum's consistently falling into factor 2, we should emphasize that the low value of petroleum's loading on this component indicates that it did have a fairly *distinct* pattern of flow in international trade circuits.

[9] Of course, a number of the agricultural goods which load on factors 3 and 5 can also be produced through capital-intensive large-scale techniques. But there are important differences. First, many of the food exports still require labor-intensive steps, since mechanization has not been developed that will efficiently cultivate or harvest the particular crop. Second, even in cases where it might be technically feasible, export agriculture is not always organized around high technology since agribusiness has found that a sort of agricultural "putting-out system" which Frank (1981) labels "strawberry imperialism" is a more effective strategy for maximizing profits and minimizing risks.

harvesting) are classified as extractive; manufactured or crafted items which require human or machine labor to transform them into social artifacts are categorized as productive.

Figure 1 classifies our factor results in two-dimensional space using the capital/labor intensity and the production/extraction based distinction. Note that while the two dimensions are correlated (i.e., HI TECH/HEAVY MANUFACTURE exports epitomize production-based commodities and are very capital intensive; FOOD PRODUCTS represent the most extraction-based cluster and tend to be most labor intensive), they are analytically distinct. Once again the results are theoretically suggestive. The notion of unequal exchange need not be limited to labor-based explanations—it could also be linked to the costs of environmental degradation, which results from economies dependent on extraction (Georgescu-Roegen, 1975; Bunker, 1984, 1985). Bunker (1984: 1018) explains, "I believe that the unbalanced flows of energy and matter from the extractive peripheries to the productive core provide better measures of unequal exchange in a world economic system than do flows of commodities measured in labor and prices." Our results suggest that there are generalized flows of trade in the international economy which are clearly differentiated according to this dimension. This finding lends credence to Bunker's claim that the extractive/productive distinction may be a crucial element structuring global inequality.

Conclusion

To our knowledge, this study is the first attempt to describe the overall pattern of commodity trade by empirically examining data on a fairly inclusive international trade *network*. While the novelty of what we have done might be expected to provoke some interest, in and of itself, our results have important implications for both measurement issues and theoretical debates swirling around the commodity problem.

No attempt is made in this paper to measure the degree of processing of commodities or the actual capital intensity of their production processes. But the patterned bundles of products in our empirical analysis are suggestive of the relevant dimensions which such scales need to incorporate. To some extent, our results complement the work of Firebaugh and Bullock (1986). One salient dimension differentiating the pattern of commodity clustering was the degree of capital intensity. Even though we looked only at more heterogeneous two-digit categories, our results seem to fall out along a rough ordinal scale that is congruent with the Firebaugh-Bullock level of processing index. This suggests that perhaps our inductive strategy, combined with the painstakingly detailed classification system that Firebaugh and Bullock (1986) have devised, could provide a rough proxy for placing commodities other than those which they have studied along a raw-material/finished-product scale.

On the other hand, the patterns that we found also suggest some difficulties for researchers who attempt to use level of processing scales as the sole basis for distinguishing the crucial dimensions of global economic exchange. First of all, in interpreting our results we have argued that the actual transformation of the product may only partially operationalize the degree to which capital-intensive processes are necessary to provide a commodity to the international market. Some crude materials are extractable only by means of sophisticated machinery and economic organization. Secondly, focusing on the processed/unprocessed dimension provides, at best, a very rough instrument for addressing the difference between extractive and productive exports. Firebaugh and Bullock (1986) purport to provide a rough test for Bunker's extraction-based version of unequal exchange, using the

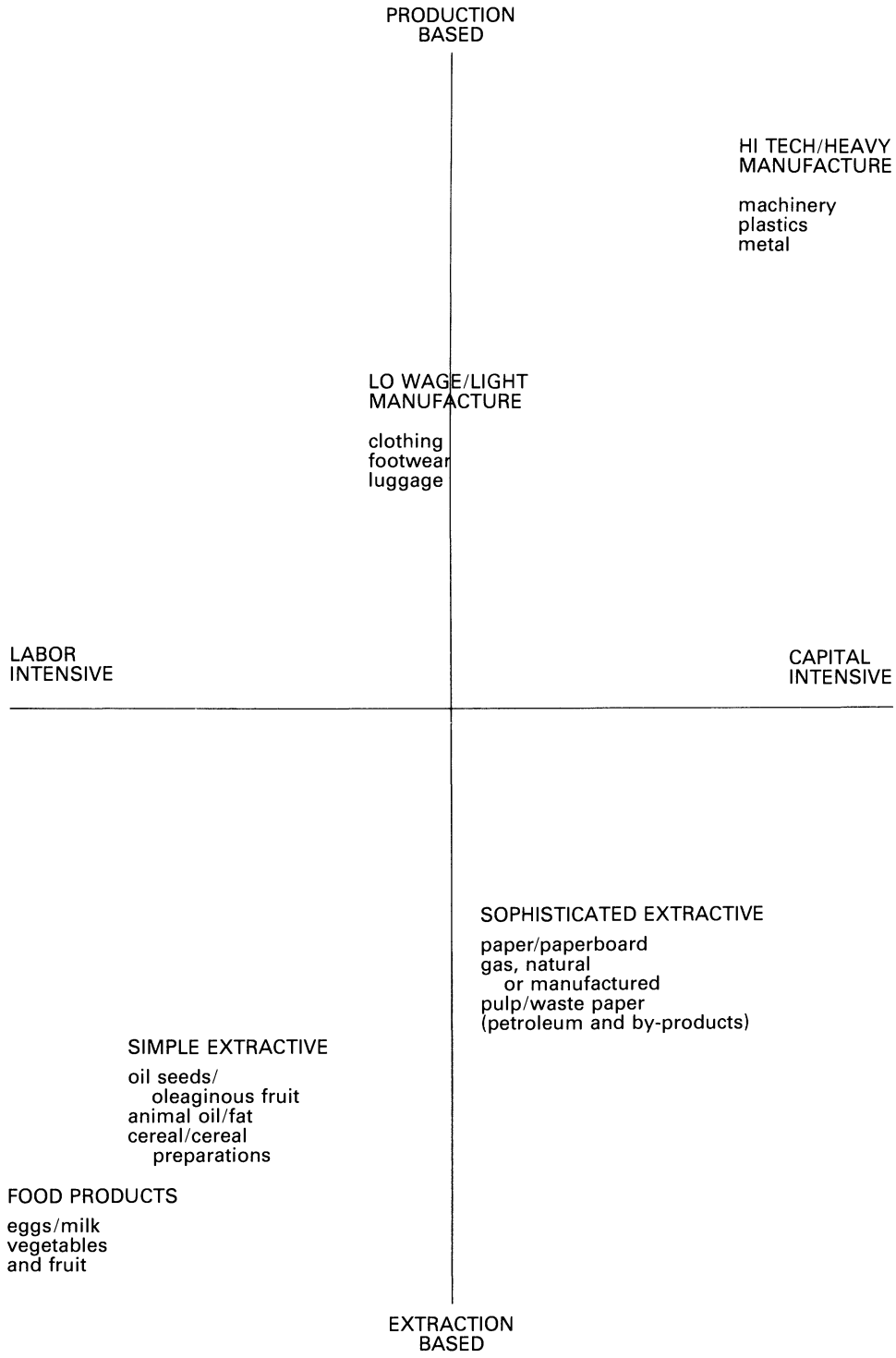

FIG. 1. Five factors with representative commodities roughly located along production/extraction-based and labor/capital-intensity dimensions.

correlation between level of processing and economic level. But they acknowledge that level of processing shows only "a relatively strong association" with "the natural resource content of LDC exports" (1986: 347). The capital-intensive extractive products associated with our SOPHISTICATED EXTRACTIVE factor include some products (paper, worked nonferrous metals) which involve substantial transformation *and* are inexorably linked to natural resource endowment. This suggests that in order to properly address the important issues which Bunker raises, a measurement instrument which explicitly incorporates the extractive/productive dimension is needed.

Finally, the results and discussion prompt some speculation about theories relating international trade to national development. Our findings seem to indicate that there are discernable patterns of global economic exchange indicative of national economic specialization. This appears to support the very general notion of a global division of labor as expected by both the neoclassical and neo-Marxist theories of international trade. But our findings also suggest that the empirical pattern is at least two-dimensional and that approaches emphasizing unequal exchange (or, for that matter, comparative advantage or other theoretical notions) need to address the commodity problem in a way which differentiates between labor-based and resource-based approaches.

This conclusion supports Bunker's basic argument that "modes of extraction," tied to environmental resources/constraints and the transformation of matter and energy, are important elements in the process of economic development. This emphasis suggests that neo-Marxist approaches, like dependency/world-system theory, may need to address issues that up to this point have been more thoroughly explored from other perspectives. One promising field of theoretical linkage may lie in human ecological approaches to macrostructural change (Hawley, 1950, 1986). This perspective investigates the complex interplay between the social and biophysical environment, technology, population, and economic and social organization and growth. While past human ecological studies have tended to take a narrow focus on "spatio-demographic" factors (Slater, 1978) and have tended toward models of technological determinism (Gibbs and Martin, 1959), Hawley's emphasis on developing a general theory to account for cumulative social change in the context of the growth and evolution of the ecosystem is more ambitious and potentially more useful. It explicitly deals with the problems of carrying capacity, resource depletion, and technological intensification that Bunker's approach confronts. Previous human ecological formulations may have focused on parochial problems or been plagued by functionalist biases, but the problems that they address are relevant to some issues that neo-Marxism and other variants of political economy often ignore (see Hawley, 1984, for an interesting discussion of the potentially fertile cross-pollination of human ecology and "Marxian theories").

Further research is necessary to establish the actual relationship between specific patterns of commodity trade and their positive or negative effect on economic growth. This paper has provided only a preliminary step toward addressing that issue, since we do not attempt to correlate our empirical patterns with development outcomes for particular nations (replicating earlier studies).[10] This study also

[10] In this research note no attempt has been made to examine the pattern of exports of particular countries or to correlate that configuration with patterns of economic development. Our results raise the question: Do nations specializing in one or another of the five clusters of products we identify experience different patterns of economic growth? One fairly straightforward way to empirically address this question is to calculate the value of each country's exports for commodities which are representative of the five factors. To do this we could use either the commodity with the highest loading on each component, or a composite score combining exports on the three or five highest loadings. These values could then be correlated with levels of economic development or growth. We hope to examine this question, and also the issue of which countries cluster together, in further analysis of this data (for preliminary analyses utilizing the quantitative methodology of network analysis to address the latter problem, see Nemeth and Smith [1985]; Smith and White [1986]).

provides a first step of a newer research agenda attempting to understand international trade as a system of relations (rather than merely as national attributes). Additional exploration of these data using quantitative network analytical techniques should allow us to provide a more detailed structural image of the actual patterns of unequal exchange.

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