Developing-Country Competitiveness in the Global Marketplace

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Overview

Lesser developed countries (LDCs) wishing to exploit their comparative advantages in the global marketplace, as one means of advancing their standard of living, are presented with an historical imperative quite different from the conventional wisdom of following the path of industrialization taken by the already industrialized countries (ICs). A serious scarcity of capital, large energy import bills, severe unemployment, and an increasingly fragile environment in LDCs have combined to make obsolete or inappropriate for LDC use much of the current IC stock of technologies. With growth rates in the consumption of basic materials in the ICs declining, competition for historically large IC markets can be expected to stiffen, while strong competition can be expected for shares of expanding LDC markets.

If LDCs are to build and maintain competitive export industries, therefore, modernization must go in hand with industrialization. Ample opportunity exists for incorporating innovative industrial technology into the LDCs. The ongoing industrialization of Brazil provides good examples of how a developing country can apply creative and appropriate, modern technology to help maintain its comparative advantages in the global marketplace.

Developing Country Perspectives on Exports

International trade is widely viewed as a prime engine of growth for developing economies [1,2,3]. In the past, many LDCs have emphasized the export of relatively low-value-added commodites such as food, fibers, and ores because of their abundant natural resouces and the ready availability of inexpensive labor. In addition, producing commodities involved relatively low energy and capital costs and required a minimal level of technological infrastructure and sophistication.

Commodity prices, however, are inherently unstable, as they are often determined by uncontrollable factors (e.g., weather) and are particularly sensitive to economic downturns in the major commodity markets which are located in and controlled by the ICs. Since 1950, steadily falling world prices for commodities in relation to LDC imports of manufactured goods (figure 1) has contributed to a continuing decline in the terms of trade of many commodity-exporting LDCs. As a result, most LDCs have been at the mercy of economic disruptions in the ICs (figure 2), from which a large majority of their manufactured imports come. In particular, the severe recession from 1980-83 has had a devastating effect on LDC growth, as shown in figure 2.

Recognizing how excessive dependence on single commodity exports results in economic instability and erosion of self-reliance, and having established sufficient industrial capabilities to begin producing manufactured goods, LDCs began in the 1950s to diversify their mix of commodities and have increasingly turned to exporting manufactured goods. The volume of manufactured exports from LDCs grew nearly twice as fast as commodity exports between 1958 and 1978 [4]. As a result, the share of manufactured goods in the exports of LDCs grew nearly 5-fold from 1960 to 1980 (figure 3). At the same time, the shares of primary commodities became more widely distributed over a number of different commodities, as shown in figure 3.*

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* Some of the particularly poor LDCs, however, are still dangerously dependent on a single export: Burundi, coffee (90 %); Colombia, coffee (90%); Ghana, cocoa (70%); Zambia, copper (70%) [5].

In initiating the shift from commodities to manufactures, LDCs have generally emphasized the production of relatively low-value-added, semi-finished materials such as steel, aluminum, and basic chemicals. In the development of such heavy industries, many LDCs have been able to use to their advantage plentiful supplies of raw materials, inexpensive domestic energy supplies, an abundance of cheap labor, and a lower level of public awareness of problems caused by industrial pollution. In addition, the relatively low cost of capital in recent decades and the technologically unsophisticated character of basic processing facilities has allowed LDCs with relatively few capital resources and minimal technological infrastructures to compete in the global markets for these manufactured goods.

Increasingly LDCs have also been exporting higher-value-added finished manufactured goods. It has been noted that by the late 1960s, Brazil was exporting clocks to Switzerland, refrigerators to the United States, furniture to Scandinavia, fashion garments to Italy, testing and measuring instruments to Germany, and photo-electric cells to the Netherlands [6].

While the manufacturing sector in many LDCs has been growing, it is still in its infancy by comparison with the ICs. The LDCs, therefore, have before them the opportunity to determine what industrial development path they will take. The most obvious option is the IC path, but can industrial growth in the LDCs follow this historical precedent?

Lessons from Industrialized Countries

To answer this question, it must first be recognized that the situation in which LDCs find themselves today is drastically different from that of the ICs at a similar period in their development: there are no captive markets to be established (e.g., by colonization); trading corridors and the vessels that travel them are governed by international law, not military might; energy is no longer cheap; sensitivity to the environment has increased; and capital is expensive. Given these important differences, LDCs cannot replicate the path of industrialization taken by the ICs.

It might be argued that adopting technologies presently commercialized in ICs, thereby skipping over a number of historical developments, would be the wisest approach for LDC industrialization. However, this is an unattractive strategy for several reasons.

Many of the technologies still commonly used in most ICs, particularly those used in the energy-intensive basic materials sector, became obsolete almost overnight as a result of the oil price shocks of the 1970s. The 1970s also brought heightened environmental awareness, leading to increased production costs necessitated by environmental-protection legislation. The years before 1970, during which much of the existing industrial stock was built, were also years of relatively low-cost capital, a situation drastically different from today [7]. Since capital and energy tend to be complementary inputs in industry, while capital and labor tend to be substitutable [8], many of the manufacturing technologies in ICs are energy-inefficient, capital-intensive, and labor-saving. Given rising costs of energy, increasing concern for the environment, the high cost of capital, and the severe unemployment problems in many LDCs, adopting the energy-guzzling, environmentally-insensitive, capital-intensive, labor-saving technologies presently commercialized in the ICs is unaffordable and inappropriate in most LDCs.

Warnings from Industrialized Countries

Technological Advances: Developing countries have been successful in exploiting their comparative advantages in some industries, but technological advances in ICs suggest that LDCs cannot rest on these laurels if they are to stay competitive in the future. One LDC success story has been in the textiles industry, where relatively crude, multi-purpose machines and low-paid, but skilled and highly flexible operators have been relied upon to keep up with rapid fluctuations in the demand for particular styles of clothing. Recently, however, the use of micro-electronics to automate and accelerate the production process has been on the rise in ICs, threatening to erode the LDC comparative advantage. Layout and cutting of material, traditionally done as manual tasks requiring on the order of 1 hour per suit, can now be done by computer-controlled layout equipment (ensuring optimal use of available cloth) and laser cutting devices, requiring a total of only about 4 minutes per suit [9]. If LDCs are to compete with such technological innovations in the ICs, they must create new comparative advantages, because traditional ones are threatened.

Saturating Markets: Given the present LDC dependence on IC markets,* the future rate of materials consumption in the ICs could also have an important bearing on industrial development in the LDCs. The growth of industrialized country markets for semi-finished materials has been slowing in recent decades. While the weight of basic materials (excluding food and fuel) imported by the US grew at an average rate of 4.4% per year from

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* Industrialized market economies have consistently accounted for about 3/4 of the value of all LDC market economy exports over the past two decades. In 1979, ICs imported 66% of LDC commodity exports (excluding fuel) and 63% of their manufactured exports [4].

1950-1970, it decreased 1/2% per year from 1970-1980 [10,11]. Growth in the physical quantity of finished manufactured imports had been robust (11.8% per year, 1950-1970), but has also slowed recently (4.4% per year, 1970-1980). An overview of the development of consumption patterns in ICs can provide some insight into why IC import growth has slowed and what can be expected in the future.

Growth rates in the consumption of basic materials are typically higher than the growth rate of the economy as a whole, when such materials are first introduced into an economy. For example, in the case of steel (figure 4, lower), the consumption per unit of GNP in the United States grew rapidly from the mid-1800s up until about 1920, during which time a significant share of the physical infrastructure of the country was built: mines were dug, factories and commercial buildings were constructed, transportation systems were developed, and the residential sector was rapidly growing. A steady rise in per capita steel consumption accompanied this expansion (figure 4, upper). But while per capita consumption continued to rise (except around the time of the Great Depression) for about another 30 years, consumption per unit of GNP peaked in the 1920s, and has steadily declined into the present, so that the current intensity of steel use in the US economy (measured in kg per dollar of GNP) is about that which characterized the end of the 19th century. Per capita consumption reached saturation in the 1950s, and has actually been declining over the past decade, suggesting that further growth in consumption will, at best, keep pace with population, which is projected to grow less than 1% per year until 2000 [10]. Such saturation and downward trends in the use of steel are also evident in other industrialized countries, including France, Germany, Sweden, and the UK [12].

Declining steel intensity is a manifestation of a more general phenomenon occurring in industrialized societies. Individuals are reaching the limit of their capacity to consume material goods. Each American currently consumes on average his or her weight in basic materials every day (figure 5). But while per capita material consumption appears to have saturated at this high level, consumption of higher value-added-intensive quantities is growing rapidly. The "information explosion" is one manifestation of this.

Competition from substitutes is also playing a fundamental role in affecting the use of materials. While direct substitution is occurring -- aluminum and plastics in place of steel, for example -- saturation trends are seen in the consumption of the substitutes as well. Figure 6 shows this in the case of aluminum and ethylene (a major feedstock in the production of plastics such as polyvinyl chloride and polyethylenes).

Competition is encouraging more efficient use of material. In the steel industry, this is reflected in the greater emphasis being put on the production of higher quality (lighter and stronger) steel [13,14]. As an example, steel girders used in recent repairs to the Eiffel Tower weigh 1/3 as much as those they replaced [15]. Major changes in the efficiency of aluminum use have occurred recently as well. Twelve-ounce beverage containers, which account for about 23% by weight of all domestic aluminum shipments in the US, now use 22% less metal in the sidewalls than in 1966, while the introduction of necking at the ends of cans has resulted in a 13% drop in the weight of lids [16].

Saturating consumption of steel, aluminum, and ethylene are but three examples of economy-wide trends in ICs. US data show saturation behavior in the consumption of a wide range of other basic materials as well, e.g., paper, cement, textiles, ammonia, and chlorine [12,17].

Protectionist Policies: As IC market growth slows, and LDCs continue to capitalize on their comparative advantages in the production of manufactured goods, protectionist sentiments (and policies) are growing stronger in the ICs. While protectionist policies provide short-term aid to selected economic groups in the particular countries which institute them, they tend to breed global economic inefficiency over the long term. Since the LDCs as a group constitute a larger export market for the EEC, the US, and Japan than any one of the three does for either of the other two, protectionist measures which restrict LDC growth are likely to have detrimental affects on IC economies as well [1].* Furthermore, LDCs require export earnings if they are to service foreign debts. While the prospect of default on a small loan may be a problem for the debtor, that on a large loan is a problem for the creditor. Clearly, protectionism is not only damaging to developing countries, it is antithetical to a healthy global economy.

What options are available for developing countries to increase their share of global markets in the face of tighter IC markets, technological advancements in the IC finished manufactures industry, increasing protectionist policies (spurred on by major recessions in 1973-74 and 1980-83), and the heightened competition for new LDC markets that can be

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* A particular example is the Multifibre Arrangements, under permanent enforcement of which US textiles consumers would pay $1.00 in tariffs for every $0.07 gained by workers whose jobs are preserved [1]. The group hit hardest by higher prices in protected ICs are likely to be the poor, as they expend a proportionately greater share of their income on low cost goods typically imported from developing countries [5].

expected as a result of these other factors?

Building and Maintaining a Competitive Edge in Developing Countries

Modernization of the industrial base, which should not be equated with retracing the path of Western industrialization, is a key to future LDC competitiveness in global markets of manufactured goods.

Evidence suggests that technology which raises overall productivity, the major goal of modernization, does so by solving a number of problems simultaneously [18]. Truly innovative technology which raises overall productivity tends, for example, to decrease energy consumption more than "add-ons" designed solely to reduce energy use with existing technology, and will often be able to mitigate environmental problems more effectively than measures targetted at modifying existing technology to meet new environmental standards. The introduction of new technology that would minimize total cost in areas where labor is abundant would also tend to generate more employment than efforts which seek to generate employment by emphasizing the more labor-intensive existing technologies.

Two primary and equally important vehicles for the development of innovative industrial technology in LDCs can be identified: technological leap-frogging and efficient, appropriate utilization of indigenous resources [19,20]. Leap-frogging, in the context of LDC development, implies learning from the experiences of ICs, passing over part of the path followed by the ICs, and thus arriving by a new route at an advanced level of technology. Efficient utilization of indigenous resources does not mean simply applying traditional IC ideas to local LDC resources, but rather it involves the creative and appropriate use of these resouces, often in ways that have never been used before. The ongoing modernization of Brazilian industry provides good examples of leap-frogging and innovative use of indigenous resources in the developing world.

The Brazilian Example of Industrial Modernization

Brazil has been on a path of modernization for a number of years, with the result that it is one of the most industrially advanced of all developing countries. One area in which Brazilian industry has been particularly successful has been in substituting indigenous energy for expensive imported oil. The Brazilian experience lends support to Berg's theory of technological innovation [18], in that the Brazilians have reaped more than just energy benefits.

Perhaps the technological advancement in Brazil most widely recognized around the world is the ethanol-from-sugarcane program designed to wean the Brazilian transport sector from its dependence on increasingly expensive imported petroleum fuels. While the presently operating ethanol distilleries do not incorporate state-of-the-art production technology, the Brazilians appear to have made the wisest choice in proceeding as they have, given constraints of a less than fully developed technological infrastructure and a serious scarcity of capital.

The success and technological appropriateness of the Brazilian ethanol program is evident in a recent critical analysis by Geller [21]. He found the ethanol equivalent of a barrel of gasoline costs only 6 to 13% more than an actual barrel of gasoline refined from imported petroleum (without using shadow pricing). In addition, the ethanol program makes efficient use of rich indigenous resources of land and labor. To meet the ambitious production goal of nearly 11 million liters of ethanol by 1985 will require land area equivalent to less than 6% of that used for food crops in 1982. In addition, the program may help stem urban migration, as the equivalent of nearly 500,000 full-time jobs in rural areas will have been created by 1985, with further expansions planned. Capital investments per job created range from $6,000 to $28,000. The employment-generating efficiency with which this capital is being used can be judged by comparison to average industrial investments in Brazil of $42,000 per job created and the phenomenal $200,000 per job created at a particular oil-refining petrochemical complex. Along with increasing ethanol production has come the development of automobiles designed to operate on 100% ethanol, in itself an example of a technological leap.

Another technological success is the Brazilian steel industry, which has become a major supplier of steel to global markets using an adaptation of the charcoal-steel technology last commonly seen in the industrialized world in the late 1700s. ICs abandoned this technology with the discovery that coal-based factories could be built considerably larger than charcoal plants to take advantage of economies of scale resulting from decreased labor costs as a fraction of total production cost [22]. While coal facilities were generally more capital-intensive, this disadvantage was out-weighed by rising charcoal prices resulting from increased wages paid to workers in the charcoal-making industry.

As Brazil is without an indigenous metallurgical coal supply, adopting the steel production technology common in most of the industrialized world would have entailed importing significant quantities of coal. Brazil has chosen instead to utilize its tremendous land resource to grow plantations of Eucalyptus trees, charcoal from which fuels the steel industry. Brazil recognized that a charcoal-based steel industry would be ideal precisely because of the greater intensities of labor inherent in smaller operations, the lower capital investments required, and the additional employment generation that would result from establishing a charcoal-making industry.

While the brick beehive kiln, the technology upon which the Brazilian charcoal industry is based, is not the most efficient system available for making charcoal, by comparison to more advanced retort systems it requires more labor and less capital per unit of charcoal-making capacity (in the case of capital, it requires over 40 times less than retort systems [23]!), suggesting that the beehive is the wisest choice for present-day Brazil. The steel industry is actively working to develop more efficient beehive kilns and higher yielding species of Eucalyptus. The latest advance in charcoaling has come with the incorporation of a tar recovery technique and has produced overall conversion efficiencies nearing 60% [23]. In addition, test plantations have produced wood yields as high as 70 cubic meters per hectare per year [24].

Another advanced technology being developed to exploit Brazil's large biomass resource is the production of methanol from wood using an innovative gasifier design in the first stage of the process. While world methanol prices are presently depressed owing to the softening of the world oil price, because methanol (an ideal vehicular fuel) can be derived from wood or other lignocellulosic feedstocks which do not require the use of prime agricultural land (as in the case of ethanol from sugarcane), methanol from biomass promises to become an increasingly important fuel as liquid fossil fuel prices rise in the future.

While wood gasification is an old technology, its commercial use in making methanol has never been done before. As a result of research and development work over the past several years, the Sao Paulo State Energy Company is now using and marketing a modern gasifier which is tailored to the use of biomass as a feedstock and which allows greater methanol production per unit of wood input through the use of electricity (rather than combustion of a fraction of the wood) as the heat source for gasification [25], a unique adaptation of technology appropriate for hydro-power rich Southern Brazil.

Summary

Recognizing trade as one means by which to advance their well-being, developing countries have looked to exports, traditionally of commodities, as an important element of economic development. Given the inherent instablility of commodity prices, they have been shifting more and more in the recent past to the export of manufactured goods, relying for the most part on their traditional comparative advantage -- the ready availability of inexpensive labor -- to compete in the global marketplace. However, as slow growth tightens industrialized country markets and competition for new developing country markets intensifies, developing countries will no longer be able to rely entirely on their traditional comparative advantages. Neither can they afford to industrialize by following the path taken by the industrialized countries.

The infant state of industrial technology in many developing countries presents them with a tremendous opportunity to build an industrial sector which can compete successfully for future global markets. To achieve this will require following a path of modernization which emphasizes technological leap-frogging and creative, appropriate utilization of indigenous resources. With the thoughtful application of innovative technology, overall improvement in productivity can contribute to attaining a number of other important development goals, including greater employment, protection of the environment, and decreased dependence on expensive imported oil.

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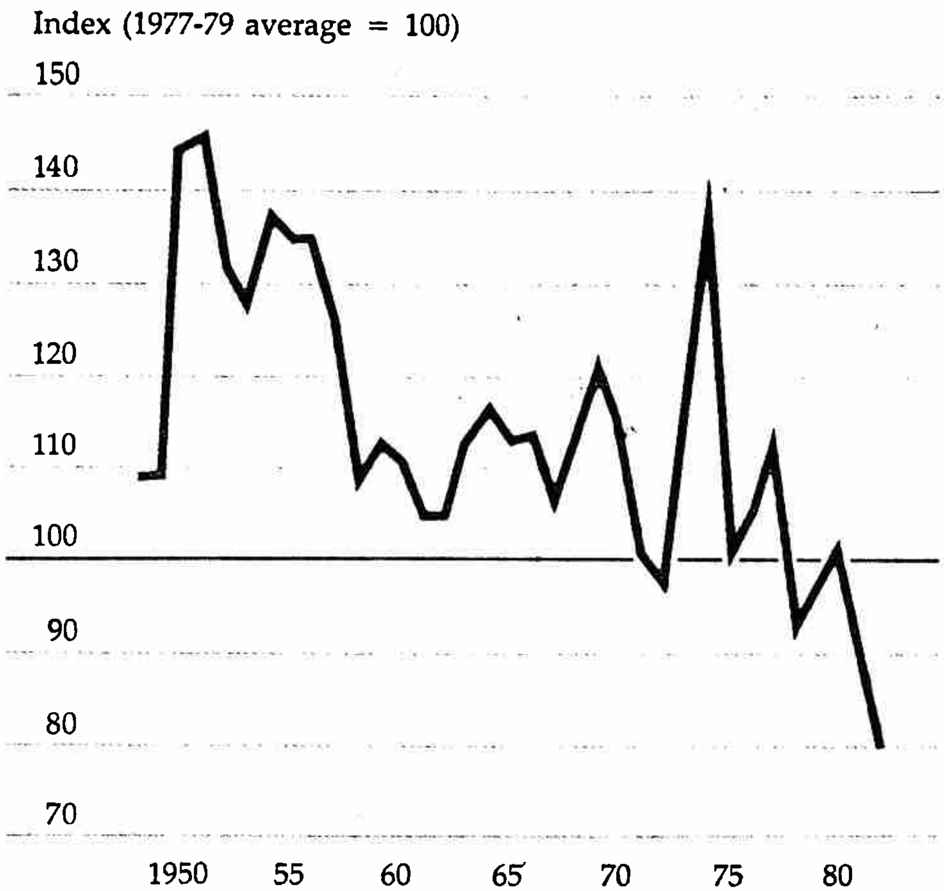
Composite commodity price index, 1948-82

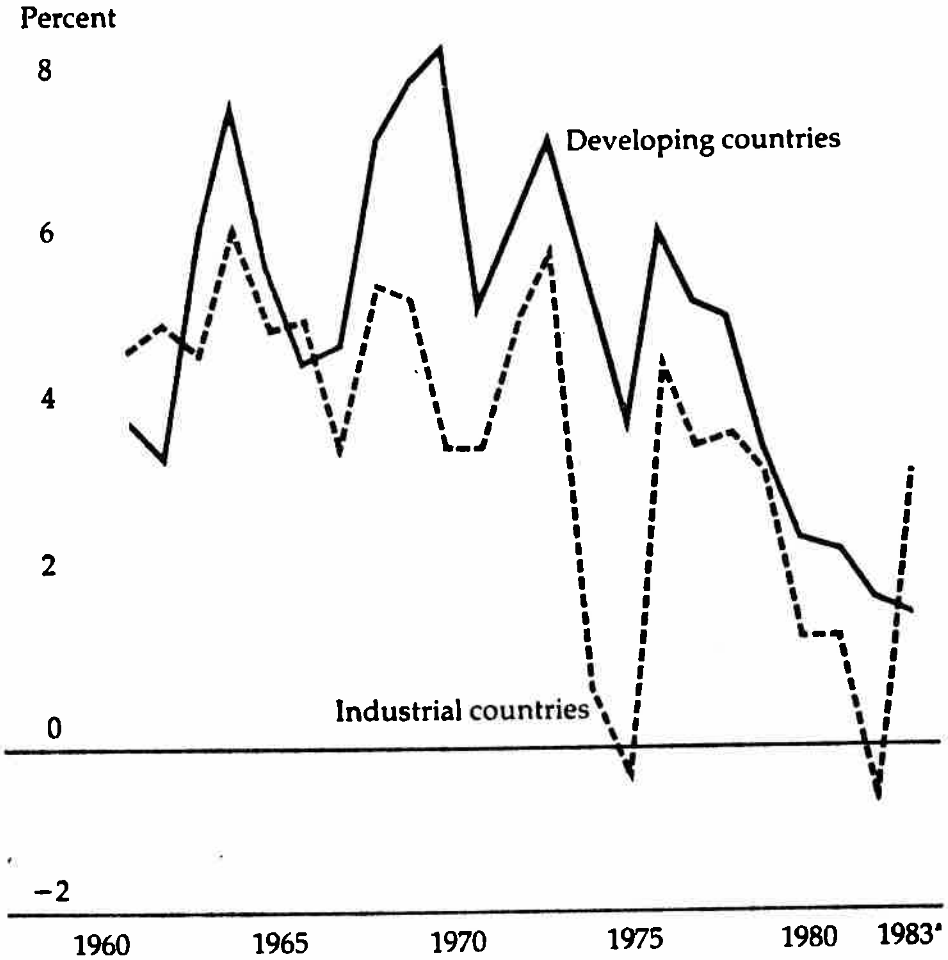


The graph shows non-oil commodity prices as measured by the price of manufactures imported by developing countries. The commodities are coffee, cocoa, tea, maize, rice, wheat, sorghum, soybeans, groundnuts, palm oil, coconut oil, copra, groundnut oil, soybean meal, sugar, beef, bananas, oranges, cotton, jute, rubber, tobacco, logs, copper, tin, nickel, bauxite, aluminum, iron ore, manganese ore, lead, zinc, and phosphate rock.

Figure 1. Source: (5)

FIGURE 2.1

Growth rates of GDP for developing and industrial countries, 1961–83

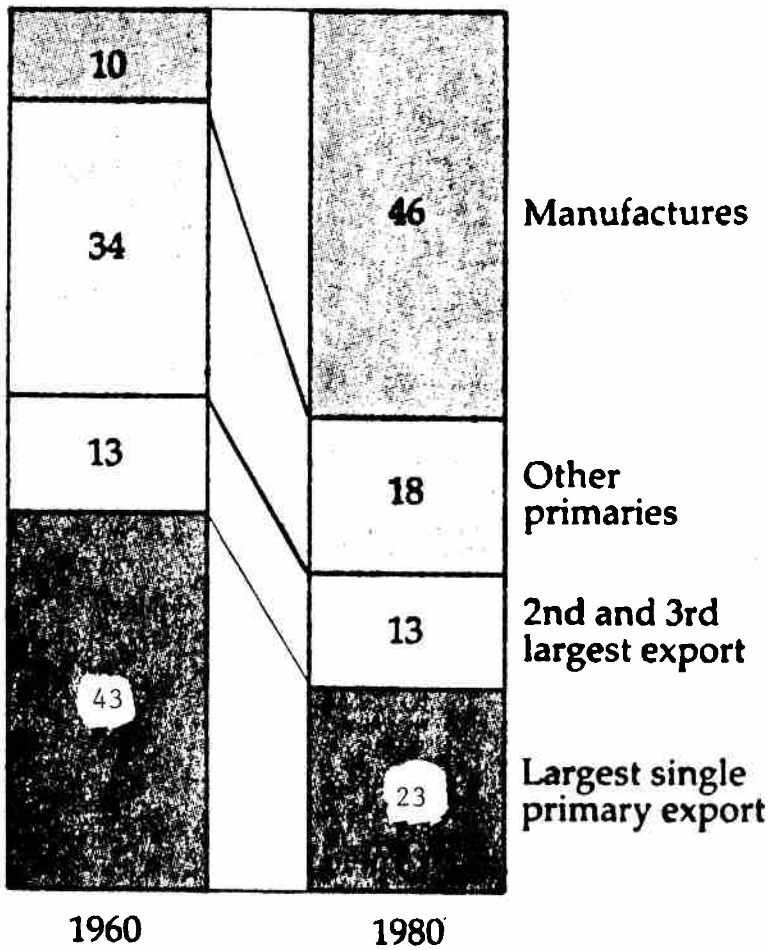


a. Estimated.

Sources: For developed countries, OECD, 1983; for developing countries, World Bank data.

Figure 2. Source (1)

Export structure of selected developing countries (percent)



Excludes major exporters such as Korea, Hong Kong, and Singapore. Includes India, Mexico, Brazil, and Egypt.

Source: Riedel, 1984.

Figure 3. Source: (1)

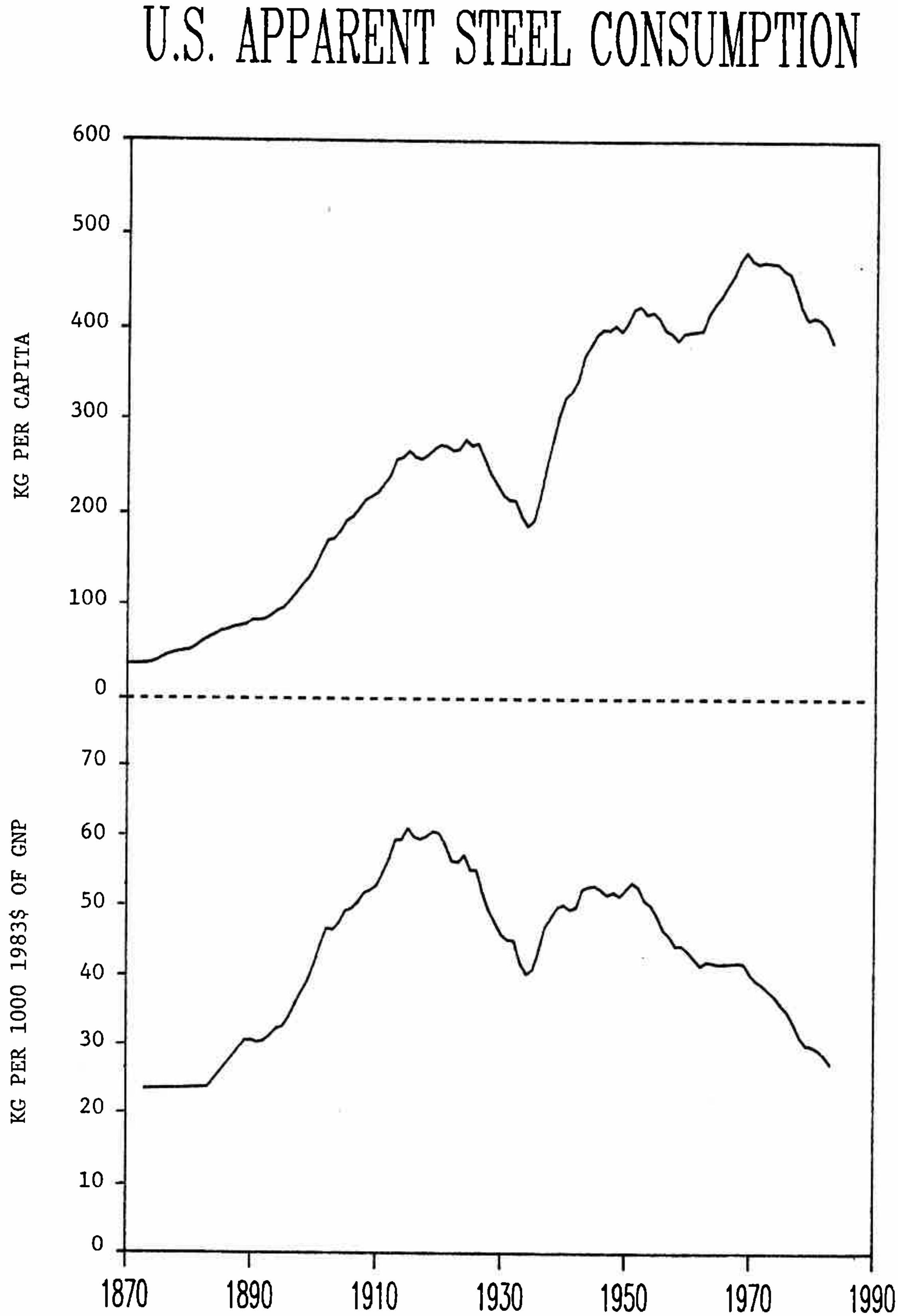
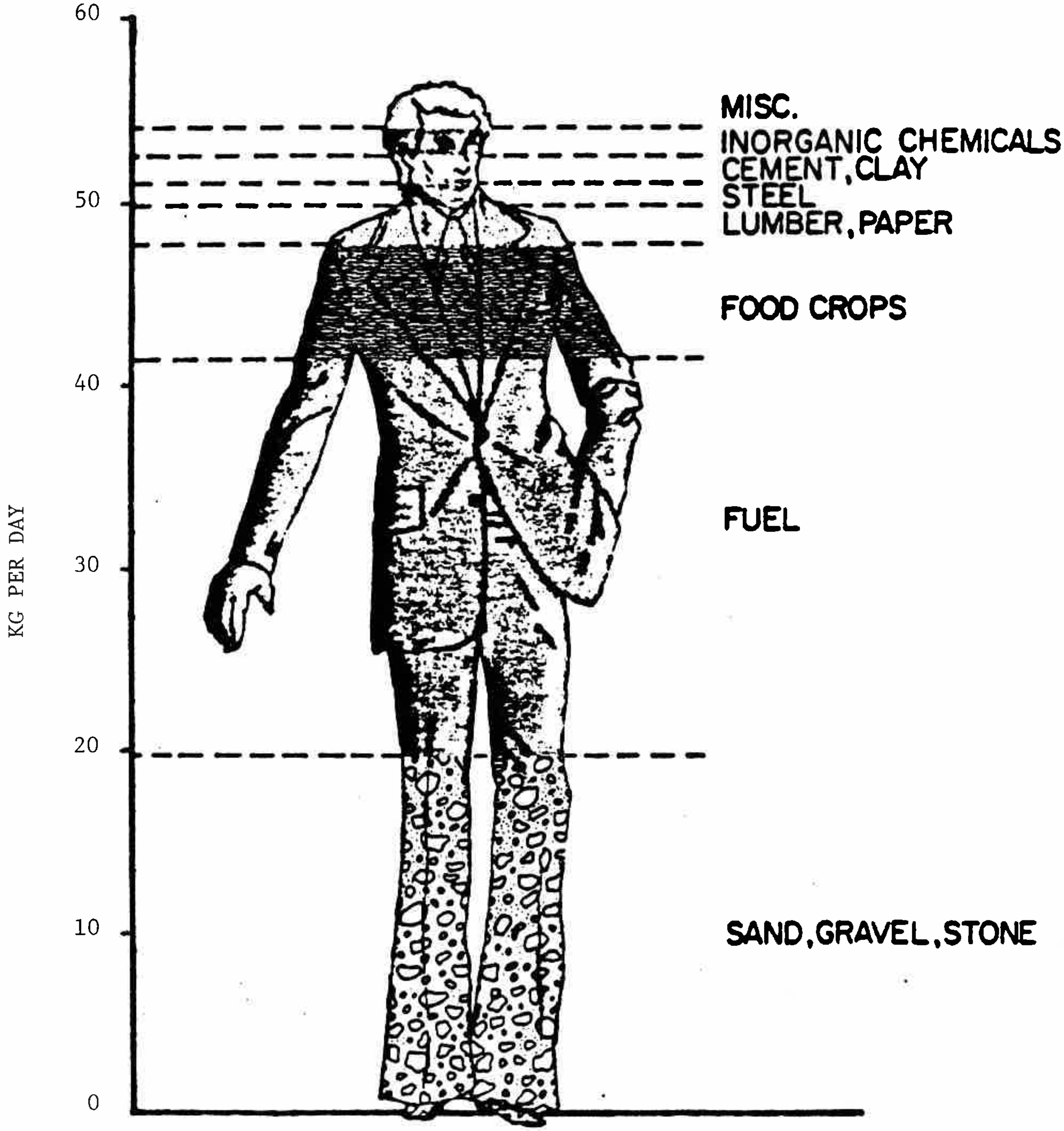


Figure 4. Source: (12)



PER CAPITA CONSUMPTION OF BASIC MATERIALS
IN THE U.S. (1975)

Figure 5. Source: (17)

U.S. APPARENT ALUMINUM CONSUMPTION
AND TOTAL ETHYLENE PRODUCTION

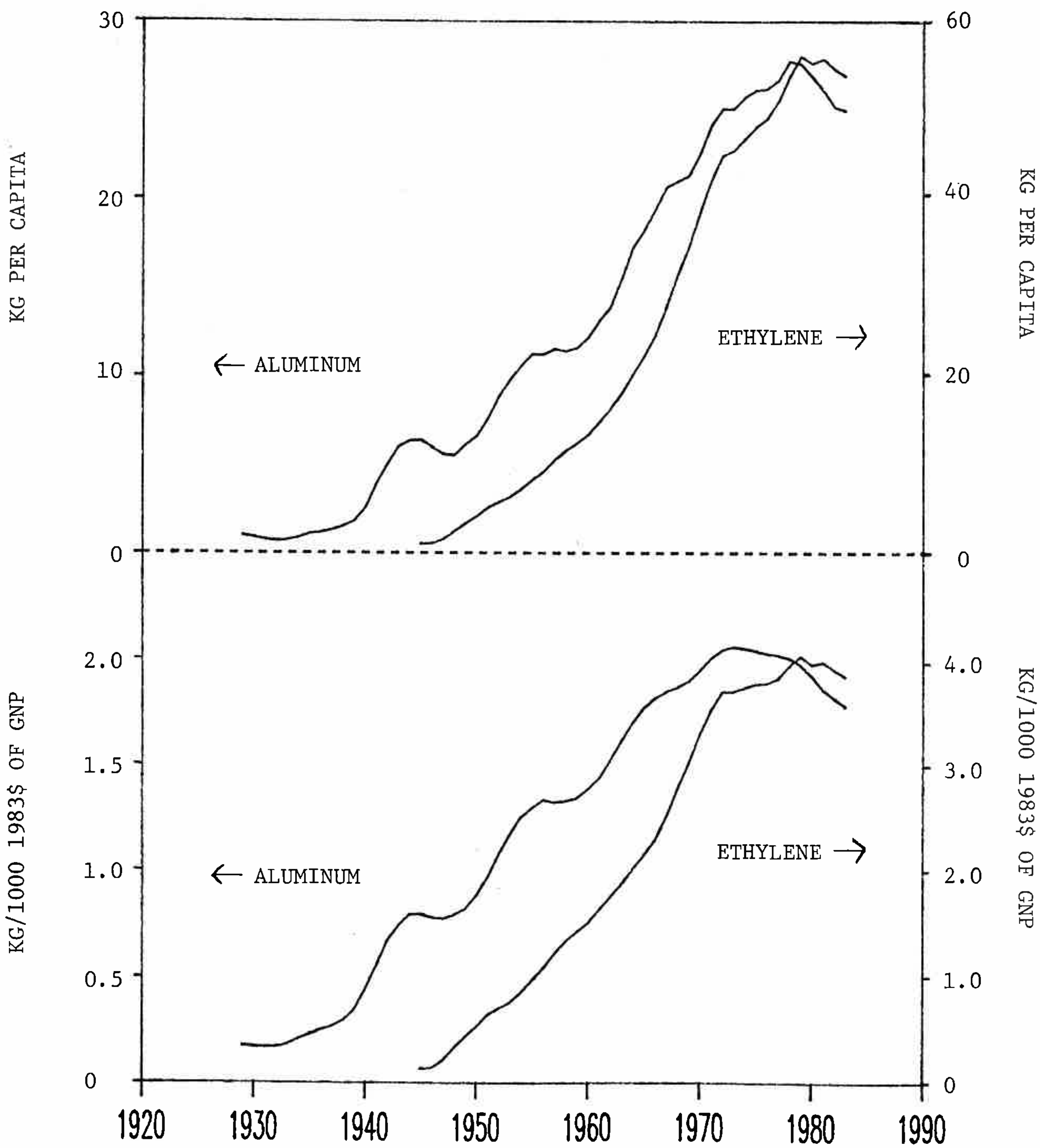


Figure 6. Source: (12)

References

1. World Development Report 1984, Oxford University Press, New York, 1984.

2. "Annual Report of the Council of Economic Advisors," Economic Report of the President, US Govt. Printing Office, Washington, D.C., Feb. 1984.

3. Morrison, T.K., Manufactured Exports from Developing Countries, Praeger Publishers, New York, 1976.

4. United Nations Statistical Yearbook, 1979/80, United Nations, New York, 1981.

5. World Development Report 1983, Oxford University Press, New York, 1983.

6. Chenery, H.B. and Hughes, H., "Industrialization and Trade Trends: Some Issues for the 1970s," Prospects for Partnership: Industrialization and Trade Policies in the 1970s, H. Hughes (ed.), Johns Hopkins University Press, Baltimore, MD, U.S.A., 1973.

7. Goldemberg, J., Johansson, T.B., Reddy, A.K.N., and Williams, R.H., Energy for a Sustainable World, forthcoming book.

8. Berndt, E.R., "Aggregate Energy, Efficiency, and Productivity Measurement," Annual Review of Energy (3), 1978.

9. Hoffman, H.K. and Rush, H.J., "The Impact of Micro-electronics in the Third World: Problems and Potential," Adjustment or Protectionism: The Challenge to Britain of Third World Industrialization, Catholic Institute for International Relations, London, 1980.

10. US Statistical Abstract, 1984, Dept of Commerce, Bureau of the Census, Washington, D.C., December 1983.

11. Historical Statistics of the United States, Colonial Times to 1970, Dept of Commerce, Bureau of the Census, Washington, D.C., 1975.

12. Larson, E., Williams, R.H., Bienkowski, A., "Material Consumption Patterns and Industrial Energy Demand in Industrialized Countries," Center for Energy and Environmental Studies Report 174, Princeton University, Princeton, NJ, U.S.A., December 1984.

13. "Survival in the Basic Industries," Business Week, April 26, 1982.

14. "Steelmakers Put Emphasis on Efficiency," The New York Times, December 29, 1983.

15. "Steelyard Blues," The Economist, October 13, 1984.

16. Vais, J., Director of Economic and Marketing Research, Kaiser Aluminum and Chemical Co., Oakland, CA, U.S.A., personal communication, October 1984.

17. Ross, M. "The Export of Energy Consumption," to be published by Cambridge Energy Research Associates, Cambridge, February 1985.

18. Berg, C.A., "Energy Conservation in Industry: The Present Approach, The Future Opportunities," prepared for the Council on Environmental Quality, Washington, D.C., May 1979.

19. Socolow, R.H., "Resource-Efficient High Technology, Basic Human Needs, and the Convergence of North and South," Center for Energy and Environmental Studies Working Paper No. 56, Princeton University, Princeton, NJ, U.S.A., April 1982.

20. Marsden, K., Trade and Employment Policies for Industrial Development, World Bank, Washington, D.C., 1982.

21. Geller, H., "Ethanol from Sugarcane in Brazil," Annual Review of Energy (10), 1985 (in press).

22. Hyde, C.K., Technological Change and the British Iron Industry, 1700-1870, Princeton University Press, Princeton, NJ, U.S.A., 1977.

23. "Florestal Acesita, Man-Made Forests for Wood and Charcoal in Brazil," Florestal Acesita S.A., publication, Belo Horizonte, Brazil, October 1983.

24. Rodrigues de Almeida, M., Florestal Acesita S.A., Belo Horizonte, Brazil, presentation at the Second End-Use Oriented Global Energy Policy Workshop, Sao Paulo, Brazil, June 1984.

25. "CESP Methanol Program," Sao Paulo State Energy Company briefing memorandum, Sao Paulo, Brazil, February 1984.