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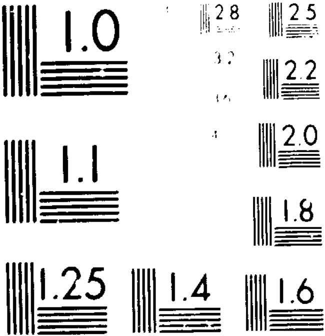
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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

INDUSTRIAL PROCESSING OF NATURAL RESOURCES

UNITED NATIONS

INDUSTRIAL PROCESSING OF NATURAL RESOURCES

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna

INDUSTRIAL PROCESSING OF NATURAL RESOURCES

UNITED NATIONS
New York, 1981

ID/261

UNITED NATIONS PUBLICATION

Sales No. E.81.II.B.1

Price: $US 5.00

EXPLANATORY NOTES

A comma (,) is used to distinguish thousands and millions.

A full stop (.) is used to indicate decimals.

References to dollars ($) are to United States dollars, unless otherwise stated.

References to "tons" (t) are to metric tons, unless otherwise specified.

The following abbreviations are used in this report:

CES	constant elasticity of substitution
CMEA	Council for Mutual Economic Assistance
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
NTB	non-tariff barrier
OECD	Organization for Economic Co-operation and Development
RBI	resource-based industrialization
SITC	Standard International Trade Classification (Revised)
TNC	transnational corporation
UNCTC	United Nations Centre on Transnational Corporations

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I. Resource-based industrialization: rationale and concepts

The Lima Declaration and Plan of Action on Industrial Development and Co-operation, proclaimed at the Second General Conference of the United Nations Industrial Development Organization (UNIDO) held in Lima in 1975, called for 25 per cent of world industrial production to be located in developing countries by the year 2000. Many strategies for industrial development have been proposed to help developing countries move towards this ambitious target. One strategy calls for the higher stages of industrial processing of natural resources, currently exported from developing countries in unprocessed or semi-processed form, to be established in those countries. This study examines the economic rationale for such a strategy, and analyses policy options open to Governments that adopt it.

The strategy of a country basing its industrial development partially or completely on the higher stages of processing its natural resources is derived from the knowledge that considerable industrial value added is generated by producers engaged in such activities, and from the belief that they can be competitively located in the countries where the natural resources are available.

With varying degrees of disappointment, many developing countries are turning from the other policies they have been pursuing. Protectionist doors are closing in the faces of those who chose in the late 1960s and 1970s to base their economies upon a high rate of growth of manufactured exports. Raw material exporting countries are experiencing just as much volatility in the real prices of their commodities as before the 1973 prices boom. At present, real commodity price indices show sharp falls even from 1977 levels. In part, then, the renewed interest in what has come to be called resource-based industrialization (RBI) derives from dissatisfaction with recent alternative experience.

In different countries, a variety of specific reasons serve to explain the present interest in RBI. Policy-makers in some developing countries expect fundamental shifts in the location of processing activities as a result of impending technological changes. The introduction of continuous casting, for example, will affect the copper, iron and steel, and aluminium industries. By making possible lower minimum efficient scales of production, such processes can remove some of the obstacles which have hampered attempts by developing countries to process their raw materials to a greater extent.

On the other hand, it is precisely the problems associated with current technologies that lead some policy-makers in developing countries to anticipate increased participation in processing. The growing hostility of pressure groups and public opinion in developed countries to various types of pollution associated with processing suggests that some developing countries may become increasingly attractive sites for the more dangerous or obnoxious process. Rising demand is also a significant factor. Some analysts expect that demand for non-fuel minerals will roughly double during the period 1979-1989, and that three times the present level of output may be required if world population reaches 6 billion by the year 2000.

Elements of RBI are currently being advocated in various countries in an effort to promote widespread industrialization based on hydrocarbons. Several Middle East countries are beginning substantially to increase their capacity in refining and petrochemicals, with a view to diversifying their exports, hitherto largely confined to crude petroleum.

A further incentive to RBI stems from the fact that many Governments consider control over natural resources an essential component of their development effort. The extent of involvment of transnational corporations in the processing of raw materials is central to this issue.

The concept of industrial processing of natural resources

Traditionally, industrial development is viewed from what may be called a "horizontal perspective", that is, attention is focused on the various activities as they relate to the final goods and services produced by the industrial branch. An examination of manufacturing in terms of light and heavy industry or consumer, intermediate and capital goods is a useful way of depicting industrial progress. In this perspective, however, the different activities within a given industrial branch cannot be distinguished. An examination of industrial processing of natural resources, however, requires a "vertical perspective", that is, activities must be examined according to their stage of processing, for example, primary, semi-finished and finished goods, rather than according to the characteristics of the final product (e.g. chemicals, furniture etc.)

Differences in the manufacturing structure of the industrialized and the semi-industrialized countries are not fully explained by the fact that the production of certain industrial branches takes place in the former economic grouping but not in the latter. Industrial activities are usually reported in the same industrial branches in both developed and developing countries. It is important to ascertain the extent to which one set of processing activities is conducted in a developed country while a different set of activities is performed in the same branch in a developing country. Thus, the pattern of industrial processing, and not only the presence or absence of a particular industrial branch, becomes a distinguishing feature of developed and developing countries. Investigation according to a vertical instead of a horizontal arrangement of industrial activities is helpful in discerning the gap between the two economic groupings.

At a more specific level, most products go through some form of processing chain, either before final use by the consumer, or through use, without physical transformation, as a component in the assembly of a complex product. The notion of a processing chain used here refers to a series of successive stages of processing in which the output of one stage provides the primary, material inputs for the following stage. Most of the literature on processing concentrates on what we define here as a "simple" processing chain in which a raw material goes through a series of processing operations before final use. Such processing methods are applied to oil-seeds, which undergo crushing, extraction and refining before end-use; timber, which in one chain goes through shredding, pulping and then various processes of paper-making; and bauxite, which is crushed and smelted into alumina, and then refined into aluminium ingots for further processing.

While the simple case in which each operation in the processing chain produces one easily distinguishable transformed version of the basic input is that most frequently referred to in literature on the subject, it by no means follows that most processing chains in fact conform to such a pattern. In the simple processing chain each stage involves the performance of only one specific industrial process on the single primary input. There are two common divergences from this method in practice. First, there is what might be called the explosive stage, in which a variety of parallel processes occur, each taking the single primary input through different physical transformations and each resulting in a different end-product. Such explosive stages in a processing chain may obviously have very different degrees of complexity, from, for example, the working-up of timber into various items of furniture to a petrochemicals complex using one feedstock, but producing a wide variety of chemicals as end-products. The second common divergence from the typical simple processing chain might be described as the implosive stage. Here there are several primary inputs, one of which may predominate, and processing combines them into one identifiable output. A third possibility is for a stage in a processing chain to be both explosive and implosive, that is, a variety of inputs are combined and processed in different ways to produce a variety of outputs. That in fact is the most common case in most processing, or manufacturing, activities.

However, even complex explosive and implosive processing chains will usually include a series of stages which conform to the simple chain pattern. Thus, in the case of explosive chains, the basic natural resources may go through a series of processing operations in which they are the only primary resource input before the explosive stage is reached. After that stage, in some cases, the various outputs might then continue along their own simple chains. The processing chains for metals and petrochemicals could be thus characterized. Similarly, in the case of implosive chains, the various resource inputs into the implosive stage may have gone through simple processing chains before reaching that stage. The various inputs into any complex product such as automobiles, airplanes and ships are examples of such chains.

Though there are simple chains in which the end-product to be consumed is only, or predominantly, a homogeneous processed version of one primary natural resource, most chains will contain a subchain of simple processes. This study is restricted to an analysis of simple chains or subchains, although it may be fairly easily adapted to complex stages in explosive and implosive chains.

In most discussions of the location of processing capacities the list of economic determinants is broken down into sets. The choice of factors is nearly as arbitrary as the definitions given to the concept of processing itself. Thus, the establishment of a typology of independent variables to explain *ex post* and to predict *ex ante* the location of international processing activities is not without pitfalls. The choice of a typology is beset by two major difficulties. The first is the hegemony of the transnational corporations (TNCs). To the extent that a TNC is influential in the market for a particular commodity, in its mining, refining, transport, processing, marketing or indeed in the whole range of commodity-related activities, certain economic factors become the responsibility of the TNC. For instance, a TNC that already owns substantial refining capability in the copper industry would be reluctant to accelerate the obsolescence of home-sited plants just to take advantage of a marginal shift in costs favourable to a developing country site. Two points are involved here. The first is that minimal levels of investment in processing facilities are often extremely large. The capital costs of an aluminium smelter, for instance, are

200-220 million dollars. Capital values of such magnitude cannot be easily written off. That is particularly the case where government grants are available to accelerate depreciation, reduce profits tax, or provide outright capital assistance. The automobile assembly industry provides an example of competition within a developed country for the final stage of a manufacturing process. However, the willingness of Governments, for a variety of political and economic reasons, to underwrite the creation of new car assembly capacity must delay access of developing country suppliers in the market. The internal decision-making processes of TNCs must also be considered. The whole subject of TNC decisions, and the extent to which they differ from the decisions of firms which are not TNCs, cannot be entered into here. It should be noted, however, that theories of management decision-making, including approaches other than profit or sales maximization, will produce results different from strict profit maximization with no entrepreneurial freedom as outlined in neoclassical firm theory.

The second difficulty encountered in the construction of a typology is that the concept of comparative advantage is a portmanteau term. Some economists have attempted to deal with it separately from other criteria such as capital, skilled labour, input availability etc. But if the theory of comparative advantage is to be a useful indicator of production capacity, and if results such as the Leontieff paradox are not to arise, definitions more precise than the simple distinction between labour and capital must be employed.

In the following section, the involvement of developing countries in raw materials processing is reviewed. Such a review should provide a basis for an assessment of various factors relating to the theory of comparative advantage.

Involvement of developing countries in processing activities

This section reviews the progress that developing countries have made in diversifying the composition of their exports out of unprocessed raw materials. There are, of course, many different means of assessing such progress. No single indicator is in itself adequate. The review therefore begins by considering various macro-economic indicators and then goes on to examine individual commodities in more detail. The simplest indicators are the share of developing countries in all international trade, which is best shown as a matrix of trade flows between blocs of countries, and the share of commodities in the total exports of that economic group. The total exports can then be refined to show how the proportions differ between continents and by degree of processing.

The overriding characteristic of world trade since the mid-1950s has been the falling share of trade in non-fuel primary products. During the period 1955-1976, it fell from 42 per cent to 21 per cent of total world trade. There was a corresponding increase in the share of manufactures, from 45 per cent to 57 per cent, and a doubling in the share of fuels, from 11 per cent to 20 per cent.

Turning from world trade to the exports of developing countries, total exports in various categories are shown in table 1. It is useful to distinguish here between total export earnings and non-petroleum earnings. Overall, the share of manufactured goods rose from 9.6 per cent in 1960 to 21.3 per cent in 1973. By 1976 they had fallen back slightly to 17.3 per cent. Nevertheless, in absolute terms those exports

TABLE 1. COMPOSITION OF THE MERCHANDISE TRADE OF DEVELOPING COUNTRIES IN SELECTED YEARS

	Exports				Imports			
Item	*1960*	*1970*	*1973*	*1977*	*1960*	*1970*	*1973*	*1977*
	Billions of dollars							
Primary commodities	24.6	42.1	85.7	237.9	11.1	16.3	32.7	81.3
Non-oil commodities[a]	17.0	26.2	42.6	73.5	8.2	12.1	22.9	42.2
Petroleum[b]	7.6	15.8	43.1	164.4	2.9	4.2	9.8	39.1
Manufactures[c]	2.6	9.6	23.1	49.6	17.1	38.9	68.7	167.2
Total exports and imports	27.2	51.6	108.8	287.5	28.0	55.2	101.4	248.6
Total non-oil exports and imports	19.6	35.8	65.7	123.1	25.1	51.0	91.5	209.4
	Percentage							
Primary commodities including oil	90.4	81.6	78.8	82.7	38.8	29.5	32.2	32.7
Non-oil primary commodities	62.3	51.0	39.2	25.6	28.4	21.9	22.5	17.0
Petroleum	28.1	30.6	39.6	57.2	10.4	7.6	9.7	15.7
Manufactures	9.6	18.6	21.3	17.3	61.2	70.5	67.8	67.3
	Share in non-oil exports				*Share in non-oil imports*			
Primary commodities	86.7	73.2	64.8	59.7	31.7	23.7	25.0	20.2
Manufactures	12.9	26.8	35.2	40.3	68.3	76.3	75.1	79.8

Source: UNIDO, based on data supplied by the United Nations Statistical Office and the *Monthly Bulletin of Statistics*, various issues.

[a]SITC 0 to 4 and 68 (non-ferrous metals).

[b]SITC 3.

[c]SITC 5 to 8, excluding 68 (non-ferrous metals).

rose from $23.1 billion to $49.6 billion during the 1973-1977 period. Excluding oil from primary commodity earnings, the share of manufactured goods rose from 12.9 per cent in 1960 to 35.2 per cent in 1973 and 40.3 per cent in 1976.

For many large developing countries, exports of manufactures are beginning to overtake commodity exports, as the figures in table 1 imply. For instance, in January 1979 Brazilian officials announced that in 1978 the country's export earnings from manufactures had exceeded its primary commodity earnings. Manufactures contributed 52 per cent of earnings while commodity exports were reduced by the very low price of coffee prevailing for much of the year. There is no doubt that Brazil will continue to exhibit substantial growth in manufacturing export earnings.

Another way of assessing the involvement of developing countries in processing is to break down the commodity imports of the developed market economies according to origin and to the amount accounted for by each processed resource. Table 2 contains data for 1979. In that year, developing countries accounted for $39.1 billion worth of imports in the seven categories included, while trade among developed countries amounted to $122.9 billion. The larges single category was food, beverages, tobacco and related items, the same category in which the share of developing countries was highest (47 per cent). The smallest share was recorded in the pulp and paper category (2 per cent). When imports are classified under three headings, processed, semi-processed and unprocessed, the importance of developing countries can be assessed by category. The following three categories predominate in the exports of processed goods to developed market economies (the percentage of goods processed before export is given for each category): fibres, textiles and clothing (52.2 per cent); pulp and paper (49.1 per cent); and hides, leather and leather products (43.4 per cent). In terms of absolute values, however, it can be seen that the fully processed goods are worth comparatively little, accounting for only $5.9 billion, or 15 per cent, of total developing country exports of $39.1 billion. Considered in absolute dollar terms, unprocessed goods still dominate the trade flow, accounting for $22.1 billion, or 57 per cent, of the total. Very roughly, the ratios of developing country exports that are processed, semi-processed and unprocessed are 1:2:4. By contrast, developed market economy imports of products in the seven above-mentioned categories from other members of the same economic grouping show a ratio very close to 1:1:1 (processed goods imports worth $45.2 billion, followed by semi-processed goods valued at $42.1 billion and unprocessed goods at $35.6 billion). Combining the two sets of values shows that developing countries provided 12 per cent of the processed goods imports of developed market economies, 21 per cent of the semi-processed imports and 38 per cent of unprocessed goods.

Considering the seven categories in more depth reveals those aspects of trade between developing and developed countries that most closely resemble trade among developed countries. The clearest case of similarity is in the food, beverages and tobacco category. Here it is apparent that while 74 per cent of developing country exports to developed market economies are unprocessed, 61 per cent of trade between developed countries is also in unprocessed items. The other category in which developed market economy imports of unprocessed varieties from other developed market economies are also significant is that of leather, leather goods and hides. Here the share of unprocessed imports of developed market economies from other developed market economies is 30.8 per cent.

The distribution of trade outlined above is confirmed when calculations are based on a finer definition of processing chains according to their dominant material

TABLE 2. ANALYSIS OF IMPORTS OF DEVELOPED COUNTRIES IN 1973 IN SELECTED PRODUCT GROUPS BY DEGREE OF PROCESSING

Item	*Import values (billions of dollars)*			*Imports from developing countries (percentage)*				*Imports from developed countries (percentage)*			
	From developing countries (A)	*From developed countries (B)*	*A/B*[a]	*Unprocessed*	*Semi-processed*	*Processed*	*Total*	*Unprocessed*	*Semi-processed*	*Processed*	*Total*
Food beverages, tobacco, etc.	17.8	37.9	0.47	74.4	22.6	3.0	100.0	61.0	28.1	10.8	100.0
Hides, leather and products	1.5	4.6	0.33	22.7	33.9	43.4	100.0	30.8	22.3	46.9	100.0
Rubber and products[b]	1.2	3.7	0.32	89.1	0.4	10.6	100.0	19.3	10.3	70.5	100.0
Wood and mechanical wood products[c]	4.0	9.5	0.42	56.8	38.3	4.9	100.0	16.0	58.0	26.0	100.0
Pulp, paper, etc.	0.2	11.7	0.02	–[d]	50.8	49.2	100.0	–[d]	73.3	26.7	100.0
Fibres, textiles and clothing[e]	7.1	21.6	0.33	25.1	22.7	52.2	100.0	20.5	40.4	39.1	100.0
Ores and metals	7.3	33.8	0.22	47.0	45.1	7.9	100.0	12.5	21.4	66.0	100.0
Total	39.1	122.9	0.32	56.6	28.2	15.2	100.0	29.0	34.1	36.8	100.0
	Value *(billions of dollars)*			22.1	11.0	5.9	39.1	35.6	42.1	45.2	122.9

Source: UNCTAD, "Processing of primary products in developing countries: problems and prospects", 13 April 1976.

[a] The ratio represents the relative importance of imports from developing countries compared with those from developed countries.

[b] Including synthetic rubber.

[c] Including conifers as well as non-conifers.

[d] Pulpwood trade is insignificant and therefore ignored.

[e] Including artificial and synthetic products.

input[1] or when industrial characteristics (e.g. machinery) are considered. Since no readily available trade classification was suitable for this purpose, an *ad hoc* scheme had to be designed. The following 21 product groups were analysed:[2]

Live animals	Leather and furs
Meat	Rubber
Dairy products	Wood and cork
Fish	Glass
Cereals	Textiles
Fruit and vegetables	Non-metallic minerals
Sugar	Metals
Coffee, tea, cocoa	Chemicals
Pulp and paper	Other goods
Tobacco	Metal products and machinery
Animal and vegetable oils and fats	

The specific products included in each group were then arranged according to six processing stages in increasing order of importance:

1. Raw material
2. Processed raw material
3. Semi-processed product
4. First transformation or raw finished product
5. Second transformation or simple finished product
6. Complex finished product

To some extent the grouping of products as well as the distribution of processing stages required that several arbitrary decisions be made. The results should therefore be regarded as tentative and preliminary. At the present exploratory stage, however, the heuristic value of the classification would seem to outweigh its deficiencies.

Table 3 shows the distribution of the total exports of developed market economies and developing countries for the six processing stages. A comparison of the two economic groupings reveals that exports of raw materials (stage 1) are much more important among developing countries, while exports of complex finished products (stage 6) stand out in developed market economies. At intermediate processing stages (2 through 5) the contrast between the two economic groupings is not so great, but the relative specialization of developing countries in the lower processing stages is confirmed.

In general, the figures in table 3 show that the pattern of exports of developed market economies has remained more stable than that of developing countries. The biggest changes in relative terms was the fall in the share of export earnings derived from processed raw material exports accompanied by an increase in the share of complex finished products. In the case of developing countries, there have been larger changes. The most notable is the substantial fall of about one third in raw material export earnings in 1974. By 1976 that change had levelled out somewhat to give a fall of 25 per cent over the longer period. There were corresponding rises in the contribution of stages 3, 5 and 6.

[1] There may be only one dominant material input in the case of product groups such as wood and cork or rubber. Alternatively, some product groups such as chemicals may require a variety of material inputs.

[2] One group, other goods, is a residual of heterogeneous items. Petroleum, coal and gas products were excluded from the analysis.

TABLE 3. DISTRIBUTION OF TOTAL EXPORTS OF DEVELOPED MARKET ECONOMIES AND DEVELOPING COUNTRIES IN SELECTED YEARS BY PROCESSING STAGE

(Percentage)

	Exports of developed market economies[a]			*Exports of developing countries*[a]		
Processing stage	*1968*	*1974*	*1976*	*1968*	*1974*	*1976*
1. Raw material	12.8	11.8	12.0	54.1	13.3	40.7
2. Processed raw material	7.0	6.7	4.8	8.9	7.8	6.4
3. Semi-processed	7.6	9.0	7.9	6.9	12.6	8.7
4. First transformation	12.1	13.0	10.4	8.1	8.3	7.8
5. Second transformation	9.7	9.7	9.3	6.8	9.9	8.8
6. Complex finished product	50.9	49.9	55.6	15.3	26.1	27.6

Source: Based on data supplied by the United Nations Statistical Office.

[a]For a list of the countries included, see the annex.

The foregoing aggregate export figures may be considered in terms of the 21 product groups listed above. The results are given in table 4. A comparison of the structure of each processing chain reveals only a limited number of instances where the exports of developed market economies were concentrated in the later processing stages while those of developing countries were not. Thus, differences in the processing patterns of developing countries and developed market economies are not the same for all raw material inputs.

Seven product groups may be noted in which developing countries did hold a significant advantage in exporting at later stages in the processing chain. A comparison for textiles is dubious, however, since developing countries specialize at both the raw material and the finished product stages. Thus, developing countries appear to be relatively specialized in downstream activities for six product groups, namely meat, dairy products, pulp and paper, animal and vegetable oils and fats, leather and furs, and glass.[3]

Among the six product groups the highest proportion of exports of finished varieties from developing countries occurs in the case of leather and furs. While approximately one fifth of developing country exports of this type of commodity are totally unprocessed, about two fifths are exported as complex finished products. Major investments are under way in many developing countries to set up large-scale tanning factories, and more capacity in the footwear industry is likely to appear.

Another aspect of the trend towards greater processing in developing country exports is reflected in table 5, which shows how the shares of the first and sixth processing stages changed during the period 1968-1974. It is noticeable that in nearly every case, the share of exports in stage 1 fell. Only in cereals did the importance of stage 1 rise, while for pulp and paper and tobacco the share of stage 1 was unchanged.[4] Among the product groups with the greatest shifts into more intensive processing before export were dairy products, leather and furs, wood and cork and

[3]Together, the six product groups or processing chains represented 12 per cent of the exports of developing countries in 1974.

[4]The export levels for live animals, glass and machinery also remained unchanged because of the definition of the concepts employed.

TABLE 4. DISTRIBUTION OF EXPORTS OF PRODUCT GROUPS FROM DEVELOPED MARKET ECONOMIES (DME) AND DEVELOPING COUNTRIES (DC)[a] BY PROCESSING STAGE IN 1976

(Percentage)

Product groups and economic grouping	*Processing stage*[b]					
	1	*2*	*3*	*4*	*5*	*6*
Live animals						
DME	100	–	–	–	–	–
DC	100	–	–	–	–	–
Meat						
DME	79.4	7.2	–	–	2.1	11.0
DC	70.5	0.3	–	–	3.2	26.0
Dairy products						
DME	12.5	–	–	87.5	–	–
DC	14.5	–	–	85.5	–	–
Fish						
DME	66.0	7.2	–	–	26.8	–
DC	85.0	2.6	–	–	12.4	–
Cereals						
DME	85.3	3.6	–	6.2	0.6	4.3
DC	74.0	20.1	–	2.6	1.0	2.3
Fruits and vegetables						
DME	64.9	3.8	–	18.9	–	12.0
DC	65.4	1.5	–	20.6	–	12.5
Sugar						
DME	1.3	–	34.2	40.6	6.9	17.0
DC	2.3	–	71.1	24.3	0.4	1.9
Coffee, tea, cocoa						
DME	25.5	–	5.9	16.7	13.9	38.0
DC	91.6	–	0.2	3.5	3.8	0.3
Pulp and paper						
DME	0.9	23.0	–	43.5	32.6	–
DC	0.2	14.3	–	19.3	66.2	–
Tobacco						
DME	50.8	–	–	5.4	43.8	–
DC	91.9	–	–	0.8	7.3	–
Animal and vegetable oils and fats						
DME	46.0	9.3	15.7	5.2	18.1	5.3
DC	27.6	0.4	29.0	1.5	39.9	1.6
Leather and furs						
DME	45.0	35.4	0.5	–	6.1	13.0
DC	7.5	47.8	0.0	–	3.9	40.0
Rubber						
DME	0.8	0.4	20.6	12.2	13.6	52.4
DC	92.0	0.2	0.1	0.6	1.2	5.9
Wood and cork						
DME	17.1	44.7	22.0	9.2	7.0	–
DC	49.1	26.1	20.2	2.0	2.6	–

Product groups and economic grouping	*Processing stage*[b]					
	1	*2*	*3*	*4*	*5*	*6*
Glass						
DME	-	6.8	11.5	29.4	36.9	15.4
DC	–	3.1	22.8	13.7	34.5	25.9
Textiles						
DME	12.8	0.8	21.7	27.0	9.6	28.1
DC	17.9	0.1	9.5	17.0	5.4	50.1
Non-metallic minerals						
DME	28.8	–	13.5	25.9	18.7	13.1
DC	40.0	–	36.0	12.0	6.1	5.9
Metals						
DME	11.2	13.5	4.8	23.6	23.9	23.0
DC	41.0	27.7	1.6	8.5	7.8	13.4
Chemicals						
DME	1.3	8.3	44.5	11.9	13.3	20.7
DC	32.5	7.5	21.5	8.4	7.7	22.4
Other goods						
DME	10.2	–	–	3.9	20.2	65.7
DC	18.1	–	–	7.7	28.0	46.2
Metal products and machinery						
DME	–	–	–	–	–	100.0
DC	–	–	–	–	–	100.0

Source: Based on data supplied by the United Nations Statistical Office.

[a] For a list of countries included, see the annex.

[b] The processing stages are as follows:

1. Raw material
2. Processed raw material
3. Semi-processed product
4. First transformation or raw finished product
5. Second transformation or simple finished product
6. Complex finished product.

textiles. As for the share of stage 6, it can be seen that gains occurred in 12 out of the 14 categories in which the share of stage 6 was not zero by definition. In the case of leather and furs, the rise was quite spectacular, from 3.6 per cent in 1968 to 50.6 per cent by 1974.

Trade in minerals and metal products is treated separately here, largely on grounds of convenience, since the end-products of a small group of basic ores and minerals are extremely numerous, and generalization about trends in developing country involvement in the processing of those commodities is hazardous. To set the following discussion in context, it should be noted that mineral products as a whole represent a substantial fraction of the export earnings of developing countries. As table 6 shows, in 1960 the contribution of nine major minerals was 15 per cent, by 1970 it had risen to 23 per cent, and in 1976 it amounted to 18 per cent of total primary commodity earnings. Together those nine minerals account for about 80 per cent of the total mineral exports of developing countries (excluding fuels).

TABLE 5. SHARE OF EXPORTS BY PRODUCT GROUP AT THE FIRST AND LAST PROCESSING STAGES FOR SELECTED DEVELOPING COUNTRIES[a] IN 1968 AND 1974

(Percentage)

	Processing stage			
	Raw material		*Complex finished product*	
Product group	*1968*	*1974*	*1968*	*1974*
Live animals	100.0	100.0	0.0	0.0
Meat	60.6	59.1	32.1	32.7
Dairy products	19.8	7.5	0.0	0.0
Fish	83.3	80.7	0.0	0.0
Cereals	58.1	64.5	1.0	1.1
Fruit and vegetables	68.3	66.5	13.2	14.3
Sugar	0.7	0.5	0.8	0.5
Coffee, tea, cocoa	95.5	84.2	0.1	1.1
Pulp and paper	0.0	0.0	0.0	0.0
Tobacco	91.0	91.0	0.0	0.0
Animal and vegetable oils and fats	30.6	29.0	1.4	1.5
Leather and furs	61.9	15.5	3.6	50.6
Rubber	97.8	94.0	1.3	3.5
Wood and cork	55.0	37.8	0.0	0.0
Glass	0.0	0.0	13.5	21.3
Textiles	47.5	25.9	26.9	42.1
Non-metallic minerals	52.5	41.3	4.4	4.5
Metals	47.9	35.8	8.2	12.1
Chemicals	25.9	16.3	23.2	25.3
Other goods	24.2	15.5	33.7	49.1
Metal products and machinery	0.0	0.0	100.0	100.0

Source: Based on data supplied by the United Nations Statistical Office.

[a]For a list of the countries included, see the annex.

TABLE 6. EXPORT EARNINGS OF DEVELOPING COUNTRIES FROM MAJOR NON-FUEL MINERALS IN SELECTED YEARS

(Millions of dollars)

Commodity	*SITC revision 2*	*1960*	*1970*	*1975*	*1976*
Bauxite, alumina and aluminium		187	582	1 123	1 188
Bauxite	287.31	111	211	396	495
Alumina	287.32	57	259	511	403
Aluminium	684.1	19	112	216	290
Copper	287.1, 682.1	960	2 887	2 849	3 536
Iron ore	281	475	1 044	2 166	2 250
Lead	287.4, 685.1	92	133	176	173
Manganese ore	281.7	121	97	232	242
Nickel	287.2, 683.1	20	190	352	320
Phosphate rock	271.3	136	214	1 598	927
Tin	287.6, 687.1	445	631	993	1 217
Zinc	287.5, 686.1	79	131	400	482
Total (non-fuel minerals)		2 515	5 909	9 889	10 335
Total (primary commodities)		16 700	25 300	48 800	57 570
Proportion of non-fuel minerals		15%	23%	20%	18%

Source: World Bank, *Commodity Trade and Price Trends* (1978).

In a number of countries mineral exports are important components of gross domestic product (GDP). Exports of non-fuel minerals regularly contribute 25 per cent or more to the GDP of Bolivia, Gabon, Liberia, Mauritania, Suriname and Zambia, and 10-25 per cent in Chile, Guinea, Guyana, Indonesia, Jamaica, Mexico, Sierra Leone and Zaire.

Trade in ores and derived metal goods has also been analysed for the year 1973. The results are shown in table 7. Trade with developing countries among developed market economies was not far from equilibrium in that year. Overall, developed

TABLE 7. TRADE IN 1973 OF DEVELOPED MARKET ECONOMY COUNTRIES AMONG THEMSELVES AND WITH DEVELOPING COUNTRIES IN ORES, METALS AND METAL MANUFACTURES (SITC 281, 283, 67, 682-689)

(Millions of dollars)

	Trade of developed market economy countries with developing countries				*Trade among developed market economy countries*			
	Imports		*Exports*		*Imports*		*Exports*	
Degree of processing	*Value*	*Percentage*	*Value*	*Percentage*	*Value*	*Percentage*	*Value*	*Percentage*
Unprocessed								
Iron ore and concentrates	1 794	24.5	3	–	2 083	6.2	1 262	3.9
Non-ferrous ores and concentrates	1 648	22.5	37	0.5	2 147	6.4	1 794	5.6
Subtotal	3 442	47.0	40	0.5	4 230	12.6	3 056	9.5
Semi-processed								
Pig iron	42	0.6	23	0.3	266	0.8	254	0.8
Ferro-alloys	279	3.8	24	0.3	463	1.4	531	1.7
Crude steel	52	0.7	686	8.6	1 484	4.4	1 948	6.1
Blister copper	293	4.0	–	–	39	0.1	118	0.4
Refined copper	1 305	17.8	93	1.2	1 520	4.5	1 086	3.4
Alumina	286	3.9	53	0.7	303	0.9	324	11.0
Aluminium	176	2.4	131	1.6	1 094	3.2	1 118	3.5
Other unwrought non-ferrous metals	867	11.8	207	2.6	2 072	6.1	2 032	6.3
Subtotal	3 300	45.1	1 217	15.3	7 241	21.4	7 411	23.1
Processed								
Rolled steel	276	3.8	4 264	53.5	12 470	36.9	11 921	37.2
Worked copper	32	0.4	237	3.0	1 386	4.1	1 356	4.2
Worked aluminium	26	0.4	214	2.7	1 113	3.3	1 117	3.5
Other worked non-ferrous metals	6	0.1	49	0.6	262	0.8	285	0.9
Subtotal	340	4.6	4 764	59.8	15 231	45.1	14 679	58.8
Metal manufactures	244	3.3	1 946	24.4	7 064	20.9	6 884	21.5
Total	7 326	100.0	7 967	100.0	33 766	100.0	32 030	100.0

Source: UNCTAD, "Processing of primary products in developing countries: problems and prospects", 13 April 1976.

market economies imported $7,326 million worth of ores and metal items from developing countries, and their exports of such products to those countries were valued at $7,967 million.

The trade by degree of processing was, predictably, very asymmetrical. The exports of developing countries were dominated by unprocessed (47 per cent) and semi-processed (45.1 per cent) goods. Their exports of processed goods, valued at $340 million, accounted for only 4.6 per cent of their exports. By contrast, the exports of developed market economies to developing countries were dominated by processed goods (59.8 per cent). Semi-processed (15.3 per cent) and wholly processed (0.5 per cent) goods were far less important. Another comparison reveals that trade among developed market economies is also dominated by trade in fully processed goods. Trade in unprocessed goods was only 12.5 per cent of total imports and 9.5 per cent of total exports.

The figures show that refined copper is the single most valuable export from developing countries to developed market economies among the categories considered, accounting for nearly 18 per cent of all export earnings from ores and metals. On the other hand, the single most valuable export from developed market economies to developing countries is rolled steel, which represented over half the value of their exports.

Summary of trends

The relative importance of primary products in global trade has fallen sharply since the 1950s, from 42 per cent in 1955 to 21 per cent in 1976. For developing countries also, the predominance of the trade flow of primary products has been reduced, falling by one half by 1976. Correspondingly, the importance of manufactured goods has risen rapidly, although the recent upsurge in exports of such goods has in fact been dominated by a handful of developing countries. In 1974 almost one half of the exports of developed market economies were complex finished goods, whereas only 21 per cent of developing country exports were in that form. The bulk of developing country exports, 61.5 per cent, belonged to the first three of the six processing phases identified above. However, that figure reflects an improvement since 1968, when 69.9 per cent of developing country exports belonged to the first three processing stages.

Developing countries have, in general, established a much wider involvement in downstream processing activities, especially with regard to meat and dairy products, pulp and paper, oils and fats, glass and leather and furs. Indeed, approximately 40 per cent of developing country exports of leather and furs are now fully processed items. Between 1968 and 1974 the share of complex finished goods in the total exports of a sample of 19 developing countries rose from 15.3 per cent to 26.1 per cent. By 1976, with a slightly different sample the figure reached 27.6 per cent. However, the distribution remains bipolar, with the weight of exports still being concentrated in the first category, and the second biggest share being in manufactures.

One conclusion is that specialization at early stages in certain processing chains cannot be explained by the inability of developing countries to export more elaborate products. Rather, the barriers to domestic processing are more likely to be associated with problems specific to each chain or product group.

II. Determinants of the location of processing capacity

The involvement of developing countries in the processing of raw materials having been reviewed, an examination of the economic determinants of the location of processing capacities follows. The factors determining the location of various stages of processing are input availability, conditions of processing and characteristics of output. Input availability is measured by comparative advantage criteria, which are used to assess whether raw materials are present in sufficiently large quantities to justify their being processed *in situ*, whether all the necessary complementary inputs are also present in sufficient quantities, and whether they can be imported at advantageous prices.

The conditions of processing are determined by the technologies used in the processing of raw materials and involve three main aspects. The first is the extent to which economies of scale impede the siting of capacity in developing countries, either because the raw material itself or because other inputs are not sufficiently abundant. The second is the range of technological choice in the industry, or the availability of processing systems that may be used more advantageously in developing countries. The third is the development of technologies, or variants of existing technologies, that may alter some of the circumstances referred to above.

The characteristics of output relate to difficulties that may be encountered in supplying the end-products to the consumers. Various aspects are considered, such as the processed good itself and growth of domestic demand for it, transport problems and costs, and tariff and non-tariff barriers levied on processed or semi-processed items as they move to other markets. The difficulties of marketing and distribution are also raised in the light of the often integrated and oligopolistic conditions of many commodity processing markets. The same questions are dealt with again in a review of secondary or spin-off output created in the process of manipulating the main commodity. Examples of such output include wood shavings and other cuttings left over from sawmilling and acid created by zinc or copper smelting.

Comparative advantage

In practice, the theory of comparative advantage, which continues to be used as a convenient method for determining the location of economic activity, now has to be hedged with numerous theoretical qualifications.

In the neoclassical (Heckscher-Ohlin) tradition, comparative advantage is usually discussed in terms of the relative intensities of two factors of production, labour and capital. Treating labour as undifferentiated and holding all the other factors constant, the countries with abundant supplies of labour are presumed to have a comparative advantage in exporting goods based on the intensive use of labour inputs. There are of course, many inadequacies in such a highly simplified model.[5]

Ricardo's simple dictum about "the principle which determines that wine shall be made in France and Portugal, that corn shall be grown in America and Poland, and that hardware and other goods shall be manufactured in England"[6] is no longer sufficient. In particular, the assumptions that technology is of a homogeneous nature in different countries, and that production is divisible in the sense that economies of scale are minimal, are not appropriate.[7] Nowadays, "it is obvious that both the ability to produce superior products and the possession of superior technology constitute sources of comparative advantage in trade additional or alternative to comparative advantage based on relative factor abundance".[8] However, it is useful to see what the neoclassical approach would predict about resource-based industries. In a study carried out in 1976, a set of labour and capital coefficients were collected for typical countries at various income levels from $200 to $4,600 *per capita.*[9] Of Ricardo's 30 sectors, 8 correspond to industries considered as resource processers in this study: wood and cork, primary metal processing, industrial chemicals, fertilizers, rubber, metal products, paper, and petroleum refining. Not surprisingly, among those sectors, wood and cork consistently rank highest in labour and lowest in capital intensity for countries at all income levels (see table 8). On the other hand, primary metal processing is labour intensive and of median capital intensity. As expected, other industries are all of below-median labour intensity and above-median capital

TABLE 8. RANKING OF RESOURCE-BASED SECTORS BY FACTOR INTENSITY AT VARIOUS LEVELS OF GNP *PER CAPITA*

	Labour coefficient at various levels of GNP				*Capital coefficient[a] at various levels of GNP*			
Sector	*$200*	*$500*	*$1 500*	*$4 600*	*$200*	*$500*	*$1 500*	*$4 600*
Wood and cork	420	350	230	80	0.76	0.76	0.76	0.76
Primary metal	290	250	200	60	0.92	0.92	0.92	0.92
Industry chemicals	140	110	70	20	1.14	1.14	1.14	1.14
Fertilizer	140	110	70	20	1.82	1.82	1.82	1.82
Rubber	120	110	90	60	0.70	0.70	0.70	0.70
Metal products	120	120	120	60	1.01	0.96	0.81	0.75
Paper	110	110	110	70	0.93	0.93	0.93	0.93
Petroleum refining	40	30	20	10	1.77	1.77	1.77	1.77
Median sector	145	125	115	50	0.91	0.94	0.92	0.83

Source: J. Stern, "The employment impact of industrial projects: A preliminary report", Discussion Paper No. 14 (Harvard Institute for International Development, April 1976), pp. 22 and 25.

[a]Includes inventory.

[5]For an analysis of the theory of the location of processing activities, see chapter III.

[6]D. Ricardo, *On the Principles of Political Economy and Taxation,* P. Sraffa, ed. (Cambridge 1962), vol. I, p. 133.

[7]H. G. Johnson, *Technology and Economic Interdependence* (London, Macmillan, 1975), pp. 33-34.

[8]*Ibid.*, p. 35.

[9]See J. Stern, "The employment impact of industrial projects: A preliminary report", Discussion Paper No. 14 (Harvard Institute for International Development, April 1976).

intensity. However, rubber, metal products and paper become more labour-intensive in high-income countries, while rubber ranks quite low in capital intensity for all countries. Such data show a clear advantage for developing countries in wood products, a surprising advantage (or at least no strong disadvantage) in primary metals, and the expected clear disadvantage in industrial chemicals, fertilizer and petroleum refining (except in oil-exporting countries with abundant capital). Other industries show ambiguities, particularly a potential factor reversal in going from poor to rich countries, that make judgement difficult. The consistently higher manning requirements (lower labour productivity) in low-income countries should also be noted. In the first four industries listed in table 8, developing countries use five to seven times the manpower per unit of output required in the industrial countries.

The unexpected rankings of industry using average data[10] by income class do not show up in the probably more reliable data on labour coefficients presented for Malaysia, the Republic of Korea and Yugoslavia. Of the 52 sectors of activity in the Republic of Korea, all resource-based industries rank thirty-fourth or lower, except wood products (fifth) and metallic products (thirteenth). But the latter do not include lumber and plywood, which rank 34, or several specified basic metals and their products, which rank close to the bottom. Of the 37 sectors of activity in Malaysia, sawmills rank 14, tyres 17 and ferrous metal products, with half the labour intensity of tyres, rank 22. Non-ferrous metals, industrial chemicals and petroleum refining are the three least labour-intensive industries. The pattern is the same in Yugoslavia, where wood products rank 7, metal products 12 and rubber products 13, but basic metals, paper chemicals and petroleum rank close to the bottom. A study of investment potential in Tanzania[11] showed all resource-based industries except wood products to have capital-labour ratios of 3 to 10 times the average for all industry and labour coefficients of one third to 80 per cent less than average. Except perhaps for wood products and tyres, the data therefore offers little to support a hypothesis that developing countries have a comparative advantage in resource processing on the basis of lower labour costs.

It is not surprising to find that cost information, albeit spotty and ambiguous, does not unequivocally support the case for processing being carried out in developing countries just because of low absolute labour costs. Table 9 summarizes the available evidence. It shows that labour as a a share of total cost is normally by far the smallest of the three cost components. One difficulty with this type of comparison, however, is that a low labour share may simply reflect relatively low wage costs per unit of output sufficient to influence comparative advantage.

The only explicit reference to the costs of skilled manpower in the information compiled in table 9 is for sawmills and plywood. Of the 18 per cent share of labour in total production costs of sawmills in Ghana, 3 per cent went to expatriates and 8 per cent to skilled Ghanaian workers. In the sector of plywood, about one third of the 16 per cent labour costs went to expatriates and another one third to skilled Ghanaians. However, the critical impact of technical and managerial skills is not likely to be seen in their direct costs, but rather in the achievement of more efficient production and high quality output. It is generally accepted that most developing countries lack those skills and need to import them, thus giving a clear advantage to

[10] J. Stern, *op. cit.*

[11] M. Roemer, G. Tidrick and D. Williams, "The range of strategic choice in Tanzanian industry", *Journal of Development Economics*, vol. 3, No. 3 (October 1976).

TABLE 9. APPROXIMATE SHARES OF LABOUR, CAPITAL AND RAW MATERIAL IN TOTAL PRODUCTION COSTS FOR RESOURCE-BASED INDUSTRIES

(Percentage)

Industry	*Raw material*	*Value added*	
		Labour	*Capital*
Copper, refined			
From ore	60	...	...
Aluminium			
Alumina from bauxite	24	10	40
Aluminium ingots			
from alumina	28	13	30
from bauxite	7	16	41
Semi-fabricated products			
from aluminium	43	21	15
from bauxite	3	28	32
Steel			
Pig iron from ore and coal	55-74	2-4	19-30
Crude steel			
from pig iron	65-74	2-5	10-13
from ore and coal	35-55	3-7	24-34
Rolled steel			
from crude steel	55-74	1-4	17-38
from ore and coal	21-30	3-8	40-50
Ammonia from natural gas	22-43	2-6	41-46
Wood products from timber			
Sawmills	32	18	12
Plywood	31	10-16	12-23
Pulp and paper	26	4-6	30-34
Leather			
Corrected grain			
Leather from raw hides	56	9-18	11-17
Quality welted shoes			
from leather uppers, soles etc.	48	5-18	22

Sources: For copper, M. S. Brown and J. Bultler, *The Production, Marketing and Consumption of Copper and Aluminium* (New York, Praeger, 1968), p. 5; for aluminium, N. Girvan, *Foreign Capital and Economic Underdevelopment in Jamaica* (University of the West Indies, 1971), p. 78; for steel, W. Baer, *The Development of the Brazilian Steel Industry* (Nashville, Vanderbilt Press, 1969), p. 124; for ammonia, *Fertilizer Industry, Industrialization of Developing Countries: Problems and Prospects,* Monograph No. 6 (United Nations publication, Sales No. 69.II.B.39, vol. 6), p. 20; for wood products, J. Page, "The timber industry and Ghanaian development", in *Commodity Exports and African Economic Development* (Lexington, Mass., D. C. Heath, 1974), p. 107; K. G. Koehler, "Wood processing in East Kalimantan", *Bulletin of Indonesian Economic Studies,* vol. 8, No. 3 (November 1972), p. 112; National Council of Applied Economic Research, *Paper Industry: Problems and Prospects* (New Delhi, NCAER, 1972), pp. 157-159; for leather, "Draft world-wide study of the leather and leather products industry" (UNIDO/ICIS.45), pp. 77-78 and p. 111.

competing processers in developed countries. One study has noted that, in the case of steel mills, it has taken decades or even a lifetime to acquire managerial skills.[12] The very low productivity in the newer mills is probably due to the fact that there has not been sufficient time to acquire such skills.

Capital costs account for a major part of the total costs of most industries, as shown in table 9. Because capital is more likely than labour to cost the same in different countries, relative capital costs are not subject to the same ambiguities as labour costs. The largest capital shares, from 40 to 50 per cent, are in integrated steel production and petrochemicals (ammonia). Aluminium processing (excluding semi-manufacture) has a 40 per cent share and pulp and paper about one third. Most metal processing is likely to show capital shares of 40 per cent or more, or at least to dominate the non-raw-material costs. The production of ammonia from natural gas appears to follow a similar pattern. When capital costs are such a large fraction of the total, savings on capital charges are important. Cheaper sources of finance in developed countries may sometimes tip the balance in their favour.

High absolute capital costs, as shown in table 10, must also be mentioned. The need to ensure a steady return from the very substantial sums committed to processing plants is likely to have been a dominant impulse behind the vertical integration that now characterizes several commodity processing industries. It can be seen from the table that nickel processing is the most expensive in terms of total operating costs per ton, and that direct reduction steel-making is the cheapest

TABLE 10. INVESTMENT REQUIREMENTS AND COSTS OF RUNNING MINERAL PROCESSING OPERATIONS[a]

Process	*Capital investment (dollars per t of annual capacity)*	*Annual capital charge (dollars per t)*	*Operating costs (dollars per t)*	*Total costs (dollars per t)*
Alumina refining	650	105	54	159
Aluminium smelting	2 700	440	518	958
Copper smelting	2 000	325	220	545
Copper refining	500	81	132	213
Steelmaking[b]				
DR/EF	370	60	110	170
BF/BOF	820	133	110	243
Lead				
Smelting and refining	700	113	132	245
Nickel processing				
Sulphides	8 200	1 340	860	2 200
Laterites	12 000	1 960	1 370	3 300
Tin smelting	8 000	1 300	410	1 710
Zinc smelting	1 600	260	150	410

Source: "Mineral processing in developing countries" (UNIDO/IOD.328), December 1979, p. 81.

[a]All values are averages of 1977 conditions for new projects, expressed in 1978 dollars.

[b]DR/EF = direct reduction/electric furnace; BF/BOF = blast furnace/basic oxygen facility. It should be noted that the DR/EF figures are especially uncertain.

[12]William Johnson, *The Steel Industry in India* (Cambridge, Harvard University Press, 1966), p. 94.

process. Those figures are approximate values, however, and different sources and, in particular, different ways of attributing capital costs to the annual capital charge per ton of output would yield other results.

Finally, developed countries have another advantage. As producers of capital equipment, they have a cost advantage in the price of capital goods, one that is increased by the often poor conditions under which plant construction must take place in developing countries. Partial evidence on the subject is provided by a recent survey of construction costs for petrochemical plants producing basic, intermediate and final products. Costs in developing countries were 25-35 per cent higher than in developed market economies, depending on the type of plant.

Technological change

Some significant changes in minerals processing technology may alter the location of plants in future. Copper, iron and steel, aluminium and also paper are likely to be affected.

One of the most pervasive technical improvements recently has been continuous casting in the metals industries. This process takes molten metal from the final reduction phase of processing and casts it directly into shapes for final use or for subsequent manufacture. In copper, continuous casting from refined copper cathodes results in better quality wire bars which command 30 per cent price premiums on the market. Due to the quality and delicacy of the product, there is a danger that transport will cause damage. Continuous casting must therefore be located near the market and careful control of cathode production requires skilled labour. Since wire bar is the semi-manufacture responsible for about half of copper demand, it has been predicted that continuous casting will take up 70-80 per cent of new mill capacity over the next few years.[13]

One interesting consequence of the emergence of continuous casting techniques in copper is that agencies from two major copper-producing countries, Chile and Zambia, have bought into processing plants in Europe. CODELCO, the national copper company of Chile, took an interest in a new DM 40 million venture to produce wire rods at Emmerich in the Federal Republic of Germany, while some copper companies in Zambia, in which the Government has a majority share-holding, have bought half the equity of a continuous casting rod plant in France. The following three factors were important in those acquisitions: technology can more easily be bought and adapted close to the places where it is produced; closeness to markets for end-products reduces delays in responding to changes in demand patterns; and transport costs are cut.

In the case of both aluminium and steel, continuous casting is likely to increase the attraction of locations in developing countries. Chemical companies are looking for ways of recovering aluminium for the abundant clays found in countries with developed market economies. Some plants are already reported to be using such processes,[14] but costs are still high. Although the objective of the companies engaged

[13] M. Roemer, "Resource-based industrialization in the developing countries: A survey of the literature", paper prepared for UNIDO, 1976, p. 89.

[14] P. K. Rohatgi and C. Weiss, "Technology forecasting for commodity projections: A case study on the effect of substitution by aluminium on the future demand for copper", *Technology Forecasting and Social Change*, vol. II, 1977, pp. 25-46.

in the research is to unfetter themselves from dependence on overseas bauxite supplies, 77 per cent of which are located in developing countries, such work may have the unintended result of allowing firms in developing countries to compete as aluminium metal suppliers, because the recovery methods eliminate the alumina processing phase and lower the scale of operation and the investment needed to reduce the ore to metal.

Although more abundant clays would become sources of aluminium, bauxite should still be the richest source.[15] The second type of research being conducted into aluminium processing is aimed at reducing the inputs to produce each ton of aluminium. Results here are likely to affect smelting primarily, where increased conductivity of the cathode and the electrolytic solution would reduce both power and capital needs.

In the United States of America, rising electricity charges, notably in the Pacific north-west region, where much of the primary aluminium production is carried on, are increasing the attractions of establishing recycling plants, which use only around 5 per cent of the energy consumed by new primary smelters and will increasingly be set up in future.[16]

The shift is already under way in the case of iron. The direct reduction of iron ore into sponge iron, using natural gas instead of coke, was developed in Mexico. The Hojalata y Lamina (HyL) process demands high-grade ore and cheap natural gas, both of which are present in Mexico. The gas is substituted for coal and the sponge iron can be reduced to steel in electric arc furnaces, on a very small scale with varying inputs of scrap. The use of those two inputs may direct comparative advantage towards countries like Mexico and Venezuela, which have both iron ore and natural gas, and also to petroleum producers in the Middle East that have abundant gas and can import ore cheaply.[17] The other attractions of the direct reduction method for developing countries is that it allows economic production at lower levels of operation: in the range of 100,000-500,000 t/a, or around 10 per cent of minimum efficient production using a blast furnace and basic oxygen converter. The ability to operate at initially lower levels of output provides greater flexibility in the building-up of a domestic steel industry.

Direct reduction is increasingly being planned in small steel plants. It is no longer "an interesting technical curiosity full of promise".[18] The attraction of this technique will grow all the more as the installation costs of conventional plants increase. Recent plants in Brazil and the United States (Ohio), have cost respectively $1,700 and $1,400 per ton of output per year. It is hoped that costs will be cut to 60 per cent of conventional costs. A conference held by the United Nations Institute for Training and Research in Mexico early in 1979 undertook to spread information about the technique.

Automatic metal pouring is being improved upon by firms from developed countries in an effort to reduce scrap and labour costs and to meet health and safety improvements. To the extent that this reduces prices or diminishes the advantages of

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[15] S. Brubaker, *Trends in the World Aluminium Industry* (Baltimore, Johns Hopkins University, 1967).

[16] *Chemical Week*, 1 March 1979, p. 29.

[17] T. R. Stauffer, "Energy-intensive industrialization in the Arabian Gulf: A new Ruhr without water?" (Harvard University, Centre for Middle Eastern Studies, 1975).

[18] *Engineering and Mining Journal*, January 1979, p. 82.

developing country sites as a result of lower safety standards, it will retard the growth of developing country exports to developed market economies.[19]

Technological changes in pulp and paper allow different wood inputs to be used. If more tropical broad-leaved wood can be used instead of long-fibred conifers, pulp and paper plants may in future be more frequently sited in developing countries.

The subject of change in processing technologies raises the question of who is to introduce the change. There are a number of reasons why integrated companies, which may be transnational, have an interest in discovering new processing techniques, and why those companies are therefore likely to be in the forefront of such changes. First, the development of new techniques raises the possibility that processes can be repatriated or brought closer to the domestic market. Although there are, of course, economic factors which may dictate continued use of sites in developing countries, some analysts believe that in principle companies based in developed market economies want as much of their processing activities as possible to be located in developed market economies also.[20] The opportunity to diminish tax liabilities and the positive attraction, to executives, of international travel are two factors which others have considered to have contrary effects. Certainly it is unwise to generalize about the aversion of companies to location in developing countries. The opinion that unfamiliarity with the social and economic environment of developing countries creates a barrier to the acquisition of the necessary information is not consistent with the historical experience of private foreign investment in the electronics, the textile or the footwear industries.

External economies

Apart from the economies of scale which are likely to operate in the processing of raw materials themselves, there are two sets of external economies which may influence the siting of plants. The first concerns the by-products created, by accident or design, when the main raw material is under manipulation. Various problems may arise, one of which involves demand. Many, or indeed most, developing countries are unlikely to have demand of sufficient volume to absorb all the by-products created by a major plant. An example of this is the creation of residues when tropical hardwood logs are processed into sawn wood, veneers or plywood. In the process, 40-60 per cent of the raw material input will be wasted unless the off-cuts and particles are consolidated into, for example, particle board or pulp. In Finland, around 11 per cent of sawmill revenues come from residue, without which no sawmill would be profitable. Both products in turn require large-scale plants, larger indeed than an optimally scaled plywood plant. Synthetic resins, which are used for gluing sections of discarded pieces into usable boards, must also be applied. Thus, for the sake of the by-product, wood log processing may be most advantageously located in developed countries.

A second problem raised in connection with by-products can also be illustrated by the wood products branch. To be competitive, particle board has to be inexpensive when it reaches importers in developed market economies. Therefore, transport costs become a crucial determinant of location and usually favours a siting in a developed country. Similarly, a zinc or copper smelter creates sulphuric acid as a

[19] *Foundry Management and Technology*, vol. 107, No. 2 (January 1979), pp. 26-45.

[20] M. Roemer, *op. cit.*, p. 47.

by-product. This is expensive and awkward to transport, so once again the process which yields sulphuric acid is better located where the demand for it is greatest. Such reasoning allegedly dissuaded the operators of the Bougainville Copper Mine in Papua New Guinea from setting up a local smelter. Again, natural gas, which occurs as a by-product of crude oil production, is extremely expensive to transport to places where it can be sold. Often, for want of transportation or an effective marketing mechanism, it is simply flared. Even in 1978, 200 billion cubic metres of natural gas per year, the energy equivalent of about 4 million barrels of crude oil production per day, was being flared. The cost per ton of transporting the gas when liquefied is estimated at about four times the cost of transporting crude oil in a supertanker. The capital cost of gathering, liquefying and subsequently regasifying the gas is also high. The cost of the Bonny liquefaction plant in Nigeria, for instance, was estimated in 1979 at 4.5-4.9 billion dollars.[21]

The third point pertaining to by-products is that, like processed raw materials, they may face oligopolistic marketing arrangements. Even if the raw material itself can be advantageously processed at locations in developing countries, and the output sold either domestically or in market economy countries, the problem of market access for the by-products may once again dictate a siting in a market economy country for the whole operation.

The parallel issue is whether economies of scale in the provision of complementary inputs to the processing plant tend to pull the whole processing operation towards established locations in market economies. Aluminium smelting was sited not in Jamaica but in the southern states of the United States in the 1950s, partly to reap economies of scale from chemical inputs such as aluminium fluoride. The production of basic chemicals from salts, sulphur and hydrocarbons gains from location near user industries, since each chemical has many end uses and many of them are subject to economies of scale.[22]

Linkage effects can be generated by the initiation of certain processing plants. The intensity with which backward and forward linkages are thrown off by resource-based industries differs greatly. In the case of new industrializers in North Africa and the Middle East, there is considerable scope for linkages based on natural gas, much of which would otherwise be wastefully flared once it appears as a by-product of crude oil, running through to fertilizers, petrochemicals and sponge iron.

An attempt[23] has been made to quantify the extent of the linkages generated by 18 different sectors. In developing countries, basic metals has the second highest rank, paper is sixth, chemicals and petroleum refining are seventh, metal products and machinery are eighth, and wood products and furniture are ninth. Among the resource-based sectors, only rubber falls below the median.

The creation of smoke, noxious fumes or other environmental nuisances during raw material processing may lead to increased developing country siting in future. In principle, the location decision for polluting plants should be determined by a trade-off between, on the one hand, the higher capital costs of setting up or modifying existing plants with low pollution output, leading to location where

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[21] *Petroleum Economist*, February 1979, p. 47.

[22] *Chemical Industry*, Industrialization of Developing Countries: Problems and prospects (United Nations publication, Sales No. 69.II.B.39, vol. 8).

[23] Pom Yotopoulos and Jeffrey Nugent, "A balanced-growth version of the linkage hypothesis test", *Quarterly Journal of Economics*, vol. 87, No. 2 (May 1973), pp. 157-171.

capital is relatively abundant, and on the other, the external diseconomies of processing in a less pollution-conscious developing country. The trade-off is heavily affected by political perceptions in developed countries, however, and public attitudes to pollution might suggest that more and more processing should be carried on elsewhere. A recent survey concludes that developing countries "may be disposed to take very dangerous risks and sometimes they will be aided and abetted in this propensity by interests in market economies . . . because the latter see opportunities for operating in developing countries in ways which would not be possible at home".[24] However, evidence on this point is uncertain. While it seems to be generally true that environmental standards in developing countries are less strict than in developed countries, there is substantial variation among the former.[25] Moreover, the more permissive standards by no means imply that "a massive flight of environmental damaging industrial or extractive activities" will take place. "Among [United States] mining companies the evidence at present is that quite the opposite seems to be the case."[26] Political risk and the existence of external economies in market economy country sites seem to keep polluting industries in those locations, despite the high capital costs of meeting public health requirements there.

Economies of scale

Virtually all natural resource-based industries exhibit economies of scale. That naturally presents difficulties for most developing countries, since it requires them to choose between several difficult options. First of all, they can, in recognition of the minimum efficient scale of production, abandon efforts to process and export only the unprocessed variety of a commodity. That will entail importing manufactured versions of the same commodity from other countries. Second, developing countries can go ahead with the project and attempt to export the excess over domestic consumption. The problems they face here are the same as those discussed elsewhere, in particular the escalation of transport costs, tariff and other trade barriers, and the difficulty of breaking into marketing schemes that may be carefully guarded by the existing dominant corporations. While regional groupings such as the Andean Group and the Economic Organization of West African States may be of some help in circumventing those problems, they tend to offer markets growing much more slowly, and from a far lower base, than do the markets of developed countries. The second option also entails overcoming the poor transport and other infrastructural bottlenecks that characterize trade between developing countries. Finally, it may entail importing one or more complementary inputs to service the raw material that is being processed in such large quantities. The third option is to install the technology but to operate it at less than the minimum efficient scale of output, in view of the difficulty of exporting the extra output and, possibly, importing the extra inputs. That option may still be rational if it creates substantial external economies.

[24] A. Kneese, "Development and environment", *Third World Quarterly*, vol. 2, No. 1 (Janaury 1979), pp. 84-90.

[25] I. Walters, "Environmental attitudes in LDCs", *Resources Policy*, vol. 4, No. 3 (September 1978), pp. 200-204.

[26] *Ibid.*, p. 203.

Table 11 contains estimates of minimum economic plant sizes. Only for the largest developing countries are the industries which present the greatest minimum efficient scale of production, namely steel, petrochemicals, pulp and paper, likely to be feasible options. In the case of integrated steel mills, the production of flat rolled items yields a 20 per cent cost saving for each 100 per cent increase in capacity up to 800,000 t/a, than a further 10 per cent cost saving on an output of 1-6 million t/a. In 1965 it would have taken only five steel plants of typical size in developed market economies to supply the entire demand generated by developing countries.

TABLE 11. MINIMUM ECONOMIC PLANT SIZES

Type of plant	*Minimum economic capacity (t/a)*
Alumina	400 000
Aluminium	60 000-80 000
Copper smelter	100 000
Copper refinery (primary)	60 000
Steel mill (integrated)	1 000 000
Steel mill (DR/EF)[a]	100 000
Tin smelter	15 000
Lead smelter, refinery	30 000
Zinc smelter	30 000
Nickel smelter (sulphide)	25 000
Nickel refinery	25 000
Ferro-nickel plant (oxide)	10 000-15 000

Sources: Compiled from various sources including World Bank, United Nations Industrial Development Organization, Centre for Natural Resources, Energy and Transport.

Note: Considerable economies of scale (up to 20 per cent per unit of product) can still be achieved at larger capacities (for example, up to 5,000,000 t/a for integrated steel mills, and up to 1,000,000 t/a for alumina refineries).

[a] DR = direct reduction; EF = electric furnace.

In petrochemicals and refining, most developing countries are unable to obtain the 20-30 per cent unit cost savings yielded by doubling plant capacity. The example of Colombia is often cited. In that country, unit investment costs are six times the equivalent cost in the United States, while production is only 20 per cent of that of United States plants. Moreover, the transport of crude oil is also subject to considerable economies of scale. Shipment in a 275,000-t carrier costs only half the unit cost of using an 80,000-t carrier.[27]

The case of tin smelting illustrates the last two policies mentioned. Brazil, which has six tin smelting plants together capable of smelting 17,000 t/a, has insufficient mining output, amounting to 6,400 t in 1977. It therefore imports tin concentrates (1,750 t in 1975) to help move its smelters towards more efficient costings. On the other hand, the excess smelting capacity of Nigeria, amounting to 13,500 t/a with mined output of only 3,000-4,000 t/a, is not fed by tin imports. The spare capacity is simply left idle. The very high capital cost of aluminium smelters (referred to

[27] *Petroleum Economist,* August 1976, p. 290.

below in the section on co-operant inputs) did not deter Bahrain and Ghana from their investments, for they bring in alumina from Australia, Guinea and Jamaica for processing.

In other industries, there are similar economies of scale. In pulp and paper, the unit investment cost can be cut by up to 25 per cent by doubling capacities up to 1,000 t/d.

In copper smelting and refining, there is some debate about optimal plant size. Of 77 smelters in market economy countries, only 8 are smaller than 20,000 t/a, and the average is 81,000 t/a. It is suggested that the minimum efficient plant size for cost savings is 100,000 t/a. It appears, however, that local circumstances may favour smaller operations, and 30,000-50,000 t facilities have been reported as successful.

Transport costs

The importance of transport costs in determining the location of processing facilities should not be underestimated. Even when transport costs amount to only a modest proportion of production costs, their variation can still be an important determinant of location, particularly where production techniques and input costs are similar among competing locations.

At the earliest processing stages, ores can be smelted to improve the value-to-weight ratio of the cargo, but this improvement varies according to the commodity. In copper concentrates, only 25 per cent of the ore by weight is copper; in iron ore and pellets, the proportion of iron is 50-60 per cent; in bauxite, the proportion of metal is 20 per cent. In zinc and lead concentrates the share is 50 per cent. In logs, up to half the weight is waste, and round wood takes up more room than sawn wood or boards. Taking the commodity a further stage of processing may not, however, yield comparable gains in value-to-weight ratios. In the case of copper, there is a negligible weight saving in transforming blister into refined copper. Rubber gains weight as well as volume when made into tyres, and this militates against developing country sitings for tyre factories (other than for domestic or regional consumption at least). Similarly, sulphur is difficult and costly to transport in its processed forms, the most important of which is sulphuric acid, and thus is exported in its unprocessed form. Ease of handling is an additional advantage in the processing of a powder such as alumina. Powder can be handled by automatic devices more readily than ingots. Indeed, new developments in techniques for handling several primary commodities have made it easier, and often therefore cheaper, to manipulate unprocessed goods.

Discrimination by shipping conferences against developing country processing has been alleged in several studies, and the evidence assembled to date does appear to support that view for some commodities. If so, the actual pattern of incidence of transport costs over processing chains may not serve to stimulate fabrication in developing countries.

However, it is to be expected that shipping costs will be higher for processed goods, since shipping costs will be a smaller proportion of value, which is higher than for unprocessed goods, and thus a lower demand elasticity for transport is likely. Shipping conferences do appear to discriminate against those of their customers who have the lowest price elasticity of demand, either because shipping is a small share of total costs, or through the lack of competition with other freighters.

Transport costs that escalate with processing act like tariffs to protect processing industries in importing countries. If a raw material, for example timber, has an f.o.b. cost in the exporting country about half that of the semi-manufactured product, for example plywood, and both carry freight charges of 10 per cent of f.o.b. value, then freight charges are equivalent to 10 per cent of value added. If plywood industries in importing countries have similar cost structures and access to home-grown timber, then they are afforded effective protection by transport costs of 10 per cent. However, if the shipping charge on plywood were 15 per cent of value, then the importing country producers have twice the effective protection, 20 per cent. Those results require that rate escalation should be based on the value of the processed commodity, and there is indeed a possibility that such escalation does occur. However, the discriminating monopolist model used by Bennathan and Walters (1969) can only explain shipping cost escalation on the basis of volume or weight, but not value. Their argument depends on low elasticity of demand, which in turn is based on shipping costs being a low fraction of total costs. But if shipping costs escalate as a fraction of value, then the elasticity condition is violated. The only way value escalation could be explained is if there is less competition from tramp steamers to carry processed goods than in the case of bulk raw materials, a special situation that seems unlikely to apply widely for all commodities. Unfortunately, despite the alleged escalation of shipping rates with processing, there is little documentation to confirm it.

Tariff and non-tariff barriers

New or potential processers face considerable difficulties because of tariff and non-tariff barriers (NTBs). The last round of negotiated decisions under the General Agreement on Tariffs and Trade (GATT) to be fully implemented at the time of writing, the Kennedy Round, made the deepest tariff cuts on goods of particular interest to traders in developed countries. Average tariffs on goods largely traded between developing and developed countries remained marginally higher, nearly 0.5 per cent,[28] than those on goods mostly traded among developed countries. That did nothing to assist exporters based in developing countries. The prevalance of NTBs will also do nothing to assist the marketing efforts of firms in those countries.

The second point of interest is that of tariff escalation, which refers to a structure of tariffs having the effect of protecting most intensively those stages of processing which are most advanced. Thus, one might typically find duty-free or nearly duty-free entry to developed country markets for unprocessed raw materials but significantly higher tariffs confronting those same materials once they have been transformed into semi-processed goods. Some examples are leather and woollen goods, which face tariff escalation as outlined below. Taking entry into the United States as an example, the nominal tariff on unprocessed hides and skins is found to be only 1.1 per cent. For raw wool it is 9.7 per cent. For leather, the first transformation of hides and skins, the tariff is 4.7 per cent, and for wool yarn, an early transformation of wool, the tariff is 20.7 per cent. For the third phase of processing, shoes and wool fabrics respectively, the tariffs are 16.6 per cent and 20.7 per cent. Such a phenomenon naturally presents increasing market access

[28] UNCTAD, "The Kennedy Round: Estimated effects on tariff barriers" (TD/6/Rev.1).

problems as the level of processing carried out by developing country firms increases.[29]

The third point is that the various existing preference schemes exhibit exclusions and qualifications which severely restrict the scope for large volume growth in any processed areas. Chief among such exclusions are the familiar agricultural NTBs in the various GSP country schemes adopted under the general system of preferences; exclusions of "sensitive" items, which tend to be those in which developing countries have already demonstrated particular export competence in the past; and ceilings, tariff quotas, maximum country amounts and rules of origin. Taken together, those restrictions can be a formidable barrier to the selling by developing countries of more processed items on developed country markets.

Finally, it should be mentioned that firms based in countries belonging to the Organization for Economic Co-operation and Development (OECD) are active in requesting protection on many types of mineral imports, as well as on manufactured items. In 1978 the United States copper companies filed a petition with the International Trade Commission for relief from refined copper imports. The companies wanted a quota to be established to restrict imports to their 1974 value, since by 1977 imports were accounting for 19.2 per cent of the United States market by value. Similarly, zinc companies were seeking import relief in the form of a 7 cents per pound duty on any zinc consignment over 350,000 short tons (318,000 t). United States zinc smelting and refining output fell from 1 million t in 1968 to 329,000 t in 1977.[30]

Complementary inputs

The processing of raw materials naturally requires the presence of certain infrastructural facilities, roads, electricity, gas, water etc., as well as raw material inputs to the process itself. Thus, steel production requires the proximity of coal, which was a major factor in the location of the first steelworks in the course of the industrial revolutions of the developed market economies. Another factor to consider is that usually the output of any processing stage is likely to be in turn an input for a further stage. That may be true of all or part of the output. If most of the output of a processing stage is to be combined with other inputs in yet more processing, then the relative importance of the various inputs must be appraised. If some are costly to transport, or represent a major share of the inputs to later phases of processing, the location of the later phases are not likely to be the same as the earlier phases. Each of the three factors will now be examined.

Infrastructural requirements are particularly large for aluminium smelting, which needs considerable amounts of electricity. Electricity consumption accounts for around 14 per cent of the cost of aluminium ingots at average power costs, although the variation can be from 8 per cent to 32 per cent. Transmitting energy is expensive, and a price differential of $0.005 per kWh for electricity is sufficient to outweigh transport costs anywhere.[31] That is why Jamaica still lacks a smelter and why

[29] UNCTAD, "The processing before export of primary commodities–Areas for further international co-operation" (TD/229/Supp.2).

[30] *Engineering and Mining Journal*, April 1978.

[31] W. Michalski, "Wishful thinking and reality in the concept of vertical integration in developing countries in metal production", *Resources Policy*, September 1978, p. 208.

smelting became possible in Surinam only when a hydroelectric plant was built. Hence "cheap" energy locations are favoured for aluminium smelting, and alumina is moved long distances to smelters situated near suitable sources of power. On the other hand, processing bauxite into alumina demands less energy. The processing of crude oil into petrochemicals also needs major energy inputs. For example, a petrochemicals complex with an annual output of 300,000 t of plastics requires an average electric power input of 83,000 kW.[32]

Raw material inputs needed to complement the commodity that is actually being processed must also be considered. Coal is an important complementary input in steelmaking. The poor supply of coking coal in Brazil helps to explain the high cost of steel from that country and why Brazilian mills tend to be located near coasts to allow shiploads of imports. Mexico, by contrast, has good supplies of coking coal, but they are not sited near iron ore deposits. Petroleum producers in the Middle East with excess natural gas supplies associated with crude oil production are unable to use all the gas satisfactorily, and often flare it off. But if, as Iran planned, alumina is imported for smelting and iron ore is imported for reduction, better use is made of the gas.

With tin, the problem is the lack of complementary metals. Forty per cent of the tin output is used in making tin plate for cans, but less than 0.5 per cent of the tin plate is actually tin, the rest being steel plate. Thus the last few phases of tin processing cannot readily be executed outside locations with sufficient steelmaking capacity. Moreover, the trend towards lighter tin-plate gauges, the use of electrolytic tin production, demanding less tin per unit of tin-plate output, and the substitution of aluminium and tin-free steels in tin-plate products all mean that the share of tin in a wide range of traditional uses is falling.[33]

Transnational corporations

"In the case of mineral ores and concentrates, there are few world market transactions, most of the transactions being internal, within companies, based on administrative decisions concerning appropriate transfer prices. Where an open market does exist for raw materials, it is usually a thin market, representing only a small fraction of the total value of unprocessed and semi-processed materials generated."[34]

As the above quotation implies, many of the markets for mined, semi-processed and processed raw materials are dominated by oligopolistic TNCs. This section looks at the extent of their involvement, assesses the reasons for it, and then examines the impact that such involvement has upon the international location of processing facilities.

There are certain minerals the mining and processing of which are dominated by five or fewer TNCs. In the case of bauxite, the biggest corporation is responsible for over one fifth of world output. Table 12 shows the shares of mined output accounted for by the major company and the top five companies together. It also

[32] "First worldwide study of the petrochemical industry, 1975-2000", (UNIDO/ICIS.83), p. 141.

[33] *Industrial World* (New York, December 1978), pp. 21-28.

[34] H. Malmgren, "The raw material and commodity controversy", *Contemporary Issues* (Washington, International Economic Studies Institute), No. 1, 1975.

TABLE 12. INVOLVEMENT OF TRANSNATIONAL CORPORATIONS IN MINERAL PROCESSING

(Percentage)

Mineral	Share of mineral output		Share of processed output	
	Of biggest company	*Of biggest companies*	*Of biggest company*	*Of biggest companies*
Bauxite	22	54.6	22.4 13.1	60.1[a] 50.1[b]
Copper	11.1	43.1	9.9 8.3	39.5[b] 32.8[a]
Iron ore	12.0	45.0	...	...
Steel	...	...	7.5	24.7
Lead	n. a.	n.a.	7.7	33.7[a]
Nickel	...	...	36.8	77.8[a]
Tin	...	...	29.6	77.0[b]
Zinc	6.8	27.5	12.2	31.7[c]

Source: S. Sinclair, "Resource-based industrialization", a consultant paper submitted to UNIDO, January 1980.

[a]Refining.

[b]Smelting.

[c]Reduction.

shows their shares in processed output. It can be seen that TNCs are well established in all seven minerals. They are also important in exporting unprocessed raw materials to developed country trading partners or subsidiaries. Moreover, for the United States, related party imports of several major primary commodities originating in developing countries may substantially exceed the overall average. Bananas, rubber (milk or latex), bauxite and cotton are probable examples. In other cases, however, developing country exports of commodities to the United States involve TNCs only to a limited extent. In copper, phosphates, sugar, kapok, tin and certain vegetable oils the proportion managed by TNCs is zero. It is therefore apparent that very few generalizations about the nature or extent of TNCs' involvement in raw material mining or processing are possible. The example of copper shows the differing degree of TNC involvement at various stages of processing.

In the copper industry, nationalization of mines and processing facilities have been successful in reducing TNC control over the market since the late 1960s, partly because those firms were not fully integrated forward into intermediate processing stages, and also because copper processing technology is widely known and easily acquired.[35] For example, in 1970, the eight largest copper corporations owned over one half of the copper production capacity in developed market economies and developing countries. Approximately 30 per cent of that total was government owned and controlled, the remainder being transnational operations. But in 1975 the share of production capacity owned by TNCs had been reduced, as a result of nationalization, to around 20 per cent.[36] Those circumstances have led to a

[35]Raymond Vernon, *Sovereignty at Bay: The Multinational Spread of United States Enterprise* (New York, Basic Books, 1971), pp. 40-44.

[36]United Nations Centre on Transnational Corporations (UNCTC), "Transnational corporations and the processing of raw materials: impact on developing countries" (ID/B/209), p. 5.

considerable concentration of the decision units responsible for copper exports. Almost all the export trade of Chile, Zaire and Zambia is handled by government-run marketing organizations. In Peru, marketing of copper is controlled by the Government, while in Papua New Guinea all copper production originates from ore mining. Among the major exporting countries the copper trade of only Canada and the Philippines, accounting for 22 per cent of net world exports, is dispersed among several individual mines.

Refining capacity was distributed among approximately 30 corporations in 1974, with the 10 largest accounting for about 60 per cent of total capacity.[37] In the case of electrolytic copper, the 15 largest firms supplied 25 per cent of total capacity.[38] Those companies have been integrated from mining through refining. The strength of the copper and other metal companies is indicated from trade patterns in the early 1960s, which showed that most trade is within firms and that ownership ties, rather than transport costs, determine the pattern of copper trade.

At the latest stage of semi-fabrication and fabrication, ownership is more dispersed. In the case of semi-fabrication, the 22 largest firms account for about one half of total capacity in developing countries and developed market economies. Significantly, only one of those firms is located in a developing country (Argentina).[39] The degree of concentration falls considerably in copper fabrication and manufacturing, where buyers number about 600,[40] including the electrical, machinery, construction and automobile industries. The capacities of even the largest fabricators is far below the output and sales of major producing units, and, for the most part, they are independent without forward links. Value added at the fabrication stage is fairly small, and 80-90 per cent of the value of fabricated products is represented by the refined copper itself.[41]

Relative scarcity of copper has improved the bargaining strength of the exporting countries, while at the same time raising problems. Falling grades of the ore now being mined have raised capital requirements. For example, a new copper mine would cost $2,500 per ton of yearly output (prices are currently $1,400 per ton). The 1 billion dollar expansion of the Disputada mine in Chile means it will be the most expensive copper mine in the world when it enters production in the early 1980s. Few developing countries can afford to finance projects of such magnitude without considerable foreign participation. Growing scarcity has also encouraged the substitution of aluminium for copper in many electrical uses, TNC entry into the aluminium industry and a potential shift in processing technology. Those forces all tend to reduce the bargaining strength of developing countries.[42]

Integrated companies have shown a strong preference to build smelters and refineries in their home countries, a tendecy reflected in the data on copper production capacity. In 1966, developed countries owned 51 per cent of world mining capacity, but 60 per cent of smelting and 78 per cent of refining capacity. By

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[37] *Ibid.*

[38] B. R. Stewardson, "The nature of competition in the world market for refined copper", *Economic Record,* June 1970, p. 172.

[39] UNCTC, *op. cit.*, p. 6.

[40] Stewardson, *op. cit.*

[41] Marian Radetzki, "Market structure and bargaining power", *Resources Policy,* vol. 4, No. 2 (1978), p. 118.

[42] Ann Siedmann, ed., *Natural Resources and National Welfare: The Case of Copper* (New York, Praeger, 1975), p. 10.

1976, it was estimated that the balance would have shifted slightly in favour of the industrialized countries, to 47, 63 and 79 per cent of the mine, smelter and refinery capacity, respectively. The imbalances are greatest for Western Europe (4 per cent of the mine capacity and 21 per cent of refining capacity[43]).

Some developed country firms attempt to ensure supplies for their refineries by entering long-term contracts of 5 to 20 years with exporters of concentrates, possibly undertaking mining investment in return. That pattern helps to explain why no smelting capacity was constructed at Bougainville in Papua New Guinea or at various mines in Zaire.[44] A counter-trend may be observed in the case of some developed countries, however. In Japan, the efforts of the Government to secure raw material supplies have increased the country's willingness to establish processing activities in developing countries, primarily in copper and aluminium. Smelting activities in those industries are being steadily transferred to the source of ore supply in order to use locally available electric power.[45]

Iron ore patterns can also be explained largely in terms of the need of iron and steel companies to secure long-term ore supplies to feed to their mills, and their consequent involvement in ore mining. Approximately 20 per cent of trade in iron ore is in the form of internal transactions between mines and steel companies under common ownership. But in the case of iron ore, several state monopolies have begun to form countervailing agencies to balance the quasi-monopolistic power of the steel companies. One such agency is the Indian State Trading Corporation.

Again in the aluminium industry, the large investments required (a standard smelter with a 100,000 t/a capacity would have cost $220 million in 1978) explain why firms should wish to protect themselves by controlling both beneficiation and mining, and should therefore integrate vertically.

The need for security of inputs is clearly an important impulse in the creation of vertically integrated firms in certain minerals and at certain processing stages. Indeed, the need to ensure adequate returns from even larger blocks of capital investment has long featured in the literature on the growth of large or transnational firms.

Thinking in terms of the adoption by developing countries of similar corporate forms, however, Michalski has warned: "At least in the field of metal production, it may be stated that the general demand for vertical integration of developing nations in the raw material sector is far too simple a concept. Only project-based analysis can reveal the economic possibilities for building up metal processing and manufacturing industries in individual developing nations."[46]

A different perspective on TNCs and their involvement in raw material processing comes from their importance in marketing. Firms in several developing countries have recognized that the involvement of one or more TNCs in a processing plant can help overcome two problems other than finance. First, TNCs sometimes enter projects with a "buy-back" clause which obliges the TNC to purchase a proportion of the output of the plant it is involved in setting up. That reduces the market risk facing the partners in developing countries. A case in point is the new

[43] A. Siedmann, *op. cit* pp. 8-9 and p. 64. Percentages refer to developed market economies and developing countries only.

[44] Raymond Mikesell, *Foreign Investment in Copper Mining* (Baltimore, Johns Hopkins University Press, 1975), pp. 121 and 186.

[45] See T. Ozawa, "Technology imports and direct foreign investment in Japan", *Journal of World Trade Law*, November-December 1977.

[46] W. Michalski, *op. cit.*, p. 208.

Brazilian pulp mill at Cenibra, 50 per cent of the output of which will be bought by the Japanese firm with an interest in its construction. By 1979 the plant was expected to produce over 260,000 t/a.[47] The second problem often faced by processers in developing countries, namely, marketing their output to customers in developed countries, can also be mitigated by TNC involvement. If a TNC possesses its own wholesale or retail outlets, and a fully vertically integrated firm is very likely to, then the problem of marketing is naturally reduced. Brand loyalty, and other familiar types of entry barrier, are likely to have appeared in the market through the years, and newcomers would undoubtedly find those hurdles difficult to cross. An example might be coffee processing. Setting up plants to process coffee more intensively is sufficiently demanding of skills and capital in a developing country location without also having to worry about marketing a new brand of coffee to consumers.

Prospects for further processing in developing countries

The preceding analysis has shown that, for certain raw materials, processing techniques are changing in such a way as to draw processing facilities irresistibly to either developing countries or developed market economies. This section will tie together the different trends and consider ways in which location decisions might be affected by policies of inducement by prospective host-country Governments.

An analysis[48] of mineral processing prospects to the year 1983 has established that there are at least seven developing countries where the development of an integrated copper industry could be contemplated, based on existing copper mines. Possibilities for further copper smelters are, on the other hand, thought to be limited. Seven countries, furthermore, could use their iron ore mining capacity to support large-scale integrated steelworks, and several others could reasonably establish small mills based on new technologies.

For all developing countries, table 13 shows current and projected mineral processing capacities as a share of recoverable mine production. It can be seen that in all cases developing countries should be processing a greater share of their minerals by 1983. Lead processing will increase so that all lead mined in developing countries will be at least partially processed in those countries. Only in the cases of steelmaking, alumina refining and aluminium smelting will less than half the level of mined output be domestically processed. Further analysis has shown some of the implications of moving towards the targets suggested in table 6 for the seven minerals.

The investments required to attain the 1983 figures are indicated in table 14. Developing countries would have to invest approximately $180 billion to close the current processing capacity gap. The magnitude of this figure becomes apparent when it is noted that, for 1977-1990, developing countries as a whole are projected to spend 60-70 billion dollars (in 1978 dollars) on all their investments. The export revenue that might arise from such investment would be around $54 billion, which is four times as high as the overall exports of the seven minerals from all developing countries. However, the net addition to foreign exchange flows would be rather less, because of the need to import equipment and certain inputs.

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[47] *Forest Products Review* (Washington), Summer 1978, pp. 12-13.

[48] "Mineral processing in developing countries" (UNIDO/IOD.328), December 1979.

TABLE 13. CURRENT AND PROJECTED MINERAL PROCESSING CAPACITY OF ALL DEVELOPING COUNTRIES AS A PERCENTAGE OF RECOVERABLE MINE PRODUCTION

Type of activity	*Processing capacity as a percentage of recoverable mine production* 1977	1983
Alumina refining	32	42
Aluminium smelting	14	19
Copper smelting	84	85
Copper refining	62	63
Steelmaking	23	29
Lead processing	95	100
Nickel processing	59	79
Tin smelting	92	94
Zinc processing	55	81

Source: "Mineral processing in developing countries" (UNIDO/IOD.328), December 1979, chap. 2.

Table 14 suggests the predominance of the iron ore and steel processing chain, which accounts for at least 75 per cent of the total investment, export earnings and processing gap for the seven minerals. Such trends are, however, merely estimates. Each location decision depends upon many variables, perhaps the two most volatile of which are technological change and product substitution. The first factor has already been dealt with, since impending change naturally affects current location planning. Here the latter factor, substitution between products, is dealt with.

A major reason for the belief that the success of the Organization of the Petroleum Exporting Countries as a cartel of commodity exporters could not be

TABLE 14. OPPORTUNITIES FOR FURTHER MINERAL PROCESSING IN DEVELOPING COUNTRIES

Processed minerals	*Estimated investment required to close the current processing gap (billions of dollars)*	*Estimated employment potential arising from the closure of the current processing gap (thousands of jobs)*	*Estimated potential export value arising from the closure of the current processing gap (millions of dollars)*
Bauxite, alumina and aluminium	38.8	137	12 600
Copper	1.7	6	560
Iron ore, iron and steel	137.8	840	40 300
Lead	0.2	1	50
Nickel	1.0	1	290
Tin	0.1	1	30
Zinc	1.0	3	250
Total	180.6	989	54 080

Source: "Mineral processing in developing countries" (UNIDO/IOD.328), December 1979, chap. 2.

repeated elsewhere is the relatively greater ease of substitution among other materials. In copper, aluminium and steel, there are other minerals (aluminium, steel and tin, respectively) that can with varying degrees of difficulty be substituted. It must therefore be expected that efforts to process more commodities within developing countries may on occasion be met with a switching by consumers of the mix of their demands. The reasons for such switching could include discrimination (a desire to buy from integrated producers based in developed countries) or price-sensitivity (processed output in developing countries is, perhaps, more expensive because of production inefficiencies). But whatever the reasons, the extent to which mineral substitution may limit greater processing by developing countries must be examined.

In principle the power of the raw material supplier is greater the higher his share of world supply and the lower the price-elasticity of demand and of other supplies.[49] For many major materials, however, supply conditions are not at all favourable. Too many different countries produce iron ore to allow the tight operation of a cartel,[50] and in the case of bauxite, there are substantial deposits in developed countries.[51] Indeed, developing countries as a whole have been cast in the role of merely marginal suppliers for a range of commodities. Only in tin, bauxite, cobalt and petroleum are developing countries dominant, and even in the cases of cobalt and bauxite there are alternative materials of sources that could be used *in extremis.*[52]

The efforts of copper companies to achieve price leadership in the past 20 years have been interpreted not so much as an exercise in joint profit maximization as in price stabilization. The objective of price stabilization was to forestall shifts to other materials, chiefly aluminium, plastics and carbon fibre, which would more or less be irreversible, for only when the average cost of copper inputs fell below the marginal cost of new substance inputs would reshifts occur.[53]

Factors other than price may lead to substitution. The United States federal regulations requiring automobiles to attain a fuel consumption rate of 8.6 l per 100 km by 1985 means that Detroit companies will be using a great deal more aluminium to build cars in future, along with reinforced plastics and high-strength low-alloy steel, instead of heavier steel grades.[54]

Strategic considerations also play a part. The United States has been almost totally dependent upon imported platinum and chromium supplies. But now the Bureau of Mines has found that bombarding iron with high-energy beams of chromium ions yield an alloy with the excellent corrosion-resistance characteristics of bulk chromium alloy.[55] Fewer chromium imports may therefore be expected in future.

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[49] M. Radetzki, "The potential for monopolistic commodity pricing by developing countries", in G. K. Helleiner, ed., *A World Dividend* (Cambridge, 1976).

[50] F. E. Banks, "The 'new' economics of iron and steel", Discussion paper (University of New South Wales).

[51] I. Kravis, "The possible uses of commodity agreements", *Banca Nazionale del Lavoro Quarterly Review,* December 1978, p. 314.

[52] M. H. Govett and G. J. S. Govett, "The new economic order and world mineral production and trade", *Resources Policy,* December 1978, p. 236.

[53] P. Hallwood, *Stabilization of International Commodity Markets* (Greenwich, Connecticut, JAI Press, 1979), chap. 8.

[54] *Chemical Week,* 31 January 1979, p. 29.

[55] *Industrial World* (New York), December 1978, pp. 21-28.

Lead is also losing ground to plastics and aluminium for use in cable covering. In addition, its diminishing use as an ingredient to anti-knock petroleum in markets of countries belonging to the OECD means that demand for lead will rise only slowly in future. The case study of jute presented in a subsequent section illustrates the problem of substitution by other products.

Aluminium

High-quality bauxite, which contains over 40 per cent aluminium oxide, is heavily concentrated in tropical locations. Except for the Northern Territory of Australia, the deposits are primarily located in developing countries. In 1977, the bauxite mines of developing countries were responsible for 54 per cent of world output. Australia, with 33.7 per cent of the output, is the only developed country with more than 4 per cent of world output. The estimated 1982 figure for the developing country share of bauxite output is 63.8 per cent, with overall output rising from 74.1 million t in 1977 to 128.0 million t by 1982. Developing countries contain 77 per cent of known bauxite reserves, a total of 18,720 million t, while developed market economies have the remaining 5,480 million t. The biggest single source is Guinea, with 8,200 million t, or 33 per cent of the total.

Most bauxite is traded within the six companies that effectively dominate the world aluminium metal market. Together those six account for some 60 per cent of world bauxite production and 55 per cent of primary aluminium production. Bauxite not sold within the major integrated firms is generally marketed under long-term contracts to independent producers. Because of the peculiarities of the tax-credit provisions of United States tax laws and the predominance of firms of that country in the industry, bauxite prices appear to have been set in the past largely to minimize corporate tax liabilities.

The location of bauxite mining is relatively consistent with the location of identified bauxite reserves. Developing countries have 77 per cent of reserves, with 62 per cent of bauxite mining capacity in 1976 and 67 per cent of capacity projected for 1983. On the other hand, alumina refining and smelting are heavily concentrated in developed countries. Only 26 per cent of current aluminium capacity and 13 per cent of smelting capacity are located in developing countries, although current expansion and new project plans seem likely to increase those shares to 36 per cent and 21 per cent, respectively, by 1983. In particular, later processing facilities for aluminium processing are concentrated in developed countries. The United States has only 3 per cent of bauxite capacity but 24 per cent of alumina and 35 per cent of aluminium. For Japan, the figures are 0, 8 and 14 per cent, respectively, and for the Federal Republic of Germany, 0, 6 and 6 per cent.

The major bauxite producers in developing countries include Jamaica (18 per cent of world capacity outside the group of countries belonging to the Council for Mutual Economic Assistance (CMEA)); Guinea (16 per cent), Suriname (8.5 per cent) and Guyana (4 per cent). All those countries possess some refining capacity, but far less than is required to process all their bauxite output.

The high transport costs for bauxite in relation to unit mining costs are one factor that might imply processing at the mining location. But processing facilities are in fact closely related to the predominance of the integrated firms, four of which have their bases in North America and two in Europe.

The costs of undertaking processing are substantial. Costs can vary greatly, of course, depending on the terrain and the supporting facilities needed, but reasonable guidelines in 1978 dollars are $650 per ton for alumina and $2,700 per ton for aluminium smelting. Some plants exceed those costs. The Asahan project in Indonesia cost more because entirely new power generating facilities had to be constructed. Adding in operation costs yields a total cost of $1,276, excluding the cost of the bauxite input, to convert 4.6 t of bauxite into 1 t of aluminium metal. Capital costs per job from these figures are around $520,000 each for alumina and $243,000 each for aluminium. It can be seen that initial costs are thus very high, considering that recent alumina and aluminium projects have planned scales of 80,000-800,000 t/a.

Should developing countries become larger producers of primary aluminium, it appears that there are at least reasonable market prospects. Demand for aluminium is generally forecast to continue at fairly high levels. The World Bank, for example, projects consumption increases averaging 7.6 per cent per annum for the period to 1985.[56] On the basis of those demand projections, it appears virtually certain that there will be a shortage of smelting capacity by the mid-1980s. Thus a substantial opportunity, in general, exists for the creation of additional refining and smelting facilities located closer to the sources of raw materials.

Copper

Developing countries account for approximately two thirds of identified world copper reserves, excluding figures for the CMEA and possible copper recovery from underwater manganese module mining. By far the largest amounts are in Chile, which accounts for 21 per cent of world reserves. Other significant proven reserves are located in Peru (8 per cent), Zambia (7 per cent) and Zaire (6 per cent). Zaire presently exports most of its copper as blister, which is then refined in Belgium. Papua New Guinea exports its concentrate to Germany and Japan for smelting. Mexico has as yet been unable to finance a smelter and refinery, and so is likely to continue exporting mostly concentrates.

Western Europe (mainly Belgium and the Federal Republic of Germany) and Japan dominate processing capacity for concentrate and blister copper. Belgium has no mining capacity, but 1.1 per cent of smelter capacity and 5.1 per cent of refinery capacity, while the Federal Republic of Germany has negligible mining output, but 3 per cent and 5.5 per cent of processing capacity.

Most concentrate suppliers in developing countries are linked by long-term contracts to smelters, mainly in Western Europe and Japan. Those links are often part of the schemes that set up the mines in the first place. There is at present considerable excess capacity in smelting and refining, and further additions to capacity are planned in Mexico, the Philippines and the Republic of Korea. Hence concentrate producers should have little difficulty in finding treatment facilities for their output.

About 25 per cent of the mine output of developing countries is smelted *in situ* but refined overseas. The two main blister suppliers are Peru and Zaire. Blister is mainly sold under short- or medium-term contracts, and there is no shortage of refinery facilities. Developing countries had 54 per cent of 1977 mining capacity, and

[56] World Bank, *Price Prospects for Major Primary Commodities* (June 1977).

39 per cent of smelter capacity. They also had 27 per cent of world refinery capacity. Projections to 1983 show those shares increasing to 59, 44 and 31 per cent, respectively.

Among the major copper producers, Chile and Zambia are integrated to a substantial extent through to the stage of refined copper. Most of the output of Zambia is refined before export, as is 7 per cent of that of Chile. Most of the remainder in Chile is smelted locally and exported as blister. Peru plans to expand its refining capacity, which at present refines half of its mine output, the remainder being exported primarily as blister. The Philippines exports all its copper in concentrates, and by 1983 a new smelter will probably process 25 per cent of mine output.

TNCs are important agents in the copper market. In mining, the top 13 firms control 65.8 per cent of capacity. In smelting, the top 15 control 73 per cent of capacity, and in primary refining, the top 14 control 63 per cent of capacity. However, some of those concerns are government enterprises, such as Codelco in Chile, and Centromin in Peru. Moreover, it is rare to find a corporation integrated from mining through to refining. Thus, to a large extent, the position of the copper producers is considerably more flexible than that of bauxite producers, who usually have few options other than links with one of the major aluminium companies.

Economies of scale in copper processing mean that capital entry costs are large. In 1978 dollars, average capital costs per unit of capacity (t/a) would be $2,000 for copper smelters and $500 for refineries. In both cases the estimates are for large plants (e.g. 50,000 t/a or more). Integrated projects, which process from the mine through to refining, have unit capital costs of $6,000-$8,000, of which roughly one third would be for the smelting and refining components. But costs can be much higher. The Iranian complex at Sar Chesmeh will cost up to $14,000 per unit of capacity and the La Oroya smelter in Peru will have very high unit costs because of its small capacity. Adding operating costs gives $545 per ton for smelting and $213 per ton for refining, or $760 per ton for both. The estimated capital cost per job in smelting and refining is around $350,000.

Iron and steel

Developing countries had 39.6 per cent of world iron ore mining capacity in 1977, and by 1983 their share should rise to 44.7 per cent. Those percentages represent 259,000 t and 356,000 t respectively. By far the biggest iron ore producer among developing countries is Brazil, which accounts for 14.5 per cent of world mine capacity, and plans to increase its share to nearly 18 per cent by 1983. Other major iron ore producers are India (7.3 per cent), Chile (2 per cent) and Mauritania (1.5 per cent). Brazil is also an important location of iron ore reserves, with 22.5 per cent of world reserves in 1969, a percentage second only to that of Canada (25.2 per cent) and exceeding that of India (6.5 per cent) and Cuba (2 per cent). In all, developing countries have roughly 40 per cent of known world iron ore reserves outside the CMEA countries. Exploration is, however, only in its infancy in Australia, Brazil and much of Africa, and the results of investigations there might change the distribution of reserves considerably.

Despite their importance in iron ore, developing countries are less significant steel producers. In 1977 they accounted for 9.3 per cent of world steel output, and by 1983 should account for 15-16 per cent. The increasing share of developing countries in steel capacity reflects both new projects planned (notably in Algeria, Brazil, India, Mexico, the Republic of Korea and Venezuela) and the stagnant production of the OECD steel industry.

There are a number of reasons for the disparity between developing countries as sources of iron ore and sources of crude steel. First, the value of iron ore is usually small compared with the final value of finished steel. That naturally diminishes the incentive to process more fully close to where the ore originates. Second, steel producers need to be familiar with market conditions, so as to locate in developed countries where the overwhelming bulk of steel is consumed. Third, the linking of specific ore mines to steel plants by way of vertically integrated companies (captive mines) or through long-term ore-purchase agreements reduces the ability of firms in developing countries to produce for domestic consumers. In the United States, most steelmakers obtain a high proportion of their ores from captive mines, whereas steelmakers in Western Europe buy perhaps one third of their ore through spot contracts and short-term purchases. But in all cases the domination of the market by one (normally owned) steel company tends to reduce the bargaining power of ore producers. That is particularly true where quasi-governmental bodies co-ordinate ore purchases. The relative abundance of iron ore, and the ease with which one source of supply can be replaced by another, is another reason why steel producers are able to impose hard conditions on ore sellers. The substantial degree of over-capacity existing in most OECD countries also reduces the likelihood of moving through ore to steel production based on export growth.

Figures for company concentration in iron ore show that the six largest firms between them accounted for 52.1 per cent of world ore output in 1976, while the top 11 steel-making firms between them accounted for 40.7 per cent of world steel output in the same year.

Capital costs in steel production, in terms of 1978 dollars, average $500-$1,000 per t/a. The cost per job created is around $160,000, based on 5,000 jobs being created for a 1-million-ton plant.

Lead

In 1977 developing countries had just over 33 per cent of world lead-mining capacity. That share is projected to fall fractionally by 1983. While production in developing countries will indeed increase (from 999,000 t in 1977 to approximately 1,122,000 t by 1983), the rise will be offset by the very large new mines planned in Canada, Ireland, South Africa and Spain. The major lead mines in developing countries are located in Mexico (6.4 per cent of world capacity), Morocco (2.9 per cent), Namibia (1.9 per cent) and Peru (8.1 per cent). By far the largest known reserves of lead are sited in Australia, Canada and the United States. Among developing countries, significant reserves (although only a fraction of the reserves of developed countries) are in Iran, Mexico, Namibia and Peru. Known reserves in developing countries amount to 15 per cent of the world total.

In 1977 developing countries possessed 25.2 per cent of world smelter and refining capacity in lead. By 1983 their share should have slightly increased to 27.5 per cent. There should be large increases in Peru (a doubling of capacity to 5.3 per cent of world capacity) and the Republic of Korea (a 500 per cent rise to

1.5 per cent of world capacity). Peru processes one third of its mine output domestically, but that figure should rise to 70 per cent by 1983. Mexico processes about half of its mine output domestically, while Namibia processes all of its lead locally. Large processing facilities exist in a number of developed market economies, notably in Japan (with over 200,000 t/a), where smelting capacity is four times bigger than domestic mine output. Other smelting capacity is in Belgium (3.2 per cent of smelting capacity but no mine output), the Federal Republic of Germany (8.1 per cent) and France (4.4 per cent).

Most concentrate sellers operate under two- or three-year contracts with OECD smelters. There is no extreme concentration in the industry at that stage. The nine biggest firms carry out 52.6 per cent of primary lead refining, but at the smelter-refinery stage concentration is rather greater.

Estimating the capital costs is difficult because most recently constructed plants have either been based upon the new imperial smelting furnace technology, which treats lead and zinc together, or have been less than the optimal capacity of 100,000 t/a. But a 1978 dollar estimate would be roughly $700 per t/a. At a 10 per cent annual amortization over 10 years, that $700 figure becomes an annual capital charge of $113 per ton. Operating costs vary widely according to the degree of purity of the concentrate input. An overall cost, including amortized capital costs, is around $24.5 per ton. The cost per job created is of the order of $160,000.

Nickel

The bulk of proven and prospective world nickel reserves are located in developing countries. Approximately 70 per cent of known reserves in 1977 were in those countries. However, despite their large share of world nickel reserves, developing countries at present have less than half of world mine capacity. In 1977 their share stood at 42 per cent, and by 1983 it should reach 49.3 per cent. That forecast may be upset by cancellations due to the present weak state of the nickel market. The largest nickel producer, New Caledonia, has 15.5 per cent of world mine capacity. Cuba (4 per cent), Philippines (6 per cent) and Indonesia (4 per cent) are other important nickel mining locations. New Caledonia has also by far the biggest share of known nickel reserves, around 30 per cent.

Nickel processing is still less dominated by developing countries than mining. Only about a quarter of processing capacity is located in those countries and just under one half of mining capacity. In 1977 the total share of developing countries in processing was 27.3 per cent. However, by 1983 that figure should have risen appreciably to 40.6 per cent. New Caledonia is also a significant processer, with 9 per cent of world capacity, or 33 per cent of the capacity of developing countries. By 1983 Cuba is expected to increase its capacity to about 9 per cent of world mining and refining. Its present shares are 4 per cent and 5 per cent, respectively (1977 figures).

The trend towards greater processing in developing countries has been accelerated by the shift in nickel production away from sulphide ores, typically found in developed market economies, towards lateritic oxide ores, typically found in tropical developing countries. The latter cannot effectively be concentrated, so transport costs as a share of the value of unseparated nickel prohibit export before treatment.

As recently as 1950 the world nickel market was a virtual monopoly, with Inco accounting for 85 per cent of total sales. Although by 1977 there were 10 companies responsible for 96.7 per cent of refining capacity, the typical company is still tightly integrated vertically. Nickel producers in developing countries who are not part of an integrated TNC have two options. They can build their own domestic treatment plant, or they can bid for a sub-contracting arrangement. But their bargaining power will be weak because of the oligoponistic structure of the market, since only Japanese companies and Amax in the United States buy appreciable amounts of foreign mine production. That contrasts with the position in copper, where considerable excess smelting capacity exists, and mine operators are therefore able to drive reasonably good bargains.

Capital costs in nickel are lower and more predictable for sulphide operations, since the technology has been proven over the years. Investments are $7,735 per ton for mining, $6,328 for smelting and $1,875 for refining. Discounting those investments over 10 years at 10 per cent per annum and adding in operating costs yields total costs of around $2,200 per ton of metal content for sulphides, and $3,300 for lateritic oxides. However, those figures are only broad indicators. The cost per job created in nickel sulphide smelters is 1-2 million dollars.[57] Comparable figures for oxide operations are not available.

Tin

Alone of the minerals considered in this section, tin is predominantly processed to the metal stage within developing countries. In 1977 developing countries held 88.1 per cent of world mine capacity, a figure which should rise marginally to 89.9 per cent by 1983. The dominant countries in 1977 were Bolivia (15.3 per cent of world total), Malaysia (36.3 per cent), Indonesia (12.1 per cent) and Thailand (11.6 per cent). Some of those shares would fall if the 1983 mining target were met. Thus, the share of Bolivia in world mining capacity would drop fractionally to 14.8 per cent. Developed countries account for less than 10 per cent of known tin reserves outside the CMEA group of countries, with developing countries holding the balance. Such a distribution closely matches the distribution of mining capacity.

Among developing countries, the share of Malaysia in mine capacity and production (36 per cent and 31 per cent, respectively) far outweighs its share of reserves (10 per cent). Similarly, the share of Bolivia in mine capacity and production (15 per cent and 17 per cent) exceeds its 12 per cent share of known reserves.

Overall, 72 per cent of smelting capacity is located in developing countries, a figure which is projected to reach 76 per cent by 1983. Current expansion plans should give Bolivia the ability to smelt virtually all of its mine production by the early 1980s. Malaysia already does this, and takes in some concentrates from other countries of South-east Asia. Only Zaire of the major mine producers has a sizeable shortfall of smelter capacity, with most of its tin being exported in concentrate form to smelters in Belgium.

Because of the virtual self-sufficiency of developing countries in tin processing, the most important markets for developing countries are the terminal markets for tin metal in Penang, London and New York.

[57] "Mineral processing . . .", *op. cit.*

In contrast to other metals, tin mines and processing facilities are largely in the hands of government enterprises in developing countries, and whatever vertical integration exists in the industry is carried out by those enterprises. However, some TNCs are still significant in the industry, with the eight biggest companies controlling 88.9 per cent of smelting capacity in 1977. Most of these company facilities are also located within the developing countries.

Capital cost estimates are not readily available, because of both the small number of projects from which data come and the fact that much of the expansion of the industry comes from small-scale gravel-pump mines in South-east Asia, for which data are unavailable. Indicative costs per ton would be about $4,000 for mining, $15,000 for dredging and $8,000 for smelting and refining. Adding operating costs yields total costs of $1,710 per ton after capital costs are amortized over 10 years.

Zinc

Some 35 per cent of known reserves of zinc are located in developing countries. The biggest sources of zinc in the world are Canada (24.9 per cent), the United States (19.4 per cent) and Australia (11.6 per cent). The major sources among developing countries are Mexico (2.8 per cent) and Peru (2.2 per cent). Mine production is also concentrated in developed market economies. In 1977 the share of developing countries was 28.9 per cent, a figure which may fall to 27.3 per cent by 1983. Such a fall would chiefly reflect expansion in Canada, Ireland, Spain and South Africa. Peru and Mexico are the dominant mine sites in developing countries, with 8 per cent and 5 per cent of world mining capacity, respectively. Peru currently exports nearly all its zinc in concentrate form, but plans under way should allow for domestic processing of around half of its mine output by 1983. Mexico is currently able to handle about two thirds of its mine output, with the remainder being treated in the United States. Overall, the involvement of developing countries in zinc processing should rise from 14.8 per cent in 1977 to 19.7 per cent in 1983, bringing the mining and processing share into closer alignment.

Zinc processing plants in developed countries require extra inputs of concentrates from developing countries to attain minimum efficient scales of production. Since 1960, the total concentrate deficit for zinc plants in Japan, the United States and Western Europe which were filled by developing countries has increased from around 8,000 t/a to 2 million t/a.

Integrated producer groups dominate the zinc trade carried on outside the CMEA countries. Some 40 firms account for 85 per cent of zinc mine production and 95 per cent of zinc reduction capacity. In Europe, five groups account for 80 per cent of reduction capacity. Capital costs in zinc mining and processing average $260 per ton amortized over 10 years. Adding in operating costs yields a total of around $410 per ton for new zinc smelters in developing countries. The estimated capital cost per job created is $320,000.

Various implications of resource-based industrialization

Recently Irving Kravis pithily summed up some of the issues facing raw material exporting countries thus: "A higher price for tea will help Sri Lanka, but there is no feasible tea price that will make it rich."[58] For most developing countries that is correct. To be sure, there are a small number of countries and territories for which the selling price of one or a handful of primary commodities is the most important determinant of their economic performance. Examples are Iran, New Caledonia, Suriname and Zambia, where primary product earnings from one or two items normally account for over 85 per cent of total export revenue. One understandable response to such a situation is to try to process the goods more intensively before exporting them. By adding value, the benefits of more stable prices, higher income elasticity of demand, less producer competition and greater internal income diffusion might be gained. There might, moreover, be spin-off or linkage effects to stimulate the domestic economy further. But would such a strategy necessarily make the best use of the available resources?

Any economic analysis of the attractions of RBI strategies in a developing country will of necessity contrast the extent, nature and distribution of the gains from RBI with those accruing from alternative policies. Thus, for instance, the gains from using natural gas in locations in the Middle East as an energy input for aluminium smelters cannot only be considered in the light of value added in aluminium. While much of the gas gathers when crude oil is being produced, and is therefore secured at virtually no cost, once it is collected it does acquire an alternative value as an export in its own right, or as an input to another type of processing, for instance, as a feedstock for the petrochemicals industry. In the former case, a decision to export gas as a fuel implies heavy investments in liquefaction facilities and special ships. In the latter case, the attendant costs of a petrochemicals industry must be reviewed. A full analysis of the optimal use of the gas would therefore ideally assess the flow of costs, both accounting and economic, and benefits following from each of at least three alternative sectoral strategies. Since that is clearly an extremely difficult task, one has to proceed instead on the basis of informed speculation. The approach adopted in designing the criteria for such an analysis is also outside the scope of this study.[59] All that can be done here is to contrast in summary form the types of benefits that are likely to flow from RBI as opposed to other strategies.

The high capital costs of setting up processing facilities were discussed above. It is clear that neither the employment nor the income when reviewed in the light of the number of jobs directly generated by such investments will be substantial. For example, tin smelting ideally needs to be conducted at 15,000 t/a. At a capital cost of $160,000 per job and an output of 20 t/a per man, an investment of $128 million is needed and provides employment for only 750 men. The employment gain can, of course, be substantially changed by judicious selection of ancillary processes such as packaging, warehousing, transport and so on. Although the evidence suggests that RBI has poor interpersonal income distribution effects upon a developing country, it may perform no worse than alternative strategies. A survey of the distributional impact of different industrial policies and structures in developing countries found the interpersonal income distribution fairly insensitive to industrial structure.

Although the literature on RBI is silent on the subject of interpersonal distribution, it does contain some observations on interregional distribution. Copper smelting, bauxite beneficiation, iron and steel, wood products and pulp and paper

[58] I. Kravis, *loc. cit.*

[59] J. Cody, H. Hughes and D. Wall, eds., *Policies for Industrial Progress in Developing Countries*, a study jointly sponsored by UNIDO and the World Bank (Oxford University Press, 1980).

economize on transport if located near the natural resource.[60] Often the regions containing those resources, especially forest regions, are the least developed of the country concerned, since they more or less exclude agriculture. India has to some extent used the steel industry as an instrument of interregional justice by not allocating more than one mill to any one state.

The employment aspect of RBI is none the less disquieting. One must ask how far factor substitution is possible to alter the labour-capital mix for a given level of output. The consensus in the literature is that there is not much scope for changing factor proportions, especially in the basic metal industries where technological changes do not entail substitution. Given the high fraction of raw material costs and the low share of labour costs, it is unlikely that managers would give much consideration to substitution possibilities.

The above seems borne out by time series estimates of constant elasticity of substitution (CES) production functions for copper mining (but not processing) in the United States and three developing countries. The elasticity of substitution in the United States was found substantially higher than in Chile, Zaire or Zambia. After allowing for technological change and capacity utilization, Della Valle estimated an eleasticity of 0.4 for United States mining and zero (statistically insignificant, with a standard error over twice the estimated coefficient) for Zambia. He attributes the result to both the much lower wage share in Zambia and the reluctance of TNC investors to reduce employment, despite rising wages, in foreign countries where their employment practices have become political issues.

Della Valle provides only one result that includes processing: he estimates the elasticity for the aluminium industry in the United States as a whole during the period 1958-1968 and finds a high value, 1.1. Although that is consistent with the high labour share in aluminium processing in the United States, it contradicts the conventional wisdom that basic metals industries have fixed coefficients. One possible explanation is that the study does not allow for technological change. Since wages were rising, a good part of the apparent substitutability could well have been caused by changes in technology, especially automation of materials handling, rather than by pure substitution along a production isoquant with a given technology. That raises the question of using older technologies in developing countries to increase the labour component. However, older technologies would not be competitive if newer technologies made substantial improvements in the efficiency of ore reduction. Since a significant number of innovations in copper,[61] aluminium[62] and iron and steel have been resource-saving (or made it possible to process lower grades competitively), the use of older technologies is probably not economically feasible.

Wood processing, with its higher labour shares in tropical countries and considerably more potential for manual materials handling than in basic metal industries, should have more potential for labour-capital substitution. An estimated CES production function for sawmilling in Ghana, with pooled cross-section and time-series data and allowance for technological change, yields a statistically significant elasticity estimate of 1.1.[63]

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[60] M. Roemer, "Resource-based industrialization . . .", *op. cit.*, p. 61.

[61] Della Valle, "Productivity and employment in the copper and aluminium industries" in A. S. Bhalla, ed., *Technology and Employment in Industry* (Geneva, ILO, 1975), p. 305.

[62] S. Brubaker, *op. cit.*, p. 164.

[63] M. Roemer, "The neoclassical employment model applied to Ghanaian manufacturing", *Journal of Development Studies*, vol. II, No. 2 (January 1975), pp. 75-92.

III. A framework for analysing the location of processing activities

In this chapter a framework for analysing the considerations affecting the location of processing activities is presented. First, the relevant concepts useful for a discussion of the subject are developed. The policy-making process is then analysed.

Processing activities

In our analysis,[64] each stage in a simple processing chain is called a processing activity. The phrase processing activity is used to describe a process in which a primary resource input (that is, one which when processed, along with any secondary resource inputs,[65] becomes the output of that activity) is worked on by a technologically determined combination of labour, capital and management in conjunction with utilities (especially energy and water) to produce a processed form which, after transporting and marketing, moves on up the processing chain to become either the resource input of the next stage or the final consumable output. The exact nature of the activity will be determined by the nature of the resource inputs, the output required and the available technologies. Each of the seven inputs (ignoring secondary resource inputs and assuming that all the costs involved in carrying out an activity can be attributed to one of the seven inputs) can be decomposed. For example, labour can be decomposed into skill characteristics, capital into different forms of physical and financial capital, management into entrepreneurship and administration, utilities into energy and water etc., transport into its various forms, and marketing into advertising, packaging and provision of after-sales servicing.

In introducing transport and marketing as separable processing inputs into the analysis of location decisions, the discussion moves away from traditional analysis. In the case of marketing this is simply to make good an omission of traditional analysis. By considering transport as a production input we stress its economic importance, drawing attention to the fact that products have location characteristics which help determine the competitiveness of different locations as production points for different markets. Identical products brought to a common market at a given time from different production points can be regarded as varying in their transport intensiveness or need for transport inputs.

The reason for this departure from orthodoxy can best de demonstrated by example. Thus, assume that two countries (A and B) have been producing vegetable

[64] The analysis in this study is restricted to simple chains or subchains, although it may be fairly easily adapted to complex states in explosive and implosive chains.

[65] Secondary resource inputs are those which, while required to complete the process, usually constitute only a minor part of total resource costs.

oil for their home markets and have identical linear homogeneous production functions of degree one, identical (real) input prices and identical (real) distribution and marketing costs. Both countries now consider exporting their vegetable oil to a third country market (C) which is four times further away from country A than from country B. In that case, it is more expensive, in terms of real resource costs, to produce vegetable oil for the C market in A than it is in B, assuming constant unit distance transport costs and no distortions. Country B will capture any export markets in C. Such effects of transport costs are incorporated in orthodox trade theory from the point of view of the importing country (optimal sources of supply), but in this study the intention is to focus the analysis on optimal production locations with respect to alternative markets, and it is analytically more useful to treat transport and marketing as production inputs.

Input intensity

Input intensity refers to the share of total cost of a processing activity, in a given location for a given market, which is attributed to a single input. An activity is described as being intensive in the use of a given input if the costs of using that input account for the largest share of the total cost of that activity. Thus, if the labour input into a processing activity accounts for 40 per cent of the total costs of carrying out that activity, and no other input accounts for as much as 40 per cent of total costs, the activity is then described as labour-intensive. It is important to note that different stages in a processing chain may be intensive in different inputs. In a three-stage chain the first activity may be resource-intensive, the second labour-intensive and the third energy-intensive.

For given input prices, the locations of the production point and its target market will determine the share of transport costs. The nature of the markets for the product and the producers' status in those markets will determine the share of marketing costs. The share of resource, labour, capital and utility inputs will be determined by the nature of the product and available technologies. The analysis can be simplified by making the assumption, which is realistic in the case of activities in simple processing chains, that the specification of the nature of the output for any given activity is rigidly fixed by the requirements of the next activity in the chain, for which the output is the primary resource input. While the possibility of variations in the nature of the output can be empirically significant, especially in consumer-oriented activities, the assumption focuses the discussion on the more important issue of technology.

For given input prices, available technologies will determine the relative intensity in use of each of the four inputs which are involved in the transformation processes carried out in an activity. If the technology choice facing the entrepreneur is of the Leontief type (i.e. there is no choice), then with given input prices the relative input intensities are *a priori* fully specified. If available technology allows substitution among the inputs, some knowledge of the behavioural characteristics of the entrepreneur is required before the prevailing input intensity can be determined. If the entrepreneur seeks to minimize the costs of producing a given level of output, then with given input prices the input intensity of the activity will be determined. If, however, different sets of input prices or available technology can obtain in different locations or at the same location at different times, if different entrepreneurs have different behavioural characteristics, or if the demand of an activity for a given input in one location is a substantial part of total demand for that input, the input intensity (calculated, as explained above, in terms of share in total costs) of an activity can vary among locations, over time, and in different plants at the same location at the same time.

Efficient location points

Having defined some necessary concepts, the discussion can turn to a framework within which it should be possible to analyse the issues facing developing countries when they decide to base their industrialization strategy, at least partially, on processing current exports of unprocessed or semi-processed natural resources. All such natural resources go through a series of processing stages (processing chain) before final consumption in a modified form or as a component of a complex product. Each stage in a processing chain constitutes an industrial activity in which various inputs are combined in order to carry out the processing of the resource in natural or semi-processed form.

Knowledge of availability of technologies allows the identification of the possible bundles of inputs required to carry out a processing activity. Knowledge of the prices of inputs (allowing for quality differences) in various locations will permit the identification of a ranking (efficiency ranking) of the locations on scales of total costs, including transport and marketing, for the markets for which the output is intended. However, the minimum cost location calculated in that way for a given market need not be that in which supplies of the input used most intensively in the activity are available most cheaply. The determinant of the minimum cost location, given physical input intensity requirements, will, in theory, be the variability of input prices among locations weighted by the physical contributions of each input to the activity, after allowance is made for substitution possibilities. That important point can be demonstrated with a simple example. Take two locations carrying out a processing activity where both hope to sell their output on a market in a third location, and assume that inputs are qualitatively homogeneous in both locations. Assume that the same process techniques, in terms of physical input intensity requirements, are to be used, and that the proportion of primary resource inputs, utilities, labour and capital is 65:25:5:5. Transport and marketing costs are assumed to be identical in both cases. Typical factor price conditions might be that the unit cost of labour and capital is 1 in both locations, that the unit cost of the primary resource input is 1 in the first location and 1.5 in the second, and that the unit cost of the utility input is 3 in the first location and 1 in the second. In that case, although the input in which the activity is physically most intensive is cheapest in the first location, total processing costs are lowest in the second location. The total cost ratio can be said to be dominated by the greater variability in unit costs (weight by physical intensity) between the two locations of the second input. It is important to note a serious implication of this analysis: input intensity can vary from one activity to another within a single processing chain. Therefore, an efficient location for one activity need not and often will not be an efficient location for any or all succeeding activities in that processing chain.

It may be argued that the preceding example is set in a three-country, six-factor and one-commodity pre-Ricardian world of absolute advantage, and that in a multi-commodity world the forces of comparative advantage efficiency incentives would ensure that the location with less expensive supplies of an input will establish production lines in activities which use that input relatively more intensively than in the example given. Although the point is true, there are many reasons why the activity might still be located, efficiently, in the location in question. First, there might not be any activity which uses the input more intensively. Secondly, the activity using the input more intensively might already be established at a level of capacity which already meets total market demand. Thirdly, the potentially more efficient use of the cheaper input might have entry barriers; for example its use might call for a technology which is not available to the entrepreneurs in that location. Fourthly, the potentially more efficient activity might require supplies of other inputs (including secondary resource inputs) which are not available in the amounts needed, at the original price or even at all. There are other, more complex, reasons (some of which will be discussed in later sections) why the potentially more efficient use of a relatively cheap input may not be open to a country. For present purposes, the concept of input dominance has been introduced to demonstrate that the absolute least-cost production location for a processing activity is not necessarily that location where the input it uses most intensively is available most cheaply.

In the example offered, it was assumed that for a given market, transport and marketing costs for the output of the processing activity from both locations to that market were identical. It may of course be that they are not identical, in which case the differences in such costs between the two locations may be sufficient to outweigh the difference in direct processing costs, thus making the location with the higher processing costs the lower-cost location for production for the market in question. In a situation in which there are several markets, it is clear that different locations can be lowest-cost locations with respect to different markets. This would explain why it is possible for different producers with different direct processing costs in different locations to coexist efficiently. Such a situation can also arise if the lower-cost locations have natural physical or installed capacity production limitations. In both types of situation the lower-cost producers may be able to attract quasi-rents. In fact, only in pure or near pure natural monopoly cases would one expect to find a situation in which all markets were supplied from one processing location.

To sum up, this section has argued that with given technological parameters and given production input prices in various locations, there will be an efficiency ranking of different processing locations based on the total production input costs of a given level of output. It has been further argued that when transport and marketing input costs of supplying different markets are included, the location and nature of each market will impose their own efficiency ranking of different processing locations. Further it was argued that the least-cost processing location for an activity (ignoring transport and marketing costs) need not be the location where the input used most intensively is available most cheaply, and that subsidiary inputs could have a dominating influence on efficiency rankings. It was also pointed out that the fact that a location is a minimum-cost processing point (inclusive of transport and marketing costs) for a given activity does not imply that it will be efficient to undertake the activity there.

Such will be the case if more efficient activities can be located there. Finally, it was pointed out that an activity is likely to be carried out in various locations with different total costs if the lowest-cost supplier is unable to meet total world demand.

Socially optimum locations

In a world of known actual and potential activity and market location points, with known supplies and costs of production of inputs, with known technical parameters and a known number of final products, it would be possible, albeit with some difficulty, to devise a solution in terms of the distribution of the various processing activities which would minimize the total costs of supplying the markets with a given level of output of all or any one product. The existence of known input prices and their variability among locations ensures the existence of such a solution. However, since input prices, even in a world with no government intervention, are determined by market forces derived from the existing natural and international distribution of wealth and income, and since market imperfections and externalities exist, it is unlikely that any Government or group of Governments would regard such solutions as desirable.

Each individual Government, any given group of Governments or all the Governments in the world, could in theory establish any of an infinite set of desirable distributions of processing activities. Only one of them would be the same as that which market forces alone would bring about. Such a coincidence of objectives of Governments and market-determined solutions is unlikely to occur. In reality each Government, more or less, establishes its own objectives and derives from them its plan for the development of its industrial sector. The plans are likely to be inconsistent with each other, being derived from varied political objectives, and with market-determined outcomes. While there is, in theory, scope for negotiation to prevent such inconsistencies on either a general industry or individual industry basis, experience has shown that it is not utilized. The operational significance of the inconsistency is founded in the power that individual Governments have to intervene in markets.

In sum, there is no such thing as a socially optimal locational distribution of a processing activity. Each sovereign Government with an interest in the activity will have its own notion of what distribution is socially optimal, and there is no reason why those notions should be consistent with each other, or with any internationally agreed notion of social optimality, or with the distribution of activities which would be determined by market forces. The resultant divergences between plans, and between each plan and the market outcome, provide the motive for government intervention.

Policy process

In the preceding section it was argued that at any given time there will be some theoretical geographical dispersion of an industrial processing activity which would minimize total world costs of satisfying a given level and distribution of world demand. The basic thrust of the argument was that such a market-cost minimizing solution was unlikely to be the most efficient solution because of the presence of market imperfection and externalities. Further, that solution was unlikely to be universally accepted as optimal by Governments throughout the world. Each Government will have its own conception of optimality, and there is no reason why such conceptions should be mutually consistent. This section moves away from purely abstract considerations and examines the problems faced by a single developing country Government as it seeks to identify and implement its own conception of the optimal distribution of processing activities in which it has an interest, in a situation in which the objectives and practices of other Governments and the need for efficiency impose constraints on its freedom of action.

The starting point of the analysis is the assumption that the politicians of the developing country in question are examining the possibility of establishing downstream processing activities for domestic natural resources which are currently being exported in unprocessed or semi-processed form. Assuming that there is some current export suitable for further processing, the civil servants concerned will have to face the following three basic questions. First, what is the economic viability of the technically feasible probjects for downstream processing? Second, are the economically viable projects consistent with the socio-economic objectives of the Government and with the objectives of other countries? Third, what policy measures are required to ensure that the projects are taken up?

Economic viability

The most fruitful approach to the examination of economic viability is to identify for each technically feasible project the reasons why market forces alone (allowing for policy distortions) have not already led to the establishment of that project. Such an approach identifies the problems that policy formulators and administrators will have to face and overcome if the project is to be successfully established. Those problems can be classified into the following categories: technical barriers; market imperfections; domestic policy inconsistencies; commercial viability (in contra-distinction to economic viability); and information gaps. Those categories have obvious interdependencies, which will be referred to below, but taking them separately makes the analysis more manageable.

Technical feasibility

In the pre-feasibility study stage, civil servants will need some knowledge of the technically determined input requirements of the processing activity and of the likely physical availability of those inputs in their country. All feasible versions of the necessary technology may require inputs which are not physically available in the quantity or quality required. Here the possibilities of filling the gaps through international trade (i.e. by importing the missing inputs) must be examined. Where inputs are actually or effectively non-tradeable, it may be the case that the technical requirements of the activity cannot be met. The distinction between actual and effective non-tradeability is made in order to identify strict non-tradeability as in the cases of climatic conditions and land, and effective non-tradeability because of the prohibitive costs of importing the inputs (as in the case of fresh water) or of prohibitions of one form or another imposed by the potential suppliers.

If any of the essential inputs required by an activity are not available, then the project must be rejected. This would appear to be a simple feasibility test, but there may be complications in identifying essential inputs and determining whether or not they are available. Such complications, which can take various forms, are discussed in the following sections. For the time being, however, the analysis will proceed on the assumption that all inputs required have been identified as physically available in the desired quantities and qualities for all projects under consideration.

Market imperfections

For a processing activity to be considered economically viable the Government must be satisfied that its output could be sold competitively on world markets at prices that would cover total costs. The processing activity may not already be established either because input prices are too high or because the output price on world markets is too low to support competitive and profitable production. The cause may be imperfections in the input or output market. Alternatively, there may be such imperfections in the technology market that the technology is either not available to the country, or only at a price which would make the activity uncompetitive. The consequences of those imperfections will be discussed separately, attention being given first to imperfections which distort input prices.

The standard economic theory of market imperfections demonstrates why the prices of the same input may vary from location to location. Such variability may, in the language of the preceding section, shift input dominance away from inputs which have relatively low prices, or which are readily available, in a given location to inputs which have relatively high prices, or which are relatively scarce, in that location. Variations in input prices, introduced by market imperfections, may be sufficiently large to result in alterations in the total cost rankings of the alternative locations for a processing activity. Such a situation is illustrated in table 15, which reflects a pre-imperfection situation in two locations A and B, in which the total input costs for a given unit of supplies to a given market are 95 in A and 90 in B. An imperfection is now introduced which raises the price of input 2 in location B from 20 to 30. Thus the imperfection converts the producer in location B from the lower-cost to the higher-cost supplier (even though it remains the lowest-cost location for supplies of input 1, the input used most intensively), and dominance has shifted from input 1 to input 2.

TABLE 15. HYPOTHETICAL INPUT COSTS AT TWO LOCATIONS

		Costs at two locations (hypothetical units)		
Input		*A*	*B*	*BI*
1		55	50	50
2		20	20	30
3		5	5	5
4		5	5	5
5		5	5	5
6		5	5	5
	Total	95	90	100

There are many forms of price-raising imperfections, although the common denominator will normally be some degree of monopoly control over the supply of the input. The following paragraphs give illustrative (but non-exhaustive) examples of such imperfections in each of the input markets being considered in this study.

Imperfection in primary resource input markets

Supplies of the primary natural resource input may be controlled by a monopolist, domestic or foreign, who practises price discrimination by offering lower prices to foreign purchasers of the unprocessed form of the natural resource. Price discrimination may exist for many reasons, for example, where domestic monopolists benefit from export incentives. Or foreign monopolists exploiting the natural resource may be vertically integrated TNCs supplying the natural resources to subsidiary processing firms abroad which they wish to favour through price discrimination. For both domestic or foreign monopolists there may be opportunities for corrupt practices in foreign trade not available in domestic sales, and they might therefore be keen to seek direct export opportunities by offering lower prices abroad, the lower prices being compensated for by the income from the corrupt practices. Similar reasons can be put forward to explain why the prices of secondary resource inputs might be higher in one location that in another, only in this case it might be that supplies are obtained from abroad where the monopolists may operate the reverse discrimination–higher prices for the location being considered than for domestic or other preferred users.

Imperfections in other input markets

Price-distorting imperfections exist in the capital market in both its financial and physical form. The restricted number of controllers of domestic financial capital in most countries can, in the absence of effective government control, discriminate among applicants and vary access to, and the cost of, supplies of financial capital. Restricted access to foreign exchange can lead to similar distorting imperfections.

In the case of utilities–water, electricity, gas, oil, roads and other forms of infrastructure–their nature is such that they tend to be supplied on a purely monopolistic or almost purely monopolistic basis in most countries. The major price differences between locations in such cases result partly from different production planning cirteria and partly from different pricing policies practised by (or imposed on) the suppliers. For example, where the Government is the supplier, it may operate cross-subsidization or general subsidization schemes, or it may impose user charges for infrastructural services or carry the cost on general revenues. In the case of energy, the price differences between locations will partly reflect the extent of competition among different forms of energy available.

The marketing input is such a heterogeneous category of inputs that it is not possible to say more than wherever monopolistic elements occur there is a possibility that pricing practices may discriminate among purchasers in different locations.

It is known that discriminatory pricing practices are operated by airlines and sea freight suppliers. Those practices result in different unit costs per mile being applied to different locations and different types of cargo. Thus unit costs may vary at different stages in the same processing chain. Unit costs may also differ on different land (road, rail and river) routes according to whether the different countries en route act as monopolists and charge different taxes on the right to use such routes, or the actual suppliers of the transport service follow discriminatory pricing policies.

Technical inputs

The preceding paragraphs have demonstrated how imperfections in input markets can have differential locational effects, thus upsetting rankings of locations according to unit total costs of production of given levels of output desired for given markets. It may also be the case that the market for the technical knowledge on how to combine those inputs in a cost-minimizing way will be affected by imperfections. One example of such an imperfection was referred to earlier, the case where machinery prices were affected because the technical knowledge embodied in them was covered by patents, or because they embodied unpatented but secret technical knowledge. Similarly, access to the technology might be not through the machinery itself but through skilled managers who have knowledge of how to establish the processing activity efficiently. In all such cases, the overseas owner of the technology has a monopolistic control over access to that technology and can establish the price at which, or other conditions on which, he is prepared to make it available. In such a situation the owner of the technology may well sell or rent the technology to some purchasers only at prices (for machinery or designs) or rental fees (royalties, management fees etc.) which raise the current capital costs to a level where it would be uneconomic to carry out the activity in locations which are discriminated against. The nature of such discrimination will depend on whether or not the owner of the technology is himself engaged in carrying out the processing activity. If he is, then his strategy will be to limit potential competition. Alternatively, the owner may sell or rent the technology on a market segmentation basis, or according to co-operative agreements, which protect his own business and raise the cost of the technology to entrepreneurs in potentially competitive locations. If the owner of the technology is not involved in the activity himself, possible because the technology is not activity-specific but applicable in non-competing activities, then there will be an incentive for him to sell or rent to the highest bidder on a sole right, or similar, basis. Whenever entrepreneurs in a given location face monopolistic ownership of crucial technology, they may be confronted by prices or conditions which would make that technology uneconomic in that location. The development of duplicate technology may be feasible but uneconomic. Moreover, the technology may have been developed in a location with a different spectrum of input prices and qualities. The prices and qualities of the inputs available in the new location might make the application of that technology in that location uncompetitive. In all those cases it may appear, *a priori,* that using existing technology as it is, or suitably adapted, the new location would be a competitive supplier of the output of the activity. That position may, however, be non-attainable because monopolistic ownership of the technology restricts access to its use or raises the cost of using it (in its existing or adapted form).

Imperfections in the output market

Imperfections in the markets for inputs and technology may raise total costs above world prices. That may explain why the activity has not been established in that location. However, even if the sum of any such cost increases wei insufficient to remove the competitive advantage of a location at current world market prices, the activity might still not have been established because imperfections in the output market make world market prices unobtainable to entrepreneurs in the location under consideration. Products become more differentiated as they come closer to the final consumption point, where the location of production may itself become grounds for discrimination by the consumer.

In addition, new suppliers at higher stages in the chain have to compete against existing suppliers with entrenched brand names, consumer images and loyalties, and traditional supplier commercial relationships (where buyers know their suppliers in the sense of having a degree of confidence in quality continuity and delivery data performance). Furthermore, downstream markets are more likely to be characterized by monosony either because of the entry costs (advertising to establish brand names or supplier images) already referred to, or the costs of acquiring, in the final stages, orders from the limited number of wholesalers or retailers and distribution networks.

In the case of intermediate goods, new suppliers have to offer buyers incentives to offset the uncertainties, concerning quality and ability to meet delivery dates, inevitably associated with their very newness. The consequence is that new suppliers have to make their product attractive by offering discounts or by absorbing market entry costs which (for a time at least) lower their effective price realizations. The lower obtainable world market prices, even if only temporary, may be sufficiently large to explain why an activity has not been established in a new (actually or potentially) lower-cost location, and why given markets continue to obtain given levels or expanded levels of supplies from older higher-cost locations.

In some locations the processing activity may be owned by, or involved in some other form of co-operation with, the buyers in given markets, so that the new location will have to offer a total package of lower prices or some form of profit-sharing arrangement in order to induce the buyer to shift his source of supply and forgo his investments in the other locations. Alternatively, the new location would have to take on the market entry costs of entering into direct competition. Again, the estimated impact on local effective net realization might be such as to have militated against the establishment of the activity.

In sum, although a straight comparison of the physical requirements of current technology with physical availability of inputs may seem to indicate that a location would be economically attractive for a given activity at current world market prices, imperfections in the markets for technology, for production, transport and marketing inputs, and for the output, may have, individually or in some combination, a major impact on returns to that activity, sufficient to make it uneconomic in that location.

Policy conflicts

The existence of market imperfections is not the only reason why a processing activity may not have become established in an apparently economic location. The civil servants examining the reasons for the non-establishment of processing activities should be aware of the possibility that government policy itself may have prevented establishment. That is because the overall policy framework within which individual processing activities must operate is designed to achieve many other objectives. It is frequently the case that policies established to move the system towards one objective are completely or partially inconsistent with the preconditions for other objectives. This section will examine each inconsistency in turn and illustrate them with commonly found examples. It should be noted that civil servants are not assumed to have neglected questions of overall policy optimality. The aim is to identify specific inconsistencies which have apparently prevented the establishment of processing activities by making them effectively unprofitable to the entrepreneurs who might have established them. Thus, the concern will be with policy inconsistencies that raise input prices or physically restrict access to such inputs; that impose conditions that either raise overhead costs or in specific instances prove impossible to meet; or that lower net price realizations from the sale of outputs. Issues concerned with the reconciliation of policy inconsistencies will be examined below in a separate section. The present analysis is restricted to the uncompensated impact of such inconsistencies.

Raised input prices

Import substitution

Policies relating to overall industrial development may raise prices of, or restrict access to, supplies of inputs. Many developing countries follow an overall industrial strategy of import substitution involving the protection of domestic industry from foreign competition by a structure of tariffs and other import restrictions. The domestic prices of the output of protected industries will tend to be higher than imported substitutes, so that where such inputs are used in processing activities, their total operating costs will be raised, perhaps sufficiently to prevent them from being established.

While the price-raising effects of import substitution policies are most obviously observed in the markets for secondary resource and capital machinery inputs, they are also potentially present in all other input markets. In primary resource and utility input markets, the price of capital used in the activities producing those natural resources and utilities may be affected. In the case of marketing, the effect may appear where physical inputs such as packaging and labelling materials are required, and in the case of transport markets, where domestically owned freight facilities are protected as a matter of policy. Import substitution policies can also raise the cost of labour to a processing activity. The higher prices of consumer goods will affect real wages so that increased money wages are required to attract domestic or foreign labour.

Pricing and industrial policy limitations

Natural resource input costs may be raised by pricing policies such as the establishment of minimum prices for certain, usually agricultural, commodities. The purpose is generally to attempt to ensure minimum incomes for the producers of the natural resources, but one direct effect is to raise the cost of such products to processing activities. An indirect effect also occurs if the product with the minimum price competes for productive resources with other products which could provide the basis for a processing activity. Such a situation is frequently encountered in agriculture, and the consequence is that the processing activity has to pay a higher price for its natural resource input to ensure adequate supplies of that input in the face of competition for the productive resource (land) from the product with the policy-imposed minimum price. Therefore, the processing activity might not be competitive at given world market prices for the processed output, and hence in this case, and all other cases of price raising, all activities further down the processing chain would have a cost bias introduced against them.

Where price controls establish maximum prices for the domestically sold output of an activity, the possibility exists that such controls might impose losses on domestic sales sufficiently large to offset profits on exports to the point where no entrepreneur would consider it worthwhile to establish the activity in situations where profitable access to the domestic market formed a significant part of the overall profitability calculations.

Policies opposed to monopolies, foreign partnership and dominance, and favourable to small-scale undertakings, can raise the prices of inputs to the point where processing activities become uncompetitive on world markets, if the price effect on the policy is relatively large or the output of the affected industry is used intensively in the processing activity. Such situations will arise if there are significant economies of scale in the industries affected by those policies, economies which cannot therefore be realized. The cost-raising effects of the policy-imposed scale of operation at less than minimum cost will be passed on in the form of higher input prices to processing activities further down the processing chain.

Fiscal policy

The fiscal policy of a country may impose a tax structure on industrial activities such that the effect of indirect taxes on input prices may make some processing activities uncompetitive on world markets if the firm tries to pass on the taxes via higher output prices, or unprofitable if they have to be met out of revenues obtained at current or discounted world market prices.

With regard to the impact of selected policies on input prices or access to inputs, the effects of each policy were considered independently and in national isolation. It may well be that several input-price-raising policies operate simultaneously with a corresponding effect. It may also be the case that even if the sums of such cost-raising policies were insufficient in themselves to make a processing activity uncompetitive at current world market prices, with or without new entry discounts, they may well be sufficient if other countries with competing locations for any activity are operating policies which reduce input costs for that activity. The existence of locations for an activity in other countries in which input prices for that activity are increased by less than they are in the country under consideration may explain the non-existence of an apparently profitable processing activity.

Government-imposed conditions of operation which raise costs

Other government policies may set out conditions which processing activities must meet if they are to be allowed to develop. Clearly, another possible reason why a specific activity is not found in a given location is that such conditions have either prevented it from being established or have imposed costs which the entrepreneurs felt unable or unwilling to meet. Commonly found examples of such policies include: policies towards foreign investment, monoply and the small-scale sector; regional and anti-urban congestion policies; and, more indirectly, policies towards bureaucracies and political control of industry in general.

For reasons which do not concern us here, the Governments of many, if not most, developing countries treat companies which are foreign-owned, or which have some other form of foreign participation, differently from the way in which they treat purely domestic concerns. The differential treatment takes the form of conditions which the firms with foreign involvement must meet if they wish to establish and operate in the territories concerned. Such conditions can include minimum local shareholding; participation in management by nationals; requirements for introducing new technology; the imposition of minimum levels of domestic value-added; the establishment of training schemes by foreigners to train nationals to replace them; the impositions of controls over the repatriation of capital and transmittal abroad of royalties, interest, dividends and fees; and the imposition of binding production targets or export obligations. To the extent that foreign investors or participants possess some degree of monopolistic control over entry to an industrial processing activity, and that the foreigners regard such conditions as unacceptable interference, then there will be a possibility that the activity will not be established in an otherwise minimum-cost location. The likelihood of non-establishment will be increased if there is an alternative location, where, even though direct costs are higher, the package of conditions offered is considered sufficiently less restrictive to outweigh the higher costs.

Anti-monopoly policy has already been referred to above in connection with the impact it can have on input prices. It can also affect the economies of a processing activity directly by raising processing costs, if, for example, it is imposed in such a way as to prevent firms from reaping economies of scale or of vertical or horizontal integration. Similarly, policies reserving certain activities for the small-scale sector, when those activities are characterized by significant technical economies of scale, will militate against that location becoming internationally competitive in those activities. On the other hand, policies which fail to provide adequate support, for example with respect to infrastructure, utilities or financial capital, for small-scale firms might prevent the establishment of processing activities in which small-scale firms would otherwise have a competitive edge. In all three cases activities which may appear to the civil servants carrying out evaluation exercises to be economically viable may not have been established because of such policies, or distortions in the market created by them.

Many developing countries apply regional policies that impose conditions as to the locations where new industries must establish, or that will only provide basic infrastructure and utility services in certain locations. Similarly, several developing countries operate anti-urban-congestion policies or environmental policies that limit the areas of location for processing industries. Such policies, however well-intentioned and desirable on social or political grounds, can and do increase the costs of carrying out processing activities. For example, they may raise transport costs for inputs and outputs, increase warehousing costs or labour costs, where labour in the imposed location has a lower productivity, and increase utility costs by imposing the need for expensive back-up energy supplies. Wherever processing costs are raised in that way, it is possible that an activity which would have location on a site of the firm's own choosing might not be established at all if the firm considers that the extra costs involved in locating at a site selected by the Government under its regional or environmental policies are such as to make the activity uncompetitive on world markets.

Finally we come to two non-economic conditions of operation for industrial processing activities, which are much neglected in the literature but which are important all the same. The first is the way in which many developing countries administer the different components of their industrial and related policies through bureaucracy-intensive licensing and certificate systems. Such systems, in some developing countries, are extensive, and the civil service administering them is understaffed and sometimes lacks experience. As a result, the following situations occur: substantial delays develop between applications for and issuance of licences and certificates; firms carrying out industrial activites have to hire special extra staff simply to meet the form-filling requirements, and divert managerial time to supervising and controlling contact with the licensing system; and arbitrary elements are introduced into the industrial development process. Delays add to costs by tying up capital unproductively and by allowing market openings to be missed. The need for extra staff and managerial time obviously adds directly to operating costs, and the element of arbitrariness introduced created uncertainties which may develop to the point where risk-averse investors may find it unacceptable. Those factors, singly or in combination, may be sufficiently significant in given locations to act as a deterrent to the establishment of industrial processing activities.

Reduced price realizations from sale of output

The third type of policy-induced distortion can reduce net realizations from sales of processed output, for example, by intervening between the activity and the world market and preventing the entrepreneur from obtaining world market prices. Such a policy may require the output of an industrial processing activity to be sold on world markets via marketing boards or agencies that set domestic prices for the output at less than the prices obtained in world markets. The difference between the two prices, which may be required to cover marketing board or agency costs, or to provide revenues for the Government or co-operative, may be sufficient to prevent establishment. Similarly, a fiscal policy that imposes taxes on exports of processed natural resources in situations where the taxes cannot be passed on as higher prices will lower the net income accruing to the owners of an activity, possibly to the point where they would not consider it worthwhile establishing. Finally, with regard to the exports of the output of industrial processing activities, the revenues from the sale of such exports will accrue in foreign exchange which has to be converted into domestic currency in order to cover the costs of the activity. It is possible that the Government may operate an exchange rate policy which maintains that rate at an artificially high level, thus reducing net domestic currency realizations from given foreign exchange earnings, possibly to the point where such realizations would be insufficient to cover the costs of some processing activities which would not therefore be established.

In conclusion, government policies may directly raise input prices and therefore total costs, or lower revenue from sales, to uncompetitive levels. Governments, through their policies, can also set conditions to be met by industrial activities which are sufficently unattractive or cost-raising to be unacceptable to the entrepreneurs concerned.

It may be the case, however, that having carried out their evaluations, the civil servants have not been able to identify market imperfections and government-imposed distortions or conditions that, taken singly or in combination, would make the activity economically unviable. Non-establishment of processing activities may then become explicable if questions of private commercial viability or of information gaps are considered. Either may explain the apparently paradoxical non-establishment of an economically viable processing activity. Those two issues are dealt with in the next two sections.

Commercial viability

In the preceding section it was assumed that the test of economic viability depended upon the current market prices for inputs and output, the policy framework and whether the project could meet a given level of export demand and cover total costs. It was also assumed that the decision to establish a specific activity would be taken by private sector entrepreneurs. Although that assumption will be dropped in a later section, it will be maintained for the time being.

Economic viability will be a necessary condition for establishment, but the assumption must now be dropped that, on its own, it will be a sufficient condition. In reality, the test used by entrepreneurs will be based on how much net total realizations exceed total costs, and how that margin, which will be loosely referred to hereafter as the private rate of return, compares with margins in other activities in the same location or with any activities in other locations. The test is of the commercial viability of a projected activity for the specific entrepreneur who is considering investing in its establishment. In this section attention will be focused on the nature of variations in rates of return, and on the characteristics of entrepreneurs.

When assessing the commercial viability of an investment, a private entrepreneur can make the following rate of return comparisons: between different activities in a given location (including non-industrial activities and portfolio or property investment); between different locations for the same activity; and between different activities in different locations. The perceptions of different entrepreneurs concerning the potential rates of return may well differ for the reasons discussed below. For the time being, the analysis will discuss the various comparisons as if they were all possible to all entrepreneurs, even though in practice some theoretically possible opportunities will not be open to every entrepreneur in question.

Comparisons between different activities in the same location

It is self-evident that the rates of return on different industrial activities in a given location will vary, and that some rates of return from investments in industrial activities may be less than the perceived rates of return from portfolio or property investment. Variations will depend on respective world market prices and costs. Those costs will be determined by technologically based input requirements and input prices, and by transport and marketing requirements. In addition, the market imperfections, policy distortions and policy-created limitations discussed in previous sections can have differential impacts on different activities. It is clearly possible that any single natural resource processing activity would not be seen to offer a sufficiently attractive relative rate of return to induce an entrepreneur to invest in its establishment.

It is still possible than an activity may offer a higher rate of return than all or most other investment opportunities and yet not be established. For example, an entrepreneur might consider that because of uncertainty concerning the future availability or prices of inputs, or the policy treatment of the activity concerned, the relatively high rate of return currently available from the activity was unlikely to be continued in the future. Similarly, the entrepreneur might consider that market developments such as the growth of competing activities in new locations will reduce the future rate of return.

Comparisons between different locations for the same activity

The preceding example implicitly assumed that the decision of the entrepreneur was location-specific and thus an operational one. In the present instance, determinants such as input supply conditions, output market conditions, and market imperfections and policy distortions can lead to differential rates of return. A single difference in those determinants, with all others the same, would be sufficient to result in different rates of return being obtainable in the two locations from the same activity. Obvious examples would be different input availabilities, different transport input requirements, different tax treatment of profits, or different treatment of foreign participants. A less obvious example would be discriminatory treatment of exports from different locations going into third country markets (discussed more fully below).

As in the case of the first comparison, a higher rate of return in one location may not be sufficient to attract entrepreneurs to invest in that location. Uncertainty about future relative rates of return might render an otherwise attractive location less so. Another frequently overlooked, non-economic condition is the nature of the political environment in which the locations are set. Locations where political priorities are frequently changing, so affecting the policy environment within which industry has to operate, may be less attractive, despite higher rates of return, than those where the policy framework is stable. Decisions to invest are made on the basis of long-term calculations.

The above-mentioned examples are sufficient to illustrate the fact that locations which offer higher rates of return to investment in a processing activity may be ruled out by entrepreneurs as politically unattractive.

Comparisons between different activities in different locations

Rates of return in different activities in different locations may be compared by entrepreneurs who are neither specialized in one activity nor bound to any one location (for example, a diversified TNC, as discussed below). The previous analysis of differential rates of return will also apply in that case. Moreover, a given activity in a given location, while offering a positive and even relatively high rate of return, may compare unfavourably with activities giving higher, less uncertain or more secure rates of return in that or other locations.

Types of entrepreneurs

Throughout this study the word entrepreneur is taken to refer to that person in private firms who is responsible for taking the decision on whether or not to invest in the establishment of a natural resource processing activity. The decision of an entrepreneur on whether to invest will depend not only on the market conditions and government policies already discussed but also on the nature of the firm the entrepreneur owns or works for. Types of entrepreneurs and firms considered as having significant distinguishing characteristics in this study may be described as: specialized or diversified; small-scale or large-scale; monopolistic, oligopolistic or relatively competitive; domestic or foreign; and those with or without scope for vertical integration. Those characteristic types are not mutually exclusive. The one common denominator is that all types of entrepreneurs require a project to have prospects of commercial viability.

However, it is more than conceivable that different entrepreneurs, carrying out their own evaluation of the commercial viability of the same natural resource processing activity, would perceive different potential rates of return and evaluate perceived rates of return in different ways. They could do so for a variety of reasons, of which four examples follow. First, their evaluations as to availability and prices of inputs, and access to and prices attainable in different markets, could vary because of differences in the information available to them. On availability, prices and access may in fact differ from one entrepreneur to another. For example a small unknown entrepreneur in a developing country is likely to find access to financial capital more difficult, and its cost higher, than would a large well-known TNC. Secondly, because of imperfections, different entrepreneurs may have access to different technology. Thirdly, some entrepreneurs might be able to integrate the activity vertically or horizontally with other activities under their ownership or control, and thus reap the economies which can accrue to such integration. Fourthly, some imperfections or policy-induced distortions, such as pro-small-scale, anti-monopoly, anti-foreign-participation policy instruments, may affect different types of entrepreneurs in different ways so that rates of return will vary between them.

It might also be the case that different entrepreneurs evaluating investment in the same natural resource processing activity in a given location would perceive the same rate of return as being available but would react to it in different ways. Some entrepreneurs might conclude that a given rate of return indicated commercial viability while others might conclude the reverse. Estimates of the economic uncertainty or the political insecurity of obtaining the given rate of return for a reasonable period of time may vary. Similarly, entrepreneurs will differ as to risk aversion. Hence, entrepreneurs may differ in their estimates of whether or not that given rate of return indicates commercial viability. One further distinction should be made. Entrepreneurs who are nationals of, or domestically based in, the country in which investment is planned will evaluate its rate of return in terms of the domestic currency. Those based elsewhere will evaluate it in terms of foreign currency. To the extent that there are limitations on the proportion of a pecuniary rate of return which can be converted into foreign exchange and remitted to the foreign base, the two types of entrepreneur will have different commercial evaluations of the same rate of return specified in the domestic currency of the country in which the investment is located.

What represents an acceptable level of commercial viability can therefore be shown to differ among types of entrepreneur. However, the requirement of commercial viability is still the common denominator which distinguishes all private sector entrepreneurs from managers of state-owned or publicly controlled enterprises.

The basic significance of drawing attention to the existence of different types of entrepreneurs and firms, distinguished by the above-mentioned characteristics, is that only a selection of firms has the technical ability to efficiently operate any given natural resource activity. That being the case, the civil servants evaluating the economic viability of a projected activity will have to identify which firms have that technical ability and how the characteristics of those firms will affect their evaluations of the commercial viability of the activity. Civil servants will need such knowledge in order to understand why the activity has not already been developed, and what type of measures, if any, would have to be taken to induce firms to establish it.

Information gaps

The final, but in practice all-important, reason why a natural resource processing activity may not have been established in a given location is the existence of information gaps. So far in this study it has been assumed that those evaluating the economic or commercial viability of such a project have access to all information required to carry out their evaluation, although the possibility that different evaluators may have access to different information or may interpret information differently was allowed for. In reality, however, much of the information required to carry out a comprehensive evaluation will be unavailable or expensive to locate. When such information gaps are present, the evaluators will find them with guesses or projected data, but then an element of uncertainty will become associated with the project, possibly sufficient to induce risk-averse entrepreneurs to abandon projects offering an acceptable rate of return, but calculated on the basis of soft (tentative) data.

The most obvious type of data gap is that concerning the availability of the natural resource and other inputs, in terms of their prices, quality and quantities. When it is recalled that the analysis is directed to cases of natural resource processing activities which have not been established, it will be appreciated that evaluations of the economic and commercial viability of carrying out such an activity in the future will depend on data as to the likely future availability of the required inputs and their prices and quality. Such data must be soft and depend on assumptions as to many factors which will affect the future supplies, quality and prices of the activity inputs. Assumptions may have to be made on such issues as the adaptability of a labour force, political reactions to a restructuring of agricultural crop prices, the technical feasibility of exploiting new mineral deposits, the operating efficiency of new power installations, or even the timing of the availability of new utility facilities, such as a harbour. The required information will include many unknowns, so that there will be scope for varying interpretations as to the economic or commercial viability of a projected natural resource processing activity. Disagreements may then occur, for example where government evaluators use optimistic assumptions and arrive at the conclusion that the projected rate of return is highly positive, while a commercial evaluation of the same project carried out by an entrepreneur on more pessimistic assumptions might lead to a projection of a negative rate of return.

The second type of information gap which may seriously affect the relationship between the projected and actual economic and commercial viability of an activity is that concerning the existence, operating costs and input requirements of the technology to be used in the processing activity. Government officials or entrepreneurs may have information as to the availability of techniques which could be used. But the information of one or both groups may be incomplete, in that there may exist other techniques that are newer or would be more appropriate to local conditions and offer increased efficiency over the techniques allowed for the evaluation processes. In such situations, the location will prove to be less competitive on world markets, compared with locations where the more appropriate or newer techniques are employed, than was expected at the time the economic and commercial evaluations were made.

Alternatively, evaluators may lack information (or it may not exist) as to the adaptability of the known available technology to local conditions, so that projections of operating costs may prove inaccurate. Moreover, the degree of optimism inherent in the evaluation will lead to varying estimates as to potential competitiveness. In the absence of hard data, assumptions must be made about sensitivity of operating costs, variations in the quality of inputs (e.g. type and degree of impurity), variations in capacity utilization and economies of scale, the use of batch rather than continuous production runs, or variation in temperature, altitude or atmospheric conditions (e.g. humidity).

In both cases awareness of the information gaps and of their insignificance will lead both groups of evaluators to appreciate that their calculations are tentative only and subject to unknown degrees of uncertainty. Sometimes one group of evaluators, for example the civil servants, will take a more optimistic position and consider a project viable while the other group, the entrepreneurs, will calculate that it is non-viable or that the risks of it proving non-viable are too great to be acceptable.

The third type of information gap that must be filled with estimated data in order to carry out evaluation exercises concerns market potential. There are very few projected activities established under contracts involving guaranteed markets, and most will have to be evaluated on the basis of estimated market potential in terms of likely demand, prices, and destinations. While market research analysis can help define market parameters, such exercises are so questionable that few definite conclusions can be drawn from them with respect to potential sales and prices for the output of any one activity in a given location. Thus, while civil servants may argue, on the basis of commissioned market research reports, that market prospects are sufficient to justify the establishment of an activity, the potential private investors in that activity might well question the conclusions of the reports or not regard them as establishing the commercial viability of carrying out the activity in that location.

The fourth type of information gap concerns the hard data used in evaluation exercises, that is, known values of variables such as prices of existing inputs, capital equipment, and outputs. Such data correspond to market values and incorporate the effects of market imperfections and policy-caused distortions. Frequently, it will not be possible to break down the data on market prices into its components, or to determine whether or not apparent market prices are actual market prices in the sense that they are the prices at which transactions actually take place. Without knowledge as to how existing prices are determined, or what in fact they are, it is difficult if not impossible to estimate the effects on those prices of the introduction of the projected activity. This is significant because in most developing countries a single new industrial activity will be non-marginal, in the sense that on either an industry-wide or a sectoral basis it will be a significant force in the market for inputs and will have an impact on the various forces which determine the prices of those inputs. That impact will affect both the basic supply and demand relationship and the outcome of imperfections and policy distortions in the input markets. Unless the qualitative and quantitative nature of such influences on prices is known, the qualitative and quantitative nature of the impact of the new activity will be difficult to predict, and it will therefore be difficult to assess with any degree of confidence the economic or commercial viability of the projected activity.

The fifth, and final, type of information gap is the most obvious one. Potential investors in an activity, or the civil servants, may be totally unaware that economic and commercial potential for an industrial processing activity exists. In the case under consideration, that of civil servants being asked to examine the possibilities of establishing a processing activity for natural resources currently exported in raw or semi-processed form, the nature of the processing activity may be so different from the general type of industrial activities currently pursued in that location that the commercial possibilities may never have occurred to entrepreneurs. Entrepreneurs must establish industrial activities in locations where the available information indicates that they will be able to earn an acceptable rate of return, and where what is acceptable reflects economic and political uncertainties. Clearly, if the information that a location offers a superior rate of return is unavailable, they cannot consider locating the activity there.

In this section it has been argued that the existence of various types of information gap can result in the non-establishment of an industrial natural resource processing activity in a given location. The common denominator of the five types of information gap presented is that they prevent the accurate assessment of the economic or commercial viability of projected activities. The consequent uncertainty of the likely rate of return will, in conjunction with the reluctance of entrepreneurs to take risks, have a dampening effect on investment, to the point where some activities, in which information gaps or perceived risk due to ignorance are greatest, are not established.

Conclusions

This analysis has attempted to show how civil servants might respond to a request from their Government for evaluation reports on why industrial processing activities have not been established in their country to process or further process natural resources exported by the country in raw or semi-processed form. It has been argued that civil servants faced with such a request would respond on an activity-by-activity basis, estimating whether or not the costs of carrying out the activity could be covered by projected revenues from sales, thus indicating economic viability.

The analysis set out reasons why a given location could prove to be economically non-viable for a given processing activity. First, there may be physical constraints. One or more essential inputs may not be physically available, or may be non-tradeable or only available as imports at prohibitively high prices. Second, it was argued that various types of market imperfections and policy-imposed market distortions could raise costs to the point where an activity would be economically non-viable. Third, a distinction was made between economic and commercial viability, where the latter was defined as being determined by the size of the margin between total revenues and total costs and its economic and political security, in comparison with the equivalent margin obtained from other activities or in other locations. Thus the fact that a project is shown to be economically viable is not a sufficient condition to ensure that a private entrepreneur would invest in the establishment of that activity. In addition to the straight relative rate of return offered by an activity, it was argued that various other factors, such as political and policy stability and foreseeable shifts in technological determinants, affect the assessment of entrepreneurs of the private commercial viability of investment in an industrial natural resource processing activity.

The whole analysis was carried out on the assumption that hard data was available to the civil servants and entrepreneurs to enable them to carry out their economic and commercial evaluations. The final section pointed out that the real world is in fact characterized by information gaps which to varying extents replace such hard data with soft data in the form of estimates. That introduces an element of uncertainty which makes the calculation of expected rates of return subject to interpretation by risk-averse entrepreneurs in such a way as to prevent a project, which appears attractive on paper, from being undertaken.

The evaluation carried out t the civil servants ends with their submitting a report to the Government in wh they set out the nature of the requirements of the activity evaluated, assess wh r or not those requirements could be met in a location in their country on an nomically viable basis, and, if not, identify the factors which make it non-viable. report would also identify the entrepreneurs, if any, with the capability of establ ing the activity, and assess whether or not the activity appears to those entrepren urs to be commercially viable. The factors on which the entrepreneurs base a negative assessment leading to the non-establishment of the activity may also be identified. On the basis of the report, the Government then has to decide whether it should intervene in the market to ensure that the activity is established. The criteria which the Government might draw on in making such evaluations are the subject matter of the next section.

IV. Policy formulation

This chapter, drawing on the foregoing analysis, considers the general policy decision to limit or encourage a development approach that stresses RBI. It then turns to specific policy measures that may be invoked to encourage the establishment of further processing capacity.

Presented with reports assessing the economic and commercial viability of a given natural resource processing activity where none currently exists, the Government has to make a policy decision as to whether or not to intervene to achieve its objective. It must first decide whether the non-existence of the activity is the result of its economic objectives. It may well be the case that government-imposed market distortions, discussed earlier, have themselves created market conditions which led to the negative economic and commercial evaluations. Where negative evaluations were intended by the Government, it would imply that non-existence of the activity is consistent with its objectives. But non-establishment of the activity may also have been an unforeseen and unintended consequence of policy distortions introduced for other reasons or prior to the decisions to encourage establishment of local processing capacities.

Policy implications

Desired and foreseen non-establishment

It has already been shown how market distortions can lead to situations in which a potential natural resource processing activity will not develop because those distortions have a negative impact on economic and commercial evaluations of the project. That occurs where the Government considers some other allocation of resources preferable to that which would have resulted from the free allocative play of undistorted, but imperfect, market signals. Provided the Government understands the full implications of its desired allocation of resources, it can be said that the non-establishment of the activity was foreseeable and desired.

The following are examples of situations in which the non-establishment of a given activity is fully consistent with government objectives. First is the extreme case where a Government has decided that domestic ownership of all industrial activities is an economic aim derived from its political objectives. If foreign ownership is prohibited, activities which can only be established on the basis of foreign ownership because of market imperfections will not be established, and such an outcome will be desired by the Government. Similarly the Government may have established policies which set minimum levels for domestic value added, or limit payments for foreign royalties, or prohibit domestic sales, or restrict new investments to activities based on new technology. In such instances it can be said that any activity which does not meet such criteria will not be established because the Government intended that they should not be established. Thus, it can be assumed that the Government has applied its social weights for different allocations of resources in order to evaluate the trade-offs between the establishment and non-establishment of the activities and has consciously concluded that non-establishment was the preferable outcome.

Undesired but foreseen non-establishment

It is possible that a Government might decide to adopt policies which will clearly lead to the non-establishment of certain activities, although it would prefer to see such activities established. That would be an undesired outcome of policies designed to achieve other foreseen and desired allocation results. It can be argued that all cases of undesired but foreseen non-establishment are due to policy instruments which have the capacity to discriminate among types of entrepreneur or activity. Across-the-board industrial protection policies may discourage the non-establishment of export-oriented resource processing activities which the Government would, in principle, endorse. Such policies (in the absence of political constraints against them) could be modified to provide differential incidence of distortions such that the desired activities would be established and the undesirable activities would not be established.

Desired and unforeseen non-establishment

Of greatest significance in the present context are those activities which the Government would like to have seen established but which have not been established because of unforeseen policy consequences in the market. They will be of two types. First, unforeseeable changes in market conditions relevant to the activity may alter the impact of government policies. In a world characterized by stochastic processes there will be many such cases, and the only policy response required is adaptability to changing circumstances. The second type is of much more interest. Here desired activities may not have been established because of the theoretically foreseeable but actually unforeseen consequences of distortions. Non-establishment is frequently due to the impact of distortions created by policies directed at achieving resource allocations not considered to be relevant to the processing activity in question. The complexity of inter-dependencies of the economy may mask the relevance of the apparently independent distortions. Consequently the trade-off calculations based on social weights would not be carried out and no adjustments would be made to the original policies.

A simple example of such a situation would be one in which an agricultural income support policy for growers of a major food crop raised the price, by lowering returns and therefore acreage, of a secondary crop competing for the same land. The price increase of the secondary crop might be such as to push the costs of an activity processing that crop up to the point where domestic processing would not be competitive on world markets. A more complex example would be where policies designed to attract large inflows of foreign aid or private capital lead to an overvalued exchange rate that reduces both the potential domestic currency earnings of export activities and, consequently, the attraction of investing in those activities, except where the aid or private capital is used to provide subsidized finance for the activity in question.

Social weights

Governments can, within limits (discussed below), override the dictates of the market. They can carry out a social evaluation of the original assessment of the economic and commercial viability of proposed natural resource processing activities. If it indicates that an economically or commercially non-viable project would be socially desirable, then the Government can intervene in the market indirectly via new distortions or directly as an entrepreneur to bring about the establishment of that activity. Taking into account the explanations given by civil servants as to why certain activities are not already established, the Government can consider methods of bringing about the establishment of those projects which meet its criteria of social desirability.

Governments need not regard market prices as reflecting true social valuations, since they are subject to given national and international income distributions and market imperfections and distortions, and disregard external economies and diseconomies. Governments can introduce non-economic and non-commercial factors, such as political issues, into their evaluations. However, they must implicitly or explicitly attach some quantitative evaluation to both the resources required and the revenues generated. Similarly, the non-pecuniary attributes must also be taken into account. Such quantitative evaluations are referred to as social weights.

Numerous examples can be provided to show how social weights can diverge from market prices, or be used to bring into the evaluation exercise factors that would otherwise have been neglected. Those which follow are chosen to illustrate different situations. With respect to input costs, a Government may, for example, consider that at current market wages the sum of activities that entrepreneurs would consider commercially viable would be unlikely to generate sufficient job opportunities to achieve government employment targets. Here the Government would have preferred the entrepreneurs to have engaged that number of workers which they would have employed if wage rates had been at some lower level. The ratio of the lower level to the actual level indicates the social weight which the Government places on employment. The lower level itself is referred to as a shadow price, that which the Government attaches to labour. With regard to revenue, or benefit, the Government may wish to follow a development path requiring more foreign exchange than would be generated by activities established by entrepreneurs on the basis of commercial viability calculations. In that case the Government, assuming that it does not wish to adjust its planned development path, will attach a higher shadow price to foreign exchange than the price which entrepreneurs can obtain in the market, the higher price reflecting the higher social weighting which the Government places on activities generating net inflows of foreign exchange, rather than activities generating purely domestic currency flows.

Three examples of non-economic factors which entrepreneurs can be reasonably assumed not to take into account in their evaluations of commercial viability are environmental pollution, regional dispersion of industry, and defence. A Government may, however, wish to ensure that such factors are taken into account and accord them social weights in their social evaluation exercises. Thus it might prefer activities which generate no environmental pollution over those which do, activities which will be established in rural or isolated communities rather than those which would establish themselves, on the basis of prevailing market prices, in the metropolis, and activities which produce defence equipment rather than those which do not.

The nature and extent of the divergences between actual, or estimated, market prices and shadow prices, or market-determined resource allocations and socially weighted allocations, will depend on the nature of government objectives. Clearly there is no unique set of shadow prices or social weights but a very large range of possible sets of such prices or weights. The relevant set of social weights for any Government will vary as the nature of the objectives varies between different Governments or for the same Government over time, as the constraints within which the Government is seeking to attain its objectives vary, and according to how successful the Government was in moving towards its objectives in the previous period.

A full discussion of the process of formulating and implementing a set of social weights and associated shadow prices, and especially of the serious complications which occur in the presence of multi-dimensional objectives, which involve many intricate trade-off calculations, or coalition Governments, interest group lobbying tactics etc., would go beyond the scope of this study. Here it is sufficient to point out that if a Government is to take any position at all other than acceptance of *laissez-faire*, it must, consciously or unconsciously, go through such a process and establish and apply, however ephemerally, a system of social weights and associated shadow prices. For present purposes we must assume that the Government has gone through such a process and has derived, in the context of its knowledge of market conditions and technological possibilities, a system of social weights and associated shadow prices. We must further assume that the Government arrives at the conclusion that some of the possible activities would be socially desirable. On the basis of an evaluation report by civil servants it will be able to assess the reasons why the activity has not in fact been established. In other words, the Government will find its aspirations to be in conflict with the resource allocation determined by the imperfect and distorted market.

When a Government finds itself in conflict with the market, in the sense described above, it must decide whether or not to intervene in order to move the system closer to the attainment of its objectives. It can do that by introducing policy instruments designed to remove or compensate for the effects of imperfections and existing policy distortions. The purpose of government intervention is to make potential but currently non-existent activities commercially viable to private entrepreneurs or to remove the criterion of commercial viability as the determinant of whether or not an activity is established. The desired outcome would be an investment pattern in natural resource processing activities that is considered to maximize some social benefit-cost ratio. Thus, the Government is intervening to establish dominance in inputs for processing activities, or to remove the commercial significance of a lack of dominance, for locations in its territory.

Limitations to intervention

The fact that a Government is able to intervene in order to stimulate the establishment of resource processing activities which pass its social evaluation tests does not imply that it will be able to guarantee the outcome. Even if establishment succeeds, it may not be economically or commercially viable, or the capacity of the Government to provide adequate stimuli may be limited to physical, financial, political and international constraints on its freedom of action. Hence the Government may prove powerless to bring about the successful establishment of a project highly valued in social cost-benefit terms. The limitations that constrain the ability of the Government to intervene successfully are discussed briefly below.

Governments are subject to the same information gaps, and possibly other gaps covering commercial secrets, as civil servants and entrepreneurs. Uncertainties concerning the likelihood of success, that is, economic or commercial viability, will probably not be removed. All the Government can do is increase the rate of return obtainable by entrepreneurs in order to induce them to overcome their risk averseness and invest in the activity. But given the uncertainties, some activities established in this way may fail because data estimates proved incorrect. For example, supplies of inputs may not be forthcoming at the estimated levels or prices; market potential studies may prove to have been over-ambitious; available technology may turn out to be more expensive to operate locally than was anticipated; or lower-cost supplies of the processed output may appear from some unexpected location.

Government support for one region, economic sector or even individual firm, implies that other regions, sectors or firms are discriminated against. The existence of such support necessarily creates actual or potential opponents among those discriminated against. The opposition may be direct or indirect. Where the incidence of the cost of intervention is shifted to other groups in the economy it will be indirect. Earmarked taxes are an obvious example. Others include multiple exchange rates, import controls, or discriminatory tariffs for public utilities. If a Government feels it necessary, for political reasons, to accommodate the interests of such opposition groups, then its ability to intervene in support of natural resource processing activities will be constrained.

Governments formulate intervention policies within the context of policy frameworks established by other countries, both individually and collectively. Hence a Government's freedom to formulate policy independently is constrained, and its choice of policy instruments, and perhaps the success of its interventionist policies, limited. The General Agreement on Tariffs and Trade (GATT) and other agreements such as the International Copper Agreement, the International Tin Agreement and the Arrangement regarding International Trade in Textiles, more or less effectively prohibit the use of certain types of interventionist policy instruments. Any GATT contracting party that uses direct export subsidies or instruments which might appear to encourage dumping, as defined by GATT, is liable to find its policies negated by the retaliatory measures that other GATT contracting parties can impose under the agreement in such situations. Similarly, new exports of a processed natural resource to certain countries may be prevented by policy measures prohibiting such imports through quotas or similar devices, or raising the prices of those products through tariffs, which tend to escalate with the degree of processing. While each sovereign Government is in theory free to adopt any interventionist policy measure it wishes, in practice the effectiveness of some measures will be reduced by the existence of policy frameworks established by other Governments, collectively or individually.

Government efforts may be further limited if other countries are developing, with or without government interventionist measures, activities which will compete with the activity in the location under consideration for either inputs or markets. If such unforeseen competition is effective, interventionist measures introduced by the Government in that location will be nullified. If the estimated economic and commercial viabilities are changed to the extent that the cost of interventionist measures required to induce the establishment of that activity is increased to the point where it is no longer acceptable to the Government, the ranking of the benefit-cost ratio of the activity will have fallen below that of other activities which the funds could have been used to support.

Policy measures

On the basis of actual market prices, entrepreneurs will establish natural resource processing industries in locations which allow them to maximize the ratio of return, after due allowance for economic and political risk factors, from the investment. Within the wide spectrum of factors that determine rates of return, input prices (inclusive of taxes, tariffs etc.) and the output price are obviously important. Inputs include marketing and transport of inputs or output. Prices in different locations will be determined by: their input endowment; their geographical location with respect to foreign supplies of inputs and to potential markets; market imperfections; and policy distortions, including those affecting exchange rates. But a ranking of alternative locations according to gross margins cannot provide full information as to relative profitability, because effective rates of return will also depend upon the policies of each location towards profits and towards foreign investors or monopolists. In addition, allowance may have to be made for likely future variations in prices or policies.

Within the limits of input endowments and geographical position, policy measures will play a major role in determining the relative attractiveness of different locations to potential investors, whether domestic or foreign. Governments are constrained by physical, political and international factors, but they can still influence effective market prices of inputs and outputs, and also the extent to which revenues generated by investment can be realized by entrepreneurs in the desired form. Thus the logical step, for a Government to which social evaluation exercises indicate a potential for processing, is to investigate policy measures that might lead to the establishment of processing activities. Identification of problems which have hitherto prevented establishment will help in the formulation of the necessary policy measures. Problems identified in preceding sections of this study indicate relevant areas of policy for consideration. Full discussion of the wide range of policy options open to Governments, and rigorous analysis of criteria for selection from among those options, would go beyond the scope of this study.[66] The following section will therefore be limited to a listing of illustrative examples of options available and to an outline of general criteria for the selection of policy options.

Various policy options

Information centres can be established, geared to the collection and dissemination of data on market and technological developments. Advertising

[66] For such a discussion and analysis see Cody, Hughes and Wall, eds., *op. cit.*

campaigns mounted abroad can inform foreign entrepreneurs of investment opportunities. Joint government and business committees can be established to exchange views on possible investment areas and to ensure that domestic businessmen are aware of what support the Government will give to the establishment of processing activities.

The Government can introduce duty drawback schemes and subsidies to reduce prices of domestic resource inputs; foreign aid can be sought to reduce capital costs; labour subsidies can be provided, or training costs met from government funds; public utility prices can be subsidized for selected activities; discriminatory infrastructure development policies can be encouraged; national shipping or air lines can be set up; and agricultural price support schemes can be varied or replaced by farm income support schemes.

The Government can raise domestic currency realizations, for example by applying multiple exchange rates, by devaluation, by paying subsidies on exports, or by tying incentive schemes to export performance through measures such as the granting of privileged access to scarce import licences.

Policy measures to increase net profits to enterprises include various forms of tax relief such as tax holidays, exemptions from specific taxes, generous and accelerated depreciation and expense allowances, deduction schemes for marketing costs, and subsidy schemes related to net foreign exchange earnings.

Restrictions on establishment can be removed completely, or selectively, for example by allowing otherwise prohibited or restricted entrepreneurs to establish export-oriented natural resource processing activities in specific product lines or according to specific criteria such as export performance, local ownership participation, or restriction to particular geographical areas, such as export processing zones.

In order to improve access to foreign markets, Governments can negotiate bilateral agreements, participate in multilateral negotiations aimed at liberalizing world trade arrangements in specific or general product areas, seek to join group marketing arrangements, establish state trading organizations or join product cartels in order to improve bargaining strength, or establish distribution facilities abroad.

The Government can negotiate co-operative market sharing arrangements with rival suppliers, thereby limiting foreign competition. It may also create government-owned enterprises, removing commercial viability as a necessary condition for establishment.

The problems preventing establishment will vary and the nature of the package of policy measures designed to induce their establishment will therefore also vary from case to case. Governments have to decide whether to design their policy packages on a made-to-measure, that is case-by-case, basis, or on a uniform basis, that is by providing the same degree of inducement to all potential activities. Firm- or sector-specific packages of incentives are costly to design and administer, and also provide openings for corruption. The issue will turn on whether the Government wishes to ensure that a specific set of processing activities is established. If so, it will adopt a made-to-measure approach, thus making it possible to relate the incentives to the specific reasons for the non-existence of those activities. If, however, it wishes to achieve a given level of aggregate processing activity regardless of product composition, the Government may favour the administratively less costly and less corruption-prone uniform approach: a given level of incentives may be provided to all activities until the desired level of processing activity is established.

Not all theoretically appropriate packages, whether made-to-measure or uniform, will be practically possible. They may include measures which are mutually inconsistent, or they may be ruled out by the constraints referred to above. While inconsistencies must be dealt with directly by reformulating policy packages, Governments have the capacity to reduce the effects of, or to remove, many constraints by negotiation at the domestic, regional and global levels.

Annex

Countries covered in the study and extent of industrial processing in the trade of various countries in 1975

COUNTRIES COVERED IN THE STUDY

Developed market economies

Australia	Israel
Austria	Italy
Belgium	Japan
Canada	Netherlands
Denmark	New Zealand
Finland	Norway
France	Portugal
Germany, Federal Republic of	Spain
Greece	Sweden
Iceland	Switzerland
Ireland	United Kingdom
	United States

Developing countries and areas

Argentina	Mexico
Barbados	Nicaragua
Bolivia	Pakistan
Brazil	Peru
Ecuador	Philippines
Egypt	Republic of Korea
Fiji	Samoa
Guadeloupe	Saudi Arabia
Guatemala	Singapore
Honduras	Sri Lanka
Hong Kong	Sudan
Iran	Thailand
Libyan Arab Jamahiriya	Trinidad
Malawi	Tunisia
Malyasia	Turkey
Mauritania	Venezuela

EXTENT OF INDUSTRIAL PROCESSING IN THE TRADE OF DEVELOPING COUNTRIES AND DEVELOPED MARKET ECONOMIES IN 1975

(Percentage)

	Imports				Exports			
Economic grouping	*A*	*B*	*C*	*D*	*A*	*B*	*C*	*D*
Developing countries and areas								
Afghanistan	2.05	17.31	9.44	71.20	38.13	13.26	38.88	9.73
Argentina	9.06	35.70	7.49	47.75	44.32	13.97	12.67	29.05
Barbados	3.23	13.71	6.63	76.43	1.15	61.70	2.13	35.02
Bermuda	2.35	3.51	8.74	85.40	–	–	–	100.00
Brazil	6.74	20.00	3.95	69.31	39.38	29.51	3.33	27.77
Burma	–	–	–	–	26.27	18.43	6.94	48.36
Central African Republic	3.24	14.87	0.93	80.96	86.02	12.92	0.02	1.04
Colombia	7.38	21.63	0.88	70.10	55.83	14.37	6.84	22.96
Costa Rica	6.01	14.55	1.23	78.21	23.27	13.90	36.80	26.03
Congo	2.53	8.85	4.36	84.26	48.14	3.57	1.46	46.84
Egypt	21.36	26.19	4.66	47.79	41.18	23.48	7.10	28.25
El Salvador	5.56	16.67	2.12	75.65	48.74	22.62	2.96	25.57
Ethiopia	5.07	12.79	0.96	81.19	70.62	3.96	17.57	7.85
French Guiana	0.83	6.92	9.99	82.26	9.77	12.83	52.03	25.38
Gabon	2.73	8.14	1.78	87.34	93.73	0.19	–	6.08
Gambia	4.01	19.96	1.89	74.14	57.21	40.58	2.05	0.17
Ghana	7.33	20.55	2.87	69.26	77.30	18.19	0.14	4.37
Guatemala	5.57	17.90	1.89	74.64	43.98	24.24	7.54	24.25
Guadeloupe	4.71	6.88	7.50	80.91	1.49	44.36	39.12	15.03
Haiti	16.31	13.59	1.43	68.68	41.23	22.46	1.89	34.43
Hong Kong	16.16	20.76	7.14	55.94	1.47	8.27	0.81	89.45
Honduras	7.28	13.42	0.43	78.87	35.05	18.93	32.15	13.86
India	34.71	9.69	1.12	54.48	20.51	24.56	15.46	39.46
Indonesia	4.30	11.12	2.05	82.53	54.94	14.64	7.85	22.56
Iran	5.38	12.60	2.44	79.57	14.01	4.32	11.46	70.21
Iraq	4.77	20.20	3.09	71.94	14.36	20.87	20.67	40.10
Ivory Coast	3.09	11.81	4.92	80.17	61.05	15.41	3.25	20.28

Jordan	6.10	12.85
Kenya	3.82	13.90
Kuwait	3.02	6.14
Liberia	2.60	8.63
Madagascar	1.73	16.83
Malaysia	10.22	13.39
Malawi	5.10	12.12
Mali	7.85	12.25
Martinique	1.97	10.76
Mexico	14.52	13.37
Morocco	16.25	26.05
Nicaragua	4.34	15.55
Niger	17.95	9.96
Pakistan	20.26	15.56
Panama	3.41	12.65
Paraguay	–	–
Philippines	8.02	18.49
Republic of Korea	28.51	23.52
Reunion	6.60	8.19
Senegal	5.35	12.41
Singapore	9.47	12.17
Somalia	13.02	14.33
Sri Lanka	5.86	31.21
Sudan	3.52	16.10
Syrian Arab Republic	5.63	18.64
Thailand	8.15	16.07
Togo	3.52	15.18
Turkey	7.02	23.60
Uganda	2.35	12.62
United Republic of Cameroon	3.66	17.13
United Republic of Tanzania	11.45	14.18
Upper Volta	5.66	12.80
Uruguay	11.26	28.08
Venezuela	6.68	16.05
Zaire	6.26	14.67
Zambia	3.40	15.28

6.73	74.33	50.23	4.46	23.92	21.39
0.45	81.82	38.69	3.35	19.88	38.08
5.33	85.51	0.55	14.86	10.36	74.22
1.00	87.76	96.19	1.32	0.57	1.91
0.33	81.11	33.10	3.78	42.63	20.49
2.86	73.54	34.03	40.82	3.67	21.49
0.97	81.81	60.59	14.29	21.49	3.63
0.78	79.12	71.09	6.29	14.02	8.60
7.86	79.41	0.45	1.97	50.33	47.25
3.57	68.54	27.24	22.98	16.11	33.67
2.66	55.04	61.97	4.04	14.39	19.59
1.20	78.91	46.57	26.67	13.80	12.96
0.75	71.33	79.93	8.49	4.54	7.03
4.66	59.52	20.89	29.32	3.11	46.67
1.60	82.34	3.67	34.72	51.10	10.51
–	–	37.06	29.97	6.72	26.25
0.58	72.91	28.59	45.36	5.41	20.64
1.02	46.95	3.48	14.60	7.44	74.47
8.04	77.17	0.38	88.23	1.12	10.37
3.68	78.55	23.46	29.51	4.02	43.01
3.32	75.03	14.23	8.95	3.13	73.70
1.29	71.37	75.06	0.02	16.14	9.78
1.32	61.61	26.10	7.12	56.72	10.06
1.56	78.82	89.37	5.87	0.75	4.01
3.09	72.64	59.39	9.09	4.36	27.16
0.28	75.50	40.72	25.59	5.86	27.83
2.45	78.85	92.63	5.07	0.09	2.22
0.57	68.81	42.92	16.63	18.93	21.51
0.10	84.94	89.53	4.17	6.27	0.03
0.73	78.48	64.78	18.17	3.13	13.92
0.23	74.14	57.70	3.41	27.54	11.35
2.40	79.14	83.32	6.94	4.81	4.94
5.70	54.96	31.17	21.72	24.09	23.03
1.05	76.22	11.31	2.55	6.46	79.68
4.40	74.68	28.37	68.80	0.43	2.41
0.71	80.62	3.17	96.20	0.01	0.62

EXTENT OF INDUSTRIAL PROCESSING IN THE TRADE OF DEVELOPING COUNTRIES AND DEVELOPED MARKET ECONOMIES IN 1975 *(continued)*

	Imports				Exports			
Economic grouping	*A*	*B*	*C*	*D*	*A*	*B*	*C*	*D*
Developed market economies								
Australia	3.99	14.86	1.26	79.89	44.80	19.75	17.09	18.36
Austria	6.98	17.45	6.16	69.40	2.80	17.42	0.61	79.17
Belgium	15.34	17.57	5.36	61.74	7.61	19.43	2.80	70.15
Canada	5.00	10.94	4.66	79.40	20.30	19.14	8.50	52.06
Cyprus	10.13	17.37	5.24	67.26	16.89	0.87	29.90	52.34
Denmark	6.04	16.45	3.50	74.01	7.02	7.96	11.11	73.91
Finland	8.79	15.57	5.28	70.36	2.74	21.09	0.33	75.84
France	9.37	19.69	9.57	61.37	7.48	14.45	2.80	75.27
Germany, Federal Republic of	12.59	18.68	6.68	60.06	2.11	14.65	1.88	81.35
Greece	10.49	17.58	3.46	68.47	16.94	23.26	9.41	50.39
Iceland	3.12	17.64	1.51	77.73	2.62	24.50	67.52	5.36
Ireland	7.45	17.30	3.47	71.79	13.27	10.24	17.79	58.70
Israel	27.48	13.32	2.33	56.87	37.12	10.43	12.30	40.15
Italy	20.19	20.45	10.45	48.90	1.17	13.69	3.73	81.42
Japan	38.47	18.03	18.11	25.39	0.39	14.82	0.32	84.47
Malta	10.69	23.66	4.56	61.09	1.49	8.98	1.58	87.95
Netherlands	13.85	16.91	3.37	65.87	6.71	19.78	13.24	60.26
New Zealand	6.28	18.54	1.51	73.67	25.03	11.10	30.80	33.07
Norway	8.58	11.78	2.01	77.63	4.31	27.82	5.21	62.66
Portugal	20.49	19.11	6.66	53.73	6.84	22.95	1.19	69.03
Spain	23.12	20.49	6.48	49.91	3.27	10.64	11.03	75.06
Sweden	5.64	14.46	3.28	76.61	5.62	17.77	0.47	76.14
Switzerland	8.07	17.27	4.25	70.41	2.97	15.07	0.18	81.78
United Kingdom	15.13	20.60	5.53	58.74	6.83	13.22	1.65	78.29
United States	8.81	12.21	5.40	73.58	19.00	11.99	4.82	64.19

Source: UNIDO, based on data supplied by the United Nations Statistical Office.

Note: A = non processed goods expected to be processed; B = processed goods expected to be processed; C = non-processed goods exported for final use; D = processed goods exported for final use.

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Printed in Austria
80-46629–April 1981–4,350

Price: $US 5.00

United Nations publication
Sales No. E.81.II.B.1

ID/261